

## SECTION 33 81 13 – COMMUNICATIONS TRANSMISSION TOWERS

### 1.01 SUMMARY:

- A. <sup>A17</sup>**Scope:** Scope of work shall be in accordance with Paragraph 1.01 D. of Section 01 81 26 (Communications, Control, Safety, and Security Systems), as required, for radio-communications in the Works.<sup>A17</sup> This Section of the Employer's Requirements shall be read in conjunction with the Sections listed in Table 33 81 13-1.
- B. **Related Sections:**

Table 33 81 13-1: Related Sections	
1.	Section 01 81 26 - Communications, Control, Safety, and Security Systems.
2.	Section 01 82 13 - Foundations.
3.	Section 26 05 26 - Grounding and Bonding for Electrical Systems.
4.	Section 26 41 16 - Lightning Prevention and Dissipation Systems.
5.	Section 27 37 00 - Mobile Radio-communications Systems.
6.	Section 28 23 00 - Closed Circuit Video Systems.

### 1.02 REFERENCE:

- A. **Applicable Publications:** Refer to Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.02.

### 1.03 REQUIREMENTS:

A. **General Requirements:**

1. **General:**

- a. The Contractor shall meet all applicable requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).
- b. The Contractor shall furnish infrastructure in the new Locks, as required for the systems specified on Section 27 37 00 (*Mobile Radio - Communication Systems*) and Section 28 23 00 (*Closed Circuit Video Systems*).
- c. <sup>A17</sup>Towers shall be self-supported type, of triangular cross section, with 6,096 mm (20') tall sections built of galvanized steel, and adequate for marine environments with salty air atmosphere as per the information included in Volume VI, Part 7 [Hydro-meteorological Report] subject to Sub-Clause 5.1 of the Conditions of Contract, and Paragraph 1.03 J. of Section 01 81 26 (Communications, Control, Safety, and Security Systems).<sup>A17</sup>

2. **Dissimilar Metals:** Under no circumstances shall dissimilar metals be used in contact with one another.
3. **Eccentric Connections:** Towers shall be designed and built to minimize additional stresses from eccentric connections. Stresses resulting from eccentricity shall be included in the design analysis.
4. **Foundations:** Tower foundations drawings and design calculations shall be furnished in accordance with Section 01 82 13 (*Foundations*). As a minimum, foundation shall utilize 3,000 psi concrete and grade 60 reinforced steel.
5. **Galvanizing:** All steel elements shall be hot dip galvanized in accordance with ASTM A 385. Minimum zinc coating thickness shall be 4.5 mils.
6. **Grounding:** Tower grounding shall be in accordance with Section 26 05 26 (*Grounding and Bonding for Electrical Systems*), and shall include an Ufer ground encased in foundation concrete.
7. **Painting:** Towers shall not have finish paint. Note that the Employer normally buys galvanized towers and the first paint job is done approximately two years later.
8. **Structural Steel:** Shall meet the requirements of all applicable AISC, ANSI, ASCE and ASTM standards, including ASCE 10.
9. **Tower Loading:**
  - a. Loading calculations shall be in accordance with <sup>A10</sup>TIA 222<sup>A10</sup> and consider, but not be limited to, all antennas, closed circuit video system (CCVS) cameras, radio frequency (RF) transmission lines, safety climbing ladders, waveguide/transmission line ladders as applicable, wind, and concentrated loads specified herein.
  - b. <sup>A19</sup>Towers shall be designed to withstand steady winds up to 130 km/h (80.8 mi/h) with a gust factor of 1.3 while fully loaded, or as required by “Junta Técnica de Ingeniería y Arquitectura” (JTIA) Reglamento Estructural de Panamá (REP) (Panamanian Structural Design Regulations), whichever is the strictest. <sup>A19</sup>
  - c. Tower horizontal members shall be capable of supporting a vertical load of 113 kg (250 lb) at the midspan in addition to all other design loads.
  - d. Seismic loading shall be as specified in Section 01 81 16.13 (*Seismic Design Criteria*).
10. **Welding:** Shall be in accordance with AWS D1.1, and shall be done by the tower manufacturer.

**B. Equipment and Materials:**

**1. General:**

- a. Tower members shall be tubular or angular shaped.

**2. Antenna Mounts:** Towers shall be equipped with mount assemblies ready to accept the applicable antennas with standard mounts.

**3. Bolts and Nuts:**

- a. Towers shall be provided with the correct length, number, and size of anchor bolts necessary to carry the anticipated tower loads.
- b. Bolts and nuts for structural joints shall be in accordance with ASTM A 325, A 394, or A 490.
- c. Bolts conforming to ASTM A 307 and A 325 shall be galvanized in accordance with ASTM A 153. Pal nut locknuts or other locking devices shall be used to secure all nuts that are not self-locking type.
- d. The Contractor shall provide a minimum of 4% of bolts, lockwashers, and nuts in excess of the actual bolt count. The Contractor shall deliver such spare hardware where indicated by the Employer's Representative.

**4. Obstruction Lights and Controllers:** Shall include lightning protection and be equipped as required.

**5. Rest Platforms:**

- a. Rest platforms shall consist of level platforms of grating allowing room for one person to sit or stand.
- b. Platforms shall be designed and installed to support a minimum of two concentrated live loads of 113 kg (250 lb).

**6. Safety Climbing Ladders:**

- a. All climbing ladder parts shall be made of hot dipped galvanized steel. Each rung and any section of the ladder shall be capable of supporting a concentrated load of 113 kg (250 lb) and 453.6 kg (1,000 lb), respectively.
- b. Rung separation and minimum width shall be 305 mm (12 in) and 406 mm (16 in), respectively. Safety climbing ladders shall have the same size in all tower sections.
- c. The rungs shall be made of 16 mm (5/8 in) rounded solid bars, and the stiles shall be made of 51 mm (2 in) width by 6 mm (¼ in) thick, or larger flat solid bars.

7. **Tie Wraps:** Shall be adjustable, sized as required, and ultra-violet radiation (UV) resistant.
8. **Tubular Safety Rails:**
  - a. Rails shall be made of aluminum or stainless steel with notches in the carrier rail on 152 mm (6 in) spacings. Safety sleeves shall engage one of these notches in case of a slip or fall.
  - b. Rails shall be designed to absorb the impact load of 227 kg (500 lb) in a 305 mm (12 in) free fall, and to support a minimum static load of 454 kg (1,000 lb).
  - c. Rails shall be built in accordance with Federal Specification RR-S-001301 and conform to OSHA requirements in 29 CFR 1910.
  - d. Rails shall be “*Tubular Rail System*” manufactured by Antenna Products ([www.antennaproducts.com](http://www.antennaproducts.com)), Mineral Wells, TX, USA, as described in [www.antennaproducts.com/tubular.html](http://www.antennaproducts.com/tubular.html). Since this is the Employer’s current standard for safety in 37 existing towers, sole source is justified for compatibility with existing Employer safety sleeves.
9. **Waveguide/Transmission Line Support Ladders:** Shall be made of aluminum and provide space for running twice the initial amount and size of installed vertical cabling.
10. **Waveguide/Transmission Line Support Trays:** Shall be made of fiber glass, be all dielectric, and provide space for running twice the initial amount and size of installed horizontal cabling.
11. **Wires for Obstruction Lights:** Shall be marine type watertight cables with three or more #10 AWG copper conductors unless larger quantity and gage is required, extruded silicon rubber insulation, glass braid, and braided metal armor, suitable for up to 1,000 volts.
12. **Work Platforms:** Shall be full platforms with handrails and an access hatch, with decking made of anti-slip grating, and capable of two concentrated live loads of 113 kg (250 lb).
13. **Tower Legs:** Shall have a pair of holes at the bottom end near anchors for drainage and rust inspection purposes.
14. **Ground Rods:** Shall be 15 mm (5/8 inch) diameter by 2.44 m (8 feet) long or larger, and Copperweld type.
15. **Underground Conductors:** Shall be #2/0 or with larger ampacity, solid or stranded copper, and with rectangular or circular cross-section. Rectangular conductors are preferable for low inductance in addition to low resistance.

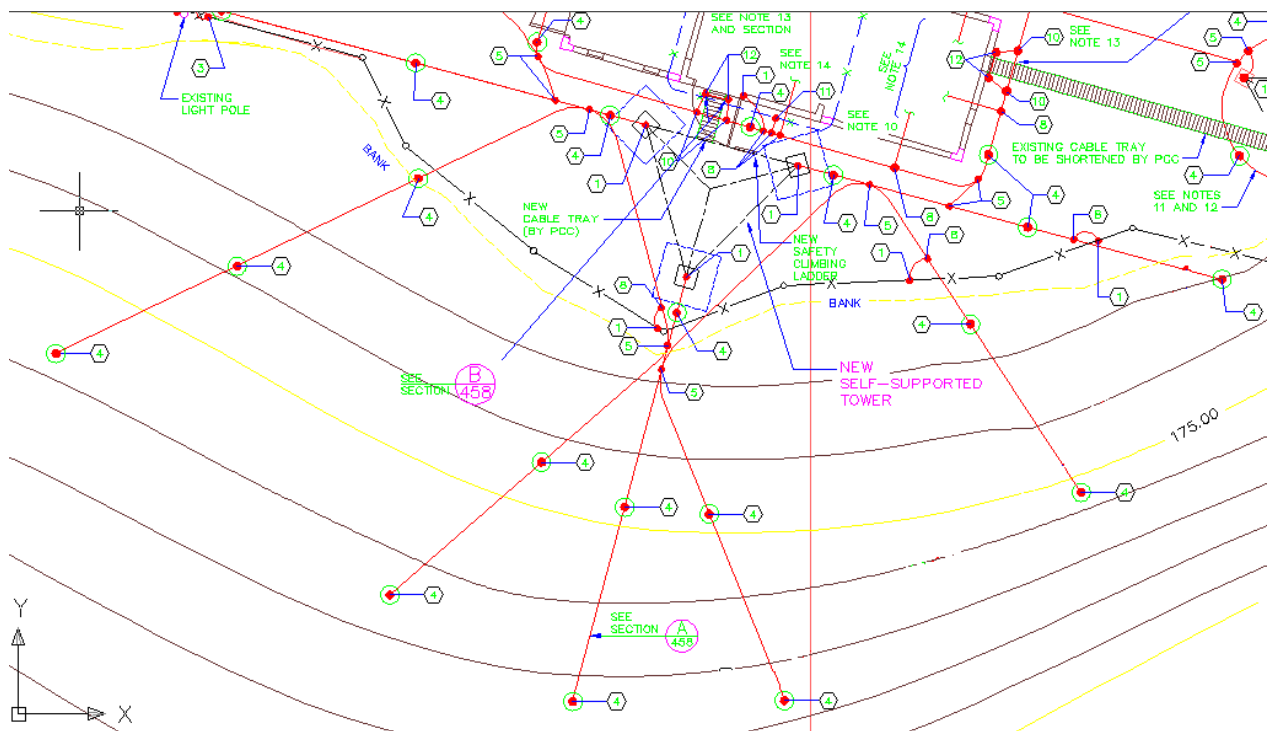
**C. Installation:**

**1. General:**

- a. All threaded fasteners shall extend no less than 38 mm (1.5 in) beyond nuts and locking devices.
- b. Bolts shall be tightened in accordance with <sup>A10</sup>TIA 222<sup>A10</sup> and RSCS Specifications. Excessive torque shall be avoided.
- c. There shall be no conduits along towers.
- d. Tower installation shall not start before 28 days from the date of concrete pouring in tower foundation.
- e. Tower elements shall not be in direct contact with earth at any time.
- f. Defective or deformed elements shall be replaced.

**2. Grounding and Bonding:**

- a. Work shall include a ground loop around the tower base and radials going away from the building where communications equipment is housed, as illustrated on Figure 33 81 13-1. Tower ground shall also be bonded to ground loop around the building.



**Figure 33 81 13-1:** Example of typical tower radials going away from equipment shack.

- b. There shall be no **down-conductors** from top to bottom of the towers. The tower's metal structure shall be used as **down-conductor**.
  - c. All RF transmission line and waveguide shields shall be grounded to the tower at two points: near each antenna and near the horizontal tray for building entrance.
  - d. Underground conductors shall be buried at least 0.8 m deep. All above and below ground connections shall be done by exothermic welding.
  - e. Whenever cables need cleaning before making welded connectors, cleaning shall be made with a metal brush. Cables shall never be cleaned with acid.
  - f. Ground conductors shall not change direction abruptly.
- 3. **Rest Platforms:** (reserved)
- 4. **Safety Climbing Ladder:**
  - a. One ladder shall be installed on an outside face of the tower from bottom to top of each tower, offset 152 mm (6 in) to the left of the tower face's center.
  - b. Separation from the waveguide/transmission line support ladder shall be uniform and as close as possible to 305 mm (12 in).
  - c. **Lower end of ladders shall not be embedded in concrete.**
- 5. **Top Platform:** Shall be installed approximately 1 m below tower top.
- 6. **Tubular Safety Rails:** Shall be installed on all safety climbing ladders without the use of special tools or equipment.
- 7. **Waveguide/Transmission Line Support Ladder:**
  - a. One ladder shall be installed on an outside face of the tower bottom to top of each tower, offset 152 mm (6 in) to the right of the tower face's center. Width shall be as required and no less than 610 mm (24 in).
  - b. **Lower end of ladders shall not be embedded in concrete.**
  - c. Photographs 33 81 13-1 through -3 illustrate standard Employer installation practices to be followed.



**Photograph 33 81 13-1:** Close-up of safety climbing ladder (with rail) and waveguide/transmission line support ladder.



**Photograph 33 81 13-2:** Close-up of waveguide/transmission line support ladder, installed without welding.



**Photograph 33 81 13-3:** Typical installation of tower safety climbing ladder (left) and waveguide/transmission line support ladder (right) on outside of tower face.

8. **Wires for Obstruction Lights:** Shall be installed on a waveguide/transmission line support ladder, and shall be tied with approved tie wraps.
9. **Ground Rods:** Spacing between rods shall not exceed twice the rod length.
10. **Tower Foundations:**
  - a. Prior to concrete placement, bottom of excavation shall be compacted, dry and free from loose materials, and sides of excavation shall be rough and free of loose cuttings.

- b. Concrete shall be placed in a manner that will prevent segregation of concrete materials and other occurrences which may decrease the strength or durability of the foundation.
- c. Foundations shall be a single one for all three tower legs, and shall be made of monolithic concrete with reinforced steel. Steel shall be covered by no less than 76 mm (3 inches) of concrete, and shall not be welded.
- d. Anchors shall be placed within the manufacturer recommended tolerances.
- e. After leveling of first tower section, the space between concrete foundation and tower leg flanges shall be filled with grouting, with a slot for drainage as illustrated in Figure 33 81 13-2.
- f. Upper concrete surface between anchors shall be level with a scratched finish. Upper concrete surface outside anchors shall be slightly sloped for drainage purposes.
- g. All exposed edges shall be chamfered 19 mm (0.75 inch) minimum, as illustrated in Figure 33 81 13-3. Sharp edges are unacceptable.

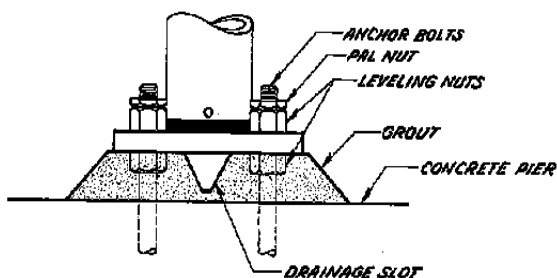


Figure 33 81 13-2: Grouting and drainage in tower anchorage area



Figure 33 81 13-3: Edge chamfering of foundation edges (ref. upper left corner)

- h. Tower base area shall be covered by 152 mm (6 inch) or thicker layer of gravel (on geo-membrane) or asphalt with to prevent grass growth, and shall extend no less than 1 m beyond tower legs.

#### 1.04 DESIGN CRITERIA/SYSTEM PERFORMANCE:

##### A. General:

1. **Problem to be Solved:** Towers shall solve the following business needs:
  - a. Provide a stable, self-supporting structure of adequate height and dimensions adequate for installation of C CVS and radio communication devices.



2. **Restrictions to be Considered:**

- a. Safety tubular rail system shall be sole source (ref. paragraph 1.03 B. 8.) or fully meet the Employer's standard for safety for compatibility with Employer safety sleeves existing at the time of installation.

B. **Design Criteria:**

1. Towers and components shall meet all applicable requirements of Panama's *Dirección de Aeronáutica Civil* (AAC, [www.aeronautica.gob.pa](http://www.aeronautica.gob.pa)), as well as U.S. FAA ([www.faa.gov](http://www.faa.gov)) and FCC ([www.fcc.gov](http://www.fcc.gov)) Rules and Regulations, whichever is the strictest.
2. Towers shall meet all applicable requirements of <sup>A10</sup>TIA 222. <sup>A10</sup>
3. All design, including analysis, computations, and installation drawings shall be certified by a licensed professional engineer.

C. **System Performance:**

1. Towers shall provide the required height and clearance to RF antennas and CCVS cameras.
2. Structural rigidity shall be such that sway and twist do not exceed  $\pm 0.5^\circ$  under the maximum design load and wind conditions.

**1.05 SUBMITTALS:** The following shall be submitted for substantiation purposes:

- A. **Design:** The following shall be in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), <sup>A9</sup>Subparagraph 1.05 D.: <sup>A9</sup>
  1. Calculations, including foundation design and tower loading, both by a certified civil or structural engineer.
  2. Critical path method (CPM) diagram, with monthly updates.
  3. Descriptive literature.
  4. Drawings, including tower, foundation, lightning protection, and obstruction lighting.
  5. Protection methods for corrosion, fungus/humidity, lightning/surge, thermal, and vibration.
  6. Quality assurance and control plans.
  7. Specifications.
  8. Any other data required for review.
- B. **Re-submittals Just Prior to Purchasing Materials:** All items in A. above that have changed from original submittal shall be resubmitted in a design conference in

accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.05.

**C. Upon Receipt of Shipped Items in Panama:**

1. Instruction manuals for installation and maintenance.
2. Packing lists.

**D. Prior to Issuance of Taking Over Certificate:**

1. As-Built drawings.
2. List of recommended spare parts.
3. Test reports.

**1.06 QUALITY ASSURANCE:** Shall include the following in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.06:

**A. Factory quality control tests (FQCT).**

**B. Final field inspection tests (FFIT):**

1. **Galvanizing:** Shall be inspected in accordance with the procedures of AZI Inspection Manual.
2. **Verticality:** Towers shall be **plumb and** vertical within the limits specified in **ASCE 10 and** <sup>A10</sup>TIA 222<sup>A10</sup> when viewed from any two directions **approximately** 90° apart in the horizontal plane **or three directions approximately 120° apart**. This shall be verified by a certified surveyor.

**C. Warranty.**

**END OF SECTION**