

**Requirements Specification:**

**Robotic Positioning Manipulator & Support Structure for 3D Additive Construction with Planetary Regolith Simulant**

NASA Kennedy Space Center (KSC), Surface System Office (NE-S)

NASA KSC is developing a new method of 3 Dimensional (3D) Additive Construction using regolith simulant and robotics. In order to position the regolith print head that the KSC Surface Systems Office (NE-S) is developing, a robotic positioning manipulator and an integrated support structure (known hereafter as the Robotic Positioning System) is required that can be programmed to follow specific tool paths required for repetitive 2D layers of additive regolith material resulting in discrete 3 dimensional objects with salient characteristics for in situ resource utilization.

The Robotic Positioning System (RPS) shall be capable of having a work envelope which is sufficient to provide a tool path necessary for 3D printing a 1 meter radius inverted hollow half sphere dome. *A good candidate robot for this capability is the Fanuc Model M-410iB/160.*

The RPS shall consist of an articulated type of robotic mechanism arm capable of carrying a 160 kg end effector payload which shall be attached at the wrist interface.

The RPS shall have a maximum payload reach of at least 2000 mm horizontal and 400 mm vertical with a repeatability of  $\pm 0.5$  mm.

The RPS shall have a throughput of 700 cycles/hour.

The RPS shall have mechanical brakes on all axes.

The RPS shall have an electric servo drive by AC servo motor.

The RPS shall have brushless AC servo motors.

The RPS shall have standard RS-232, Ethernet, and PCMCIA interfaces (Storage Media Cards)

The RPS shall include a Robot Controller Manual Package, robot mounting base and a Human-Machine Interface.

The RPS shall be floor mounted.

The RPS shall be capable of being installed on a concrete floor foundation in an indoor laboratory environment.

The RPS support structure shall be capable of carrying and re-acting the dynamic forces from robotic operations with a mounted robot arm weighing up to 2500 kg, that is anchored into a concrete floor.

The end axis of the RPS shall be such that the print head will mount is held flat to ground regardless of robot position or pose, created by a four bar linkage.

**Services the Vendor shall provide:**

Project Management for Equipment and Services Proposed Herein

Project Engineering

System Application Software

System Assembly

Installation Supervision at NASA KSC

Facility in Florida

Start Up Supervision and Debug.

Cell Control Hardware and Software.

**Services NASA shall provide at Swamp Works (Engineering Development Lab Annex):**

On-Site Project Management

Equipment transportation from PaR Systems to the installation facility

Relocation of existing equipment at customer facility / site preparation.

Electrical power and air drops.

Foundation preparation

Unloading of the truck and placing the equipment at the installation site

Systems electrical and mechanical installation