Requirements and Specifications for the Experimental Test Range (ETR) Positioning System

I. This requirements document outlines components to the ETR model positioning and mounting system as part of the overall upgrade to a state of the art Radar Cross Section (RCS) and Antenna Measurement compact range chamber facility. Government Furnished Equipment (GFE) in the following tables are items the contractor's provided equipment will need to interface with. The contractor shall work with the NASA Safety Office and the NASA Technical Monitor to ensure compliance with NASA Standard STD-8719.9, http://standards.nasa.gov/documents/viewdoc/3314944/3314944, during installation of the positioning system.

1. STRING REEL SYSTEM

The contractor shall provide the following:

a. One of the following reel controller options for coordinated motion of the string reel system with the capability of lifting 1,500 pounds:

i. A 4-axis position controller to operate the Government furnished string reel motors; or

ii. A system for the operation of the four (4) Government furnished motor controllers.

b. A computer and software system for operation from the control room of the selected reel controller option, paragraph (a) above. The software shall be capable of operating each reel independently and operating all of the reels simultaneously in a coordinated motion mode.

c. A remote hand held controller for the control of all options from inside the 40 foot chamber (indicated below) to have direct user observation of the string system motion.

The geometry in which the reels will be used is as follows:
Each Government furnished floor mounted reel is located at each of the 4 corners of a 40 foot square in the ETR. The strings run vertically from each reel through a pulley in the ceiling equipped with a load cell and back down to the floor. For operation, the string ends from all reels are brought together to a point mounted at the center of gravity on the model to be lifted inside the 40 feet square up to a maximum height of 25 feet anywhere above the square. The reel system then lifts the model through the tensioning of the strings, in a coordinated fashion, to place it on a foam column at the center of the RCS test zone. The existing load cell and string reel control cables are long enough to reach the old control room which is the same distance from the chamber as the new control room.

The controller and computer system identified as items (a) and (b) above shall be located outside the chamber in the control room 50 feet from the nearest reel. The coordinated motion of the 4 reels shall be such that the operator can lift the model vertically as well as move it cross range and down range (3 orthogonal axes). Each of these 3 motions axes shall be controlled independently. The strings must remain tensioned at all times regardless of the location of the model in the 40 foot square up to the maximum height.

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The 4 ceiling load cells attached to the pulleys shall provide load feedback to the controller and these values shall be displayed on the controller or computer display. The load cells enable the user to prevent overloading the operating capability of the system. In addition to digital encoding of the 4 load cells in the ceiling, the contractor shall provide encoding at the controller for a fifth load cell to be used in the chamber interior. The fifth load cell is for the string reel user. Examples of use would be for overall weight feedback or line stretching.

450 feet of 2,000 pound test spectra cord, with a diameter less than or equal to 0.25 inches, shall be provided by the contractor for the reels. The contractor shall install the strings in four equal 112.5 foot lengths on the reels and run them through the ceiling pulleys for operation.

Government Furnished Equipment for String Reel System	
ITEM	MODEL #
String Reel Motors (4 each)	Orbit AL-1260-1B
Motor Controllers (4 each)	Orbit AL 4901-3A OP 1
Mounted ceiling pulleys (4 ea.)	N/A
Load cells (5 ea.)	Sensotec Model: RM/1075-01 Range 0-1000 pounds EXC – 10.0 VDC

2. RCS OGIVE PYLON

The contractor shall provide the following:

a. A 4:1 ratio 3000# ogival RCS pylon approximately 16 feet tall including rail height (see section 5 for rail requirements). This pylon shall provide an overall model support height of 18 feet from the floor. The 18 foot height includes the length of the Government furnished rotator tip. The Government furnished rotator tips will dictate the maximum working load (see table below). The safety factor for the new pylon shall be “3”.

b. Variable speed azimuth position controller to drive the azimuth rotator in each of the two (2) Government furnished tips (see table below). The controller shall receive and display digital encoder feedback to 0.01 degree accuracy.

Government Furnished Equipment for RCS Ogive Pylon	
ITEM	MODEL #
1500# pitch rotator tip	MI Technologies Model# 55551
500# azimuth tip w/ spline drive	MI Technologies Model# 55551

The range height is based on the 500 pound RCS rotator.

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3. ANTENNA POSITIONER

The contractor shall provide the following:

a. A slide assembly compatible with the Government furnished positioner described in the table below. This slide assembly can be operated manually with a hand crank. The travel requirement for the slide is four feet from the rotator face to the vertical axis of rotation.

b. An antenna positioner mast with roll axis head compatible with the slide assembly. The load capability shall be 1,000 pounds. The total height of the mast, slide assembly plus the rail mounted Government furnished antenna positioner shall be 18 feet (see section 5 for rail requirements).

Government Furnished Equipment for Antenna System	
ITEM	MODEL #
Antenna Positioner	Scientific Atlanta Model number: PROD ORDER #9371, Assembly number: 41385

4. RAIL POSITIONING SYSTEM COMPONENTS

Rail Positioning System Components (RPSCs) are defined to be the following 4 items in paragraphs (a) through (d) below:

a. RSC Ogive Pylon Rail Mounting System
b. Azimuth Rotator Rail Mounting System
c. Antenna Positioner Rail Mounting System
d. Manlift Rail Mounting System

a. RSC OGIVE PYLON RAIL MOUNTING SYSTEM

The contractor shall provide a rail mounting system for the RCS ogive pylon (section 2). The contractor shall ensure the pylon/rail interface, the rail attachment to the floor and the operation of the linear axis drive can operate smoothly under working load conditions, without creating a binding moment on the rails over the entire range of travel.

b. AZIMUTH ROTATOR RAIL MOUNTING SYSTEM

The contractor shall provide a rail mounting system for the three (3) Government furnished azimuth rotators for linear movement in the range and for removal to the model preparation area. The azimuth rotator will be used with a 15 foot tall foam column and used alone for smaller light weight targets and with the string reel support for larger heavier targets.

Government Furnished Equipment for Azimuth Rotator Rail Mounting System	
ITEM	MODEL #
Azimuth Rotator	Orbit Technologies AL-860-1
Azimuth Rotator	Orbit Technologies AL-560-1
Azimuth Rotator	Orbit Technologies AL-561-1

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c. ANTENNA POSITIONER RAIL MOUNTING SYSTEM

The contractor shall provide a rail mounting system for the Government furnished antenna positioner with contractor provided mast and slide (section 3)

d. MANLIFT RAIL MOUNTING SYSTEM

The contractor shall provide a manlift rail mounting system capable of transporting the Government furnished Skyjack manlift. The rail mounting system shall be designed to secure the Skyjack manlift during movement into the chamber.

Government Furnished Equipment for the Manlift Rail Mounting System	
ITEM	MODEL #
Manlift	Skyjack Model number – SJIII 3219; Serial number – 231431

The azimuth rotators and manlift may use the same cart and these units can be interchanged using a forklift. No precision alignment pins are required. Control cables for the RSPCs must be in a cable management system. Control cables for the pylon rotators, AUT positioner, and azimuth positioners may be connected once the positioners are in the quiet zone.

5. RAIL SYSTEM

The contractor shall provide the following:

a. A design for a twin parallel rail system to allow any of the 4 RPSCs to be moved independently from the model preparation area into the chamber test area. The chamber test area is defined as the last 10' of the rails nearest the compact range reflector. The design must indicate the proposed method for storing and switching the RPSCs in the model preparation area.

b. The rail hardware including base mounts for all rails for floor attachment as described in the design submitted under paragraph (a) above. Alternatively, the contractor may use the existing Government rail hardware, as described in attachment 3 to this RFQ. Either option is acceptable to the Government. The contractor shall mount the rail system to the existing concrete floor centered cross range (20 feet from either side wall) such that the RCS ogive pylon moves centered in the mezzanine second floor slot. (See attachment 4)

c. A linear axis motor/driver and controller for moving the positioners along the rails. The linear motion controller shall include an encoder with 0.05 inch accuracy for model positioning over the 10 feet of rail closest to the reflector (Model test zone) as indicated on the Rail Diagram, attachment 3 to the RFQ. The linear axis encoder shall have feedback display in the control room.

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d. All required mechanisms for mounting the RPSCs to the rails and mechanical interface with the linear axis positioner

e. Complete installation, mechanical checkout, and compliance testing of the rails in the ETR

The floor mounted rail system shall allow the RPSCs to be moved from the model handling area into and out of the chamber. The system shall also provide the ability for the RSPCs to pass each other in the control room through a transfer or rotator slide assembly. Refer to the Rail Diagram, attachment 3 to the RFQ. The rail system shall be motorized to handle the movement of models up to 1,500 pounds (working load conditions) on the RCS Ogive Pylon.

Government Furnished Equipment for Rail System	
ITEM	MODEL #
360 degree curved rails with 6 bearing blocks	THK HCR35A 6UU +60/1000R-6T
2 inch round SS rails (see attachment 3)	Thomson LSR-32-PD
Pillow Blocks (14 ea.)	SPB-32-OPN

The RPSCs can be turned manually if less than 50 pounds of pressure is required to move the RPSC.

II. REQUIREMENTS FOR ALL SYSTEMS LISTED ABOVE

The contractor shall provide all power, control, and encoder cabling for the systems requiring power and axis control (4 string reels, 5 load cells, pylon azimuth and tilt, rail linear axis movement, azimuth rotator and antenna positioner). Wired remote control for operation in the chamber shall be provided for the string reel system and the linear axis rail motion for the RPSCs, in addition to local front panel control of each controller system. The positioning controllers and cabling provided by the contractor may be used for multiple devices. The azimuth axis control and encoders for the pylon, and the Government furnished azimuth rotators, shall have computer interface control for integration with the eventual RCS Radar. All cable trays or cable run hardware shall be provided.

III. FINAL ACCEPTANCE TESTS

The following are the minimum acceptance test procedures the contractor shall meet to demonstrate system capability and functionality.

a. String Reel System: The contractor shall demonstrate the operation of the string reel system to a NASA technical team. Using the remote controller, in the range, the contractor operator shall instruct the NASA team on the up, down, and lateral motion of this positioning system by lifting a NASA provided, 500 pound balanced target from an arbitrary floor position, in the 40'x40' footprint, to the top of a NASA provided foam column. The test shall show the following:

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1) That the 4 string reels are continuously taut, moving in a coordinated fashion regardless of the position in the 40'x40'x25' cube of operation. The position accuracy needed in the cube of operation is 1 inch in the x, y, z planes. The model should move slowly enough that the pickup point can be controlled within one inch. There shall be no creep in time as described in the acceptance testing.
2) The motion is smooth and the operator is able to place, coaxially, the target on the top of the foam column providing approximately 50 pounds of pressure to provide friction for azimuthal rotation.
3) After turning off the string reel system with the target on top of the foam column, there is no creep in the string lines due to motor movement. This may require a pre-stretch procedure for the spectra lines prior to the load lift and will be tested by re-measuring the 50 pound column pressure after eight hours. The pressure shall be within 10% of the starting value.

Following the successful completion of the contractor demonstration, a NASA technical attendee will successfully repeat the identical test under the supervision of the contractor.

b. RCS Ogival Pylon: The contractor will demonstrate the motorized motion of the RCS pylon along the entire length of the rail system with a 500 pound test load mounted to the rotator. The test will show the following:

1. Centered motion in the mezzanine floor slot;
2. Smooth non-binding motion on the floor rails
3. Safe motorized cut offs at each end of the rail travel.

The motion test over the encoded section (10 foot section closest to the reflector) will involve pylon travel from one end to an arbitrary mark on the rail, stopping, and travel to the opposite end. The contractor shall perform the demonstration by front panel manual operation in the control room.

A NASA technical operator shall then perform the same test. The RCS pylon shall permanently reside on the main rail. A second test for the pylon is a demonstration of the correct operation of the azimuth and pitch control of the NASA provide ogival head. The contractor shall rotate the head axis through 360 degrees showing start, stop and variable speed front panel operation that verifies the front panel position display. A NASA technical operator will then perform the same test. The test shall be repeated for the pitch motion.

c. Rail System: The contractor shall demonstrate the motorized motion of the manlift rail mount system over the entire rail length. A second demonstration shall show the method of disengaging the manlift system from the main rail to allow the antenna positioner or the azimuth positioner to pass each other (turntable or other system).

d. Azimuth Rotator Rail Mounting System: The contractor shall demonstrate the linear motorized motion of the azimuth rotator rail mounting system over the entire rail length.

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A second demonstration shall show the system of disengaging this mounting system from the main rail to allow positioning systems to pass each other (turntable or other system).

e. Antenna Positioner Rail Mounting System: The contractor shall assemble the antenna mast and slide assembly to the Government furnished antenna positioner. The roll, azimuth and pitch capability shall be demonstrated with the existing Government furnished Orbit/FR 959 software and controller.

The turntable is a suggested option for managing the RSPCs and may be either manually driven or motorized under local control. If manually driven no more than 50 pounds of force is required to move the cart. The RSPCs may be driven under local interactive control up to the precision measurement region.

The minimum acceptance test procedures shall be delivered to the Government a minimum of 30 days prior to the delivery of the equipment for approval before testing commences.

IV. WARRANTY OR MAINTENANCE AGREEMENT

The contractor shall provide a 2 year parts and labor warranty for all systems provided.

V. SCHEDULE

a. Acceptance test procedures shall be delivered within 210 days from award.
b. All equipment shall be delivered within 240 days from the date of award.
c. Installation of all equipment shall be completed 15 days after delivery.
d. Acceptance testing shall be completed 15 days after installation is complete.
e. Total performance time is 270 days.

VI. ATTACHMENT 3 – RAIL LAYOUT DIAGRAM

VII. ATTACHMENT 4 – ETR CUTAWAY DRAWING

VIII. ATTACHMENT 5 – ANSWERS TO INDUSTRY QUESTIONS

IX. ATTACHMENT 6 – BUILDING SCHEMATIC 1

X. ATTACHMENT 7 – BUILDING SCHEMATIC 2