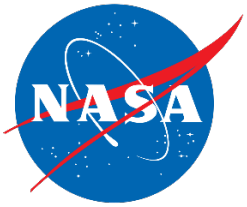

National Aeronautics and Space Administration | NASA Headquarters
Advanced Exploration Systems Division | Human Exploration and Operations Mission Directorate
300 E ST SW Washington D.C. 20546-0001

Lunar Terrain Vehicle (LTV)
Request for Information 7.0

RFI No. NNH20ZCQ001L

Issued: August 30, 2021

Responses Due: October 1, 2021

Table of Contents:

1.0 PROJECT INTRODUCTION

NASA requires a human-class rover that will extend the exploration range of Extravehicular Activity (EVA) suited crewmembers on the surface of the Moon. NASA refers to this mobility capability as the Lunar Terrain Vehicle (LTV). NASA previously sought information on the LTV from industry in February 2020. NASA is seeking information from United States (U.S.) industry with regards to the LTV surviving an extended lunar night, achieving 10 years of service duration for the LTV, the Lander delivering the LTV to the lunar surface, and information on the current ability for industry to support LTV commercial services.

NASA is seeking innovative ideas, novel approaches, relevant state-of-the-art commercial technologies, industry proposed solutions and feedback through this Request for Information (RFI) that could lead to the potential development of an LTV for lunar operations. This RFI is open to responses from all U.S. commercial entities. This request is for information and planning purposes only. The goal is to allow industry the opportunity to provide information to help inform the development of the LTV. This LTV RFI has an emphasis on the development of a human class lunar rover to extend the exploration range of EVA-suited crewmembers on the surface of the Moon.

1.1 GENERAL INFORMATION

This RFI is used solely for soliciting information and planning purposes and does not constitute a solicitation. In accordance with Federal Acquisition Regulation (FAR) 15.201(e), responses to this RFI are not offers and cannot be accepted by NASA to form a binding contract. NASA is under no obligation to issue a solicitation or to award any contract on the basis of this RFI. However, NASA may utilize the information resulting from this RFI in developing its acquisition strategy.

Respondents are encouraged to provide information that is not constrained by limited/restricted data rights. However, if proprietary data is included in a reply, Respondents should clearly and properly mark any propriety or restricted data contained within its submission so it can be identified and protected. Respondents are solely responsible for all expenses associated with responding to this RFI. NASA intends to evaluate all data received and responders may be contacted for further discussion on an as needed basis. Please note, NASA as well as support contractors and/or their sub-contractors working on behalf of the Government may be reviewing the information. Responses to this RFI will not be returned, and respondents will not be notified of the result of the review.

The Government does not intend to award a contract on the basis of this RFI or to offer any compensation for the information solicited. The information provided is voluntary and will not affect the ability to bid on future requirements. No solicitation exists; therefore, respondents should not request a copy of a solicitation. If a solicitation is released in the future, it

will be synopsized in beta.SAM.gov and on appropriate NASA online locations. It is the respondent's responsibility to monitor these sites for the release of any solicitation or synopsis.

Summary of Dates:

- SAM.gov Posting Date: August 30, 2021
- RFI Response Due Date: ***October 1, 2021 at Noon Central***

Point of Contacts (POCs):

Procurement POC:

Lamar Mueller | Team Lead
NASA Lyndon B. Johnson Space Center
BL – Lunar & Planetary Exploration Procurement Office
Office: 281.483.7158 | Email: perry.l.mueller@nasa.gov

Shyra Cullins | Contract Specialist
NASA Lyndon B. Johnson Space Center
BL – Lunar & Planetary Exploration Procurement Office
Email: shyra.cullins@nasa.gov

1.2 TECHNICAL INFORMATION

NASA is seeking information that could potentially inform the development of the LTV. It is anticipated that the LTV could be used to transport both cargo and crew. The LTV could also transport scientific instruments and technology demonstration payloads. NASA intends to explore the southern polar regions of the Moon about once per year with two crewmembers on the surface. Without a mobility capability, the EVA-suited crew will be limited to an exploration walking distance of 1-2 kilometers (kms) around their landing site. The focus of this RFI is on the LTV, so industry partners should submit information focused on LTV capabilities.

NASA is interested in exploring the possibility of a cost-effective development effort resulting in an LTV to be delivered to NASA for integration and launch as a payload aboard a Commercial Lunar Payload Services (CLPS) launch, potentially in the 2027 timeframe. The LTV will be used for Extravehicular Activities (EVA) mobility support, for science and exploration including potential teleoperations, transportation support for small cargo and possibly other tasks. Table 1.2.1, LTV General Capability Descriptions, lists current conceptual reference capabilities required of this system.

Table 1.2.1 LTV General Capability Descriptions

Capability Title	Reference Capability Description	Capability Supporting Comments
1 General Attribute	The LTV is an unpressurized vehicle that can carry two EVA-Suited Crew Members	NASA assumes ~550 kilograms (kgs) for two EVA-suited crewmembers.
2 Launch Constraints	The LTV total mass and size allows it to be launched on a CLPS-sized lander.	NASA is asking for vendor input on the LTV mass that would be required to survive operations in the lunar environment. NASA would like to minimize the LTV mass.
3 Range	The LTV must carry a minimum of 800 kgs on a single charge around the Lunar South Pole Region for distances up to 20 km without having to stop to recharge the LTV batteries. The LTV must be capable of continually operating for an 8-hour duration during a 24-hour period. (exception - periods where the vehicle is surviving the lunar night)	The LTV will be able to carry 2 EVA suited astronauts greatly extending the area of exploration away from either the Human Landing Systems (HLS) landing site or Artemis Base Camp. The LTV will need to be available for an 8-hour EVA for each day the Astronauts are present on lunar surface.
4 Surface Conditions	The LTV must be capable of traversing across lunar highland terrain, meeting or exceeding conditions experienced by the Apollo Lunar Roving Vehicle (LRV).	The south polar region of the Moon is composed of heavily cratered highlands terrain. Apollo 16 also operated within highland terrain. Slopes as high as +/- 20 degrees will need to be traversed by the LTV.
5 Recharging Capability	The LTV must be capable of recharging itself and external power exchange.	The LTV could be recharged in the nominal lunar surface environment by LTV internal power sources, such as an on-board solar array. The LTV cannot count on any external power exchange while needing to survive extended lunar night durations.

Capability Title	Reference Capability Description	Capability Supporting Comments
6 Lunar Environment Survivability	The LTV must survive the extreme temperatures on the lunar surface to include a south pole lunar night. The LTV must allow for reuse across lunar nights and between human missions. The LTV must survive the extreme temperatures on the lunar surface at the south pole, the lunar surface dust environment and be capable of entering Permanently Shadowed Regions (PSR).	NASA is anticipating on being able to spend up to 2 hours in a PSR. The LTV will encounter lunar nights every month that can range in duration from a few hours to up to 36 hours. NASA Lunar Surface Scientists have identified that an LTV in the planned area of operation on the lunar south pole will encounter two extended lunar nights per Earth year. NASA is soliciting information from industry on the ability for the LTV to survive the extended lunar nights.
7 Mission Performance	The LTV must be able to support at least 10 years of the Artemis Program.	NASA is asking for input from industry on how to achieve the desired LTV operational duration.
8 Remote Operations	The LTV must be capable of being operated by onboard crew, remote crew members on the lunar surface or in Cislunar space, or from Earth.	The LTV could transport cargo or science payloads between locations with masses or distances that exceed crew capabilities. Crew members will be only available for LTV operations for approximately a month out of every year. Teleoperations will provide additional LTV scientific and Artemis base logistic capabilities. Partial or conditional autonomous operations could be used to assist Teleoperations.
9 Failure Tolerance	All LTV failures that could result in Loss of Crew or the crew having to walk back to the Artemis base camp will be 1 fault tolerant.	Due to the risk associated with a contingency walk back scenario, failure tolerance with respect to LTV mobility is required.

1.3 REQUEST FOR INFORMATION

Since this is a request for information only, no evaluation letters and/or results will be issued to the respondents. Interested parties are requested to respond to this RFI by answering the following questions. The Response, exclusive of the one-page summary described below, shall

not exceed **15 pages** (including attachments), and shall be a minimum of 12-point Times New Roman font style.

Responses should include:

- Company/Entity information: (instructions below)
- Details of your current or planned capabilities that would support this development activity, including how NASA-provided resources (other than funds) can assist in the development of your capabilities.

Responses should answer the following questions:

1. Extended Lunar Night Survival:

   NASA studies have identified that an LTV that is operating near the lunar south pole will encounter at least two extended lunar nights per Earth year.

   The extended lunar night durations are anticipated to last at least 85 hours in duration depending on the location on the lunar surface. The LTV will need to be capable of changing locations (5~10 km between locations) during the lunar night to limit the lunar night duration. If the LTV is completely stationary during the lunar night, the lunar night duration is anticipated to be significantly greater than 85 hours.

   Most lunar nights are on the order of a few hours to 36 hours in duration and are expected to occur on the order of once a month.

   An LTV that can survive a 125-hour extended lunar night duration greatly increases the operational flexibility of locations where the LTV can be located during the extended periods of darkness.

   a. What are the current or potential (near term) capabilities that industry has for an LTV to survive a Lunar night with a duration of 85 hours? Please indicate what technology will be used and provide assumptions for those solutions.

   b. What vehicle mass is required for an LTV to survive a lunar night duration of 85 hours? Please provide assumptions for sizing calculations and vehicle level Master Equipment List with mass allocations for each major subsystem.

   c. What are the current or potential (near term) capabilities that industry has for an LTV to survive a Lunar night with a duration of 125 hours? Please indicate what technology will be used and provide assumptions for those solutions.

   d. What vehicle mass is required for an LTV to survive a lunar night duration of 125 hours? Please provide assumptions for sizing calculations and vehicle level Master Equipment List with mass allocations for each major subsystem.

e. During an extended duration lunar night, how much energy is needed for the LTV to maintain the temperatures of its critical equipment above the survival temperature limits?

f. What operational constraints/requirements would your approach to surviving the extended Lunar nights place on the LTV?

2. 10 years of Operational Duration:

NASA is planning for the LTV to have an operational duration on the lunar surface of 10 years. Being able to perform maintenance on the LTV on the lunar surface is a capability NASA is considering. Maintenance would only be able to occur when crew is present, and all needed maintenance is desired to be completed using a few hours of EVA time (as little of time from a single EVA as possible).

a. Is maintenance required to meet a 10-year operation duration for the LTV? Will being able to perform maintenance on the LTV result in a significant reduction in the LTV launch mass (if so, how much)?

b. Which LTV components would be candidates for the being maintainable or replaceable on the lunar surface? At what frequency would the maintenance or replacing of the items identified need to occur?

c. What other solutions are available (other than an LTV that can be maintained) to industry that result in an LTV having an operational duration of 10 years on the lunar surface? Please provide descriptions of the solutions and an estimate LTV mass range for the solution.

3. Lunar Lander for LTV:

NASA is currently considering utilizing a Commercial Lunar Payload Services (CLPS) lander to deliver the LTV to the lunar surface. With this approach, it will be NASA's responsibility to secure the lander utilizing the NASA CLPS contract. It would be the LTV contractor's responsibility to work with the CLPS Lander Vendor to integrate the LTV with the lander.

a. Please comment on the planned NASA approach for securing a Lunar Lander for LTV. Please indicate any significant strengths or weaknesses to this approach.

b. To minimize potential impacts to the LTV vehicle development, when would an LTV vendor expect to start interfacing with a CLPS Lander vendor? (Please answer in terms of standard engineering project development milestones. (Example: System Requirement Review (SRR), Preliminary Design Review (PDR), Critical Design Review (CDR)

4. Commercial Services:

NASA is considering acquiring LTV capabilities as a service. NASA would rely on the LTV contractor to provide the full suite of services and equipment required to perform all activities and operations necessary to enable 10 years of LTV operation on the lunar surface. NASA would purchase LTV time and capabilities as required to support the Artemis mission and other NASA scientific needs.

a. Please provide any information that would assist NASA in deciding the feasibility of a service-based approach. Please provide any assumptions, requirements, or information to help NASA understand the ability for industry to support this approach.

b. Please provide any information regarding the maturity of the commercial landscape for lunar surface mobility, and how it is expected to grow and impact future operations on the lunar surface.

c. In order to maximize the benefits of a public/private partnership, NASA is pursuing corporate/commercial contributions for the LTV. What corporate/commercial contributions would your company bring to the partnership, and how would they be leveraged?

2.0 INSTRUCTIONS FOR SUBMITTAL

Respondents are instructed to provide the information as requested in table 2.1 below. To facilitate a prompt review, please provide a one-page summary with your response. The one-page summary shall include:

- Company's name, address, primary POC, and telephone number,
- Company's Government size standard/type classification (Large, Small, Small Disadvantaged, 8(a), Woman- Owned, Veteran-Owned, Service-Disabled Veteran, Historically Underutilized Business Zones (HUBZone); number of years in business, DUNS number; CAGE code,
- A description of the Company's specific capabilities that are relevant to the RFI requirements.

Table 2.1

Volume I.	One-page summary - per instructions in this RFI Section 2.0	Contained within the Electronic copy
Volume II.	RFI Responses – identified by RFI topic being responded to as listed in Section 1.3	Contained within the Electronic copy

Request for Information Responses:

RFI Respondents should submit replies electronically to:

Perry.L.Mueller@nasa.gov
Shyra.Cullins@nasa.gov

The subject line of the e-mail shall read "Lunar Terrain Vehicle RFI." Responders may submit proprietary information, export-controlled information (including International Traffic in Arms Regulation (ITAR) restricted information), or confidential information in response to this RFI, but this is strictly voluntary. Responses that contain proprietary, Export Administration Regulations (EAR), ITAR, or other sensitive but unclassified (SBU) information, are required to clearly mark that data accordingly. ITAR/EAR data is allowed to be sent through e-mail or file transfer if properly labeled as such (see pages 29-30 of the NASA Guidebook for Proposers at:

https://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2018.pdf)

and encrypted in accordance with Federal Information Processing Standards (FIPS) 140-2 and as defined by appropriate Federal regulations. Files can be encrypted with a password sent by separate e-mail or alternate arrangements can be requested for other compliant secure file transfer services. Responses shall not include classified information.

All responses must be received by ***Noon Central Time*** on the due date.

Please provide the response in one **searchable**, unlocked PDF file with edit permission enabled. Please use 12-point Times New Roman font where paragraphed, as well as single spaced pages printed one-sided. Please respond in the same format as the RFI request (Sections and letter, i.e. Volume II –Topic 1-b.). Please note: Once the RFI response is submitted, it cannot be recalled or replaced.