1. PURPOSE

This Statement of Objectives (SOO) defines the mission need, objectives, desired outcomes and constraints to enable industry to propose commercially viable and credible solutions for advanced In-Space Manufacturing (ISM) technologies supporting future lunar, Martian, and deep-space exploration missions.

NASA will actively engage with selected Offerors through ongoing technical engagement, milestone reviews, and Government insight and oversight activities to support assessment of technical progress, and achievement of program objectives. Offerors are expected to apply independent scientific and engineering judgment in selecting technical approaches and proposed solutions that best satisfy the objectives and outcomes defined herein.

See Appendix A for additional solicitation details.

2. BACKGROUND/MISSION NEED

NASA's strategic objective to extend sustained human presence beyond Earth orbit requires the ability to autonomously produce critical tools, replacement parts, and functional materials during long-duration missions. In-space manufacturing capabilities reduce dependence on Earth-based resupply, increase mission adaptability and resiliency, and improve operational sustainability for future exploration architectures.

Aligned with NASA's Moon-to-Mars (M2M) objectives, In-Space Manufacturing (ISM) technologies are being advanced to support future lunar surface operations, Mars missions, orbital platforms, and other deep-space applications. NASA seeks integrated manufacturing systems capable of reliably producing mission-relevant components in microgravity environments while minimizing crew intervention and operational burden.

Current manufacturing technologies have demonstrated promising capability at lower technology readiness levels; however, substantial technical challenges remain in achieving reliable, autonomous, and repeatable manufacturing operations in reduced-gravity and microgravity environments. These challenges include feedstock management, process stability, quality assurance, anomaly detection, post-processing, and end-to-end workflow integration across diverse materials and manufacturing methods.

This effort is fundamentally a research and development initiative intended to mature integrated ISM capabilities from laboratory and subsystem demonstrations toward operationally relevant manufacturing systems suitable for future spaceflight applications. NASA anticipates leveraging the results of this effort to inform future exploration architectures, orbital manufacturing capabilities, and resilient operational concepts for long-duration human and robotic missions.

3. OBJECTIVES

The overall objective of this effort is to develop, integrate, and demonstrate advanced in-space manufacturing technologies capable of producing functional components from multiple

feedstocks in microgravity-relevant environments. The effort shall focus on integrated manufacturing workflows, autonomous operational capability, quality assurance, and scalable manufacturing approaches suitable for future exploration missions. Proposed approaches shall mature integrated technologies from a starting Technology Readiness Level (TRL) of 3-4 to a TRL of 5. The scope of work described herein applies to all Contract Line Item Numbers (CLINs) under this Topic (see Section 6, Contract Structure, of the Appendix A).

Successful efforts shall address the following key objectives:

3.1 **Objective 1** - Develop and validate an integrated manufacturing system capable of producing functional components using multiple feedstocks, including metals, polymers, composites, conductive inks, and dielectric materials. Demonstrations shall validate manufacturing accuracy, repeatability, and process stability in relevant operational environments.
3.2 **Objective 2 –** Develop and demonstrate autonomous monitoring, inspection, and fault management capabilities capable of identifying, characterizing, and responding to manufacturing anomalies with minimal crew intervention. Proposed approaches shall support reliable and continuous manufacturing operations for future space-based applications.
3.3 **Objective 3** – Engineer and demonstrate a complete manufacturing workflow from feedstock handling and deposition through post-processing, inspection, process monitoring, and anomaly recovery. Integrated workflows shall demonstrate reliable operation in reduced-gravity and microgravity-relevant environments while supporting compatibility with future orbital and surface platform integration.
3.4 **Objective 4** – Demonstrate manufacturing processes capable of producing mission-relevant components with repeatable performance, dimensional accuracy, and operational consistency across representative manufacturing conditions. Demonstrations shall characterize process stability, yield, and quality metrics necessary for future operational implementation.
3.5 **Objective 5** – Develop scalable ISM system architectures and operational concepts suitable for future long-duration exploration missions. Proposed systems shall address extensibility to future orbital, lunar, and Martian applications while minimizing operational complexity, crew workload, and logistics dependence.

4. PERFORMANCE OUTCOMES

The requirements contained in Attachment B4 establish the minimum technical capabilities and performance objectives expected to be achieved during execution of the proposed effort. Successful efforts shall achieve the following outcomes and associated performance objectives:

4.1 Demonstration of integrated multi-feedstock manufacturing processes capable of producing functional components in reduced-gravity or microgravity-relevant environments.
4.2 Validation of manufacturing process stability, repeatability, and dimensional accuracy sufficient to demonstrate advancement toward operationally relevant ISM capability.
4.3 Demonstration of autonomous monitoring, inspection, anomaly detection, and fault recovery capabilities that reduce crew dependence and support continuous manufacturing operations.
4.4 Validation of integrated manufacturing workflows including feedstock handling, material deposition, post-processing, inspection, data logging, and anomaly recovery functions.
4.5 Characterization of manufacturing yield, process consistency, operational reliability, and environmental performance necessary to support future spaceflight implementation.

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4.6 Delivery of technical data, operational insights, and manufacturing performance results supporting future NASA trade studies, mission architecture development, and operational planning for in-space manufacturing systems

5. CONSTRAINTS AND SCOPE

The following in-scope and out-of-scope constraints apply to all proposed technical approaches. Offerors shall ensure their proposed technical approach strictly adheres to these boundaries. See Section 8.2, Evaluation Criteria, of Appendix A for additional information regarding evaluation considerations associated with compliance to scope boundaries.

5.1 In-Scope: The following elements shall be considered in scope and included in this effort:

5.1.1 Multi-Feedstock Manufacturing Processes: Additive manufacturing processes supporting metals, polymers, composites, conductive inks, dielectric materials, and related manufacturing approaches relevant to future space applications.

5.1.2 Autonomous Monitoring and Inspection: Integrated process monitoring, inspection, anomaly detection, fault management, and telemetry collection capabilities supporting autonomous operations.

5.1.3 Integrated Manufacturing Workflows: End-to-end manufacturing workflows including feedstock handling, material deposition, post-processing, inspection, process monitoring, and operational recovery functions.

5.1.4 Microgravity-Relevant Demonstrations: Testing and demonstrations in environments relevant to reduced-gravity or microgravity operational conditions.

5.1.5 Operational Data Collection: Collection and reporting of manufacturing process data, operational telemetry, quality metrics, and performance characterization results supporting future NASA assessments.

5.2 Out-of-Scope: The following elements shall be considered out of scope and excluded from this effort:

5.2.1 Ground-Only Manufacturing Systems: Manufacturing systems or process demonstrations that do not provide relevance or applicability to space-based operational environments.

5.2.2 Crew-Dependent Inspection Operations: Approaches requiring continuous manual inspection or sustained crew intervention for nominal manufacturing operations.

5.2.3 Full Operational Flight Systems: Procurement or qualification of fully flight-certified operational manufacturing systems intended for deployment.

5.2.4 Non-Relevant Manufacturing Processes: Manufacturing technologies or applications not aligned with NASA exploration objectives or future orbital, lunar, or Martian operational needs.

5.2.5 Standards Development Activities: Development of new manufacturing certification standards or broad industrial quality assurance frameworks beyond those necessary to support proposed demonstrations.

6. DELIVERABLES

Offerors shall propose deliverables appropriate to the maturity, scope, and technical approach of their proposed efforts. Deliverables are expected to provide sufficient technical evidence

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to demonstrate progress toward or accomplishment of the stated objectives and outcomes. The desired deliverables of a successfully awarded contract include:

6.1 Design reviews including systems requirements, system design, preliminary design, and final design. Associated review artifacts, data packages, and supporting documentation shall be provided in formats mutually agreed upon during review planning with NASA.
6.2 Integrated manufacturing demonstrations and supporting technical documentation validating manufacturing capability, workflow integration, process stability, and operational performance.
6.3 Prototype manufacturing hardware, subsystem assemblies, or integrated demonstration systems representative of the proposed ISM architecture.
6.4 Technical reports, briefings and programmatic documentation describing system design, manufacturing processes, integration activities, testing methodologies, performance characterization, operational data, and technical progress, schedule status, and risk posture throughout the period of performance.
6.5 Operational datasets and manufacturing telemetry supporting process validation, anomaly characterization, quality assessment, and future NASA trade studies.
6.6 Test reports documenting manufacturing performance, environmental operation, process repeatability, inspection results, and operational reliability under relevant demonstration conditions.
6.7 Documentation describing pathways for advancing demonstrated manufacturing technologies toward future flight-relevant implementation, including identification of major technical risks, operational constraints, and future maturation needs.
6.8 Programmatic and operational planning documentation supporting execution and lifecycle activities, which may include integrated master schedules, concepts of operations, design guidance for manufacturing capabilities and expected material properties, and risk management approaches appropriate to the proposed effort.
6.9 Government insight activities including technical interchange meetings, monthly status reports and meetings, milestone reviews, demonstrations, and site visits, as appropriate and coordinated with the Government, to support technical assessment, collaboration and programmatic visibility throughout the period of performance.

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