NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NOTICE: 99-GSFC-02

National Environmental Policy Act; TERRIERS Mission

AGENCY: NASA's Goddard Space Flight Center

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 TERRIERS mission. The mission involves the processing and launching of the TERRIERS spacecraft. The spacecraft would be launched from Vandenberg Air Force Base, California using an L-1011 aircraft carrying a Pegasus XL launch over the Pacific Ocean several miles from the coastline. The spacecraft is a university developed and operated platform, commissioned under a cooperative agreement between NASA and the Universities Space Research Association (USRA). Boston University would be responsible for its operation through a one year mission to study ionospheric phenomena.

DATE: Comments in response to this notice must be provided in writing to NASA on or before April 7, 1999.

ADDRESSES: Written comments should be addressed to Mr. Paul DeMinco, Goddard Space Flight Center, Code 180, Greenbelt, Maryland 20771. The Environmental Assessment (EA) prepared for this mission which supports the 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 (301-286-0840)

(c) Lompoc Public Library, 501 East North Avenue, Lompoc, CA 93436-3406

(d) Santa Maria Public Library, 420 South Broadway, Santa Maria, CA 93454-5199

(e) Santa Barbara Public Library, 40 East Anapamu Street, Santa Barbara, CA 93101-2000

(f) University of Califorinia, 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 Mr. Paul DeMinco at the address or telephone number indicated herein.

FOR FURTHER INFORMATION CONTACT: Paul DeMinco, 301-286-0840, Paul.A.DeMinco.1@gsfc.nasa.gov, or Lizabeth Montgomery, 301-286-0469, Lizabeth.R.Montgomery.1@gsfc.nasa.gov.

SUPPLEMENTAL INFORMATION:

NASA proposes to process and launch the TERRIERS satellite into orbit to gather information about the ionosphere. The TERRIERS satellite would be shipped to Vandenberg Air Force Base, California where it would be processed and launched. The proposed mission and the no-action alternative were examined in the EA. The no-action alternative would not fulfill the need to gain a better understanding of the upper reaches of the earth's ionosphere.

The launch vehicle chosen for this mission is the Pegasus XL. The vehicle selection was driven by satellite size and weight. The Pegasus was specifically developed for placing satellites like TERRIERS into Low Earth Orbit. Vandenberg was chosen as the launch site because of the desire to meet the science objectives via a polar orbit. The Pegasus has a track record for launch success, and is considered a logical choice for this mission.

The environmental consequences of the pre-launch processing and launching of the satellite were considered. The possible environmental impacts that were considered included, but were not limited to, air and water quality impacts, land resources, noise, marine and biotic resources, cultural and historic resources, socio-economic effects, hazards, and launch debris. The areas of potential impact included those areas involved in the pre-launch processing and launching at Vandenberg Air Force Base. Expected impacts to the human environment arise almost entirely from activities associated with the launch of the Pegasus XL which is air-released several miles off the coast from an L1011 aircraft. Air impacts from such a launch would be short term and not substantial. There would be no impact on threatened or endangered species or critical habitat, cultural resources, wetlands or floodplains. Hazards associated with TERRIERS have been analyzed and do not raise any environmental concerns. The mission does not involve the use of radioactive material. No other environmental issues of concern were identified. The activities involved with this mission are within the normal scope and level of operations at the site.

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

for W. J. Townend
A.V. Diaz
Director
NASA's Goddard Space Flight Center

3/12/99
Date

original

ENVIRONMENTAL ASSESSMENT for TERRIERS

February 1999

Prepared for and in cooperation with:

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

Environmental Assessment
For
TERRIERS

Lead Agency:

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

Proposed Action:

NASA proposes to implement the Tomographic Experiment using Radiative Recombinative Ionospheric Extreme Ultra-Violet and Radio Sources (TERRIERS) mission which would include the processing of the TERRIERS spacecraft at Vandenburg Air Force Base California and then the launching of the spacecraft via a Pegasus XL rocket. The spacecraft would be used to investigate the physical phenomena in the earth's ionosphere.

For Further Information:

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Date:

February 1999

EXECUTIVE SUMMARY

The National Aeronautics and Space Administration (NASA) 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 Tomographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources (TERRIERS) mission. This EA discusses the mission objectives as well as the potential environmental effects. The scope of this assessment includes the processing and launching of the TERRIERS spacecraft.

Both the proposed mission and the no-action alternative were examined in this EA. The no-action alternative would not fulfill the need for increasing our knowledge base by obtaining the new science data.

The processing and launch activities involved in this mission are within the normal scope and level of activities conducted at the site involved. These activities would produce no substantial adverse impacts on the existing environment at the site.

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ABBREVIATIONS AND ACRONYMS

EUV	Extreme Ultra-Violet
GISSMO	Gas Ionization Solar Spectral Monitor
ppm	Parts per million
STEDI	Student Explorer Demonstration Initiative
TERRIERS	Tomographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources
TESS	Tomographic EUV SpectrographS
USRA	Universities Space Research Association
VAFB	Vandenberg Air Force Base

1.0 PURPOSE AND NEED

NASA has prepared this Environmental Assessment (EA) for the proposed TERRIERS mission to comply with the National Environmental Policy Act of 1969, as amended (NEPA) (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 Subpart 1216.3). This EA discusses the mission objectives, as well as the potential environmental effects. The scope of this assessment includes the processing and launching of the TERRIERS spacecraft.

TERRIERS is designed to conduct a global upper-atmospheric study. Using a combination of ground based and space instruments, the satellite would survey the upper atmosphere using a technique called tomography, measuring ultraviolet light emissions, to construct an image of Earth's ionosphere. Although the ionosphere has been studied in great detail with various ground and space-based instruments, currently there is no means to obtain these types of global images. Such measurements are crucial to the advancement of our understanding of many upper atmosphere phenomena.

The purpose and need for the TERRIERS mission is twofold. First it would allow the scientific investigation of physical phenomena in the earth's ionosphere to advance our understanding. And secondly, it would demonstrate the capability of universities to develop a small spacecraft and manage the subsequent orbiting mission within a low cost envelope.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Mission Description

TERRIERS is the second of a three-experiment set of missions under the umbrella of the Student Explorers Demonstration Initiative, (STEDI). The STEDI program became an approved NASA endeavor as a consequence of an unsolicited proposal provided by the Universities Space Research Association. The purpose of this proposal was to demonstrate that universities had the capability to develop small spacecraft and that they could manage the subsequent orbiting mission within a low cost envelope. NASA accepted responsibility for obtaining a launch conveyance for the spacecraft, and entered into an agreement with USRA to manage an Announcement of Opportunity, a selection process, and ultimate day to day project management oversight of the selected university experiments. TERRIERS spacecraft was developed by Boston University under a cooperative agreement between NASA and the Universities Space Research Association (USRA).

The primary mission of TERRIERS is to make sensitive spectroscopic measurements of important ionospheric dayglow and nightglow emissions which contain information to reconstruct or verify absolute F region electron density altitude profiles along a meridian. The combination of instruments on the spacecraft would make two-dimensional, daily global measurements of the ionosphere that would provide insights into many current ionospheric science issues including equatorial anomalies, ionospheric neutral coupling, traveling atmospheric disturbances, and gravity wave disturbances. The goal of TERRIERS is to utilize the new EUV (extreme ultra-violet) tomographic technique in conjunction with more conventional ground and space based measurements to study the F region of the ionosphere.

GISSMO would make daily measurements of the solar EUV emissions. The radio beacon and visible photometers would make independent measures of the ionosphere to reach difference altitudes with varying resolutions

The TERRIERS spacecraft was developed at Boston University using existing facilities, and with the assistance of Aero Astro as a sub-contractor. TERRIERS would be delivered to the Vandenberg Air Force Base (VAFB) for launch. The spacecraft would arrive at the launch site approximately two to three weeks before intended launch. Ground processing operations would consist of about 14 days of spacecraft integration and checkout and final launch preparations. TERRIERS mission would then be launched from VAFB by Orbital Sciences Corporation using an L-1011 aircraft carrying a Pegasus launch vehicle. The spacecraft would operate in a near polar orbit of 97.8 degrees inclination, and a 550 km circular orbit with a mission life of one year.

2.2 Satellite Description

TERRIERS is a compact spin-stabilized spacecraft in a sun-synchronous 8:30AM/8:30PM orbit. The spacecraft carries a series of 5 identical Tomographic EUV

SpectrographS (TESS), two visible photometers, a gas ionization solar spectral monitor (GISSMO), a radio beacon and a high school payload. The spacecraft is composed of flight hardware and ground support equipment designed for transportability, integration, test and operations. TERRIERS has one deployable antenna for a radio beacon. The antenna is stowed and then deployed on orbit. The spacecraft has a mass of about 125 kg (275 lbs) and generates about 30 watts of average power. It would be supported by optical and radar ground measurements for ground truthing and coordinated campaigns. The TERRIERS spacecraft is pictured in below.

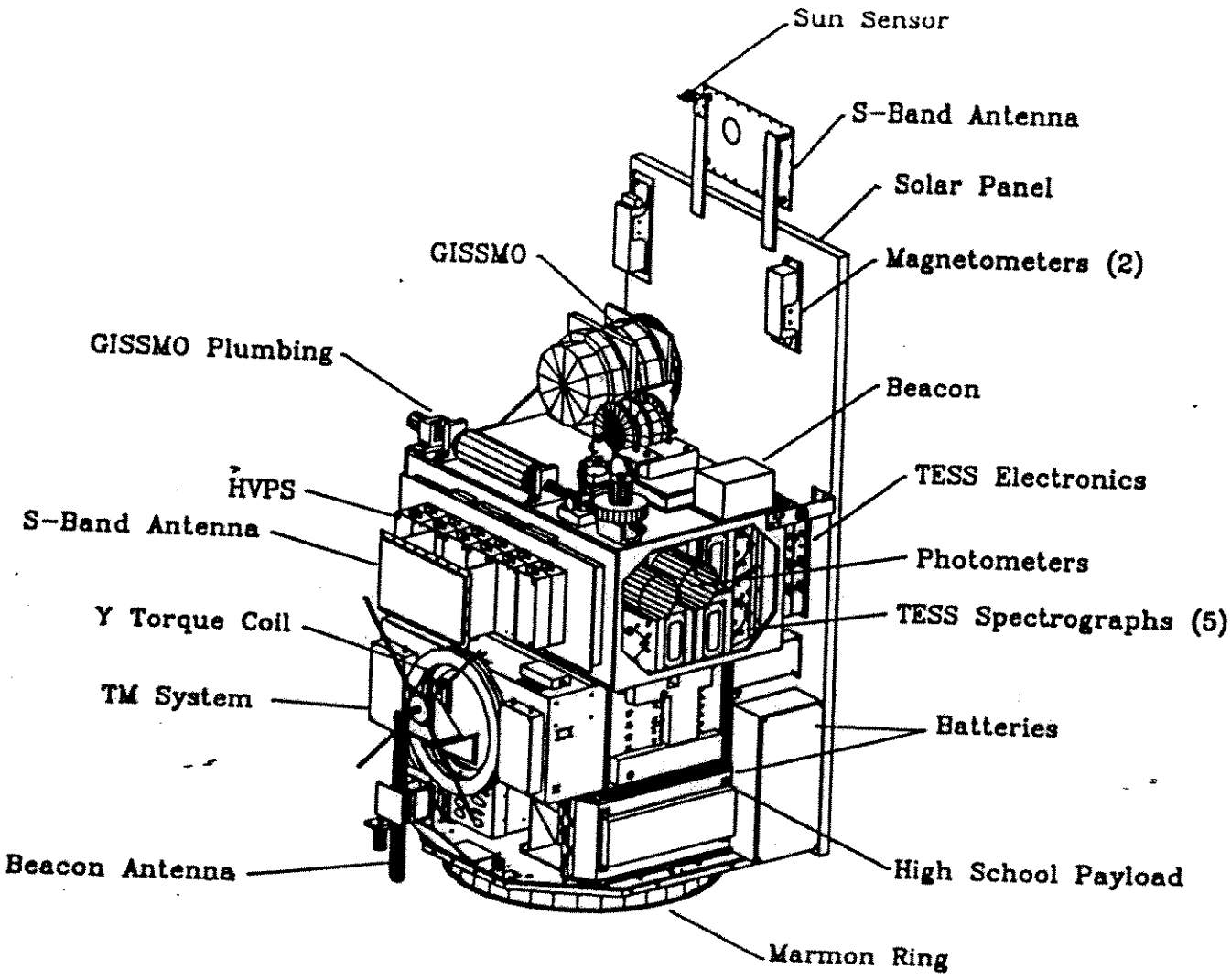

Diagram of the TERRIERS Satellite

2.3 Launch Vehicle Description

The Pegasus XL is the launch vehicle which was chosen for this experiment. The Pegasus for the TERRIERS mission has three-stage solid rocket motors and a fourth-stage fueled with liquid hydrazine. The Pegasus XL launch vehicle is carried aloft by the Orbital L-1011 "Stargazer" aircraft to an altitude of approximately 11,877 m (39,000 ft) over the open Pacific Ocean, where it is released and then free-falls 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 540 km (335 mi) above the earth in approximately ten minutes. The launch occurs approximately 185 km (115 mi) off the coast of California, and range control is exercised from the VAFB installation. 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) and 68 kg (150 lbs) of liquid hydrazine.

2.4 Alternatives to Proposed Payload

The alternatives considered in this assessment were the proposed action and the no-action alternative. The no-action alternative in which the TERRIERS mission would not be implemented was used as the baseline.

2.5 Alternatives to Proposed Launch

Launch vehicle selection was driven by the spacecraft size and weight as well as the desired orbital insertion energy. NASA advertised the requirement for a launch vehicle which could loft small satellites into orbit via the Ultra-Light Expendable Launch Vehicle (UELV) procurement in 1995. The only other potential vehicle which could have met both the cost constraint and the insertion requirement at the time was a configuration of the excess Minute Man assets. The open procurement decided the choice of vehicle. Cost was a very important consideration in this demonstration, given that these were pathfinder missions for future university explorers with intended cost caps for total mission expenditures.

3.0 AFFECTED ENVIRONMENT

VAFB, where TERRIERS would be processed and 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 processing for TERRIERS would take place at Building 1555 in North Vandenberg.

The environment at VAFB has been previously described in several NASA programmatic environmental assessment, the Earth Observing System Final Programmatic Environmental Assessment (EOS 1997) and the New Millenium Program Programmatic Environmental Assessment (NMP 1998).

4.0 ENVIRONMENTAL IMPACTS OF PROPOSED ACTION AND ALTERNATIVES

The proposed activities involved in the processing and launching of the TERRIERS mission are similar to those addressed in both the Earth Observing System (EOS) and New Millenium Program (NMP) programmatic environmental assessments (EOS 1997 and NMP 1998). Thus, the environmental impacts of the TERRIERS mission are consistent with those outlined in these programmatic environmental assessments.

All payload processing procedures at VAFB would take place in Building 1555 using existing trained personnel. The proposed activities fall within the normal scope of operations at VAFB. Launch from the L-1011 equipped with the Pegasus launch vehicle is also within the scope of normal operations at VAFB. The environmental consequences of Pegasus operations is addressed in several environmental documents, including the EOS and NMP documents (EOS 1997 and NMP 1998) and the environmental assessments for Pegasus activities at VAFB (PEGASUS 1992), at Wallops Flight Facility in Virginia (PEGASUS 1993), and at Edwards Air Force Base California (PEGASUS 1989). The environmental impacts associated with the processing and launching of the TERRIERS mission is summarized below.

4.1 Air Quality

Processing and launching activities have potential air quality impacts associated with them. Processing activities include cleaning the spacecraft with volatile solvents. These activities would take place indoors with adequate ventilation and would not impact the external environment. They are also within the normal scope of operations at the facilities.

During the loading of the hydrazine propellant in Building 1555 a minute amount of hydrazine vapor will be released into the air. The predicted values of values of 0.005 parts per million (ppm) for public exposure will be contained well within Building 1555 perimeter fence and no significant environmental impacts are expected. A hydrazine spill would require short-term mitigative actions and is not expected to create a health hazard.

Impacts from normal Pegasus operations are not expected to have a substantial 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 launch vehicle 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. Such emissions are considered highly localized and transient in nature. Due to the small amount of solid rocket propellant, the impact on stratospheric ozone from a Pegasus launch would be negligible.

4.2 Water Quality

Water usage for satellite payload processing fits within the current scope of water discharge permit definitions. Local and regional water sources would not be affected since there would be no groundwater withdrawals. Water utility piping is used at VAFB to meet miscellaneous onsite needs. Solvents used during processing would be disposed of as hazardous wastes in compliance with Federal, state and base regulations. No substantial hydrologic or water quality effects are expected from processing the TERRIERS satellite.

Launch vehicle processing would result in the generation of hydrazine contaminated liquid and solid waste from propellant transfer process. The hazardous waste will be disposed of in accordance with approved procedures and VAFB Hazardous Waste Management Plan.

4.3 Land Resources

Processing of TERRIERS at VAFB would take place indoors, in existing facilities, using existing personnel and fall under the scope of normal activities at VAFB. No unique effects on land resources would result from these activities. Since TERRIERS would be launched from the air and over the ocean, there are no substantial affects on terrestrial resources. No wetland or floodplains have been identified in environmental assessment documents for Space Launch Complex 2W at VAFB (NMP 1998). No wetland or floodplain impacts are anticipated.

4.4 Noise

Processing activities would occur during normal hours at VAFB and are not expected to generate any noise above normal operational activities at VAFB. Impacts from the L-1011 carrier aircraft are insignificant when compared to routine VAFB traffic. There would be no measurable noise impact to resident populations during launch due to the fact that this operation would occur several miles off of the coast.

4.5 Biotic Resources

Normal processing as well as Pegasus launch operations are not expected to cause substantial impacts to the biota at VAFB. Since the launch of the Pegasus takes place 185 km (115 mi) off the California coast, normal launch activities do not affect terrestrial biota. The listed endangered or threatened species are located in colonies away from the launch activities and thus away from the immediate influence of these activities.

4.6 Marine Resources

During a normal Pegasus launch, spent stages impact the open ocean. Toxic concentrations of metals would not likely to occur due to the small amounts of metal involved, slow oxidation rates and large amounts of ocean water available for dilution.

Along with the spent stages there would be small amounts of propellant. Concentrations in excess of the maximum allowable concentration of these components for marine organisms would be limited to the immediate vicinity of the spent stage. There would be no substantial environmental effects from the spent stages due to small amount of residual propellants and the large volume of 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.

4.7 Cultural and Historical Resources

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

4.8 Socioeconomic Effects and Environmental Justice

Processing and launch activities would take place using existing personnel, far away from any residential areas. No jobs would be created or re-located during these activities. There are no substantial socioeconomic effects resulting from the TERRIERS mission. EO 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 environmental effects of their activities on low-income populations or minority populations in the United States. The TERRIERS mission does not raise any environmental justice concerns. The mission is small in size and scope and would not produce any substantial environmental or human health impacts on the population. Therefore, there would be no disproportionately high or adverse impacts on minority or low-income populations from the implementation of the TERRIERS mission.

4.9 Hazards

The TERRIERS spacecraft involves only one hazardous source in its build up (standard cleaning solvents) and batteries represent the only hazard source during its operation. Solvents used for cleaning during the spacecraft construction include ethyl alcohol and isopropyl alcohol. The amount used is minimized and controlled at all times. Solvents are stored in approved containers. VAFB operates as a generator of hazardous waste and as a Treatment, Storage, and Disposal facility. The hazardous wastes generated during the processing and launch of TERRIERS would be managed in accordance with VAFB's Hazardous Waste Management Plan.

The satellite contains two types of batteries, 4 nickel-Cadmium (NiCd) batteries (made by General Electric) and 26 C-sized alkaline batteries produced by Duracell. The NiCd batteries contain electrolytes which do not present a hazard during normal operations. They would be trickle-charged during ground operations at VAFB. A hazard would exist

if a battery was ruptured. However, these batteries are encapsulated in an aluminum box. Alkaline batteries typically contain potassium hydroxide (KOH), manganese dioxide (MnO_2) and zinc (Zn). Alkaline batteries are not considered toxic unless through overheating and disassembly, KOH leaks out in which case inhalation, digestion, and skin contact would pose problems.

The GISSMO instrument contains a high-pressure neon gas delivery system manufactured and tested in conformance with 49 CFR and carrying a safety factor of 4. This is a medium pressure system and would not present a hazard should it rupture.

Non-ionizing radiation is generated by the communications link. The radio beacon would radiate 150, 400 MHz (.5W/channel) while the main transmitter would radiate 1.5 W at 2,272.9 GHz. The S-band would be utilized and associated antenna would have hats to prevent inadvertent emission during integration. The VHF system would not be utilized without clearance during integration and is only expected to be powered up twice. An RF hazards analysis has been performed on the spacecraft transmitters, and it has been determined that they do not present a hazard to personnel or inadvertent electro-explosive ordnance initiation. The system would not radiate during captive flight. RF silence would be assured during connection of ordnance devices as is standard procedure.

An accident Risk Assessment was developed by Boston University to address all potential hazards associated with the TERRIERS mission. The hazards are summarized in the Accident RISK Assessment Report (Cotton 1998). The assessment identifies procedures to mitigate any potential negative affects and minimize risks. The hazards are within the normal scope of operations at VAFB and meet all NASA safety requirements. No substantial environmental consequences are associated with these activities.

4.10 Launch Failure

In the unlikely event of a launch failure, the Pegasus rocket would destruct due to an accidental or system initiated rupturing of the propellant containers. Due to the hypergolic (ignite on contact) nature of the liquid propellant, a failure would results in a spontaneous burn of the liquid propellant and a somewhat slower burning of the solid propellant. The environmental effects of burning 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 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 XL and its light propellant load act to reduce the potential environmental effects of a launch failure.

4.11 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 is that the total footprint of objects impacting the earth's surface may not exceed 8 square meters. The TERRIERS spacecraft in its entirety is much smaller, and it is expected to burn up upon re-entry.

4.12 Pollution Prevention

In implementing the TERRIERS 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 TERRIERS mission will be managed in compliance with both NASA and USAF requirements and objectives for Pollution Prevention.

4.13 No-Action Alternative

Although the absence of launching operations might spare the environment immediately off the coast of VAFB from potential environmental impacts, the launch of the Pegasus XL from the L1011 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 increasing fundamental knowledge of the physics of the region of interest.

5.0 LIST OF PREPARERS

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(B.C.E., Civil Engineering; M.S. Administration of Science & Technology).

6.0 REFERENCES CITED

EOS 1997. Earth Observing System Final Programmatic Environmental Assessment, Jet Propulsion Laboratory, (JPL D-12737), October 1997.

NMP 1998. New Millenium Program Programmatic Environmental Assessment, Jet Propulsion Laboratory, (JPL D-14472), June 1998.

PEGASUS 1989. Environmental Assessment for Pegasus Air-Launched Space Booster Edwards AFB/Western Test Range, CA., September 1989.

PEGASUS 1992. Environmental Assessment for the Orbital Sciences Corporation Commercial Launch Services Program at Vandenberg Air Force Base, California, December 1992.

PEGASUS 1993. Environmental Assessment for the Pegasus Expendable Launch Vehicle Program at Goddard Space Flight Center Wallops Flight Facility Wallops Island, Virginia, September 1993.

TERRIERS 1998. TERRIERS Accident Risk Assessment Report, Revision 5.0, Dr. Dan Cotton, Boston University, December, 1998.

USRA 1994. Cooperative Agreement Between NASA and the Universities Space Research Association (NCCW0048), May 12, 1994.