IG-97-013

AUDIT REPORT

21-INCH HYPERSONIC TUNNEL AT PLUM BROOK STATION

LEWIS RESEARCH CENTER

January 14, 1997

National Aeronautics and Space Administration

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Reply to Attn of: W

January 14, 1997

TO: 0100/Director

FROM: W/Assistant Inspector General for Auditing

SUBJECT: Final Report
Review of 21-Inch Hypersonic Tunnel at Plum Brook Station
Assignment No. A-LE-95-006
Report No. IG-97-013

The NASA Office of Inspector General has completed a survey of the 21-Inch Hypersonic Tunnel stored at Plum Brook Station. Overall, we determined that Lewis Research Center (LeRC) did not have firm future requirements justifying the continued storage of the tunnel. Although there was no programmatic need for the tunnel as a whole, we determined that the individual tunnel components have significant value and could possibly benefit other users. Consequently, we recommended that LeRC identify customers that could use the tunnel components and dispose of the tunnel in the most economical manner.

We issued a discussion draft report on October 4, 1996. On October 31, 1996, we held preliminary discussions with the LeRC Director and other Center representatives regarding the report. After thorough review, LeRC waived its right to a formal exit conference and provided a brief written response on December 20, 1996. The response is shown in Appendix 1 of the report.

LeRC management concurred with the recommendations. However, since LeRC's response did not include a proposed course of action, we request to be included in the concurrence cycle for closure of the recommendations. If you have any questions or need additional information, please contact Chester Sipsock, Director, Environmental Programs, at 216-433-5412; Robert Wesolowski, Director, Audit Division-A, or me at 202-358-1232.

Debra A. Guentzel

Debra A. Guentzel

Enclosure
cc:
JX/Mr. W. Stamper
LaRC/102/Mr. R. Harris
LeRC/0100/Mr. B. Fails
LeRC/0110/Mr. J. Schaefer
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21-INCH HYPERSONIC TUNNEL AT PLUM BROOK STATION

LEWIS RESEARCH CENTER, CLEVELAND, OHIO

INTRODUCTION

The NASA Office of Inspector General (OIG) has completed a survey evaluating the Lewis Research Center's (LeRC) justification for retaining the 21-Inch Hypersonic Wind Tunnel (HWT), currently stored at the NASA Plum Brook Station, Sandusky, Ohio.

The HWT is a continuous flow, variable density wind tunnel that demonstrates excellent flow quality over Mach Numbers 4 to 11. The tunnel provides ideal flow capability for supporting computational fluid dynamics validation and small scale system experiments. The major components of the wind tunnel system are the hypersonic nozzle, the test section, and the adjustable diffuser. Exhibit 1, on page 3, shows the tunnel layout.

Inaugurated in 1959, the HWT was originally located at the Jet Propulsion Laboratory in Pasadena, California, where it was operational through 1975. The tunnel, idle from 1976 to 1987, was scheduled for demolition because it was no longer needed to fulfill the Jet Propulsion Laboratory's mission and the space was needed to build a parking lot. However, developing needs for hypersonic flow testing relevant to the now defunct National Aero-Space Plane Project, and related follow-on activity, stimulated an interest in reactivating the facility at LeRC in Cleveland, Ohio. Officials from the Jet Propulsion Laboratory, Langley Research Center (LaRC), NASA Headquarters, LeRC, and the National Aero-Space Plane Project Office formed a panel to address the tunnel's future. Based on the input of the panel and LeRC's keen interest in saving the HWT, NASA dismantled the tunnel during the summer of 1988 and shipped it to its present location.

In their present status, the tunnel's components are recorded in the NASA Equipment Management System as inactive equipment being

held for a firm future requirement. This type of classification requires the equipment to be identified for use on a specific project or program by a specific date, known as the retention date. Primary responsibility for recertifying the retention date on an annual basis lies with the director of the organization responsible for the equipment. In the case of this tunnel, the responsibility presently rests with the Facility Group Director for Propulsion Facilities, Office of the LeRC Director.

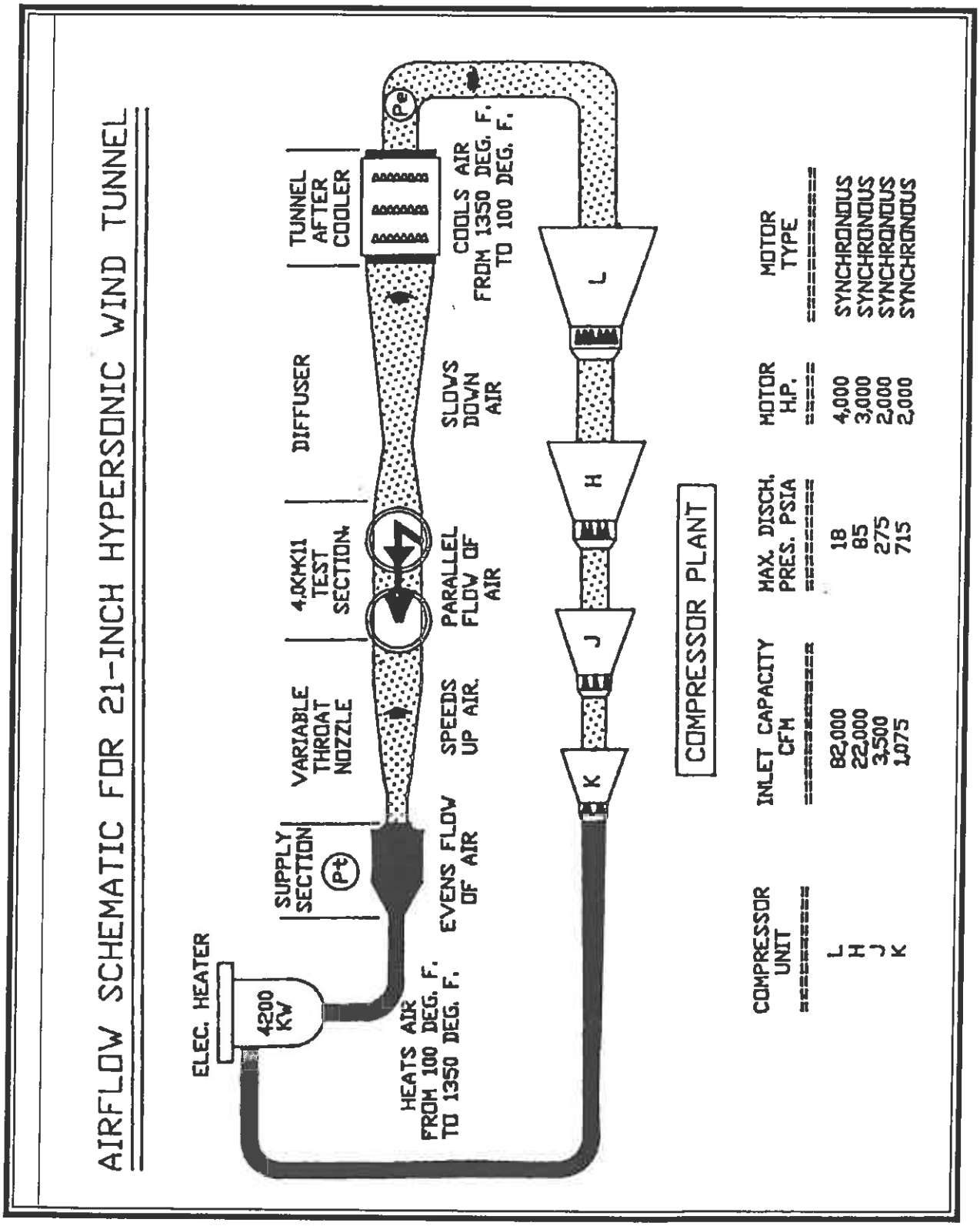

Exhibit 1: *Tunnel Layout*

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OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVES

The objective of our survey was to determine whether LeRC had adequately justified retaining the 21-Inch HWT. Specifically, we wanted to determine if the tunnel's inactive status had been evaluated in order to identify and document future uses and/or users.

SCOPE AND METHODOLOGY

We reviewed the appropriate NASA guidelines to determine the processes governing the retention and disposal of inactive equipment. We also discussed the storage procedures with various government and contractor personnel to determine what controls were in place for reviewing and disposing of inactive equipment. This involved a review of the storage file relating to the tunnel components in order to determine the degree of procedural compliance.

We reviewed LeRC proposals for using the tunnel in order to determine what alternatives have been considered. This involved various external and internal reactivation proposals which included cost, site, and capability variables. We visited proposed reactivation sites to better understand the options available to LeRC. We also distributed a list of tunnel components to various NASA and Department of Defense facilities that do wind tunnel testing to determine the extent to which components may be used.

In addition, we discussed NASA wind tunnel capabilities and program needs with LeRC, LaRC, and Plum Brook Station management and engineers in order to determine the distinction between the HWT's capabilities and those of other NASA wind tunnels. In some cases, this involved touring the facilities with NASA personnel. We also reviewed documents and reports related to significant topics such as the NASA Reinvention Process, the Federal Laboratory Review, the National Facilities Study, and the NASA Zero Based Review to determine whether the HWT was addressed in any or all of the reviews.

MANAGEMENT CONTROLS REVIEWED

Management controls identified and tested to the extent necessary to meet survey objectives included whether:

- the tunnel and its components were stored in a controlled environment and access to the storage building was physically controlled; and

- tunnel transactions have been promptly recorded and properly classified in order to remain relevant and valuable to management in controlling operations and making decisions.

The tunnel and its components were stored in a controlled environment and access to the storage building was adequate to prevent unauthorized access or use of the tunnel components. However, we did identify weaknesses in the process of justifying the tunnel's continued storage, which is discussed in the Observations and Recommendations section of this report.

SURVEY FIELD WORK

Field work was conducted from June 1995 through October 1995 at LeRC, NASA Plum Brook Station, and LaRC. Work was suspended in favor of higher priority work and resumed in March 1996. The survey was performed in accordance with generally accepted government auditing standards.

OBSERVATIONS AND RECOMMENDATIONS

OVERALL EVALUATION

LeRC does not have firm requirements justifying the continued storage of the 21-Inch HWT. Although the tunnel was once earmarked for a specific LeRC project, the tunnel has remained stored since 1991 with no future program requirements. NASA guidelines require the identification of a specific program or project for which the equipment is held and an indication of the date the equipment is to be reactivated. In the event such planned use does not materialize, the equipment should be put through excessing procedures. However, the processes in place did not provide adequate controls to ensure that retention of inactive equipment was justified. Therefore, LeRC was able to retain the tunnel since 1991 on the premise that future needs could arise and storage costs were minimal. As a result, tunnel components that could be made available for other uses, or disposed of, have continued to sit idle and accrue storage costs. By making the tunnel components available to other users, LeRC could potentially save the agency in excess of $1.6 million and avoid another $3.2 million in reactivation, operation, and storage costs.

LERC HAS NOT JUSTIFIED CONTINUED TUNNEL STORAGE

LeRC has not identified any current or future program needs that justify retaining the 21-Inch HWT. After considerable debate and analysis, the tunnel was dismantled at the Jet Propulsion Laboratory and shipped to LeRC in 1988 in hopes of being resurrected through a 1991 Construction of Facilities Project. A review of the property custodian's file pertaining to the 21-Inch HWT revealed that LeRC had justified storing the tunnel until approximately September 1991 for a firm future requirement related to a proposed Construction of Facilities Project supporting work relevant to the now defunct National Aerospace Plane. With that project being terminated and related follow on hypersonic research also rejected by NASA Headquarters, the tunnel has remained stored at Plum Brook Station. Since September 1991, LeRC has not made the annual justifications tied to a firm future program need that is required for the center to continue storing the tunnel.

FIRM FUTURE REQUIREMENTS DO NOT EXIST

In order to determine the need for continued storage, we discussed the issue with management officials at LaRC, the NASA lead center for hypersonic research; NASA Headquarters; and LeRC. Our discussions revealed that firm program requirements calling for the capabilities of the tunnel do not exist.

LaRC's Director, Hypersonic Vehicles Office, believes program needs for a tunnel with the HWT's capabilities may not exist for another 10 years. This official also stated that, if a need were to arise, existing NASA wind tunnels would be adequate to support hypersonic research. The official's statement reiterated the sentiment of the LaRC Center Director in a 1987 letter to NASA Headquarters which stated, in part:

> "the hypersonic aerodynamic/aerothermodynamic capabilities provided by various LaRC wind tunnels duplicate, and in most cases exceed those provided by the HWT; that is, the HWT would not provide the agency with a significant increase in capability in terms of flow conditions, flow quality, or test core size."

Recently, the LaRC Director, Hypersonics Vehicle Office, also advised that hypersonic funding at NASA and throughout the country has dropped precipitously over the past few years. The Head of LaRC's Aerothermodynamics Branch further supported the decline in hypersonic research by pointing out that several hypersonic wind tunnel facilities were recently closed.

Although LeRC management has investigated several hypersonic research initiatives, there remains no firm requirement for continued retention of the tunnel. LeRC management agrees program plans and funding scenarios are uncertain and could not provide a clear program or project to support reactivation of the tunnel.

While firm program requirements do not exist, various LeRC, LaRC, and NASA Headquarters hypersonic managers would like to retain the tunnel because (1) potential future program needs could materialize and (2) storage costs of about $11,000 annually are minimal. Acknowledging that a near term need did not exist, LaRC's Director, Hypersonic Vehicles Office, endorsed retaining the tunnel as a backup in case of failure of an existing LaRC facility. In addition, the NASA Headquarters Assistant Director, High Performance Aircraft Division, Program Evaluation Office, and LeRC's Hypersonic Program Manager support retention due to the tunnel's hardware value, the possibility of future program needs arising, and low storage costs.

Whereas certain management officials clearly would like to retain the 21-Inch HWT, NASA Headquarters has specifically directed NASA centers to review and eliminate redundant facilities. The purpose of NASA's recently completed Reinvention Process was to reduce overlap and significantly cut costs without affecting world-class space and aeronautics programs. The first of six principles governing the reinvention process was to eliminate parallel capabilities among NASA centers.

Included in the reinvention process were reviews such as the NASA Federal Laboratory Review performed by a task force under the auspices of the NASA Advisory Council. Completed in February 1995, the report recommended NASA reduce redundant capabilities and enter into joint discussions with DoD regarding the best use of facilities. Also, a National Facilities Study completed April 1994 by an interagency study team echoed the message contained in the Federal Laboratory Review. These reviews were considered in conjunction with NASA's own Zero Based Review Process (completed May 1995) which involved internal reviews performed at each center that also considered consolidation or closure of low usage/idle facilities. Senior management from LeRC's Aeropropulsion Facilities and Experiments Division stated that the 21-Inch HWT was not included in any of the above studies because the tunnel was categorized as idle equipment rather than an idle wind tunnel facility.

NASA Guidelines Require Periodic Review Of Inactive Equipment

NASA guidelines require the issue of inactive equipment to be addressed in a timely manner. The NASA Equipment Management Manual, NASA Handbook (NHB) 4200.1D, section 1.210 states that each installation will maintain an effective program for timely disposal of equipment no longer required by NASA. Part of the program should involve periodic reviews, no less than annually, to determine whether inactive equipment should be retained or turned in for alternate use or excess. Section 1.306 provides that the division director is the principal equipment using official in the NASA Equipment Management Program responsible for the equipment assigned to the organization, including all aspects of its use and condition and the accomplishment of walk-through inspections. The manual further states, in section 2.204, that items retained in an inactive status are to be documented to identify the specific program or project for which the equipment is held and will indicate the date when reactivation of the equipment is planned. In the event such planned use does not materialize, a change to the status code is required.

LeRC continued to store the inactive tunnel because equipment retention procedures did not adequately address the intent of the NHB 4200.1D. A review of the property custodian's file revealed little or no documentation of continued review and recertification of the tunnel's status. The only certification on record was one made on April 25, 1989, by the Director of LeRC's Facilities Engineering Division. The certification indicated that the components were needed for a future program and the estimated use date given was September 1, 1991. According to the property custodian, a listing of inactive equipment assigned to an individual (equipment user) was sent each quarter to verify if the equipment should continue to be stored or turned in for use elsewhere or excess. If the property custodian did not receive a response to the storage request, continued storage was deemed acceptable. Simply stated, the process relied on informal communications, often verbal in nature.

The property custodian did not request an annual certification addressing future program needs and potential use dates for the tunnel. According to the Hold Storage Coordinator, who oversees the property custodian, this occurred because there was no standard practice or information system capability that allowed for timely identification of inactive properties with elapsed retention dates. In order to identify any of this property, the property custodian would have to come across it during a review of the file. With the volume of files in Hold Storage, randomly identifying items in Hold Storage with expired retention dates was systematically restricted.

The Hold Storage Coordinator has acknowledged that the processes used in the past were not sufficient to meet NASA requirements. In fact, the LeRC Logistics and Technical Information Division restructured the Hold Storage Program in October 1995, and formalized the new processes in August 1996 with the issuance of a Standard Operating Procedure. The new process requires the recertification of justification for continued retention of all items being held in Authorized Hold Storage. The intent of the process is to require all holders of property in Hold Storage to thoroughly provide information justifying the storage of all property. Without the submission of current and valid information, the item will be turned over to property disposal for disposition after cognizant management approval. The restructured program will also incorporate a means of identifying inactive equipment held past its retention date. Therefore, the property custodian will be able to identify and request recertification in a more effective manner.

TUNNEL COMPONENTS MAY HAVE OTHER USES

Although LeRC is now taking measures to insure that inactive equipment has been properly justified for retention, the tunnel has accumulated storage costs of approximately $77,000 since 1989. In addition, tunnel components which could be used by LeRC, other agencies, organizations, universities, or countries have not been utilized.

To determine the extent of possible use outside of LeRC, we distributed a list of 27 tunnel components recorded in the NASA Equipment and Management System. This listing was provided to Ames Research Center; LaRC; Wright Patterson Air Force Base in Dayton, Ohio; and Arnold Engineering Development Center in Arnold, Tennessee. LaRC representatives indicated an interest in using a heat transfer shield and windows from the tunnel's test section. Ames officials showed potential interest in using some of the motors and requested additional information. After reviewing the additional technical information provided by the OIG, Ames management determined the Center could not use the motors.

Tunnel components may also have uses within LeRC. For example, according to the Engine Research Building Aeropropulsion Facilities Manager, a compressor from the tunnel could be used to upgrade/rehabilitate LeRC's central air systems which support center-wide test facilities. An April 1994 cost analysis revealed that the center could save significant dollars by using the tunnel's compressor as opposed to purchasing a new one. According to the Research Support Systems Manager, who performed the cost analysis, the savings would total approximately $1.6 million.

Currently, the Research Support Systems Manager stated that LeRC is in the process of coordinating the use of the compressor to upgrade LeRC's central air systems. In fact, LeRC is scheduled to receive fiscal year 1997 and 1998 money for this specific purpose.

By determining where tunnel components could be put to further use, LeRC would avoid significant reactivation costs necessary to get the tunnel into a functional mode. Reactivation costs would involve engineering, instrumentation, and installation efforts. These costs could vary significantly, depending on whether the tunnel would be part of a new facility or combined with an existing structure. LeRC management conducted internal studies in October 1994 to explore alternative site locations and costs for tunnel reactivation for future hypersonic propulsion testing relative to X-Plane initiatives. Options

pursued site-wise included both Plum Brook Station and test cell locations within LeRC's Engine Research Building (ERB). LeRC concluded that the least expensive alternative would be to install the tunnel in test cell W-2 located in the ERB. Through a combination of reactivation studies performed since 1989 and studies involving test cell W-2, the ERB Aeropropulsion Facilities Manager determined the W-2 option would cost roughly $2.2 million.

In addition to the one time reactivation costs, LeRC would also be subjected to recurring operating and storage costs. According to the ERB Aeropropulsion Facilities Manager, operating costs would be roughly $1 million annually. This estimate is based on past experiences with comparable capabilities located in the ERB. With storage costs estimated at $11,000 annually, LeRC has already spent approximately $77,000 to store this tunnel since it was brought over from the Jet Propulsion Laboratory.

In summary, LeRC would need a firm requirement and about $3.2 million to get the tunnel into a useable condition in order to justify keeping it. In our opinion, absent both of the above, any cost being incurred to store tunnel components is a waste of funds. We believe, given the existence of similar adequate capabilities at other NASA facilities, the future costs of reactivating, operating and storing the tunnel could be avoided.

CONCLUSION

The 21-Inch HWT has been inoperable since 1976. It was only through an oversight that the tunnel avoided excess proceedings. Whatever reasons NASA had for holding onto this tunnel in the past are no longer valid given the current mandate to cut costs of government. Rather than simply excessing the tunnel, the OIG determined that individual tunnel components have significant value and could possibly benefit other users. We believe NASA should assess alternative uses of the tunnel components as soon as possible to maximize the potential cost savings that could be available to the agency. By eliminating the tunnel, NASA would avoid significant, but unnecessary, costs for tunnel reactivation, operation, and storage.

RECOMMENDATION 1

The LeRC Facility Group Director, Propulsion Facilities, should identify customers that could use tunnel components. Priority consideration should be given to customers within NASA and to any external customers supporting NASA's ongoing or planned work in the field of hypersonic research and development. Consideration also

should be given to the Department of Defense as recommended in the NASA Federal Laboratory Review. Once customers are identified, the tunnel should be disposed of in the most economical manner.

Management's Response Concur.

RECOMMENDATION 2 If there are no potential uses for the tunnel components, we recommend the tunnel components be disposed of as was planned in 1987 before the tunnel was moved from the Jet Propulsion Laboratory to LeRC.

Management's Response Concur.

Evaluation of Management's Responses Management's comments are responsive to Recommendations 1 and 2. However, since LeRC management has not formally outlined its proposed actions accompanied by a timetable, the OIG would like to remain in the concurrence cycle for closure of the recommendations. In this way, the OIG will be in the best position to monitor LeRC's future actions relative to the disposition of the tunnel and to assess the cost benefits provided to the agency.

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Management's Response to Recommendations

National Aeronautics and
Space Administration
Lewis Research Center
Cleveland, OH 44135-3191

Reply to Attn of: 0200

TO: 0160/Director, Environmental Programs
Office of the Inspector General, LeRC

FROM: 0100/Director

SUBJECT: Review of the Discussion Draft (A-LE-95-006)

Thank you for the opportunity to review the discussion draft, A-LE-95-006, Review of the 21-inch Hypersonic Tunnel at Plum Brook Station. After thoroughly reviewing our programmatic needs, both present and future, we have decided to concur with both of the recommendations contained in the draft report.

Accordingly we wish to waive our right to an exit conference regarding this matter and move directly to the written comment stage. Should you have any questions regarding this matter, please feel free to contact me.

Donald J. Campbell

Note:

After reviewing the discussion draft report, LeRC decided to concur with the OIG recommendations. The above document, dated December 20 ,1996, serves as LeRC's formal written comments.

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