Environmental Assessment
Building 38 Modifications for Advanced Subsonic Combustion Test Rig

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Prepared for:

Office of Environmental Programs
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SECTION 1

SUMMARY AND CONCLUSIONS

This Environmental Assessment (EA) has been prepared in response to a proposed action at NASA Lewis Research Center (LeRC) in Cleveland, Ohio, to develop the capability to perform advanced subsonic combustion (ASC) tests on turbine engines. The proposed action would involve installing and operating ASC test equipment at the site of a former combustion equipment rig in Building 38.

The results of this new ASC testing are expected to be the development of higher efficiency turbine engines, with improved fuel efficiency and reduced emissions. This testing is critical to meeting NASA's stated goals of its engine efficiency program, as well as addressing environmental and energy needs of the nation.

This EA is prepared pursuant to the National Environmental Policy Act (NEPA), whereby NASA is required to consider and document the environmental impacts of such an action. The proposed action and two alternative actions have been considered in this EA and are listed below:

1. Installation of the test equipment at Building 38
2. No action taken to perform ASC testing
3. Perform the testing elsewhere at another site.

The impacts these three alternatives would have on environmental parameters have been evaluated and are summarized in Table 1. The Proposed Action column assesses the potential impacts of the proposed alternative against the environmental parameters, and identifies the impacts as "Not Expected" or "Possible". "Not Expected" implies that NASA's assessment, based on available information, indicates that there is little to no likelihood of adverse environmental impacts associated with the proposed action. "Possible" implies that NASA's assessment indicates that environmental impacts are possible or likely. The final two columns compare the expected environmental impacts of the alternatives against those of the proposed action, and indicate whether the environmental consequences of the alternatives are anticipated to be greater, similar, or less than the proposed action.

In general, the environmental parameters expected to be most impacted by the proposed action are Air Resources, Water Resources, and Noise. Noise is a direct consequence of testing jet engines and jet engine components. The water resources may be impacted in that a part of the ASC is a water quench that will scrub the air, capturing unburnt fuels and hydrocarbons. The water quench is circulated through a cooling tower, and the cooling tower blowdown is discharged to the sanitary sewer system. The air resources may be affected in two respects. There will be atmospheric exhaust from the test system with the potential for the release of hydrocarbons and combustion products. Future beneficial impacts on air resources are expected as a result of the testing of engine designs that reduce emissions to the atmosphere.

Neither of the two alternatives considered were determined to be more attractive than the proposed alternative.

NASA concludes that the proposed action and its alternatives are absent significant environmental impacts.

Table 1

Summary of Environmental Impacts of Alternatives

	Proposed Action	No Action	Alternate Site
Land Resources	Not Expected	Similar	Similar/ Greater
Air Resources	Possible	Greater	Similar/ Greater
Water Resources	Not Expected	Similar	Similar
Noise	Not Expected	Similar	Similar
Biotic Resources	Not Expected	Similar/ Greater	Similar/ Greater
Floodplains/ Wetlands	Not Expected	Similar	Similar/ Greater
Historical/ Archeological/ Cultural	Not Expected	Similar	Similar/ Greater
Social/Economic	Not Expected	Similar	Greater
Solid Waste	Not Expected	Similar	Greater
Hazardous Waste	Not Expected	Similar	Similar/ Greater

SECTION 2

PURPOSE AND NEED FOR THE PROPOSED ACTION

INTRODUCTION

NASA is contemplating the addition of advanced subsonic combustion test equipment to assist in developing more efficient combustors for turbine engines. The background for the advantages that may be provided by such development, and the need for specific testing equipment, are provided in this section.

BACKGROUND

NASA's Lewis Research Center has had a long and productive history in aircraft engine development. During its 50 year history, the nation's air fleet has moved from relatively simple (but massive) radial engines to turbojets, in many varieties.

Turbojets, in turn, have allowed the development of a civil aviation fleet that has changed air travel into a 400 billion passenger mile per year industry, one that has connected both coasts into a single business day and one that services nearly 20% of total passenger miles traffic in the U.S. Internal combustion engines thirty years ago required complete rebuilds every 2000 hours, and failed frequently in flight. Turbine engines were fuel inefficient. By contrast today's turbine engines are lighter, more fuel efficient, last 7 times longer, and rarely fail. They also burn cleaner.

Even so, engines can be further improved. A small change in performance translates to a large change in flight economics. Were it not for performance improvements fostered by NASA, aircraft travel would still be a true luxury enjoyed by a very few.

The industry consumes 20 billion gallons (75.71×10^9 liters) of fuel/year. A 5% improvement in performance could easily conserve 1 billion gallons (3.79×10^9 liters) of fuel per year in future aircraft fleets.

PURPOSE AND NEED

NASA has stated goals in support of its engine efficiency improvement program. One of those goals is to increase the temperature and pressure at the combustor inlet. In a sense this is equivalent to increasing the compression ratio in an automobile engine, higher performance can be extracted from an engine of the same weight, and fuel efficiency will improve. Additionally, it is expected that reduced NOx emissions will be observed.

Further increases in combustion pressure and temperature will require new materials, new designs, and testing of the materials and designs. Currently, NASA/Lewis does not have equipment to test combustors at the elevated temperature and pressure of the stated goals. Accordingly, NASA now desires to upgrade its testing facilities to provide testing of improved combustor designs.

NASA wants to develop the capability to perform advanced subsonic combustion (ASC) tests. The results of these tests are expected to be critical improvements of combustor designs to deliver higher performance to turbine engines. The ASC tests will allow operation of the engines at upgraded temperatures and pressures of 1300 F and 900 psi (704.4 C and 6.21×10^6 Pascal), compared to previous maximum capabilities of 900 F and 600 psi (482.2 C and 4.14×10^6 Pascal).

NASA is considering installing the ASC equipment on the site of a former combustion equipment rig in Building 38 at the Lewis Research Center. To this end, NASA conducted a Preliminary Review which conceptually lays out the requirements for and sketches out the plans necessary to accommodate ASC equipment at this location. Requests for Action (RFAs) were generated and returned to the review committee; the Environmental Assessment was in response to one of those RFAs.

The National Environmental Policy Act requires that NASA consider and document the environmental impacts of a decision to proceed as soon as practicable in the process. The time following preliminary design (which specifies how a decision may be implemented) is a practicably early time.

The project design lays out the following equipment to perform the ASC tests:

a) A new preheat facility which is jet fuel fired at an estimated 18 MMBTU (18 million British Thermal Units)/hour (5.274 megawatts). An existing natural gas fired preheater may occasionally be used at low operating conditions.

b) A new, electrically driven compressor (low frequency noise)

c) A small scale test rig (burning JP5 and Jet A for 16-32 hours per week, generating inside high frequency sounds from pressure drops across valves)

d) A closed-loop quench system, containing contact cooling water. The contact cooling water will have traces of unburned fuel and combustion products.

SECTION 3

DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

The proposed action and alternatives are:

1. Installation of the test rig in Building 38 at NASA LeRC, Cleveland, Ohio.

2. No action taken to develop the capability to perform advanced subsonic combustion (ASC) tests.

3. Perform the ASC testing elsewhere at another facility.

Each of the three choices are briefly described below:

INSTALLATION OF THE TEST RIG IN BUILDING 38

The proposed action would include the installation and operation of a new preheat facility, a new electrically driven compressor, a small scale test rig, and a quench facility. The preheater will be jet fuel fired and operate at 18 MMBTU (18 million British Thermal Units)/hour (5.274 megawatts). The test rig will operate for 16-32 hours per week, burning Jet A and JP5 fuels, at a maximum rate of 23.3 gallons per minute (1.47 liters/sec). The quench facility will generate contact cooling water with potential for containing unburned fuel and combustion products. The water will recirculate through cooling tower #1. Cooling tower #4 has been dismantled and will be rebuilt. When construction is complete of the new cooling tower #4, the quench water from this test system will recirculate through cooling tower #4.

NO ACTION

This alternative would either act to prevent the development of higher performance combustors (with the consequential negative impacts on future aircraft performance and continued greater NOx emissions), or cause the testing to be performed elsewhere, essentially equivalent to the third alternative.

PERFORM THE TESTING ELSEWHERE

At a minimum, this alternative will involve the installation and operation of test equipment very much like that noted in the proposed action. Unlike the proposed action, where the test rig will be backfit into an existing test facility and additional components of the system are already in place (fuel pumps, fuel tanks etc.), this alternative may require more resources to construct the complete system, and would be dependent on the site chosen.

SECTION 4

AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACT OF ALTERNATIVES

INTRODUCTION

This section has been organized consistent with the format of NASA's Environmental Resources Document and addresses those factors identified in the Facility Project Implementation Handbook (Reference 9) and 14 CFR 1216.3. This section will generally describe the environmental factors, and assess the impact of each of the three alternatives described in Section 3 against those parameters. The impact of the three alternatives will be compared and contrasted to the following:

- o Land Resources
- o Air Resources
- o Water Resources
- o Noise and Vibration
- o Biotic Resources
- o Floodplains and Wetlands
- o Historical, Archeological and Cultural Factors
- o Social and Economic Factors
- o Solid Waste
- o Hazardous Waste

LAND RESOURCES

The soils covering the majority of the Central Area of the Lewis Research Center consist of "Allis Complex". The Allis Complex is formed in clayey material overlying shale bedrock. The soil has low permeability above the bedrock as is poorly drained.

The Central Area comprises 177.7 acres (71.92×10^4 square meters) of land space of NASA's approximately 365 total site acres (147.72×10^4 square meters), and is rather densely built-up. Approximately 30% of the Central Area is considered open or underdeveloped.

INSTALLATION OF THE TEST RIG IN BUILDING 38

The proposed action is not expected to have a negative impact on land resources. The proposed action will involve installation of the test rig and its associated components into an existing building. Additionally, already existing components intended for use in this system (such as high pressure fuel pumps, fuel tanks) are already in place. There is a potential that in final design, some foundation and soil excavation would be required to fit the compressor and preheater into the existing site. The impact on the land/soils would be limited to within the Building 38 compressor room.

NO ACTION

The no action alternative would involve no impact to the land resources, as there would be no activity occurring at the site of this investigation.

PERFORM THE TESTING ELSEWHERE

At a minimum, the impact to land resources required by this alternative would mirror those of the proposed alternative. At worst, this alternative requires additional land resources.

AIR RESOURCES

The U.S. Environmental Protection Agency (EPA) holds the primary responsibility for administering the Clean Air Act. This authority has been delegated to the Ohio EPA, who has contracted with the Cleveland Division of Air Pollution Control (CDAPC) to administer the program in Cleveland and Cuyahoga County. Most of LeRC is within the municipal boundries of the City of Cleveland. The Cuyahoga County area is considered a non-attainment area for ozone (moderate non-attainment), PM10 (particulate matter <10 microns, secondary non-attainment), NOx (nitrogen oxides), and SO2 (sulfur dioxide). In the fall of 1993, CO was taken off the list of pollutants contributing to non-attainment in the Cuyahoga County. Daily air quality is most influenced by vehicle traffic. An air emission inventory has been performed at LeRC, and NASA is in the process of developing a strategy to permit its air sources.

INSTALLATION OF THE TEST RIG IN BUILDING 38

At two points within the proposed test system there is the potential for impacts to the air quality. There will be exhaust to the atmosphere from the heat exchanger after air passes through a quench spray. The exhaust from the test rig itself, after the air passes through another quench spray, will also be released to the atmosphere. Both have the potential for the release of burnt and unburnt hydrocarbons and combustion products (CO, NOx). The anticipated emissions from testing are approximately 14.5 tons/year CO and approximately 3 tons/year NOx. These emissions are well below the non-attainment area conformity apllicability threshold

values of 100 tons/year for both CO and NOx. Therefore we can determine that this action is in conformity with the State Implementation Plan (SIP).
Although initially, this alternative would have more of an impact on air resources than the no action alternative, a future goal of this testing is to provide jet engines that produce reduced emissions to the environment.

Although a water quench to mitigate emissions is proposed as part of this system, it is likely that air permits for this test operation will be required. This facility will be added to the air emission inventory listing mentioned above and assessed for air permit needs. The EPA may place administrative restrictions on the operation, to prevent any significant air quality impacts.

NO ACTION

There would be no immediate consequential impacts to air resources posed by this alternative, as no action generating additional emissions would occur. In a broader sense, though, the impacts of the no action alternative would have a net negative impact on the potential for designing jet engines in the future which are capable of reduced emissions generation.

PERFORM THE TESTING ELSEWHERE

The impacts to air resources posed by this alternative will be quite similar to those of the preferred alternative. An increase in air emissions will be observed during testing over that of no testing occurring whatsoever. Additionally, an increase in short term emissions (dust generation) could be observed under this alternative over that of the preferred alternative if construction activities were necessary to build a facility to house the test rig. Air permits would most likely be warranted at this facility also, and would need to be applied for and obtained in the appropriate manner.

WATER RESOURCES

Wastewater discharges are regulated under the Clean Water Act (CWA), which regulates water quality on both health-based standards and technology-based standards. All discharges to the waters of the United States require permitting under the National Pollutant Discharge Elimination System (NPDES). Lewis' Industrial Waste Sewer System (IWS) discharge is regulated under the NPDES permit.
Additionally, sanitary sewer discharges are under the authority of the North East Ohio Regional Sewer District (NEORSD), although no

formal permit has been issued. Lewis may discharge the IWS basins to the stream, compliant to its NPDES permit, or may discharge the basins to the sanitary sewer system, with prior approval of the NEORSD. Presently, the IWS basins are discharged to the sanitary sewer system, with permission from the NEORSD.

INSTALLATION OF THE TEST RIG IN BUILDING 38

The impact to water resources from this alternative are not expected to be significant in nature. The quench sprays at two points in the test system will be in contact with and scrub the air emissions of unburnt fuels (hydrocarbons) and products of combustion (CO, NOx). The primary quench and secondary quench sprays will require approximately 200 gallons per minute (GPM) and 800 GPM of water respectively. It is proposed that this contact cooling water will go to cooling tower #1, where it will be recirculated. When the cooling tower is emptied and cleaned, approximately once every two years, the cooling tower water is pumped to the IWS basins and ultimately to the stream or sanitary sewer system.

NO ACTION

A no action alternative will have no impact on the water resources from a testing standpoint.

PERFORM THE TESTING ELSEWHERE

This alternative could involve the construction of a facility to circulate cooling water through and potentially the need for subsequent water permits. If the system is set up as a closed loop, as with the proposed action, there is little to no likelihood of an impact to the water resources.

NOISE

The U.S. EPA has Guidelines for "environmental" noise, but there are no enforceable standards. Noise control for stationary sources is primarily driven by OSHA workplace standards. Local noise ordinances for the communities adjacent to the Lewis site deal with zoning restrictions for noise levels in residences and commercial facilities. Additionally, through LeRC's Safety Permit process, environmental noise will be controlled if noise levels exceed LeRC's internal standards, which are lower than OSHA's.

INSTALLATION OF THE TEST RIG IN BUILDING 38

Construction activities necessary to install the new equipment for the test rig are not anticipated to generate noise levels in excess of normal ranges and will be short term. It is anticipated that high frequency noise will be generated during testing of the jet engines, only in the immediate area (~100 feet/304.8 meters) of the test rig. Ambient noise levels in the vicinity of Building 38 are often quite high and it does not appear that the running of this test rig will add any significant contribution. Design requirements include the use of low noise valves and quantitative assessments are planned. There are no previously known community noise complaints from this area, and none are anticipated, as there will be no decibel change at the Lewis perimeter.

NO ACTION

There will be no noise issues under this alternative as no testing would occur.

PERFORM THE TESTING ELSEWHERE

Given that the anticipated test conditions (ie. length of tests etc.) will be the same at another location, the impacts of this alternative in regard to noise will be similar to those of the preferred alternative. If the alternate site chosen is located in a more remote area, the potential exists for the noise from running this test rig to be viewed as more of a nuisance than it would be at the proposed site where some levels of noise are already acceptable.

BIOTIC RESOURCES

In general, Biotic Resources in this assessment, will refer to the impacts on plant and wildlife resources, and endangered and protected species, that each of the alternatives has.

INSTALLATION OF THE TEST RIG IN BUILDING 38

The preferred alternative is expected to have no impact on biotic resources, because there are no biotic resources in the Building 38 area. Building 38 is enclosed within a heavily developed testing area, which is mainly comprised of asphalt.

NO ACTION

No impact to biotic resources will occur based on a no action alternative in regard to testing. Over the long term, though, the potential exists for much greater impacts to this resource than the preferred alternative, due to additional investigation for increasing amounts of fuel to serve the future needs of jet engines.

PERFORM THE TESTING ELSEWHERE

If a facility were selected similar to that of the preferred alternative, the impacts to biotic resources would be expected to be quite similar to those of that alternative. However, if this alternative necessitated the construction of a new facility to house the test rig, more severe impacts to biotic resources might be observed either due to new construction, or due to the upset to resources generated by the new site location.

FLOODPLAINS AND WETLANDS

Of concern under this category, is the impact of the alternatives on facilities in wetlands or within the 100-year floodplain (Building 38 is not a "critical action" facility).

INSTALLATION OF THE TEST RIG IN BUILDING 38

None of the activities involved with the preferred alternative is expected to have an impact on wetlands or floodplains. The preferred alternative involves little to no construction activities, except installation of said equipment inside Building 38. Additionally, Building 38 is not in the 100-year floodplain.

NO ACTION

This alternative should not have any impact on the wetlands and floodplains in the area.

PERFORM THE TESTING ELSEWHERE

The potential impacts of this alternative to the wetlands and floodplains will be very dependent on the location of an alternative site chosen to install the test rig and perform the testing. Particularly in the case of new construction of a facility, special care would be needed to assess the local wetlands and floodplains considerations and any potential impacts.

HISTORICAL, ARCHEOLOGICAL AND CULTURAL FACTORS

The essence of investigating this category is to assess the impact of the alternatives against the three noted parameters and to ensure these are preserved for future generations.

INSTALLATION OF THE TEST RIG AT BUILDING 38

There are no known historical or archeological factors apparently affected by proceeding with this proposed action. The building site is not historical and no archeological artifacts have been identified in the vicinity of the proposed test site. No additional excavation is anticipated under this proposed alternative, therefore no potential for disturbing archeological or cultural parameters.

NO ACTION

A no action alternative would have no impact on the historical, archeological, or cultural parameters as there would be no activity and therefore no potential for a disturbance of such.

PERFORM THE TESTING ELSEWHERE

The impact to historical, archeological, and cultural factors posed by this alternative would be dependent on the alternate site chosen for construction of the test facility. An investigation would obviously be warranted of a new site to identify the potential impacts that construction of such a site would pose on these factors.

SOCIAL AND ECONOMIC FACTORS

Assessed under this category are factors such as local economics, workforce, and sociological features in the local area such as population and employment levels, and the impacts of each alternative on these.

INSTALLATION OF THE TEST RIG IN BUILDING 38

The impacts of this preferred alternative would be minimal on social and economic factors. The addition of employees to install the test equipment is the most likely impact, and although it would increase employment levels at that time, it would be short-term and have a relatively minor impact. Present NASA engineer and technician employees would operate the test rig once installed. Therefore the effects of this alternative on employment levels and local economics will be small.

NO ACTION

This alternative would have no impacts on the social and economic factors in the community.

PERFORM THE TESTING ELSEWHERE

The impacts of this alternative have the potential to be greater than either of the other alternatives. The costs of constructing a facility to house the test rig, if needed, would far exceed those of backfitting the test equipment into the existing test site. Additionally, the need for a larger construction activity would neccessarily employ a larger number of workers for a longer term than that of the preferred alternative, although this would be temporary also.

SOLID WASTE

Considered under this category are the generation, management, and disposal of solid wastes associated with an alternative to be considered. Solid waste is regulated at the federal level by the Resource Conservation and Recovery Act (RCRA), Subtitle D and State Solid Waste Codes. In Ohio, licenses to dispose of solid waste are issued by the Ohio EPA and monitored by the local county health departments. Currently, NASA Lewis contracts with Browning Ferris Industries (BFI) to pick up and transport solid wastes to Oberlin Landfill in Lorain County and Glenwillow Landfill in Solon, Ohio for final disposal. Lewis' "Soil Excavation and Removal Policy" generally outlines procedures for handling, sampling, and disposal of soil and excavation wastes.

INSTALLATION OF THE TEST RIG IN BUILDING 38

Solid wastes will be generated under this proposed alternative but the amounts are expected to be insubstantial. The new test equipment will be backfit into an existing structure during the installation process. Wastes generated would likely include scrap metal from the previously existing test assembly (most of which has already been removed), wastes generated from the installation of new control equipment in the already existing control room, and packing materials associated with new equipment. All solid wastes generated will be disposed of according to applicable solid waste disposal regulations. No excavation is anticipated at this time and there would therefore be no soil wastes generated.

NO ACTION

No solid wastes will be generated by the no action alternative.

PERFORM THE TESTING ELSEWHERE

The impacts of this alternative are anticipated to be far greater than either of the other alternatives. Packing materials and the like generated from the new equipment installation will be quite similar to those of the preferred alternative. Additionally, and of greatest impact, is the potential to generate large amounts of soil due to excavation and construction of a new testing facility. Dependent on the alternate site chosen, soil sampling and solid waste generation and disposal would likely be required, in addition to the generation and disposal of typical construction debris (wood, paper, brick/concrete, scrap metal etc.).

HAZARDOUS SUBSTANCES AND HAZARDOUS WASTE MANAGEMENT

This category considers the generation and management of hazardous wastes as it impacts the alternatives considered. As with solid wastes, several federal regulations and state laws regulate hazardous waste management. A solid waste is considered a hazardous waste if it exhibits a hazardous characteristic or if it is a listed waste in 40 CFR Part 260, Chapter I, Subpart D. Applicable federal and state regulations for hazardous wastes are described in detail in the Environmental Resources Document (Reference 1). Specific regulations also exist for disposal of Pesticides, Underground Storage Tanks (USTs), radioactive wastes, asbestos, and PCBs. Although these wastes are not hazardous, they must be managed according to promulgated regulations. Hazardous wastes generated at NASA Lewis Research Center are held for a maximum of 90 days, and are stored and transported from Lewis' central chemical storage facility for final disposition.

INSTALLATION OF THE TEST RIG AT BUILDING 38

The generation of hazardous waste during the implementation of this alternative is not expected. No soil excavation is anticipated at this time. There is the remote possibility that oils, lubricants, solvents used in the installation, preparation, or start-up of the new test equipment could become contaminated to the extent of being considered hazardous. The amount of hazardous waste generated under this scenario would be very minimal and of little significance.
There is a separator pit (#4) near Building 38 that collects discharges to the Industrial Waste System from building drains in the area. The separator pits at NASA (there are 26 in total) are sampled and cleaned annually. Separator pit #4 has not contained hazardous constituents in the past and is not expected to in the future (as the ASC test rig will use the same fuels as did the prior test rig in Building 38). If sampling data indicates hazardous constituents, the pits would be cleaned out and the contents disposed of as hazardous waste.

No asbestos has been identified in the area under consideration in this alternative. Lead paint was present in the area that would house the new test equipment. Lead paint abatement has occurred under a separate remediation program and is complete.

NO ACTION

Hazardous waste generation would not occur under the no action alternative.

PERFORM THE TESTING ELSEWHERE

The impacts of choosing an alternative site for the ASC testing would most likely be similar to that of the proposed action in terms of hazardous waste generation. If excavation and construction are necessary, care would have to be exercised to choose a "clean" site so as not to generate hazardous waste soils. As noted in the preferred alternative, the installation and preparation of equipment, could generate hazardous waste.
In addition, the potential exists at any alternate site for the applicability of any of the factors noted above in this section; i.e., Pesticides, UST's, radioactive wastes, asbestos, PCB's, lead paint. The alternate site would have to be assessed for each of these issues, and the appropriate abatement and disposal procedures implemented as necessary.

SECTION 5

LIST OF AGENCIES AND INDIVIDUALS CONSULTED

ORGANIZATION	INDIVIDUAL	INFORMATION PROVIDED
NASA Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135	Peter Pachlhofer Arthur Gedeon Robert Puzak Bonnie Wheeler Ransook Evanina Beth Cooper	Land Resources, Air Resources, Water Resources, Hazardous Waste, Solid Waste, Noise
The Bionetics Corporation 1100 Apollo Drive Brook Park, Ohio 44142 (216) 977-7585	Theodore Thomas Christopher Cole Michael Bajorek	Water Resources, Noise, Air Resources, Biotic Resources Hazardous Waste
Bureau of Engineering Services, D.A.P.C. 1925 St. Clair Cleveland, Ohio 44114 (216) 664-2324	Lian Ang	Air Resources

SECTION 6

REFERENCES

1. Environmental Resources Document, NASA Lewis Research Center, August 1990.

2. Soil Excavation and Removal Policy, NASA Lewis Research Center, December 1990.

3. NASA Management Instruction (NMI) 8800.13.

4. NASA Handbook (NHB) 8800.11.

5. NASA Lewis Preliminary Review, June 10, 1993, and subsequent Requests for Action.

6. NASA Lewis Research Center Preliminary Assessment, SAIC, June 1991.

7. 40 CFR Part 1500, Council on Environmental Quality Regulations.

8. National Environmental Policy Act (NEPA), Public Law 91-190, 42 U.S.C. 4321 et. seq.

9. NASA Facility Project Implementation Handbook (FPIH), NHB 8820.2, Chapter 3: Planning and Appendix A: Definitions.

10. 14 CFR Subpart 1216.3 (NASA) Procedures for Implementing the National Environmental Policy Act (NEPA).

11. Personal communication with Cleveland Division of Air Pollution Control's Lian Ang (12/22/93).

12. Floodplains Study, Kucera & Associates, March 1984.