Environmental Assessment
Replacement of 20 Inch Mach 6 CF_4 Tunnel Heater System, Building 1275

NASA Langley Research Center

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Submitted to:

National Aeronautics and Space Administration
Langley Research Center
Mail Stop 429
Hampton, VA 23681-0001
Attention: Michelle Morris

Submitted by:

Science Applications International Corporation
Environmental and Health Sciences Group
1710 Goodridge Drive
McLean, VA 22102

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LIST OF ABBREVIATIONS AND ACRONYMS

ACBM	Asbestos Containing Building Material
ACOE	Army Corps of Engineers
AMRL	Applied Marine Research Laboratory
AQCR	Air Quality Control Region
ASME	American Society of Mechanical Engineers
BMPs	Best Management Practices
CAA	Clean Air Act
CDNL	C-Weighted Day-Night Noise Level
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF_4	Carbon Tetrafluoride
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CZMA	Coastal Zone Management Action of 1992
dB	Decibel
EA	Environmental Assessment
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
FR	Federal Register
FWPCA	Federal Water Pollution Control Act
HCRMP	Historic Cultural Resources Management Plan
hp	Horsepower
HRPDC	Hampton Roads Planning District Commission
HRSD	Hampton Roads Sanitation District
KNO_3	Potassium Nitrate
LAFB	Langley Air Force Base
LaRC	Langley Research Center
lbm/sec	Pounds Mass per Second
lbs/sec	Pounds per Second

LIST OF ABBREVIATIONS AND ACRONYMS (cont.)

MCL	Maximum Containment Level
MHZ	Megahertz
MSA	Hampton Roads Metropolitan Statistical Area
MW	Megawatts
NAAQS	National Ambient Air Quality Standards
$NaNO_3$	Sodium Nitrate
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHLs	National Historic Landmarks
NMI	NASA Management Instruction
NO_X	Nitrous Oxides
NO_2	Nitrous Dioxide
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
ODU	Old Dominion University
OEE	Office of Environmental Engineering
OSEMA	Office of Safety Environment and Mission Assurance
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl
ppm	Parts per Million
psi	Pounds per Square Inch
psig	Pounds per Square Inch Gauge
RCRA	Resource Conservation and Recovery Act
SO_X	Sulfur Oxide
TBT	Tributyltin
TSCA	Toxic Substances Control Act
ug/m^3	Micrograms per Cubic Meter
USFWS	United States Fish and Wildlife Service
VCRMP	Virginia Coastal Resources Management Program
VDEQ	Virginia Department of Environmental Quality
VHWMR	Virginia Hazardous Waste Management Regulations
VOC	Volatile Organic Compound
WQS	Water Quality Standards

SECTION 1.0. EXECUTIVE SUMMARY

This EA (Environmental Assessment) evaluates the proposed replacement of the 20 Inch Mach 6 CF_4 Tunnel heater system in Building 1275 at NASA LaRC (National Aeronautics and Space Administration Langley Research Center) in Hampton, VA. The CF_4 wind tunnel is heavily used by NASA as an aerothermodynamic research instrument for producing experimental results of real-gas effects on blunt to moderately blunt "re-entry type" aerospace vehicles and planetary probe models. The existing heater system has experienced performance problems in the past including three failures caused by corrosion. The CF_4 wind tunnel must meet required testing criteria to maintain a state-of-the-art hypersonic test facility for continuing experimentation.

Replacement heater system configurations considered by a NASA Study Team included: (1) electrical storage heater systems; (2) electrical continuous heater systems; (3) combustion fired continuous heater systems; (4) electrical storage/continuous heater systems; and (5) combustion fired storage/continuous heater systems. Each heater system was compared against several evaluation criteria, designed and agreed upon by members of the NASA Study Team. These evaluation criteria included 10 factors within three categories: (1) minimum technical requirements; (2) other technical requirements; and (3) cost factors. The combustion fired storage/continuous heater system received the greatest average technical score. Because meeting minimum technical requirements was the most important criterion for the research facility, replacement of the existing system with a combustion fired storage/continuous-type heater system will comprise the Proposed Action for this assessment.

This EA evaluates the potential impacts of the Proposed Action and the No Action Alternative relative to heater evaluation criteria (minimum technical requirements); environmental resources (physical and biological); waste management (nonhazardous, hazardous solid, and radioactive wastes); and socioeconomic resources (historic, archaeological, and cultural factors; coastal resources management; economic, population, and unemployment factors; traffic and parking; aesthetic resources; energy; and environmental justice). Impacts are characterized as either adverse, significant adverse, or no impact. Characteristics of each impact are located in Appendix A.

Neither the Proposed Action nor the No Action Alternative are expected to have any significant adverse impacts on any environmental resources, waste management, or socioeconomic resources. Furthermore, the Proposed Action is not expected to have any significant adverse impacts related to meeting heater evaluation criteria. The No Action Alternative, however, is expected to have a significant adverse impact relative to meeting heater evaluation criteria. Determination of the most adequate heater system configuration was based upon meeting minimum technical requirements of the evaluation criteria. For this reason, it is the conclusion of this EA that the Proposed Action also be considered the Preferred Alternative and a FONSI (Finding of No Significant Impact) be issued.

SECTION 2.0. PURPOSE AND NEED FOR THE PROPOSED ACTION

2.1. FACILITY BACKGROUND

The NASA LaRC is located in the City of Hampton, Virginia (Figure 2.1). Approximately 70 percent of the work performed at NASA LaRC requires the use of computer modeling, wind tunnels, and other facilities and techniques used to perform aeronautical research; the remaining effort entails support to the national space program. With 18 major research facilities and over 175 shops and administrative/support resources, NASA LaRC is one of NASA's largest research centers (Foster Wheeler, 1996).

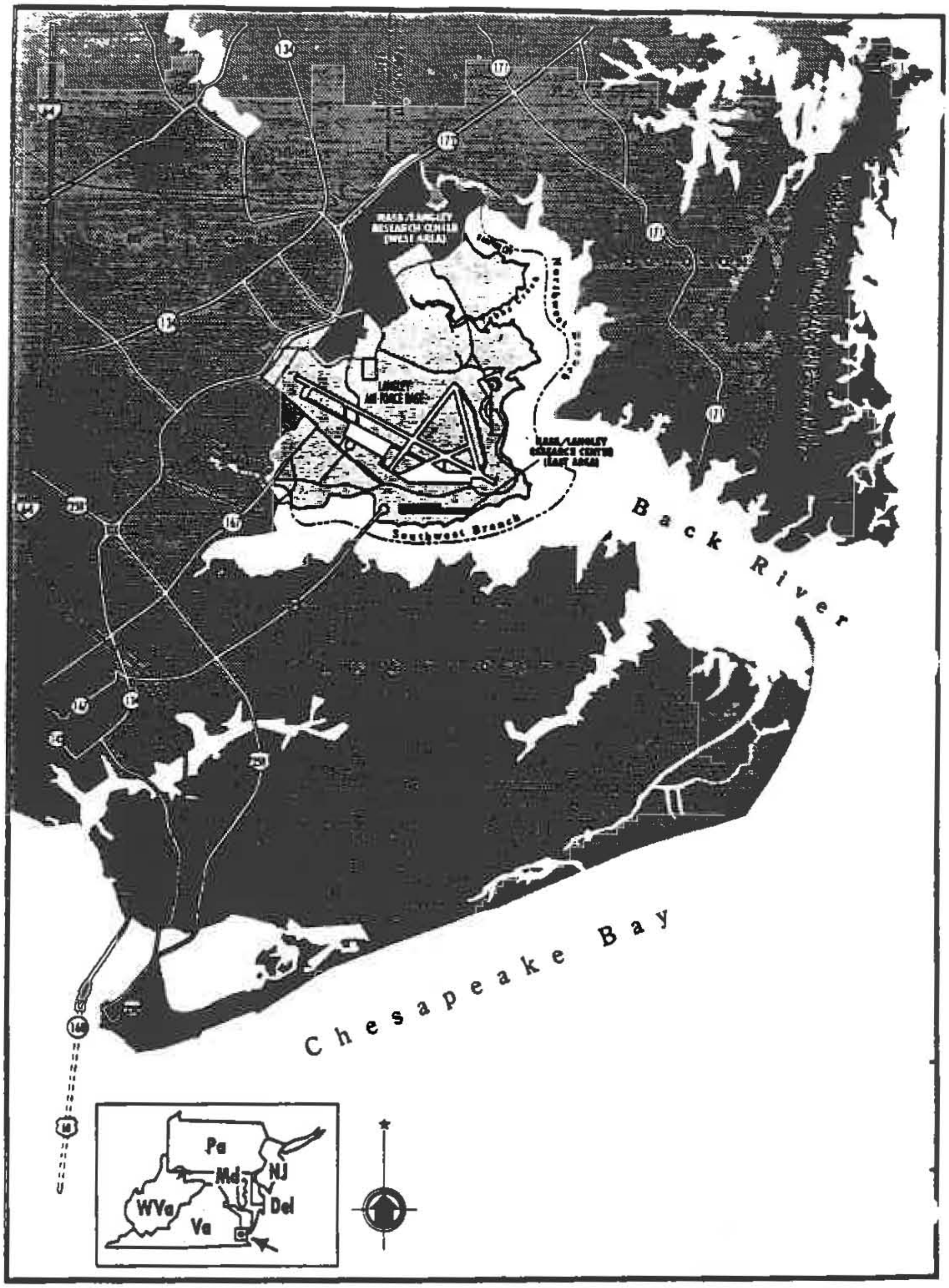
The 20 Inch Mach 6 CF_4 Tunnel housed in Building 1275 is located within Zone 2 (Resources/Support/Community) of the Land Use Plan of the West Development/Constraint Area at NASA LaRC (Figure 2.2). The laboratory-type operation consists of a 20 Inch Mach 6 CF_4 Tunnel which utilizes a complete reclamation system for capturing CF_4 gas. The facility is recognized as the only operational, relatively low enthalpy, conventional type heavy gas hypersonic facility in the United States (NASA LaRC, 1997). The CF_4 hypersonic wind tunnel is an integral component of the NASA LaRC Hypersonic Facilities Complex, representing two-thirds of the nation's hypersonic test capability (NASA LaRC, 1997).

The 20 Inch Mach 6 CF_4 Tunnel is heavily used by NASA as an aerothermodynamic research instrument for producing experimental results of real-gas effects on blunt to moderately blunt "re-entry type" models, such as aerospace vehicle concepts and planetary probes. Understanding the effects of real-gas phenomena on vehicle aerodynamics is important to defining the optimum design approach required for space transportation systems in the future (NASA LaRC, 1997). The current 20 Inch Mach 6 CF_4 Tunnel heater system has experienced poor performance and failure events leading to environmental concerns in recent years. The CF_4 hypersonic wind tunnel must meet required testing criteria to maintain a state-of-the-art hypersonic test facility for continued experimentation.

2.2. PROJECT PURPOSE

NASA LaRC proposes to modify the heater system of the current 20 Inch Mach 6 CF_4 Tunnel to improve testing performance and productivity, reduce environmental concerns, and expand technical requirements of the facility to meet experimental needs, while continuing to operate a unique real-gas facility. The Proposed Action includes modification of the existing tunnel facility to accommodate a replacement gas heater and construction of a natural gas pipeline connecting Building 1275 to the existing 6-inch gas main in the vicinity of Building 1221.

Figure 2.1. NASA LaRC Vicinity Map



2.3. PROJECT NEED

This section discusses the need for the Proposed Action and includes a description of the CF_4 hypersonic wind tunnel and heater system, as well as a history of the heater system including corrosion failures, environmental concerns, and performance record.

2.3.1. 20 Inch Mach 6 CF_4 Tunnel Description

Converted in the early 1970's from a 20 inch hypersonic arc heated tunnel, the existing tunnel is now a blow-down-to-vacuum laboratory-type facility. Enhanced instrumentation added in the early 1980's improved the facility's compatibility with other hypersonic facilities located at NASA LaRC (NASA LaRC, 1997). In the late 1980's, the facility evolved into the current 20 Inch Mach 6 CF_4 Tunnel.

The facility utilizes CF_4 as a test gas to simulate real-gas operating at hypersonic (Mach 6) conditions. The gas flows from a set of high pressure [5000 psig (pounds per square inch gauge)] manifolded bottles through pipes to a heater system which can release gas at temperatures ranging from 600 to 1000^0 F (Fahrenheit). The CF_4 gas is completely recovered through a closed reclamation system (NASA LaRC, 1996). Figure 2.3 shows a schematic diagram of the 20 Inch Mach 6 CF_4 Tunnel circuit.

2.3.2. Existing Heater History

The original heater system for the CF_4 hypersonic wind tunnel consisted of 316 stainless steel tube coils immersed in a molten lead storage unit (Figure 2.4.). The molten lead medium served as an excellent source for heat transfer. The coiled tube bundles provide a large surface area well suited for internal convection heat transfer (NASA LaRC, 1997). The heater system has experienced problems, including corrosion-related failures and poor performance, using its original molten lead storage unit as well as subsequent 'replacement' heater systems. General system maintenance requirements including regular replacement of burned out heater elements, the need to refill storage units at quarterly intervals, and periodic inspections of tube thickness and integrity are extensive and time consuming (NASA LaRC, 1997). The maintenance downtime experienced with the current heater system and potential environmental concerns have led researchers to deem the current facility unacceptable. A time line of the upgrades/enhancementsand system failures of the CF_4 hypersonic wind tunnel are detailed in Table 2.1.

Figure 2.3. NASA LaRC CF_4 Hypersonic Wind Tunnel

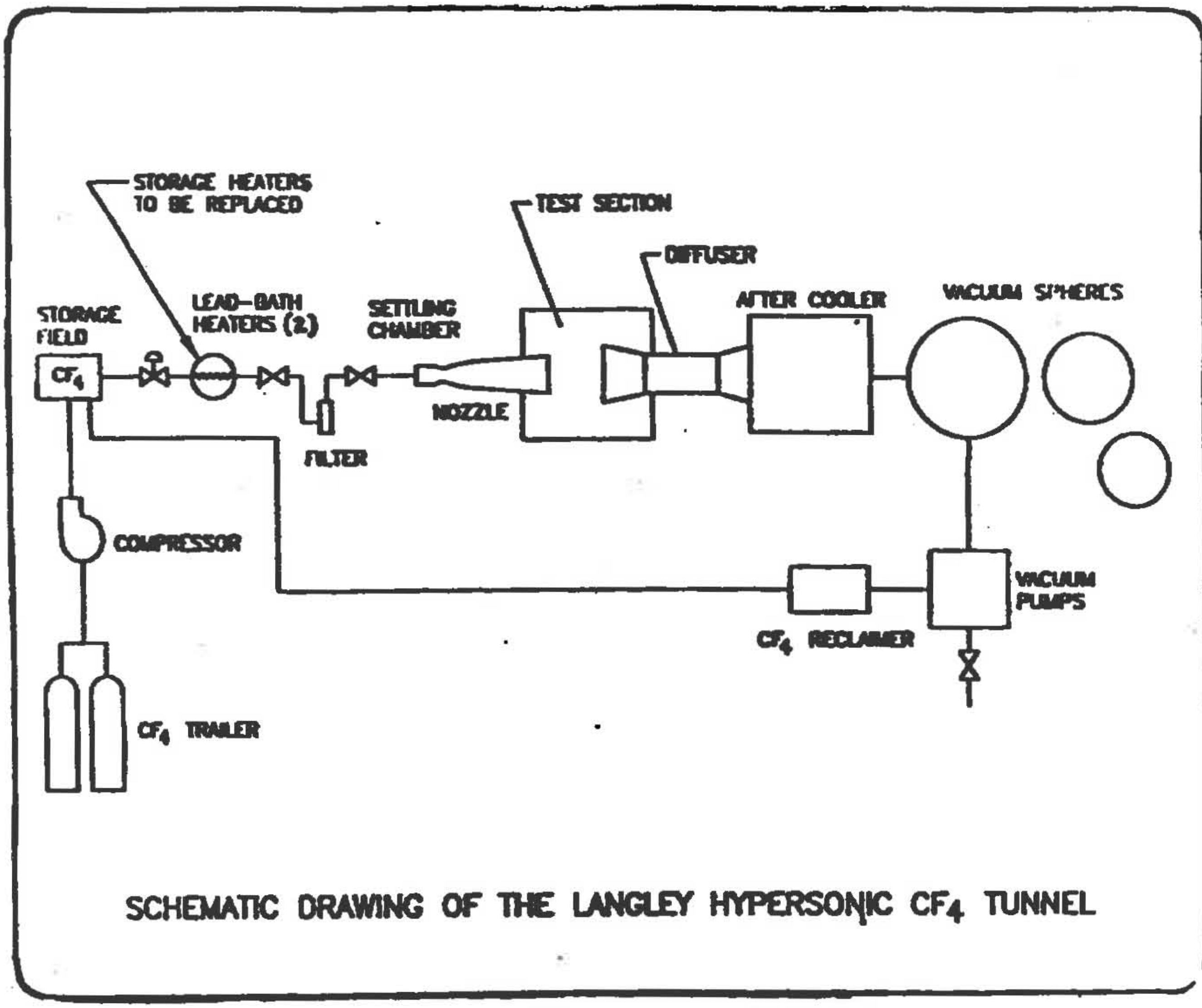


Figure 2.4. NASA LaRC CF_4 Heater System

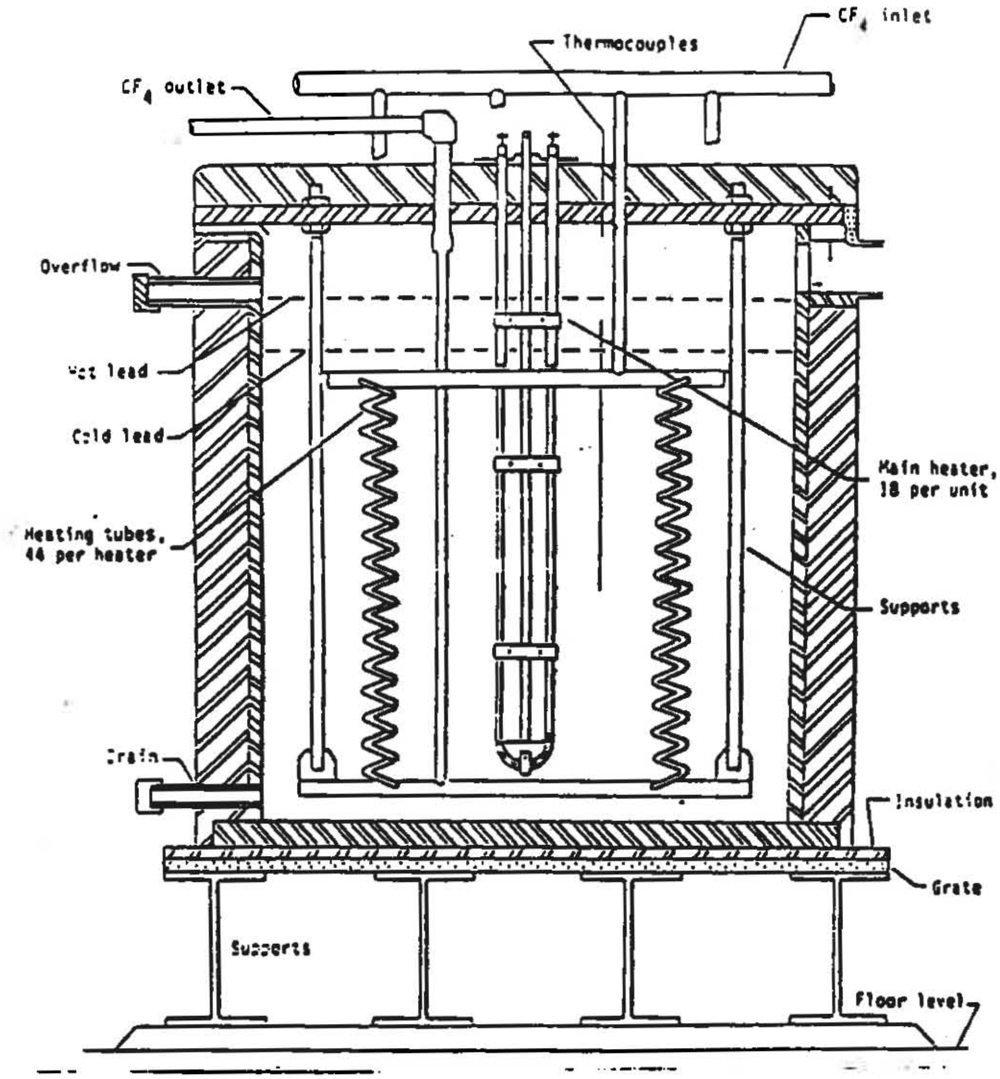


Table 2.1. Timeline of the CF_4 Hypersonic Wind Tunnel

DATE	EVENT
Early 1970's	Originally developed as a 20 Inch hypersonic arc heated wind tunnel.
Early 1980's	Upgraded for greater compatibility with other NASA LaRC hypersonic facilities.
Late 1980's	Evolved into the existing Mach 6 CF_4 hypersonic wind tunnel using 316 stainless steel coiled tube bundles and a molten lead medium.
January 1988	**First failure** - 316 stainless steel tube bundles experience internal corrosion. - Recommend tube bundle replacement to 347 or 321 stainless steel.
July 1988	Tube bundles replaced using 347 stainless steel.
April 1993	**Second failure** - 347 stainless steel tube bundles experience internal corrosion. - Recommend tube bundle replacement to a nickel-chromium alloy material. - Recommend replacement of lead medium to tin.
November 1993	Tube bundles replaced using Inconel 600. - Replace one heater unit with molten tin, other unit is left inactive.
March 1995	**Third failure** - Inconel 600 tube bundles experience external corrosion. - Recommend replacement medium compatible with Inconel 600.
Summer 1995	Tin medium replaced with heat transfer salts (sodium nitrate and potassium nitrate).

Source: NASA LaRC (1997, 1995, 1993, 1988)

2.3.2.1. Corrosion

The coiled tube bundles of the heater system have failed three times in the past decade; twice due to clogging from internal corrosion. The initial 316 stainless steel coiled tube bundles were in working order for approximately seven years before failing in 1988. Tube failure was credited to extremely localized internal corrosion of the 316 stainless steel tubes. A previous hydrotest left water in the CF_4 storage trailer which eroded the chromium alloy layer needed for corrosion resistance (NASA LaRC, 1998b; 1988). These tube bundles were replaced with 347 stainless steel tube bundles and lasted for five years prior to failing from internal corrosion in 1993. Both accidents splattered lead in the heater storage room requiring an extensive clean-up (NASA LaRC, 1993). After these failures, it was recognized that although CF_4 gas is inactive at low temperatures, in the presence of moisture at higher temperatures, the CF_4 gas forms fluorine gas and hydrogen fluoride. Thus, CF_4 gas can cause the inner corrosion of the coiled tube bundles (NASA LaRC, 1997).

To replace the damaged 347 stainless steel tube bundles, Inconel 600 was used for the tube bundle material for its proven resistance to fluorine gas and hydrogen fluoride. In addition, recommendations to replace the heat storage material from molten lead to molten tin were accepted. The Inconel tube bundle surfaces were oxidized to prevent any external corrosion due to a known incompatibility between Inconel 600 and tin. After approximately four months of use, the tubes failed during post heating hydrostatic tests (NASA LaRC, 1995a). External corrosion to the oxide layer from the molten tin rather than internal corrosion from the CF_4 gas generated the tube failure as some areas of protection wore off or were not completed. After this failure, the molten tin medium was replaced with heat-transfer salts (50 percent $NaNO_3$ [sodium nitrate] and 50 percent KNO_3 [potassium nitrate]) which are commonly used in the heat-treating process of some metals. The heat-transfer salts appear to be compatible with the Inconel 600 tube bundles (NASA LARC, 1998b).

Learning from the previous corrosion failures, the effects of high temperature (1200^0 F) moist CF_4 gas are currently being tested with the Inconel 600 tubes and the heat-transfer salt medium. As of June 1997, tests have shown low to no corrosion. Testing will be expanded to include additional potential heater materials and Inconel 625 tube bundles which may sustain greater strength (NASA LaRC, 1996). However, heater performance has been less effective using the alternative tin and heat-transfer salt mediums due to their poor heat storage capability and transport properties.

2.3.2.2. Environmental Concerns

The first heater system failure occurred in 1988, splattering lead on the walls of the heater storage room. An extensive cleanup effort was required before the tube bundles could be repaired and experimental testing resumed. Environmental concerns over ruptures or leaks releasing lead or lead vapors prompted the replacement of the molten lead medium to tin. However, after a tube failure, molten tin also splattered on the walls of the heater storage room requiring additional cleanup activities (NASA LaRC, 1995a). Heat-transfer salts are presently used on an experimental basis in order to curb environmental concerns. Currently, the facility has one heater storage unit of heat-transfer salts and one inactive heater storage unit of lead.

2.3.2.3. Efficiency/Performance

The 20 Inch Mach 6 CF_4 Tunnel heater system is designed to operate as a storage heater. Heat is stored in a liquid medium and released quickly as the CF_4 gas is circulated through the tube bundles (NASA LaRC, 1998b). Maintaining a constant temperature is difficult since heat is removed from the storage medium much faster than it can be re-supplied. For optimal performance at the start of a test run, a relatively constant temperature is maintained for a short time to allow the CF_4 gas and the tube bundles to heat up (NASA LaRC, 1997). The longer the test run, the more likely decreasing temperatures will be significant enough to affect the test results (30 to 70^0 F variation over a 30 second test run). New experiments demand longer run times of 180 seconds.

Additionally, reheating between test runs currently takes 0.75 to 1 hour (NASA LaRC, 1998b). The current storage heater system is unable to perform long test runs without temperature decay (NASA LaRC, 1997).

2.4 SCOPE OF ENVIRONMENTAL ASSESSMENT

This EA addresses environmental issues related to modifying the 20 Inch Mach 6 CF_4 Tunnel located in Building 1275 on NASA LaRC. This EA was prepared in accordance with the following regulatory requirements:

- NEPA (National Environmental Policy Act) - 40 CFR (Code of Federal Regulations) Parts 1500-1508.

- NASA NEPA regulations - 14 CFR Part 1216.3.

SECTION 3.0. DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

This section of the EA describes alternatives for the proposed NASA LaRC modification of the Building 1275 CF_4 gas heater system. From 1996-1997, several heater system configurations were considered by the NASA Study Team (NASA LaRC Proposed Heater Modifications for the 20 Inch Mach 6 CF_4 Tunnel_Concept Study Report Team; Section 3.1) and tested against numerous evaluation criteria determined by the Team to be essential for a replacement heater system (NASA LaRC, 1997). One heater system configuration tested by the NASA Study Team, the combustion fired storage/continuous heater system met all necessary evaluation criteria (Section 3.2). Thus, replacement of the existing system with the combustion fired storage/continuous heater system configuration is the Proposed Action for this EA (Section 3.3.). The other alternative considered in this EA is the No Action Alternative (Section 3.4.).

3.1. INTRODUCTION

In September 1996, the NASA Study Team began an investigation of potential replacement heater systems for the proposed modification. NASA's investigation of potential heater system technologies included consideration of custom-designed basic heater systems proposed by members of the NASA Study Team as well as an analysis of several commercially manufactured heater systems.

Market surveys were developed to identify available equipment and potential heater designs that could be manufactured to meet new heater requirements (NASA LaRC, 1997). Corporations specializing in the design and manufacture of high temperature heater systems were located from advertisements found on the Internet and references in previous NASA documents reporting on high temperature heaters (NASA LaRC, 1997). The market survey consisted of phone interviews with manufacturers and follow-up discussions with businesses able to provide adequate heater systems for the proposed Building 1275 CF_4 hypersonic wind tunnel renovation (NASA LaRC, 1997).

Heater systems considered in the initial investigation included: (1) electrical storage heater systems; (2) electrical continuous heater systems; (3) combustion fired continuous heater systems (4) electrical storage/continuous heater systems; and (5) combustion fired storage/continuous heater systems. Table 3.1 lists heater system configurations considered by the NASA Study Team.

Table 3.1. Heater System Configurations Considered by the NASA Study Team

Description	Heater Type	Energy Source
Double Heat Exchanger	Storage	Electrical
Combustion Fired Heat Exchanger	Continuous	Combustion (natural gas or propane)
Tubular Electric	Continuous	Electrical
Large Pressure Vessel	Storage/Continuous	Electrical
Double Heat Exchanger	Storage/Continuous	Combustion (natural gas or propane)
Combustion Heater Second Unfired Heat Exchanger	Storage/ Continuous	Combustion (natural gas)
Passive Electrical Resistance	Storage	Electrical
Combustion Heater Existing Salt Bath Postheater	Storage/ Continuous	Combustion (natural gas or propane)
Tubular Electrical Resistance Electrical Resistance Preheater	Storage/ Continuous	Electrical

Source: NASA LaRC (1997)

The following sections briefly describe each heater system configuration. Detailed descriptions of each heater system are found in NASA LaRC (1997).

Electrical Storage Heater System Configuration: This heater system configuration uses either molten metal or high pressure water as a heat transfer source. Initially, fluid is pumped through two heat exchangers. Heat is transferred into the fluid through the first heat exchanger via electrical power. The second heat exchanger transfers heat from the fluid to the CF_4 gas. This heater system is a storage type heater, uses electrical power as the energy source, and transfers heat by forced convection through either side of the two heat exchangers.

Electrical Continuous Heater System Configuration: This heater system configuration uses air to slowly increase the ambient temperature within the heater system. The heating system utilizes electrical power and tubes as a resistance element directly transferring heat to the CF_4 gas. The system then rapidly switches over to CF_4, while ramping up the power to match the new CF_4 heat transfer rates. This process can be completed in a relatively short time period (10 to 20 seconds). This air can also be used to preheat CF_4 prior to entering the heater.

Combustion Continuous Heater System Configuration: This heater system configuration uses a combustion burner to heat CF_4 flowing through the heater system. The combustion products transfer heat by forced convection into the CF_4 tubes, increasing the temperature of the gas flowing through the system. This heater system uses natural gas or propane as the energy source.

Electrical Storage/Continuous Heater System Configuration: This heater system configuration consists of a large pressure vessel with a mounted series of finned tube heater bundles which heat a large column of gas. This configuration is a combined storage/continuous heater system that preheats a large amount of CF_4 gas to handle heater start-up times and maintain a continuous supply of heated CF_4 gas.

Combustion Storage/ContinuousHeater System Configuration: This natural gas system consists of two heat exchangers in a series. The first is a combustion fired unit which uses combustion products to convectively heat a CF_4 gas-filled coiled tube. The second heat exchanger is unfired, but uses the combustion products of the first unit to preheat a second coiled tube, adding thermal capacitance to the system.

3.2. HEATER SYSTEM EVALUATION METHODOLOGY

Evaluation criteria, designed and agreed upon by members of the NASA Study Team, include 10 factors within three categories: (1) minimum technical requirements; (2) other technical requirements; and (3) cost factors. Heater system configurations were evaluated against each evaluation criterion by the Team (NASA LaRC, 1997) and scored appropriately. It is important to note that the NASA Study Team evaluated costs separately from technical performance; cost factors were evaluated for information and budgeting purposes only (NASA LaRC, 1997). Determination of the most adequate heater system configuration was based upon based the ability of a heater system configuration to meet the minimum technical requirements (NASA LaRC, 1997). Evaluation of cost factors will, however, be included during the selection of an actual heater alternative once the actual procurement solicitation is issued.

3.2.1. Technical Requirements for New Heater System

Numerous technical requirements were developed by the NASA Study Team (NASA LaRC, 1998b) to define an improved replacement heater system for the CF_4 hypersonic wind tunnel. These technical requirements include the following evaluation criteria:

- During a test run, the heater must be capable of heating and maintaining a preset constant CF_4 gas temperature varying within a range of 500 to 1000^0 F. CF_4 gas enters the heater at 70^0 F. A temperature control tolerance of no greater than 1% shall be allowed during operation.

- The heater gas pressure shall remain constant in a test run. The required preset operating pressure can vary between 100 to 3000 psig. Depending on the pressure and temperature conditions, the gas flow through the heater system should range from 0.7 to 18 lbm/sec (pounds mass per second). The pressure drop through the heater system shall not exceed 200 psi (pounds per square inch) at inlet conditions of 70^0 F, 1250 psig at 18 lbm/sec, and an outlet temperature of 1000^0 F.

- Each work day, a maximum time limit of one hour is needed to preheat the system without gas flow into the tunnel. Upon starting test runs, a maximum of five seconds will be used to stabilize flow conditions. CF_4 gas or tube bundles should not require additional heating time. The test runs will operate for 10 to 180 seconds. A maximum of 30 minutes will be required to reheat the heater in preparation for the next test run.

- Designed to the ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, the heater will have a design pressure of at least 3000 psig at the heater outlet. Heater materials in contact with the CF_4 will be made of Inconel and temperatures will not exceed 1350^0 F.

- The replacement heater system will require high reliability and long life (50,000 pressure cycles at temperature). Heater maintenance should be minimal and overall performance maintenance should occur once a year during scheduled facility shutdown period.

- The replacement heater must be completely integrated with the current tunnel facility, requiring minimal changes to existing operations. The heater will be operated using semi-automatic electronic controls from the existing control room.

The NASA Study Team devised weighting factors for each evaluation criterion based upon the relative significance/importanceof each characteristic to the determination of a replacement heater system. The evaluation criteria, including weighting factors, are listed in Table 3.2.

Each heater system configuration was scored independently by NASA Study Team members. Each member rated a particular configuration by assigning numerical scores from 1 to 10 for each evaluation criteria. A total score was then established for each heater system.

Table 3.2. Heater System Evaluation Criteria Including Weighting Factors.

Characteristic	Specifications	Weighting Factor
Operating Pressure	Variable from 100 to 3000 psig	8%
Operating Temperature	Variable from 500 to 10000^0 F	8%
Maximum Surface Temperature in Contact with CF_4 Gas	1350^0 F	8%
Stabilization Time	5 seconds maximum	8%
Run Time Capability	10 to 180 seconds	6%
Temperature Control Tolerance	1% maximum	6%
Mass Flow Rate	Variable from 0.7 to 18 lbm/sec	4%
Maximum Pressure Drop	- 200 psig max @ 1250 psig inlet - 18 lbs/sec (pounds per second) - 1000^0 F	4%
Maximum Preheat Time	1 hour	4%
Maximum Reheat/Cooling Time	30 minutes	4%
Design Life	-25 years at 50,000 total pressure cycles -250 heat cycles per year -8 pressure cycles per heat cycle	n/a
Maintenance Requirements	Limit to Annual Shutdown	n/a
Availability/Reliability of Energy Source	Situation Dependent	8%
Environmental Concerns	Situation Dependent	8%
Efficiency	Situation Dependent	6%
System Integration	Situation Dependent	6%
Materials Proposed	Situation Dependent	6%
Is Heater Within State of Art or Developmental	Situation Dependent	6%

Source: NASA LaRC (1997)

3.2.2. Scoring Results

The combustion fired storage/continuous heater system received the highest average technical score (NASA LaRC, 1997). Because meeting the minimum technical requirements was the most important criterion for the research facility, the combustion fired storage/continuous-type heater system was selected as the most appropriate configuration (NASA LaRC, 1997).

3.3. PROPOSED ACTION

In order to meet the objective of replacing the existing Building 1275 heater system with a single, more reliable, efficient, and environmentally compatible heater system (NASA LaRC, 1997), the design team recommended the installation of a combustion fired storage/continuous-type heater system. Thus, the installation of a combustion fired storage/continuous heater system is proposed and evaluated in this EA.

3.3.1. Combustion Fired Storage/Continuous Heater System

A combustion fired storage/continuousheater system consists of two heat exchangers in series. The first heat exchanger is a combustion fired unit which uses natural gas combustion to convectively heat a coiled tube containing CF_4 gas. The second heat exchanger is unfired, but uses the combustion products of the first unit to preheat a second coiled tube. This adds thermal capacitance to the system. Because the system is fueled by natural gas, a natural gas line will be constructed from an existing source at the existing 6-inch gas main in the vicinity of Building 1221.

Among all heater systems tested by the NASA Study Team, the combustion fired storage/continuous heater system was the only configuration which met all criteria. This system satisfies the 5-second stabilization time due to the large thermal storage capacity of the second unfired heat exchanger. As a result, heated CF_4 gas is immediately available for injection into the tunnel.

The combustion fired storage/continuous- type heater system also meets all run time, heater recovery time, and temperature accuracy requirements. This system type has a large capacity burner that is built and sized to handle maximum heat rate conditions (7.1. MW [megawatts] Heat Input) and is controlled easily for quick response times. As a result, the heater can run continuously at maximum heating conditions without any temperature decay. In addition, a combustion fired storage/continuous-typeheater system can be started in one hour or less and reheated between runs within one-half hour. In addition, the combustion fired storage/continuous heater system can cool itself between runs using dilution air, if needed, within 30 minutes.

3.3.2. Natural Gas Line

To power a combustion fired storage/continuous-type heater system, a natural gas pipeline will need to be piped from the existing 6-inch gas main in the vacinity of Building 1221. Although the piping route has not been determined, it is anticipated that the pipeline will be laid parallel and adjacent to existing roadways and sidewalks within the General Research/Support/Community functional zone at NASA LaRC.

3.3.3. Installation of a Combustion Fired Storage/Continuous Heater System

A short feasibility study was conducted by the NASA Study Team to determine whether or not the proposed heater system configuration could reasonably be installed in Building 1275 with minimal operational changes (NASA LaRC, 1997). The large size of the selected heater was identified as a potential problem.

A site visit determined that the best location for the replacement heater was Room 107 (the location of the existing heater). Other locations were considered, including Room 123, but all other alternative locations would require additional piping between the heater and settling chamber, possibly increasing CF_4 losses during a heater shutdown.

As determined by NASA LaRC (1997), the following structural changes may be needed:

- Removal of the existing heater system.
- Architectural/civil/structural changes to the building. It is expected that a second floor will be added to Building 1275 in order to house the combustion fired storage/continuous heater system, increasing the building's height by approximately 16 feet. The addition will cover approximately 1,200 square feet. A separate enclosure will be constructed around the heater including a separate heating and ventilation system.
- The second floor addition will be connected to the existing structure with insulated steel metal siding. The existing foundation will bear the weight of the second floor addition.
- Mechanical and electrical changes to Building 1275.
- Installation of motor starters and power for the fan motor.
- Installation of the heater system, including the interconnection of stack ducts.
- Welding and installation of the interconnecting CF_4 pipe.

- Installation of electrical wiring between the current control panel and the new combustion fired storage/continuous-type heater system.

- Installation of a natural gas line, regulated to 8 psig. It is assumed that a 4-inch diameter pipeline is needed. A larger pipeline may be used if excess capacity is being considered. The line will be installed from Building 1275 to the existing 6-inch gas main in the vicinity of Building 1221.

- Modification of the existing CF_4 pressure control and safety relief system.

3.4. NO ACTION ALTERNATIVE

The No Action Alternative entails operating the facility with the current heating equipment and infrastructure (i.e., operating the molten salt heater and maintaining an inactive lead heater). This alternative would not provide the needed capabilities for integrating the functions of the Building 1275 CF_4 hypersonic wind tunnel. In addition, the No Action Alternative would not meet the expected research demand from other NASA LaRC facilities.

SECTION 4.0. AFFECTED ENVIRONMENT / ENVIRONMENTAL CONSEQUENCES

This section characterizes existing environmental conditions at NASA LaRC. Existing conditions establish the baseline against which environmental impacts associated with the Proposed Action and the No Action Alternative are evaluated in this EA. The affected environment describes environmental resources and related concerns at NASA LaRC including physical and biological resources, waste management issues, and socioeconomic resources.

This section also includes a comparison of environmental consequences under the Proposed Action and No Action Alternative, previously discussed in Section 3.0. This evaluation is based on the use of identifiable impact categories for each environmental resource.

4.1. PHYSICAL RESOURCES

Physical resources that may be impacted by the Proposed Action and the No Action Alternative include land use, water quality, air quality, noise, wetlands and floodplains.

4.1.1. Land Use

Land use plans address the integration of man-made and natural environments and human activities occurring within the NASA LaRC community. Approximately 70 percent of the work at NASA LaRC is aeronautical research using computer modeling, wind tunnels, and other facilities and techniques. Comprising 18 major research complexes, NASA LaRC is one of the largest NASA research centers (Foster Wheeler, 1996).

The 20 Inch Mach 6 CF_4 Tunnel is located in Building 1275 within a highly developed, industrial section of NASA LaRC's West Area within Zone 2 of NASA's Land Use Plan (Figure 4.1). The largest of the NASA LaRC functional zones, Zone 2 (General Research/Support/Community) serves as the core for the surrounding functional zones (Foster Wheeler, 1996).

Land use for the Proposed Action is similar to and suitable for existing land use at the facility and within the area. All proposed construction and upgrades will be internal to the facility, with the exception of a floor added to Building 1275. Lateral expansion of the building is not planned. No land is proposed to be excavated or cleared for the proposed facility construction. Therefore, no significant impact to existing land use is anticipated from the Proposed Action.

The Proposed Action will require the use of natural gas as an energy source. A pipeline will be laid connecting Building 1275 to the existing 6-inch gas main in the vicinity of Building 1221. The pipeline is expected to be constructed within existing developed areas and laid along existing NASA LaRC roadways, although a final routing determination will not be made until mid-1998. No significant adverse impacts to existing land uses are anticipated from the pipeline construction.

Under the No Action Alternative, the project would not be constructed. Therefore, no significant adverse impacts to land use to NASA LaRC are expected.

4.1.2. Water Quality

NASA LaRC is near Back River, a tidal estuary of the Chesapeake Bay. Brick Kiln Creek runs along the western boundary and joins the northwest branch of the Back River. Brick Kiln Creek drains approximately 40 percent of the West Area (Foster Wheeler, 1996). Most of the remaining West Area and a part of LAFB (Langley Air Force Base) is drained by Tabbs Creek (Figure 4.2.) which flows northward to connect with Back River near its northwest and southwest branches. Tides Mill Creek drains a small portion of the southern West Area, whereas the East Area drains to the Back River (Foster Wheeler, 1996). The tunnel facility is located approximately 200 meters from the northwest branch of Back River.

The wind tunnel facility heater replacement will not generate additional waste water. The Proposed Action is not anticipated to increase wastewater discharge or impact local water quality.

NASA LaRC has developed a Facility Storm Water Discharge Pollution Prevention Plan. The plan lists seven categories of BMPs (Best Management Practices) used to prevent or mitigate storm water and/or storm sewer system pollution resulting from facility activities. One of these BMP categories, Sediment and Erosion Control, is particularly relevant to pipeline construction activities. As the pipeline trench is constructed, underlying soils are exposed to wind and rain. To prevent sediment erosion events that may potentially degrade local surface waters, structural vegetative and/or stabilization measures are recommended as BMPs (NASA LaRC, 1995b). Because it is less than 5 acres, the construction area does not require a NPDES (National Pollutant Discharge Elimination System) storm water construction permit. Construction activities are to be performed in compliance with appropriate State regulations and, historically, have not caused an increase in sediment discharge to receiving waters. No increase in storm water runoff is anticipated from the Proposed Action. No significant adverse impacts are anticipated from the Proposed Action.

No projects would be implemented under the No Action Alternative, the existing baseline environment would remain unchanged. Therefore, no significant adverse impacts to water resources are anticipated.

4.1.3. Air Quality

Under the CAA (Clean Air Act), NAAQS (National Ambient Air Quality Standards), air quality issues affecting NASA LaRC are administered at the Federal (EPA [Environmental Protection Agency] Region III, Philadelphia) and State (VDEQ [Virginia Department of Environmental Quality], Air Division, Tidewater) levels. An air quality monitoring station is maintained by VDEQ approximately six miles southwest of NASA LaRC at the Virginia School for the Deaf and Blind in Hampton, Virginia. The VDEQ station is not operated continuously but does collect data on criteria pollutants regularly (Foster Wheeler, 1996). The ambient air quality standards for the NASA LaRC area in 1991 are summarized in Table 4.1. Figure 4.3 provides a map identifying the major sources of criteria pollutant emissions at NASA LaRC.

According to the Virginia Department of Environmental Quality, the Hampton Road Intra-State AQCR (Air Quality Control Region) is currently classified in attainment of all National Ambient Air Quality Standards, including ozone (smog). NASA LaRC is located within the Hampton Road Intra-State AQCR. Ozone forms from the combination of NO_x (nitrous oxides) and VOCs (Volatile Organic Compounds). As a currently permitted facility, the Proposed Action to modify the heater system meets conformity exemption conditions via the applicability test [FR (Federal Register) Volume 58, No. 228, pp. 63214]. The total direct and indirect emissions from the Proposed Action will not exceed the de minimis level of 100 tons per year of VOCs or NO_x. Therefore, the Proposed Action is exempt from conformity determination to the Virginia State Implementation Plan.

The Proposed Action may contribute to increased airborne particulate concentrations of minor and/or temporary fugitive dust emissions during construction operations. Dust emissions from construction activities should be minimized by use of standard construction dust control measures in accordance with Virginia Rule 5-1: Fugitive Dust Emissions. Implementation of BMPs during construction including structural, vegetative, or stabilization measures will reduce any potential adverse impacts. Activities (e.g., painting and welding) which may generate insignificant secondary emissions of particulate matter, VOCs, and toxic air pollutants are anticipated to be minimal and insignificant.

Table 4.1. Ambient Air Quality Standards and Observed Ambient Concentrations for NASA LaRC Area [Foster Wheeler, 1996].

Pollutant	National Primary Standard[a]	National Secondary Standard[a]	Virginia Standard[a]	Observed Ambient Concentrations[b]
Suspended Particulate Matter <10 µm				
Annual Average	50 µg/m³*	50 µg/m³	50 µg/m³	26 µg/m³
24 hour maximum	150 µg/m³	150 µg/m³	150 µg/m³	59 µg/m³
Sulfur Dioxide				
Annual Average	0.03 ppm**	None	0.03 ppm	0.006
24 hour maximum	0.14 ppm	None	0.14 ppm	0.022
3 hour maximum	None	0.50 ppm	None	None
Carbon Monoxide				
8 hour maximum	9 ppm	None	9 ppm	4.3
1 hour maximum	35 ppm	None	35 ppm	7.9
Nitrogen Dioxide-Annual Average	0.053 ppm	0.053 ppm	0.053 ppm	0.020 ppm
Ozone - 1 hour maximum	0.12 ppm	0.12 ppm	0.12 ppm	0.147 ppm
Lead - Quarterly arithmetic mean	1.5 ppm	1.5 ppm	1.5 ppm	0.03 ppm

* µg/m³ = micrograms per cubic meter ** ppm = Parts per Million

[a] Ambient standards (excluding those using annual averages) are not to be exceeded more than once per year.

[b] Virginia School Monitoring Station values from 1991.

Sources: Foster Wheeler (1996)

NASA LaRC has reduced NOx emission rates in recent years by utilizing natural gas instead of oil as an energy source (Table 4.2.). The Proposed Action will modify the heater system resulting in a possible emission rate alteration. Predicted NO_x and CO (carbon monoxide) emission rates for the Proposed Action are within current permit limits set for the facility. Yearly run time estimates for the Proposed Action equate to 1,375 hours producing calculated NO_x emissions of no more than three tons per year and CO emissions of less than 12 tons per year.

Table 4.2. Comparison of 1994 Actual Emission Rates to 1997 Estimated Emission Rates at NASA LaRC.

Chemical	1994 Actual Emissions (ton/year)	1997 Estimated Emissions (ton/year)
Criteria Pollutants		
Carbon Monoxide	2.96	2.4
Nitrogen Oxides (as NO_2)	24.09	5.6
Particulate $Matter_{10}$	2.97	*
Sulfur Oxides (as SO_2)	27.97	1.3
VOCs		
Total VOCs	**9.98**	-

* 1997 data not available.

Source: Foster Wheeler (1996)

4.1.4. Noise

Regulations under the City of Hampton Code, Section 22 - Noise prohibits unreasonably loud or disturbing noises which may be destructive to the life and health of individuals within the Hampton city limits (Foster Wheeler, 1996). NASA LaRC conducts its research and experimental testing within noise levels within the regulations established by the Occupational Safety and Health Act of 1970 (29 CFR 1910 et seq.) (Foster Wheeler, 1996).

Noise levels at NASA LaRC are considered to be typical of many research installations. Primary noise sources at NASA LaRC are generated by wind tunnels and compressor stations. Most of the wind tunnels (including Building 1275) are closed-loop tunnels (test gas medium is recirculated and reclaimed) where noise is contained within the confines of the facility (Foster Wheeler, 1996).

The Proposed Action will involve noise from the operation of heavy construction equipment. This construction noise will be compatible with the existing daytime noise in the area arising from traffic, military aircraft, and other adjacent wind tunnel facilities. However, noise levels are not expected to increase beyond existing levels during construction events.

Noise measurements indicate that the current heater system does not produce any measurable noise. The Proposed Action incorporates a 400 hp (horsepower) engine to drive the heater fan. NASA LaRC regulations require noise levels to be below 85 dB (decibels). Any noise generated by the

Proposed Action will be accounted for in the design plans and will meet NASA LaRC noise regulation requirements. No significant noise impact would be expected from increased operation of the hypersonic wind tunnel.

Neither the Proposed Action nor the No Action Alternative are expected to have significant adverse impacts on noise levels currently experienced at NASA LaRC.

4.1.5. Wetlands and Floodplains

Regulations on floodplain and wetlands management applicable to NASA LaRC are specified in 14 CFR 1216.2 and addressed by NMI (NASA Management Instruction) 8800.10B, Floodplains and Wetlands Management. These regulations require NASA field installations to include floodplain and wetland protection in planning activities. These NASA regulations and management instructions also require consultation with ACOE (Army Corps of Engineers), USFWS (United States Fish and Wildlife Service), FEMA (Federal Emergency Management Agency), and public notice for project development in wetlands or floodplains.

Wetlands

NASA LaRC is located in an area of low topographic relief surrounded by a shallow estuarine environment. NASA LaRC is close to the northwest and southwest branches of the Back River, and is within the tidal zone of the Chesapeake Bay. The principle drainageways in the vicinity of NASA LaRC, Brick Kiln Creek and Tabbs Creek, are tidal creeks with extensive tidal marshes (Foster Wheeler, 1996).

In 1991, NASA/NASA LaRC contracted with Bionetics at Kennedy Research Center who subcontracted Old Dominion University to perform a wetland field survey at NASA LaRC in order to identify and map the boundaries of forested wetlands on NASA LaRC property. The predominant wetland areas in the vicinity of NASA LaRC are the tidal marsh wetlands associated with the Brick Kiln Creek and Tabbs Creek. The CF_4 hypersonic wind tunnel facility is located approximately 200 meters from the nearest wetland area (Figure 4.4. and Figure 4.5.).

No wetlands occur in the vicinity of Building 1275 or along the proposed route of the natural gas pipeline. Because the proposed construction is within the existing building footprint and BMPs for sediment erosion control will be implemented during pipeline and building construction phases, neither the Proposed Action nor the No Action Alternative are expected to have any significant adverse impacts to adjacent wetlands.

Floodplains

The stillwater elevation for the 100-year floodplain for the City of Hampton near NASA LaRC is estimated by FEMA at 8.5 feet (2.6 meters) above mean sea level (FEMA, 1987). The 500-year floodplain is at 9.8 feet (3.0 meters) above mean sea level (Foster Wheeler, 1996). Building 1275 is within the 100-year floodplain, but not the 500-year floodplain (Figure 4.4 and Figure 4.5).

Neither the Proposed Action nor the No Action Alternatives are expected to contradict any existing environmental documentation regarding NASA actions within the 100-year and 500-year floodplains. In addition, no lateral encroachment is scheduled to occur during construction, so no significant adverse environmental impacts are anticipated. No activities are expected to occur within the stillwater elevation of the 500-year floodplain.

4.2. BIOLOGICAL RESOURCES

Boyd and Ware (1973) prepared a listing of LaRC and LAFB biological resources. In 1985, the Virginia Herpetological Society published a survey of amphibians and reptiles found in the NASA LaRC area. In addition, NASA LaRC has conducted several biological surveys, including wetland surveys (ODU [Old Dominion University], 1992; 1991a,b,c) and the Tabbs Creek Remedial Investigation (Ebasco, 1995). Most recently, NASA LaRC contracted with ODU-AMRL (Applied Marine Research Laboratory) to perform a multi-season baseline survey of the flora and fauna of NASA LaRC (ODU, 1995). Additionally, according to Foster Wheeler (1996) a survey of bald eagles and peregrine falcons at LAFB was conducted in 1994 by GEO-Marine, Inc. under contract with ACOE.

4.2.1. NASA LaRC Terrestrial and Aquatic Vegetation

NASA LaRC contains approximately 159 acres of natural terrestrial vegetation which has previously been classified into four categories: Mixed deciduous /pine forest (94 acres), disturbed forest (30 acres), pine plantation (18 acres), and disturbed deciduous forest with brackish influence (17 acres) (Figure 4.6). A total of 164 plant species has been identified within the grounds of NASA LaRC (ODU, 1995).

The No Action Alternative is not expected to have any significant adverse impacts on terrestrial or aquatic vegetation at NASA LaRC. All activities associated with the Proposed Action are scheduled to occur within the General Research/Support/Community, a heavily developed functional zone within NASA LaRC. Thus, the Proposed Action is not expected to have any significant adverse impacts on any populations of terrestrial or aquatic vegetation at NASA LaRC.

4.2.2. NASA LaRC Fish and Wildlife

Mammals

Fourteen species of mammals have been identified at NASA LaRC (ODU, 1995). It has been estimated, however, that an additional 12 species should be present at NASA LaRC, but were not encountered during the course of the ODU baseline study (ODU, 1995). Mammals known to occur at NASA LaRC include white-tailed deer, rabbit, raccoon, squirrels, muskrats, opossums, shrews, and fox (NASA LaRC, 1996).

Amphibians and Reptiles

Numerous amphibian and reptile species are also common to the area. Sixteen species of reptiles and amphibians have been identified within the grounds of NASA LaRC (ODU, 1995). It has been estimated that an additional 19 species should be present at Langley, but were not encountered during the course of the ODU baseline study (ODU, 1995).

Avifauna

A total of 118 bird species have been observed within the perimeter of NASA LaRC (ODU, 1995). These species include both waterfowl and wading birds that use the coastal marshes for foraging and/or roosting. Waterfowl and wading birds include herons, egrets, ducks, gulls, and geese. Species observed in Tabbs Creek include the following: Caspian tern, great blue heron, green heron, osprey, herring gull, great egret, white ibis, Virginia rail, plover, killdeer, sandpiper, red-winged blackbird, and grey catbird (Ebasco, 1995). Preliminary surveys did not observe any peregrine falcons on or near NASA LaRC.

Fish

Thirty-three finfish species were collected from NASA LaRC waters during the ODU baseline survey. All finfish species were common to the Lower Chesapeake Bay and its tributaries (Foster Wheeler, 1996). The benthic communities of tidal creeks draining NASA LaRC were determined by ODU scientists to be fairly low in species diversity, but within range of species diversity of similar oligohaline and mesohaline portions of estuaries of the southeastern United States (ODU, 1995).

The No Action Alternative is not expected to have any significant adverse impacts on populations of fish and wildlife at NASA LaRC. All activities associated with the Proposed Action are scheduled to occur within the General Research/Support/Community, an industrialized area at NASA LaRC. Minimal natural habitat is in the facility. Thus, the Proposed Action is not expected to have any significant adverse impacts on fish and wildlife at NASA LaRC.

4.2.3. Endangered and Threatened Species

ODU conducted endangered and threatened species surveys at NASA LaRC in 1995. In addition to the 1995 ODU baseline survey, a review of the Virginia Natural Heritage Program database in 1996 indicated that no Federal or State listed endangered or threatened species are known to occur at NASA LaRC.

No plants listed as threatened or endangered were found in any of the habitat types at NASA LaRC although the following two species have been determined to be rare or uncommon in the area: the angle pod (*Matelea carolinensis*) and the adder's tongue (*Ophioglossum vulgatum*).

According to the 1995 ODU survey, none of the reptile or amphibian species identified or expected to occur at NASA LaRC are currently listed as threatened or endangered. However, three northern diamond terrapins (*Malaclemmys terrapin terrapin*), a Federal candidate species, were captured, identified, and released (ODU, 1995).

None of the mammal species identified within the grounds of NASA LaRC are listed as threatened or endangered. Two species, however, are listed as species of special concern in the Commonwealth of Virginia. These species include the river otter (*Lutra canadensis*) and the marsh rabbit (*Sylvilagus palustris*), a species not identified by the ODU (1995) baseline survey but that is expected to inhabit NASA LaRC.

Three avian species found on the grounds of NASA LaRC are listed as threatened or endangered. These three species include the bald eagle (*Haliaeetus leucocephalus*), the gull-billed tern (*Sterna nilotica*), and the Henslow's sparrow (*Ammodramus hensolowii*). All three of these species were determined by ODU scientists to be transient migrants that utilize the NASA LaRC facility as a foraging stop (ODU, 1995). Although surveys for endangered peregrine falcons (*Falco peregrinus*) were historically conducted, none were found within NASA LaRC boundaries.

Eight avian species are listed as species of special concern in the Commonwealth of Virginia. None of these species, however, were determined to be nesting at the NASA LaRC facility during the ODU baseline survey. Five of these eight species are potential nesting species. These five species include the northern harrier (*Circus cyaneus*), the brown creeper (*Certhias americana*), the winter wren (*Troglodytes troglodytes*), the hermit thrush (*Catharus guttatus*), and the purple finch (*Carpodacus purpureus*). The remaining three avian species, the brown pelican (*Pelicanus occidentalis*), little tern (*Sterna antillarum*), and great egret (*Casmerodius albus*) were determined by the ODU scientists to be unlikely nesting species at NASA LaRC due to the lack of suitable nesting habitat.

No listed endangered, threatened, or special concern finfish species inhabit or utilize bodies of water within the NASA LaRC facility. There are no listed endangered, threatened, or special concern benthic flora in bodies of water within the NASA LaRC facility.

The No Action Alternative is not expected to have any significant adverse impacts on endangered or threatened species at NASA LaRC. All activities associated with the Proposed Action are scheduled to occur within the General Research/Support/Community, a heavily developed functional zone within NASA LaRC. Thus, the Proposed Action is not expected to have any significant adverse impact on any populations of endangered or threatened species at NASA LaRC.

4.3. WASTE MANAGEMENT

Waste management issues that may be impacted by the Proposed Action and the No Action Alternative include nonhazardous and solid waste, hazardous waste, and radioactive materials and non-ionizing radiation.

4.3.1. Nonhazardous and Solid Waste

Nonhazardous wastes are defined as hazardous materials not regulated by the EPA or VHWMR (Virginia Hazardous Waste Management Regulations) and include oil, grease, antifreeze, and lubricants. Solid wastes are comprised of nonhazardous materials such as paper, tires, metal objects, refuse, and dried or treated sewage sludge. Nonhazardous and solid wastes at NASA LaRC are disposed in the Refuse Fired Steam Generating Facility or by disposal in an off-site permitted landfill. Recycling activities are being initiated at NASA LaRC for many solid waste items that would otherwise be disposed. The Proposed Action is not anticipated to affect the quantity or disposal of nonhazardous or solid waste generated by the facility.

It is anticipated that lead or lead-containing materials may be encountered during activities of the Proposed Action. Specifically, it is known that lead splatters exist on the enclosure wall and the cinderblock wall behind the current heater system of Building 1275. It has been determined by NASA LaRC Environmental Personnel that the lead content on the enclosure wall is insignificant and that any construction waste created during demolition can be safely disposed of, as routine, nonhazardous construction debris by an approved contractor in a pre-determined construction landfill. No construction is expected to be done to the cinderblock wall behind the current heater system as a result of any activity associated with the Proposed Action. If construction does affect the cinderblock wall, removal of any construction material will be done in accordance with all applicable NASA LaRC Regulations.

4.3.2. Hazardous Waste

NASA LaRC generates hazardous waste from its research and development operations, laboratories, instrument repair, and operations and maintenance functions. NASA LaRC is a generator of hazardous waste under EPA Permit No. VA2800005033 (Foster Wheeler, 1996). NASA LaRC is not authorized to transport hazardous waste offsite, store hazardous waste beyond a 90-day accumulation period, or dispose of hazardous waste onsite. Transport of hazardous waste to offsite disposal sites is performed by appropriately permitted contractors for NASA LaRC.

NASA LaRC is considered a large-quantity generator of hazardous waste and has operated a 90-day storage area located in Building 1166 since 1991. In addition, NASA LaRC operates 42 satellite accumulation areas located throughout the center.

NASA LaRC maintains a list of approved contractors for transport and disposal of hazardous waste offsite. NASA LaRC requires the contractor to characterize the waste to ensure proper treatment and disposal. The only hazardous wastes expected to be encountered during the Proposed Action are asbestos or asbestos containing material and insignificant amounts of lead and/or lead containing material. No hazardous waste is expected to be encountered during the No Action Alternative.

It is anticipated that asbestos or ACBMs (Asbestos Containing Building Materials) may be encountered during the Proposed Action. Specifically, asbestos is known to exist as insulation materials on certain pipes and storage tanks throughout Building 1275. It is NASA LaRC policy to comply with all Federal and State regulations applicable to asbestos (NASA LaRC, 1996). These include CAA, TSCA (Toxic Substances Control Act), FWPCA (Federal Water Pollution Control Act), OSHA (Occupational Safety and Health Administration) regulations, and Commonwealth of Virginia regulations which parallel Federal requirements. If a health hazard is found to exist, prompt and effective action is taken. NASA LaRC has a continual inspection program of each facility to determine presence of any ACBMs. Any asbestos encountered during any activity associated with the Proposed Action will be removed as necessary in accordance with NASA LaRC regulations, specifically Section 01060, Langley Safety and Environmental Requirements, part 1.20, "Asbestos Operations".

It is the policy of NASA LaRC to prevent contamination of the environment with PCBs (polychlorinated biphenyls) and to comply with all Federal, State and local regulations applicable to PCBs. NASA LaRC policy is to minimize use of PCBs at NASA LaRC and withdraw items containing PCBs from service whenever practically and economically feasible to do so. No PCBs are expected to be encountered during any activity associated with the Proposed Action. Should any PCBs be encountered, NASA LaRC has a detailed PCB Management and Spill Response Program (NASA, 1991) which provides information on the nature of PCBs along with applicable rules and regulations pertaining to proper handling and management of PCB materials and equipment.

Disposal of hazardous waste shall be conducted in accordance with RCRA and Federal Regulations, State regulations (VR 672-10-1), and LHB 8800.1, Chapter 5 (Environmental Program Manual).

4.3.3. Radioactive Materials and Non-Ionizing Radiation

Regulations issued by OSHA define radiation areas and high radiation areas for the work place (29 CFR 1910.96). Radiation areas are based on a major portion of the body being exposed to radiation doses in excess of 5 millirem per hour in excess of 100 millirem for five consecutive days. High radiation areas are accessible areas where a major portion of the body could receive radiation doses in excess of 100 millirem per hour. The above doses are not averaged; they refer to exposure in any single hour or block of days.

For non-ionizing radiation, OSHA established a radiation protection guide for normal environmental conditions and for incident electromagnetic energy of frequencies from 10 MHZ (megahertz) to 100 MHZ (29 CFR 1910.97). This radiation protection guide is 10 milliwatts per square centimeter, as averaged over any possible one-hour period.

Operation of the Proposed Action will not require the use of and will not produce radioactive materials or non-ionizing radiation. During construction, x-ray examination of piping welds will be performed in accordance with the Langley Facility Safety Requirements, Ionizing Radiation (LHB 1710.5).

4.4. SOCIOECONOMIC RESOURCES

Socioeconomic resources that may be impacted by the Proposed Action and the No Action Alternative include Historic, Archaeological, and Cultural Resources; Coastal Resources Management; Economic, Population, and Employment Factors; Traffic and Parking; Aesthetic Resources; Energy; and Environmental Justice.

4.4.1. Historic, Archaeological, and Cultural Factors

NASA has a programmatic agreement among National Conference of State Historic Preservation Officers and the Advisory Council on Historic Preservation that addresses consultation and mitigation measures for projects which, through demolition, alteration, or new construction affect facilities designated as NHLs (National Historic Landmarks). Historical inventories of NASA LaRC produced five NHLs (Foster Wheeler, 1996). A comprehensive inventory of NASA LaRC is on-going and under contract with the National Park Service.

NASA LaRC is developing an HCRMP (Historic Cultural Resources Management Plan) under the direction of its Facility Preservation Officer. This plan will be based upon information obtained from previous archaeological surveys and building inventories within NASA LaRC as well as Center-wide archaeological Phase I and Phase II surveys under contract with ACOE (Figure 4.7.). The plan will specify zones of "cultural resource potential" and will likely establish a Historic District within NASA LaRC.

The No Action Alternative is not expected to have any significant adverse impacts on any historic, archaeological, or cultural resources at NASA LaRC. All activities associated with the Proposed Action are scheduled to occur within the General Research/Support/Community, a heavily developed functional zone within NASA LaRC. Thus, the Proposed Action is not expected to have any significant adverse impacts on any historic, archaeological, or cultural resources.

Furthermore, all expected activities associated with the Proposed Action (except for the proposed placement of a natural gas pipeline) are scheduled to occur within the Building 1275 footprint. Final determination of the pipeline pathway will be determined by NASA LaRC in mid-1998. At that time NASA LaRC environmental personnel will assess whether the proposed placement will cross any regions likely to contain archaeological artifacts. If necessary, the pipeline routing will be adjusted to avoid areas believed to contain historic resources. Should historic resources be encountered during pipeline construction, detailed surveys will be conducted to ensure resource preservation and appropriate pipeline re-routing.

4.4.2. Coastal Resources Management

The CZMA (Coastal Zone Management Action of 1992; 16 U.S.C. 1451 et seq.) requires Federal agencies to ensure that the following are consistent with the enforceable policies of the approved State coastal zone management program: (1) proposed projects within the coastal zone, and (2) proposed projects outside the coastal zone which affect resources within the coastal zone. The VCRMP (Virginia Coastal Resources Management Program) is administered by VDEQ-Division of Public and Intergovernmental Affairs.

In implementing the VCRMP, VDEQ-Division of Public and Intergovernmental Affairs considers an activity to affect the coastal zone if it requires a permit or approval under any of the listed programs. The activity is considered to be consistent with the VCRMP if it is consistent with all the applicable programs (i.e., applies for and receives all applicable State licenses, permits, and approvals). Both the Proposed Action and the No Action Alternative do not require a permit or approval under any of the listed programs and are, thus, considered to be consistent with the Coastal Resources Management Plan of the Commonwealth of Virginia.

4.4.3. Economic, Population, and Employment Factors

NASA LaRC is located in the City of Hampton, which had an estimated population of 137,700 in 1996. Hampton is part of a large metropolitan area in Southeastern Virginia comprising the MSA (Hampton Roads Metropolitan Statistical Area). The MSA consists of Chesapeake, Gloucester, Hampton, Isle of Wight, James City, Matthews, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, Williamsburg, and York; as well as Currituck County in North Carolina. The population of the entire MSA was estimated at 1,520,057 for 1996. Data from the 1990 census put the MSA population at 1,444,710, which indicates a growth rate of 19.4% in the ten years since the 1980 census.

Total employment in the Hampton Roads Metropolitan Statistical Area in 1995 was 881,253. Military personnel comprised 120,644 (13.7%) of these employees. The MSA per capita income totaled $17,179 in 1990 and has increased to $20,332 in 1995 (HRPDC, 1998).

With a total annual budget for the 1996 fiscal year of $624.6 million, NASA LaRC plays an important role in the area's economy. Excluding civil service and contractor payrolls, NASA LaRC contributed $180.7 million to the Hampton Roads economy in the 1996 fiscal year. This consisted of $165.2 million in awards to businesses, $8.1 million for non-profit institutions, and $7.4 million to educational institutions.

Total permanent employment at NASA LaRC equaled 4,295 (includes civil servants and contractor employees) as of September 1996, making it a major local employer. 2,462 (57.4%) of these employees were civil servants and 1,833 (42.6%) were contractor employees working for 29 contractors either on-site or nearby. Salaries and benefits for all civil servant employees for Fiscal Year 1996 totaled $174.6 million. Employment projections at NASA LaRC predict civil servant employment to remain fairly stable, while contractor employment is projected to decline approximately 33% over the next four years until the year 2000. The projected level of employment for NASA LaRC in the year 2000 is 3,654 permanent employees (NASA LaRC, 1998c).

Neither the Proposed Action nor the No Action Alternative are expected to have any significant adverse impacts on NASA LaRC employment projections. No change in the number of operating personnel is anticipated with either the No Action Alternative or the Proposed Action. The capital expenditure for this renovation is a minor addition to the $2.2 billion NASA LaRC facility, but will provide a great benefit for local businesses involved in the construction and renovation project.

4.4.4. Traffic and Parking

The proposed addition to the CF_4 hypersonic wind tunnel will fit into the footprint of the existing building and will not require expansion into the surrounding areas. No displacement of parking spaces is anticipated. Since there will be no increase in facility personnel with either the No Action Alternative or the Proposed Action, no significant adverse impacts on long-term traffic patterns or necessary parking are expected. Construction equipment and personnel will create a minor and temporary increase in traffic, but alternate routes and parking areas will be developed during the construction phase of the project.

4.4.5. Aesthetic Resources

Building 1275 is located on the eastern border of the NASA LaRC property line. The adjacent area is marsh land leading to the Northwest Branch of the Back River (Foster Wheeler, 1996). Despite the additional height of the building after the renovation, it will not be visible to any local residential or commercial areas outside the NASA LaRC. Neither the No Action Alternative nor the Proposed Action are expected to have any significant adverse aesthetic impacts on the local population.

4.4.6. Energy

The Proposed Action involves installing a natural gas fueled combustion fired heater system. The NASA LaRC energy management program for energy conservation and efficiency will be followed accordingly. No additional electrical energy usage is anticipated from the Proposed Action. Alternative energy sources, such as solar power, were determined to be insufficient to meet the minimum required technical requirements described in Section 3.2.

Under the No Action Alternative, electrical energy will remain as the primary energy source.

4.4.7. Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires Federal agencies to identify and address the potential for their programs, policies, and actions to have adverse human health effects or environmental effects on minority or low-income populations. The companion Presidential Memorandum directs Federal agencies to include an analysis of the effects of their actions on minority and low-income communities, along with mitigation measures for significant adverse effects.

The area west of NASA LaRC is one of the least developed areas of the city of Hampton, VA. This area is comprised of trailer parks, an apartment complex, and an auto racing track. The trailer park area and the apartment complex are subject to significant noise sources other than the LARC wind tunnels. These sources include jet aircraft at LAFB and the automotive race track located directly across from NASA LaRC property. These sources often generate high noise levels relative to wind tunnel noise. NASA LaRC has developed a comprehensive community relations program under the Center's Superfund program and the Environmental Justice Implementation Plan. Both plans outline NASA LaRC community outreach strategies which help ensure that outreach efforts continue to target groups that constitute a representative cross-section of the local populations (Foster Wheeler, 1996).

As addressed in the previous sections, the Proposed Action will comply with all applicable environmental statutes and regulations. The proposed NASA LaRC modification of the Building 1275 CF_4 gas heater system is not anticipated to have significant adverse environmental or socioeconomic impacts for minority or low-income populations.

SECTION 5.0. DETERMINATION OF THE PREFERRED ALTERNATIVE

This section describes the identification of NASA LaRC's Preferred Alternative. Identification of the Preferred Alternative is primarily based upon the ability of the alternative to meet the necessary criteria requirements (described in Section 3.2.) and expected severity of potential environmental impacts as identified using a variety of evaluation criteria.(discussed in Section 4.0. and listed in Appendix A). Determination of a Preferred Alternative is required by CEQ (Council on Environmental Quality) Regulation 1502.14.

5.1. EVALUATION CRITERIA

The evaluation criteria against which each alternative was compared are listed in Appendix A. These evaluation criteria can be used as guidelines in determining the potential impacts of an activity. The evaluation criteria can also be used as (1) cursory screening tool for qualitative impact assessment of whether a project's potential impacts warrants more detailed evaluation or (2) rigorous decision criteria for quantitative impact assessment (US Army, 1996). The evaluation criteria listed in Appendix A were adapted from USARMY, 1996.

5.2. DETERMINATION OF PREFERRED ALTERNATIVE

The results of comparing each alternative against evaluation criteria which characterize each quality of the Affected Environment are shown in Table 5.1. Whereas both the Proposed Action and the No Action Alternative are not expected to have any significant adverse impacts to the physical resources, biological resources, waste management, or socioeconomic resources of NASA LaRC, only the Proposed Action satisfies the heater evaluation criteria. Therefore, the Proposed Action of this EA is the Preferred Alternative.

Table 5.1. Identification of Preferred Alternative

Characteristics	Alternatives	
	Proposed Action	*No Action Alternative*
Heater Evaluation Criteria		
Minimal Technical Requirements	1	3
Physical Resources		
Land Use	1	1
Water Quality	1	1
Air Quality	1	1
Noise	1	1
Wetlands and Floodplains	1	1
Biological Resources		
Terrestrial and Aquatic Vegetation	1	1
Fish and Wildlife	1	1
Endangered and Threatened Species	1	1
Waste Management	1	1
Nonhazardous and Solid Waste	1	1
Hazardous Waste	1	1
Socioeconomic Resources		
Historic, Archaeological, and Cultural Resources	1	1
Coastal Resources Management	1	1
Economic, Population, and Employment Factors	1	1
Traffic and Parking	1	1
Aesthetic Resources	1	1
Energy	1	1
Environmental Justice	1	1

1 = No Impact 2 = Adverse Impact 3 = Significant Adverse Impact

SECTION 6.0. REFERENCES

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Foster Wheeler Environmental Corporation. 1996. Final Environmental Resources Document, Langley Research Center, Hampton, VA.

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NASA LaRC (Langley Research Center). 1998b. FY00 Project: Mods to 20-Inch Mach 6 CF_4 Tunnel (B1275), Criteria and Requirements Document.

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NASA LaRC (Langley Research Center). 1993. Memorandum on Lead Bath Heater Incident, CF_4 Tunnel, B1275. September 27, 1993.

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NASA LaRC (Langley Research Center). 1991b. Environmental Program Manual, NASA Langley Research Center, LHB 1710.5.

NASA LaRC (Langley Research Center). 1988. Memorandum on Lead Bath Heater Incident, CF_4 Tunnel, B1275.

ODU (Old Dominion University). 1995. Baseline Biological Survey of Terrestrial and Aquatic Habitats at NASA Langley Research Center, with Special Emphasis on Endangered and Threatened Fauna and Flora.

ODU (Old Dominion University). 1992. Wetland Survey of Forested Lands Adjacent to Buildings 1209, 1250, 1251 at NASA Langley Research Center. Final Report. AMRL Technical Report No. 891.

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US Army. 1996. Fort Eustis, Virginia: Environmental Assessment of the Master Plan and Ongoing Mission Activities. Prepared by SAIC (Science Applications International Corporation).

SECTION 7.0. AGENCIES RECEIVING COPIES OF THIS EA

Chesapeake Bay Local Assistance Department
Department of Transportation
Department of Environmental Quality
Department of Game and Inland Fisheries
Department of Conservation and Recreation
Department of Historic Resources
Department of Mines, Minerals and Energy
Department of Agriculture and Consumer Services
Department of Environmental Quality (Tidewater Regional Office)
Department of Health
Hampton City Manager, City Hall
Hampton Roads Planning Commission
Marine Resources Commission
U.S. Department of the Interior, Fish and Wildlife Service
U.S. Environmental Protection Agency, Region III
Virginia Institute of Marine Science

APPENDIX A.
ENVIRONMENTAL EVALUATION CRITERIA

APPENDIX A. ENVIRONMENTAL EVALUATION CRITERIA

These evaluation criteria can be used as guidelines in determining the potential impacts of an activity. The evaluation criteria can also be used as (1) cursory screening tool for qualitative impact assessment of whether a project's potential impacts warrants more detailed evaluation or (2) rigorous decision criteria for quantitative impact assessment (US Army, 1996). The following evaluation criteria were adapted from USARMY (1996) which developed the evaluation criteria based upon information in the following sources:

U.S. Air Force. 1994. *Preliminary Draft Eglin AFB Environmental Baseline Study Impacts Appendices*. Prepared by the Earth Technology Corporation, Colton, CA.

Fittipaldi, J.J. and E.W. Novak. 1980. *Guidelines for Review of EA/EIS Documents*. Construction Engineering Research Laboratory Technical Report No. 92, United States Army Corps of Engineers.

USEPA. 1995. *Principles for Review of Environmental Impact Assessments, Final Draft.*

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A.1. HEATER EVALUATION CRITERIA

Minimum Technical Requirements: These criteria were developed by the NASA Study Team as being the minimum technical requirements necessary for an adequate replacement heater system for Building 1275.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity does not meet any of the minimum technical requirements as described by the NASA Study Team.
-	The activity reduces efficiency of the current operating system.

Adverse	The activity is likely to improve the current operating efficiency but does not meet any of the minimum technical requirements.
-	The activity is likely to meet a portion of the minimum technical requirements, but not all of them with no efficiency loss as compared to current operating system.
No Impact	The activity is likely to meet all minimum technical requirements.

A.2. PHYSICAL RESOURCES

Physical resources that may be impacted by the Proposed Action and the No Action Alternative include land use, water quality, air quality, noise, wetlands, and floodplains. This section suggests factors to consider in evaluating the potential impacts

Land use: Land use plans address the integration of man-made and natural environments and the human activities occurring in a community. In general, a community land use plan is implemented to protect the health, safety, and welfare of the population.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity has the potential to adversely affect the health, safety, and welfare of the populations or quality of the environment.
-	The activity creates a direct conflict among neighboring land use activities, for example, residential areas and range/training areas.
-	The activity will permanently destroy the existing land use designation, for example, convert open space to commercial facilities.
Adverse	The activity requires a change in the local land use plan.
No Impact	The activity is consistent with current land uses.

Water Quality: Evaluations of water quality include an analysis of impacts to the physical, chemical, and biological properties of a waterbody.

Impact Category	Evaluation Criteria
Significant Adverse	The activity results in the introduction of pollutants to a ground water or surface water source and pollutants are likely to cause either water sources to exceed ambient WQS (Water Quality Standards).
-	The activity is likely to result in the introduction of pollutants to potable ground and surface water and is likely to cause water systems to exceed MCL (Maximum Containment Level).
Adverse	The activity is not likely to result in the introduction of pollutants to a ground water or surface water source and pollutants are not likely to cause either water sources to exceed ambient WQS.
-	The activity is not likely to result in the introduction of pollutants to potable ground and surface water and is not likely to cause water systems to exceed MCL.
No Impact	Activity does not result in the introduction of pollutants into ground water or surface water.
-	Activity does not result in the withdrawal of ground water or surface water.

Air Quality: Air quality is impacted by the release of gases and particulate from stationary and mobile sources. Air quality is also influenced by meteorological conditions.

Impact Category	Evaluation Criteria
Significant Adverse	The activity will introduce pollutants into the air that will cause ambient air quality to exceed levels established by NAAQS for CO, SO_X, NO_X, lead, ozone, and particulate matter.
-	The activity will release air pollutants in levels that exceed NESHAP (National Emission Standards for Hazardous Air Pollutants).
-	The activity will introduce NAAQS pollutants into an area designated as a non-attainment area.

-	The activity will introduce pollutants into indoor air that exceeds OSHA exposure limits.
-	Deposition of atmospheric pollutants (either directly to surface water or to land) is likely to contribute to ambient water quality problems.
Adverse	The activity will introduce pollutants into indoor air, but will not exceed OSHA exposure limits.
-	The activity will introduce NAAQS or NESHAP pollutants, but will not exceed limits either alone in conjunction with other sources.
No Impact	The activity will result in an increase in ambient concentrations of pollutants, but will not violate NAAQS.

Noise: Transportation (aircraft, marine, and land-based traffic) and construction activities are major sources of environmental noise. Besides damaging human hearing, noise also interferes with communication, interrupts sleep, causes stress, and generally impacts the quality of life. Noise can also have an adverse impact on domestic animals and wildlife.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity will expose populated areas to day-night noise levels (non-impulsive) of 76 dB or greater
-	The activity will expose populated areas to CDNL (C-Weighted Day-Night Noise Level) 70 dB and greater.
-	The activity will cause speech interference because indoor sound levels are expected to exceed 82 dB.
-	Noise levels are associated with the activity are expected to cause domestic animals and wildlife injury, abandonment of habitat, or mortality.
Adverse	The activity will expose populated areas to day-night noise levels (non-impulsive) between 65 and 75 dB.
-	The activity will expose populated areas to CDNL between 62 and 70 dB.

- The activity will cause speech interference because indoor sound levels are between 60 and 82 dB.

- The activity causes wildlife or domestic animals to display startle effects, including fleeing the area, alteration in productivity, reproduction, growth, or parenting behavior.

No Impact	The activity will expose populated areas to day-night noise levels (non-impulsive) of 65 dB or less.
-	The activity will expose populated areas to CDNL of 62 dB or less.
-	The activity will cause speech interference because indoor sound levels of 60 dB or less.
-	The activity is not likely to cause wildlife or domestic animals to display startle effects.

Wetlands and Floodplains: Floodplains are the flat areas adjacent to the river's normal channel. These areas accommodate flood flows resulting from rainfall and snowmelt. Placing structures within the floodplain can expose them to the impacts of flooding. It can also reduce the absorptive capacity of the floodplain and increase the volume and velocity of downstream floodwaters.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity results in placement of structures within the 100-year floodplain or within areas of wetlands that are likely to incur significant damage due to flooding.
-	The activity results in the significant reduction of baseline wetland area.
-	The activity displaces the absorptive capacity of the floodplain or wetland such that it restricts the flow of the 100-year base flood and increases the potential for risk to life or damage to downstream/adjacent areas.
Adverse	The activity is located within the floodplain, but structures are not likely to sustain significant damage due to flooding.

- The activity does not displace the absorptive capacity of the floodplain.

- The activity does not reduce the baseline area of wetland.

No Impact The activity is located within the floodplain, but structures will not likely sustain significant damage due to flooding.

- The activity does not occur within a wetland area.

A.3. BIOLOGICAL RESOURCES

Biological resources that may be impacted by the Proposed Action and the No Action Alternative include vegetation, fish and wildlife, and threatened and endangered species. This section suggests factors to consider in evaluating the potential impacts

Terrestrial and Aquatic Vegetation: Vegetation provides food and shelter for fish and animals. It also prevents erosion and protects water quality. Some species of vegetation provide food or habitat during critical life history stages of invertebrate and vertebrate species. Impacts to vegetation result from land clearing for construction and from other disturbances. Aquatic vegetation is impacted directly through water-based construction and indirectly through increased sedimentation or pollutant loading from land-based activities.

Impact Category	Evaluation Criteria
Significant Adverse	The activity will result in reduced diversity of terrestrial or aquatic vegetation.
-	The activity reduces or eliminates native species or their habitats.
-	The activity requires removal of vegetation which will likely cause significant erosion.
-	The activity involves the introduction of pollutants, including sediments and nutrients, that may impact terrestrial and aquatic vegetation which serves as critical habitat for threatened or endangered species.
Adverse	The activity replaces native vegetation with non-native, but non-invasive species.

- The activity replaces native vegetation that served as food source or habitat with vegetation that provides food or habitat of lesser value.

- The activity requires removal of vegetation which will likely cause minor erosion.

- The activity involves the introduction of pollutants, including sediments and nutrients, that may impact terrestrial and aquatic vegetation which serves as habitat for indigenous species.

No Impact — The activity does not remove vegetation or the project activity is restricted to a previously developed area of the base that has already been disturbed.

Fish and Wildlife: Impacts to fish and wildlife can occur through numerous pathways including destruction of habitat and food source, restriction of population movement due to habitat fragmentation, alteration of community structure caused by changes in populations of predator or prey species, and contamination through the introduction of pollutants to the environment.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity will reduce or destroy food or habitat of importance to terrestrial, riparian or aquatic wildlife.
-	The activity eliminates fish spawning or wildlife breeding areas.
-	The activity eliminates a native population.
-	The activity will permanently (5 years or longer) reduce populations of fish or wildlife species by 50 percent.
Adverse	The activity reduces the areal extent of fish spawning or wildlife breeding areas, but does not eliminate them.
-	The activity will permanently (5 years or longer) reduce populations of fish or wildlife by 15 to 50 percent.
-	The activity results in temporary alteration of fish or wildlife habitat, but not during critical stages of the species' life cycle.

No Impact	The activity is located within a previously developed area and/or does not disturb the habitat, food source, or migratory pathways of fish or wildlife.

Threatened and Endangered Species: Threatened or endangered species can either be plant or animal. A list of threatened and endangered species is published in 50 CFR Part 17. Populations of Threatened and Endangered Species are particularly sensitive to disruption.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity, alone or in combination with other activities, is likely to jeopardize the continued existence of a species including individual members of the species or their habitat.
-	The activity is located in an area where threatened or endangered species are present and known to be sensitive to human activities.
-	The activity will destroy critical habitat of threatened or endangered species.
Adverse	The activity, alone or in combination with other activities, is likely to inhibit a species' recovery.
-	The activity is located in an area where threatened or endangered species are present, but they are not sensitive to the actions associated with the construction or operation of the activity.
No Impact	There are no threatened or endangered species in the proximity of the activity.

A.4. WASTE MANAGEMENT

Waste management issues may be impacted by the Proposed Action and the No Action Alternative include nonhazardous and solid waste, hazardous waste, radioactive materials and non-ionizing radiation. This section suggests factors to consider in evaluating the potential impacts.

Nonhazardous and Solid Waste: When considering the impact of a project on the generation of nonhazardous and solid waste, it is important to determine the volume and rate of waste generation and the capacity of waste management, including recycling and disposal systems.

Impact Category	**Evaluation Criteria**
Significant Adverse	Recyclable nonhazardous and solid wastes generated by the activity will not be recycled because the volume generated will exceed the capacity of recycling operations.
-	Accommodating the increased nonhazardous and solid waste generated will cause a substantial increase in consumer costs of waste management.
-	Storage and handling of wastes increases the potential for spills or leaks that may potentially contaminate soil, ground water or surface water.
Adverse	Nonhazardous and solid waste volumes generated will reduce the life of existing waste management and disposal operations.
-	Accommodating the increased waste generated will cause a nominal increase in consumer cost of waste management.
No Impact	The activity will not increase the waste stream.

Hazardous Waste: When considering the impact of an activity on the management of hazardous material, it is important to evaluate the usage and storage of hazardous materials in addition to the storage and disposal requirements for hazardous waste. It is important to note that for evaluation purposes, radiation and non-ionizing radiation are considered forms of hazardous waste.

Impact Category	**Evaluation Criteria**
Significant Adverse	Permanent or temporary storage tanks at the activity site are not equipped with leak detection mechanisms, secondary containment systems, spill and overfill protection or other safety services.
-	Failure of hazardous waste handling, storage or disposal poses a threat to public health and/or environmental media.

	-	Accommodating the increased hazardous waste generated will pose significant cost.
	-	The activity requires long-term generation, storage and/or disposal of large quantities of hazardous waste.
Adverse		The activity requires the removal and disposal of structural materials that contain hazardous materials.
	-	Accommodating the increased waste generated will cause a nominal increase in consumer cost of waste management.
	-	The activity requires the management of hazardous wastes.
No Impact		The activity will not generate hazardous waste.
	-	The activity will not require hazardous waste management.

5.1.5. Socioeconomic Resources

Socioeconomic resources that may be impacted by the Proposed Action and the No Action Alternative include Historic, Archaeological, and Cultural Resources; Coastal Resources Management; Economic, Population, and Employment Factors; Traffic and Parking; Aesthetic Resources; Energy; and Environmental Justice. This section suggests factors to consider in evaluating the potential impacts.

Historic, Archaeological, and Cultural Resources: These include archaeological, historic, and other cultural sites.

Impact Category		Evaluation Criteria
Significant Adverse		The activity will destroy an archaeological, historical, or other cultural site that is listed on the NRHP (National Register of Historic Places).
	-	The activity will permanently restrict public access to an archaeological, historic, or cultural site that is listed on the NRHP.
	-	The activity is located in an area where there is a high probability of finding artifacts of archaeological, historical or cultural value and no plan exists for evaluating and recovering artifacts during the course of the project.

Adverse	The activity will temporarily restrict public access to an archaeological, historic, or cultural site that is listed on the NRHP.
-	The activity is located in an area where there is a high probability of finding artifacts of archaeological, historical or cultural value but a plan exists for evaluating and recovering artifacts during the course of the project.
No Impact	The activity will not affect public access to an archaeological, historic, or cultural site that is listed on the NRHP.
-	The activity is not located in the vicinity of an archaeological, historic or cultural site that is listed on the NRHP.
-	The activity is not located in an area where there is a high probability of finding artifacts of archaeological, historical or cultural value.

Coastal Resources Management: The CZMA requires Federal agencies to ensure that the following are consistent with the enforceable policies of the approved State coastal zone management program: (1) proposed projects within the coastal zone and (2) proposed projects outside the coastal zone which affect resources within the coastal zone.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity is not consistent with VCRMP, and is likely to result in significant adverse impacts to the biological and physical resources of the coastal environment.
-	The activity is not consistent with VCRMP, and mitigation measures are not planned to avoid any potential significant adverse impacts.
Adverse	The activity is not consistent with VCRMP, and is likely to result in adverse impacts to the biological and physical resources of the coastal environment.
-	The activity is not consistent with VCRMP, and mitigation measures are planned to avoid any potential significant adverse impacts.
No Impact	The activity is consistent with VCRMP.

Economic, Population, and Employment Factors: The effects of a project on the economy depend on the size of the project, in terms of project expenditure and employment, and the duration of the project. Population characteristics potentially affected by a project include employment, migration, birth, and death rates.

Impact Category	Evaluation Criteria
Significant Adverse	The activity will cause unemployment to increase by more than 1 percent.
-	The activity will cause household income to decrease by more than 1 percent.
-	Within the economic region of influence, the activity will create or contribute to an excursion above or below the existing forecasted population by more than 5 percent.
Adverse	The activity will cause employment to increase by 0.5 to 1 percent.
-	The activity will cause household income to decrease by 0.5 to 1 percent.
-	Within the economic region of influence, the activity will create or contribute to an excursion above or below the existing forecasted population by between 1 and 5 percent.
No Impact	The activity does not result in changes to employment or household income.
-	Within the economic region of influence, the activity will create or contribute to an excursion above or below the existing forecasted population by less than 1 percent.

Traffic and Parking: Traffic and parking includes road systems which facilitate the movement of people and goods. Traffic and parking can cause aesthetic problems and create physical barriers to movement and human and wildlife passage.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity is likely to result in increased utilization of a public road such that the level of service would decrease to an unacceptable level, as defined in county or local comprehensive plans.
-	The activity requires the acceleration of planned capacity improvements by more than 5 years.
-	The activity requires development of new of significantly expanded transportation services, which will cause cumulative impacts on air and water quality, and biological resources.
Adverse	The activity is likely to result in increased utilization of a public road which may cause a decrease in the level of service; but the level of service will remain equal to or better than they level of service planned in county or local comprehensive plans.
-	The activity requires the acceleration of planned capacity improvements by 2 to 5 years.
-	The activity requires development of new of significantly expanded transportation services, which are not projected to cause cumulative impacts on air and water quality, and biological resources.
No Impact	Activity related increases in transportation are not anticipated to decrease the level of service projected in county or local comprehensive plans.
-	The activity requires the acceleration of planned capacity improvements by 1 year or less.

Aesthetic Resources: Aesthetics, in a broad sense, include the general visual, audio, and tactile environment and their emotional or psychological effect on people. Aesthetic resources refer to the structures, landscapes, and space of an area which provide information for an individual to develop perceptions of the area.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity will degrade the visual scene of the surrounding area, including interfering with natural views, destroying natural vegetative buffers, contributing smoke, causing odors and noise, or discoloring water bodies.
-	The activity will destroy, damage, or obscure scarce or unique geological features, landscapes, or other objects of particular aesthetic value.
-	The activity will deny accessibility to aesthetic resources, including recreational access.
Adverse	The activity will cause temporary disruption of the visual scene of the surrounding area, but will not disturb natural vegetative buffers.
-	The activity will degrade the visual scene of the surrounding area, but architectural and landscaping techniques are employed to minimize the impact.
-	The activity will limit accessibility to aesthetic resources, including restricted recreational areas.
No Impact	The activity will not alter the visual or aesthetic character of the area.

Energy: Several energy sources are available to power work-related activities including electricity, natural gas, coal, steam, solar, wind, and hydroelectric.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity is powered by an inappropriate energy source that cannot guarantee performance and is likely to have significant adverse impacts on biological and/or physical resources.

-	Activity is not consistent with an energy management program for energy conservation and efficiency. No mitigation is planned.
-	No energy source alternatives are considered during project design.
Adverse	The activity is powered by an inappropriate energy source that cannot guarantee performance and is likely to have adverse impacts on biological and/or physical resources.
-	Activity is not consistent with an energy management program for energy conservation and efficiency, but mitigation is planned.
No Impact	Activity is consistent with an energy management program for energy conservation and efficiency.

Environmental Justice: Executive Order 12898 (Federal actions to address Environmental Justice in minority and low-income populations) requires Federal agencies to identify and address the potential for their programs, policies, and actions to have adverse human health or environmental effects on minority or low-income populations. The companion Presidential Memorandum directs Federal agencies to include in their NEPA documents an analysis of the effects of their actions on minority and low-income communities, along with mitigation measures for significant and adverse effects.

Impact Category	**Evaluation Criteria**
Significant Adverse	The activity is likely to result in disproportionately high or adverse human health effects or environmental effects on minority or low-income populations as defined by Executive Order 12898. This action will likely result in significant adverse impacts on socioeconomic resources of a population.
Adverse	The activity is likely to result in minor human health or environmental effects on minority or low-income populations as defined by Executive Order 12898. This action will likely result in adverse impacts on socioeconomic resources of a population.
No Impact	The activity does not result in determinable health or environmental effects on minority or low-income populations as defined by Executive Order 12898. This action will not likely impact any socioeconomic resources of a population.