



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

RFI No. NNH20ZCQ001L

Issued: February 5, 2020

Responses Due: February 26, 2020

It should be understood that there is no explicit or implied commitment for future procurements in this action.

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1 PROJECT INTRODUCTION

The President's Space Policy Directive-1 instructs NASA to "Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities." NASA has therefore identified a coordinated approach to explore the lunar surface, to perform new science investigations, and to use the missions to test out systems for further exploration of the solar system. To address these objectives as cost-effectively as possible, NASA will build on the public/private partnership model to create an environment where industry can develop and mature their advanced technologies, specifically energy management and mobility and autonomous controls, while leveraging NASA system and capability developments over the next 10-20 years for commercial use.

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 has identified key LTV-required capabilities that may also have potential commercial applications. These include electric vehicle systems (e.g., energy storage, energy management and distribution, recharging), autonomous driving in high contrast lighting conditions and hazardous terrain, and extreme environment tires and possibly many others. Whereas the need to extend crewed exploration drives the LTV mission, any collateral benefits to science investigations and technology demonstrations should not be precluded where it is otherwise reasonable to include such capability (e.g. sharing of power, data, or communication resources, instrument-mounting footprints). NASA is seeking information from U.S. industry on how to approach the development of mobility capabilities with the near-term goal of launching the first LTV to the lunar surface, potentially as early as 2024.

Because of this accelerated schedule, the NASA Human Exploration and Operations Mission Directorate (HEOMD) is seeking innovative ideas, novel approaches, relevant state-of-the-art commercial technologies and acquisition strategy information 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 and to allow industry the opportunity to provide information, respond to the reasonableness and feasibility of the conceptual capabilities of the LTV within the timeframe identified, as well as to promote competition.

This RFI is one of two related to lunar mobility that is being released by NASA in a coordinated approach to explore the lunar surface, to perform new science investigations, and to use the missions to test out systems for further exploration and scientific investigation of the solar system. A second RFI, Lunar Surface Science Mobility System (LSSMS-1) is simultaneously released and sponsored by the NASA Science Mission Directorate (SMD). The SMD RFI (NNH20ZDA004L) will emphasize the development of lunar surface science mobility systems to transport and operate scientific/exploration instruments and technology demonstration payloads on future NASA missions. 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 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

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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. This RFI is for planning purposes only and shall not be considered as an obligation on the part of the Government to acquire any products or services.

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.

NASA is hosting a virtual industry day on February 12, 2020 to introduce both the HEOMD LTV RFI and the SMD LSSMS-1 RFI. Representatives of both SMD and HEOMD will describe their respective RFI's and answer questions of interested respondents. It is valuable to note that the interested communities of both classes of mobility systems are invited to participate, and the event offers a unique opportunity for respondents to gain insight and understanding of both sets of mobility objectives. While the industry day is a joint activity, respondents are advised that responses to each RFI must follow the specific instructions for that RFI. Responses to each RFI shall be stand-alone, and not rely on other responses to either RFI for context or reference.

The date for the virtual web event is **February 12, 2020 at 11:00 am EST.**

Connection details follow:

WebEx (required to view presentation charts):

<https://nasaenterprise.webex.com/nasaenterprise/j.php?MTID=mc6480b0fedb5339e1704e6f6d1502bbe>

Meeting number: 902 861 803

Meeting Passcode: February12@11E

Teleconference Number (required for audio – do not use WebEx audio):

Dial: 888-566-6142

Passcode: NASALTV

For any updates regarding the Web Event, Respondents are advised to monitor

www.nasa.gov/feature/nasa-to-industry-send-ideas-for-lunar-rovers

Following this event, please submit any additional questions in writing via email **no later than February 17, 2020 at 12:00 pm EST to hq-lunarexploration@mail.nasa.gov**. NASA intends to respond to questions received by email by February 19, 2020 on an individual respondent basis and questions and answers will not be made public.

Summary of Dates:

- beta.SAM.gov Posting Date: February 5, 2020
- Virtual Web Event: February 12, 2020 11:00am EST
- Deadline for Written Questions: February 17, 2020 12:00pm EST
- RFI Response Due Date: February 26, 2020 12:00pm EST

Point of Contact:

Programmatic POC:

Mr. Douglas Craig, NASA HEOMD/AES

douglas.a.craig-1@nasa.gov

1.2 TECHNICAL INFORMATION

NASA is seeking information that could potentially inform the development of the Lunar Terrain Vehicle (LTV). It is anticipated that the vehicle could be used to transport both cargo and crew and possibly include transport and operation of scientific instruments and technology demonstration payloads, if such capabilities are an affordable extension of the basic LTV capability. 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 1-2kms around their landing site. In addition to an unpressurized lunar terrain vehicle, NASA's analyses have also identified a future need for a habitable mobile platform (HMP) to transport crew in a shirtsleeve environment. The focus of this RFI is on the LTV, so industry partners should submit information focused on the LTV capabilities.

NASA is interested in exploring the possibility of a cost effective development effort resulting in one LTV to be delivered to NASA for integration and launch as a payload aboard a Commercial Lunar Payload Services (CLPS) launch, potentially in the 2024 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 available 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. Launch Constraints	The LTV total mass and size will allow it to be launched on a CLPS-sized lander.	CLPS landers are launched on commercial launch vehicles and will have a 3.2 meter deck and be able to land ~up to 500kgs.
2. Range	The LTV can carry 500kgs on a single charge around the Lunar South Pole Region for distances in excess of 2km.	The LTV will be able to carry 2 EVA suited astronauts beyond walking distances and over reasonable lunar surface conditions. NASA assumes ~500kg for two EVA-suited crewmembers, associated science and exploration equipment and collected/curated samples.

<p>3. Surface Conditions</p>	<p>The LTV must be capable of traversing across lunar highland terrain, meeting or exceeding conditions experienced by the Apollo Lunar Roving Vehicle (LRV).</p>	<p>The south polar region of the Moon is composed of heavily cratered highlands terrain. Apollo 16 also operated within highland terrain. The LRV was used to carry crew over slopes as high as 15 degrees, which should serve as a baseline for LTV capabilities.</p>
<p>3. Recharging Capability</p>	<p>The LTV can be recharged from internal power generation sources and from other lunar surface assets.</p>	<p>The LTV could be recharged in the nominal lunar surface environment by a variety of power sources, to include (but not limited to) a HLS descent lander, an on-board solar array, or future lunar surface infrastructure.</p>
<p>4. Lunar Environment Survivability</p>	<p>The LTV should survive the extreme temperatures on the lunar surface to include a lunar night south pole to allow for reuse across lunar nights and between human missions.</p>	<p>The lunar surface temperatures vary from 260 degrees Fahrenheit (127 degrees Celsius) to minus 280 F during a 100-hour lunar night at the lunar south pole.</p>
<p>5. Autonomous Operations</p>	<p>Autonomous operations of the LTV can aid surface exploration and enhance operational uses. Possible autonomous ops could include the ability to deploy from CLPS lander, the ability to drive paths programmed and uploaded by users on the surface, from the Gateway, or from Earth. Teleoperation of the rover on the lunar surface by astronauts or other sources may allow for increased science investigations and exploration when astronauts are not present or between missions.</p>	<p>Mobility systems could transport cargo or science packages between locations with masses or distances that exceed crew capabilities. Dual systems might enable improved overall transportation risks and allow for return of crew from extended distances (e.g. 10km-20km). In addition to cargo, the LTV should provide opportunities for integration of instruments that can be tele-operated during crew activities and between crewed missions. The LTV will also be expected to transport cargo/tools/instruments between landing sites in order to negate delivery of similar hardware in future missions. Mobility systems should accommodate the ability to autonomously load and unload cargo or science packages including excavation rovers carrying regolith.</p>

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 contain a minimum font size of 12 points.

Responses should include:

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- 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 across these three topic areas:

1. Partnerships

- a. How should NASA work with industry (e.g., co-located teams, exchange of technologies, involvement of NASA SMEs) to develop the mobility platform capability?
- b. What is the current or potential commercialization value of the required mobility capabilities development (e.g., electric vehicle systems, autonomous driving, and extreme environment tires)
- c. What other potential partners would the respondent consider (U.S. industry, International, Academia)

2. Feasibility of development

- a. What are the critical technologies that need to be developed and what is their current Technology Readiness Level (TRL)? [<https://www.nasa.gov/sites/default/files/trl.png>]
- b. What NASA capabilities will assist you in developing LTV capabilities: Integration and test facilities, technical expertise, Government Furnished Equipment, etc.?
- c. Is the development timeline (LTV by 2024) achievable? If not, why not and what is an achievable timeframe?
- d. Please comment on the feasibility and relative state of the art for meeting each of the capabilities in Table 1.2.1.
- e. What capabilities or requirements would incur the most schedule risk or drive schedule/cost disproportionately?

3. Contract mechanism recommendation

- a. How should NASA partner with industry (e.g., cost-shared contracts, NextSTEP BAA, Funded Space Act Agreements, Other Transactional Authority (OTA), Service contract) to develop the unpressurized mobility platform capability? NASA is interested in a broad range of potential partnerships ranging from no funded or non-reimbursable Space Act Agreements, Cooperative Agreements, and contracts.
 - Industry collaboration and public-private partnerships through cost-sharing or in-kind cost or technical contributions is highly desirable.
 - Identify potential future business cases for LTV on the lunar surface (e.g., contractor lease LTV to third parties when NASA not using) and discuss potential impact on contract type.
- b. Intellectual Property and Data Rights
 - What approach should be taken toward intellectual property (IP) and data rights? How can IP challenges be addressed? What contributions by development organizations should be provided with unlimited or unrestricted rights versus contributions with limited or restricted rights?

2 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, HUB Zone business); 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

Vol I.	One page summary - per instructions in this RFI Section 2.0	Contained within the Electronic copy
Vol 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:

hq-lunarexploration@mail.nasa.gov

The subject line of the e-mail shall read "Lunar Terrain Vehicle RFI." Responders may submit proprietary information, export controlled information (including ITAR restricted information), or confidential information in response to this RFI, but this is strictly voluntary. Responses that contain proprietary, 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 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 **12:00 p.m. Eastern Standard 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.

ATTACHMENT A – ACRONYM LIST

BAA	Broad Area Announcement
CLPS	Commercial Lunar Payload Services
EVA	Extravehicular Activities
FAR	Federal Acquisition Regulation
HEOMD	Human Exploration and Operations Mission Directorate
HLS	Human Landing System
HMP	Habitable Mobility Platform
IP	Intellectual Property
LTV	Lunar Terrain Vehicle
NASA	National Aeronautics and Space Administration
NextSTEP	Next Space Technologies for Exploration Partnerships
OTA	Other Transactional Authority
POC	Point of Contact
RFI	Request for Information
RFP	Request for Procurement
SAA	Space Act Agreement
SMD	Science Mission Directorate
SME	Subject Matter Expert
TBD	To Be Determined
TRL	Technology Readiness Level