Attachment B4: Technical Performance Metrics and Desired System Characteristics
Topic 4 NextSTEP-3 Appendix A

Requirement Type
1.1 – Functional Performance
1.2 – Design
1.3 – Logistics
1.4 – Safety and Mission Assurance
1.5 – Environmental
1.6 – Software

1.1 – Functional Performance –

Requirement ID	Requirement	Verification	Rationale
1.1.1	The payload shall achieve dimensional print accuracy consistent with state-of-the-art performance for each supported feedstock and deposition modality.	Analysis & Test	Maintaining high accuracy enables printed parts to integrate reliably into parameter-defined systems and applications.
1.1.2	The payload shall achieve dimensional motion accuracy with state-of-the-art performance for each supported feedstock and deposition modality.	Analysis & Test	Maintaining high accuracy enables printed parts to integrate reliably into parameter-defined systems and applications.
1.1.3	Payload shall support at least 4 material feedstocks, including individual metals, polymers, composites, electronic conductive materials, and/or dielectric conductive materials. Multiple materials within one materials classification are acceptable. Automated switching is preferred.	Inspection	Multiple feedstocks enable multiple use cases and future proofs the technology. This avoids single-process bottlenecks and expands integration opportunities.
1.1.4	Payload shall produce part/component yield at or greater than 80% for 10 consecutive samples of each test case after process optimization before final design review/CDR.	Test	High yield is critical for cost efficiency, mission reliability, and sustainability, as it minimizes material waste, ensures most components meet stringent quality standards without rework, and supports scalable, autonomous production essential for long-duration space operations.
1.1.5	Payload shall produce part/component yield at or greater than 60% for 20	Test	This threshold is important entry criteria for relevant environment testing as it validates initial tool

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	consecutive samples of each test case before an interim design review/PDR.		reliability before informed re-work. Parts to be produced must be defined by NASA prior to the System Requirements Review.
1.1.6	Provider shall have at least two independent methods for part quality verification, including in-process monitoring and/or post-process inspection. The selected methods shall capture how well the manufactured part meets design specifications and/or how well the part is able to be used for an intended application. *Functional testing capability is optional but favorable for electronics.*	Inspection/ Demonstration	Provides the ability to recognize defects and address functionality without destructive evaluation.
1.1.7	Payload shall complete test cases within allocated time specified by NASA scaled with part complexity.	Test	After process optimization, parts need to be manufactured within a reasonable time allocated for the process.
1.1.8	Provider shall have post-processing solutions available, if required to produce a functional part with the manufacturing process.	Test	The manufacturing process needs to produce parts in the final form. If post-processing is required, it must be included in the manufacturing process to ensure part functionality and facilitate testing. Parts to be produced must be defined by NASA prior to the System Requirements Review.
1.1.9	Payload shall have an autonomous fault detection, isolation, and recovery (FDIR) method.	Test	Technology should enable detection, isolation, and recovery from print anomalies to operate autonomously or with ground systems to enable success.
1.1.10	Payload shall be designed such that a full-sized part could be produced. *Except for parts being produced specifically for an application targeting the assembly of a larger structure, the payload must not require additional assembly to create a useful part.*	Inspection/ Demonstration	Ensures that the payload can produce operationally relevant parts without requiring post-printing assembly or introducing the associated failure modes. This requirement ensures the system provides meaningful manufacturing capability except in cases where multi-part fabrication is intentionally required for larger structures.

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1.2 – Design

Requirement ID	Requirement	Verification	Rationale
1.2.1	Payload shall have structural integrity that meets all intended loads during the payload lifecycle, including but not limited to launch loads, transport loads, test loads, etc.	Analysis & Test	Payload must meet NASA safety requirements and demonstrate compliance with specifications. Example/applicable standards may include those found in SSP 52005 and SSP 57000.
1.2.2	Payload shall maintain environmental integrity under all specified operational and survival environmental loads for the selected orbital platform. The payload shall withstand exposure to the survival environments without degradation and shall subsequently operate as intended within the specified operational environment.	Analysis & Test	Payload must meet NASA safety requirements and demonstrate compliance with specifications. Example/applicable standards/requirements may include those found in SSP 52005 and SSP 57000.
1.2.3	Provider shall confirm all wetted/exposed surfaces and feedstock chemicals are compatible with other feedstock chemicals and orbital platform systems.	Analysis & Inspection	Mitigate corrosion, degradation, crew-safety hazards by following standing materials and processes protocols for payloads destined for ISS or other orbital platforms.
SPEC.1.2.4	Provider shall design payload to be installable in ISS or other selected orbital platform racks. *If specialized tools are required, the provider shall furnish such tools.*	Demonstration/Inspection	Minimized crew time and reduced potential impact to ISS systems or other selected orbital platforms by matching established payload practices.

1.3 – Logistics

SPEC ID	Requirement	Verification	Rationale
SPEC.1.3.1	Provider shall use a modular tool design that limits replacement to simple crew-replaceable consumables or tool	Inspection	Toolheads, filters etc. are modular to allow crew to replace in case of damage/failure reducing risks.

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	elements, rather than requiring removal, substitution, or modification of non-modular, complex, or impractically large components.		
SPEC.1.3.2	Payload consumables shall be replaceable by crew within 30 minutes.	Demonstration	Routine task crew time should be limited to ensure alignment with milestones and reduce payload impact on crew operations.
SPEC.1.3.3	Payload fluid/electrical connectors shall be accessible for leak checks.	Inspection	Mandating crew-accessible fluid/electrical connectors enables standard ISS or other selected orbital platform leak checks and continuity testing after on-orbit mating/de-mating protocols.

1.4 – Safety and Mission Assurance

SPEC ID	Requirement	Verification	Rationale
SPEC.1.4.1	Payload shall comply with all safety protocols and Do-No-Harm criteria for both the launch vehicle and the selected orbital platform.	Analysis	ISS safety compliance governs hazard identification and control per SSP 51721; the payload's adherence ensures it meets the same baseline safety expectations as current manufacturing payloads documented in hazard records. SSP 51721 is a valid reference until the selected orbital platform provides specific requirements.
SPEC.1.4.2	If operated within a manned vehicle, any payload that contains particulates and fumes shall comply with all applicable fire safety standards and crew-health exposure limits.	Analysis	NASA-STD-6016 is a good reference for fire safety on the ISS. Requiring containment and flammability/off-gassing compliance reduces crew injury risk and fire hazards, consistent with ISS hazard reports and NASA materials standards.

1.5 – Environmental

SPEC ID	Requirement	Verification	Rationale
SPEC.1.5.1	Payload shall be able to operate in 0 g to 1 g in any orientation.	Analysis	Orientation-agnostic operation is essential because terrestrial testing (1 g - varied orientations) must correlate to microgravity performance; this assures reliable operation independent of gravity vector. SSP 57000 contains a reasonable list of requirements to

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			ensure the materials and loads of the payload can meet the environment of the ISS or selected orbital platform.
SPEC.1.5.2	Payload shall be able to function in 30% oxygen environment without ignition risk.	Analysis	Materials, enclosures, and processes must remain non-ignition-prone within the ISS oxygen envelope (localized O_2 may exceed nominal). Carrying a 30% O_2 design point reflects current ISS payload practices and provides a worst-case design limit.

1.6 – Software

SPEC ID	Requirement	Verification	Rationale
SPEC.1.6.1	Payload shall have a software system that acknowledges commands and reports health/status telemetry from ground commanding system.	Test	Command acknowledgement and health/status telemetry are required to validate execution and enable ground monitoring/diagnosis, consistent with ISS and orbital platform controller interfaces. All payload commands shall be clearly defined within the Command and Control Data Book to ensure unambiguous ground-to-payload interactions and maintain standard verification and telemetry behavior.
SPEC.1.6.2	Payload shall provide real-time fault annunciation to both crew and ground, where "real-time" is defined as the minimum signal propagation and system processing delay necessary to transmit alerts from the orbital platform to ground.	Demonstration/Test	Real-time annunciation alerts crew/ground to anomalies (over-temp, jam, off-nominal deposition) for prompt fault reporting and repair.
SPEC.1.6.3	Payload shall be able to log, store, and transmit manufacturing parameters for analysis.	Inspection	Persisting and downlinking build parameters, in-situ sensor data, and outcomes supports post-print acceptance decisions and process maturation (ISM certification).
SPEC.1.6.4	At Systems Requirements Review (SRR), compliance with all applicable Design & Construction (D&C) standards must be demonstrated, including	Inspection	Applying NASA software engineering requirements (tailored per payload class) ensures appropriate software assurance even for non-safety-critical payloads; EMC guidance has previously affirmed applicability

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	those defined in NPR 7123.1.		and tailoring processes for ISS tech demos.

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