C.28 LUNAR SURFACE INSTRUMENT AND TECHNOLOGY PAYLOADS

NOTICE: Amended February 1, 2019. The proposal due date for this program element was previously temporarily changed to "TBD" as a result of the partial government shutdown. This Amendment presents the new due date for this program element. Step-2 proposals are now due February 27, 2019.

October 18, 2018. This amendment presents final text for this program element, which was previously released as draft for community comment. This program element uses the two-step proposal submission process, as described in Section 2 of C.1 The Planetary Science Division Research Program Overview. Mandatory Step-1 proposals are due November 19, 2018, and ~~the due date for Step-2 proposals is January 17, 2019~~.

Because a data archiving plan is an integral part of the proposal and evaluated as part of the merit, no separate data management plan will be collected on the NSPIRES cover page. It is anticipated that awards will be Cost Plus Fixed Fee (CPFF) contracts and managed by PMPO at NASA MSFC.

1. Program Scope

1.1 Program Overview

This program solicits proposals for Lunar Surface Instrument and Technology Payloads (LSITP) to be integrated onto and delivered to the lunar surface by commercial lunar landers. This opportunity specifically solicits flight payloads that do not require significant additional development. Investigations are sought that address the science goals of any of the four divisions (Planetary, Earth Science, Heliophysics, Astrophysics) of the Science Mission Directorate (SMD) as well as Strategic Knowledge Gaps of the Human Exploration and Operations Mission Directorate (HEOMD) and any technology demonstration goals of the Space Technology Mission Directorate (STMD) that advance capabilities for science, exploration, or commercial development of the Moon (see Section 1.2 for a description of all of these goals).

NASA is coordinating with commercial venture(s) to land valuable scientific and technology payloads on the lunar surface, including those solicited here. NASA has issued a separate Request For Proposals (RFP) to procure lunar lander services and expects to coordinate with multiple enterprises capable of landing small payloads on the lunar surface. NASA anticipates future opportunities to integrate multiple payloads on multiple landing opportunities.

This ROSES element calls for proposals for complete, Principal Investigator led (PI-led) science instrument and technology investigations. The term "complete" encompasses all of the investigation phases including project initiation, payload preparation, payload integration, payload operations, scientific and engineering analysis of the mission data, publication of results, and final dissemination of the data including delivery to NASA's archive.

This call is specifically geared towards small payloads that can be ready quickly in order to meet the immediate need for payloads for early CLPS flights. We are interested in flight spares, engineering models, modified off-the-shelf payloads, student hardware or any other hardware that can credibly meet the aggressive timeline outlined below. Future calls for lunar payloads will occur at regular intervals for later missions. We anticipate that the next call will be released in approximately one year.

Selections for flight integration will be conducted in a two-phase process. Selections resulting from proposals to this program element will ultimately establish a catalog of eligible payloads that will be prepared for integration and flight during the initial "payload preparation phase". The second phase, the "flight phase", will be executed after a specific flight opportunity is identified. One or more of the eligible payloads from the "payload preparation phase" will be selected through an internal process for lander integration and flight based on factors including ease and cost of accommodation, hardware readiness timeline, and the suitability of the landing site for the capability of the proposed payload. Selection through the current solicitation *does not* guarantee a subsequent flight opportunity.

1.2 NASA's Relevant Strategic Goals

All proposed payloads must support NASA's goals and objectives as described below. It is the responsibility of the proposer to demonstrate how the proposed payload addresses one or more of the significant questions, goals, and objectives identified below. Only proposed payloads relevant to NASA's strategic goals and objectives will be considered for award.

To argue relevance to SMD, proposers are encouraged to refer to the Strategic Goals and Objectives of the Science Mission Directorate described in the *NASA 2018 Strategic Plan* and the Questions and Goals in the *NASA 2014 Science Plan* (both of which may be found at https://science.nasa.gov/about-us/science-strategy),in addition to other more specific documents such as decadal surveys, roadmaps, or the reports of advisory bodies or groups relevant to SMD (see for example https://science.nasa.gov/researchers/nac/science-advisory-committees).

NASA's Strategic Knowledge Gaps (SKGs) represent the knowledge that must be obtained to reduce risk, increase effectiveness, and improve the design of systems and capabilities to be used for exploration of any future human destination. NASA addresses SKGs through ground- and space-based research, targeted toward near-term mission destinations, such as the lunar surface. See https://www.nasa.gov/exploration/library/skg.html for a complete listing of the Lunar SKGs.

The technologies of primary interest are those needed to enable or enhance capabilities for future science or exploration operations, transportation, or commercial development of the Moon. Technology demonstration payloads should only be proposed if the demonstration on the lunar surface or en route to the lunar surface is critically needed and the demonstration cannot be accomplished on Earth or in any other more accessible test environment. Areas of interest for technology demonstrations include:

- *In situ* resource utilization (ISRU) for consumables production, manufacturing, and construction. Of particular interest is the acquisition and processing of lunar

volatiles or mineral oxides to produce oxygen and fuels for propulsion, power, and life support systems.

- Power generation, distribution, and energy storage
- Thermal management, including cryogenic fluid management and survival and operation of components and systems in extreme hot and cold environments including lunar night, lunar noon, and permanently shadowed areas
- Technologies to support the operation of landers, ascent vehicles, and surface mobility including navigation, autonomous precision landing, and hazard avoidance
- Technologies to support robotic and human surface operations and habitation.

1.3 Lunar Mission Description

NASA is pursuing a novel paradigm in which it will coordinate with commercial venture(s) to land valuable scientific and technology payloads on the lunar surface. Among other payloads, these missions will include the most promising payloads selected in response to this program element. Payloads to this call should be ready for delivery and integration by as early as March 2020 and must be ready no later than December 2021. It is anticipated that in most cases, payloads will be delivered in place and remain under the PI's control until they are selected for a specific flight.

NASA has not yet selected the commercial lander providers and therefore cannot predict future flight opportunities and their timing, but proposers should assume the following notional timeline for the purposes of developing their proposals. Selected payload offerors will be asked to provide updated budgets and development schedules when a specific flight opportunity is identified.

Table 1. Notional Lunar Mission Timeline

Payload Milestone	Milestone Date
Payload Delivery to Commercial Lander Provider	March, 2020-Dec, 2021
Payload Integration Complete	Delivery + 3 months
Lunar Lander Launch Date	Delivery + 5 months
Lunar Lander Achieves Lunar Orbit	Launch + 15 days
Lunar Surface Touchdown (LST)	Launch + 30 days
Lunar Surface Mission Complete	LST + 7 days
Data delivered to PDS	End of Mission + 6 months

The specific lander designs and destinations are not available at this time but NASA anticipates multiple companies will participate with a range of designs and destinations. These first missions will be to the lunar nearside and are not expected to last longer than approximately seven Earth days, as indicated in Table 1. Proposals should be clear about any landing site requirements and/or preferences to optimize science return.

1.4 Lunar Payload Technical Requirements

The payload proposed in response to this solicitation must be accommodated by commercially-provided lunar landers. Specific payload accommodations may vary by lander provider, and because these lander services are still being developed, the

payload accommodations are subject to change. To aid potential offerors in assessing the likelihood that a proposed payload can be accommodated by potential future lunar landers, Table 2 includes some of the more salient expected accommodation capabilities. These capabilities will most assuredly evolve over time, but are expected to approximately represent the initial operating capabilities of the expected lunar landers. As with most spaceflight hardware, responders should aim to minimize the resource requirements (mass, power, volume, cost, etc.) necessary to support the proposed payload.

Table 2. Engineering accommodation capabilities for a potential lunar lander

Mechanical	
Surface Delivery Mass	Although it is expected that some landers can handle significantly larger payloads, NASA is soliciting payloads for this call that are less than approximately 15 kg
Radiation	Not expected to exceed 1 krad
Surface Communication	
R/F Communication Capability	Up to 3.0 kbps per kg of payload
Wired Interface	Serial RS-422
Wireless Interface	2.4 GHz IEEE 801.11n compliant Wi-Fi
Power	
Continuous Power Level	Up to approximately 8 Watts
Peak Power Level	Potentially up to 25 Watts for one minute
Power Conditioning	Regulated and switched 28 Vdc

The preceding information represents approximate lunar lander capabilities, and its inclusion should not be interpreted as an endorsement for any specific commercial lander provider. Responses to the current solicitation should explicitly address the feasibility of integrating the proposed payload with future lunar landers.

Responders shall document expected flight payload mass and dimensions, and as many interface requirements as possible with special consideration given to the following:

- Payload launch load limits, and, if available, results of any finite element analysis or vibration testing performed.
- Payload acoustic and shock load limits and results of any acoustic testing performed, if available
- Payload thermal conditioning requirements
- Payload communication requirements (volume, bandwidth, etc…)
- Payload communication interfaces (wired, wireless, interface port(s), etc…)
- Payload power requirements (nominal, peak, power conditioning, etc…) and any grounding requirements
- Payload pointing requirements.

- Payload mechanical interface(s) (thermal isolation, bolt-hole pattern, etc…) and launch lock requirements, if any.
- Payload optical sensitivities (dust, chemicals, line-of-sight to the Sun, etc…) and keep out zones for sensor operation, if applicable
- Payload cleanliness requirements
- Payload electrical pin configuration

Responders should be aware that NASA may elect to publicly release responses to the previous interface requirement information. The purpose of releasing this information is to inform, educate, and guide the lunar lander development community. It is, therefore, not necessary to release the identity of the potential payload provider or the payload type/capability. Responders are instructed to clearly identify any information that is proprietary or not publicly releasable.

2. Programmatic Information

2.1 Eligibility to Propose

2.1.1 *Proposals from NASA centers*

Proposals from NASA centers (including JPL) will not be accepted. There is a parallel internal call for proposals from NASA centers. NASA personnel are welcome to serve as team members on proposals from other institutions.

2.1.2 *Proposals from Non-US Organizations*

Proposals from Non-US Organizations will not be accepted. However, international participation is welcome as team members or hardware providers on a no-exchange of funds basis. There is no limitation on percentage of foreign participation.

2.2 Cost Information

Proposals should clearly describe all of the investigation phases from project initiation through the archival of data acquired during the mission. Given the aggressive mission integration timeline, payloads proposed to this announcement are expected to be mature (mid to high TRL) and substantially complete at the time of proposal submission. However, NASA does anticipate that some amount of refurbishment, testing, and/or repackaging may be necessary during the payload preparation phase.

The proposal’s budget narrative must clearly, but separately, describe the "payload preparation phase" costs and the "flight phase" costs. The "payload preparation phase" costs are anticipated to be no more than $3M (RY) and the cost to execute the second phase, the "flight phase", is expected to be on the order of $1M to $3M (RY) or less. There is not a fixed cost cap and the preceding information is included only to help communicate the scope of the effort.

Although we are asking for a complete budget through data archiving, the selections made through this call are only for the "payload preparation phase". Once selected for a specific flight opportunity, a revised budget will be requested for the "flight phase”. Thus, proposers should include the best estimate for all costs for all phases in the separately

uploaded "total budget" file, but the NSPIRES (web) cover page budgets will only include the costs for the payload preparation phase.

2.3 Request for reviewer names

Proposers are strongly encouraged to provide names and contact information of up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is or stand to benefit financially from the selection (or otherwise) of the proposal. This information should be included in the appropriate question field in NSPIRES in your Step-1 proposal, or emailed to the Program Officer listed below.

2.4 Proposal Submission Process

This program element uses a two-step proposal submission process, as described in Section 2 of C.1, the Planetary Science Research Program Overview. Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization. Proposals must follow all formatting requirements that are described in program element C.1 and in the ROSES summary of solicitation. Violation of these rules is sufficient grounds for a proposal to be returned without review.

2.5 Step-2 Proposal Review and Evaluation Criteria

To accommodate the amount of information requested, no more than 25 single-spaced pages will be allowed for the science/technical/management section, including figures and tables. Proposers are reminded that the evaluation criteria for this solicitation are given in the *ROSES Summary of Solicitation* Section VI (a) and the *Guidebook for Proposers*. In addition, the evaluations for this program element will also include the following factors:

Intrinsic Merit

- The maturity and technical readiness of the instrument or payload and the extent to which the proposed activity strives to minimize the hardware and/or software modifications required to deliver the payload.
- The likelihood, and ease, that the proposed payload can be readily integrated into a commercial lunar lander.
- The quality of the management plan and project timeline for carrying out the work.
- The effectiveness and resilience of the proposed experimental designs, methods, techniques, and approaches for achieving the proposed goals and/or objectives; including operational resiliency; the ability to withstand adverse circumstances, and the potential to recover from anomalies.
- The qualification, capabilities, and expertise of proposed personnel, including planning for resiliency against an unknown timeline that may extend the launch date by months to several years from the planning schedule. The role of each Co-Investigator and collaborator will be evaluated for necessary contributions to the proposed investigation; the inclusion of Co-Is or collaborators who do not have a well-defined and appropriate role may be cause for downgrading of the proposal during the evaluation.
- The extent to which the proposal convincingly demonstrates that the payload will be available in time to support the lander integration opportunities as described in

Section 1.3. While we have provided a range of dates for delivery, it is important that we have payloads ready for the earliest missions so there will be some preference for payloads that can be delivered early in the range.
- Merit of the data analysis, data availability, and data archiving plan.

Cost
- The extent to which the proposal is responsive to the specific cost information documented in Section 2.1.
- The overall approach and ability to manage the project and achieve the stated objectives.

The selecting official for this program element will be the SMD Deputy Associate Administrator for Exploration.

2.6 Data Management Plans (DMPs)

Because a data archiving plan is an integral part of LSITP and evaluated as part of the merit, a data management plan should be integrated as part of the Science/Technical/Management portion of the proposal, no additional DMP section is required or allowed for this program element. This supersedes the instructions in C.1.

2.7 Award Type and Administration

Upon selection, the investigation(s) will be managed under the Lunar Program by the Planetary Missions Program Office (PMPO). The Associate Administrator for SMD has established the PMPO at the NASA Marshall Space Flight Center (MSFC) to be responsible for project oversight. There are appropriate protective firewalls between the PMPO and the rest of NASA MSFC, allowing investigators from NASA MSFC to propose as team members in response to this solicitation. The PMPO will manage the Lunar Surface Payload investigations as modified Class D under the requirements of NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements,* and as modified by the NASA SMD Class-D Tailoring/Streamlining Decision Memorandum (issued December 7, 2017). Further tailoring may be applied on a case-by-case basis after selection.

It is anticipated that awards will be Cost Plus Fixed Fee (CPFF) contracts. The NASA Federal Acquisition Regulation Supplement (NFS) 48 CFR §1852.235-72 applies. Since proposals to this program element are for contracts, unlike the rest of ROSES, the table of personnel and work effort is part of the budget. Moreover, in accordance with the clause at FAR 52.219-9, a small business subcontracting plan is also required as part of the budget.

All selected investigations must comply with the technical requirements and delivery schedules provided by NASA and/or the commercial provider(s).

3. Summary of Key Information

Expected program budget for first year of new awards	$24M - $36M

Anticipated Number of Initial Awards	8 – 12
Expected duration of awards for payload preparation phase	1-3 years
Due date for Step-1 proposals	See Tables 2 and 3 of ROSES
Due date for Step-2 proposals	See Tables 2 and 3 of ROSES
Selection Date	6 months after proposal due date
Planning Date for start of investigation	June 2019
Relevance	Proposals that are relevant to this program are, by definition, relevant to NASA. See Section 1.2
General information and solicitation overview	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see *ROSES Summary of Solicitation Section 1(g)* Order of Precedence and the *NASA Guidebook for Proposers*.
Page limit for Science/Technical/Management section	25 pages, including figures and tables
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
NASA point of contact concerning this program	Dr. Sarah Noble Lunar Surface Payloads Program Scientist Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2492 Email: Sarah.Noble-1@nasa.gov