National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, MD 20771

Reply to Attn of 451

MEMORANDUM FOR THE RECORD

The National Environmental Policy Act Compliance for Laser Communications Relay Demonstration

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, NASA's 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

The purpose of Laser Communications Relay Demonstration (LCRD) is to demonstrate and validate a reliable, capable, and cost effective optical communications technology for infusion into

operational near earth and deep space systems. To demonstrate the new capability, digital data will be encoded and transmitted via laser light from specially equipped ground stations to an experimental payload hosted on the commercial communications satellite.

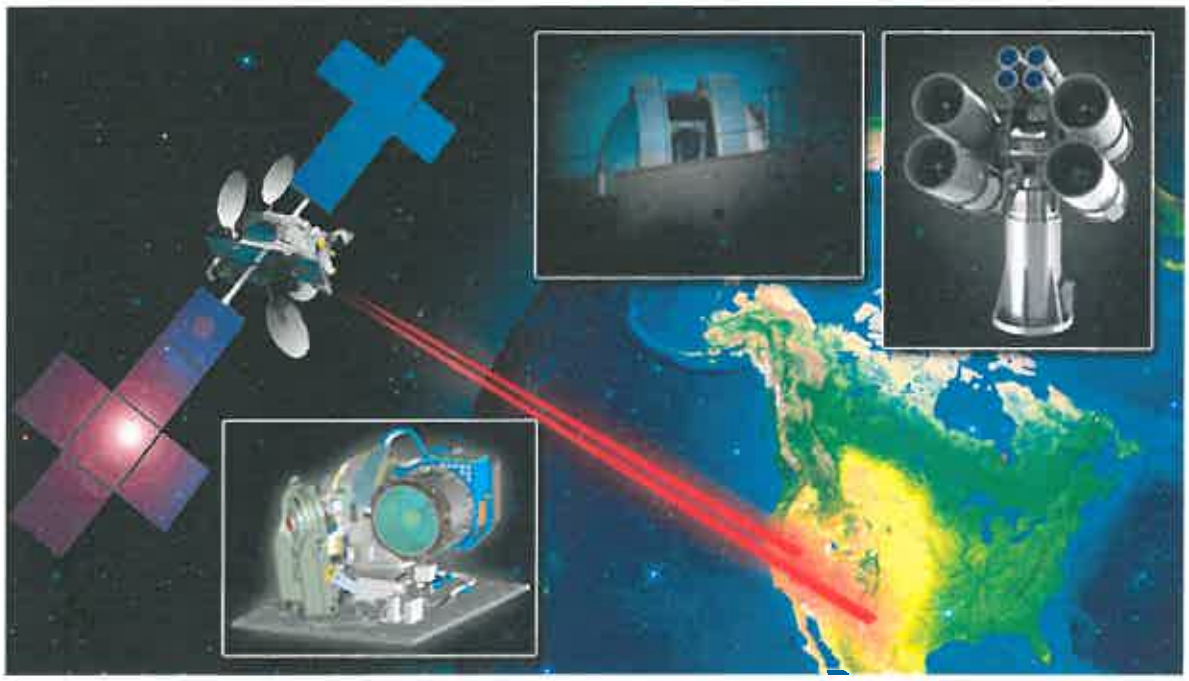
The payload will include telescopes, lasers, mirrors, detectors, a pointing and tracking system, control electronics, and a modem incorporating two different modulation formats. One modulation format is ideal for communicating with deep space missions or tiny, low-power smallsats operating in low-Earth orbit. The other can handle much higher data rates, particularly from Earth-orbiting spacecraft, including the International Space Station. Once the payload receives the data, it will then relay the data back to ground stations now scheduled to operate in New Mexico and Southern CA.

Multiple ground stations are needed to demonstrate a fully operational system. Cloud cover and turbulent atmospheric conditions impede laser communications, requiring a clear line of sight between the transmitter and receiver. If bad weather prevents a signal from being sent or received at one location, the network could hand over the responsibility to one of the other ground stations or store it for later retransmission. The demonstration is expected to run two years.

Goddard Space Flight Center (GSFC) is the lead for the LCRD and is responsible for the payload development, the LCRD Mission Operations Center (LMOC), as well as, system integration and operation of one LCRD ground station located at GSFC's White Sands Complex (WSC), New Mexico. Payload subsystems and components will be developed by GSFC or in some cases procured from vendors. Development, integration, and testing of the payload subsystem will be done at GSFC, Greenbelt, MD. The LMOC will also be housed at GSFC. Minor modification within existing facilities will be required to accomplish these tasks.

The Jet Propulsion Laboratory (JPL) is responsible for the development of the other LCRD ground stations located at JPL's Optical Communications Telescope Laboratory (OCTL) at the Table Mountain Facility in Wrightwood, CA. Massachusetts Institute of Technology/Lincoln Labs is responsible for the transfer of payload hardware technology to GSFC and supporting WSC ground station development. The plan, for the ground station at WSC, is to convert and upgrade the Lunar Laser Communication Demonstration (LLCD) ground terminal to support LCRD. LCRD will utilize the same trailer and telescope enclosure used for LLCD. The only facility change will be the addition of atmospheric monitoring equipment and possibly a concrete pad. Work at OCTL will involve minor modifications to existing facilities to support LCRD, including the addition of some aircraft monitoring equipment to meet Federal Aviation Administration (FAA) laser safety requirements.

LCRD will fly as a hosted payload on a commercial communications satellite developed by Space Systems/Loral of Palo Alto, CA. Loral would be responsible for launch operations. The launch vehicle and launch location are still to be determined with the possibility of a foreign launch. Launch is currently planned for late 2017. The launch vehicle and launch location will be identified prior to LCRD mission critical design review in the fall of 2014



3.0 Evaluation of Specific Environmental Considerations

Laser communications are between the ground stations and the space terminal payload on the geosynchronous satellite. The uplink laser beams are in the near infrared region of the spectrum (~1550nm) and are propagated into space through the telescopes at OCTL or WSC. The uplink laser transmissions pose no threat to ground observers and will be coordinated with the FAA and the Department of Defense Laser Clearinghouse, U.S. Space Command, as needed.

The downlink laser transmissions from the space terminal are in the near infrared region of the spectrum (~1550nm). The downlink laser transmissions pose no risk to ground observers and no coordination with the FAA is needed. Laser use will not present a hazard to persons or aircraft.

4.0 NASA Routine Payload Determination

The LCRD payload will be hosted on a commercial communications satellite. NASA has no control over the satellite, the launch vehicle, or launch site activities. The launch of the commercial communications satellite will occur with or without the NASA LCRD payload. As such, because NASA has no control or responsibility for the satellite, launch vehicle, or launch site activities NASA is not responsible for any NEPA compliance documentation associated with those specific operations (*See* 40 C.F.R. § 1508.18). NASA is, however, responsible for executing this NEPA review for the LCRD payload because it has primary control and responsibility for the LCRD payload.

The components utilized in the LCRD are made of materials normally encountered in the space industry. LCRD will not utilize radioactive sources, will not carry pathogenic organisms, and will not return samples to Earth. No reentry is planned for the LCRD. Minor construction and

not return samples to Earth. No reentry is planned for the LCRD. Minor construction and installation of equipment will occur at the ground station sites. Environmental reviews have been done to address modifications at the sites and the activities fall within NASA's categorical exclusions. Any impacts will be minor. The LCRD will utilize lasers at the space terminal and the two ground stations that will be in compliance with American National Standards Institute standards for safe laser operations.

LCRD has been evaluated against the NRPEA, using the RPC (see enclosed Evaluation Recommendation Package). The evaluation indicates that LCRD meets the criteria for a routine payload and falls within the scope of the reference EA. The demonstration 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 LCRD will not individually or cumulatively have a significant impact on the quality of the human environment and that a routine payload classification for the LCRD is applicable.

George W. Morrow
Director of Flight Projects

9/29/13
Date

Christopher J. Scolese
Director

24 SEPTEMBER 2013
Date

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
NEPA Environmental Checklist

Enclosure

RECORD OF ENVIRONMENTAL CONSIDERATION

1. Project Name: Laser Communications Relay Demonstration (LCRD)

2. Description/location of proposed action: The purpose of LCRD is to demonstrate and validate a reliable, capable, and cost effective optical communications technology for infusion into operational near earth and deep space systems. To demonstrate the new capability, digital data will be encoded and transmitted via laser light from specially equipped ground stations to an experimental payload hosted on the commercial communications satellite.

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

3. It has been determined that the above action:

☒ a. Is adequately covered in an existing EA or EIS. LCRD activities only
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 — 8-16-13 Date

Michael Weiss Project Manager, Code 451 — 8/16/13 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: Laser Communications Relay Demonstration (LCRD)		Date of Launch: 22 December 2017
Project Contact: Michael Weiss	Phone Number: (301)286-5720	Mailstop: Code 451
Project Start Date: 22 August 2011	Project Location: NASA GSFC	

Project Description:
The Laser Communications Relay Demonstration (LCRD) mission provides a space-based technology demonstration of optical communications, leveraging work done in the past for NASA and the Department of Defense.

A. Sample Return:	Yes	No
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:
Launch vehicle has not been determined as yet. However, commercial spacecraft contractor who will Host the LCRD payload uses launch vehicles and sites that are not listed below. There is a possibility of a foreign launch.

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.

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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?	☐	☑
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.

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:
Laser Communications Relay Demonstration (LCRD)	August 14, 2013

2 SCHEDULE

PDR/CDR:	Launch Date:
PDR: October 16-17, 2013; CDR: November 2014	December 2017

3 CURRENT STATUS

The LCRD Project, managed by NASA GSFC Code 451, is currently in the Phase B part of the project life cycle.

4 PROJECT DESCRIPTION

a. Purpose:

LCRD is comprised of space and ground based elements to advance optical communications technology toward full operational capability for both Deep Space and Near Earth applications. LCRD will provide two years of continuous high data rate optical communications in an operational environment.

b. Spacecraft:

The LCRD flight payloads will be hosted on a geosynchronous commercial spacecraft bus. The spacecraft is not managed by NASA and therefore not part of the LCRD scope.

c. Instruments:

LCRD will consist of a flight payload segment which includes two Space (GEO) optical terminals, modems, and associated payload electronics.

d. Launch Vehicle:

N/A - LCRD consists of a flight and ground segment. The flight segment is a payload hosted by a commercial spacecraft, therefore launch vehicle provisions are not part of the LCRD Project scope.

e. Launch Site:

N/A - See Launch Vehicle

f. NASAs Involvement/Responsibility:

NASA is responsible for the design, development, I&T, and operations of the LCRD system. NASA is responsible for successful execution of the demonstration and meeting the LCRD Project objectives.

g. Participants/Locations:

The current baseline plan for ground terminal locations is: 1. White Sands Complex, NM; 2. Table Mountain Facility, Wrightwood, CA

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

N/A - Not part of the LCRD Project scope. The Host spacecraft operator is responsible for decommissioning and the safe de-orbit of the spacecraft at the end of its operational mission life.

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

E. Each ground terminal consists of one or more Class IV Continuous Wave lasers of TBD output power in the infrared (approximately 1500 nm) wavelength range. The uplink optical signals transmitted from the ground terminal are contained within optical fiber and an enclosed optics assembly prior to being emitted into free-space from the telescope optical window. Maximal Permissible Exposure (MPE) and Nominal Ocular Hazard Distance (NOHD) will be calculated when the mission design is more mature.
L/M. The LCRD ground segment may require concrete pads for supporting the telescope assembly. LCRD may use existing facilities for operations and control of the ground segment.

8 What Safety hazards are associated with the mission?

9 Summary of Subsystem Components	
Propulsion (Include fuel type, amount, tank size, materials, dimensions	N/A
Communications	The flight segment consists of two Space (GEO) optical terminals, modems, and associated payload electronics. The ground terminals will consist of telescope, optics, receiver, and data processing assemblies.
Structural Materials	TBD
Power	TBD - The Ground Terminals will require power for the control systems, data processing systems, high speed electronics, uplink laser system, and receiver assembly.
Science Instruments	N/A
Hazardous Components (radioactive materials, lasers, chemicals, etc.)	Laser - Class IV, TBD Output power, infrared wavelength range
Other (include dimensions and weight of s/c)	TBD

Goddard Space Flight Center

FLIGHT PROJECT ENVIRONMENTAL CHECKLIST

Project Manager Printed Name:	Project Manager Signature:		
Michael Weiss			
Project Name:	**Date:**	**Phone Number:**	**Org. Code:**
Laser Communications Relay Demonstration (LCRD)	August 14, 2013	301.286.5720	451

Comments: