

PRECISION ELEVATION OVER AZIMUTH

ANTENNA PEDESTAL SPECIFICATION

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1.0

SCOPE

This specification describes the design, fabrication and performance of a precision elevation over azimuth antenna pedestal that is to be used in a high performance, closed loop, tracking antenna system. The pedestal shall be supplied with features such as data packages, limit switches, hand cranks, brakes, stow pins and lifting eyes. All gears, drive shafts and couplings shall be covered and enclosed. The servo system to be utilized with this pedestal, including the motors and tachometers, will be supplied by the Buyer. The tracking antenna system is designed for operation inside the protective enclosure of a metal space frame radome.

2.0

APPLICABLE DOCUMENTS

The following documents of issue in effect on the date of this specification form a part of this specification to the extent specified herein. In the event of conflict between these documents and the detailed requirements of this specification, the requirements of this specification shall take precedence.

ASTM A-36	Specifications for Structural Steel
ASTM A-325	High Strength Steel Bolts for Structural Steel Joints
AGMA 309.02	AGMA Gear Classification Manual
MIL-E-4158	General Requirements for Ground Electronic Equipment
MIL-Q-9858A	Quality Program Requirements
MIL-STD-210	Climatic Extremes for Military Equipment
MIL-STD-810	Environmental Test Methods for Aerospace and Ground Equipment

FED-STD-595	Color Requirements for Individual Color Chips
MIL-F-14072	Finishes for Ground Signal Equipment
MIL-STD-130	Identification Marking
MIL-STD-129	Marking for Shipment and Storage
MIL-P-116	Methods of Preservation
MIL-E-17555	Packaging and Packing of Electronic Equipment Accessories and Repair Parts
MIL-A-8421	Air Transportability Requirements

3.0

REQUIREMENTS

The pedestal shall be an elevation over azimuth assembly, which employs the yoke-king post design as illustrated in Figure 1, Page of this specification. The salient features of the pedestal described in this specification are presented in Table 1, Page 12. The pedestal will be used in a high performance tracking antenna system and specific emphasis shall be placed on the breakaway friction, viscous friction, stiffness and drive system backlash. All requirements are detailed in the ensuing paragraphs, which delineate the design, fabrication and performance aspects of the pedestal.

3.1 ENVIRONMENTAL

3.1.1 General

The pedestal shall be designed for operation in a radome enclosed environment. Although there are no specific requirements for operation without a radome, the pedestal shall be capable of surviving with its system reflector in a stowed position (the reflector focal axis pointed at zenith) under any probable combination of wind and precipitation loads up to the stow torque limit specified in Table 1, page 12 of this specification. Survival is defined as a condition in which no permanent structural damage exists after the pedestal has experienced the specified loading.

3.1.2 Temperature

The pedestal shall be able to operate in ambient temperatures from ^{-20°C} -20°F to ^{60°C} +140°F and shall be able to withstand ambient temperatures from ^{-40°C} -40°F to ^{70°C} +160°F when not operating, in storage or in transit.

3.1.3 Relative Humidity

The pedestal shall be designed to operate in and withstand

relative humidity up to 100%.

3.1.4 Barometric Pressure

The pedestal shall be designed to operate at altitudes up to 10,000 feet.

3.1.5 Salt Atmosphere

The pedestal shall withstand salt atmosphere as encountered in coastal regions in accordance with MIL-STD-810, Method 509, Procedure 1.

3.1.6 Ozone

The pedestal shall be designed to withstand ozone as encountered in arctic regions and in the vicinity of heavy electrical equipment.

3.1.7 Fungus

The pedestal assembly shall not support the growth of fungus in accordance with MIL-STD-454, Requirement 4, during operation, in storage or in transit.

3.1.8 Actinic Radiation

The pedestal shall withstand actinic radiation as encountered in the tropics.

3.1.9 Sand and Dust

The pedestal shall be designed to withstand sand and dust as encountered in arid regions in accordance with MIL-STD-210.

3.1.10 Seismic Loads

The pedestal shall be designed to withstand seismic loads of 1 g (32 ft./sec.²).

3.2 CONSTRUCTION AND PHYSICAL CHARACTERISTICS

3.2.1 Pedestal Structure

The pedestal structure shall be of the elevation over azimuth configuration. Both the elevation and azimuth housing shall be fabricated using ASTM A-36 structural steel. The pedestal shall be designed to permit proper accessibility to replaceable parts. Replaceable parts shall not be permanently installed such as by welding, riveting, etc. The elevation and azimuth housings shall have sufficient rigidity and strength to satisfy the performance requirements of this specification. All weldments shall be stress relieved before machining. All bearings and rotary components shall be individually covered to prevent the free ingress of dust and moisture.

3.2.1.1 Housings

The elevation and azimuth housings shall be sufficient to enclose all of the associated pedestal equipment and components. Adequate provisions shall be provided for the performance of inspection and service of all parts. The pedestal shall be so designed and constructed that it shall not be necessary to remove structural sections for inspection, adjustment and service.

3.2.2 Pedestal Drive

The pedestal drive shall have the number of gear trains per axis shown in Table 1, page 12. At least one electro-mechanical friction brake for stopping and holding the pedestal in any specified position shall be included for each axis. Mechanical stops shall be provided in elevation to insure safe operation in the event that the motors and the brakes fail to automatically stop the antenna at the limits of travel.

3.2.2.1 Motors

Unless otherwise specified, the drive motors and tachometers will be provided by the Buyer.

3.2.2.2 Gear Trains

The gear trains consist of all the pinions, gears, coupling, supporting shafts and bearings which transmit torque from the motor shaft to the reflector pick-up assembly. Materials used in the gears, shafts, etc. shall be of a quality to insure compliance with the requirements of this specification over the operating life of the pedestal. All pedestal and gear train bearings shall be of the anti-friction, roller, ball or taper roller types. All bearings shall be covered to prevent the free ingress of dust, moisture and other foreign materials. The gear train reduction shall be as specified in Table 1, page 12.

3.2.2.3 Gear Housing

The elevation and azimuth bull gears and output pinions, in the event they are not included in the gear box, shall be protected and enclosed by metal covers, which are bolted to the pedestal structure.

3.2.2.4 Brakes

Electro-mechanical brakes shall be included in each drive axis. The brakes shall be of the fail safe type; that is, power off--brake on, and shall be sufficient to provide the holding torque listed in Table 1, page 12. In addition, the brakes shall be so designed that they can be mechanically released without the removal of protective covers.

3.2.2.5 Mechanical Stops

Energy absorbent type mechanical stops (hydro-mechanical) shall be provided and installed on the elevation housing. These stops shall be of sufficient size to intercept a reflector support structure in the event

of failure of the electrical limiting assemblies. There shall be two mechanical stops per direction (four stops in elevation). The mechanical stops shall be capable of absorbing the kinetic energy associated with the maximum rotation of the antenna and associated drive train inertias as well as absorbing the maximum torque delivered by the motors. Reflector, gear train and motor inertias as well as other motor characteristics shall be as specified in Table 1, page 12.

3.2.2.6 Lubrication

The pedestal shall include the necessary lubrication provisions to insure that all shafts, bearings, and gears provide the operating characteristics throughout the life of the pedestal.

3.2.2.7 Friction

The pedestal shall be designed so that under rated load the breakaway friction does not exceed the value specified in Table 1, page 12.

3.2.2.8 Data Packages and Limit Switches

Data boxes and related components shall be provided in each axis as follows:

- 1) 3 - 1:1 data shafts
- 2) 2 - 36:1 data shafts
- 3) 1 - 1:3 data shaft (azimuth only)

Precision Class I anti-backlash gearing along with zero backlash mechanical couplings shall be provided in each data package. The data shaft position accuracy, including anti-backlash repeatability, shall be within 0.05° for the 1:1 shafts and shall be within 0.03° , referred to the pedestal output axis, for the 36:1 speed data shafts.

All output shafts and sockets of the data boxes shall be designed and manufactured for the installation of size 23 synchros and synchro hardware. Interface couplings, data shaft - to - synchro shaft, shall

be included with the data boxes. The coupling shall be designed to accept a standard synchro shaft of 0.2405 inch in diameter. Unless otherwise specified in the contract, synchros will be supplied, mounted and wired by the Buyer. Interfaces such as mounting dimensions and locations, connector location and type shall be supplied by the pedestal supplier.

The limit switches shall be integral with the data package and shall consist of five rotary switches for each axis. The switches shall be driven by a common data shaft with a 1:1 ratio for the elevation axis and a 2:1 ratio for the azimuth axis. Each switch shall be capable of handling a current of 100 ma and shall indicate a travel limit by an open circuit. The limits shall be adjusted and set in accordance with the travel limits specified in Table I, page 12 .

3.2.2.9 Stow Pins

A stow pin in each axis shall be supplied with the pedestal. Each stow pin shall incorporate two electrical interlock switches. The switches shall be the double pole, double throw type. One switch shall actuate as soon as the stow pin moves from its stored position and before it begins entry into the stow socket. The second switch shall actuate when the pin has reached its full depth.

3.2.2.10 Hand Cranks

A hand crank shall be supplied on each axis of the pedestal. The hand crank shall be easily accessible and shall be capable of positioning the antenna manually. A safety interlock shall be provided to de-energize the drive power to the pedestal. The hand crank shall include a safety clutch to prevent an inadvertent overload of the gear trains.

3.2.3 Dimensions and Configuration

The general configuration and the overall dimensions of the pedestal shall be as shown in Figure 1, page 13 .

3.2.4 Structural Interfaces

3.2.4.1 Reflector Support Structure Interface

The interface dimensions for attachment of the reflector support structure to the pedestal and for engagement with the mechanical stops shall be as shown in Figure I, page 13 .

3.2.4.2 Pedestal Mounting Interface

The pedestal mounting interface to the support tower or foundation shall be as specified in Figure I, page 13 .

3.2.5 Pedestal Mass Properties

The weight of the pedestal shall be equal to or less than the value specified in Table I, page 12. The weight shall include all the structural components of the pedestal as well as the drives, housings and covers.

3.2.6 Assembly and Assembly Hardware

3.2.6.1 Welding

Welding of A-36 steel shall be performed using ASTM-A-233 Class E60 or E70 series electrodes for manual arc welding or Grade Saw-1 or Grade Saw-2 submerged arc welding processes. All external welds shall be continuous fillet or butt welds forming closed loops to eliminate moisture paths around crevices and between adjacent welded parts.

3.2.6.2 Hardware

Stainless steel hardware shall be used to provide inherent corrosion resistance for all connectors, except where high strength is required. All high strength hardware shall be zinc plated to provide the necessary corrosion resistance qualities. For interfaces requiring precise and permanent location, close tolerance dowel pins shall be used. These shall be press fitted into place at assembly.

3.2.6.3 Accuracy of Assembly

3.2.6.3.1 Orthogonality

The orthogonality of the assembled pedestal shall be within the tolerance specified in Table I, page 12 . ^{2 miss}

3.2.6.3.2 Backlash

The backlash of the assembled pedestal in both elevation and azimuth elevation shall be no greater than the value specified in Table I, page 12 .

3.2.7 Lifting Capability

The pedestal shall be provided with two lifting eyes located on the top of the elevation housing for convenient attachment of a lifting sling. The structure shall be capable of withstanding the forces experienced when lifting the completely assembled pedestal with a lifting sling that imposes predominantly vertical loads on the pedestal.

3.2.8 Air Transportability

The pedestal and accessories shall be capable of being transported by aircraft and shall be designed to withstand or be protected against the environments to be encountered during air transportation and handling. MIL-A-8421 shall be used as a guide.

3.3 PERFORMANCE

3.3.1 Rated Load

The pedestal shall be capable of supporting a structure exhibiting the rated load as specified in Table I, page 12 . The structure, which includes the reflector, reflector support structure, counterweights and feed system, shall be securely bolted to the interface surfaces on the elevation axis as shown in Figure I, page 13 .

3.3.2 Pedestal Stiffness

The pedestal stiffness for both axes shall be equal to or greater

than the value specified in Table I, page 12 .

3.3.3 Rated Torque

The pedestal drive systems shall be capable of generating torques of not less than the values specified in Table I, page 12 .

3.3.4 Velocity

The pedestal shall be capable of providing angular velocities at the output axes as specified in Table I, page 12 , with the rated load applied under all operating conditions.

3.3.5 Acceleration

The pedestal shall be capable of developing angular accelerations at the output axes of not less than the values specified in Table I, page 12 , with the rated load applied under all operating conditions.

3.3.6 Brake Hold Torque

The brakes shall be capable of resisting torques at the output axis of not less than the values specified in Table I, page 12 .

3.3.7 Stow Pin Hold Torque

The stow pins shall be located at the output axes and shall be capable of resisting torques of not less than the values specified in Table I, page 12 .

3.3.8 Limits of Travel

The limits of travel in elevation and azimuth shall be not less than the values specified in Table J, page 12 . The angles in elevation shall be measured from the horizontal. The angles in azimuth shall be measured from stow pin location.

TABLE I

ESSCO 40 FOOT CLASS PEDESTAL - SALIENT FEATURES

Rated Load	50,000 lbs.
Rated Torque*	20,000 ft. lbs.
Intermittent Peak Torque*	40,000 ft. lbs.
Stiffness	
Elevation	6.2×10^7 ft. lbs./rad.
Azimuth	8.2×10^7 ft. lbs./rad.
Elevation Limits	
Velocity Limit	0° + 180°
Position Limit	-2° , Intermediate 99° , + 182°
Mechanical Stops (Elevation only).	-3° , + 183°
Azimuth Limits	
Velocity Limit	+ 365°
Position Limit	+ 370°
Gear Reduction Ratio*	18,000:1
Angular Acceleration*	1 deg./sec. ² (maximum)
Angular Velocity	0.002° - 1° /sec. ²
Gear Train Inertia (At output).	22,200 lb. ft. sec. ²
Gear Trains per Axis	4
Breakaway Friction*	500 ft. lbs.
Brake Hold Torque*	9,000 ft. lbs.
Stow Torque Limit*	50,000 ft. lbs.
Handwheel	1 per axis
Pedestal Weight	20,000 lbs.
Lubrication	Grease Lubricated Gearing
Structure Material	ASTM A36
Hardware	Stainless Steel and Zinc Plated, Grade 5
Estimated Service Life	15 years
Motor and Load Characteristics:	
Motor Rated Speed	3,880 rpm
Motor Rated Torque	0.5 ft. lbs.
Motor Peak Torque	4 ft. lbs.
Motor Inertia	7.5×10^{-6} lb. ft. sec. ²
Reflector Diameter	45 ft.
Reflector - Counterweight Inertia	
Elevation	89,300 lb. ft. sec. ²
Azimuth	112,000 lb. ft. sec. ²

*Applies to both the elevation and the azimuth axes

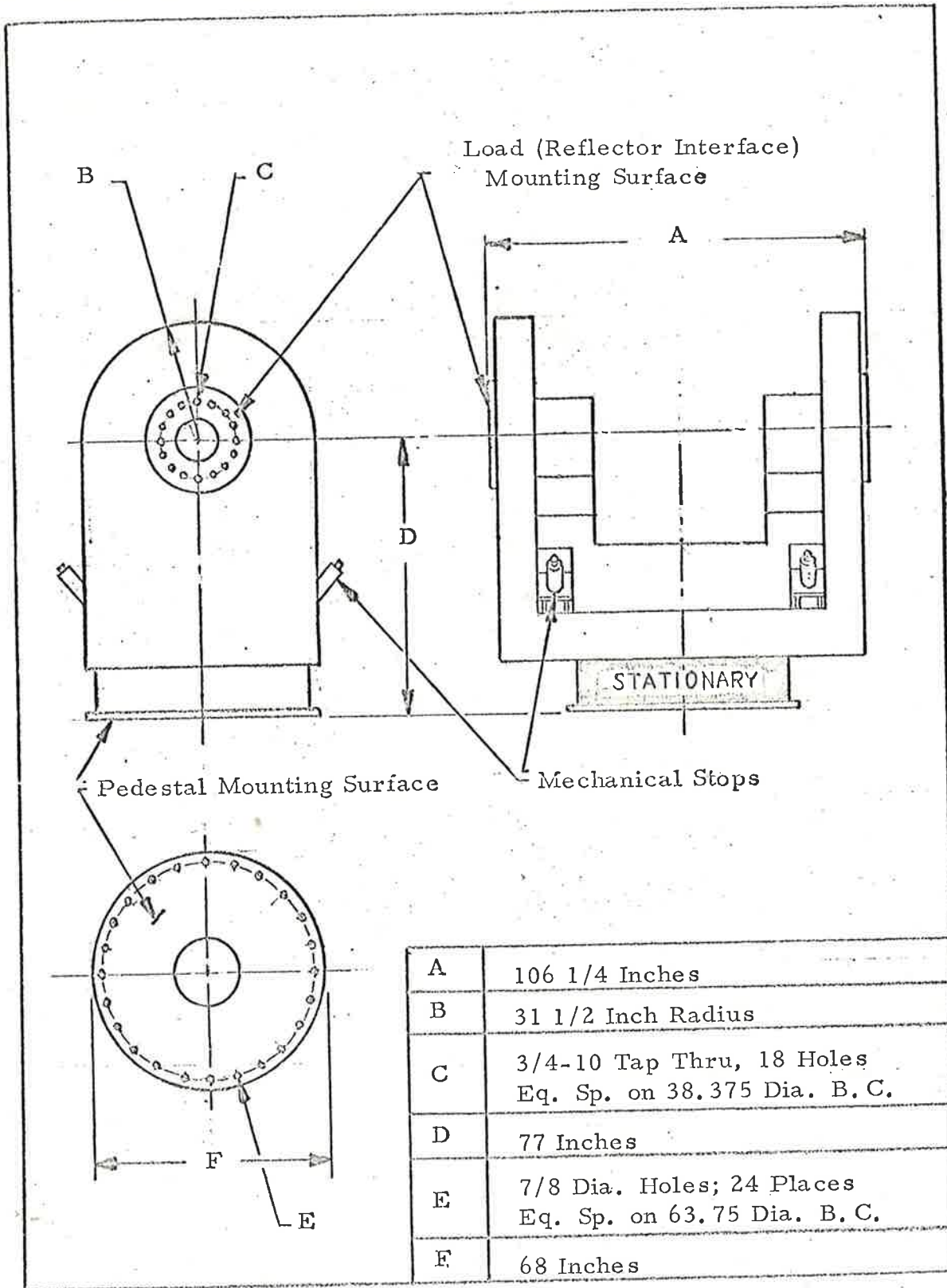


Figure 1 Pedestal Dimensions

4.0

OPTIONAL AND/OR ACCESSORY EQUIPMENT

The following items specify accessory equipment which may be employed with this pedestal. These items are not deliverable items and shall not be supplied unless adequate provision for them has been made in the contract covering the supply of all items.

4.1

REMOTELY CONTROLLED STOW PIN(S)

Remotely controlled stow pins shall be provided for the elevation or azimuth axes or both. The remotely operated pins shall also be capable of manual insertion and retraction.

4.2

PEDESTAL LIFTING SLING

A lifting sling shall be provided, which attaches to the two lifting eyes on the elevation housing and terminates in an eyelet that shall be used for attachment to a crank hook. The sling shall consist of steel wire rope and fittings adequate to safely lift the entire pedestal.

4.3

ENCODERS AND INTERFACES

Suitable encoders shall be supplied with the pedestal. The encoders shall be mounted on the output axes or incorporated in the data packages as required by the contract.

4.4

MOTORS AND TACHOMETERS

Motors, tachometers and synchros shall be supplied with and installed in the pedestal. The motors, tachometers and synchros shall be compatible with the capabilities of the pedestal.

5.0

PREPARATION FOR DELIVERY

5.1

PRESERVATION, PACKING AND MARKING

The pedestal shall be of rugged design, capable of being transported by truck, van, rail, aircraft or ship. The pedestal shall be packaged for transport in accordance with the pedestal supplier's commercial practice in a manner that will ensure safe delivery. Marking shall be in conformance with MIL-STD-129. Preservation and packing shall be in accordance with MIL-E-17555, level C/C, and MIL-P-116, Method III.

6.0

PEDESTAL SUPPLIER FURNISHED SUPPORT SERVICES

The following items specify support services which may be provided with the pedestal. These items are not deliverable items and shall not be supplied unless adequate provisions for them have been made in the contract covering the supply of all items.

6.1

PEDESTAL FOUNDATION AND TOWER

When included in the contract, the pedestal supplier shall construct the foundation and supply and emplace a tower in accordance with the tower and foundation design criteria as referenced in paragraph 7.4.4.

6.2

PEDESTAL INSTALLATION

The pedestal supplier shall install the pedestal and all accessory equipment as provided for in the contract.

6.3

TRAINING PROGRAM

The pedestal supplier shall provide personnel to conduct an on-site training program. This program shall include procedures for pedestal and accessory inspection, service and training for the proper use of the pedestal and all accessory equipment.

7.0 QUALITY ASSURANCE PROVISIONS

7.1 SERVICE LIFE

The pedestal shall be designed to provide an estimated service life of approximately 10 - 15 years when operated and serviced in accordance with the operation and service manuals described in paragraph 7.4.5. The high quality materials specified shall not be deviated from and equally high standards of workmanship shall be employed to insure compliance with this specification.

7.2 PEDESTAL TESTS

7.2.1 Pedestal Stiffness

A torque load shall be applied to the elevation axis of the pedestal to demonstrate that the stiffness is in accord with the requirements of this specification.

7.2.2 Orthogonality

The orthogonality of the assembled pedestal shall be measured to demonstrate conformance with the requirements of this specification.

7.2.3 Backlash

The backlash of each axis shall be measured at the output to demonstrate conformance with the requirements of this specification. miss 2,

7.3 QUALITY ASSURANCE PROGRAM

A quality assurance program, conforming to MIL-Q-9858A, shall be applied during the manufacture and installation of the pedestal. Adequate records shall be maintained of all receiving, in-process and final inspection and tests performed in controlling and assuring the quality of the pedestal produced in accordance with this specification.

7.3.1 Inspection and Test Conditions

All required inspections and tests shall be the responsibility of the pedestal supplier and shall be performed at prevailing ambient conditions.

7.3.2 Access to Records

During the manufacture of the pedestal, the buyer shall be allowed access to all applicable quality assurance records pertaining to the production of the pedestal and accessory equipment as specified herein.

7.4 DOCUMENTATION

7.4.1 Stress Analysis

A stress analysis of the pedestal shall be submitted after order placement, if provided for in the contract. The analysis shall encompass critical loading conditions and shall include emergency stop loads imposed on the drive system and pedestal structure.

7.4.2 Pedestal Drive Service Life Analysis

A service life analysis of the pedestal drive shall be submitted after order placement, if provided for in the contract. The analysis shall encompass the normal operating loads on all the bearings and gears in the drive train.

7.4.3 Pedestal Test Data

A test report summarizing the results of the tests described in paragraph 7.2 shall be submitted within 30 days after completion of testing.

7.4.4 Tower and Foundation Design Criteria

The tower and foundation design criteria shall be provided by the pedestal supplier after order placement, if provided for in the contract.

The design criteria shall be capable of being fully implemented by the pedestal supplier and/or others as specified and required by the contract.

7.4.5 Operation and Service Manual

An Operation and Service Manual shall be submitted at the time of delivery of the pedestal. The manual shall contain:

- (a) Operating procedures.
- (b) Dimensional Information
- (c) Service and adjustment procedures

7.4.6 Acceptance Criteria

7.4.6.1 Pedestal and Accessory Equipment Acceptance

The documentation specified in paragraph 7.4, along with visual inspection in accordance with the quality assurance provisions of this specification, paragraph 7.3, shall constitute acceptance of the component parts and accessories of the pedestal.

7.4.6.2 Installation and Service Acceptance

Installation of the pedestal and accessory items, along with visual inspection in accordance with the quality assurance provisions of this specification, paragraph 7.3, shall constitute acceptance of the installation and services supplied.

8.0 BUYER FURNISHED SUPPORT

8.1 SITE ACCESS

The buyer (user) shall provide adequate access roads and ways such that the pedestal, accessories and all necessary installation equipment can be readily delivered to the station or site.

8.2 POWER

The buyer (user) shall provide all power necessary for proper utilization of the pedestal and all accessories and for adequately performing all the installation tasks required by this specification and as required by the contract.