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

May 6, 2009

Reply to Attn of:
466

MEMORANDUM FOR THE RECORD

Subject: National Environmental Policy Act (NEPA) Compliance for Radiation Belt Storm Probes (RBSP)

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 (ELVs) 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 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 Van Allen radiation belts are two donut-shaped regions encircling the Earth, where high-energy particles are trapped by the Earth's magnetic field. Most spacecraft in Earth orbit operate

partly or entirely within the radiation belts. During periods of intense space weather, the density and energy of the trapped particles can increase, posing a danger to astronauts, spacecraft, and even some ground-based technologies.

Our society relies on more than 800 satellites for communication and navigation, and increasingly complex systems to power our activities on Earth. Understanding the radiation belts and the dangers they pose to our technologies will help us design better ways to protect them.

The Radiation Belt Storm Probes Mission is part of NASA's Living With a Star Program to explore fundamental processes that operate throughout the solar system, in particular those that generate hazardous space weather effects near the Earth and phenomena that could affect solar system exploration.

RBSP will provide insight into the physical dynamics of the radiation belts and give scientists the data they need to make predictions of changes in this critical region of space. Understanding the radiation belt environment and its variability has extremely important practical applications in the areas of spacecraft design, system design, spacecraft operations, mission planning, and astronaut safety.

Observations from the mission will enable the development of empirical and physics-based models for the radiation belts. The empirical models will be used by engineers to design radiation-hardened spacecraft, while the physics-based models will be used by forecasters to predict geomagnetic storms and alert both astronauts and spacecraft operators to potential hazards.

The RBSP mission's science objectives are to:

- Discover which processes, singly or in combination, accelerate and transport radiation belt electrons and ions and under what conditions.

- Understand and quantify the loss of radiation belt electrons and determine the balance between competing acceleration and loss processes.

- Understand how the radiation belts change in the context of geomagnetic storms.

The RBSP mission will utilize two RBSP spacecraft or probes in Earth orbit to sample the harsh radiation belt environment where major space weather activity occurs and many spacecraft operate. The RBSP probes will operate entirely within the radiation belts throughout their mission.

The probes will carry a number of instruments and instrument suites to support five experiments that will address the mission's science objectives. The instruments on the two RBSP probes will provide the measurements needed to characterize and quantify the processes that produce relativistic ions and electrons. They will measure the properties of charged particles that comprise the Earth's radiation belts and the plasma waves that interact with them, the large-scale electric fields that transport them, and the magnetic field that guides them. The two probes will take identical measurements and follow nearly the same paths with variable interspacecraft separation distances so scientists can begin to understand how the belts change in both space and time.

Each probe will carry the following:

- **Energetic Particle, Composition, and Thermal Plasma Suite (ECT)**
  RBSP-ECT will directly measure near-Earth space radiation particles to understand the physical processes that control the acceleration, global distribution, and variability of radiation belt electrons and ions.

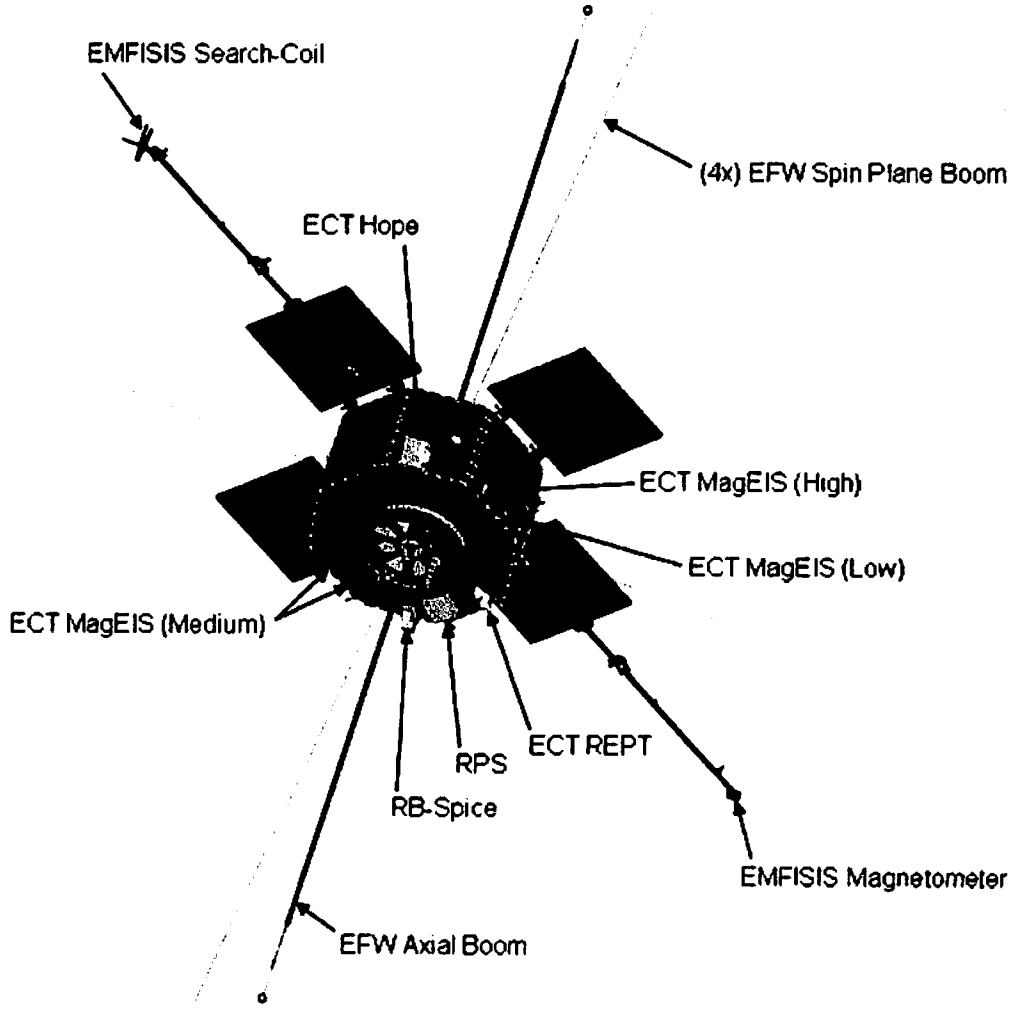
- **Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS)**
  The RBSP-EMFISIS investigation will focus on the important role played by magnetic fields and plasma waves in the processes of radiation belt particle acceleration and loss.

- **Electric Field and Waves Suite (EFW)**
  RBSP-EFW will study the electric fields in near-Earth space that energize radiation particles and modify the structure of the inner magnetosphere.

- **Radiation Belt Storm Probes Ion Composition Experiment (RBSPICE)**
  RBSP-RBSPICE will determine how space weather creates what is called the "storm-time ring current" around Earth and determine how that ring current supplies and supports the creation of radiation populations.

- **Relativistic Proton Spectrometer (RPS)**
  The RPS will measure inner Van Allen belt protons with energies from 50 MeV to 2 GeV. Presently, the intensity of trapped protons with energies beyond about 150 MeV is not well known and thought to be underestimated in existing specification models. Such protons are known to pose a number of hazards to astronauts and spacecraft, including

total ionizing dose, displacement damage, single event effects, and nuclear activation. The project's goal is development of a new standard radiation model for spacecraft design.



The Applied Physics Laboratory, Laurel, Maryland will build and operate the twin RBSP probes. The probes will be launched on an Atlas V from Cape Canaveral Air Force Station, Florida in 2011.

3.0 NASA Routine Payload Determination

The components utilized in the RBSP spacecrafts/probes are made of materials normally encountered in the space industry. RBSP will utilize low level radiation calibration sources. RBSP will not carry any pathogenic organisms. The RBSP mission will not pose any substantial hazards or environmental concerns.

The RBSP 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 RBSP mission qualifies as a routine payload and falls within the scope of the reference Routine Payload EA.

At this point no additional NEPA action or documentation is required. However, NASA is in the process of updating the NASA Routine Payload EA. Once the Agency issues the final updated EA, NASA will review the potential environmental impacts of the proposed RBSP mission in the context of the new analysis and information contained in the updated EA. If NASA determines that there are substantial new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts, NASA will formally reopen the NEPA process for this mission.

George Morrow
Director of Flight Projects

Robert Strain
Director

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
NEPA Environmental Checklist

Enclosure

RECORD OF ENVIRONMENTAL CONSIDERATION

1. Project Name: Radiation Belt Storm Probes (RBSP)

2. Description/location of proposed action: Mission to understand the radiation belt environment

   Date and/or Duration of project: Launch 5/2012

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 Program Manager, Code 250 — 4/3/2009 (Date)

Betsy Park — Project Manager, Code 466 — 4/3/09 (Date)

GSFC Routine Payload Checklist

PROJECT NAME: RADIATION BELT STORMS PROBE (RBSP)		DATE OF LAUNCH: 10/14/2011
PROJECT CONTACT: BETSY PARK	PHONE NUMBER: 6-8355	MAILSTOP: 466
PROJECT START DATE: 6/06	PROJECT LOCATION: JHU/APL	

PROJECT DESCRIPTION:
The goal of the RBSP is to understand how dynamically interacting electromagnetic fields accelerate plasmas to relativistic energies, thereby developing the capability to specify and predict changes to planetary radiation environments.

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)?		X

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

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?		X

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 (EPC's) 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		x

operations, provide a copy of the hazard evaluation and written safety precautions (NPG 8715.3).		
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:		
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

GODDARD SPACE FLIGHT CENTER
ENVIRONMENTAL CHECKLIST
FOR FLIGHT PROJECTS

1. PROJECT/PROGRAM Radiation Belt Storm Probes

2. POINTS OF CONTACT

Betsy Park	Code: 466	Phone No.: 6-8355

3. SCHEDULE

PDR/CDR: PDR: 10/08 CDR: 12/09	Launch Date: 5/18/2012

4. CURRENT STATUS

Phase A; SRMDR conducted on 10/07
Phase B started on 3/08
PDR conducted 10/08
Phase C started 1/09

5. PROJECT DESCRIPTION

a. Purpose: Gain scientific Understanding of how populations of relativistic electrons and ions in space form or change in response to changes in solar activity and the solar wind.

b. Spacecraft: RBSP (APL)

c. Instruments: REPT, HOPE, EFW, EMFISIS Suite, MagEIS, RB-SPICE, RPS

d. Launch Vehicle:
ATLAS V

e. Launch Site:
Eastern Range (KSC)

f. NASA's Involvement/Responsibility: GSFC LWS Program responsibility

g. Participants/Locations: APL; Laurel, MD

h. End of Mission, Re-entry:
Launch + 2yr + 60 days commissioning + de-orbit (uncontrolled within NASA ODA requirements)

6. Is there anything controversial about the mission?

No

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

Two spacecraft are launched on one ELV

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

No

9. Is the mission (s/c and LV) compliant with NASA policy and guidelines for orbital debris (NPD 8710.3 and NSS 1740.14)? Explain non -compliances.

Yes. Current design satisfies requirements for de-orbit via uncontrolled re-entry within the required timeframe after end of mission. Debris footprint based on preliminary materials list should be compliant. On-board propellant budgeted to support de-orbit burn if required.	
10. Has an Air Force Form 813 been completed? *(Please attach copy)*	☐ YES ☒ NO
11. During any phase, does the mission/project 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 - approximately 34.88 Kg Hydrazine (baseline) per s/c (2 s/c) (69.76 kg total)
yes	b. Ionizing Radiation Devices/Sources - AM-241, GD-148, CM-244 (see below)
pyros	c. Explosives
Hydrazine fuel	d. Hazardous Materials/Substances/Chemicals
no	e. Lasers (Class, Earth Pointing)
no	f. Disease Producing Pathogenic Microorganisms
GN2 for purge	g. Discharges of any Substances into Air, Water, or Soil
yes	h. Hazardous Wastes - leaded solder from circuit card assembly, controls in place
no	i. High Noise Levels
no	j. Sample Return to Earth
yes	k. Radio Frequency Communications
no	l. Construction/Modification/Demolition of a Facility
no	m. Land Disturbance, Tree Clearing, Removal of Vegetation
no	n. Impact on Threatened or Endangered Species
no	o. Impact/Destruction of Sensitive Wildlife Habitat
no	p. Impact on/near Areas of Cultural Significance
no	q. Impact on Local Social or Economic Conditions (Traffic, Employment, etc)
no	r. Impact on Minority or Low Income Populations
no	s. New or Foreign Launch Vehicle
no	t. Other Issues of Potential Environmental Impact
yes	u. Require any Environmental Permit - Lab permits are current
Additional Information	
When shipped to Launch Site Observatories are expected to be considered non-corrosive and non-explosive. Approval from State authorities will be required for transportation by land (wide oversized load) or air.	
12. What Safety hazards are associated with the mission?	
Hydrazine fuel, Pyros for boom and antenna deployments, GN2 asphyxiation, Li-Ion Battery - stored energy, Instrument radioactive sources.	
13. Summary of subsystem components	
Structural Materials	Al central cylinder, AL secondary structure, panels honeycomb with Al facesheet, solar array aluminum core with composite facesheet
Propulsion	8 Aerojet MR-103 G 0.9N thrusters, 3 fuel tanks/Inconel 34.88 kg per s/c x 2= 69.76 kg total (baseline)
Communications	Transceiver, two low gain antennas (forward and aft deck), 8 W SSPA
Power	50 A Hr Li-Ion Cells (8 cells), 4 deployable solar arrays - 3.89 m^2

	total cell area, using multi-junction 5.5 mil GaAs/Ge solar cells
Science Instruments	REPT, HOPE, EFW, EMFISIS Suite, Mag EIS, RB-Spice, RPS
Hazardous Components (radioactive materials, lasers, chemicals, etc.)	Radioactive Sources ECT: Am-241 (.1 µCi) 1per s/c (.2µCi total) RPS: Gd-168 (50 nCi) 8 per s/c (800 nCi total) RPS: Cm-244 (50 nCi) 8 per s/c (800 nCi total) RBSPICE: Am-241 (.01 µCi) 1per s/c (.02µCi total)
Other (include dimensions and weight of s/c)	Undeployed, each S/C is 1760 mm length by 1076 width (octagon shape) by 1260 mm height. Total mass of two S/C stacked for launch is 1334 kg (incl 30% margin)
MISSION MANAGER SIGNATURE Betsy Park	DATE 4/3/09