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

October 28, 2004

Reply to Attn of:
495

MEMORANDUM FOR THE RECORD

National Environmental Policy Act (NEPA) Compliance for Space Technology-5 (ST-5)

1.0 Introduction

The NEPA of 1969, as amended (42 U.S.C. 4321, *et seq.*), requires Federal agencies to consider the environmental impacts of a project in their decision making process. To comply with NEPA and associated regulations (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 prepared an Environmental Assessment (EA) for routine payloads launched on Expendable Launch Vehicles (ELV's) from Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base (VAFB) (Ref: *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida, and Vandenberg Air Force Base, California*, June 2002). The EA assesses the environmental impacts of missions launched from CCAFS and VAFB with spacecraft that are considered routine payloads.

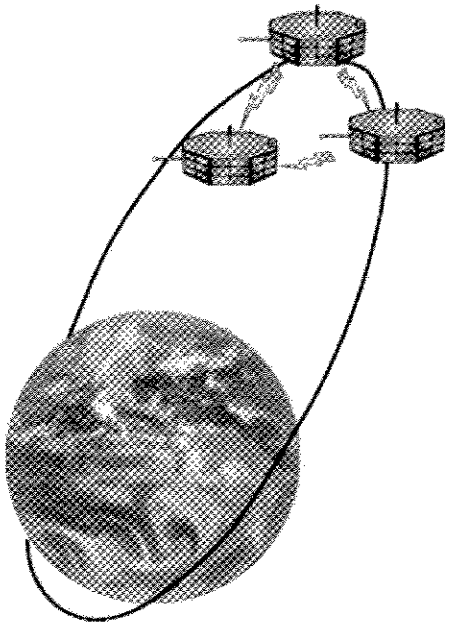
Spacecraft defined as routine payloads would utilize materials, quantities of materials, launch vehicles and operational characteristics that are consistent with normal and routine spacecraft preparation and flight activities at VAFB, CCAFS, and the Kennedy Space Center. The environmental impacts of launching routine payloads from VAFB and CCAFS fall within the range of routine, ongoing and previously documented impacts that have been determined not to be significant. Spacecraft covered by this EA meet specific criteria ensuring that the spacecraft, its operation and decommissioning, do not present any new or substantial environmental or safety concerns.

To determine the applicability of a routine payload classification for a mission launched from VAFB and CCAFS and coverage under the NASA routine payload EA, the mission is evaluated against the criteria defined in the EA using the Routine Payload Checklist (RPC).

2.0 Mission Description

The New Millennium Program (NMP) was created to identify, develop, build, and test innovative technologies and concepts for infusion into future missions. NMP's Space Technology-5 (ST-5) is part of NASA's Sun-Earth Connection roadmap, a long-term strategic plan for understanding the Sun and its influence on the Earth and other Solar System bodies. ST-5, managed by Goddard Space Flight Center, is being developed in partnership with universities, designated small businesses, and other commercial technology providers.

ST-5 will launch multiple miniature spacecraft into the Earth's magnetosphere. ST-5's objective is to demonstrate and flight-qualify several innovative technologies and concepts for application to future space missions. During flight validation of its technologies, ST-5 will measure the effect of solar activity on the Earth's magnetosphere, the region of upper atmosphere that surrounds our planet.



Incorporating this "small-size" concept into a mission is one of the primary goals of the ST-5 Project. ST-5 will design and build miniaturized components and technologies that can be integrated into small satellites, known as small-sats. The overall ST-5 system is comprised of three (3) identical, but separate, free flying earth orbiting small spacecraft that fly in a constellation spaced 100 to 5000 km apart, in a highly elliptical orbit. Each small-sat will weigh approximately 25 kilograms (55 pounds) when fully fueled and measure 50 centimeters (19.7 inches) flat-to-flat across the octagon and 30 centimeters (11.8 inches) high. These small-sized satellites will perform some of the same functions as their larger counterparts.

Each ST-5 spacecraft is comprised of the following subsystems:

1. Structural/Mechanical
2. Electrical Power System (EPS) including Solar Arrays (SA) and a Lithium-Ion Battery
3. Propulsion system (cold gas propellant system, using gaseous nitrogen, GN2)
4. Command and Data Handling System (CDH)
5. Attitude Control System (ACS) Sensors and Actuators
6. Communication System (COMM)
7. Thermal
8. Magnetometer (MAG)

The mission's multiple small-sats will be launched into space from a Pegasus rocket from CCAFS and released (utilizing a deployer mechanism that spins the spacecraft like Frisbees) into an elliptical polar orbit approximately 350 X 4,500 kilometers (215 X 2,800 miles) above our planet. The spacecraft have solar cells mounted around the body thus allowing the small-sats to collect sunlight while spinning. The sunlight is transformed into energy which is used to power all the internal components and instruments.

ST-5's small-sats will fly within the magnetosphere that surrounds our planet like a shield. While testing its "small-size" concept and multiple technologies, magnetometers onboard each of these satellites will measure the magnetic field in the magnetosphere. Collected data will be returned to scientists on the ground for analysis as the mission progresses. ST-5 will certify the suitability of these small, densely packed satellites as platforms for making scientific measurements. Future small-sat or nano-sat missions, with tens to a hundred spacecraft, can only be flown if they are capable of responding to the changes in the charged particles and magnetic fields in the harsh environment of Earth's magnetosphere that sweep over them every few seconds to a few minutes. Flying clusters of multiple satellites reduces the risk of an entire mission failing if one system or instrument fails.

ST-5's small-sats will communicate with ground stations using transponders that contain some of the same type of technology currently used in cell phone. Each small-sat will be commanded routinely from ground stations on the Earth, except for a one-week period of "lights out." During this time, the small-sats will fly "autonomously" with pre-programmed commands in a test to determine if minimal ground intervention is a viable approach for these types of satellites.

The components utilized in the ST-5 mission are made of materials normally encountered in the space industry. ST-5 will not use any lasers or radioactive materials. ST-5 will not carry any pathogenic organisms, nor will ST-5 return samples to Earth. Materials associated with the ST-5 mission pose no substantial hazards or environmental concerns.

3.0 NASA Routine Payload Determination

The ST-5 mission has been evaluated against the NASA routine payload EA for launches from CCAFS and VAFB, using the RPC (see enclosed Evaluation Recommendation Package). The evaluation indicates that the mission meets the criteria for a routine payload. The mission does not present any unique or unusual circumstances that could result in new or substantial environmental impacts. Based on this review, it is determined that the ST-5 mission qualifies as a routine payload and falls within the scope of the reference routine payload EA. No additional NEPA action or documentation is required.

Edward J. Weiler
Director

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
NEPA Environmental Checklist

Enclosure

RECORD OF ENVIRONMENTAL CONSIDERATION

1. Project Name: **Space Technology-5 (ST-5)**

2. Description/location of proposed action: The New Millennium Program's (NMP) **ST-5** will launch 3 miniature spacecraft, called small-sats, from VAFB on a Pegasus XL launch vehicle. The purpose of the mission is to test innovative concepts and technologies in the harsh environment of space. During flight validation of its technologies, ST5 may measure the effect of solar activity on the Earth's magnetosphere, the region of upper atmosphere that surrounds our planet.

   Date and/or Duration of project: Launch 1st Q 06

3. It has been determined that the above action:

__X__ a. Is adequately covered in an existing EA or EIS.
   Title: *Final Environmental Assessment for Launch of NASA Routine Payloads on ELVs from CCAFS, Florida and VAFB, California*
   Date: June 2002

___ b. Qualifies for Categorical Exclusion and has no special circumstances which would suggest a need for and Environmental Assessment.
   Categorical Exclusion: _____

___ c. Is exempt from NEPA requirements under the provisions of:

___ d. Is covered under EO 12114, not NEPA.

___ e. Has no significant environmental impacts as indicated by the results of an environmental checklist and/or detailed environmental analysis.
   (Attach checklist or analysis as applicable)

___ f. Will require the preparation of an Environmental Assessment.

___ g. Will require the preparation of an Environmental Impact Statement.

___ h. Is not federalized sufficiently to qualify as a major federal action.

Beth Montgomery NEPA Coordinator, Code 250 — 10/4/04 Date

Doug McLennan Project Manager, Code 495 — 10/8/04 Date

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: **Space Technology-5 (ST-5)** DATE OF LAUNCH: February 2006

PROJECT CONTACT: Doug McLennan PHONE NUMBER: (301) 286-8484 MAILSTOP: Code 495

PROJECT START DATE: September 1999 PROJECT LOCATION: Goddard Space Flight Center

PROJECT DESCRIPTION: Technology development and validation for small S/C constellation missions

	YES	NO
A. SAMPLE RETURN:		
1. Would the candidate mission return a sample from an extraterrestrial body?		X
B. RADIOACTIVE SOURCES:	YES	NO
1. Would the candidate spacecraft carry radioactive materials?		X
2. If Yes, would the amount of radioactive sources require launch approval at the NASA Associate Administrator level or higher according to NPG 8715.3 (NASA Safety Manual)?		
Provide a copy of the Radioactive Materials Report as per NPG 8715.3 Section 5.5.2.		
C. LAUNCH AND LAUNCH VEHICLES:	YES	NO
1. Would the candidate spacecraft be launched using a launch vehicle/launch complex combination other than those indicated in Table 1 below?		X
2. Would the proposed mission cause the annual launch rate for a particular launch vehicle to exceed the launch rate approved or permitted for the affected launch site?		X
Comments:		
D. FACILITIES:	YES	NO
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?		X
2. If Yes, has the facility to be modified been listed as eligible or listed as historically significant?		
Provide a brief description of the construction or modification required:		
E. HEALTH AND SAFETY:	YES	NO
1. Would the candidate spacecraft utilize any hazardous propellants, batteries, ordnance, radio frequency transmitter power, or other subsystem components in quantities or levels exceeding the Envelope Payload characteristics (EPCs) in Table 2 below?		X
2. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the Envelope Payload (EP)?		X
3. Would the candidate mission release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?		X
4. Would launch of the candidate spacecraft suggest the potential for any substantial impact on public health and safety?		X
5. Would the candidate spacecraft utilize a laser system that does not meet the requirements for safe operation (ANSI Z136.1-2000 and ANSI Z136.6-2000)? For Class III-B and IV laser operations, provide a copy of the hazard evaluation and written safety precautions (NPG 8715.3).		X
6. Would the candidate spacecraft contain pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health?		X
Comments: E.1. – Each of the 3 ST-5 spacecraft contains a 7.5 Ah Li-Ion battery with a mass of 650 gm.		

continued on next page

NASA Routine Payload Checklist (2 of 2)

PROJECT NAME: **Space Technology-5 (ST-5)** DATE OF LAUNCH: February 2006

PROJECT CONTACT: Doug McLennan PHONE NUMBER: (301) 286-8484 MAILSTOP: Code 495

PROJECT START DATE: September 1999 PROJECT LOCATION: Goddard Space Flight Center

PROJECT DESCRIPTION: Technology development and validation for small S/C constellation missions

F. OTHER ENVIRONMENTAL ISSUES:	YES	NO
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?		X
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?		X
Comments:		

Table 1: Launch Vehicles and Launch Pads

Launch Vehicle	Eastern Range (CCAFS Launch Complexes)	Western Range (VAFB Space Launch Complexes)
Atlas IIA & AS	LC-36	SLC-3
Atlas IIIA & B	LC-36	SLC-3
Atlas V Family	LC-41	SLC-3
Delta II Family	LC-17	SLC-2
Delta III	LC-17	N/A
Delta IV Family	LC-37	SLC-6
Athena I & II	LC-46 or -20	California Spaceport
Taurus	LC-46 0r -20	SLC-576E
Titan II	N/A	SLC-4W
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB airfield

Table 2: Summary of Envelope Spacecraft Subsystems and Envelope Payload Characteristics (EPC)

Structure	**Unlimited:** aluminum, magnesium, carbon resin composites, and titanium **Limited:** beryllium [50 kg (110 lb)]
Propulsion	Mono- and bipropellant fuel; 1000 kg (2200 lb) (hydrazine); 1000 kg (2200 lb) (monomethyhydrazine) Bipropellant oxidizer; 1200 kg (2640 lb) (nitrogen tetroxide) Ion-electric fuel; 500 kg (1100 lb) (Xenon) SRM; 600 kg (1320 lb) (AP)-based solid propellant
Communications	Various 10-100 W (RF) transmitters
Power	Solar cells; 150 A-Hr (Ni-H_2) battery; 300 A-Hr (LiSOC) battery; 150 A-Hr (NiCd) battery
Science instruments	10 kW radar ANSI safe lasers (Section 4.1.2.1.3)
Other	Class C EEDs for mechanical systems deployment Radioisotopes limited to quantities that are approved for launch by NASA Nuclear Flight Safety Assurance Manager Propulsion system exhaust and inert gas venting

NEPA Environmental Checklist

1. Project/Program

Space Technology-5 (ST-5)

2. Points of Contact

Project Manager:	Doug McLennan	Code:	495	Telephone:	X8484
S/C Manager:	Eric Krupacs	Code:	495	Telephone:	X1456
Instrument Manager:	Angela Russo	Code:	596	Telephone:	X2554
Other:		Code:		Telephone:	

3. Schedule

Formulation Process (Phase A/B): 9/99 – 11/01

Implementation Process (Phase C/D): 12/01 – 2/06

Launch Date: February 2006

Other Milestone Dates: End of mission – June 2006

4. Current status

Integration and test of first spacecraft underway

5. Project Description

a. Purpose/Need: Technology development and flight validation mission.

b. Spacecraft/Instruments: Three-axis flux-gate magnetometer

c. Launch Vehicle: Pegasus XL

d. Launch Site: VAFB Space Launch Complexes

e. Alternatives (to or for the mission): N/A

f. NASA's Involvement/Responsibility: Mission management

g. Participants/Locations: Goddard Space Flight Center

h. Mission Life: 3 months

i. End of mission, Re-entry: uncontrolled within 25 years

6. **Is there anything controversial about the mission?**

No

7. **Is there anything unique, unusual, exotic about the mission, spacecraft, and instruments?**

No

8. **Is there any environmental documentation for spacecraft, launch vehicle (NEPA or EO12114)?**

No

9. **Is the mission compliant with NASA policy and guidelines for Orbital Debris? (NPD 8710.3 and NSS 1740.14)**

Yes (the three spacecraft will re-enter within 25 years and will burn-up completely so that no debris will strike the earth)

10. **Has an Air Force Form 813 been completed?** (Please attach copy)

No

11. **Does the mission include or involve:**

Check all that apply. If uncertain indicate with a "?"
For all that apply provide an explanation. Use the additional space below if needed.

_____a. Fuels
_____b. Radioactive Material
_____c. Explosives
_____d. Chemicals
X____e. Hazardous Materials/Substances (3 small - 650g Li-Ion batteries)
_____f. Lasers (Class, Earth Pointing)
_____g. Disease Producing Pathogenic Microorganisms
_____h. Construction/Modification of a Facility
_____i. Discharges of any substances into air, water, or soil
_____j. Generation/Use/Storage/Disposal of Toxic or Hazardous Substances
_____k. Generation of Hazardous Wastes
_____l. Generation of High Noise Levels
_____m. Sample Return to Earth
X____n. Generation of Ionizing or Nonionizing Radiation
_____o. Impact on Local Social or Economic Conditions
_____p. Removal of Vegetation or Destruction of Habitat
_____q. Impact/Affect on Minority or Low Income Populations

_____r. Affect Any Threatened or Endangered Species_____
_____s. Affect Areas of Historical or Cultural Significance_____
_____t. New or Foreign Launch Vehicle_____
_____u. Other Issues of Potential Environmental Impact_____

12. What hazards are associated with the mission?

None

Doug McLennan, Code 495 — July 7, 2004

Project Manager, Code — **Date**

Explanations

X-band transponder generates non-ionizing radiation.

Summary of ST-5 Subsystems

Structural Materials	Aluminum; graphite epoxy; beryllium copper (< 50 g); titanium
Propulsion	Compressed, dry nitrogen
Communications	3.5 watt, X-band transmitter
Power	Triple-junction GaAs solar cells, 7.5 A-hr Li-Ion battery
Science instruments	Miniature 3-axis flux-gate magnetometer
Other (include dimensions and weight of s/c)	Each of the 3 spacecraft has a mass of 25 kg. The spacecraft is an octagon ~30 cm in height and 50 cm flat-to-flat across the octagon.