NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NOTICE: 99-GSFC-01

National Environmental Policy Act; FUSE and WIRE Missions

AGENCY: NASA's Goddard Space Flight Center Explorers Program

ACTION: Finding of No Significant Impact

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321, *et seq.*), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and NASA policy and procedures (14 CFR Part 1216 Subpart 1216.3), NASA has made a Finding of No Significant Impact (FONSI) with respect to the proposed FUSE and WIRE missions. The missions would involve the testing, processing, and launching of the FUSE and WIRE spacecraft. The FUSE spacecraft would be launched aboard a Delta II 7320 from Cape Canaveral Air Station, Florida, while WIRE would be launched from Vandenberg Air Force Base, California, using the Pegasus XL launch vehicle. The Explorer Program's FUSE and WIRE missions are components of "Origins" Program that answers fundamental questions about the origin and density of the universe. FUSE would explore the universe through high resolution spectroscopy at far ultraviolet wavelengths, while WIRE would study the evolution of starburst galaxies.

DATE: Comments in response to this notice must be provided in writing to NASA on or before February 25, 1999.

ADDRESSES: Written comments should be addressed to Ms. Lizabeth Montgomery, Goddard Space Flight Center, Code 205.2, Greenbelt, Maryland 20771. The Environmental Assessment (EA) prepared for the FUSE and WIRE missions which supports this FONSI may be viewed at :

(a) NASA Headquarters, Library, Room 1J20, 300 E Street SW, Washington, DC 20546 (202-358-0167)
(b) NASA, Goddard Space Flight Center, Greenbelt, MD 20771 (301-286-0469)
(c) Central Brevard Library and Reference Center, 308 Forrest Avenue, Cocoa, FL 32922
(d) Cocoa Beach Public Library, 550 North Brevard Avenue, Cocoa Beach, FL 32931
(e) Melbourne Public Library, 540 East Fee Avenue, Melbourne, FL 32901
(f) Merritt Island Public Library, 1195 North Courtenay Parkway, Merritt Island, FL 32953

(g) Port St. John Public Library, 6500 Carole Avenue, Cocoa, FL 32927
(h) North Brevard Public Library, 2121 South Hopkins Avenue, Titusville, FL 32780
(i) Lompoc Public Library, 501 East North Avenue, Lompoc, CA 93436-3406
(j) Santa Maria Public Library, 420 South Broadway, Santa Maria, CA 93454-5199
(k) Santa Barbara Public Library, 40 East Anapamu Street, Santa Barbara, CA 93101-2000
(l) University of California, Santa Barbara Library, Government Publications Department, Santa Barbara, CA 93106-9010

A limited number of copies of the EA are available on a first request basis by contacting Ms. Lizabeth Montgomery at the address or telephone number indicated herein.

FOR FURTHER INFORMATION CONTACT: Lizabeth R. Montgomery, 301-286-0469 or Lizabeth.R.Montgomery.1@gsfc.nasa.gov.

SUPPLEMENTAL INFORMATION:

NASA proposes to test, transport, process, and launch two investigative satellites (FUSE and WIRE) into Earth's orbit in order to gather astronomical information. FUSE and WIRE have been tested at NASA's Goddard Space Flight Center, Maryland, and would be processed and launched from Cape Canaveral Air Station, Florida, and Vandenberg Air Force Base, California, respectively. Both the proposed missions and the No-Action Alternatives were examined in the EA. The No-Action Alternatives would not fulfill the need for more accurate data to better understand the formation and origin of the universe. Launch vehicle selection for the FUSE and WIRE missions was driven by satellite size and weight and desired orbital placement. The Delta II 7320 selected for FUSE is a reliable and cost-effective alternative to the shuttle, and has less effect on the environment than the larger Delta II 7925. No other launch vehicle was preferable on the basis of capability, environmental impact and reliability. The Pegasus launch vehicle selected for WIRE is a cost-effective alternative to the much larger Delta II, Atlas and Taurus, and has a negligible effect on the environment.

The environmental consequences of all aspects of the testing, transporting, pre-launch processing, launching, and re-entry of FUSE and WIRE were considered. The possible environmental impacts that were considered included, but were not limited to, air and water quality impacts, local land area contamination, adverse health and safety impacts, and adverse effects in wetland areas and areas containing historical sites. The areas of potential impact considered in this assessment were those affected by the activities that would originate and take place at NASA's Goddard Space Flight Center, Cape Canaveral Air Station, and Vandenberg Air Force Base. Expected impacts to the human environment for both missions arise almost entirely from launch activities and are bounded by the normal launch of the Delta II 7925. Air impacts from the launch of the

Delta II would be short-term and not substantial. Short-term water quality and noise impacts, as well as short-term effects on plants, and animals, would occur only in the vicinity of the launch complex. There would be no impact on threatened or endangered species or critical habitat, cultural resources, wetlands or floodplains. Accident scenarios have also been addressed. Hazards associated with the FUSE and WIRE missions have been analyzed and do not raise any environmental concerns. These missions would not involve the use of radioactive material. No other environmental issues of concern were identified. All of the activities involved in these missions are within the normal scope and level of activities at the various sites involved.

On the basis of the FUSE and WIRE EA, NASA has determined that the environmental impacts associated with the missions would not individually or cumulatively have a significant impact on the quality of the human environment.

A.V. Diaz
Director
NASA's Goddard Space Flight Center

1/26/99
Date

FINAL ENVIRONMENTAL ASSESSMENT FOR FUSE (FAR ULTRAVIOLET SPECTROSCOPIC EXPLORER) AND WIRE (WIDE-FIELD INFRARED EXPLORER) MISSIONS

January 1999

Prepared for and in cooperation with:

National Aeronautics and Space Administration
Explorers Program Office
Goddard Space Flight Center
Greenbelt, Maryland 20771

Environmental Assessment

for

FUSE (Far Ultraviolet Spectroscopic Explorer) and WIRE (Wide-Field Infrared Explorer) Missions

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Lead Agency: National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Proposed Action: NASA's Office of Space Science (OSS) is responsible for all of NASA's programs relating to astronomy, the solar system, and the sun and its interaction with Earth. The objective of the OSS "Origins" Program is to answer fundamental questions about the origin and destiny of the universe. The "Origins" program is designed to maintain a sufficient level of scientific investigation and technological innovation so that the United States retains a leading position in research and exploration through the end of the century. The FUSE and WIRE missions are components of this strategy. NASA proposes to implement the FUSE and WIRE missions, which include the testing, processing, and launching of spacecraft from Cape Canaveral Air Station and Vandenberg Air Force Base, respectively.

For Further Information:
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NASA's Goddard Space Flight Center
Greenbelt, Maryland 20771
Telephone: (301) 286-0469
FAX: (301) 286-1745

Date: January 1999

EXECUTIVE SUMMARY

The National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center (GSFC) has determined that an Environmental Assessment (EA) should be prepared in accordance with the National Environmental Policy Act (NEPA) to evaluate the environmental consequences of implementing the Far Ultraviolet Spectroscopic Explorer (FUSE) and Wide-Field Infrared Explorer (WIRE) missions. This EA discusses the missions' objectives as well as their potential environmental effects. The scope of this assessment includes the testing, transporting, processing, launching, and re-entry of each spacecraft.

Both proposed missions and the No-Action Alternatives were examined in this EA. The No-Action Alternatives would not fulfill the need for more accurate data to better understand the formation and origin of the universe.

The environmental consequences of all aspects of the testing, transporting, pre-launch processing, launching, and re-entry of FUSE and WIRE were considered. Among the possible impacts that were considered are air and water quality impacts, local land area contamination, adverse health and safety impacts, the disturbance of biotic resources, socioeconomic impacts, and adverse effects in wetland areas and areas containing historical sites. All of the activities involved in these missions are within the normal scope and level of activities conducted at the various sites involved. Individually and cumulatively, these activities will produce no substantial adverse impacts on the existing environment at these sites.

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ABBREVIATIONS AND ACRONYMS

AL_2O_3	aluminum oxide
CCAS	Cape Canaveral Air Station
CO_2	carbon dioxide
CO	carbon monoxide
CEQ	Council on Environmental Quality
ESSB	Earth System Science Building
ERR	Eastern Range Regulation
EA	Environmental Assessment
EOSDIS	EOS Data and Information System
EOS	Earth Observing System
ELV	Expendable Launch Vehicle
FUSE	Far Ultraviolet Spectroscopic Explorer
FONSI	Finding of No Significant Impact
FES	Fine Error Sensor
FWS	Fish and Wildlife Service
GSFC	Goddard Space Flight Center
GEMs	Graphite Epoxy Motors
HUT	Hopkins Ultraviolet Telescope
HCl	hydrochloric acid
IRAS	Infrared Astronomical Satellite
JPL	Jet Propulsion Laboratory
KOH	potassium hydroxide
KSC	Kennedy Space Center
LC-17	Launch Complex 17
LiF	lithium fluoride
LEO	Low-Earth Orbit
MDP	Maximum Design Pressure
MEOP	Maximum Expected Operating Pressure
MSPSP	Missile System Pre-Launch Safety Package
NMI	NASA Management Instruction
NMP	New Millenium Program
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO_x	nitrogen oxides
N_2O_4	nitrogen tetroxide
OSHA	Occupational Safety and Health Administration
OSS	Office of Space Science
ORFEUS	Orbiting Retrievable Far and Extreme Ultraviolet Spectrometers
PM-10	particulate matter smaller than 10 microns
PAF	Payload Attach Fitting
PPF	Payload Processing Facility

Psi	pounds per square inch
PSP	Project Safety Plan
REEDM	Rocket Exhaust Effluent Diffusion Model
SRP	Safety Review Panel
SiC	silicon carbide
SRM	solid rocket motor
SRMU	Solid Rocket Motor Upgrades
SLC-2	Space Launch Complex 2
USAF	U.S. Air Force
VAFB	Vandenberg Air Force Base
WIRE	Wide-Field Infrared Explorer

1.0 PROPOSED ACTION AND ALTERNATIVES

1.1 PURPOSE AND NEED FOR PROPOSED ACTION

NASA's Office of Space Science (OSS) is responsible for all of NASA's programs relating to astronomy, the solar system, and the sun and its interaction with Earth. The objective of the OSS "Origins" Program is to answer fundamental questions about the origin and destiny of the universe. The "Origins" program is designed to maintain a sufficient level of scientific investigation and technological innovation so that the United States retains a leading position in research and exploration through the end of the century. The FUSE and WIRE missions are components of this strategy. Specifically, OSS hopes to gain insight into three fundamental parameters: the Hubble expansion rate, the microwave background spectrum, and the abundances of light elements. These parameters are essential to our understanding of the universe and how it evolves, according to the Big Bang theory.

NASA has determined that an EA should be prepared to evaluate the environmental consequences of implementing the FUSE and WIRE missions. The scope of this EA includes the testing, transporting, processing, and launching of each satellite. This document was completed in accordance with the following regulations: the NEPA of 1969, as amended (42 U.S.C. 4321, *et seq.*); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508); Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions"; and NASA's policy and implementation procedures (14 CFR Subpart 1216.3).

1.2 FUSE

1.2.1 Mission Description

FUSE, a mission within NASA's "Origins" program, is managed under the Explorers Program at GSFC. The purpose of the FUSE mission is to place a single Explorer-class spacecraft into orbit around the earth in March of 1999. Current plans call for using a two-stage Delta II 7320-10C (10 foot fairing), Expendable Launch Vehicle (ELV) with three Graphite Epoxy Motors (GEMs) strapped-on. FUSE would be launched into an 775-km (482-mi) circular orbit for a three-year mission, with a total satellite mass to orbit of 1360 kg (2998 lbs). The proposed orbit is inclined by 25 degrees with respect to the equator, and it would take FUSE about 101 minutes to orbit the earth once.

From March of 1999 until the end of its mission, FUSE would make observations in response to scheduled instructions from Mission Operations Control at the Johns Hopkins University in Baltimore, MD. These observations would include major investigations under principal investigators from collaborating institutions, as well as guest investigators. The FUSE observatory is scheduled for long-term studies of space as well as observations of "targets of opportunity" and moving targets such as comets and transient phenomena. An autonomous groundstation located at the University of

Puerto Rico - Mayaguez is expected to relay data and instructions between FUSE and the control center. The instrument would autonomously acquire and track targets, making multiple observations when necessary. Data would be stored in computer memory on the satellite until contact with the ground station is established, and then downlinked to earth.

1.2.2 Science Objectives

The FUSE instrument would make unique contributions to the "Origins" theme by looking at a region of the spectrum (905 – 1195 Angstroms (**Å**)) that is largely unexplored. In the 1970s, the Copernicus mission opened the far ultraviolet universe by obtaining spectra of bright, hot stars within ~1 kiloparsec of the Sun.[1] Two telescopes, the Hopkins Ultraviolet Telescope (HUT) and the Orbiting Retrievable Far and Extreme Ultraviolet Spectrometers (ORFEUS), flown on shuttle missions in the 1990s, have also provided brief glimpses into the FUSE wavelength range. FUSE would be able to observe sources more than 10,000 times fainter than Copernicus at a resolution many times better than that obtainable with either HUT or ORFEUS. This increase in sensitivity would enable FUSE to explore the outer reaches of the Milky Way. It also would make it possible to use quasars and active galactic nuclei as continuum sources for absorption line studies of distant clouds.

The spectral window opened by FUSE would permit the study of many astrophysically important atoms, ions, and molecules which cannot be investigated in any other way. Most of this spectral window is not accessible with the Hubble Space Telescope, which has optics that transmit light only at wavelengths longer than 1150 Å. FUSE would provide an unprecedented opportunity to make accurate measurements of the relative abundances of deuterium and helium in a wide variety of astrophysical environments. Deuterium is the product of the conversion of protons into helium during the Big Bang. Deuterium locked into stars during their formation is destroyed by stellar nucleosynthesis[2], and should therefore decrease in abundance over time.

In addition to measuring the abundance of deuterium, FUSE would make significant contributions to many areas of astronomy, including:

- Measurements of interstellar oxygen VI absorption and determinations of the properties of hot gas in the Milky Way and Magellanic Clouds;
- Investigations of highly ionized gas associated with active galactic nuclei, to provide insight into the mechanisms for ionizing gas clouds near massive black holes;

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[1] A kiloparsec is a unit of measure for interstellar distances. It is equal to 3.09×10^4 trillion km or 1.92×10^4 trillion mi.

[2] Nucleosynthesis is the production of a chemical element from hydrogen nuclei or protons.

- Searches for the observational signature of the hot intergalactic medium, to determine how the universe evolved at high redshifts;

- Studies of nova and supernova explosions and their remnants, to test theories of heavy element nucleosynthesis and the evolution of stars;

- Studies of the hottest atmospheric layers of stars, to provide information about mass loss through stellar winds (hot stars) and the structure of stellar coronae (cool stars);

- Measurements of molecular hydrogen, the primary constituent of the cold interstellar medium, from which protostars and their planetary systems form;

- Investigations of jets and circumstellar disks, to understand the properties of stars in early stages of their evolution; and

- Determinations of the abundances of primordial gases in comets and planetary atmospheres, to understand the origin and evolution of the solar system.

1.2.3 Satellite Description

The FUSE satellite is composed of the spacecraft and the scientific instrument. The instrument consists of four telescope mirrors with a 39 x 35 cm (15 x 14 in) clear optical opening. The light from the four optical channels is dispersed by four spherical holographic diffraction gratings and recorded by two detectors. Two channels with silicon carbide (SiC) coatings cover the range 905-1100 Å and two channels with lithium fluoride (LiF) coatings cover the range 1000 - 1195 Å. Actuators on the mirror mountings would maintain the instrument's focus. A Fine Error Sensor (FES) would maintain the spacecraft pointing stability to 1.27 cm (0.5 in). The instrument design is shown in Figure 1.

The FUSE mechanical subsystem consists of the primary spacecraft structure, the mechanisms, and the solar array assemblies. The spacecraft structure is the main load-carrying structure that supports the instrument and spacecraft hardware. The structure weighs 542 kg (1195 lbs) and consists of an aluminum trapezoidal frame with external aluminum honeycomb panels for equipment mounting. The structure is approximately 0.91 m (3 ft) tall and 1.82 m (6 ft) in diameter, and is capable of supporting 755 kg (1664 lbs). Flight loads are transferred from the instrument to the spacecraft structure through three thermally isolated flexure mounts, and then from the spacecraft structure to the launch vehicle through the 6915 Payload Attach Fitting (PAF). The FUSE spacecraft is shown in Figure 2.

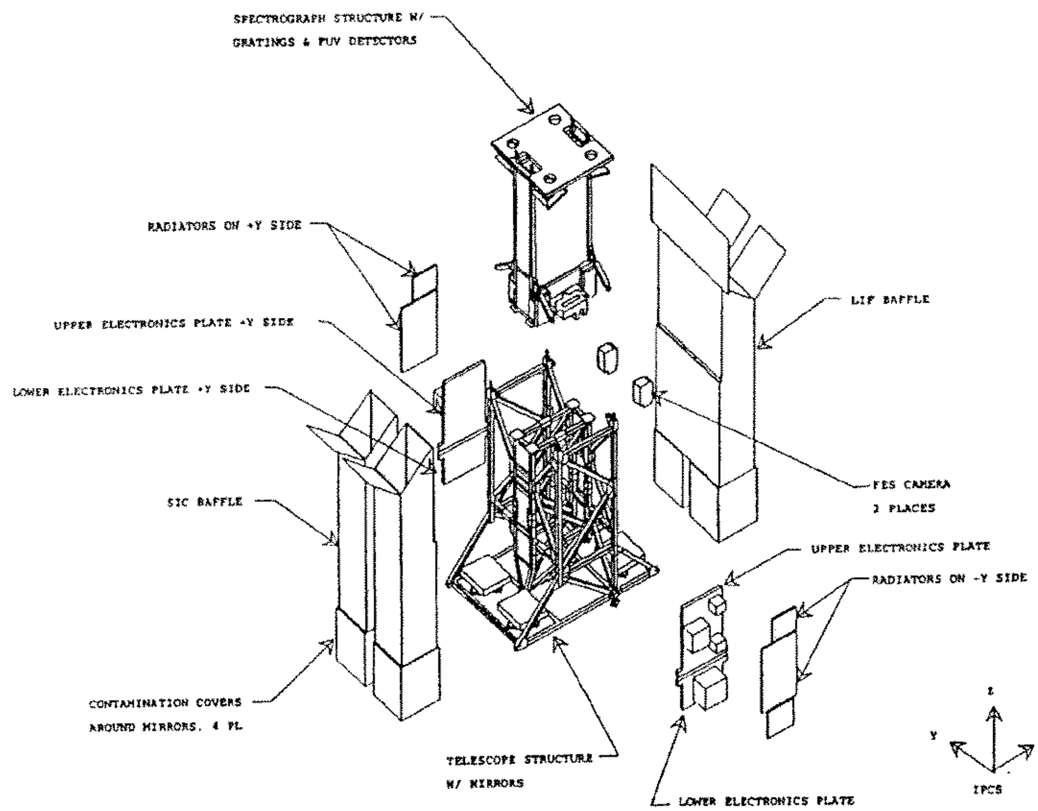

Figure 1. Structural diagram of the FUSE instrument

1.2.4 Launch Vehicle Description

The FUSE payload would be integrated with a Delta II 7320 ELV. The Delta II launch vehicle consists of a payload fairing and first and second stage propulsion systems with three GEMs used as strap-on boosters to the first stage. During ascent, the payload would be protected from aerodynamic forces by a 10-foot payload fairing. The payload fairing would be jettisoned from the launch vehicle during second-stage powered flight at an altitude of at least 111 km (69 mi).

The first stage of the Delta II is powered by a liquid bipropellant main engine and two Vernier[3] engines. The first stage propellant load consists of approximately 96,243 kg (212,179 lbs) of RP-1 fuel (thermally stable kerosene) and liquid oxygen as an oxidizer. The main engine and Vernier engines are ignited at liftoff. The three GEMs are ignited in flight and are jettisoned after burnout of the solid propellant. The Delta II

[3] Vernier engines are small, supplementary rocket engines used for making small adjustments in speed and attitude.

second stage propulsion system has a bipropellant engine that uses Aerozine 50 (a 50/50 mix of hydrazine and unsymmetrical dimethyl hydrazine) as fuel and nitrogen tetroxide as oxidizer. The second stage has a total propellant load of 6,019 kg (13,270 lbs). An example of a two-stage Delta II launch vehicle is shown in Figure 3. Note that the FUSE launch vehicle will carry three GEMs instead of nine.

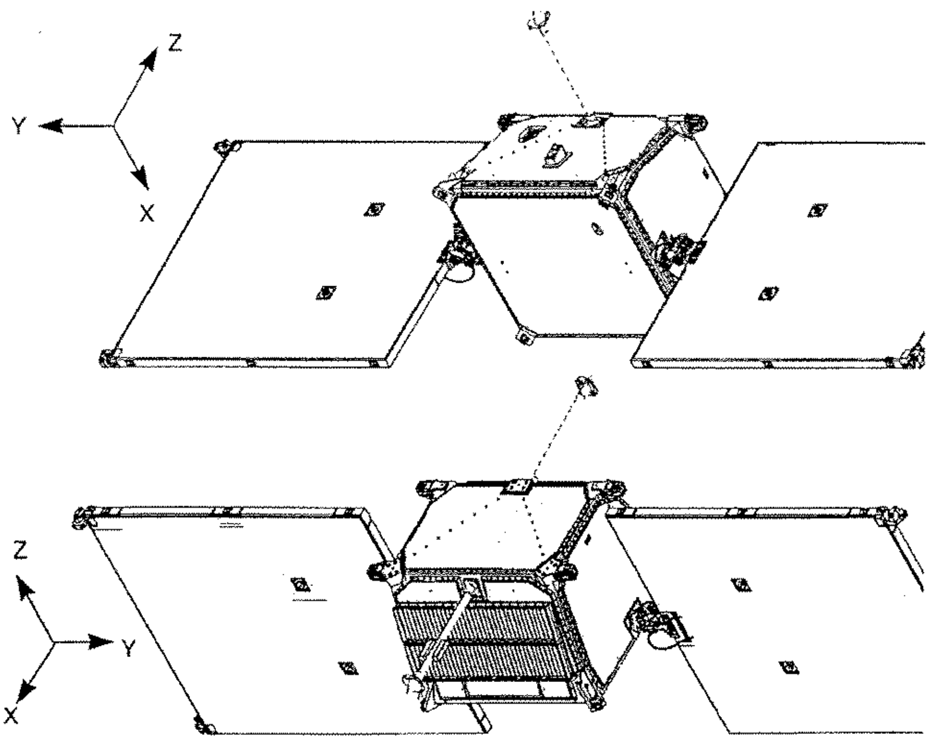

Figure 2. FUSE spacecraft structure. The FUSE instrument attaches to the top of the structure to form a rectangular satellite body.

1.3 WIRE

1.3.1 Mission Description

WIRE is one of the Small Explorer missions, designed to detect galaxies with unusually high star formation rates. The mission would be launched from Vandenberg Air Force Base (VAFB) by Orbital Sciences Corporation using an L-1011 aircraft carrying a Pegasus launch vehicle, to an altitude of 11,887 m (39,000 ft). WIRE would be launched into a 570-km (354-mi) sun-synchronous, circular orbit with a 97 degree inclination. The mission length would be 4 months, over which time it would survey 100 square degrees of sky, cataloging at least 30,000 starburst galaxies.

Delta II 7920-10 Launch Vehicle

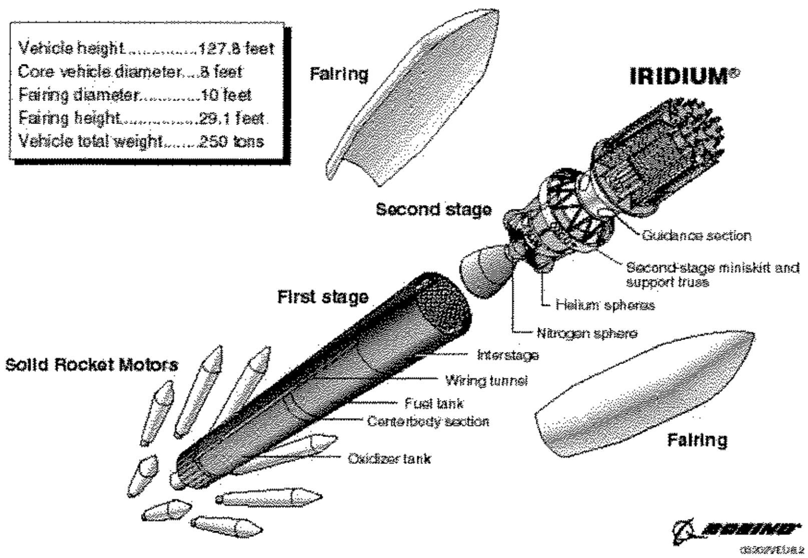

Figure 3. Example launch vehicle configuration for the Delta II 7920-10C. The FUSE launch vehicle would also have two stages, but only three solid rocket motors.

From March of 1999 until the end of its mission, WIRE would make observations in response to scheduled instructions from GSFC. WIRE's survey strategy would consist of repeated, stare-mode observations of star fields in order to accumulate sufficient exposure time to observe faint sources. The on-orbit ground contact plan calls for two downlinks/uplinks per day using the Wallops and Poker Flat ground stations. Each contact would last approximately 8 minutes. Between the ground contacts, WIRE would make autonomous observations.

WIRE would be capable of detecting typical starburst galaxies five billion light-years away and luminous protogalaxies at much greater distances. The catalog of galaxies would exceed the size of the existing Infrared Astronomical Satellite (IRAS) Point Source Catalog. It would also produce a large-area catalog of galaxies 500 times fainter than those found in the IRAS Faint Source Catalog. Using a 28-cm (11-in) aperture telescope with no moving parts and a field of view about the size of the full moon, the instrument's detectors would be sensitive to infrared light at two wavelengths, 12 and 25 micrometers (μm).

1.3.2 Science Objectives

The WIRE mission would consist of four months of observations in two infrared color bands at 12 μm and 25 μm. The sensitivity of the telescope is bounded by the density of the many faint, unresolved sources in the field of view and the resolving power of the telescope. The WIRE survey would detect primarily galaxies with unusually high rates of star formation or "starburst" galaxies which emit most of their energy in the far-infrared. The number of these faint sources at a given flux level depends on their as yet unknown evolutionary rate.

One of the most important goals of modern astronomy is to understand the formation and evolution of galaxies. Starburst galaxies are an important population because they represent 30 percent of the energy budget of the local universe and because almost all of their luminosity is due to star-forming regions. They represent more than 30 percent of the star formation occurring today. WIRE would help reveal the role of starbursts in the evolution of all galaxies. Models of protogalaxies[4] also predict ultraluminous starbursts at early epochs, implying that WIRE may determine when galaxies formed.

The objective of the WIRE mission is to answer three questions.

1. What fraction of the luminosity of the universe at redshifts of 0.5 and beyond is due to starburst galaxies?

2. How fast and in what ways are starburst galaxies evolving?

3. Are luminous protogalaxies common at redshifts less than 3?

The scientific impact of the WIRE data would be immediate. The number of sources as a function of flux density would indicate the rate of evolution of the starburst galaxy population, that is, the variation of the number and luminosity of these galaxies with cosmic epoch. The infrared color distribution of sources detected as a function of flux density would reveal the nature of the evolution of starburst galaxies and point to protogalaxy candidates. Follow-up observations at other wavelengths would test assumptions and lead to many new discoveries.

The WIRE survey reaches so deeply into unexplored territory that it presents a significant opportunity for scientific investigation and discovery in many areas. Examples of additional investigations include exploring the proposed link between quasars and ultra-luminous galaxies, searching for brown dwarfs, searching for circumstellar disks around main sequence stars, and exploring the large-scale distribution of galaxies at high redshifts. There is great potential for discovery of entirely new phenomena at these faint flux levels.

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[4] Protogalaxies are clouds of gas that condense to form star clusters.

1.3.3 Satellite Description

The WIRE satellite consists of a spacecraft and an instrument. The WIRE instrument primarily consists of two components: an infrared optical assembly, which is an integral, non-moving telescope, and a cryostat, which is a two-stage cooling system designed to keep the optical assembly at approximately 12° Kelvin (K) or -439° Fahrenheit (°F). There are two infrared detector arrays which are part of the assembly that are cooled to 6.5°K (-448°F). The instrument weighs about 95 kg (209 lbs), including the 5 kg (11 lbs) of solid hydrogen in the cryostat and the instrument electronics, located inside the spacecraft. The WIRE instrument is pictured in Figure 4.

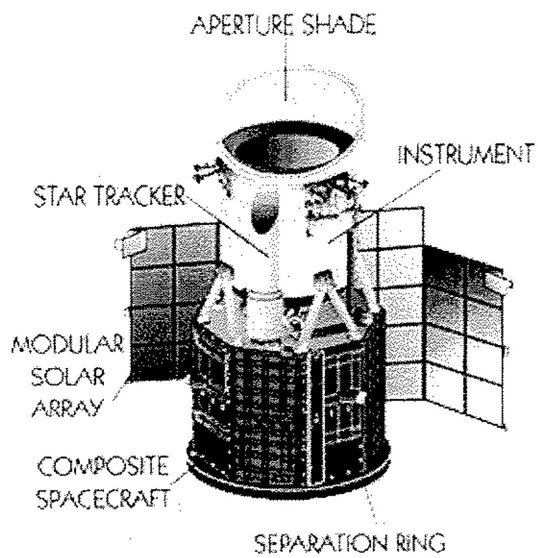

Figure 4. Diagram of the WIRE spacecraft.

The WIRE spacecraft includes an S-band transponder to transmit both scientific and engineering data to the ground and to command the spacecraft from the ground. The spacecraft bus was designed and built by GSFC, and consists of mechanical and electrical subsystems, an attitude control system, communications, a thermal system, and a command and data handling system. The primary structure of the spacecraft is approximately 1.85 m (6.1 ft) high, has a diameter of nearly 86 cm (34 ft), and weighs approximately 252 kg (556 lbs).

1.3.4 Launch Vehicle Description

The three-stage Pegasus XL launch vehicle would be carried aloft by the Orbital L-1011 "Stargazer" aircraft (Figure 5) to an altitude of approximately 11,877 m (39,000 ft) over the open Pacific Ocean, where it would be released and then free-fall in a horizontal position for five seconds before igniting its first stage rocket motor. With the aerodynamic lift generated by its delta wing, the small rocket achieves its targeted orbit of 570 km (354 mi) above the earth in approximately ten minutes. The vehicle carries

15,955 kg (35,175 lbs) of solid propellant (12,160 kg in the first stage, 3,024 kg in the second stage, and 771 kg in the third stage). The Pegasus XL configuration is pictured in Figure 6.

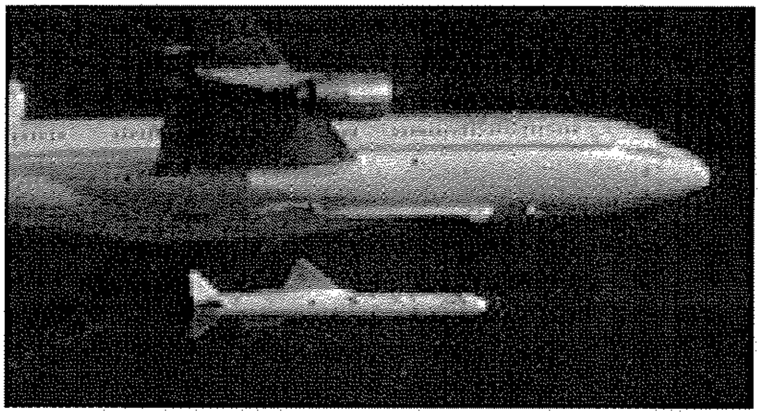

Figure 5. Photo of the L-1011 "Stargazer" with a just-released Pegasus launch vehicle.

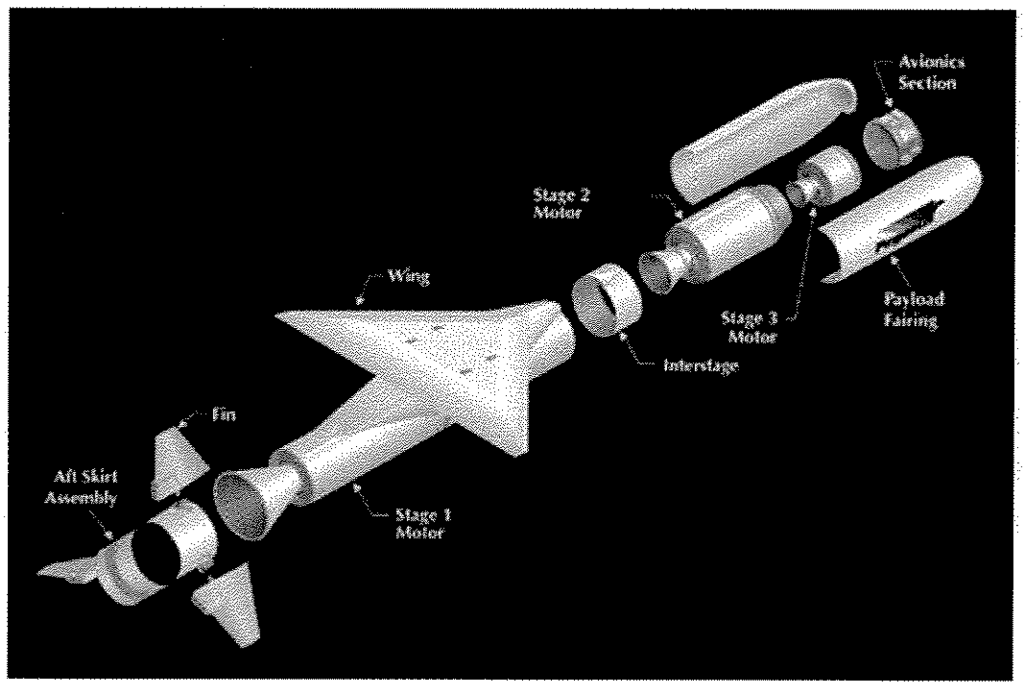

Figure 6. Expanded diagram of the Pegasus launch vehicle.

1.4 ALTERNATIVES TO PROPOSED PAYLOADS

1.4.1 FUSE

The alternatives considered in this assessment were the proposed action and the No-Action Alternative. Under the No-Action Alternative, the FUSE mission would not be implemented. This alternative was used as the baseline against which the potential environmental effects of the proposed action were measured.

1.4.2 WIRE

The alternatives considered in this assessment were the proposed action and the No-Action Alternative. Under the No-Action Alternative, the WIRE mission would not be implemented. This alternative was used as the baseline against which the potential environmental effects of the proposed action were measured.

1.5 ALTERNATIVES TO PROPOSED LAUNCH VEHICLES

1.5.1 FUSE Launch Vehicle Alternatives

Launch vehicle selection for the FUSE mission is driven by spacecraft size and mass and desired orbital insertion energy. Other considerations which must be addressed in selection of the launch vehicle include cost, reliability, and potential environmental impacts associated with the launch system. The FUSE strategic mission is also a factor in launch vehicle selection. The FUSE instrument was originally intended to be flown on the space shuttle and transferred to an existing Explorer platform now in orbit. However, the conflicting strategic missions of the FUSE and shuttle programs would make the use of the shuttle logistically unreasonable. Shuttle payloads are scheduled according to strategic priorities that include the development of an international space station.

The proposed launch vehicle, the Delta II mid-lite ELV, is a reliable and cost-effective alternative to the shuttle. The Delta has been launched over 260 times since 1960. The Delta II 7320 (or mid-lite) is more cost-effective than its larger cousin the Delta II 7925, burns less fuel, and has less impact on the environment. A more thorough description of each of the space vehicles that can be considered for launching FUSE is provided in the New Millennium Program (NMP) EA (NASA 1998).

1.5.2 WIRE Launch Vehicle Alternatives

Launch vehicle selection for WIRE and other similar missions is driven by satellite size and weight and desired orbital placement. Alternative launch vehicles for WIRE include the Delta II 7925 and 7326, Atlas IIAS, and Taurus. All of the alternative launch vehicles provide more performance and cost significantly more than that which WIRE requires. The alternatives do not provide an advantage with respect to environmental impacts. A description of each of the alternative vehicles is provided in the NMP EA (NASA 1998). Environmental impacts for the alternative vehicles have been addressed in previously published EAs and FONSIs (NASA 1995b and FONSI 1995 [Delta], NASA 1997b and FONSI 1997 [Athena], USAF 1992 and FONSI 1993 [Taurus], USAF 1987 and FONSI 1987 [Titan]).

2.0 AFFECTED ENVIRONMENT

2.1 GODDARD SPACE FLIGHT CENTER

GSFC, where the FUSE and WIRE instruments are being tested, is located in suburban Maryland, Northeast of Washington, D.C. GSFC is a NASA field center encompassing a major U.S. laboratory for developing and operating unmanned scientific spacecraft. It is also the hub of the Space Agency's communications and data network for manned spacecraft. The center manages many of NASA's Earth Observing System (EOS), astronomy, and space physics missions. Instrument and spacecraft testing for FUSE and WIRE is performed in Buildings 7, 10, and 29 at GSFC. The environmental characteristics of GSFC and its surrounding resources have been described thoroughly in GSFC's Environmental Resources Document (NASA 1993a).

2.2 FUSE

2.2.1 Cape Canaveral

CCAS, from which FUSE would be launched, is located in Brevard County on the eastern coast of Florida, near the city of Cocoa Beach and 75 km (45 mi) east of Orlando. The station occupies nearly 65 km^2 (25 mi^2) of the barrier island that contains CCAS, and is adjacent to the NASA Kennedy Space Center (KSC), Merritt Island, Florida. CCAS is bounded by KSC on the north, the Atlantic Ocean on the east, the city of Cape Canaveral on the south, and the Banana River and KSC/Merritt Island National Wildlife Refuge on the west. Launch operations are the primary activity at CCAS and KSC. Over 3,000 launches have been conducted at CCAS and KSC since 1950. Spacecraft processing for the FUSE mission would take place in Hangar AE at CCAS; launch activities would occur at Launch Complex 17 (LC-17).

The affected environment of CCAS is described in detail in numerous EAs including the NMP programmatic EA (NASA 1998).

2.3 WIRE

2.3.1 Vandenberg Air Force Base

VAFB, from which WIRE would be launched, is located in Santa Barbara County, California. It occupies 39,822 hectares of land and is bounded on the west by 56 km (35 mi) of Pacific Ocean coastline. The nearest cities are Santa Maria, 10 km (6.2 mi) to the northeast and Lompoc immediately to the east. The base is administratively divided into North Vandenberg and South Vandenberg. North Vandenberg contains Space Launch Complex 2 (SLC-2) and South Vandenberg houses SLC-4 and SLC-6, which is part of the California Commercial Spaceport. Spacecraft testing and processing for WIRE would take place at the Astrotech commercial Payload Processing Facility (PPF) just south of SLC-2.

The surrounding environment at VAFB has been described in detail in previous environmental assessments, including the Astrotech payload processing program (Astrotech 1993), the EOS Programmatic Environmental Assessment (NASA 1997a), and the NMP assessment (NASA 1998).

3.0 ENVIRONMENTAL IMPACTS OF PROPOSED ACTION AND ALTERNATIVES

3.1 PROPOSED ACTION

3.1.1 FUSE

The FUSE instrument is being tested at GSFC in Greenbelt, MD, from August, 1998 to mid-December of 1998, when it will be shipped to CCAS for launch. The environmental consequences of testing, processing, and integration of FUSE with its Delta II 7320 ELV, and launch from LC-17 at CCAS are discussed below.

Testing, processing, and launching procedures for the FUSE mission are similar to those for NASA's EOS and NMP missions, with the sole exception that the FUSE instrument performs different functions. Thus, the possible impacts of processing and launching FUSE are consistent with those outlined in the NMP Programmatic EA (NASA 1998) for activities at CCAS. All payload processing procedures at CCAS will take place indoors in Hangar AE using existing trained personnel. The proposed testing and payload processing procedures fall within the normal scope of operations at GSFC and CCAS. The environmental effects of GSFC operations are documented in GSFC's Environmental Resources Document (NASA 1993a). Ground operations at CCAS are similar to those used for NMP payloads and are documented in the NMP Programmatic EA (NASA 1998).

FUSE would be launched from CCAS in Florida in mid-March of 1999, using a Delta II 7320 with two stages and three GEMs strapped-on. For the purposes of this assessment, the environmental effects of launching the Delta II 7320 are considered bounded by the larger Delta II 7925. The Delta II 7925, with nine GEMs and three stages, carries a greater propellant load and has a greater environmental impact than the Delta II 7320. The environmental impacts of the Delta II 7925 launch program are described in the Environmental Impact Statement of the Delta II 7925 (MDSSC 1992). Several EAs have since been prepared for missions using the Delta II (e.g. NASA 1994a, NASA 1995b) as well as Findings of No Significant Impact (e.g. FONSI 1995).

3.1.1.1 Air Quality

Testing and processing activities at GSFC and CCAS have potential air quality impacts associated with them. Testing and processing includes cleaning the instrument with small amounts of volatile solvents. These chemicals will be used indoors under environmentally controlled conditions with adequate ventilation and will not impact the external environment. These activities are within the normal scope of operations at both facilities.

The majority of the emissions will be produced during launch by the GEMs and the first stage. Products of GEM combustion that are of potential environmental concern are carbon monoxide (CO), hydrochloric acid (HCl), aluminum oxide (AL_2O_3) in soluble and insoluble forms, and nitrogen oxides (NO_x). The only exhaust product of the first stage that is of potential environmental concern is CO.

In a normal launch, exhaust products from the Delta II are distributed along the launch vehicle's path. The quantity of exhaust emitted per unit length of trajectory is greatest at ground level and decreases continuously. The portion of the exhaust plume that persists longer than a few minutes (the ground cloud) is emitted during the first few seconds of flight and is concentrated near the pad area. It consists of the rocket exhaust effluents and deluge water. The ground cloud resulting from a normal Delta II launch is predicted to have a radius of about 80 m (262 ft) (NASA 1998).

The primary areas of concern associated with the ground cloud are 1) the effects of the cloud constituents on humans, plants, and animal life, and 2) the possibility of producing a localized acid deposition from rain showers falling through the ground cloud. Since all non-essential personnel are evacuated from CCAS prior to launch, the potential human health effects on the general population were assessed at the CCAS boundary and beyond. The primary constituent of concern in the launch cloud is HCl.

To estimate the peak ground level concentrations of pollutants, the US Air Force has conducted an evaluation of gaseous and particulate emissions for the Delta II 7925 using the Rocket Exhaust Effluent Diffusion Model (REEDM) (NASA 1998). These models are used to calculate peak ground level concentrations of various pollutants in ground clouds.

Hydrogen chloride concentrations in the Delta II exhaust plume should not exceed 0.792 parts per million (ppm) beyond about 13 km (8 mi). The maximum 60-minute average concentration is predicted to be 0.28 ppm at 14 kilometers. The nearest uncontrolled area (i.e., general public) for a worst-case meteorological scenario is about 4.8 km (3 mi) from LC-17. Appropriate safety measures would be taken to ensure that the permissible exposure limits defined by the Occupational Safety and Health Administration (OSHA) (5 ppm for an 8-hour time-weighted exposure limit) are not exceeded for personnel in the launch area (NASA 1998).

Based upon these comparative studies and the distance to the nearest uncontrolled area, HCl concentrations are not expected to be high enough to be harmful to the general population. Although National Ambient Air Quality Standards (NAAQS) have not been adopted for HCl, the National Academy of Sciences (NAS) has developed recommended limits for short-term exposure to HCl, ranging from 20 ppm for a 60-minute exposure to 100 ppm for a 10-minute exposure. Both the peak HCl concentration of 0.79 ppm and the maximum 60-minute mean concentration of 0.28 ppm are well below the NAS recommended limits (NASA 1998).

The same predictive modeling techniques used for HCl were also applied to CO and AL_2O_3. For Delta launches, the maximum 60-minute CO concentrations were predicted to be 1.76 ppm except for brief periods during actual lift-off. During launch, gases are exhausted at temperatures ranging from 1,000 to 1,600 °C (2,000 to 3,000 °F). Most of the gases immediately rise to an altitude of about 610 m (2,000 ft), where they are dispersed by the prevailing winds. Carbon monoxide gas is expected to rapidly oxidize to carbon dioxide in the atmosphere and, therefore, CO concentrations for Delta launches are not expected to exceed the NAAQS of 35 ppm (1-hour average) beyond the immediate vicinity of the launch complex (NASA 1998).

Aluminum oxide exists as a crystalline dust in solid rocket motor (SRM) exhaust clouds, but is inert chemically and is not toxic. However, since many of the dust particles are small enough to be retained by the lungs, it is appropriate to abide by NAAQS for particulate matter smaller than 10 microns (PM-10). The peak AL_2O_3 concentration beyond the distance of the nearest CCAS property boundary predicted by the model for a Delta launch was 49 mg/m^3 (NASA 1998). The maximum 60-minute mean concentration predicted is 3.07 mg/m^3 at 10 km. The maximum 24-hour Al_2O_3 concentration is predicted to be 0.004 mg/m^3 at 12 km, which is well below the 24-hour average NAAQS for PM-10 of 0.15 mg/m^3. The NAAQS for continuous emitters of particulate matter should not be exceeded by a Delta II launch (NASA 1998).

Nitrogen oxides may enter the atmosphere through propellant system venting, a procedure used to maintain proper operating pressures. Air emission control devices will be used to mitigate small and infrequent pollutant sources. First stage propellants will be carefully loaded using a system with redundant spill-prevention safeguards. Aerozine 50 vapors from second stage fuel loading will be processed to a level below analytical detection by a citric acid scrubber. Likewise, N_2O_4 vapors from second stage oxidizer loading will be passed through a sodium hydroxide scrubber. These scrubber wastes will be disposed of by a certified hazardous waste contractor (NASA 1998).

During the last 20 years there has been an increased concern about human activities that affect the upper atmosphere. Space vehicles that use SRMs have been studied concerning their potential contribution to stratospheric ozone depletion because of the exhaust products, with the primary depleting component being HCl. The net stratospheric ozone depletion from a Delta II 7925 has been predicted to be on the order of 0.001 percent per launch (in a global, annually averaged sense). There have been an average of six Delta launches per year for the past eight years. Assuming this average, launching six Delta 7925s with nine GEMs in a twelve-month period is expected to result in a cumulative net stratospheric ozone depletion on the order of 0.006 percent (NASA 1998).

Since the ground cloud for a Delta II launch is very small (about 80 m or 262 ft) and concentrates around the launch pad, there should be no substantial acid deposition beyond the near-pad area (NASA 1998).

Rockets contribute very minor amounts of HCl to the atmosphere when compared with other human-made sources. In a report to the American Institute of Aeronautics and Astronautics, extensive analyses led to the conclusion that "the effects of rocket propulsion on stratospheric ozone depletion, acid rain, toxicity, air quality, and global warming were extremely small compared to other anthropogenic impacts" (AIAA 1991).

3.1.1.2 Hydrology and Water Quality

Municipal water is used at CCAS for payload processing, deluge water (for fire suppression), launch pad wash down, and potable water. Water usage for payload processing fits within the current scope of water discharge permit definitions. Solvents and rinsates generated during processing will be disposed of as hazardous materials in compliance with all existing federal, applicable state, and local base regulations. It is expected that no more than 3.8 l (one gallon) of each solvent or rinsate would be used to process FUSE. No substantial hydrologic or water quality effects are expected from testing or processing of the FUSE satellite.

Most of the deluge and launch pad washdown water is collected in a concrete catchment basin; however, minor amounts may drain directly to grade. The only potential contaminants used on the launch pad are fuel and oxidizer, and the only release of these substances would occur within sealed trenches and should not contaminate runoff. Any accidental or emergency release of propellants from the Delta vehicle after fueling would be collected in the flume located directly beneath the launch vehicle and channeled to a sealed concrete catchment basin. If the catchment basin water meets the criteria set forth in the FDEP industrial wastewater discharge permit, it is discharged directly to grade at the launch site. If it fails to meet the criteria, it is treated on site and disposed to grade or collected and disposed of by a certified contractor. No discharges of contaminated water are expected to result from medium launch vehicle operations at LC-17. To ensure this, the groundwater in the discharge area is monitored quarterly by Air Force Bioenvironmental Engineering Services (NASA 1998).

The primary surface impacts from a normal Delta II launch involve HCl and Al_2O_3 deposition from the ground cloud. The cloud would not persist or remain over any location for more than a few minutes. Depending on wind direction, most of the exhaust may drift over the Banana River or the Atlantic Ocean, resulting in a brief acidification of surface waters from HCl. Aluminum oxide is relatively insoluble at the pH of local surface waters and is not expected to cause elevated aluminum levels or significant acidification of surface waters. The relatively large volume of the two bodies of water compared to the amount of exhaust released is a major factor working to prevent a deep pH drop and fish kills associated with such a drop. There have been no fish kills recorded in the Atlantic Ocean or Banana River as a result of HCl and Al_2O_3 deposition during a normal launch. A normal Delta II launch would have no substantial impacts to the local water quality (NASA 1998).

3.1.1.3 Land Resources

Testing and processing of FUSE will take place indoors, in existing facilities, using existing personnel. Testing and processing both fall within the scope of normal activities at GSFC and CCAS. No unique effects on land resources would result from these activities.

The launch of the Delta II would have negligible effects on the land forms surrounding LC-17. The LC-17 launch area is not located in a 500-year floodplain. The ascent track of all vehicles and the planned re-entry of spent sub-orbital stages are over open ocean. However, launch activities could have some small impacts near the launch pad associated with fire and acidic deposition. Minor brush fires are infrequent by-products of Delta launches, and are contained and limited to the ruderal vegetation within the launch complexes; past singeing has not permanently affected the vegetation near the pads. Wet deposition of HCl, caused by rain falling through the ground cloud or exhaust, could kill or damage vegetation. Wet deposition is not expected to occur outside the pad fence perimeter, due to the small size of the ground cloud and the rapid dissipation of both the ground cloud and solid rocket motor exhaust plume (NASA 1995b).

3.1.1.4 Noise

Testing activities at GSFC will occur indoors during normal hours of operation. These activities are not anticipated to create noise above and beyond normal operational noises at GSFC. Likewise, payload processing activities at CCAS are well within the normal scope of operations.

The engine noise and sonic booms from a normal Delta II launch are typical of routine CCAS operations. To the surrounding community, noise from launch-related activity appears, at worst, to be an infrequent nuisance rather than a health hazard. In the history of U.S. Air Force (USAF) space-launch vehicle operations from CCAS, there have been no problems reported as a result of sonic booms, most probably because the ascent track of all vehicles and the planned re-entry of spent sub-orbital stages are over open ocean, thus placing sonic booms away from land areas (NASA 1995b).

3.1.1.5 Biotic Resources

Normal testing, processing, and Delta II launching operations are not expected to cause substantial impacts to terrestrial, wetland, or aquatic biota at CCAS. The elevated noise levels of launch are of short duration and would not substantially affect wildlife populations. Wildlife encountering the launch-generated ground cloud may experience brief exposure to exhaust particles, but would not experience any significant impacts. Aquatic biota may experience acidified precipitation, if the launch occurs during a rain shower. The impact is expected to be insignificant due to the brevity of the ground cloud and the high buffering ability of the surrounding surface waters to rapidly neutralize excess acidity (NASA 1995b).

Any action that may affect federally listed species or their critical habitats requires consultation with the U.S. Fish and Wildlife Service (FWS) under Section 7 of the Endangered Species Act of 1973 (as amended). The U.S. FWS has reviewed the actions which would be associated with a Delta II launch from LC-17 and has determined that those actions would have no effect on state or federally listed threatened or endangered species residing on CCAS and adjoining waters (NASA 1992).

3.1.1.6 Marine Resources

The potential effects of a normal launch on the marine environment are considered minimal to nonexistent. During a normal Delta launch, spent stages impact the open ocean. The environmental effect of launch debris is considered negligible, due to the small amounts of metal involved, slow rates of oxidization, and large amounts of ocean water available for dilution.

The impact on marine resources from emissions is also considered negligible. The greatest emissions occur in the vicinity of the launch pad and later emissions are diluted quickly by the atmosphere. Normal launch emissions would make a negligible contribution to acid deposition over ocean areas.

3.1.1.7 Cultural and Historical Resources

Since no surface or subsurface areas will be disturbed and rocket launches are typical activities at CCAS, no archeological, historic, or cultural sites listed or eligible for listing in the National Register of Historic Places are expected to be affected by the testing, processing, or launching of FUSE.

3.1.1.8 Socioeconomic Effects and Environmental Justice

Testing, processing, and launching activities would take place using existing personnel, away from residential areas. No jobs would be created or re-located during these activities. There are no substantial socioeconomic effects resulting from the FUSE mission. Executive Order 12898, Federal Actions to Address Environmental Justice In Minority Populations and Low-income Populations, directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their activities on low-income populations or minority populations in the United States. The FUSE mission does not raise any environmental justice concerns. The FUSE project is small in size and scope and would not produce any substantial environmental or human health impacts on the population as a whole. Therefore, there would be no disproportionately high or adverse impacts on minority or low-income populations from the implementation of the FUSE mission.

3.1.1.9 Hazards

A number of potential environmental safety hazards exist for the FUSE satellite. FUSE does not contain ordnance or radioactive materials among its components.

Safe hardware and support equipment will be used to ensure safety for both personnel and equipment during all phases of testing and operation. A Project Safety Plan (PSP) and a Missile System Pre-Launch Safety Package (MSPSP) have been prepared in accordance with Jet Propulsion Laboratory (JPL), KSC, and Air Force Eastern Range Safety Office requirements. The MSPSP documents FUSE satellite compliance with the requirements established by the Eastern and Western Range Regulations, EWR 127-1 dated 31 March 1995 as tailored for FUSE, August 1996. This document also serves to demonstrate that requirements and procedures are met to obtain flight and ground payload safety approval.

Shipment of the FUSE spacecraft would employ a pre-existing, reusable, environmentally controlled shipping container equipped with an accelerometer. The container will be continually flushed with LN_2 from a 450 liter (119 gallon) Dewar. The spacecraft would be installed in the shipping container within a lowboy trailer and moved via a planned highway route (selected for freedom from obstructions) from GSFC to CCAS. Structural analysis for the spacecraft would be primarily based on the launch system launch loads which significantly exceed the anticipated ground handling and transportation loads. The solar arrays and batteries would be shipped separately in an air-ride moving van. Upon arrival at the Eastern Range, the spacecraft would be thoroughly inspected for damage. Transportation of the spacecraft between the payload processing facilities and launch facilities at CCAS would involve the use of cranes, trucks, small generators, and support vehicles.

The FUSE instrument design calls for a radiative cooling system of anhydrous ammonia-filled aluminum pipes. FUSE heat pipes would be pressurized and permanently sealed by the manufacturer and the minimum purity level of the anhydrous ammonia would be 99.998 percent. The Maximum Expected Operating Pressure (MEOP) is 2668 kilopascals (Kpa) or 378 psi, which is the vapor pressure at saturation of ammonia at 60 °C (140 °F). The Maximum Design Pressure (MDP) is 6894 Kpa (1000 psi), which is the vapor pressure at saturation of ammonia at 105°C (221 °F). The cooling system design includes a total of 24 such pipes. The largest pipe contains 7.0 g (0.247 oz) of anhydrous ammonia, and the total anhydrous ammonia for all heat pipes is 157 g (5.54 oz). The heat pipes meet MIL-STD-1522. Therefore, hazards from the ammonia are considered controlled. This radiator design has been used on over 100 missions by NASA.

The stimulation lamps used to support on-orbit instrument calibration and aliveness checks contain trace amounts of mercury. The instrument contains 2 bulbs with 50 mg each (100 mg or 3.5×10^{-3} oz total) of mercury. These mercury lamps are located in the spectrograph cavity of the Far Ultra-Violet instrument. They are not considered hazardous due to the small quantity of mercury and their inaccessibility.

The FUSE Nickel-Cadmium (NiCd) batteries contain approximately 150 ml (4.0×10^{-2} gal) of potassium hydroxide electrolyte per cell for a total of 3.3 l (0.87 gal) per battery. The batteries are sealed and pressurized to 414 Kpa (60 psi). Three thermistors and two Platinum Resistance Thermometers are used to monitor battery temperature. Because the electrolyte is absorbed by separators within the battery cells, there is little or no free electrolyte within the cells. Batteries will be shipped in the discharged state, with each cell shorted, and in a temperature controlled environment. The FUSE program will use both non-flight (test and integration) and flight batteries. The satellite will be shipped with the non-flight batteries installed, while the flight batteries are shipped separately. Safe plugs will be installed on the spacecraft when received at CCAS.

The ring laser gyro contains a class 1, Helium-Neon (HeNe) type, 632.8nm wavelength laser, with an intensity of approximately 20 microwatts. The laser would be un-powered during launch, but would be pre-launch tested in Hangar AE and on the stack. The laser units are encased in a standard metallic electronics enclosure and are not capable of emitting light. Unplanned access is not permitted as the units would be too deeply buried inside the spacecraft to permit even visual inspection. Because the ring laser gyros are sealed against external light, and additional shielding is provided by their location in the spacecraft, they pose no laser hazard. In addition, the extremely low power output of the laser in the gyro should negate any safety concerns.

Cleaning materials and other processing materials will be used in Hangar AE in a well-ventilated area. Application of some of the processing materials is for contingency use only. This would include the solar array repair kit chemicals and solothane. These potential hazards are enumerated in the MSPSP. All hazardous wastes generated at CCAS are managed according to the 4th Space Wing Petroleum Products and Hazardous Waste Management Plan (OPlan 19-14). Hazardous wastes produced during processing and launching operations would be collected and stored in hazardous waste accumulation areas before being transferred to a hazardous storage area. These wastes would eventually be transported to an off-station licensed hazardous waste treatment/disposal facility (NASA 1998).

While potential health and environmental hazards connected to the FUSE mission exist, a number of safety mechanisms are in place to minimize risks. All potentially hazardous activities at GSFC and CCAS have been documented and hazard reduction addressed. The procedures are within the scope of normal activities at both GSFC and CCAS and meet all NASA safety requirements. No significant environmental consequences are associated with these activities.

3.1.1.10 Launch Failures and Accidents

The potential for an accidental release of liquid propellants will be minimized by strict adherence to established safety procedures. Post-fueling spills from the launch vehicle will be channeled into a sealed concrete catchment basin and disposed of according to the appropriate state and federal regulations (NASA 1995b).

The most severe propellant spill accident scenario would be releasing the entire launch vehicle load of nitrogen tetroxide (N_2O_4) at the launch pad while conducting propellant transfer operations. This scenario would have the greatest potential impact on local air quality. Airborne NO_X levels from this scenario are expected to be reduced to 5 ppm within about 150 m (500 ft) and to 1 ppm within approximately 300 m (1,000 ft). Activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure to concentrations that are above federally established standards to the vicinity of the spill. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area (NASA 1995b).

In the unlikely event of a launch vehicle destruction, either on the pad or in-flight, the liquid propellant tanks and SRM cases would be ruptured. Due to their hypergolic (ignite on contact) nature, a launch failure would result in a spontaneous burning of most of the liquid propellants, and a somewhat slower burning of the SRM propellant fragments. Any such release of pollutants would have only a short-term impact on the environment near the pad (NASA 1995b).

Launch failure impacts on water quality would stem from unburned liquid propellant being released into CCAS surface waters. For most launch failures, propellant release into surface waters would be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system. However, if there were an early flight termination and failure of the vehicle destruct system, it is remotely possible that the entire Stage II propellant quantity could be released to the ocean. Impacts to ocean biota systems would be localized and transient in nature, and these systems would be expected to recover rapidly due to the large amount of ocean water available for dilution (NASA 1995b).

3.1.1.11 Orbital Debris

NASA Management Instruction (NMI) 1700.8 states that "NASA's policy is to employ design and operations practices that limit the generation of orbital debris, consistent with mission requirements and cost-effectiveness." Orbital debris is a NEPA issue only as to its potential impact upon returning to earth. The general guideline for orbital debris returning to earth is that the total "footprint" of objects impacting the earth's surface may not exceed 8 m^2. The NMI requires that each program or project conduct a formal assessment for the potential to generate orbital debris. A debris assessment for the FUSE mission was prepared and approved by NASA in 1996 (JHU 1996). The launch, operation, and re-entry of the FUSE satellite satisfies the conditions of NASA's policy objectives. The FUSE spacecraft will not exceed the total surface "footprint" guideline and it is expected to burn-up upon re-entry.

3.1.1.12 Pollution Prevention

In implementing the FUSE mission, NASA will comply with Toxic Release Inventory requirements, Emergency Planning and Community Right-to-Know responsibilities, and State and Local Right-to-Know and Pollution Prevention requirements. NASA will support the Local Emergency Planning Committee as requested and will make available all Pollution Prevention and Community Right-to-Know information upon request (NASA 1998).

In compliance with Executive Order 12856, "Pollution Prevention and Community Right-to-Know," NASA has developed a comprehensive agency program to prevent adverse environmental impacts by: 1) Moving ahead of compliance; 2) Emphasizing pollution source elimination and waste reduction; and 3) Involving communities in NASA decision processes. By the end of 1999, NASA and the USAF will have achieved a 50 percent reduction (1994 baseline) in total releases of toxic chemicals to the environment and off site transfers of such materials for treatment and disposal (NASA 1998). The FUSE mission is managed in compliance with both NASA and USAF requirements and objectives for Pollution Prevention.

3.1.2 WIRE

The proposed testing, processing, and launching procedures for the WIRE mission are similar to those for NASA's EOS, with the sole exception that the WIRE instrument will be making observations of space instead of earth. The WIRE mission and its possible impacts are consistent with those outlined in the EOS Final Programmatic Environmental Assessment (NASA 1997a). The WIRE instrument will be tested at GSFC until January of 1999, when it will be shipped to VAFB for launch. The environmental consequences of testing, processing, and integration of WIRE with its Pegasus ELV and launch from VAFB are discussed below.

All payload processing procedures at VAFB would take place at the Astrotech commercial PPF just south of SLC-2, using existing trained personnel. The proposed testing and payload processing procedures fall within the normal scope of operations at GSFC and VAFB. The environmental effects of Astrotech's PPF operations are fully documented in a previous EA (Astrotech 1993). Ground operations at VAFB are similar to those used for EOS payloads. Launch from the L-1011 equipped with the Pegasus launch vehicle and WIRE spacecraft is also within the scope of normal operations at VAFB. A FONSI has been published for the Orbital Sciences Corporation's commercial launch program, which is responsible for launching WIRE (FONSI 1993).

The environmental impacts of launching WIRE using the Pegasus XL launch vehicle are fully described in USAF 1991 and NASA 1997a. Any additional unique impacts of operating the L-1011 are covered by previous publications (FONSI 1993).

3.1.2.1 Air Quality

Testing and processing, at GSFC and VAFB, and launching activities have potential air quality impacts associated with them. Testing and processing activities include cleaning the spacecraft with volatile solvents. These activities will take place indoors with adequate ventilation, and will not impact the external environment. These activities are within the normal scope of operations at the facilities.

The environmental effects of normal operations at the Astrotech PPF are described in a previously published EA (Astrotech 1993). Impacts from normal Pegasus operations are not expected to have a significant impact on air quality. Carrier aircraft impacts from ground operations, takeoff, and departure associated with Pegasus launches are insignificant when compared to routine VAFB aircraft traffic. Emissions from the Pegasus ELV itself would be highly localized, of extremely short duration, and would occur at an altitude that would readily facilitate exhaust dissipation.

Launch vehicle exhaust emissions have a potential for increasing ozone-depleting chlorine compounds; however, such emissions are considered highly localized and transient in nature. The Pegasus ELV uses only 15,955 kg (35,175 lbs) of solid propellant, while the Delta II 7925 carries 102,262 kg (225,450 lbs) in its first two stages. The effects of a Pegasus launch on stratospheric ozone are negligible.

3.1.2.2 Hydrology and Water Quality

Municipal water is used at VAFB for payload processing and potable water. Water usage for payload processing fits within the current scope of water discharge permit definitions. Local and regional water resources are not affected since there are no groundwater withdrawals. Water utility piping is used at VAFB to meet miscellaneous onsite needs. Solvents and rinsates generated during processing will be disposed of as hazardous materials in compliance with all existing Federal and applicable state and local base regulations. It is expected that no more than 3.8 l (one gallon) of each solvent or rinsate material would be used to process WIRE. No substantial hydrologic or water quality effects are expected from testing or processing of the WIRE satellite.

3.1.2.3 Land Resources

Testing and processing of WIRE would take place indoors, in existing facilities, using existing personnel. Testing and processing both fall within the scope of normal activities at GSFC and VAFB. No unique effects on land resources would result from these activities. Since WIRE would be launched from the air and over water, there would also be no substantial effects on terrestrial resources. No wetlands or floodplains have been identified in environmental assessment documents for SLC 2W at VAFB (NASA 1998). No wetland or floodplain impacts are anticipated.

3.1.2.4 Noise

Testing activities will occur during normal hours of operation at GSFC and VAFB. Once the cryostat on the WIRE spacecraft is filled with hydrogen, the spacecraft will be monitored 24 hours per day. These activities are not anticipated to create noise above and beyond normal operational noises at VAFB.

Impacts from normal Pegasus operations are not expected to cause an increase in noise levels at VAFB. Carrier aircraft noise from ground operations, takeoff, and departure associated with Pegasus launches are insignificant when compared to routine VAFB aircraft traffic. Since the launch of Pegasus takes place 185 km (84 mi) off the Monterey, California coast, noise effects are not measurable to any population.

3.1.2.5 Biotic Resources

Normal testing, processing, and Pegasus launching operations are not expected to cause substantial impacts to biota at VAFB. The listed endangered or threatened species at VAFB are located in colonies away from the payload processing and L-1101 flight staging areas under consideration. The nearest colonies are in Canada Honda Creek and along the rocky coastline. Since the launch of Pegasus takes place 185 km

(84 mi) off the Monterey, California coast, normal launch activities do not affect terrestrial biota or any endangered or threatened populations.

3.1.2.6 Marine Resources

During a normal Pegasus launch, spent stages impact the open ocean. The environmental effect of launch debris is considered negligible, due to the small amounts of metal involved, slow rates of oxidization, and large amounts of ocean water available for dilution.

Environmental effects due to emissions are also considered negligible, due to the small amount of propellant carried by the Pegasus and rapid dilution by the atmosphere.

3.1.2.7 Cultural and Historical Resources

Since no surface or subsurface areas will be disturbed and rocket launches are typical activities at VAFB, no archeological, historic, or cultural sites listed or eligible for listing in the National Register of Historic Places are expected to be affected by the testing, processing, or launching of WIRE.

3.1.2.8 Socioeconomic Effects and Environmental Justice

Testing, processing, and launching activities would take place using existing personnel, far away from existing residential areas. No jobs would be created or re-located during these activities. There are no substantial socioeconomic effects resulting from the WIRE mission. EO 12898 directs federal agencies to identify and address disproportionately high and adverse human health environmental effects of their activities on low-income populations or minority populations in the United States. The WIRE mission does not raise any environmental justice concerns. The WIRE project is small in size and scope and would not produce any substantial environmental or human health impacts on the population as a whole. Therefore, there would be no disproportionately high or adverse impacts on minority or low-income populations from the implementation of the WIRE mission.

3.1.2.9 Hazards

The WIRE instrument is a cryogenically cooled, infrared telescope. The WIRE instrument has no moving parts once the vent valves have been opened and the aperture cover is removed on orbit. The WIRE cryostat is composed of three pressure/vacuum vessels, the primary hydrogen tank, the secondary hydrogen tank, and the outer vacuum shell. The cryostat will not be filled with hydrogen or helium until the satellite is at the PPF at VAFB, and once filled, the temperature and pressure will be monitored continuously until launch. In addition, the tanks are equipped with redundant burst disk assemblies that are designed to release if temperature and pressure build up enough and will experience a maximum differential of 207 Kpa (30 psi). The WIRE telescope/sensor and the two hydrogen tanks are enclosed in the vacuum shell. The vacuum shell will not be opened until the aperture door is ejected, several days into orbit. Although the solid hydrogen poses a personnel safety issue, it is thoroughly addressed in the MSPSP and does not pose an environmental concern.

WIRE possesses an ordnance subsystem, which is a series of pyrotechnic devices that opens valves and ejects covers after orbital insertion. There are three inhibits on the activation circuitry, two of which prevent the ordnance systems from activating until the spacecraft is detached from Pegasus, and the third is ground-controlled. These safety mechanisms are designed to prevent hazards associated with the ordnance subsystems.

The materials used in WIRE were dictated by the need for solid hydrogen as the cryogenic agent, hence materials that performed well under the temperatures and conditions associated with hydrogen were used. The tanks and telescope are made of an aluminum alloy, shown to be safe for handling solid hydrogen and with low impacts to the scientific instrument once deployed. Hydrogen is a colorless, odorless liquid and vapor, classified as a simple asphyxiant and is flammable in air. There are also potential hazards associated with severe cold burns and a sudden release-of-pressure. The other hazardous material used in the cryostat is helium. Helium is a colorless, non-toxic liquid, but it acts as an asphyxiant in high concentrations. Exposure to liquid helium can result in frost bite or cryogenic burns. Within the material matrix of the instrument are arsenic and beryllium. Both of these chemicals are present in very small quantities within the telescope and cryogenic vessel. These materials are not considered to be hazardous since they are in solid form and contained.

The power supply for the spacecraft also contains a Super Nickel-Cadmium battery system which contains a 31 percent potassium hydroxide (KOH) electrolyte concentration. The battery is equipped with five temperature sensors mounted on top of the battery. The battery weighs 11.5 kg (25.3 lbs). The critical burst pressure, based on Hughes pneumatic burst test, is greater than 3447 Kpa (500 psi). The maximum expected operational pressure is 338 Kpa (49 psi). Thus, the safety factor is at least 10:1.

The spacecraft also presents non ionizing radiation hazards. These hazards, resulting from inadvertent activation of a transponder, are very small. The radiation hazards were analyzed and found to be restricted to an area within 14.2 cm (5.6 in) of the antennas while the transponder is activated. This minimum safe distance will be maintained at all times, and the transponder is equipped with software that monitors for the separation of the spacecraft from the Pegasus launch vehicle and disables the transponder while WIRE is not separated.

Cleaning materials and other processing materials will be used in the Astrotech PPF in a well-ventilated area. Potentially hazardous materials are documented in the MSPSP. VAFB operates as a generator of hazardous waste and as a Treatment, Storage, and Disposal facility. The disposal of hazardous wastes generated during the processing and launch of WIRE is governed by VAFB's Hazardous Waste Management plan (Astrotech 1994).

While potential health and environmental hazards connected to the WIRE mission exist, a number of safety mechanisms are in place to minimize risks. All potentially hazardous activities at GSFC and VAFB have been documented and hazard reduction addressed. The procedures are within the scope of normal activities at both GSFC and VAFB, and meet all NASA safety requirements. No substantial environmental consequences are associated with these activities.

3.1.2.10 Launch Failure

In the unlikely event of a launch failure, the Pegasus missile would destruct due to an accidental or system-initiated rupturing of the propellant containers. The environmental effects of burning solid propellant would be transient in nature. Any air quality effects from burning fuel would be temporary and mitigated by natural dispersion. In the unlikely event of a failure in the missile's destruct system, some solid propellant would reach the open ocean, where its effects on the environment would again be temporary and would be mitigated by the large quantity of water available for dilution. Likewise, metal components would reach the ocean floor and oxidize slowly, with no significant increase in metal concentrations in the surrounding environment. Overall, the small size of the Pegasus missile and its light propellant load act to reduce the potential environmental effects of a launch failure.

3.1.2.11 Orbital Debris

NMI 1700.8 states that "NASA's policy is to employ design and operations practices that limit the generation of orbital debris, consistent with mission requirements and cost-effectiveness." Orbital debris is a NEPA issue only as to its potential impact upon returning to earth. The general guideline for orbital debris returning to earth is that the total "footprint" of objects impacting the earth's surface may not exceed 8 m^2. The NMI requires that each program or project conduct a formal assessment for the potential to generate orbital debris. WIRE's compliance with NASA policy objectives has been verified by simple inspection. The launch, operation, and re-entry of the WIRE satellite satisfies the conditions of NASA's policy objectives. The WIRE spacecraft will not exceed the total surface "footprint" guideline and it is expected to burn up upon re-entry.

3.1.2.12 Pollution Prevention

In implementing the WIRE mission, NASA will comply with Toxic Release Inventory requirements, Emergency Planning and Community Right-to-Know responsibilities, and State and Local Right-to-Know and Pollution Prevention requirements. NASA will support the Local Emergency Planning Committee as requested and will make available all Pollution Prevention and Community Right-to-Know information upon request (NASA 1998).

In compliance with Executive Order 12856, "Pollution Prevention and Community Right-to-Know," NASA has developed a comprehensive agency program to prevent adverse environmental impacts by: 1) Moving ahead of compliance; 2) Emphasizing pollution source elimination and waste reduction; and 3) Involving communities in NASA decision processes. By the end of 1999, NASA and the USAF will have achieved a 50 percent reduction (1994 baseline) in total releases of toxic chemicals to the environment and off site transfers of such materials for treatment and disposal (NASA 1998). The WIRE mission is managed in compliance with both NASA and USAF requirements and objectives for Pollution Prevention.

3.2 NO-ACTION ALTERNATIVE

3.2.1 FUSE

Although the absence of launching operations related to FUSE might spare the environment surrounding CCAS LC-17 of potential environmental impacts, the launch of a single satellite is within the scope of existing operations at CCAS and would have a limited impact on the surrounding environment. In addition, cancellation of the mission would preclude scientists from gaining important information concerning the nature of space beyond our solar system.

3.2.2 WIRE

Although the absence of launching operations related to WIRE might spare the environment surrounding VAFB of potential environmental impacts, the launch of a single satellite from an L-1011 is within the scope of existing operations at VAFB and would have limited impact on the surrounding environment. In addition, cancellation of the mission would preclude scientists from gaining important information concerning the nature of space beyond our solar system.

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