I. ***SPECIFICATION - GSD2002.001***

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE (GOES)
RECEIVE ANTENNA SYSTEM (GRAS)

FOR THE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)
SATELLITE OPERATIONS FACILITY (NSOF)
SUITLAND, MD.

Specification: GSD2002.001

GOES RECEIVE ANTENNA SYSTEMS (GRAS)

1. PROJECT SUMMARY

This project involves providing four (4) Azimuth/Elevation (Az/El) remotely controllable paraboloidal receive antenna systems for the new NOAA Satellite Operations Facility (NSOF) building, scheduled for readiness for antenna installation on its roof in September 2004. Each antenna system shall consist of: (a) the paraboloidal antenna; (b) a dual band - L/X feed sub-system; (c) dual redundant LNA paths for each feed; (d) an antenna local, operations area remote monitor/control, and external PC interface; (e) interconnecting cabling between the roof antenna and an operation control area, (f) dual redundant L-Band Downconverters, (g) 70 MHz Intermediate Frequency (IF) Distribution amplifiers, and (h) an IN-SNEC CORTEX NT L-Band receiver. The project includes a remote Control, Monitor, and Test sub-system (CMTs) that, via Personnel Computer (PC) NIC interface, will allow remote the position control, to view the status of, or test any of the four antenna systems.

SCOPE

This requirement involves design and development; in-plant and onsite testing; system/subsystem installation and integration as well as and training and documentation for the operation and maintenance of the GRAS. Systems design and development shall focus upon the maximum feasible use of Commercial-off-the-Shelf (COTS) products, as opposed to developmental products, tailored to the requirements set forth herein. Once accepted the GRAS shall operate continuously performing a 24X7 mission with a 99.99 per cent availability over the systems life. The GRAS system hardware shall be based upon off-the-shelf designs, equipment, components that have had a demonstrated, successful heritage. It is desirable that the proposed hardware allow for technology refreshment where applicable. The GRAS CMTs shall be based upon off-the-shelf PC based hardware and software , but customization may be required to meet NOAA's specific mission requirements. While little custom equipment design is anticipated for the project, if proposed, it is desirable that the Government acquire the rights to any custom designs. The GRAS antennas shall be installed, tested, and integrated on the roof of the new NSOF, Suitland, Maryland. (See URL http://www.osd.noaa.gov). The government will provide access to the new building's electrical power, signal and power grounding system, lightning protection, and signal conduits from the roof to the operations area. The GRAS CMTs shall be installed in a designated NSOF operations area.

1.2 APPLICABILITY AND ACCURACY OF DOCUMENTATION

When references are made to the NOAA NESDIS Standards identified herein, only the applicable portions set forth in the reference apply. If no specific reference is identified, then the entire NESDIS standard requirements apply (see Appendix D).

2. GENERAL REQUIREMENTS

The antenna system design shall be Commercial Off The Shelf (COTS) based upon a product(s) available and previously installed and made operational. The COTS antenna must be tailored to meet the requirements set forth below. The antenna system shall be an elevation over azimuth mount, being capable of step tracking spacecraft in nominally geostationary orbits with inclinations as large as 6E and longitudinal drift of +/- 5E per day.

2.1 MATERIALS AND WORKMANSHIP

The requirements of Standard No. S24.802, Paragraphs 3.2 through 3.2.5.6, apply.

2.2 DESIGN AND HARDWARE

The requirements of Standard No. S24.802, Paragraphs 3.3 through 3.4, apply. To the extent that the customary products' commercial warranties provide, it is desired that the design life of the antenna system be as follows:

a.	Structure (pedestal, reflector, feed)	- 20 years
b.	Electronics (Feed, Controls, Motors, Brakes)	- 10 years
c.	Controller (Local, remote, remote interface)	- 5 years
d.	Other	- 20 years

2.3 ENVIRONMENTAL CONDITIONS

The system shall operate at the specified G/T (per paragraph 6.2) when subjected to any reasonable combination of the following conditions:

- The environmental conditions specified in Paragraphs 3.14 through 3.14.7 of NOAA/NESDIS Standard No. S24.802, except the operating lower temperature limit shall be -20^{o} C. (Heaters may be used, if desired at the lower temperatures.)

- Precipitation - fog, mist, or rain up to 2 inches per hour.

- All external surfaces coated with 0.1 inches of ice.

- Six (6) inches of snow accumulation if positioned in such a manner,

- Wind Low: steady velocity of up to 28 mph with gusts to 40 mph,
  Medium: one minute mean wind speed up to 45 mph and gusts up to 60 mph,
  High: operation in average winds up to 60 mph with gusts up to 80 mph,
  Maximum: survival, stowed and non-operating, in up to 100 mph winds with guststo 125 mph. (These velocities all apply to L-Band performance—see Table 4.1 for X-band).

The antenna system must meet the minimum tracking requirements under the specified environmental conditions. The Offeror's extrapolation of wind conditions at the location will be an important element of the environmental stresses.

2.4 RACK MOUNTED EQUIPMENT

All operations area electronic equipment shall be rack mounted in a standard 42.26 cm (19 inch) rack. The panels shall comply with paragraphs 3.5 through 3.5.2 of Standard S24.802.. The contractor provided rack shall be a Pentair EPS part no # E8242-3 or equivalent – it is desired that the cabinet color be 24172 (green), the equipment panels number 26555 (cream), and legends number 27038 (black) per S24.802 paragraph 3.13.3.

2.5 ANTENNA EQUIPMENT ENCLOSURES

All electronic equipment mounted on the antenna shall be enclosed in an RFI shielded, pressurized (if necessary) and waterproof box with easy access for maintenance. Offerors shall describe in its O&M Plan the steps required to replace any item in this enclosure. The outer conductor of all cables shall be sealed and grounded to the outer surface of the cable entrance plate via a "feed thru" connector. Any conductor without an outer conductor that can be grounded shall be run in metallic pipe or conduit, which shall be grounded at the cable entrance plate. If air inlets and outlets are required to meet the required operating temperature range, the openings in both the inner and outer walls shall be covered with a mesh that is insect, rodent, and bird proof.

The contractor shall provide an equipment enclosure for the drive systems electronics, fiber optics electronics, electrical power distribution, etc. The Government will provide all electrical power to an offeror equipment shelter, or other designated demarcation point. The contractor must provide all branch circuit wiring and make all connections from the wire drops provided by the government. The equipment enclosure shall be a NEMA 4 type and include any heating, ventilation, and air conditioning required to maintain reliable operation of the equipment under all specified environmental conditions.

2.6 INSTALLATION AND TEST

The GRAS antennas must be installed on the roof of the NSOF, and its respective control/test electronics integrated into a designated operations area that can be up to 150 meters from an antenna. All tools and test equipment required to install and test the GRAS shall be provided by the contractor. The Contractor should recommend any necessary test equipment that should be maintained on site by the Government. NOTE: Antenna installation is likely to occur during construction of the NSOF. Therefore, antenna installation must be coordinated with the overall building's construction. The designated NOAA representative and COTR shall serve as the NOAA/NESDIS focal point for the building.

3. ANTENNA SYSTEM - STRUCTURAL AND MECHANICAL REQUIREMENTS

Each antenna system shall consist of the following items:

a. Antenna to Foundation Interface/Template
b. Support structure and pedestal
c. Reflector and feed assembly
d. Counterweight(s)
e. Control System - local, remote, and external interface
f. Systems interface cabling - fiber optics and electrical power and
g. Other facility ancillary and/or integration equipment as required

3.1 STRUCTURE

The antenna structure includes all components of the antenna, which form the primary load-carrying path for the antenna. Interface with the NSOF building must include consideration of the effects of wind torque in foot pounds, roof loading, and the dead weight of the equipment, which must be burdened by the environmental loadings to determine anchoring stresses, etc. The antenna shall be designed such that there will be no on-site welding required during the installation process except for Cadweld or similar connection to the building's grounding system. All welding shall be performed prior to installation. Mechanical components of the antenna may include, but are not necessarily limited to: actuators, motors, brakes, couplings, jack screws, etc. It is desired that the antenna either exclude or minimize use of any hydraulic components.

3.2 SURVIVAL

The antenna system shall be designed such that, after being exposed to the loads corresponding to the combination of extreme environmental and operating conditions, no part of the antenna shall be permanently deformed nor suffer degradation of performance below those specified in this document.

3.3 GEARS AND PINIONS

All final drive gears and pinions shall meet the tolerances specified for AGMA quality number 8, coarse pitch gears, as listed in the Gear Handbook - AGMA 390.03. The contractor shall provide a certificate certifying the hardness of each gear, gear segment, or pinion in the "as shipped" condition.

After final assembly, all drive gears and pinions shall have run out of pitch radii checked by use of two dial indicators (positioned at each end of teeth) measuring the radial position of a pitch pin or wire placed between adjacent tooth faces for all teeth. The results of these measurements shall be recorded in the final system test report. Gear to pinion clearance shall be set to minimum backlash without interference after parts are normalized, with sufficient clearance to prevent mechanical interference from temperature gradients.

Sufficient backlash characteristics must be addressed to maintain the required antenna pointing accuracy.

Limitations on axial run out, hardness, and backlash of the gears to be used, along with their method of manufacture and adjustment, and shall be submitted to the Contracting Officer's Technical Representative for review and approval as part of the preliminary design review.

3.4 BOLTED JOINTS

All joints in structural steel members must conform with the document "Specifications for Structural Joints Using ASTM A-325 or A-490 Bolts" (AISC), except that all nuts used in bolting structural steel joints shall be "Stover" (or equal) heavy hex collar lock nuts, grade C, for use with ASTM A-+325 high strength bearing bolts. All bolts used to connect structural steel members, or assemblies, shall be ASTM A-325 high strength bearing bolts, Lamson and Sessions, or equal. These bearing bolts shall be of sufficient length to provide a full diameter knurl in all sheer planes of the joint.

Nuts shall be tightened using the guidance in the document, "Specifications for Structural Steel Joints Using ASTM A-325 or A-490 Bolts", except that hardened steel washers (Rockwell hardness of C 38 to C 45) shall be installed under all nuts.

3.5 STRESSES

The following-stress limits apply to the structural design of this antenna system.

3.5.1 Steel. Unless otherwise specified, the provisions of the EIA Standard RS-222-D should prevail in the design of the steel portions of the antenna. No increase in design stresses shall be used to compensate for loading due to wind, either alone or in combination with other forces (as allowed in AISC Code, Section 15, Paragraph E).

3.5.2 Aluminum. Unless otherwise specified, the recommendations contained in the ALCOA "Structural Aluminum Handbook" should prevail in the design of aluminum parts.

3.6 WELDS

It is highly desirable that steel welds pass a magnetic particle inspection test. If included in the Contractor’s production procedures criteria for meeting this requirement must be submitted to the COTR for approval. The Contractor shall identify its sampling methodology for critical welds, where failure could jeopardize the integrity of the structure. It is desired that the Contractor use radiographic inspection. Standard criteria for passing this test are given in the ASME Boiler and Pressure Vessel Code, Section VIII, Paragraphs US-51 and 52. Any welds to be radiographed shall be submitted to the COTR for his review.

3.7 SUPPORT STRUCTURE AND PEDESTAL

The support structure and pedestal shall be rigid supporting the solid-surface antenna reflector and feed. The structure and pedestal shall be tall enough to provide at least 0.5 meters (1.5 feet) of clearance between the rim of the reflector and the building and any support structure or power distribution boxes when the antenna is pointed horizontally. Any access doors and openings must be waterproof. Any equipment enclosures (electronic and electrical) must be in accordance with NEMA 4.

3.7.1 Stairs and Ladders

Stairs, ladders, or other access conveyances shall be provided for maintenance personnel to obtain easy access mechanical or electronic assemblies mounted on the antenna. Alternately, re-positioning of the antenna to a negative elevation may also permit such access. It is necessary that personnel have obstacle-free access to bearings, drive mechanisms, motors, brake assemblies, surface of the reflector, feed, etc. Location details should be provided in the technical proposal. While stairs are preferred, safety enclosures, OSHA cages, and safety lighting must be provided on any ladders and in the maintenance vicinity, unless prohibited by mechanical interference.

3.7.2 Pedestal

The pedestal and base shall be rigid supporting all required equipment and provide a solid base for the drive and control system to fulfill the antenna coverage and accuracy requirements.

3.8 AXIS TRAVEL RANGE

The antenna mount shall provide at least ± 90 degrees of travel for the azimuth axis referenced to due south and at least 0 to +91 degrees for the elevation axis, with the zero point at true horizontal. Travel range is defined as the angular distance between final limit switch locations. The positions denoting the travel range are 178 deg. East Long., and 251 deg. West long.

3.9 AXIS ACCURACY

Each axis shall be adjustable such that it can be positioned within 10 seconds of arc from its true reference position. This adjustment shall also be capable of correcting for reasonable settlement of supports. The initial alignment shall also be within this accuracy. The pedestal position sensors and indicators shall indicate the position of the main RF beam, relative to the true axes with a maximum error of 0.005 degrees in each axis. The antenna should be referenced to a true north alignment- the encoders in turn should be referenced to true north and level orientation. While the encoder resolution is achievable, the encoders need to be referenced to the antenna orientation in inertial space. The resolution of the angle position indicators should be 0.001 degrees. The differential error between any two indicated positions is desired to be a maximum of 0.002 degrees.

3.10 MECHANICAL STOPS

Mechanical stops shall be provided at each extreme position of each axis to be able to absorb the full kinetic energy of the antenna moving at maximum velocity plus the full drive torque of the motors, so that there will be no contact of the antenna reflector with the building or any associated structure.

3.11 COUNTERWEIGHT

Counterweights shall be provided to balance the antenna in all positions and prevent undue strain to the pedestal and drive mechanism. The counter weight may be a large, fixed weight and trim weights. The trim weights shall be accessible and removable. The allowable imbalance should be biased towards the stow position of the antenna.

3.12 REFLECTOR SURFACE ACCURACY

The main reflector individual panel surface accuracy and the surface accuracy of the overall main reflector configuration (individual panel position with respect to one another and to other panels of the reflector) shall be commensurate with attaining the RF specifications (namely antenna gain and antenna temperature) listed elsewhere in the document under low wind loading conditions. The acceptable surface accuracy shall be no worse than 0.02 inches RMS; however, the offeror may justify a different surface accuracy with accompanying analysis. The antenna surface accuracy shall be optimized for an elevation angle of 30E.

3.13 CORROSION PROTECTION

The antenna including fasteners, structure, reflector with feed, control cabinet, motors, etc. shall be corrosion protected. While stainless steel fasteners are preferred, fasteners must as a minimum be galvanized. The coating requirements for the antenna structure, reflector, and other assemblies can be found in Appendix A in the list of supplemental documentation on the associated WEB site. The contractor is required to provide its coating system procedure for all antennas delivered under this contract. The antennas must be coated prior to shipment from the contractor's facility.

4.0 RECEIVE ANTENNA CONTROL SUB-SYSTEM

The antenna systems must be capable of being controlled locally, at a remote location in an operations control area, and via an external personal computer NIC interface. For personnel safety, the access control scheme should be granted from the closest position to the antenna, with the assurance of safety interlocks at all control points. Control at the base of the antenna must have precedence over remote control, and control is typically only provided to the remote location when a switch is positioned at the base of the antenna location. Similarly, the external computer interface can only be utilized if enabled by the remote controller. Status information should be available at all control locations at all times.

4.1 ANTENNA CONTROLLER OPERATING MODES

The antenna system shall provide the operating mode for L-Band listed below. The primary tracking mode shall provide an orbital determination algorithm utilizing step track to gather data. The algorithm shall be adaptive to provide immunity to scintillation, orbital maneuvers, and mean wind perturbation. The Offeror must specify its proposed tracking mode for the future X-Band operations, which shall be incorporated herein.

4.1.1 Step Track Mode (L-band)

The polarizer must be driven by step track mode and shall optimize the azimuth, elevation, and polarization angles. The step track mode shall provide the capability to optimize the antenna position with respect to the desired satellite by monitoring the satellite signal strength via a step track receiver. The step track receiver shall interface to the IF distribution amplifier. The Step track mode shall ensure the pointing loss of the antenna does not exceed 0.5 dB.

As part of proposal explain the range of adjustment of the following parameters;

a. Step size for each axis
b. Integration time
c. Scan cycle time
d. Signal degradation required to re-start step track
e. Threshold signal level required for step track operation

4.1.2 Program Track Mode

In the program track mode, the antenna system is driven to follow a sequence of angles in a specific time sequence, calculated from acquisition data stored in the antenna control unit. The acquisition data may be in accordance with any of the following formats:

a. North American Air Defense Command (NORAD) 2 line orbital element data referenced by Spacecraft Identification (ID) and epoch time. (Ref. NASA Standard STDN No. 724, paragraph 3.2.1.5.)
b. Improved Interrange Vectors (IIRV) referenced by spacecraft ID, vehicle ID, message type, and epoch time. (Ref. NASA Standard STDN No. 724, paragraph 3.2.1.3.)
c. Right Ascension declination. This format shall be used to track selected stars in order to check the antenna system performance.
   The information shall be in the format HR.,MR.,SR.,DD.,MD.,SD. where: HR.,MR.,SR.=right ascension in hours, minutes, seconds.
   DD.,MD.,SD. = declination in degrees, minutes, seconds.

4.1.3 Manual Position

An operator must be able to change the orientation of the antenna system via the "manual controls" (type-in position commands, move slider bars on the screen, etc.) or equivalent.

4.1.4 Local control for maintenance using a PMU control box .

The antenna controller shall have a provision for local antenna maintenance control at its base. The personnel maintenance unit (PMU) (or personnel service unit) control box must provide a readout and enough cable to reach the antenna feed.

4.1.5 Stow Position

In the Stow position the antenna shall be smoothly driven to a stow position and have the brakes engaged. If needed, remotely controlled stow pins may be used to meet the maximum wind requirement of these specifications. The stow pins must only be engaged in response to a separate command after sensors show that the antenna is in the stow position. The stow position and the uses under which the Contractor must impose it during the course of antenna operations must be included in the Operations and Maintenance Procedures, for the purpose of protecting the antenna and personnel for damage and potential injury.

4.1.6 Standby

In the Standby position any drive signal is usually gradually reduced to zero and the brakes engaged. Power is then removed from as much of the antenna system as possible, provided an operator, or computer control system, is able to switch the antenna system to any other mode whenever desired.

4.1.7 Auxiliary

It is desired that an operator be able to select any one of 40 pre-defined sets of pointing angles, or enter specific angles via the keyboard. Each set shall include azimuth and elevation. Angles may also be implemented as part of the manual position mode, if part of the system design.

4.2 POINTING AND TRACKING

4.2.1 Pointing Accuracy

The pointing accuracy shall be defined as the precision with which the antenna can be commanded to point to a certain position and be held at the position under the environmental operating conditions of paragraph 2.3. The pointing error shall be the gauge for the accuracy and defined as the angular vector determined from the azimuth and elevation angles that are entered into the controller via operator or program inputs, and the actual pointing.

A means must be offered to correct the effects of wind loading, or deflections, on antenna positions. The major contributors of the pointing error must be categorized under the following four items:

(1) Mechanical Alignment Errors
(2) Structural Deformation Errors
(3) Servo Errors

(4) Encoder Errors
(5) Variations in Signal Amplitude

Table 4.1 has been provided as a suggestion on how the pointing error could be presented and calculated in the proposal. Enough detail and explanation must be presented to permit proper evaluation.. The Contractor may present an alternative analysis to this table, and provide an explanation for the differences.

The drive system shall be capable of providing a pointing accuracy of ±10% of the 3 dB bandwidth at the highest operating frequency in low wind conditions. This accuracy may be reduced to ±20% for medium winds and ±40% for high winds.

Table 4.1.1 - Operational Wind Conditions: L-Band

Wind Conditions	Two-Axis RMS Pointing Error (degrees)	Wind Speeds
Low Wind	0.020	28 mph average 40 mph gusts
Medium Wind	0.040	45 mph average 60 mph gusts
High Wind	0.08	60 mph average 80 mph gusts

Table 4.1.2 - Operational Wind Conditions: X-Band

Wind Conditions	Two-Axis RMS Pointing Error (degrees)	Wind Speeds
Low Wind	0.010	28 mph average 40 mph gusts
Medium Wind	0.020	45 mph average 60 mph gusts
High Wind	0.04	60 mph average 80 mph gusts

4.2.2 Calibration

Provision shall be made to calibrate the antenna-pointing angle using known reference points such as known radio stars.

4.3 DRIVE VELOCITY AND ACCELERATION

The velocity shall be at least 0.25 degree/second in azimuth and 0.25 degree/second in elevation. The acceleration shall be at least 0.25 degree/second^2 for both axes. These degrees are dependent on the power provided to the positioner drives. Each axis shall have independently adjustable software limits for velocity and acceleration to restrict these parameters to lower values when desired.

4.4 IRIG B TIMING SYSTEM INTERFACE

The Antenna Control Unit (ACU) shall either interface to an IRIG B timing signal (see URL http://www.phys.washington.edu/~berns/SUPERK/GPS/irigcode.html) for definition and PDF description) or have a self-contained timing interface that is accurate to that of the government furnished IRIG B or other official timing source. An IRIG B signal will be made available as GFE from the operations control area on an RG 223 or equivalent coaxial cable.

4.5 AXIS BRAKES

Brakes must be provided on both axes to hold the antenna under all required conditions. Minimally, the brake system should be of the fail-safe type, mechanically applied and electrically released, capable of stopping the antenna within one degree of travel, have the thermal capacity to withstand two full load stops in 30 seconds, and operate independently for each axis. The must shall be capable of manual release and manual re-application. If the brakes are manually released, it is desired that they be automatically reset when the electrical power is restored. In using the brake manual release, each axis should have access points that allow for manual movement of the axis.

4.6 PERSONNEL SAFETY UNITS

Personnel safety units (PSUs) shall be provided at all work areas on the antenna. The exact locations should be presented to the COTR in the design review for his concurrence. Each PSU must include a safe/operate switch and a visual indicator to show when the antenna drive system is disabled.

When the safe/operate switch is in the safe position, the drive system shall remove all servo drive power, apply both sets of brakes , and disable control units for the antenna.

4.7 WARNING LIGHT

A flashing red warning light shall be provided. The warning light shall be turned on whenever the antenna is in a control mode that will allow antenna movement. The light should be readily visible, in full sunlight, from any position within 100 ft of the antenna.

4.8 RADOME

An alternative design may be proposed for the Government's evaluation, using a space frame radome or similar product to achieve or exceed performance requirements, consistent with the desired G/T margin, while preventing environmental degradation and lightning strikes, while mitigating the need to use the stow position during extreme weather events.

5. RF SYSTEM REQUIREMENTS

5.1 GENERAL

The receive path equipment defined in this specification consists of RF bandpass filters, Low Noise Amplifiers (LNA) and an optional RF to fiber-optic modem that interfaces the L-Band and X-Band receive signals with the Downconvert / IF Distribution Amplifiers located in the NSOF building operations room. The RF paths for both L and X- band shall be dual redundant systems having transfer switches to remotely change path if an LNA fails. The output of the antenna system will be converted and fed to an IF distribution amplifier located up to 500 feet away. Fiber-optic paths are desired for each band for the long run (up to 500 feet) to the operations room equipment. Simultaneous L and X-band operations are required. A 1 dB compression point is envisioned at the LNA input, with a system linearity of –50 dBm, and filter rejection characteristics in the range of +/- 10% of the operational band.

5.2 SYSTEM FIGURE OF MERIT (G/T)

For elevation angles greater than 10E it is desired that the commercial antenna system provide the following G/T, consistent with implementation loss factors in the link budget analysis. It is minimally required that the excess G/T margin be not less than 3 dB. The Government's conceptual system figure of merit is:

L-Band	18.1 dB/K
X-Band	33.0 dB/K

It is desirable that the G/T be met with an RF band pass filter with an insertion loss of less than 0.4 dB placed between the LNA and the antenna terminals, in accordance with the Contractor's design. The L-band filter typically has a 35 MHz bandwidth $< \pm$ 0.5 dB of ripple across the band.

If these performance characteristics cannot be met the Contractor must show in its link budget, with an accompanying explanation, how the system performance implementation will compensate.

The contractor must demonstrate the required G/T by measurements made after installation at the NOAA site. Offerors shall include in their proposal an analysis of how the required G/T is achieved and maintained including antenna reflector deformation from wind, structural and surface alignment, including attention to receiver noise, system temperature, dynamic range,

filtering distribution, etc. The offeror shall also include a description of, and the accuracy provided by, the proposed method to demonstrate compliance of this requirement.

5.3 OPERATING FREQUENCY RANGES

The antenna system shall operate over the following frequency bands:

a. L-Band 1675 to 1710 MHz
b. X-Band 7450 to 8400 MHz

5.4 SYSTEM AMPLITUDE RESPONSE - Within each of the specified operating frequency bands, the end-to-end amplitude variation with frequency shall not exceed 1 dB peak-to-peak.

5.5 VSWR - The VSWR at the input or output of any module, replaceable sub-assembly, waveguide, or transmission line shall not exceed 1.2:1 over its applicable operating frequency band.

5.6 LNA REQUIREMENTS

5.6.1 Gain

The combined gain of the LNA and losses of the RF/fiber-optic path should be designed to ensure that input requirements to the IF distribution amplifier are met. The design shall ensure that the distribution amplifier contributes no more than 0.1 dB to the system noise figure. (The IF distribution amplifier should have a noise figure of $\leq$ 20 dB). The contemplated design is for a two redundant amplifier paths.

5.6.2 Bandwidth - The 1 dB bandwidth must be 35 MHz for L-Band and 100 MHz for X-Band receive paths. Ripple within this bandwidth shall be a maximum of 0.5 dB p-p.

5.6.3 Gain Compression - The LNA shall have a 1 dB gain compression point of at least -50 dBm input signal level.

5.7 RF FILTER AND DIRECTIONAL COUPLERS

Filter insertion losses must be included in the G/T calculations for the system. A reference load and noise source should be able to be injected to measure the power levels and perform system temperature calibration. The filter system shall include a directional coupler at the antenna port for RF test purposes. The coupling should be 35 dB nominal, with a maximum variation of 0.5 dB over any of the desired frequency bands. The directivity should be at least 20 dB in each coupled direction. Each coupled port should have a type N female connector with a screw-on cap and retaining chain. The loss between the through ports of the couplers should be included in the insertion loss.

5.8 ANTENNA PERFORMANCE - The antenna system performance should shall comply with the following characteristics at all pointing angles.

5.8.1 Polarization - The antenna system should provide rotatable linear polarization of at least 360 degrees with an accuracy of 0.1 degree. The polarization drive should provide a maximum velocity of at least 0.5 degree/second. The cross polarization levels achieved by the Contractor must be specified.

5.8.2 **Antenna Sidelobe Radiation Pattern** - Offerors shall use the radiation pattern in ITU recommendation P.465 as a reference. This recommendation states the radiation patterns shall produce sidelobes with a gain (G) less than or equal to the following:

$$G = 32 - 25 \log M \text{ dBi for } 1^o \# M < 48^o$$
$$= -10 \text{ dBi for } 48^o \# M \# 180^o$$

Where M = the angle between the antenna main beam center and the direction considered.

Offerors are not required to meet this pattern but shall compare it to the radiation pattern of the product being offered. It is desired that antennas come as close as possible to the ITU recommended pattern. As part of the reflector's surface alignment, the contractor shall provide the theoretical antenna pattern and measured radiation pattern for the COTS product offered in the technical proposal.

5.9 ANTENNA SYSTEM L-BAND DOWNCONVERTER

The contractor shall provide two L-Band down converters for each antenna system in accordance with the Appendix B requirements. The two down converters shall be provided to allow for online switching should a failure occur. The L-Band downconverters must be controllable via the GRAS CMTs.

5.10 ANTENNA SYSTEM 70 MHz INTERMEDIATE FREQUENCY (IF) AMPLIFIERS

The contractor should minimally provide 12 channel IF amplifiers for each antenna system. A recommended IF distribution amplifier specification is provided in Appendix C, but is not mandatory. IF distribution amplifiers must be controllable via the GRAS CMTs. Selection of an alternate amplifier must be attended by specifications that establish the basis for selecting that unit.

5.11 IN-SNEC CORTEX NT RECEIVER REQUIREMENTS

The contractor shall provide an IN-SNEC Cortex NT receiver, or equivalent receiver, for each antenna system. The IN-SNEC CORTEX specifications are included in Appendix D, for review. Selection of an alternate receiver must be attended by specifications that establish the basis for selecting that unit.

5.12 TEST SIGNALS

Provision shall be made to inject test signals at the antenna terminals, LNA input, optical transmitter input, and all other appropriate locations. Antenna test signals shall be interconnected via fiber optic cabling/electronics between the antenna feed and the operations area. Breakout boxes should be provided at all fiber optic transmitter/receiver interface points for test purposes. Interface fixtures and/or pigtail cables must be furnished to all fiber optic paths including spares.

5.13 WIRES, CABLES AND WAVEGUIDE

The contractor shall supply and install all necessary antenna system wiring, cabling and waveguide. All cables and connectors should be in accordance with Standard No. S24.803 and paragraphs 3.6 through 3.7.3 of Standard No. S24.802. Appropriate sparing levels should be addressed in the sparing TIM.

5.14 FIBER OPTIC LINKS

Single mode fiber optic cabling with integral transceiver electronics must be provided for all antenna systems control and signal connections between the antenna and the operations room.

5.15 CABLE MARKING

All cables should be permanently identified as specified in Standard S24.803. Individual conductors in multi-conductor cables should be color coded or otherwise identified and traceable at any point on their length. The COTR will provide the contractor with a block of suitable cable numbers, upon request, that are compatible with the existing cables.

6. ANTENNA SYSTEM BUILDING / FACILITY INTERFACE REQUIREMENTS

6.1 FOUNDATION AND ACCESS

Within 30 days after contract award the contractor must provide the COTR with a mounting template and all data necessary to define the foundation requirements to support the antenna structure and equipment shelter, such as bolt size, strength, weight, distribution of mass, wind loading and location, the maximum forces that will be applied, surface tolerances, etc. Any special access requirements, cable and conduit locations, assembly areas, crane access, etc. shall also be provided. Preliminary foundation and access data, as well as power requirements, shall be included in the proposal.

6.2 LIGHTNING PROTECTION AND GROUNDING

The grounding and lightning protection of the antennas and associated equipment must be integrated with the building system. Each antenna should include air terminals in accordance with Standard S24.809, section 3.2.7, and all of section 4.3 that applies to antennas. The

interface to the building ground system should be equivalent to the perimeter counterpoise (PCP) as described in section 4.3.3.3; only two (2) CADWELD and/or equivalent connections are required. The antenna systems shall also comply with the requirements of sections 3.2.6, 3.2.9, 3.2.11, 3.2.13, 3.3.6, 3.3.7, 4.4.8, and 4.5 of S24.809.

6.3 AC POWER

Offerors must provide a summary of the AC power requirements for the equipment shelter at the antenna including all electronic equipment. Two power system interfaces are required: utility for motors, lights, heating and similar loads; and UPS/tech for electronic equipment - fiber optic and LNA electronics. Offerors shall provide their power requirements in accordance with this division. The contractor shall coordinate with the NOAA COTR or the designated representative when interfacing with the building contractor.

The Government will provide the utility and UPS/tech electrical main power cables to interface to the contractor supplied power distribution panels. All electrical conductors must be copper. The requirements for primary power and power supplies as specified in Paragraphs 3.10 through 3.10.7 of Standard No. S24.802 are incorporated into this specification. All electrical work shall comply with the applicable requirements of the National Electrical Code (NEC) and applicable Prince George's county requirements.

6.3.1 Voltage and Load

The available power interfaces for each system must be 240/120/110 VAC 1-phase, 60 Hz or 208 VAC, 3-phase, 5 wire, wye-connected. The offeror's proposal must identify the utility and UPS/tech power loads expected given the equipment offered.

6.3.2 Power Cable Protection

At the contractor supplied distribution panels the contractor should provide absorption type transient suppressors mounted across the supply lines, as close as possible to the distribution panel boards when they enter the antenna equipment structure. The suppressors may be SP-3Y 120/208 V, manufactured by Innovative Technology, Inc. of Brooksville Florida, or approved equal. These units should be located/installed so that they can be replaced without interrupting power to the operating equipment.

The offeror must provide transient suppression on the wires between the antenna drive motors and their control circuits. The contractor must recommend device types and mounting locations during the appropriate TIM, and obtain the COTR's approval before ordering these devices.

No connection between the neutral and ground conductors shall be permitted except at the secondary of any power transformer in the power distribution system. No connection shall be permitted between the two distribution systems, except through the ground connections.

7. GRAS CONTROL, MONITOR AND TEST SUBSYSTEM (CMTs)

7.1 GENERAL

The GRAS CMTs are intended to provide remote control and monitoring for any of the GOES NSOF antenna systems, as well as remote test capabilities. When selected, the remote Personnel Computer (PC) controller should be able to display all screens available on the antenna's ACU. The test subsystem must also be able to exercise the antenna drives, generate test signals, measure these signals with a PC based spectrum analyzer, and store the captured data for historical purposes. The data storage file should be retained in a RAID drive system integral to the PC. The control process must be implemented with LABVIEW or equivalent COTS software. It is desired, not mandatory, that all custom firmware/glueware developed for this purpose become the property of the Government, inclusive of source code.

The CMTs should be installed in a contractor provided 19 inch equipment rack. The controller is envisioned to be implemented either with an industrial PC or workstation class server in the NSOF systems operations room. Each system should be capable of a standard 19 inch mounting in no more than 7U of space (each U = 1.75 inch). The systems will ideally be an Industrial Intel based unit with P4 technology @ approximately 2.2 GHZ, with an ATA100 hard drive interface minimum (SCSI is also permitted). A minimum of 1.5 GB of RAM and 80 GB of Hard drive space RAID is required. The PC display must be a flat 18 inch LCD NEC model 1820 or equivalent. This display should be installed in no more than 10U of rack space. The PC should contain a mouse and/or trackball and a keyboard mounted on a slide out shelf of no more than 2U. The system should interface to, and utilize, a National Instruments Spectrum analyzer unit PXI_5660 with two Spectrum Analyzer cards, RF switch, Labview firmware, etc. or equivalent.

The system must be capable of having test signals injected into the desired receive path. The system shall then be capable of measuring the test signals passed through the test inject system or measuring signals received from external sources, such as the orbiting GOES, on any antenna so connected and at any of the required operating frequencies of the antenna system. The test equipment shall be directly interfaced or via IEEE 488. The system must allow for test to be conducted on a system while other system remote monitoring is also possible.

7.2 INJECT SIGNAL LEVEL

The system must be able to inject a test signal into the input of any LNA at levels over a minimum range of -100 dBm to -50 dBm in increments of 0.1 dB or less. A test inject switch (TIS) located at the input of each LNA, shall allow the test signal to be injected into that LNA. This input switch should be combined with the primary/redundant LNA select switch. Other switches should be provided to route the test signal to any of the four antennas provided, plus provide for at least eight other antennas that the Government may provide.

7.3 SIGNAL MEASUREMENTS

The CMTs must be able to capture the signal's spectrum - signal level (C/N), occupied bandwidth, phase noise, etc. Off-air measurements must also include the ability to retain and

display measurement data, by storing this data in a graphical presentation mode with the ability to record and playback the data, to enable operators to search for interfering signals, zero in and then determine its characteristics.

7.4 OVERALL PERFORMANCE

The test inject system is intended to be used to test the receive paths. Therefore, all specifications listed herein for the receive paths shall also be the minimum requirements for the test inject paths, except that it is desired that any spurious discrete frequency outputs be at least 65 dB below the desired signals.

7.5 CMTs RF SWITCHES

The switches located between the RF filter output and the inputs to the LNAs shall be transfer type switches, mounted as close as physically possible to the RF filter output. All other RF switch types proposed shall be specified in the proposal.

7.6 OTHER CMT CAPABILITIES

The CMTs must be able to view a test signal from input to output at the IF distribution amplifier. The CMTs must be able to show the status of the complete equipment string for each antenna (LNA, DC, IF amplifiers). The CMTs should be capable of reassigning equipment in the string if it is an enabled control point. The CMTs should also be able to measure the amplitude and differential delay of the test inject-receive path loop for any antenna and frequency band.

8. SYSTEM SUPPORT REQUIREMENTS

8.1 SPECIAL TOOLS AND TEST EQUIPMENT

The provisions of paragraphs 3.18 and 3.19 of Standard S24.802 are desired to be incorporated as part of this requirement, except that the list of special tools and test equipment required to run the acceptance tests and to perform normal maintenance procedures should be included with the Contractor's proposal. Special tools and test equipment are defined as those items not listed in the Federal Supply Catalog or available from multiple domestic sources.

8.2 SPARES

The contractor shall provide a listing of the recommended spare parts, with the quantities needed at each site. NOAA Standard S24.805 provides reference information for the Contractor's consideration. A preliminary list must be provided in the proposal. The list will be finalized during TIM interactions. A full set of spare parts must be provided at time of antenna acceptance.

8.3 DOCUMENTATION

All project documentation to be delivered to the government must be delivered in paper and electronic form. Two paper copies and two identical copies of the electronic document must be provided on separate media. The media may be delivered on floppies or CD's. The media shall not be read-only types or write-locked in any manner, to enable the government to modify and maintain configuration control of the equipment therein. Any graphics included in these documents may be provided embedded in the document and in its native drawing package format. Acceptable word processing formats include Microsoft WORD or Corel WordPerfect (preferred). Acceptable graphic formats include Corel Draw, AutoCAD, and Visio Technical. Other formats may be proposed by the contractor for approval by the COTR. Graphics files that are delivered separately shall be named consistent with their names in the parent document. Documentation provided by a COTS equipment supplier must also be provided in electronics form. If not offered by the supplier the contractor must arrange to manually scan the document into the electronic format of the other documentation delivered. Scanned documentation may be in read-only form.

8.4 DESIGN REVIEWS

The contractor must provide design reviews as specified in the price chart, section (b)(2). The initial review must show how specification requirements will be implemented by the Contractor's proposed antenna system. The first review should occur as soon as possible after contract award.

The timing for the additional TIM reviews will be set forth in the IPMS, approved following award, at the first TIM.

8.5 TRAINING

The contractor must develop and submit a training program for the project. Courses for the project are subject to the Contractor's proposed training plan, but should include basic systems Operations and Maintenance (O & M), an advanced course to modify the firmware for the CMTs, and a refresher course for O & M. It is envisioned that the first course have a duration of approximately 32 hours split between classroom and hands on exercises, be provided either during installation or within three months after final acceptance of all antenna systems. The advanced firmware course may also be of 32 hours in duration and given within six months after final acceptance of all antenna systems. The refresher O & M course ideally should be 24 hours in duration and given within three months after the antenna systems are made operational. NOTE: This course may occur as much as up to one year after systems final acceptance, based on the Contractor's logistics support plan.

It is highly desired that the training courses be in accordance with the NOAA S24.804 baseline. Each course must provide for at least ten students. The Government has the right to videotape any training class.

8.6 MONTHLY PROGRESS REPORTS

The contractor must provide monthly progress reports, as set forth in the contract terms.

8.7 TEST PLANS AND ACCEPTANCE TESTING

The Contractor shall prepare and submit to the COTR for review and approval, an In-plant Test Plan and a Final on-site Acceptance Test Plan.

Both test plans must include a procedure, test diagram, check off points and formal sign off for the participants. The contractor shall pre-run all tests proposed and submit this data to the government with appropriate signoffs. The government must then witness the test(s) or elect to accept the results of the contractor' prior testing. The Contractor shall provide the Government two weeks advance notice of any tests to be conducted.

All test data taken shall be submitted for the record in hard copy and in electronic form.

8.8 WARRANTY

The contractor must warrant the antenna in accordance with its standard and extended warranty plans, as proposed. This warranty should include: the structure, RF and tracking, cabling, CMTs, and associated items for a period of no less than two (2) years after final systems acceptance. The contractor's warranty must provide specific terms related to providing equipment repair and on-site technical assistance until problems are resolved. Options for three (3) and (5) year extended warranties must also be provided.

8.9 QUALITY ASSURANCE PROVISIONS

The Contractor May appoint a Quality Control person, who will be required to certify all inspection requirements, as established by the commercial process in place at the plant. If it appoint a QC person, it is highly desirable that a QC record documents the certifications made, and that it be provided to the Government as part of the project documentation.

8.10 FINAL ACCEPTANCE

Final acceptance (Antenna System Sell-Off) shall occur when the antenna systems successfully pass all of the approved in-plant and on site tests, and all deliverables are received and accepted – including any Special Tools, Operating Spares, Operation and Maintenance Manuals. Refresher training needs only to be planned for Final Acceptance.

END OF SPECIFICATION.