NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NOTICE: 99-GSFC-03

National Environmental Policy Act: Imager for Magnetopause-to-Aurora Global Exploration **(IMAGE)** and High Energy Solar Spectroscopic Imager **(HESSI)** 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 IMAGE and HESSI missions. The missions would involve the testing, processing, and launching of the IMAGE and HESSI spacecraft. The IMAGE spacecraft would be launched aboard a Delta II 7326 launch vehicle from Vandenberg Air Force Base, California in February 2000. HESSI would be launched from Cape Canaveral Air Station, Florida, using the Pegasus XL launch vehicle in July 2000. IMAGE and HESSI are part of NASA's "Sun-Earth Connection Program", a program designed to answer fundamental questions about the solar atmosphere and flares, the Earth's magnetosphere and upper atmosphere, and the connections among them. IMAGE and HESSI are both managed under the Explorers Program at NASA's Goddard Space Flight Center. The objective of the IMAGE mission is to determine the global response of the magnetosphere to changing conditions in solar wind. The HESSI mission objective is to investigate the physics particle acceleration and energy release in solar flares.

DATE: Comments and environmental concerns must be provided in writing to NASA on or before February 14, 2000.

ADDRESSES: Written comments should be addressed to Mr. Robert Buchanan, Goddard Space Flight Center, Code 410, Greenbelt, Maryland 20771. While hard copy comments are preferred, comments by electronic mail may be sent to Robert.P.Buchanan@gsfc.nasa.gov. The Environmental Assessment (EA) prepared for the IMAGE and HESSI 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 Mr. Robert Buchanan at the address, telephone number, or electronic mail address indicated herein.

FOR FURTHER INFORMATION CONTACT: Robert Buchanan, 301-286-0491, Robert.P.Buchanan.1@gsfc.nasa.gov, or Lizabeth R. Montgomery, 301-286-0469, Lizabeth.R.Montgomery.1@gsfc.nasa.gov.

SUPPLEMENTAL INFORMATION:

NASA has reviewed the EA for the IMAGE and HESSI missions, and has determined that it represents an adequate and accurate analysis of the scope and level of associated environmental impacts. The EA is hereby incorporated by reference in this FONSI.

NASA proposes to test, process, and launch two investigative satellites, IMAGE and HESSI, into Earth's orbit in order to gather astronomical information. IMAGE would be processed and launched at Vandenberg Air Force Base (VAFB), California in February 2000. HESSI would be integrated with the Pegasus launch vehicle at VAFB and then would be ferryed to Cape Canaveral Air Station (CCAS), Florida, for launch in July 2000.

Both the proposed missions and the No-Action Alternatives were examined in the EA. The No-Action Alternative would preclude scientists from gathering important information concerning the sun and its interaction with the Earth. The environmental consequences of testing, processing, and launching of IMAGE and HESSI spacecraft were addressed. The possible environmental impacts that were considered included, but were not limited to, air and water quality impacts, land and biotic resources, adverse health and safety impacts, launch debris and re-entry. Launch vehicle selection for the IMAGE and HESSI missions were driven by spacecraft size and weight, and desired orbital placement. The environmental impacts of the launch vehicles have been addressed in previous NASA environmental assessments. The areas of potential impact considered in this assessment were those affected by the activities that would originate and take place at CCAS, VAFB, Southwest Research Institute, San Antonio, Texas, Lockheed Martin Missiles & Space, Sunnyvale, California, and University of California, Berkeley, California.

All of the activities involved in these missions are within the normal scope and level of activities at the various sites. The components, which would be utilized in the spacecrafts and instruments, would be of materials normally encountered in the space industry. The spacecraft would not utilize any fuel/propellants or Earth-pointing lasers. Both the IMAGE and HESSI spacecrafts would carry minute quantities of radioactive material needed for the scientific instruments and/or instrument calibration. The use of the radioactive sources in these missions has been reviewed in accordance with Presidential Directive/National Security Council Number 25 (PD/NSC-25) and NASA Safety Policy and Requirements. For the IMAGE and HESSI missions the launch approval requirements have been met. The sources are of low level, are adequately contained, have limited accessibility, and pose no substantial hazard to personnel or the environment.

There would be no substantial impact on air or water quality, threatened or endangered species or critical habitat, cultural resources, and wetlands or floodplains. No other environmental issues of concern were identified in the EA. Hazards associated with the IMAGE and HESSI missions have been analyzed and do not raise any environmental or safety concerns.

On the basis of the IMAGE and HESSI EA, NASA has determined that the environmental impacts associated with the missions would not have a significant impact on the quality of the human environment.

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

1/3/00
Date

ENVIRONMENTAL ASSESSMENT FOR IMAGE (IMAGER FOR MAGNETOPAUSE-TO-AURORA GLOBAL EXPLORATION) AND HESSI (HIGH ENERGY SOLAR SPECTROSCOPIC IMAGER) MISSIONS

December 1999

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

Environmental Assessment

for

IMAGE (Imager for Magnetopause-To-Aurora Global Exploration) and HESSI (High Energy Solar Spectroscopic Imager) 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 "Sun Earth Connection" Program focuses on the solar atmosphere and flares, earth's magnetosphere and upper atmosphere, and the connections among them. The "Sun Earth Connection" 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. The IMAGE and HESSI missions are components of this strategy. NASA proposes to implement the IMAGE and HESSI missions, which include the testing, processing, and launching of these spacecraft from Vandenberg Air Force Base, California and Cape Canaveral Air Station, Florida, respectively.

For Further Information:
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Date: December 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 Imager for Magnetopause-To-Aurora Global Exploration (IMAGE) and the High Energy Solar Spectroscopic Imager (HESSI) 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 NASA's science needs.

The environmental consequences of all aspects of the testing, transporting, pre-launch processing, launching, and re-entry of IMAGE and HESSI 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. On the basis of this IMAGE and HESSI EA, NASA has determined that the environmental impacts associated with the missions would not have a significant impact on the quality of the human environment.

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ABBREVIATIONS AND ACRONYMS

CCAS	Cape Canaveral Air Station
CEQ	Council on Environmental Quality
ERR	Eastern Range Regulation
EA	Environmental Assessment
EOS	Earth Observing System
ELV	Expendable Launch Vehicle
EWR	Eastern and Western Range
FONSI	Finding of No Significant Impact
FWS	Fish and Wildlife Service
GSFC	Goddard Space Flight Center
GEMs	Graphite Epoxy Motors
HESSI	High Energy Solar Spectroscopic Imager
IMAGE	Imager for Magnetopause-To-Aurora Global Exploration
KOH	potassium hydroxide
KSC	Kennedy Space Center
LEO	Low-Earth Orbit
LMMS	Lockheed Martin Missiles & Space
Ml	milli-liter
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
OSHA	Occupational Safety and Health Administration
OSS	Office of Space Science
PAF	Payload Attach Fitting
PPF	Payload Processing Facility
PSP	Project Safety Plan
RPM	revolutions per minute
SLC-2W	Space Launch Complex 2 West
SRP	Safety Review Panel
SRM	solid rocket motor
SSL	Space Sciences Laboratory
SwRI	Southwest Research Institute
UCB	University of California, Berkeley
USAF	U.S. Air Force
VAFB	Vandenberg Air Force Base

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 "Sun-Earth Connection" Program is to answer issues pertaining to the solar atmosphere and flares, earth's magnetosphere and upper atmosphere, and the connections among them. The "Sun-Earth Connection" 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 IMAGE and HESSI missions are components of this strategy. Specifically, OSS hopes to gain insight into space physics which is the study of the heliosphere (the sphere of influence of the Sun) as one system. In addition, it seeks to explore and understand the dynamics of the Sun and its interactions with the Earth and other planetary bodies and with the interstellar medium

NASA has determined that an EA should be prepared to evaluate the environmental consequences of implementing the IMAGE and HESSI 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 procedures (14 CFR Subpart 1216.3).

1.2 IMAGE

1.2.1 Mission Description

The Explorers Program at NASA's GSFC along with Southwest Research Institute (SwRI), providing the science instrument package, and Lockheed Martin Missiles and Space, providing the spacecraft bus, are the lead organizations managing and developing the IMAGE mission. The purpose of the IMAGE mission is to place a single Explorer-class spacecraft into orbit around the earth in February of 2000. Plans call for using a three-stage Boeing-Delta II 7326-2.90 m (9.5 foot fairing), Expendable Launch Vehicle (ELV) with three Graphite Epoxy Motors (GEMs) strapped-on. IMAGE would be launched from VAFB into an 1000-km (540-nmi) X 45,923 km (24,796.5-nmi) elliptical orbit for a two-year mission, with a total satellite mass to orbit of 494.07 kg (1089.24 lbs.). The proposed orbit will be inclined by 90 degrees with respect to the equator, and the orbit period is approximately 13.7 hours.

From February of 2000 until the end of its mission, IMAGE would make observations in response to scheduled instructions from the Mission Operations Control Center located at NASA's Goddard Space Flight Center in Greenbelt, MD.

1.2.2 Science Objectives

The mission objectives are to obtain the first global images of the major plasma regions and boundaries in the Earth's inner magnetosphere and to study the dynamic response of these plasma populations to variations in the flow of charged particles from the Sun.

The IMAGE observatory would provide the missing global context, the "big picture" that will allow space researchers, for the first time, to study the Earth's magnetosphere as a coherent global system of interacting components, driven by the highly variable input of mass, momentum, and energy from the solar wind. The IMAGE mission would coincide with solar maximum, a period of the most intense solar activity during which the Earth will be continually buffeted by explosive eruptions of plasma from the Sun. The images of the Earth's inner magnetosphere that would be captured by the instruments on board the IMAGE spacecraft are thus expected to be dramatic ones.

To achieve this objective, IMAGE would employ energetic neutral atom (ENA) imaging, conventional photon imaging at ultraviolet wavelengths, and radio sounding to obtain global images of the principal plasma regions and boundaries of Earth's inner magnetosphere. Using these various techniques, IMAGE would be able to obtain global images of different regions simultaneously, making it possible to relate processes occurring in one region to events observed in another, different region.

Changes in the latitude and local time of orbit apogee would allow the spacecraft to view the inner magnetosphere from a variety of perspectives and to focus on particular regions, processes, and phenomena. Science operations would be conducted in different phases, corresponding to IMAGE's different orbital phases.

1.2.3 Spacecraft Description

The IMAGE observatory is planned as a spin-stabilized spacecraft that measures 2.2 meters (7.25 feet) in diameter and 1.45 meters (4.75 feet) in height and weighs 494.07 kg (1089.24) (including instruments). Viewed from either end, it has the form of a regular octagon. Arrays of high-efficiency, dual-junction gallium-arsenide solar cells attached to the spacecraft's eight sides and two end panels provide power to the scientific instruments and subsystems, which together will require an orbit- averaged power of 250 Watts. (When the spacecraft is in eclipse, power is supplied by a Super Nickel-Cadmium battery.) The instruments are located on the payload deck in the middle of the spacecraft; subsystems for electrical power, communications, command & data handling, and attitude determination and control are mounted in four bays below the payload deck. Cutouts in the side panels accommodate the instrument apertures, the deployers for the Radio Plasma Imager's (RPI) radial antennas, and radiators used for thermal control. Extending above and below the spacecraft, parallel to its spin axis, are two 10-meter (32.8 ft) axial antennas for the RPI; the RPI's four radial antennas, positioned 90 degrees apart, will be deployed in the spin plane. When deployed, the thin (0.321 mm) beryllium-copper antennas will each extend 250 meters (820.3 ft) from the spacecraft.

IMAGE has a nominal spin period of 2 minutes (= a spin rate of 0.5 ± 0.01 rpm); its spin axis is perpendicular to the orbital plane. Spin rate and spin-axis orientation are controlled and maintained by a single magnetic torque rod according to attitude information provided by a sun sensor and star tracker. Attitude knowledge is accurate to within 0.1 degree.

The IMAGE spacecraft design (Figure 1) has three antennas for S-band communication with the ground: a medium-gain helix antenna and two low-gain omni-directional antennas. One of the omni antennas is mounted on the aft end panel of the spacecraft; the other is mounted together with the helix antenna on the forward panel. The helix antenna would be used to transmit data from the spacecraft to the ground; the co-mounted omni antenna would be used to receive uplinked commands and data. The second omni antenna would be switched off after the spacecraft has attained its final orbital orientation.

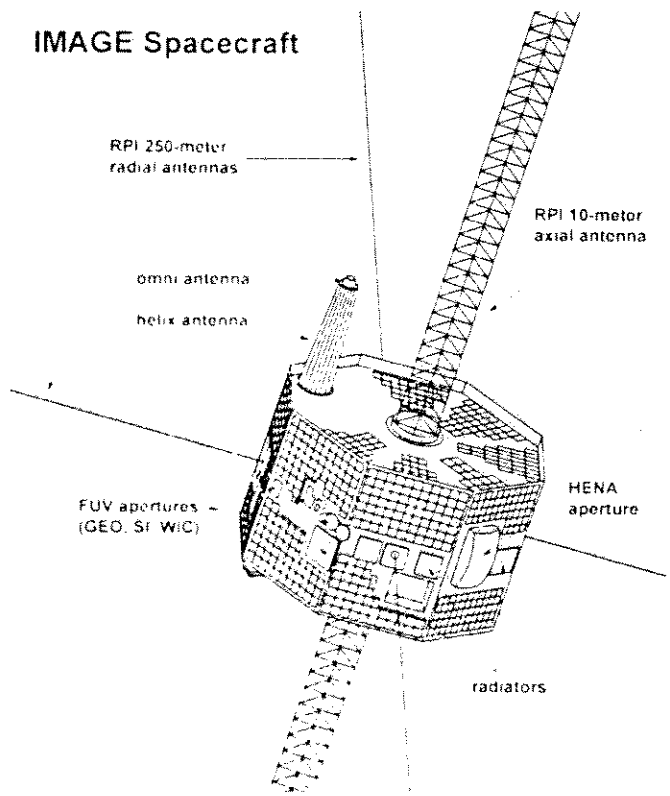

Figure 1. IMAGE Observatory On-orbit Configuration

1.2.4 Launch Vehicle Description

The IMAGE payload would be integrated with a Boeing-Delta II 7326 ELV. The Delta II launch vehicle consists of a payload fairing and first, second and third 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 2.9 meter (9.5 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 third stage propulsion system is a solid motor, designated as a STAR 37, provided by Thiokol Aerospace. The three-stage Delta II 7326-9.5 launch vehicle is shown in Figure 2.

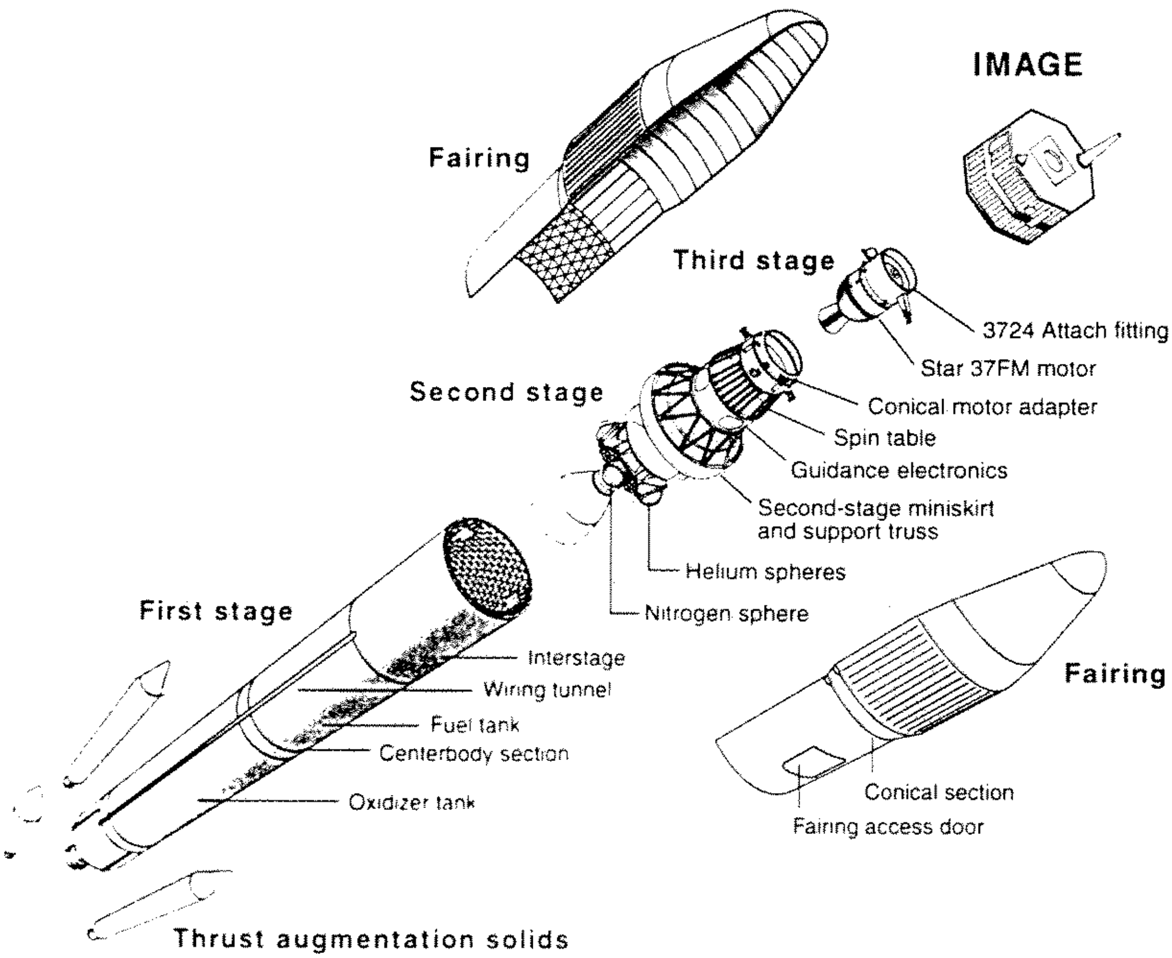

Figure 2. IMAGE Launch Vehicle Configuration

1.3 HESSI

1.3.1 Mission Description

The Explorers Program at NASA's GSFC along with the University of California at Berkeley, providing the science instrument, and Spectrum Astro Incorporated, providing the spacecraft bus, are the lead organizations managing and developing the HESSI mission. The primary scientific objectives of HESSI is to understand the following processes that take place in the magnetized plasmas of the solar atmosphere during a flare:

- Impulsive energy release
- Particle acceleration
- Particle and energy transport

These high-energy processes play a major role at sites throughout the universe ranging from magnetospheres to active galaxies. Consequently, the importance of understanding these processes transcends the field of solar physics; it is one of the major goals of space physics and astrophysics.

The HESSI observatory would be integrated and tested with the Pegasus launch vehicle at VAFB and ferryed to Kennedy Space Center/Cape Canaveral Air Station (KSC/CCAS) for launch. Orbital Sciences Corporation, of Dulles, VA, would use the L-1011 aircraft carrying a Pegasus launch vehicle, to an altitude of 11,887 m (39,000 ft). HESSI would be launched in July 2000 into a 600-km (373-mi) circular orbit with a 38 degree inclination with a mission length of 3 years.

From July of 2000 until the end of its mission, HESSI would make observations in response to scheduled instructions from University of California at Berkeley (UCB).

1.3.2 Science Objectives

The primary scientific objective of the High Energy Solar Spectroscopic Imager (HESSI) is to understand particle acceleration and explosive energy release in the magnetized plasmas at the Sun. The Sun is the most powerful particle accelerator in the solar system, accelerating ions up to tens of GeV and electrons to hundreds of MeV. How the Sun releases this energy, presumably stored in the magnetic fields of the corona, and how it rapidly accelerates electrons and ions with such high efficiency, and to such high energies, is presently unknown.

HESSI would provide the first hard X-ray imaging spectroscopy, the first high-resolution spectroscopy of solar gamma-ray lines and the first imaging of solar gamma-ray lines. HESSI combines an imaging system consisting of 9 rotating modulation collimators (RMCs), each with a high-spectral resolution germanium detector (GeD) covering energies from soft X-rays (3 keV) to high-energy gamma-rays (20 MeV).

HESSI's gamma-ray imaging spectroscopy would provide the first imaging of energetic protons, heavy ions, relativistic electrons, neutrons, and positrons; the first information on the angular distribution of accelerated ions; and detailed information on elemental abundances for both the ambient plasma and the accelerated ions.

1.3.3 Spacecraft Description

The HESSI spacecraft as planned 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 Spectrum Astronautics of Gilbert, Arizona. The spacecraft bus 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 2.10 m (6.9 ft) high, has a diameter of nearly 86 cm (34 in,) and weighs approximately 268 kg (591 lbs.).

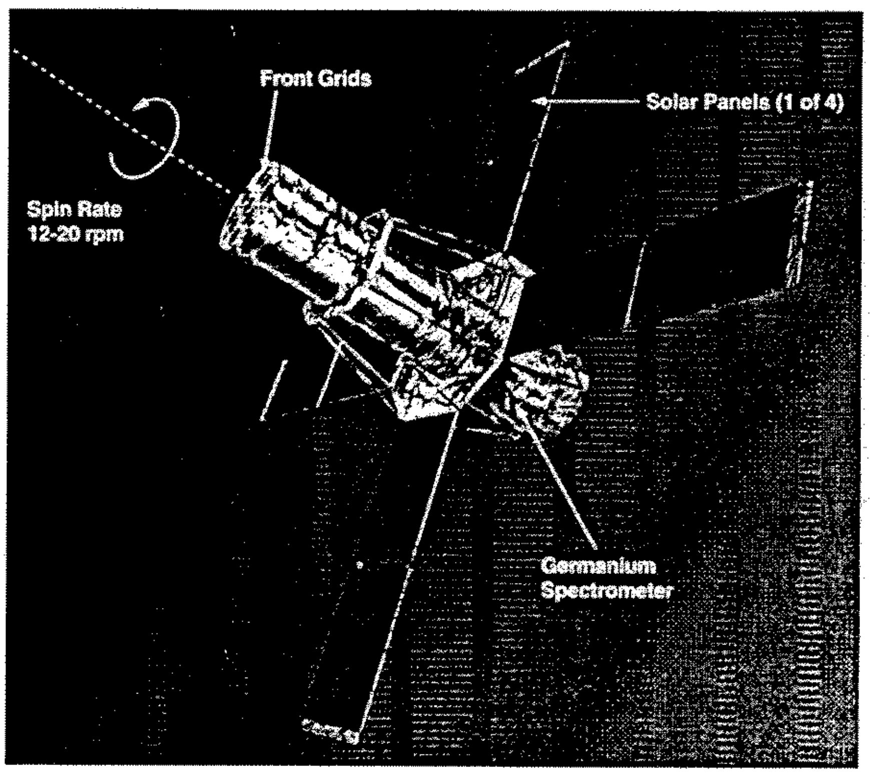

Figure 3. Diagram of the HESSI On-Orbit Configuration

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 4) to an altitude of approximately 11,877 m (39,000 ft) over the open Atlantic 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 600 km (373 mi.) above the earth in approximately ten minutes. The Pegasus XL configuration is pictured in Figure 5.

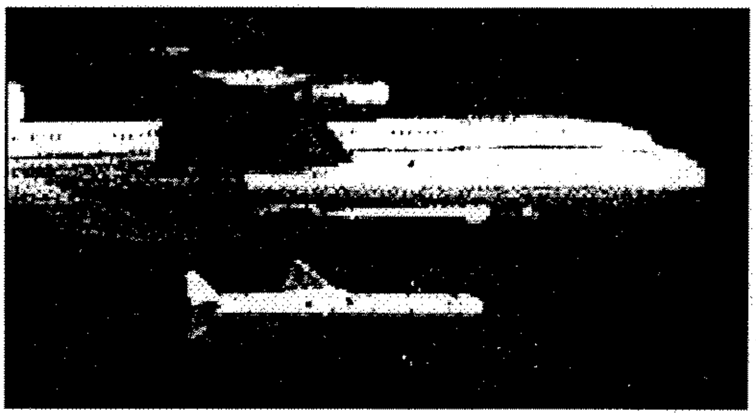

Figure 4. Photo of the L-1011 "Stargazer" with a just-released Pegasus launch vehicle.

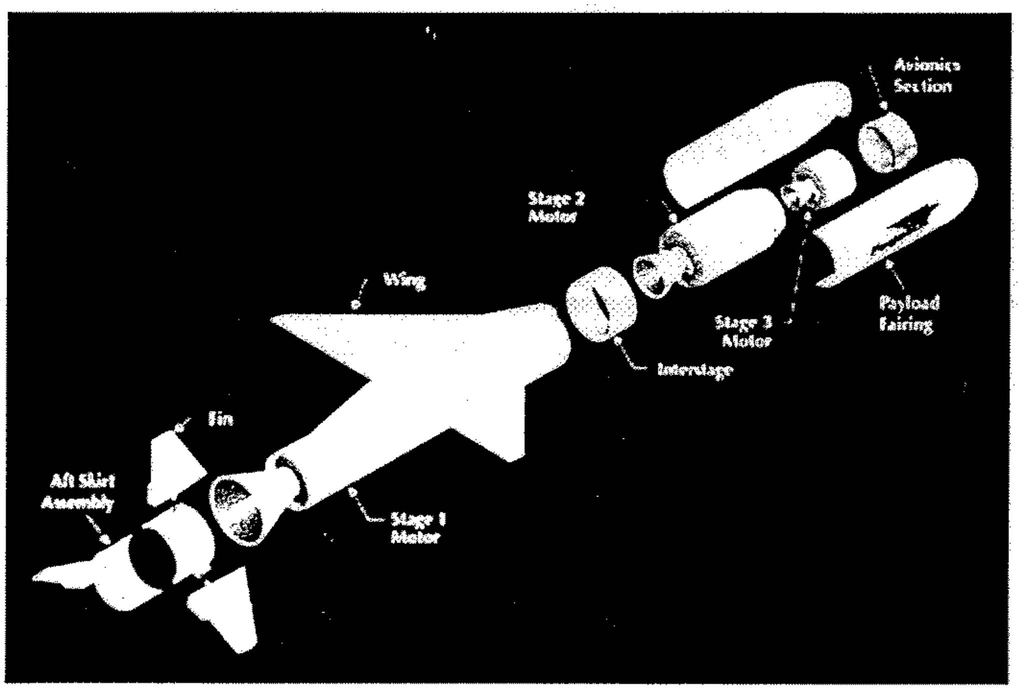

Figure 5. Expanded diagram of the Pegasus launch vehicle.

1.4 ALTERNATIVES TO PROPOSED PAYLOADS

1.4.1 IMAGE

The alternatives considered in this assessment were the proposed action and the No-Action Alternative. Under the No-Action Alternative, the IMAGE 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 HESSI

The alternatives considered in this assessment were the proposed action and the No-Action Alternative. Under the No-Action Alternative, the HESSI 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 IMAGE Launch Vehicle Alternatives

Launch vehicle selection for the IMAGE 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 IMAGE strategic mission is also a factor in launch vehicle selection.

The proposed launch vehicle, the Delta II Med-lite ELV, is a reliable and cost-effective alternative to the Space Shuttle. The Delta has been launched over 260 times since 1960. The Delta II 7326 (or Med-lite) is more cost-effective, than the larger Delta II 7925, burns less fuel, and has less impact on the environment. Less capable launch vehicles would be unable to place the IMAGE spacecraft in the desired orbit. A more thorough description of each of the space vehicles that can be considered for launching IMAGE is provided in the New Millennium Program (NMP) EA (NASA 1998).

1.5.2 HESSI Launch Vehicle Alternatives

Launch vehicle selection for HESSI and other similar missions is driven by satellite size and weight and desired orbital placement. Alternative launch vehicles for HESSI include the Delta II, Athena I, or a Taurus. All of the alternative launch vehicles provide more performance and cost significantly more than that which HESSI requires. The alternatives do not provide an advantage with respect to environmental impacts. Less capable launch vehicles would be unable to place the HESSI spacecraft in the desired orbit. A description of each of the alternative vehicles is provided in the NMP EA (NASA 1998).

2.0 AFFECTED ENVIRONMENT

2.1 IMAGE

2.1.1 Southwest Research Institute (SwRI)

SwRI, located in San Antonio, Texas is an independent, nonprofit, applied engineering and physical sciences research and development organization dedicated to technology development and transfer. SwRI occupies 4,856,400 square meters (1,200 acres) in San Antonio, Texas. Approximately 2,700 employees work in more than 157,935 square meters (1.7 million square feet) of laboratories, offices, and workshops. Program development offices are located in Houston, Detroit, and Washington, D.C. SwRI conducts R&D projects for an even mix of private industries and government agencies. Industrial clients range from small manufacturers to blue chip corporations, in the U.S. and abroad.

SwRI, where the IMAGE instruments are being designed and tested, has managed a number of NASA's astronomy and space physics missions. The personnel safety aspects at SwRI while the IMAGE payloads are undergoing integration and test have been described in "SwRI System Safety Program Plan for the IMAGE Mission" (8089-SSPP-01). The science instruments being developed and tested are within previous experience at SwRI with no environmental effects expected from the planned activities.

2.1.2 Lockheed Martin Missiles & Space (LMMS)

LMMS, located in Sunnyvale, California, was selected by SwRI to design, fabricate the spacecraft and environmentally test the Observatory for the IMAGE mission. Additionally, he IMAGE instrument package will be integrated onto the bus at LMMS prior to shipment to VAFB. LMMS has an extensive history of supplying space flight hardware to the federal government and private corporations over 30 years.

The personnel safety aspects at LMMS while the IMAGE Observatory is undergoing integration and test have been described in the LMMS generated document "IMAGE Spacecraft/Observatory Systems Description and Safety Assessment Package" (LMMS/P458551 Rev. A; dated 15 June, 1998). Observatory environmental testing is well within previous experience at LMMS with no environmental effects expected from the planned activities.

2.1.3 Vandenberg Air Force Base

VAFB, from which IMAGE would be launched, is located in Santa Barbara County, California. It occupies 398 square kilometers (98,400 acres) 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 IMAGE would take place at the NASA Building 1610 just south of SLC-2W.

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

2.2 HESSI

2.2.1 University of California, Berkeley (UCB)

The Space Sciences Laboratory (SSL) of UCB is the lead organization, for NASA-GSFC, on the design, development and testing of the HESSI Imaging system. University of California at Berkeley is located approximately 25 miles (40 km.) north of San Francisco and just East of the San Francisco Bay. The Space Sciences Laboratory at Berkeley was initiated in 1958 by a committee of the faculty who recognized that the new technology of rockets and satellites opened new realms of investigation and research to the physical, biological, and engineering sciences.

SSL has extensive experience with space flight instruments and payloads. A brief list of those successful NASA missions include: (1) Extreme Ultraviolet Explorer-EUV, (2) Fast Auroral Snap-shot Explorer-FAST, (3) Solar Orbiting Heliospheric Observatory-SOHO, and (4) Far Ultraviolet Spectroscopy Explorer-FUSE. No environmental effects at UCB is expected as a result developing and testing the HESSI observatory.

2.2.2 Spectrum Astro Incorporated (SAI)

SAI, located in Gilbert, Arizona, is a research and development aerospace company specializing in the development of high performance, low-cost space systems for sophisticated defense, scientific and commercial opportunities. SAI currently operates from a 4645 square meter (50,000 square foot) facility and maintains additional offices in Manhattan Beach, CA, Colorado Springs, CO, and Herndon, VA.

Spectrum Astro is performing the design and development effort of the HESSI spacecraft bus and will work with UCB on the integration and test of the HESSI instrument. Previous spacecraft bus built by SAI are the MSTI – 1,2,3 for the Ballistic Missile Defense Organization (BMDO) of the USAF and the New Millennium Deep Space-1 spacecraft bus for NASA's Jet Propulsion Laboratory. Additionally, SAI has been selected, along side seven other contractors, by NASA/GSFC's Rapid Spacecraft Development Office (RSDO) Indefinite Delivery/Indefinite Quantity program that will support NASA's space and earth science technology needs. No environmental effects at SAI is expected as a result of design, fabrication and testing the spacecraft bus.

2.2.3 Vandenberg Air Force Base (VAFB)

VAFB, where HESSI would be integrated with the Pegasus launch vehicle, is located in Santa Barbara County, California. It occupies 398 square kilometers (98,400 acres) 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. The facility where the HESSI spacecraft and the Pegasus launch vehicle will be integrated is Orbital Sciences Corporation (OSC) Building 1555 located on North Vandenberg. NASA and OSC has used B1555 previously for integrated launch vehicle and spacecraft testing (FAST, TRACE, SWAS missions).

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

2.2.4 Cape Canaveral Air Station

CCAS, from which HESSI 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 HESSI mission would take place in Building 1555 at VAFB; launch activities would occur at "The Skid Strip" located on CCAS.

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

3.0

ENVIRONMENTAL IMPACTS OF PROPOSED ACTION AND ALTERNATIVES

3.1 IMAGE PROPOSED ACTION

The IMAGE mission was tested at Lockheed Martin Missiles and Space (LMMS) in Sunnyvale, CA, from January 1999 to August of 1999 and is scheduled to be shipped in January 2000 to VAFB for launch processing. The environmental consequences of testing, processing, and integration of IMAGE mission with its Delta II 7326 ELV from SLC-2W at VAFB are discussed below. Environmental consequences of launching a Delta II expendable launch vehicle has been addressed previously in EOS & NMP EA (e.g. 1997a and 1998).

Testing, processing, and launching procedures for the IMAGE mission are similar to those for NASA's EOS and NMP missions, with the sole exception that the IMAGE instruments performs different scientific functions. Thus, the possible impacts of processing, ground processing and launching IMAGE are consistent with those outlined in the NMP Programmatic EA (NASA 1998) for activities at VAFB. The proposed testing and payload processing procedures fall within the normal scope of operations at LMMS and VAFB. All payload and launch processing procedures at VAFB will take place indoors in NASA-Building 1610 and at SLC-2W using existing trained personnel. The personnel safety aspects of IMAGE operations are documented in IMAGE Missile System Pre-launch Safety Package (MSPSP).

3.1.1 Air Quality

IMAGE testing and processing activities at LMMS and VAFB have minor 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 payload processing facilities.

3.1.2 Hydrology and Water Quality

Municipal water is used at VAFB 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 IMAGE. No substantial hydrologic or water quality effects are expected from testing or processing of the IMAGE satellite.

3.1.3 Land Resources

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

3.1.4 Noise

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

3.1.5 Biotic Resources

Normal testing, processing, of the IMAGE Observatory are not expected to cause substantial impacts to terrestrial, wetland, or aquatic biota at LMMS or VAFB

3.1.6 Marine Resources

The potential effects from IMAGE processing at LMMS and VAFB on the marine environment are considered minimal to nonexistent.

3.1.7 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 IMAGE.

3.1.8 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 IMAGE 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 IMAGE mission does not raise any environmental justice concerns. The IMAGE project is small in size and scope and would not produce any substantial environmental or human health impacts. Therefore, there would be no disproportionately high or adverse impacts on minority or low-income populations from the implementation of the IMAGE mission.

3.1.9 Hazards

The IMAGE Observatory presents routine environmental safety hazards which are discussed below.

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 NASA-GSFC, NASA-KSC and the Air Force Western Range Safety Office requirements. The MSPSP documents IMAGE satellite compliance with the requirements established by the Eastern and Western Range Regulations, EWR 127-1 dated 31 March 1995 as tailored for IMAGE, November 1999. This document also serves to demonstrate that requirements and procedures are met to obtain flight and ground payload safety approval.

Shipment of the IMAGE spacecraft would employ an environmentally controlled shipping container equipped with an accelerometer. The container will be continuously purged with GN_2 from six (6) 200 ft^3 steel cylinders. Structural analysis for the spacecraft would be primarily based on the launch vehicle predicted loads which significantly exceed the anticipated ground handling and transportation loads. The Nickel-Cadmium battery would be installed, ready for flight, in the IMAGE spacecraft bus. Upon arrival at the Western Range, the spacecraft would be thoroughly inspected for damage. Transportation of the spacecraft between the payload processing facilities and launch facilities at VAFB would involve the use of cranes, trucks, small generators, and support vehicles.

The IMAGE mission contains two radioactive materials among its components. The first includes two 0.075 micro-curie sources of Americium 241 used for calibration for the High Energy Neutral Atom Imager (HENA). The Americium 241 is sealed and permanently secured to the shutter door inside the HENA sensor head. The instrument housing is sufficient to absorb the alpha and most the gamma. For comparison, common household smoke detectors contain 10 to 25 micro-curies of Americium 241. The sources are licensed under the Johns Hopkins University/Applied Physics Laboratory number MD-27-014-02 (Dated September 1998 and expires July 2003). The second radioactive source includes a total of 7.903 x 10^-9 curies of depleted uranium (DU) that is plated onto the surfaces of three mirrors, one mirror in each sensor head within the Extreme Ultraviolet Imager (EUV). A cap coat is plated over the depleted uranium as a seal. A survey of the instrument at the exposed surfaces detected no radiation above the normal background count. More detail on this survey is in Appendix A, Table 5, Item 3 of the IMAGE MSPSP. The use of the radioactive sources on the IMAGE mission has been reviewed in accordance with Presidential Directive/National Security Council Number 25 (PD/NSC-25), "Scientific or Technological Experiments with Possible Large Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space" dated December 14, 1977, as revised May 8, 1996 and NASA Safety Policy and Requirements Document (NHB 1700.1). These documents establish the level of review, analysis and approval required for launch of radioactive material based on the level of radiological risk. For the IMAGE mission, the approval of the NASA's Nuclear Safety Assurance Manager is the only action required. The IMAGE sources are low level, are adequately contained, and have limited accessibility, posing no significant hazard to personnel or the environment. Finally, in the unlikely event of a launch vehicle failure, the minute amount of radioactive material poses no significant hazard to personnel or the environment.

The design of the IMAGE observatory calls for a radiative cooling system of anhydrous ammonia-filled aluminum pipes embedded into the payload deck and survival heaters to maintain thermal control during initial orbit acquisition and anomalous events. The heat pips draw heat away from the instruments to the outer edge of the payload deck where it is "dumped" into a radiator forming a ring around the middle of the spacecraft. The heat pipes will be pressurized and permanently sealed and the minimum purity level of the anhydrous ammonia would be 99.998 percent. The Maximum Expected Operating Pressure (MEOP) is 2668 kilo-pascal (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 heat pipes are designed with a factor of safety of 4.0 to ultimate and the total anhydrous ammonia for all heat pipes is 200 g (7.06 oz). The heat pipe system design meet MIL-STD-1522 and complies with EWR-127-1. Therefore, hazards from the ammonia are considered controlled. This radiator design has been used on over 100 missions by NASA.

The IMAGE mission employs a mercury filled passive nutation damper as one of the four spacecraft's Attitude Determination and Control (AD&C) subsystems. The complete AD&C subsystem provides reorientation and spin rate control for mission attitude acquisition, Radio Plasma Imager radial antenna deployment, and normal mission operations. The nutation damper is a sealed steel tube formed into a ring and partially filled with approximately 88 milli-liters (~ 3.0 fluid oz.) of mercury. The ring lies flat in the spin plane and centered on the spin axis near one end of the spacecraft. Nutation causes the mercury to roll around the interior of the ring. Turbulence in the mercury dissipates energy, damping the nutation. This sealed steel tube is proof-tested to 65 +/- 0.5 PSIG with helium (He) and leaked checked with He at minimum pressure of 40 PSIG. This leak test is performed as a final step in the fill procedure. The location of the nutation damper within the spacecraft structure provides adequate protection to prevent any accidental damage to the damper. In the unlikely event of a launch vehicle failure, analysis indicates that the mercury poses no significant hazard to personnel or the environment.

The IMAGE observatory RF system (Non-ionizing) consists of a 5-watt S-band transponder feeding a medium-gain helical transmit antenna or a pair of omnidirectional antennas. The pair of omnidirectional, low-gain antennas and a power-combiner/splitter are used to feed the uplink commands and ranging signals from the ground station to the transponder receiver. All ground testing of the RF link is established by using an antenna coupler (RF hat) at the spacecraft connected via RF cabling to the RF console. The RF console RF transmitter is connected to the spacecraft in a similar manner.

Finally, RF leak tests of equipment will be made before use. Adequacy of these measurements is verified by analysis, inspection and test data.

The IMAGE Nickel-Cadmium (NiCd) battery contains approximately 700 grams (24.7 ounces) of potassium hydroxide. The battery is pressurized and sealed to a nominal flight level of 30 psig (146.5 kgs/m^2) when fully charged. Battery leakage and rupture is the only hazard associated with the spacecraft electrical power subsystem. The Department of Transportation classification of this battery, per provision A-67, is non-hazardous and non-spillable. 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. The Battery will be shipped in the discharged state, with each cell shorted, and in a temperature controlled environment. The IMAGE program will use two spacecraft batteries: (1) non-flight (test and integration) and (2) flight battery.

Cleaning materials and other processing materials will be used in NASA Building 1610 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 VAFB are managed according to the 30th 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 IMAGE mission exist, a number of safety mechanisms are in place to minimize risks. All potentially hazardous activities at LMMS and VAFB have been documented and hazard reduction addressed. The procedures are within the scope of normal activities at both LMMS and VAFB and meet all NASA safety requirements. No significant environmental consequences are associated with these activities.

3.1.10 Launch Failures

Launch from the Delta II ELV is within scope of normal operations at VAFB. The environmental consequences of a Delta II failure has been addressed in several environmental documents, including the EOS and NMP EA documents (NASA 1997 and NASA 1998)

3.1.11 Orbital Debris

NASA Safety Standard 1700.14 , "Guidelines and Assessment Procedures for Limiting Orbital Debris", along with NASA Management Instruction (NMI) 1700.8, "Policy to Limit Orbital Debris Generation," 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 (86 ft^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 IMAGE mission was approved by NASA-Headquarters in July 1999 (SwRI-8089-DAR-01 1997). The launch, operation, and re-entry of the IMAGE satellite satisfies the conditions of NASA's policy objectives. The IMAGE spacecraft will not exceed the total surface "footprint" guideline and it is expected to burn-up upon re-entry.

3.2 HESSI PROPOSED ACTION

The proposed testing, processing, and launching procedures for the HESSI mission are similar to the previous NASA Small Explorer (SMEX) missions. The HESSI mission and its possible impacts are consistent with those outlined in the EOS Final Programmatic Environmental Assessment (NASA 1997a). HESSI payload integration is scheduled at University California at Berkeley (UCB) with environmental testing of the Observatory at NASA's Jet Propulsion Laboratory. The observatory would then be shipped to VAFB in April of 2000 for processing with Pegasus launch vehicle before the ferry flight to KSC/CCAS. The environmental consequences of testing, processing, and integration of HESSI with its Pegasus ELV and launch from KSC/CCAS are discussed below.

The safety aspects of HESSI payload processing operations are documented in HESSI Missile System Pre-launch Safety Package (MSPSP). The possible impacts of processing and launching HESSI are consistent with those outlined in the NMP Programmatic EA (NASA 1998) for activities at VAFB and KSC/CCAS. The proposed integration, testing and launch processing procedures fall within the normal scope of operations at UCB, NASA-JPL, VAFB and KSC/CCAS. The payload processing procedures at VAFB would take place at the NASA facility (B836) and OSC's facility (B1555) using existing trained personnel. Ground operations at VAFB are similar to those used for previous NASA SMEX payloads. After ferrying to KSC/CCAS, the launch from the L-1011 equipped with the Pegasus launch vehicle and HESSI spacecraft is also within the scope of normal operations of a launch program, which is responsible for launching HESSI.

The environmental impacts of launching HESSI using the Pegasus XL launch vehicle are fully described in USAF 1991 & 1992 and NASA's EOS and NMP EA (1997a 1998).

3.2.1 Air Quality

Testing and processing, at UCB, NASA's Jet Propulsion Laboratory, VAFB, and launching activities at KSC/CCAS have minor 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.

3.2.2 Hydrology and Water Quality

Municipal water is used at VAFB and KSC/CCAS 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 HESSI. No substantial hydrologic or water quality effects are expected from testing or processing of the HESSI satellite. No wetland or floodplain impacts are anticipated.

3.2.3 Land Resources

Testing and processing of HESSI would take place indoors, in existing facilities at NASA-Building 836 and OSC-Building 1555, using existing personnel. Testing and processing both fall within the scope of normal activities at VAFB. No unique effects on land resources would result from these activities. Since HESSI would be launched from the air and over the Atlantic Ocean, there would also be no substantial effects on terrestrial resources.

3.2.4 Noise

Testing activities will occur during normal hours of operation at UCB, NASA-JPL, VAFB and KSC/CCAS. Impacts from normal Pegasus and HESS integrated operations are not expected to cause an increase in noise levels at VAFB or KSC/CCAS. Carrier aircraft noise from ground operations, takeoff, and departure associated with Pegasus launches are insignificant when compared to routine VAFB and KSC/CCAS aircraft traffic. Since the launch of Pegasus takes place 185 km (84 mi.) off the KSC, FL coast, noise effects are not measurable to any population.

3.2.5 Biotic Resources

Normal testing, processing, and HESSI/Pegasus launching operations are not expected to cause substantial impacts to biota at VAFB or KSC/CCAS. The listed endangered or threatened species at VAFB and KSC/CCAS are located in colonies away from the payload processing. Since the launch of Pegasus takes place 185 km (84 mi.) off the Florida coast, normal launch activities do not affect terrestrial biota or any endangered or threatened populations.

3.2.6 Cultural and Historical Resources

Since no surface or subsurface areas will be disturbed and rocket launches are typical activities at KSC/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 HESSI.

3.2.7 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 HESSI 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 HESSI mission does not raise any environmental justice concerns. The HESSI project is small in size and scope and would not produce any substantial environmental or human health impacts. Therefore, there would be no disproportionately high or adverse impacts on minority or low-income populations from the implementation of the HESSI mission.

3.2.8 Hazards

The HESSI Observatory presents routine environmental safety hazards and are discussed below.

The HESSI Instrument contains a small source of Cesium-137 used as a detector monitoring device. The cesium-137 gamma-ray source produces a single gamma-ray line at 662 keV. Its has an activity of 5 nanocuries, or about 200 nuclear decays per second. The radiation dose to someone 0.9 meters (3 feet) from the spacecraft will be roughly one one-hundred-billionth of a rem/s, lower than natural background exposure. The Cesium-137 will be implanted in a foil which will be fixed inside a sealed aluminum container bolted to the side of the HESSI spectrometer. The use of the radioactive source on the HESSI mission has been reviewed in accordance with Presidential Directive/National Security Council Number 25 (PD/NSC-25), "Scientific or Technological Experiments with Possible Large Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space" dated December 14, 1977, as revised May 8, 1996 and NASA Safety Policy and Requirements Document (NHB 1700.1). These documents establish the level of review, analysis and approval required for launch of radioactive material based on the level of radiological risk. For the HESSI mission, the approval of the NASA's Nuclear Safety Assurance Manager is the only action required. The HESSI source is low level, is adequately contained, and has limited accessibility, posing no significant hazard to personnel or the environment. Finally, in the unlikely event of a launch vehicle failure, the minute amount of radioactive material poses no significant hazard to personnel or the environment.

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 HESSI is not separated. In addition, the only other non-ionizing radiation source within the instrument are 46 individual small alignment laser diodes mounted in the Imager. The power level of each diode is 3 mW at a wavelength of 670 nm. The diodes point along the spacecraft spin axis. 44 of the diodes are enclosed with pinholes that reduce the power level to 10^{-7} W each. The remaining two are exposed. The diodes are powered by external GSE attached via a test connector. The lasers will only be used once during final check-out at VAFB, prior to mate with the launch vehicle. Thus, they will not be activated or used while HESSI is in orbit.

The HESSI battery subsystem consists of one Common Pressure Vessel (CPV) Nickel Hydrogen (NiH_2) battery supplied by Eagle Picher. The battery stores power in eleven 15 amp-hour CPV cells, each under 1000 psig and designed to leak-before-burst, connected in series to produce 28 +/- 4V and having a combined mass of 14.4 Kg (31.8 lbs). Temperature monitors are mounted on top of the battery. The battery manufacturer, Eagle Picher, has conducted an analysis to assess the explosion potential of the cells. The manufacturer concluded that these cells are incapable of exploding from internal pressure and elaborate precautions are taken to minimize the possibility of electrolyte leakage. Each cell is designed and tested to MIL-STD-1522A and meets the leak-before-burst design criteria. The batteries have a 3 to 1 safety factor for design ultimate and the has been burst tested to 3 times the Maximum Operating Pressure (MOP) after cycle testing. The proof test will be to 1.5 times MOP as well as a helium leak test will be conducted. Lastly, Eagle-Picher Nickel-Hydrogen (NiH_2) cells have collectively 200,000,000 cell-hours in actual orbit operation with no prior history of on-orbit failure, or debris generation.

The HESSI RF communication subsystem consists of a 5-Watt STDN S-band transponder coupled to four omni-patch low-gain antennas through a RF assembly. All ground testing of the RF link is established by using an antenna coupler (RF hat) at the spacecraft connected via RF cabling to the RF console. The RF console RF transmitter is connected to the spacecraft in a similar manner. Finally, RF leak tests of equipment will be made before use. Adequacy of these measurements is verified by analysis, inspection and test data.

Cleaning materials and other processing materials will be used in the NASA-Building 836 and OSC B1555 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 HESSI is governed by VAFB's Hazardous Waste Management plan.

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

3.2.9 Launch Failure

In the unlikely event of a launch failure, the Pegasus vehicle would destruct due to an accidental or system-initiated rupturing of the solid motor propellant cases. 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 reduce the potential environmental effects of a launch failure to a very small level.

3.2.10 Orbital Debris

NASA Safety Standard 1700.14 , "Guidelines and Assessment Procedures for Limiting Orbital Debris", along with NASA Management Instruction (NMI) 1700.8, "Policy to Limit Orbital Debris Generation," 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 (86 ft^2). The NMI requires that each program or project conduct a formal assessment for the potential to generate orbital debris. HESSI's compliance with NASA policy objectives has been verified by simple inspection. The launch, operation, and re-entry of the HESSI satellite satisfies the conditions of NASA's policy objectives.

The HESSI spacecraft will not exceed the total surface "footprint" guideline and it is expected to burn up upon re-entry.

3.3 IMAGE – HESSI POLLUTION PREVENTION

Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements", pledges the federal government to prevent pollution at the source and commits the government to comply with the Emergency Planning and Community Right to Know Act (EPCRA) and Pollution Prevention Act (PPA).

Federal agencies must report annually on the amount of toxic chemicals generated as waste or released into the environment as part of the Toxic Release Inventory under EPCRA and PPA. Federal agencies must also comply with the emergency planning and notification requirements of EPCRA, which requires notification of chemicals stored on the facility and the reporting of an annual chemical inventory.

Each Federal Agency was required to establish a voluntary goal to reduce total releases and off-site transfers of toxic chemicals or toxic pollutants by 50%.

They were also required to establish a plan and goals for eliminating or reducing the unnecessary use and acquisition of extremely hazardous substances and toxic chemicals.

NASA as an agency is complying with Executive Order 12856. NASA has achieved a 50% reduction in releases of toxic chemicals to the environment and off-site transfers for treatment and disposal. NASA Centers have established chemical inventory databases for use in management and reporting of the chemicals. Each Center performs TRI reporting and emergency planning and notification reporting to the local authorities. Each Center also submits annual Pollution Prevention Progress. The NASA Centers work to identify and implement pollution prevention opportunities through source and waste reduction and new technologies.

3.4 NO ACTION ALTERNATIVE

3.4.1 IMAGE

Although the absence of launching operations related to IMAGE might spare the environment surrounding VAFB SLC-2W of potential environmental impacts, the launch of a single satellite is within the scope of existing operations at VAFB 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 the Sun-Earth Connection.

3.4.2 HESSI

Although the absence of launching operations related to HESSI might spare the environment surrounding VAFB and KSC/CCAS 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 the Sun-Earth Connection.

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