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

April 25, 2003

Reply to Attn of: 410

MEMORANDUM FOR THE RECORD

National Environmental Policy Act (NEPA) Compliance for Galaxy Evolution Explorer (GALEX)

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

GALEX is a small explorer class mission that is part of NASA's Structure and Evolution of the Universe theme. The objective of the mission is to map the history and evolution of the universe. GALEX is an orbiting space telescope that will observe hundreds of thousands of nearby and distant galaxies in ultraviolet (UV) light. Additionally, GALEX will view the stars in our own galaxy, the Milky Way. The observations will help scientists understand how galaxies evolve and change, and the history of star formation. GALEX will perform both imaging and spectroscopy, conducting several types of surveys, some of which will be science "firsts." Data collected by GALEX will populate a large unparalleled archive that will fill in missing pieces of the current cosmological puzzle. The archive will be available to both the science community and the general public. GALEX will complement the capabilities of current observatories, such as HST and FUSE and future ones planned for later this decade.

GALEX will be launched on an air launched Pegasus XL launch vehicle over the Atlantic Ocean in the 1st Quarter 2003. The Pegasus will be carried by an L-1011 Stargazer from CCAFS. GALEX will orbit 690 kilometers above the Earth at an inclination of 29 degrees to the equator.

GALEX is a 3-axis stabilized spacecraft. The spacecraft weighs 277.2 kilograms, and measures 1.97 meters in height, 1.12 meters in diameter with solar arrays stowed, and 2.79 meters wide with solar arrays deployed. Electrical power to the spacecraft will be provided by gallium arsenide solar arrays and nickel-hydrogen batteries. GALEX uses a single instrument with state-of-the-art UV detectors.

The components utilized in the GALEX spacecraft and instruments are made of materials normally encountered in the space industry. GALEX does not use any radioactive materials. GALEX does utilize lasers in the Ring Laser Gyros (RLG's) used to assist in Attitude Sensing for the spacecraft. The RLG's are contained within an aluminum box and no laser radiation is emitted outside the unit. GALEX does not carry any pathogenic organisms, nor will GALEX return samples to Earth. Materials/hazards associated with GALEX do not raise any environmental or health (safety) concerns.

The results of the GALEX Orbital Debris Assessment indicate that the mission meets the less than 8 m^2 casualty area requirement, but exceeds the less than 25-year orbit life requirement. Based on Code Q's recommendation, Code S has accepted the Orbital Debris Assessment. (Note: This is an on-orbit issue and not a NEPA issue and does not affect the mission qualifying as a routine payload.)

3.0 NASA Routine Payload Determination

The GALEX 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 GALEX 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.

W. F. Townsend

for 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: **Galaxy Evolution Explorer (GALEX)**

2. Description/location of proposed action:
GALEX is an orbiting space telescope that will observe galaxies in ultraviolet light across 10 billion years of cosmic history. GALEX will be launched on an air launched Pegasus XL. The Pegasus will be carried from CCAFS by an L-1011 Stargazer to the launch site over the Atlantic Ocean.

Date and/or Duration of project: Launch 1st Q 03

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 Montanus — NEPA Coordinator, Code 205.2 — 3/5/03 Date

Frank Snow — Project Manager, Code 410 — 3/20/03 Date

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: **Galex** DATE OF LAUNCH: 3/25/03

PROJECT CONTACT: Mr. Frank Snow PHONE NUMBER: 301-286-7494 MAILSTOP: 410

PROJECT START DATE: 12/5/97 -- Phase A PROJECT LOCATION: GSFC Small Explorer's Office; Launch Site: KSC

PROJECT DESCRIPTION: Perform 1st Ultraviolet All-Sky Imaging Survey and Map History of Star Formation Over Redshift Range 0<z<2

	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:		

NASA Routine Payload Checklist (2 of 2)

PROJECT NAME: **Galex** DATE OF LAUNCH: 3/25/03

PROJECT CONTACT: Mr. Frank Snow PHONE NUMBER: 301-286-7494 MAILSTOP: 410

PROJECT START DATE: 12/5/97 -- Phase A PROJECT LOCATION: GSFC Explorer's Office; Launch Site: KSC

PROJECT DESCRIPTION: Perform 1st ultraviolet all-sky Imaging Survey and Map History of Star Formation over Redshift Range 0<z<2

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

Summary of GALEX Subsystems

Structural Materials	Aluminum, graphite epoxy composites, invar telescope components, fused silica optics, fiberglass, MLI Blankets, Stainless Steel Hardware
Propulsion	No Propulsion Subsystem
Communications	5 Watt S-band Transmitter, 6 Watt X-band Transmitter
Power	GaAs Solar Arrays 11 CPV Nickel Hydrogen (16 Amp hour Battery)
Science instruments	Near UV and Far UV Detectors, Telescope: F 3.0 Meter 0.5 Meter Aperture
Other (include dimensions and weight of s/c)	Satellite Mass 277.2 Kg Overall Dimensions: 1.97 Meters Tall, 1.12 Meter Diameter with Solar Arrays Stowed. 2.79 Meters Wide with Solar Arrays Deployed

NEPA Environmental Checklist

1. Project/Program

Galex / GSFC Code 410 Small Explorer's Program Office

2. Points of Contact

Project Manager: Mr. Frank Snow* Code: 410 Telephone: 301-286-7494
S/C Manager: N/A (see 5g below) Code: Telephone:
Instrument Manager: Mr. Bill Davis Code: 410 Telephone: 301-286-3038
Other: Code: Telephone:
*Frank Snow is GSFC Mission Manager. Frank Snow and Bill Davis are primary NASA GSFC Civil Servant POCs for the Galex mission.

3. Schedule

Formulation Process (Phase A/B): Phase A: 12/0519/97;
Phase B: 05/04/1998
Implementation Process (Phase C/D): Phase C: 02/23/1999
Launch Date: 03/25/2003
Other Milestone Dates: N/A

4. Current status

Galex was transported to the KSC Launch Site for final checkouts on 02/02/2003. The project is on schedule for the 03/25/03 Launch Date.

5. Project Description

a. Purpose/Need: Galex will perform the first Ultraviolet All-Sky Imaging Survey and will map the history of the universe over the Redshift Range $0<z<2$. The Imaging and Spectroscopy surveys will answer the questions of star formation and metal production history of the galaxies, and when and where the stars and elements seen today originated. The resulting science will produce a statistically powerful database of UV images and spectra of nearby and distant galaxies.

b. Spacecraft/Instruments: Orbital Sciences Corporation, Space Sciences Group, is the spacecraft vendor. The three-axis stabilized spacecraft will be in a 28.5 deg inclination/690 km LEO orbit. S/C mass is 277.2kg; S/C power output is 290 watts. Additional S/C characteristics include: Inertial Pointing ACS, 11-16Ahr Common-Pressure-Vessel (CPV) Nickel-Hydrogen batteries, GaAs Fixed Solar Arrays with $3m^2$ total area, 4 reaction wheels, a star tracker, and sun sensors. There is no propulsion, consumables, or cryogenics. All subsystems are made of materials and components commonly used in the space industry. All S/C and instrument materials and quantities are within the Envelope Payload Characteristics.

The Instrument was primarily developed by Cal Tech and JPL. It utilizes a 50cm aperture optical telescope with Al and MgF_2 coatings, MgF_2 and Fused Silica Detector Windows, CsI and CsTe Detector Photo cathodes, an ion-etched, fused silica aspheric astigmatism corrector, a dichroic beam splitter, and a rotating grism wheel. All materials and components are commonly used in the space industry.

c. Launch Vehicle: The Launch Vehicle is a Pegasus XL, designed and manufactured by Orbital Sciences Corporation, Launch Services Group (OSC LSG).

d. Launch Site: CCAFS skidstrip

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

f. NASA's Involvement/Responsibility: Galex is a GSFC, Code 410 Small Explorer's Program Office Mission. Galex is a Principle Investigator (PI) mission type. The Explorer's Program Office and the Galex Mission Manager are responsible for the management of Galex project development, launch, and on-orbit checkout.

g. Participants/Locations: California Institute of Technology (Cal Tech) is the Galex PI, with overall responsibility for delivering the Galex S/C and associated mission science to GSFC. Cal Tech developed the instrument science, provided test support, and will conduct the mission operations, including science operations, data analysis, and science analysis. JPL, under contract to Cal Tech, provides overall project management and implementation. They also developed the Galex instrument. The S/C vendor, also under contract to Cal Tech, is Orbital Sciences Corporation Space Science Group (OSC SSG), in Dulles, Virginia. They developed the S/C bus, performed integration & testing, developed L/V interfaces, and are responsible for the Ground Data Systems and conducting Mission Operations. The Mission Operations Center is also located at the OSC facility in Dulles, Va.

h. Mission Life: Baselined Mission Life is 28 Months.

i. End of mission, Re-entry: 4 year useful mission life. The Galex Orbital Debris Analysis indicates both the L/V and the S/C exceed the <25-year maximum on lifetime orbit guidelines. The S/C will re-enter in 56 years. The Pegasus third stage will re-enter in 54 years. The Galex project has investigated both lower and higher orbits to reduce either the orbit lifetime or park the satellite in a long duration orbit. Neither option is feasible. Lower orbits would result in curtailing the science mission. 690km was selected as the lowest orbit consistent with the nominal science mission. Orbits higher than 800km also resulted in reduced science. The Pegasus XL capability is also limited to about 800 km for the Galex Satellite Mass. This non-conformance is the only non-conformance in the Galex

Orbital Debris Analysis. Code Q recommended acceptance of the Galex Orbital Debris Analysis, with the one identified non-conformance.

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)?

Spacecraft - No

Launch Vehicle - Yes, the Pegasus XL has a previously documented and approved Environmental Impact Assessment.

9. Has an orbital debris analysis been completed? (If yes, what is returning to earth?) Yes; see 5i above. The analysis concludes the Pegasus third stage fails to burn up completely and leaves debris over a 1.56m^2 area. The S/C also fails to burn up completely and leaves debris over a 5.637m^2 area. Both projections meet the less than 8m^2 requirement.

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.

L/V a. Fuels Solid Propellants Only
___ b. Radioactive Material
L/V c. Explosives Destruct Ordnance
___ d. Chemicals
L/V e. Hazardous Materials/Substances Destruct Ordnance
S/C f. Lasers (Class, Earth Pointing) Contained, Non-Earth Pointing
___ g. Disease Producing Pathogenic Microorganisms
___ h. Construction/Modification of a Facility
L/V i. Discharges of any substances into air, water, or soil Rocket Exhaust
L/V j. Generation/Use/Storage/Disposal of Toxic or Hazardous Substances Destruct Ordnance

L/V; S/C k. Generation of Hazardous Wastes Normal Launch Site Processing Waste Products (alcohol wipes, etc); KSC is responsible for proper hazardous material management and disposal.

L/V l. Generation of High Noise Levels L-1011 Take-off on KSC Skid Strip

m. Sample Return to Earth

L/V; S/C n. Generation of Ionizing or Nonionizing Radiation Both produce non-ionizing radiation. Sources are transmitters and lasers.

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

Frank Snow
Project Manager, Code

3/20/03
Date

Explanations

L/V – all L/V affirmative responses are enveloped within material, quantity, and power limitations already documented and approved in previous Pegasus XL NEPA documents.

S/C – Galex lasers are contained and non-earth pointing (not applicable to class III or IV Laser requirements and restrictions). All non-ionizing exposure levels are below MPE's as defined in the Routine Payload EA guidelines (enveloped within NASA and ANSI requirements).