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

October 28, 2004

Reply to Attn of:
492

MEMORANDUM FOR THE RECORD

National Environmental Policy Act (NEPA) Compliance for Gamma-Ray Large Area Space Telescope (GLAST)

## 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

GLAST is a mission that is part of NASA's Structure and Evolution of the Universe theme within NASA's Office of Space Science. The astronomical satellites in this theme are designed to explore the structure of the Universe, examine its cycles of matter and energy, and peer into the ultimate limits of gravity: black holes.

GLAST is NASA's next major mission dedicated to observations of high energy gamma rays. It follows in the footsteps of the Compton Gamma Ray Observatory-Energetic Gamma Ray Experiment Telescope (CGRO-EGRET), which was operational between 1991 and 1999. For the GLAST mission, NASA is teaming with the U.S. Department of Energy and institutions in France, Germany, Japan, Italy and Sweden.

GLAST will have the ability to detect gamma rays from the most energetic phenomena in the universe. Gamma rays are the most energetic form of light; GLAST will detect gamma rays that are roughly 10 million to 150 billion times more powerful than the light visible to the human eye. Radiation of such a magnitude can only be generated under the most extreme conditions: strongest gravity, highest temperatures, most dense plasmas, extreme magnetic fields. GLAST will observe thousands of black holes, magnetized pulsars, gamma ray bursts, and other gamma ray sources throughout the universe and will directly contribute to NASA's mission to explore the universe.

The GLAST observatory will be launched on a Delta 2920H-10 launch vehicle from CCAFS in 2007. Once launched, GLAST will reside in a low-earth circular orbit (565 km altitude), at a 28.5 degree inclination. The mission is being designed for a lifetime of 5 years, with a goal of 10 years of operations. The observatory weighs approximately 4627 kg (10,201 lbs) and measures 2.65 m x 2.25 m x 2.97 m (stowed). The electrical power system is comprised of GaAs solar arrays and a $NiH_2$ cell battery.

GLAST will employ two instruments to observe the gamma-ray universe, the Large Area Telescope (LAT) and the GLAST Burst Monitor (GBM). The primary instrument is the LAT. It has a wide field-of-view, allowing it to see large areas of the sky at the same time. It will detect gamma rays with 10 million to 150 billion times the energy of the light detected by the human eye (in technical terms, it detects gamma-ray energies of 20 million electron volts to greater than 300 billion electron volts, where the energy of visible light is roughly 2 electron volts).

The secondary instrument onboard is GBM. The GBM is designed to observe gamma ray bursts, which are sudden, brief flashes of gamma rays that occur about once a day at random positions in the sky. These bursts are still a mystery to astronomers; no one knows what causes them, or what physical forces are at work. All that is known is that they are among the most powerful explosions in the universe. The GBM has such a large field-of-view that it will be able to see bursts from over two-thirds of the sky at one time, providing locations for follow-up observations of these enigmatic explosions. The combination of the GBM and the LAT provides a powerful tool for studying gamma-ray bursts, particularly for time-resolved spectral studies over a very large energy band.

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

**3.0 NASA Routine Payload Determination**

The GLAST 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 GLAST 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:** **Gamma-Ray Large Area Space Telescope (GLAST)**

2. Description/location of proposed action: GLAST is a high energy gamma-ray observatory designed for making observations of celestial sources. GLAST will be launched on a Delta 2920H-10 rocket from CCAFS into an orbit at an altitude of 565 km and an inclination of 28.5 degrees.

Date and/or Duration of project: Launch 1st Q 07

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 — Date 6/9/04

Kevin Grady Project Manager, Code 492 — Date 7/12/04

## NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: **Gamma-ray Large Area Space Telescope (GLAST)** DATE OF LAUNCH: February 2007

PROJECT CONTACT: Kevin Grady PHONE NUMBER: 301.286.3308 MAILSTOP: 492

PROJECT START DATE: PROJECT LOCATION: GSFC

PROJECT DESCRIPTION: GLAST is a high energy gamma-ray observatory designed for making observations of celestial sources in the energy band extending from 20 MeV to 300 GeV with complimentary coverage between 10 KeV and 25 MeV for gamma-ray bursts. The design mission duration is 5 years with a 10-year goal.

| A. SAMPLE RETURN: | YES | NO |
|---|---|---|
| 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 |

continued on next page

**NASA Routine Payload Checklist** (2 of 2)

PROJECT NAME: (GLAST) DATE OF LAUNCH: February 2007

PROJECT CONTACT: Kevin Grady PHONE NUMBER: MAILSTOP:

PROJECT START DATE: PROJECT LOCATION:

PROJECT DESCRIPTION:

| 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<br>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<br>**Limited:** beryllium [50 kg (110 lb)] |
| Propulsion | Mono- and bipropellant fuel; 1000 kg (2200 lb) (hydrazine);<br>1000 kg (2200 lb) (monomethyhydrazine)<br>Bipropellant oxidizer; 1200 kg (2640 lb) (nitrogen tetroxide)<br>Ion-electric fuel; 500 kg (1100 lb) (Xenon)<br>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;<br>150 A-Hr (NiCd) battery |
| Science instruments | 10 kW radar<br>ANSI safe lasers (Section 4.1.2.1.3) |
| Other | Class C EEDs for mechanical systems deployment<br>Radioisotopes limited to quantities that are approved for launch by NASA Nuclear Flight Safety Assurance Manager<br>Propulsion system exhaust and inert gas venting |

# NEPA Environmental Checklist

## 1. Project/Program

Gamma-Ray Large Area Space Telescope (GLAST

## 2. Points of Contact

| | | | | | |
|---|---|---|---|---|---|
| Project Manager: | Kevin Grady | Code: | 492 | Telephone: | 63308 |
| S/C Manager: | Joy Bretthauer | Code: | 492 | Telephone: | 61050 |
| Instrument Manager: | Bernie Graf (LAT) | Code: | 492 | Telephone: | 61287 |
| Other: | Bill Browne (GBM) | Code: | 492 | Telephone: | 63570 |

## 3. Schedule

Formulation Process (Phase A/B): 1/99 – 4/03

Implementation Process (Phase C/D): 4/03 – 2/07

Launch Date: 02/07

Other Milestone Dates:

## 4. Current status

S/C CDR (5/04), Mission CDR (9/04)

## 5. Project Description

a. Purpose/Need: GLAST is a high-energy gamma-ray observatory designed for making observations of celestial sources

b. Spacecraft/Instruments: Spectrum Astro RSDO SA200-HP bus, Large Area Telescope (LAT), GLAST Burst Monitor (GBM)

c. Launch Vehicle: Delta II ~~7920~~ 2920H-10 with 3-meter fairing

d. Launch Site: Eastern Range LC-17

e. Alternatives (to or for the mission): None

f. NASA's Involvement/Responsibility: GSFC has overall responsibility for the GLAST Project

g. Participants/Locations: The Governing Program Management Council (GPMC) is the NASA Headquarters PMC. Marshall Space Flight Center (MSFC) is responsible for providing the GLAST Burst Monitor (GBM) instrument and the GBM Instrument Operations Center (IOC). NASA and the Department of Energy (DOE) have joint responsibility for development of the Large Area Telescope (LAT) instrument and LAT IOC, which are managed by the Stanford Linear Accelerator Center (SLAC). In addition to overall mission management, GSFC is responsible for the development of the Anti-Coincidence Detector (ACD), a subsystem of the LAT, and for the Science Support Center (SSC). Launch services are provided by Kennedy Space Center (KSC).

h. Mission Life: 5-year design, 10-year goal

i. End of mission, Re-entry: Controlled

**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)?**

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

**Yes**

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

**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.

Yes a. Fuels Hydrazine (291 kg)
No b. Radioactive Material
No c. Explosives
Yes d. Chemicals Anhydrous ammonia in heat pipes
Yes e. Hazardous Materials/Substances Note 1
No f. Lasers (Class, Earth Pointing)
No g. Disease Producing Pathogenic Microorganisms
No h. Construction/Modification of a Facility
No i. Discharges of any substances into air, water, or soil
No j. Generation/Use/Storage/Disposal of Toxic or Hazardous Substances
No k. Generation of Hazardous Wastes
No l. Generation of High Noise Levels
No m. Sample Return to Earth

No n. Generation of Ionizing or Nonionizing Radiation
No o. Impact on Local Social or Economic Conditions
No p. Removal of Vegetation or Destruction of Habitat
No q. Impact/Affect on Minority or Low Income Populations
No r. Affect Any Threatened or Endangered Species
No s. Affect Areas of Historical or Cultural Significance
No t. New or Foreign Launch Vehicle
No u. Other Issues of Potential Environmental Impact

**12. What hazards are associated with the mission?**

Launch, reentry

**Project Manager, Code** **Date** 7/12/04

**Explanations**

1. 1536 Cesium Iodide (CsI) crystals (1188 kg total), tungsten foils (156 kg total) in the LAT and two Bismuth Germinate (BGO) crystals (22.9 kg total), 12 Sodium Iodide (NaI) crystals (7.1 kg total) in the GBM.
CsI, BGO, and NaI crystals oxidize during reentry and pose no hazard; tungsten foils survive reentry and impact in the ocean. The CsI crystals are Thallium-doped and, although the exact numbers are proprietary (crystals were acquired through European partners), the maximum is a few hundred parts/million. The crystals are sealed during manufacture and are in accessible after the Calorimeter has been integrated. There is a small amount of beryllium on each NaI detector. Each detector has a lens of beryllium approximately 155 mm in diameter and less than 0.508 mm thick. This amounts to a total of 0.017657 kg per detector or 0.21189 kg for all twelve.

## Summary of GLAST Subsystems

| | |
|---|---|
| Structural Materials | Aluminum, titanium, M55J graphite composite, beryllium |
| Propulsion | 291 kg hydrazine |
| Communications | 5.6 W S-Band transmitter<br>10.0 W Ku-Band transmitter |
| Power | GaAs solar cells; 125A-hr, $NiH_2$, 4.5", IPV-cell battery |
| Science instruments | Large Area Telescope (LAT) – 16 pair-production gamma-ray trackers and calorimeters<br>GLAST Burst Monitor (GBM) – 12 NaI scintillators and two Bismuth germinate (BGO) gamma-ray detectors |
| Other (include dimensions and weight of s/c) | In LAT: 1536 CsI crystals (1188 kg total), tungsten foils (156 kg total)<br>In GBM: 2 BGO crystals (22.9 kg total), 12 NaI crystals (7.1 kg total)<br>Observatory dimensions (X×Y×Z): 2.65 m × 2.25 m (stowed; 6.2 m solar array on both sides when deployed) ×2.97 m<br>Observatory mass: NTE 4627 kg |