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

March 12, 2004

Reply to Attn of:
464

MEMORANDUM FOR THE RECORD

National Environmental Policy Act (NEPA) Compliance for Solar Dynamics Observatory (SDO)

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

SDO is the first Space Weather Research Network mission in NASA's Living With a Star (LWS). Our Sun is an extremely active star. This activity can often create what is known as "Space Weather" a phenomenon caused by radiation and atomic particles expelled from the Sun by way of solar flares and coronal mass ejections (CME). This activity impacts planet Earth and human society in numerous ways: electronic failures in satellites and airplanes, immediate and long-term hazards to astronauts as well as aircraft crews. The effects don't stop there. Electrical power to our homes and businesses just like communication and navigation systems can all also be interrupted by geomagnetic storms driven by blasts from the Sun.

SDO is being designed to help us understand the Sun's influence on Earth and Near-Earth space by studying the solar atmosphere on small scales of space and time and in many wavelengths simultaneously. As such, SDO will provide us with the tools and scientific understanding that will enable us to improve the quality of forecasts of solar activity.

SDO is set to launch in the 2nd Quarter of 2008 on an Evolved Expendable Launch Vehicle (Delta IV or Atlas V) from CCAFS. The mission will be delivered into a geosynchronous transfer orbit (GTO). SDO's propulsion system will then perform a circularization maneuver to boost the spacecraft into geosynchronous orbit (GEO).

The science of the Solar Dynamics Observatory optimally will be performed on a 3-axis stabilized spacecraft that allows nearly continuous observations of the Sun and a scientific data rate well in excess of 100 Megabits per second at Ka-Band. The spacecraft weighs 3200 kilograms, and measures approximately 5 meters high and 2 meters wide.

SDO will contain a suite of instruments, which will provide the observations that will lead to a more complete understanding of the solar dynamics that drive variability in the Earth's environment. The three instruments are: the Helioseismic and Magnetic Imager (HMI), the Atmospheric Imaging Assembly (AIA), and the Extreme Ultraviolet Variability Experiment (EVE).

The HMI will extend the capabilities of the SOHO/MDI instrument with continuous full-disk coverage at considerably higher spatial and temporal resolution line-of-sight magnetograms with the optional channel for full Stokes polarization measurements and hence vector magnetogram determination.

The AIA will image the solar atmosphere in multiple wavelengths to link changes to surface and interior changes.

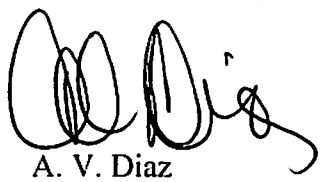
The EVE will measure the solar Extreme-Ultraviolet (EUV) irradiance with unprecedented spectral resolution, temporal cadence, and precision.

The components utilized in the SDO spacecraft and instruments are made of materials normally encountered in the space industry. SDO will not use any radioactive materials

or lasers. SDO will not carry any pathogenic organisms, nor will SDO return samples to Earth. Materials/hazards associated with SDO do not raise any environmental or health (safety) concerns.

3.0 NASA Routine Payload Determination

The SDO 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 SDO 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.



A. V. Diaz

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
NEPA Environmental Checklist

Enclosure

RECORD OF ENVIRONMENTAL CONSIDERATION

1. Project Name: **Solar Dynamics Observatory (SDO)**

2. Description/location of proposed action: SDO is the first Space Weather Research Network mission in NASA's Living With a Star (LWS) Program. The purpose of the SDO mission is to help us understand the Sun's influence on Earth and Near-Earth space by studying the solar atmosphere on small scales of space and time and in many wavelengths simultaneously. As such, SDO will provide us with the tools and scientific understanding that will enable us to improve the quality of forecasts of solar activity. SDO is set to launch in the 2nd Quarter of 2008 on a Delta IV from CCAFS.

Date and/or Duration of project: Launch 2nd Q 08

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 — 2/25/04 Date

K. O. Schwer
Ken Schwer Project Manager, Code 464 — 2/26/04 Date

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: **Solar Dynamics Observatory** DATE OF LAUNCH: April 2008

PROJECT CONTACT: Dave Ward PHONE NUMBER: (301) 286-2170 MAILSTOP: 464.0

PROJECT START DATE: December 2001 PROJECT LOCATION: GSFC

PROJECT DESCRIPTION: SDO will provide near continuous coverage of solar activity and provide data on the types of phenomena which impact Earth, near-Earth space and humanity

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? **2 Ka-band Antennas at White Sands Complex; Possibility that the launch pad clean room facilities may require upgrades**		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 (EPCs) in Table 2 below? **8 cell Li Ion Battery; MON-3***		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: **MON-3 ("Multiple Oxides of Nitrogen-3%") is the typical application of Nitrogen Tetroxide when used as a Propulsion System Oxidizer. Itc ontains 3%wt NO added to N2O4. We believe that is the Oxidizer referred to in Table 2.**		

NASA Routine Payload Checklist (1 of 2)

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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** **Solar Dynamics Observatory/Living with a Start**

2. **Points of Contact**

Project Manager: Ken Schwer Code: 464 Telephone: 6-3225
S/C Manager: Brent Robertson Code: 591 Telephone: 6-6392
Instrument Manager: Tom Anderson Code: 464 Telephone: 6-1189
Other: Ray Pages, Ground Systems Mgr Code: 581 Telephone: 6-6012

3. **Schedule**

Formulation Process (Phase A/B): December 2001 – Spring 2004
Implementation Process (Phase C/D): Spring 2004 – April 2008
Launch Date: April 2008
Other Milestone Dates: Mission PDR (02/04), Mission CDR (01/05), Mission Ops Review (01/07)

4. **Current status**

Approved for Phase B

5. **Project Description**

a. Purpose/Need: SDO will provide near continuous coverage of solar activity and provide data on the types of phenomena which impact Earth, near-Earth space and humanity

b. Spacecraft/Instruments: SDO consists of three instrument suites. HMI (Stanford), EVE (LASP at Boulder) and AIA (LMSAL , Palo Alto)

c. Launch Vehicle: Delta IV or Atlas V
d. Launch Site: Kennedy Space Center
e. Alternatives (to or for the mission): None

f. NASA's Involvement/Responsibility: The spacecraft and ground system are being developed at Goddard Space Flight Center as an In-House development effort

g. Participants/Locations: GSFC, Stanford, LASP, LMSAL

h. Mission Life: 5 yr with 10 yr expendables

i. End of mission, Re-entry: Orbit raising out of Geosychronous orbit

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)?**

Expecting to use existing NEPA documentation
We believe that SDO is in the envelope of requirements.

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)

Not yet

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 MMH Biprop using MON-3
____ b. Radioactive Material
X c. Explosives 9 pyro valves as part of propulsion system
____ d. Chemicals
____ e. Hazardous Materials/Substances
____ f. Lasers (Class, Earth Pointing)
____ g. Disease Producing Pathogenic Microorganisms
? h. Construction/Modification of a Facility Ka-band antenna @ WSC
____ 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?

Use and handling of MMH and MON-3

K. O. Schwer

Ken Schwer
Project Manager, Code 464

2/26/04

Date

Explanations

Multiple Oxides of Nitrogen - 3% (MON-3)

MON-3 is 3 wt% nitric oxide (NO) added to Nitrogen tetroxide (N_2O_4). N_2O_4 MON-3 is the typical Oxidizer used in spacecraft with bi-propellant propulsion systems with MonoMethyl Hydrazine (MMH) as the fuel.

References:
Kennedy Space Center Propellants & Life Support Branch)
MIL-PRF-26539

SDO plans to construct (2) Antennas that support Ka and S-band frequencies. White Sands Complex currently has (2) antenna pads that are vacant that SDO plans to use. If the antenna pads cannot support the weight of the purchased system, modifications will need to be made to the existing pads to strengthen them. A core sample may be needed to determine strength of existing pad.

Summary of SDO Subsystems

Structural Materials	Aluminum structure, M55J/954-3 (Cyanate Ester carbon fiber reinforced composites) face sheets, 0.040" thick, QI layup **(Note: no beryllium used on structure)**
Propulsion	Bipropellant System with 516 kg of Monomethal Hydrazine and 851 kg of Mixed Oxides and Nitrogen (MON-3)
Communications	Ka-band System – 2.5 watt transmitter with 0.75 m high gain antenna S-Band system – 5 watt GSTDN transponder going thru omni antennas
Power	GaAs triple junction solar cells 100amp hour LiIon Battery
Science instruments	Helioseismic and Magnetic Imager (HMI) – visible imager Extreme Ultraviolet Experiment (EVE) – UV spectrograph Atmospheric Imaging Assembly (AIA) – UV imaging telescope
Other (include dimensions and weight of s/c)	Mass: ~3200 kg Height: ~5m Width: ~2m **(Note: Height and Width do not include deployable appendages)** 9 pyro valves: 6 nominally closed pyro valves 3 nominally opened pyro valves