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

July 18, 2006

Reply to Attn of:

421

MEMORANDUM FOR THE RECORD

National Environmental Policy Act (NEPA) Compliance for Glory

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 purpose of the Glory mission is to provide aerosol measurements for climate change research and measurements of solar irradiance for continued monitoring.

Aerosols play a crucial role in climate. Aerosols can contribute to both warming and cooling of the Earth's atmosphere. Black carbon aerosols can contribute to global warming by absorbing the sun's radiation and re-radiating the sun's energy as infrared radiation. This infrared energy is trapped by the Earth's atmosphere in much the same way that the windshield of an automobile contributes to a parked automobile heating up in the summer's sun. Sulfate aerosols, produced from the sulfur dioxide gas that spews out of a volcano or from the burning of sulfur-bearing fossil fuels, reflect the sun's radiation out into space and typically cause cooling. Aerosols, unlike greenhouse gases, have a short lifetime in the atmosphere. Aerosols tend to mix with other agents and are transported up into the troposphere and back down again. Then, they are transported by the winds across continents and disappear within a week. Because aerosols can result from both natural and anthropogenic events, they are constantly replenished. Since the beginning of the industrial age, the anthropogenic aerosols have been increasing. Aerosols can also play a critical role in precipitation. Some species of aerosols may increase precipitation, while others may inhibit precipitation. While it is recognized that aerosols play a key role, because of the uncertainty of the composition of the aerosols in the atmosphere, there remains great uncertainty in the effect that atmospheric aerosols have on climate and weather.

The Total Solar Irradiance (TSI), together with the absorption and reflection of the radiation by the Earth's atmosphere, determines the global average temperature of the Earth. The climate of the Earth is directly affected by this balance between the intensity of the sun and the response of the atmosphere. Changes in both the solar irradiance intensity and in the composition of the atmosphere can cause global climate change. Solar irradiance intensity is purely a natural phenomenon, while the composition of the atmosphere is strongly influenced by the byproducts of modern industrial societies. Scientific consensus indicates that over the past century, the average temperature of the Earth has increased by about 0.5° C. Understanding whether the increase in temperature and the concomitant climate change are byproducts of natural events or whether the changes are caused by anthropogenic sources is of primary importance to the establishment of scientifically and economically effective policy.

The Glory mission will perform science measurements for both aerosols and TSI. Glory will provide coverage of TSI monitoring between two other missions, Solar Radiation and Climate Experiment (SORCE) and National Polar Orbiting Environmental Satellite System (NPOESS). This continued measurement of the TSI, without temporal gaps in the dataset, is essential, as any measured shift in the atmosphere temperature must be correlated with the solar irradiance.

The science goals for the Glory mission are:

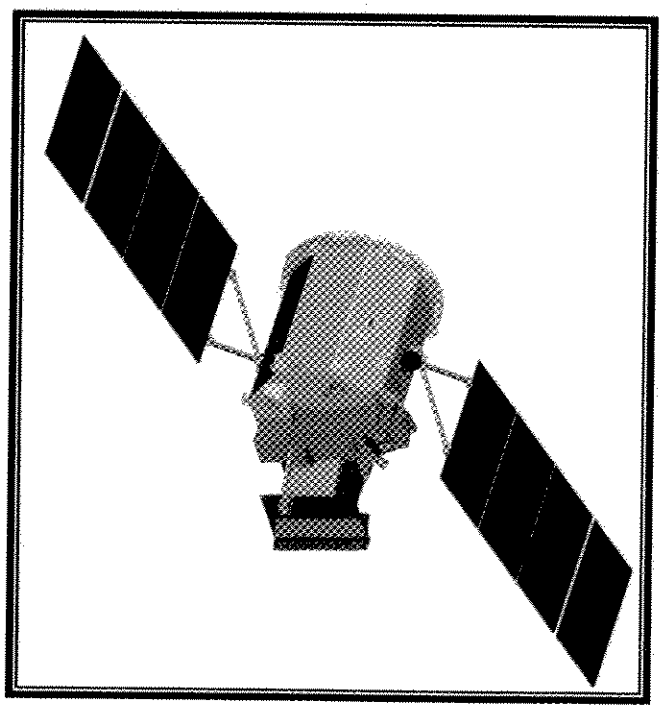
- Determine the global distribution of natural and anthropogenic aerosols (black carbons, sulfates, etc.) with accuracy and coverage sufficient for reliable quantification of the:
  - Aerosol effect on climate
  - Anthropogenic component of the aerosol effect

  - Long-term change of the aerosol effect caused by natural and anthropogenic factors

- Determine the direct impact of aerosols on the radiation budget and its natural and anthropogenic components.
- Determine the effects of aerosols on clouds and precipitation and its natural and anthropogenic components.
- Investigate the feasibility of improved measurements of black carbons and dust absorption to provide more accurate estimates of their contribution to the climate forcing function.
- Continue TSI measurement to determine the sun's direct and indirect affects on Earth's climate.

The Glory observatory will be launched from VAFB in California on a Taurus launch vehicle and placed into a sun-synchronous, circular orbit inclined 98.7 degrees with a target altitude of 705 km.

The spacecraft bus is an as-built heritage design from a previous NASA mission, Vegetation Canopy Lidar (VCL), that will use a large portion of its existing subsystems, components, and software. The bus is three-axis stabilized with deployable, articulated solar panels. It employs multiple computers and X-band/S-band radio frequency (RF) communications capabilities. The structure is a cylindrical aluminum space frame with octagonal cross-section and a mono-propellant hydrazine propulsion module sized for at least 60 months of station keeping with other satellites and eventual mission orbit lowering. The spacecraft bus also provides: payload power; command, telemetry, and science data interfaces, including onboard storage; and an attitude control subsystem to support instrument pointing knowledge requirements.



The Glory mission will perform the science measurements using three instruments, the Aerosol Polarimetry Sensor (APS), the Cloud Camera (CC), and the Total Irradiance Monitor (TIM).

The APS is a multi-spectral polarimetric sensor that has the capability to collect visible, near-infrared, and short-wave infrared polarized radiometric data scattered from aerosols and clouds. The APS is a continuous scanning, nadir-viewing sensor designed to make along-track, multi-angle observations of Earth and atmospheric scene spectral radiance.

The TIM is an active cavity radiometer that records total solar irradiance. It has four completely identical radiometers to provide redundancy and to help detect changes in the instrument response caused by exposure to solar radiation. Each radiometer consists of a shutter, a 1/2 cm^2 precision aperture followed by a detector. The TIM is mounted on a two axis gimbaled platform that allows the instrument to be pointed independent of the spacecraft bus attitude.

The CC is visible imager utilizing a non-scanning staring detector array that is analogous to a star tracker, but Earth-viewing. It consists of an optical imaging system that provides continuous cross-track coverage over a narrow swath centered on the APS along-track footprint.

The Glory project will use a combination of existing NASA and contractor facilities during instrument and spacecraft design, fabrication, assembly, test, checkout, launch, and tracking and data acquisition.

The ground systems consist of the Mission Operations Center (MOC), commercial ground stations, the APS Science Operations Center (SOC), the TIM SOC, the Distributed Active Archive Center (DAAC), and the various networks that connect them. They provide RF communication with the spacecraft, spacecraft and instrument monitoring and control, science data processing, and archive and distribution of science data products.

The components utilized in the Glory observatory are made of materials normally encountered in the space industry. Glory does not use any lasers or radioactive materials. Glory does not carry any pathogenic organisms, nor will the Glory mission pose any substantial hazards or environmental concerns.

The Glory mission will meet NASA's policy and guidelines for Limiting Orbital Debris (NPD 8710.3 and NSS 1740.14). The disposal plan for the spacecraft calls for an uncontrolled reentry within the 25 year guideline. The risk of human casualty from surviving debris is within the NSS guideline of 1 in 10,000. The plan for the 3rd stage of the launch vehicle is also an uncontrolled reentry within the 25 year guideline and the risk guideline.

3.0 NASA Routine Payload Determination

The Glory 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 Glory 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.

for 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: Glory

2. Description/location of proposed action: Development and launch of an earth observing spacecraft.

   Date and/or Duration of project: Launch 12/2008

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 7/6/2006

Bryan Fafaul Project Manager, Code 421.7 — Date 7/6/2006

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: **Glory Project** DATE OF LAUNCH: December, 2008

PROJECT CONTACT: Jaya Bajpayee PHONE NUMBER: 6-2388 MAILSTOP: 421.7

PROJECT START DATE: 2003 PROJECT LOCATION: Bldg 16-W

PROJECT DESCRIPTION: 2 instruments (aerosol measuring optical instrument and a total irradiance monitor instrument); spacecraft is old VCL Bus

	YES	NO
A. SAMPLE RETURN:		
1. Would the candidate mission return a sample from an extraterrestrial body?		X
B. RADIOACTIVE SOURCES:		
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:		
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:		
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:		
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:		

NASA Routine Payload Checklist (2 of 2)

PROJECT NAME: **Glory Project** DATE OF LAUNCH: December, 2008

PROJECT CONTACT: Jaya Bajpayee PHONE NUMBER: 6-2388 MAILSTOP: 421.7

PROJECT START DATE: 2003 PROJECT LOCATION: GSFC B-16W

PROJECT DESCRIPTION: 2 instruments (aerosol measuring optical instrument and a total irradiance monitor instrument); spacecraft is old VCL Bus

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

Glory Project/ EOS Program

2. Points of Contact

Project Manager: Bryan Fafaul Code: 421.7 Telephone: 6-7726
S/C Manager: Carey Lively Code: 421.7 Telephone: 6-8983
Instrument Manager: Mark Domen Code: 421.7 Telephone: 6-8220
Other: Jaya Bajpayee Code: 421.7 Telephone: 6-2388

3. Schedule

Formulation Process (Phase A/B): 2003 – Oct, 2005
Implementation Process (Phase C/D): Oct 2005 – Dec 2008
Launch Date: Dec 2008
Other Milestone Dates: Mission CDR – 6/2006

4. Current status

The Glory Project was confirmed in December 2005. Our spacecraft is the refurbished VCL Spacecraft bus modified to meet the Glory requirements. The VCL/Glory spacecraft bus is currently 85% built. The spacecraft will be integrated with the Cloud Camera Sensor Package, the Total Irradiance Monitor (TIM) Instrument, and the Advanced Polarimeter Sensor (APS) Instrument.
The mission Critical Design Review (CDR) is scheduled for June 2006.
The APS Instrument CDR is scheduled for April 2006.
The TIM Instrument CDR was in held in December 2005.
The Cloud Camera Sensor Package procurement is underway and is to be awarded about April 2006.
Instrument/Spacecraft integration and testing is scheduled to begin October 2007
Launch of the Glory Observatory is set for December 2008.

5. Project Description

a. Purpose/Need: Mission has 2 objectives: (1) Provide aerosol measurements for climate change research initiative; (2) provide irradiance monitor coverage between SOURCE and NPOESS
b. Spacecraft/Instruments: S/C is VCL Bus; Glory Observatory incorporates 2 instruments. APS (built by Raytheon Santa Barbara (SBRS)) provides aerosol measurements. TIM (built by LASP) measures solar irradiance.
c. Launch Vehicle: Taurus
d. Launch Site: Vandenberg AFB
e. Alternatives (to or for the mission): There are no alternatives to this mission
f. NASA's Involvement/Responsibility: NASA is providing overall management of the mission, instruments and observatory.

g. Participants/Locations: Orbital (Spacecraft) – Dulles, VA; SBRS (APS)-Santa Barbara, CA; University of CO LASP (TIM); GSFC GISS (APS Science Data Processing).

h. Mission Life: 3 years

i. End of mission, Re-entry: 2012

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)?

A separate environmental assessment has not been done for the spacecraft.

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

Spacecraft and launch vehicle are compliant with NASA Orbital Debris Policy.

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.

X a. Fuels Spacecraft contains propellant for mission and reentry

____ b. Radioactive Material

____ c. Explosives

____ d. Chemicals

____ e. Hazardous Materials/Substances

____ 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

____ 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

Bryan Fafaul
Brian Fafaul, Code 421.7

7/6/06
Date

Explanations

Glory Project:

Summary of Observatory Subsystems

Structural Materials	Aluminum, Berillium (1.036 lb)
Propulsion	Monomethyhydrazine (45kg)
Communications	X-Band, S-Band, < 20W total power
Power	Solar cells; 30 A-Hr Ni-H2
Science instruments	APS (optical instrument) TIM (active cavity radiometer)
Other (include dimensions and weight of s/c)	Class C EED for solar array deployment Launch vehicle separation system to separate payload