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

Reply to Attn of:

460

MEMORANDUM FOR THE RECORD

The National Environmental Policy Act Compliance for Ionospheric Connection Explorer Mission

1.0 Introduction

The National Environmental Policy Act (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 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 (Ref: *Environmental Assessment for Launch of NASA Routine Payloads*, November 2011). The 2011 NASA Routine Payload Environmental Assessment (NRPEA) assesses the environmental impacts of missions launched with spacecraft that are considered routine payloads from existing launch facilities at Cape Canaveral Air Force Station (CCAFS), FL, Vandenberg Air Force Base (VAFB), CA, the United States Army Kwajalein Atoll/Reagan Test Site (USAKA/RTS), Republic of the Marshall Islands, Wallops Flight Facility (WFF), VA, and the Kodiak Launch Complex (KLC), AK.

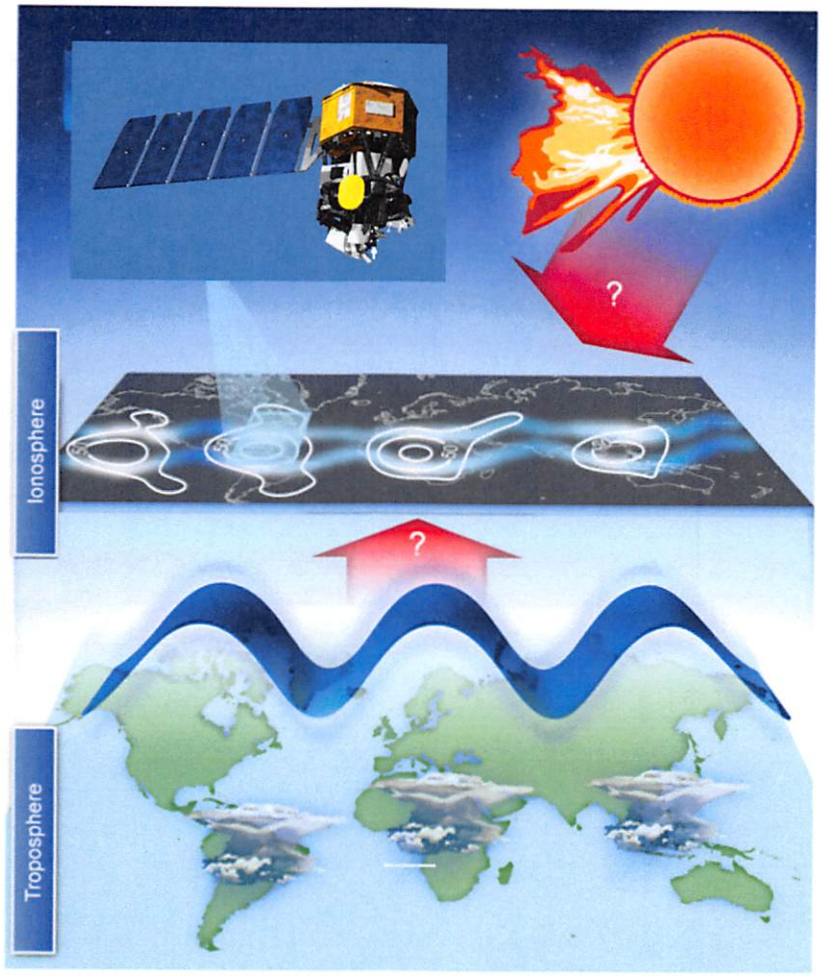
Spacecraft defined as routine payloads utilize materials, quantities of materials, launch vehicles, launch sites, and operational characteristics that are consistent with normal and routine spacecraft preparation and flight activities at CCAFS, VAFB, USAKA/RTS, WFF, KLC, and Kennedy Space Center. The environmental impacts of launching routine payloads from these sites fall within the range of routine, ongoing, and previously documented impacts that have been determined not to be significant. Spacecraft within the scope of 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, the mission is evaluated against the criteria defined in the EA using the routine payload checklist (RPC).

2.0 Mission Description

Ionospheric Connection Explorer (ICON) will explore the boundary between Earth and space, the ionosphere, to understand the physical connection between our world and the immediate space environment around us. This region, where ionized plasma and neutral gas collide and react, exhibits dramatic variability that affects space-based technological systems like GPS. The ionosphere has long been known to respond to "space weather" drivers from the sun, but recent NASA missions have shown that this variability often occurs in concert with weather on our planet. ICON will compare the impacts of these two drivers as they exert change on the space environment that surrounds us.

Though the solar inputs are now well quantified, the drivers of ionospheric variability originating from lower atmospheric regions are not. ICON is the first space mission to simultaneously retrieve all of the properties of the system that both influence and result from the dynamical and chemical coupling of the atmosphere and ionosphere. ICON will achieve this through an innovative measurement technique that combines remote optical imaging and in-situ measurements of the plasma. With this approach, ICON will give us the ability to: (1) separate the drivers and pinpoint the real cause of ionospheric variability; (2) explain how energy and momentum from the lower atmosphere propagate into the space environment; and (3) explain how these drivers set the stage for the extreme conditions of solar-driven magnetic storms. ICON's imaging capability combined with its in-situ measurements on the same spacecraft gives a perspective of the coupled system that would otherwise require two or more orbiting observatories.



ICON will investigate how large-scale patterns in our weather system affect the near-Earth space environment.

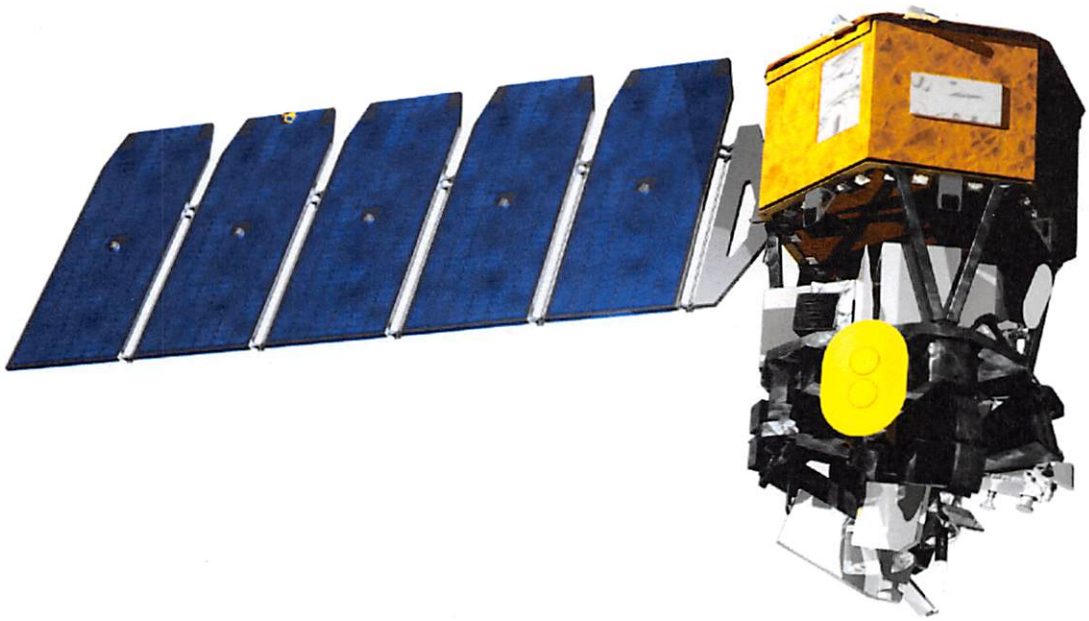
ICON's payload consists of four instruments:

- Michelson Interferometer for Global High-Resolution Thermospheric Imaging (MIGHTI)
- Extreme Ultra-Violet imager (EUV)
- Far Ultra-Violet imager (FUV)
- Ion Velocity Meter (IVM)

MIGHTI will remotely measure the neutral wind field and temperature. EUV will measure the height and density of the daytime ionosphere. FUV will measure the daytime atmospheric composition and the ionospheric electron density at night. IVM will provide measurements of the ion drift velocity in the spacecraft reference frame, the ion temperature and the total ion number density at the location of the spacecraft.

The ICON mission will be based on Orbital Sciences Corporation's LEOStar-2 platform, a spacecraft for space and Earth science, remote sensing, and other applications.

The LEOStar-2 spacecraft bus has been used for numerous NASA missions.
ICON will be launched on a NASA launch services Option B launch vehicle in mid-2017 from CCAFS.



ICON in nominal science state and attitude

3.0 NASA Routine Payload Determination

The components utilized in the ICON spacecraft are made of materials normally encountered in the space industry. Materials and operations to provide power and communications for the spacecraft and instruments will not pose substantial risks to human health and safety. ICON will not have propulsion, will not utilize lasers, will not carry pathogenic organisms and will not return samples to Earth. ICON will utilize calibration sources that contain radioactive material, similar to ones used in previous NASA missions. The A_2 mission multiple for these sources is well below the routine payload criteria of 10. An uncontrolled reentry is planned for the ICON spacecraft. The risk of human casualty from components surviving reentry is 1:13,845, below the 1:10,000 limit set forth in *NASA's Process for Limiting Orbital Debris* (NASA-STD 8719.14A).

The ICON mission has been evaluated against the 2011 NPREA, using the RPC (see enclosed evaluation recommendation package). The evaluation indicates that the mission meets the criteria for a routine payload and falls within the scope of the reference EA. The launch vehicle has yet to be selected; however, the candidate launch vehicle/launch site combinations all fall within the scope of the EA. The mission does not present any unique or

unusual circumstances that could result in new or substantial environmental impacts. Based on the analyses set forth in the 2011 NRPEA, NASA has determined that the environmental impacts associated with the ICON mission will not individually or cumulatively have a significant impact on the quality of the human environment and that a routine payload classification for the ICON mission is applicable. No additional NEPA action or documentation is required.

George W. Morrow
Director, Flight Projects

10/7/14
Date

Christopher J. Scolese
Director

20 October 2014
Date

Enclosure

Reference
http://icon.ssl.berkeley.edu/

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
Flight Project Environmental Checklist

Enclosure

RECORD OF ENVIRONMENTAL CONSIDERATION

1. Project Name: Ionospheric Connection Explorer (ICON)

2. Description/location of proposed action: ICON will explore the ionosphere to understand the physical connection between our world and the immediate space environment around us. This region, where ionized plasma and neutral gas collide and react exhibits dramatic variability. The ionosphere has long been known to respond to "space weather" drivers from the sun, but recent NASA missions have shown this variability often occurs in concert with weather on our planet. ICON will compare the impacts of these two drivers.

Date and/or Duration of project: Launch – Mid 2017

3. It has been determined that the above action:

☒ a. Is adequately covered in an existing EA or EIS.
Title: *Environmental Assessment for Launch of NASA Routine Payloads*
Date: November 2011

☐ b. Qualifies for Categorical Exclusion and has no extraordinary circumstances which would suggest a need for an 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 — 9/2/14 Date

Steven Horowitz — Project Manager, Code 460 — 9/10/14 Date

NASA ROUTINE PAYLOAD EVALUATION AND DETERMINATION PROCESS AND CHECKLIST

After a proposed spacecraft mission is sufficiently well formulated (usually the Phase B design study), the Sponsoring Entity, in coordination with the local Environmental Management Office (EMO), will prepare an environmental evaluation. An environmental evaluation is a preliminary review that determines what aspects of the proposal are of potential environmental concern. The environmental evaluation also assists in determining the appropriate level of National Environmental Policy Act (NEPA) documentation (i.e., environmental assessment [EA], or environmental impact statement [EIS]) for the proposal. The local EMO uses a comprehensive checklist to provide a level of rigor to this early evaluation of the proposal, helping to ensure that pertinent considerations are not overlooked. Local EMO review of the Routine Payload Checklist (RPC, below) forms the basis for evaluating the applicability of a NASA Routine Payload (NRP) spacecraft classification for a proposed mission.

The local EMO uses the completed RPC (and required attachments) to evaluate the proposed mission against the NRP EA criteria. If the EMO evaluation of the RPC indicates that a NRP categorization may be appropriate, the Sponsoring Entity documents this in an Evaluation Recommendation Package (ERP). The ERP is then processed for review and approval in accordance with established National Aeronautics and Space Administration (NASA) procedures and guidelines. If approved, the ERP would be attached to a Record of Environmental Consideration (REC).

The Sponsoring Entity can then proceed with the proposal while monitoring the project activities, for changes or circumstances during implementation that could affect classification of the proposed mission as a NRP spacecraft. If a NRP spacecraft categorization is determined to be inappropriate, the local EMO will initiate plans for preparation of additional NEPA documentation.

NASA ROUTINE PAYLOAD CHECKLIST

Project Name: ICON (Ionospheric Connection Explorer)		Date of Launch: Mid 2017
Project Contact: Steven J. Horowitz	Phone Number: 301-286-4620	Mailstop: 460
Project Start Date: May 2013	Project Location: University of California, Berkeley	

Project Description:
ICON will explore the boundary between Earth and space – the ionosphere – to understand the physical connection between our world and the immediate space environment around us.

	Yes	No
A. Sample Return:		
1. Would the candidate mission return a sample from an extraterrestrial body?	☐	☑
B. Radioactive Materials:	Yes	No
1. Would the candidate spacecraft carry radioactive materials in quantities that produce an A2 mission multiple value of 10 or more?	☐	☑
Provide a copy of the Radioactive Materials On Board Report as per NPR 8715.3 with the ERP submittal.		
C. Launch and Launch Vehicles:	Yes	No
1. Would the candidate spacecraft be launched on a vehicle and launch site combination other than those listed in Table C-1 below?	☐	☑
2. Would the proposed mission exceed the approved or permitted annual launch rate for the particular launch vehicle or launch site?	☐	☑
Comments:		
D. Facilities:	Yes	No
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?	☐	☑
Provide a brief description of the construction or modification required, including whether ground disturbance and/or excavation would occur.		
E. Health and Safety:	Yes	No
1. Would the candidate spacecraft utilize batteries, ordnance, hazardous propellant, radiofrequency transmitter power, or other subsystem components in quantities or levels exceeding the EPC's in Table C-2 below?	☐	☑
2. Would the expected risk of human casualty from spacecraft planned orbital reentry exceed the criteria specified by NASA Standard 8719.14?	☐	☑
3. 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 Characteristics?	☐	☑
4. Would the candidate mission, under nominal conditions, release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?	☐	☑
5. Are there changes in the preparation, launch or operation of the candidate spacecraft from the standard practices described in Chapter 3 of this EA?	☐	☑
6. Would the candidate spacecraft utilize an Earth-pointing laser system that does not meet the requirements for safe operation (ANSI Z136.1-2007 and ANSI Z136.6-2005)?	☐	☑
7. Would the candidate spacecraft contain, by design (e.g., a scientific payload) pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health or the environment beyond Biosafety Level 1 (BSL 1)[1]?	☐	☑
Comments:		

Continued on next page

[1] The use of biological agents on payloads is limited to materials with a safety rating of "Biosafety Level 1." This classification includes defined and characterized strains of viable microorganisms not known to consistently cause disease in healthy human adults. Personnel working with Biosafety Level 1 agents follow standard microbiological practices including the use of mechanical pipetting devices, no eating, drinking, or smoking in the laboratory, and required hand-washing after working with agents or leaving a lab where agents are stored. Personal protective equipment such as gloves and eye protection is also recommended when working with biological agents.

NASA ROUTINE PAYLOAD CHECKLIST

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Project Contact: Steven J. Horowitz	Phone Number: 301-286-4620	Mailstop: 460
Project Start Date: May 2013	Project Location: University of California, Berkeley	

Project Description:
ICON will explore the boundary between Earth and space – the ionosphere – to understand the physical connection between our world and the immediate space environment around us.

F. Other Environmental Issues:	Yes	No
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?	☐	☑
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?	☐	☑
3. Would any aspect of the candidate spacecraft that is not addressed by the EPCs have the potential for substantial effects on the environment (i.e., previously unused materials, configurations or material not included in the checklist)?	☐	☑

Comments:

Table C-1. Launch Vehicles and Launch Sites

Launch Vehicle and Launch Vehicle Family	Space Launch Complexes and Pads				
	Eastern Range (CCAFS)	Western Range (VAFB)	USAKA/RTS	WFF	KLC
Athena I, IIc, III[a]	LC-46	CA Spaceport (SLC-8)	NA	Pad 0	LP-1[a]
Atlas V Family	LC-41	SLC-3	NA	NA	NA
Delta II Family	LC-17	SLC-2	NA	NA	NA
Delta IV Family	LC-37	SLC-6	NA	NA	NA
Falcon I/Ie	LC-36	SLC-4W	Omelek Island	Pad 0	LP-3[b]
Falcon 9	LC-40	SLC-4E	Omelek	Pad 0	LP-1
Minotaur I	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur II-III	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur IV[c]	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur V	LC-20 and/or LC-46	SLC-8	NA	Pad 0	NA
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB Airfield	Kwajalein Island	WFF Airfield	NA
Taurus	LC-20 and/or LC-46	SLC-576E	NA	Pad 0	LP-1
Taurus II	NA	NA	NA	Pad 0	LP-3[b]
Any other launch vehicle/launch site combination for which NASA has completed or cooperated on the NEPA compliance.					

[a] Athena III is currently under design.

[b] LP-3 is currently under design.

[c] While not explicitly listed in this table, the Minotaur IV includes all configurations of this launch vehicle, including the Minotaur IV+, which is a Minotaur IV with a Star 48V 4th stage.

Key: CA = California; CCAFS = Cape Canaveral Air Force Station; KSC = Kennedy Space Center; LC = Launch Complex; LP = Launch Pad; MARS = Mid-Atlantic Regional Spaceport; SLC = Space Launch Complex; SLF = Shuttle Landing Facility; USAKA/RTS = United States Army Kwajalein Atoll/Reagan Test Site; VAFB = Vandenberg Air Force Base; WFF = Wallops Flight Facility.

NASA ROUTINE PAYLOAD CHECKLIST

Table C-2. Summary of Envelope Payload Characteristics by Spacecraft Subsystems

Structure	• Unlimited: aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion[a]	• Liquid propellant(s); 3,200 kg (7,055 lb) combined hydrazine, monomethyhydrazine and/or nitrogen tetroxide. • Solid Rocket Motor (SRM) propellant; 3,000 kg (6,614 lb) Ammonium Perchlorate (AP)-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.)
Communications	• Various 10-100 Watt (RF) transmitters
Power	• Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH_2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Nickel-hydrogen (Ni-H_2) battery.
Science Instruments	• 10 kilowatt radar • American National Standards Institute safe lasers (see Section 4.1.2.1)
Other	• U. S. Department of Transportation (DoT) Class 1.4 Electro-Explosive Devices (EEDs) for mechanical systems deployment • Radioactive materials in quantities that produce an A2 mission multiple value of less than 10 • Propulsion system exhaust and inert gas venting • Sample returns are considered outside of the scope of this environmental assessment

[a] Propellant limits are subject to range safety requirements.

Key: kg=kilograms; lb=pounds.

Goddard Space Flight Center
FLIGHT PROJECT ENVIRONMENTAL CHECKLIST

1. PROJECT/PROGRAM	Date:
ICON (Ionospheric Connection Explorer)/Explorers Program	May 27, 2014

2. SCHEDULE

PDR/CDR:	Launch Date:
MPDR - July 8-10, 2014/MCDR - February 2015	Mid 2017

3. CURRENT STATUS

Completing Phase B

4. PROJECT DESCRIPTION

a. Purpose:

ICON will explore the ionosphere to understand the physical connection between our world and the immediate space environment around us. This region, where ionized plasma and neutral gas collide and react exhibits dramatic variability. The ionosphere has long been known to respond to "space weather" drivers from the sun, but recent NASA missions have shown this variability often occurs in concert with weather on our planet. ICON will compare the impacts of these two drivers.

b. Spacecraft:

LEOStar-2 bus provided by Orbital Sciences Corporation

c. Instruments:

1) Michelson Interferometer for Global High-resolution Thermospheric Imaging (MIGHTI) - provided by the Naval Research Laboratory
2) Far Ultraviolet (FUV) Imager - provided by the University of California, Berkeley (UCB)
3) Extreme Ultraviolet Spectrometer (EUV) - provided by UCB
4) Ion Velocity Meter (IVM) - provided by the University of Texas at Dallas

d. Launch Vehicle:

ICON will be launched on a NASA Launch Services (NLS) Option B L/V in mid-2017 from CCAFS. The Launch Vehicle/Launch Site Combination will be one included in the NRPEA.

e. Launch Site:

KSC

f. NASAs Involvement/Responsibility:

GSFC/Explorers Mission Management
KSC/Launch Services

g. Participants/Locations:

GSFC, Greenbelt, MD
UCB/Berkeley, CA
Orbital Sciences, Dulles, VA

h. End-of-Mission Plan: Planned Re-entry (controlled/uncontrolled?)

Uncontrolled atmospheric reentry; post mission orbit lifetime of 4.7 yrs meets <25 yr requirement

5. Is there anything controversial or unique about the mission, spacecraft or instruments? If yes, Explain. Yes ☐ No ☑

6. Is the mission compliant with NASA requirements for limiting orbital debris (NPR 8715.6, and NASA Standard 8719.14? Explain non-compliances. Yes ☑ No ☐

7. During any phase, does the mission/project include or involve: Check yes for all that apply. If uncertain, check the corresponding box. For all that apply, provide an explanation. Use the additional space below if needed.	Yes	No	Uncertain
A. Fuels	☐	☑	☐
B. Ionizing Radiation Devices/Sources	☑	☐	☐
C. Explosives	☐	☑	☐
D. Hazardous Materials/Substances/Chemicals	☐	☑	☐
E. Lasers (Class, Earth Pointing)	☐	☑	☐
F. Disease Producing Pathogenic Microorganisms/Biological Agents	☐	☑	☐
G. Discharges/Venting of any Substances into Air, Water, or Soil	☐	☑	☐
H. Hazardous Waste Generation	☐	☑	☐
I. High Noise Levels	☐	☑	☐
J. Sample Return to Earth	☐	☑	☐
K. Radio Frequency Communications	☑	☐	☐
L. Construction/Modification/Demolition of a Facility/Lab (onsite - offsite)	☐	☑	☐
M. Land Disturbance, Tree Clearing, Removal of Vegetation	☐	☑	☐
N. Impact on Threatened or Endangered Species	☐	☑	☐
O. Impact/Destruction of Sensitive Wildlife Habitat	☐	☑	☐
P. Impact on/near Areas of Cultural Significance	☐	☑	☐
Q. Impact on Local Social or Economic Conditions (Increase in Traffic, Employment, etc.)	☐	☑	☐
R. Impact on Minority or Low Income Populations	☐	☑	☐
S. New or Foreign Launch Vehicle	☐	☑	☐
T. Other Issues of Potential Environmental Impact	☐	☑	☐
U. Environmental Permits	☐	☑	☐

Additional Information

B. The only radioactive materials on the ICON Observatory are the MIGHTI calibration sources. These sources are RF excited low pressure lamps with less than 10μCi of 63Ni embedded in the glass lamp tubes. 63Ni emits Beta particles that have less than 0.0669 MeV energy and are completely shielded; The A2 Mission Multiple is 0.00000125 per NPR 8715.3

K. The RF subsystem features a Thales Integrated S-band Transceiver (ISBT) and dual quadrifilar helix antennas coupled to provide 4-pi steradian coverage,

8. What Safety hazards are associated with the mission?

Handling of Li-Ion Battery will be controlled.

9. Summary of Subsystem Components

Propulsion (Include fuel type, amount, tank size, materials, dimensions	N/A
Communications	The RF subsystem features a Thales Integrated S-band Transceiver (ISBT) and dual quadrifilar helix antennas coupled to provide 4-pi steradian coverage,
Structural Materials	Solar array - composite panels, spacecraft structure - aluminum honeycomb panels
Power	Li-Ion Battery Solar Array
Science Instruments	1) Michelson Interferometer for Global High-resolution Thermospheric Imaging (MIGHTI); 2) Far Ultraviolet (FUV) Imager; 3) Extreme Ultraviolet Spectrometer (EUV); 4) Ion Velocity Meter (IVM)
Hazardous Components (radioactive materials, lasers, chemicals, etc.)	- The only sources of hazardous or radioactive materials on the ICON Observatory are the MIGHTI calibration sources. These sources are RF excited low pressure lamps with heritage from previous NASA missions. - Li-Ion Battery
Other (include dimensions and weight of s/c)	Observatory mass estimate is 277kg; the observatory is roughly cylindrical with a diameter of 1m and and height of 1.9m

Goddard Space Flight Center

FLIGHT PROJECT ENVIRONMENTAL CHECKLIST

Project Manager Printed Name: Steven J. Horowitz	Project Manager Signature:		
Project Name: ICON	Date: 9/10/11	Phone Number: 6-4620	Org. Code: 460

Comments:

MINOR RADIOACTIVE SOURCES BEING LAUNCHED ON GSFC SPONSORED PROJECTS

Vehicle/ Spacecraft	Planned Launch Date (Mo/Yr)	Launch Site	Number of Sources	Isotope	Total Activity (Curies)	A_2 Limit for Isotope (Ci)	A_2 Multiple for Isotope	Remarks/Disposition
NASA Launch Services (NLS) Option B L/V	Mid-2017	Eastern Test Range, Cape Canaveral, FL	2	Ni-63	3.0E-6	800	3.75E-9	Sources deposited on inner surface of glass bulbs that are part of the MIGHTI instrument.

Nuclear Launch Safety Approval Summary (Table 6.1, NPR 8715.3C, Chapter 6)					
A2 Mission Multiple	Launch Reported to NFSAM	Launch Concurrence/ Approval by	Launch Reported to OSTP	Required Level of Review and Reports	Approval/ Concurrence
A_2<0.001	Yes	Nuclear Flight Safety Assurance Manager (NFSAM)	No	Paragraph 6.3.3 Report	Concurrence letter from NFSAM