

**SPECIFICATIONS FOR  
FURNISHING AND ERECTING STEEL RADIO TOWER NEAR HARRIS, MISSOURI**

**GENERAL:**

Missouri Highways and Transportation Commission (hereafter "Commission") desires to purchase one (1) installed 150' self-supporting tower with specified antennas, feed lines, ice bridge, waveguide ladder, climbing ladder with safety climb system and other related items in accordance with the TIA-222-G and other specifications as detailed below. In addition the Commission desires to replace the fencing and all site grounding including the building ground ring located at this tower site. This tower will replace an existing tower. The exact location of the existing tower is 40° 20' 35"N, 93° 18' 47.0"W in Sullivan County, MO.

**TOWER AND INSTALLATION REQUIRMENTS:**

**1. Project Timelines.**

- a. General drawings showing the type of construction, type of members, type of connections and any other pertinent information shall be submitted with the contractor's bids.
- b. Upon award of bid a notice to proceed will be issued.
- c. It will be necessary to remove the existing tower and foundations before installing the new tower. The contractor shall develop a schedule that will minimize the time that the site is out of service.
- d. The contractor shall provide a bar chart project schedule of work and all other initial submittals including site plans, grounding plan and any other initial submittals required in this RFB within 15 days of "Notice to Proceed".

**2. Standards.** This project shall conform to the latest revisions of the following standards:

- a. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA) 222-G, *Structural Standard for Antenna Supporting Structures and Antennas*, hereafter referred to as TIA-222-G.
- b. Site Grounding and Other Items: Motorola Standards and Guidelines for Communications Sites R56, hereafter referred to as R56.
- c. Missouri Standard Specifications for Highway Construction, hereafter referred to as MoDOT Spec Book.
- d. National Electrical Code, hereafter referred to as NEC.
- e. Any applicable Federal Communications Commission standards hereafter referred to as FCC.
- f. Any applicable Federal Aviation Administration standards, hereafter referred to as FAA.
- g. Any applicable Occupational Safety and Health Administration standard and practices, hereafter referred to as OSHA.
- h. Any other standards specified in the above documents or this request for bid (RFB).
- i. In the case of a conflict, the most stringent standard shall be used.
- j. It is the responsibility of the contractor to obtain copies of any required standards. The MoDOT Spec Book can be found on the MoDOT web site at

### **3. Design Requirements.**

- a. All structural elements shall conform to TIA-222-G and the following.
  - The tower shall be triangular in cross section and of rigid frame construction. All vertical tower members shall be tubular round or solid round.
  - Towers may be fabricated in sections of 10' or 20' (+/-) lengths.
  - All parts of the tower structure shall be made of structural steel conforming to TIA-222-G. Bolts, other connecting devices and welding shall conform to TIA-222-G.
  - The structural classification as defined in TIA-222-G shall be Class II.
  - The exposure category as defined in TIA-222-G shall be Exposure C.
  - The topographic category as defined in TIA-222-G shall be Category 1.
  - Design loading shall include all current and future antennas as detailed below, all feed lines, mounting hardware, aviation lighting, climbing ladder, waveguide ladder, safety climb system, any other wiring, hardware and appurtenances as required for the final installation.
  - Design criteria shall conform to TIA-222-G, Annex B for the county of the tower installation except for frost depth as defined below.
- b. The steel structure and all steel items shall be hot dip galvanized and shall not require primer and/or paint. Hot dip galvanizing shall conform to TIA-222-G.
- c. All steel items that are not part of the tower structure shall be designed to withstand the loading for the specified application and shall meet all applicable standards in this RFB and any industry standards.
- d. Mat and pier type foundation or drilled shafts are the preferred designs for the tower foundation. No surface slab-type foundations will be allowed for any tower or guy anchor foundations. A design frost depth of at least 40" shall be used for all tower and guy anchor foundations regardless of location.
- e. The tower shall include a fixed climbing ladder or step bolts and safety climb system the entire height of the tower in accordance with TIA-222-G, Class B.
- f. Waveguide ladders shall be installed on the tower at a spacing of 5' or less increments the entire height of the tower and it is preferred that they are fabricated into the tower structure.
- g. The replacement tower shall be located as close as practical to the same location as the existing tower including the tower foundation. Existing tower foundation shall be removed in its entirety before installation of new foundation.
- h. Soil boring sample results are included in this RFB.
- i. An approximate proposed site layout and existing tower information are included in this RFB.

- 4. Initial Tower and Site Submittals.** Submittals shall include but are not limited to the following and shall conform to all requirements in this RFB. All submittals shall be legible including all details and notes in the format provided. Structural plans, foundation plans and calculations shall be sealed by a Professional Engineer (PE) registered in the State of Missouri.

- a. Detailed structural/fabrication plans of the tower structure, and all related items. The plans shall show overall dimensions, sections, size and relative location of each member, details of connection between tower sections, detail of base plates, climbing ladder and any and all other necessary structural details as required.
  - b. Structural plans shall include installation requirements to assure that the tower will be installed to withstand all required loading.
  - c. Detailed foundation plans for tower foundation and all related items.
  - d. Stress calculation of the tower and foundations in accordance with TIA-222-G and this RFB.
  - e. Details of tower side and top mount antenna supports, coaxial cable supports and any other details as required.
  - f. Project schedule as described above.
  - g. Site plans showing the exact locations of the entire installation including but not limited to the tower, foundations, equipment shelter (existing), generator slab propane tank, fencing, ice bridge, etc.
  - h. Detailed site grounding plan in accordance with R56 and this RFB.
  - i. Any other submittals required in this RFB.
5. **Removal.**
- a. The existing 150' guyed tower, guy cables and guy anchors that are on site shall be removed and disposed of. All concrete bases and guy anchors shall be removed a minimum of 1' below grade (tower foundation shall be removed in its entirety). Any and all other debris shall be removed and disposed of. No portion of any anchor can be cut off at the ground level. Anchor and foundation design and other information for the existing tower are attached.
  - b. *Preferred disposal:* deliver any recyclable materials to a scrap recycling facility rather than dumping in a landfill.
  - c. Any other antennas, feed lines and mounting hardware that are still in useable condition after demolition shall remain property of the Commission.
6. **Tower Fabrication.** Upon notification by the Commission, the contractor may order the fabrication of the tower structure. The fabricated tower shall conform to TIA-222-G and the approved drawings and specifications detailed above. All manufacturing and fabrication shall conform to TIA-222-G.
7. **Clearing and Excavating.** The contractor shall furnish all equipment, labor, forms, all material, and the performing of all operations in connection with the excavation and installation of tower base foundations, ground rings, fence post bases and any other underground items. All vegetation, roots brush, grass sod, decayed matter, rubbish, etc. shall be removed from the area and disposed of by the Contractor. Any removal of trees shall be approved by the Commission in coordination with the land owner. All excavated waste shall be disposed of by the Contractor as directed by the Commission.
8. **Tower Installation.** The tower shall be installed following the approved contractor provided schedule. Tower installation shall conform to the manufacturer's plans and requirements as approved by the Commission and requirements below. The contractor shall follow applicable Occupational Safety and Health Administration (OSHA) and any other applicable safety requirements.

- a. **Equipment and Materials.** The contractor supplied equipment and materials shall be as specified in this RFB and shall be new and the manufacturer’s latest current model.
  - b. **Tower Plumb.** The entire tower shall be plumb from the top to the bottom. The contractor shall confirm that the tower is plumb with a transit after final guy wire tensioning and provide a certification. The contractor shall demonstrate conformance if requested by the Commission.
  - c. **Galvanizing Repair.** Any damage to galvanized surfaces shall be brought to the attention of the Commission. Major damage will be reviewed by the Commission to determine if a field repair may be made. Any field repairs shall follow ASTM Standard A780. Use of paints containing zinc dust is permitted. It understood that the cad welding process detailed below will require field galvanizing repair.
- 9. Tower Concrete.** All concrete, reinforcing steel, any associated materials and installation practices shall conform to all concrete requirements in other sections of this RFB. Concrete shall have minimum design 28 day compressive strength of 4000 PSI, and compression testing shall be performed at 7 days and 28 days. The contractor shall be responsible for field quality control as described in other sections of this RFB including but not limited to making and testing concrete test cylinders. The cylinders shall remain on site until contractor is ready to break. Test reports of tower foundation concrete breaking strength shall be provided to the Commission prior to tower erection.
- 10. Antennas.** The following antennas and feed lines shall be provided and installed according to manufacturer’s specifications and this RFB. Also see antenna placement diagram below. No substitutions will be allowed unless otherwise noted.
- a. **Antennas.** Quantity 2 CommScope® DB224A VHF dipole antennas shall be provided and installed at heights shown below. Mounting leg and orientation shall be as directed by Commission staff.
  - b. **Feed Line.** All feed line for DB224A antennas shall be provided and shall be 7/8” Heliac® – Part #AVA5-50FX. See below for installation requirements.
  - c. **Antenna Schedule.** These antennas shall be installed with this project.

<u>Antenna Type</u>	<u>Base Height</u>	<u>Mount Type</u>	<u>Feed Line</u>
CommScope DB224A (primary)	150’	Top Mount Omni configured	7/8” Heliac
CommScope DB224A (Spare)	120’	Side Mount Omni configured	7/8” Heliac

- d. **Future Antennas.** The following future antennas and feed lines will not be installed at this time, but will be used for structural design purposes.

<u>Antenna Type</u>	<u>Base Height</u>	<u>Mount Type</u>	<u>Feed Line</u>
3' Round Dish – PCTEL MPCRC3649	150'	Dish Mount	
3' Round Dish PCTEL MPCRC3649	150'	Dish Mount	
15" Square "ODU" Airmux-400	150'	Leg Clamp	Outdoor CAT5
15" Square "ODU" Airmux-400	150'	Leg Clamp	Outdoor CAT5
CommScope DB224A	95'	Side Mount	7/8" Helix

- e. **Polyphaser® Coax Protectors.** The contractor shall provide and install quantity 2 Polyphaser® part # IS-50NX-C2-MA. Coax protector shall be installed according to manufacturer specifications and grounded according to R56.
- f. **Repeater Jumper.** The contractor shall provide and install quantity 1 jumper with Type N male connectors on both ends between the Polyphaser® and the MoDOT repeater. Any unused jumpers shall be neatly coiled and secured. Jumpers shall be made from Times Microwave® LMR400 cable with properly installed connectors. The length of the jumpers will be as needed to span from the Polyphaser to each repeater duplexer in the final locations. Jumpers shall be one piece, splices will not be allowed. The total loss of each jumper with connectors installed shall not exceed the following at 155 MHz.
- 0.3 dB up to 10'
  - 0.5 dB from 11' to 20'
- g. **Testing.** The contractor shall test the transmission lines and antennas after installation. The contractor shall test the lines with appropriate calibrated test equipment for losses and for SWR. Sweep test equipment shall use frequency domain reflectometry (FDR). Any shorts or other issues discovered in the transmission lines, antennas or accessories shall be corrected by the contractor. All test results and sweeps shall be provided to MoDOT for approval before final acceptance. The contractor shall be responsible for making all final connections. The installed coax cable and connectors shall not exceed the following specifications.
- **SWR Testing.** The maximum Standing Wave Ratio (SWR) measured from the transmitter side of the Polyphaser shall not exceed 1.5 with the final antenna connection in place at 155 MHz (for High VHF antennas).
  - **Return Loss Sweep Testing.** A sweep test with distance on the horizontal and dB on the vertical scale shall be run. These losses shall be measured before the final antenna connection is made (*without* the antenna in place, but including the polyphaser and all jumpers). The return loss shall not exceed 26 dB anywhere on the sweep.

- **Coax Loss Testing.** The total loss from the transmitter side of the Polyphaser to the antenna connection, including the Polyphaser, and all installed connectors shall not exceed the following losses measured at 155 MHz. These losses shall be measured before the final antenna connection is made (*without* the antenna in place, but including the polyphaser and all jumpers).

Coax Type	Length	Maximum dB Loss†
7/8" Helix	<= 100'	0.8
7/8" Helix	101' to <= 200'	1.3
7/8" Helix	201' to <= 300'	1.8
7/8" Helix	301' to <= 350'	2.0
1/2" Helix	<= 100'	1.2
1/2" Helix	101' to <= 150'	1.6
1/2" Helix	151' to <= 200'	2.1

†Including Polyphaser and both end connectors.

- **Distance to Fault Sweep Testing.** A sweep test with distance on the horizontal and VSWR on the vertical scale shall be run on the final installation with the antenna in place, including the polyphaser and all jumpers. These sweeps shall be provided to MoDOT for records.

## 11. Feed Line Installation and Grounding.

- Continuous Cables.** All coax cable runs shall be continuous from the antenna to 1' past the entry tube inside the building connecting to the Polyphaser. No splices will be allowed.
- Coax Ends.** All end connectors for 7/8" feed line shall be CommScope® 78EZN and shall be installed according to manufacturer's recommendations. No substitutions will be allowed.
- Weather Sealing.** All outdoor coax ends shall be sealed as follows; 1 layer of "courtesy tape" (electrical tape), ample butyl Coax Seal® material around the connection on top of the courtesy tape and 3 to 4 layers of 3M Super 33+® tape on top of the coax seal. The connector shall be completely weatherproof.
- Installation.** Coax cables shall be installed so as not to exceed bend radius specifications. Coax cables shall be dressed so that there are no rub points with tower steel, hardware, other cables or antennas.
- Securing Cables.** Vertical cables shall be secured at a spacing of every 5' or less using the waveguide ladder system using appropriate hanger clips. All horizontal cable runs shall be secured at a spacing of every 3' or less. The contractor shall provide and install all hanger clips designed for the waveguide ladder system and specified cables. All cables shall be properly secured at the bottom of the tower and at antenna connections and other locations to prevent stress on the end connectors and prevent any rubbing.
- Hoisting Grips.** Stainless steel lace up style hoisting grips shall be provided and installed according to manufacturer's specifications. A minimum of 1 hoisting grip shall be installed for each coax cable located at the cable. Hoisting grips for 7/8" feed line shall be CommScope® part # 19256B or equivalent.

- g. **Coax Entry Port.** A Tube entry with 4” port. The waveguide entry port shall be provided and installed according to manufacturer’s specifications on the existing building. Applicable rubber boots shall be provided for all installed cable. The entry port shall be Site Pro 1® part # TEP20 or equivalent with matching rubber boots. All unused ports shall be covered with matching rubber sealing caps.
  - h. **Grounding Kits.** Coax grounding kits shall be provided and installed according to R56 and the manufacturer’s specifications. Grounding kits are required at the antenna, tower base and at the equipment shelter entrance for each coax. Grounding kits shall be waterproofed according to R56 and the manufacturer’s specifications. Grounding kits shall be CommScope® Part #220497, no substitutions will be accepted.
  - i. **Cable Marking.** All cables shall be marked with a system to identify each cable top and bottom. A cable marking guide shall be provided to the Commission by the contractor that identifies the antenna or device connected at the top.
12. **Waveguide Ice Bridge.** The contractor shall provide and install a minimum 24” wide hot dip galvanized steel waveguide ice bridge with supports of sufficient strength to protect the cables from falling ice. Sufficient length of ice bridge shall be installed to provide full coverage between the equipment shelter and the tower. The ice bridge shall include trapeze type waveguide supports of necessary size to support all power cables and transmission lines for current and future antennas listed. Trapeze supports shall be provided at a spacing of every 3’ or less of horizontal cable run. Waveguide clips designed for both the trapeze support and the installed cable shall be provided and installed. The ice bridge kit(s) shall be Commscope® part # WB-K210-B or equivalent.
13. **Antenna Tower and Site Grounding Requirements.** Tower, building, fencing and ice shield bridge grounding must meet the latest revision of R56. The following highlights R56 items that apply to this project, but all applicable R56 standards shall be followed.
- a. **Materials.** All grounding materials including but not limited to ground rods, wire, bus bars, conduits, chemical grounding system (if used) shall conform to R56.
  - b. **Ground Rod Spacing.** Ground rod spacing and quantity required shall be determined based on R56 requirements.
  - c. **Cad Welding.** All primary connections shall be exothermically connected (cad welded) on all ends. At a minimum cad welding shall conform to “Installers and Inspectors Guide for CADWELD® Electrical Connectors” by Erico®. This requirement applies to but is not limited to the following:
    - All underground connections.
    - All tower and building ground ring connections and all connections to ground rods.
    - Connections from tower legs to the ground ring.
    - Connections from bus bars to ground rings.
    - All connections to fencing and gate jumpers.
    - Connections to ice bridge support posts and bonding jumpers.
  - d. **Dissimilar Metals.** Dissimilar metals and corrosion control measures shall be employed as specified in R56.
  - e. **Ground Bus Bars.** Bus bars are required at the tower base, outside and inside the equipment shelter (minimum of 3). Bus bars shall conform to R56.

- f. **Waveguide Ice Bridge.** Waveguide ice bridge shall be grounded in accordance with R56 including all support posts, bonding jumpers between support posts and all ice bridge segments.
  - g. **Fence Grounding.** Grounding shall be installed on all fence corner posts, gate posts, with flexible jumpers to gates.
  - h. **Equipment Shelter and AC Service.** A master ground bus bar shall be installed inside the building within 24” of the coax entry port. All internal ground connections shall be as specified in R56.
  - i. **System Resistance Requirements.** Grounding system resistance shall conform to R56 Type “B” Sites. The contractor shall test the ground resistance with appropriate test equipment and procedures and document test results. The contractor shall demonstrate conformance if requested by the Commission.
14. **Fencing and Compound.** Fencing shall conform to fencing requirements found in other sections of this RFB and the following. An approximate compound layout is included in this RFB with additional information.
- a. **Tower Base and Shelter Compound.** Fencing shall be a minimum 6’ tall chain link fence with a minimum of 3-strands of barbed wire topping enclosing the tower, building, generator and propane fuel tank. Also see MoDOT fencing specifications provided.
  - b. **Gate.** A 10’ two piece drive in gate shall be provided and installed at the tower compound. Also see radio tower equipment shelter specification and shelter compound general layout. If a buried pipe is used at the gate closure a minimum of 6” of clean rock shall be placed in the bottom of hole prior to pipe installation and back filling to allow for proper pipe drainage.
  - c. **Weed Barrier and Rock.** All fenced areas shall have 5 oz. Dewitt Pro 5 Weed Barrier fabric, or equivalent heavy duty weed barrier cloth and 4” depth of 1” clean crushed limestone installed throughout the fenced area and 1’ outside the fencing on all sides.
15. **Digital Photograph Requirements.** The contractor shall provide to the Commission digital photographs to demonstrate conformance to this RFB and related requirements. Photographs shall be of sufficient quality, quantity and detail to clearly document the required items. At a minimum the following shall photographs shall be provided.
- a. Site grounding system installation before backfilling
  - b. All foundation forms and re-bar cages before concrete is poured.
  - c. Tower section connection points.
  - d. Antenna installation showing mounts, properly dressed cables, etc.
  - e. Feed line installation demonstrating proper cable supports, hoisting grips, weather sealed connections, ground kit installation, etc.
16. **Final Tower Documentation.** The following final documentation is required in addition to any other documents required in this RFB.
- a. **As Built Drawings.** If any changes are made to the site layout, grounding plans, or other drawings, final as-built drawings shall be provided.
  - b. **Tower Plumb Certification.** Certification that the entire tower is plumb shall be provided.
  - c. **Coax sweeps.** The results of coax cable SWR and loss testing shall be provided.

- d. **Cable Marking Guide.** A guide to the cable marking shall be provided.
- e. **Grounding Test Results.** A report of the grounding system resistance shall be provided.
- f. **Concrete Cylinder Test Results.** Test reports of tower concrete breaking strength.
- g. **Construction Photographs.** Digital photographs to demonstrate conformance to specifications and any other photographs taken to document the installation.

# Harris Tower Antenna Placement

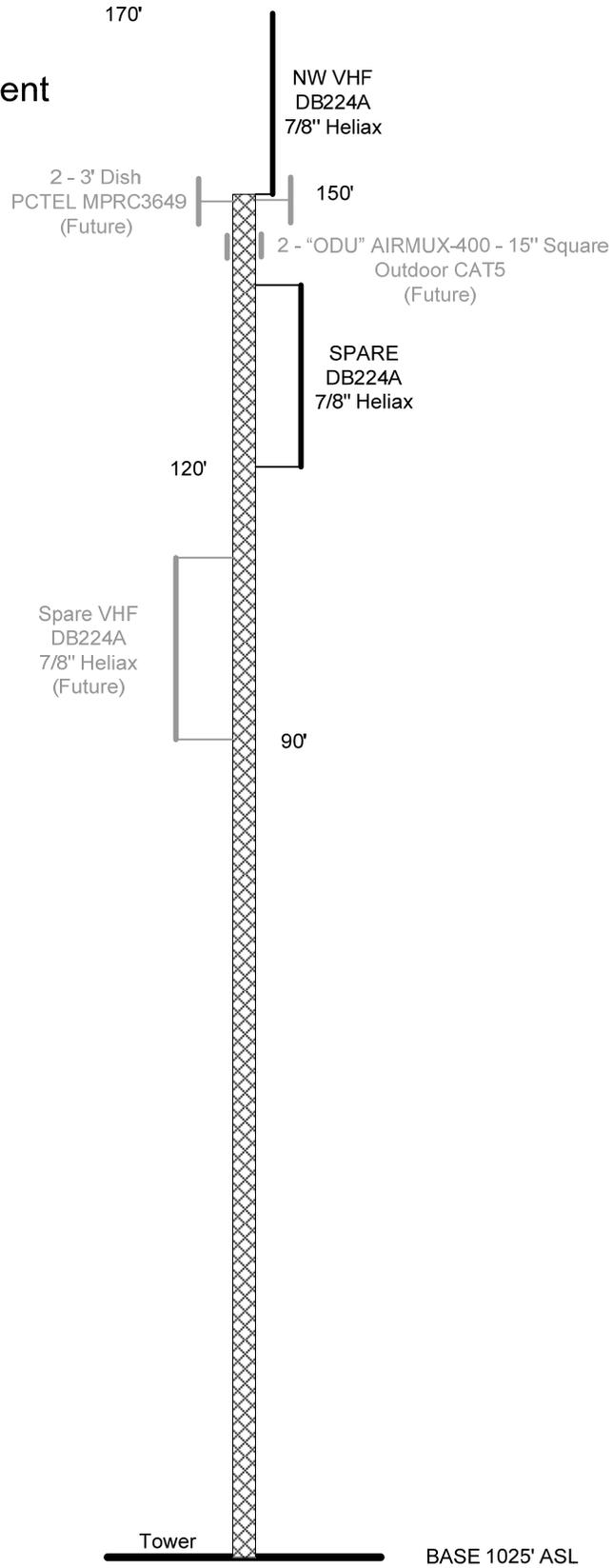
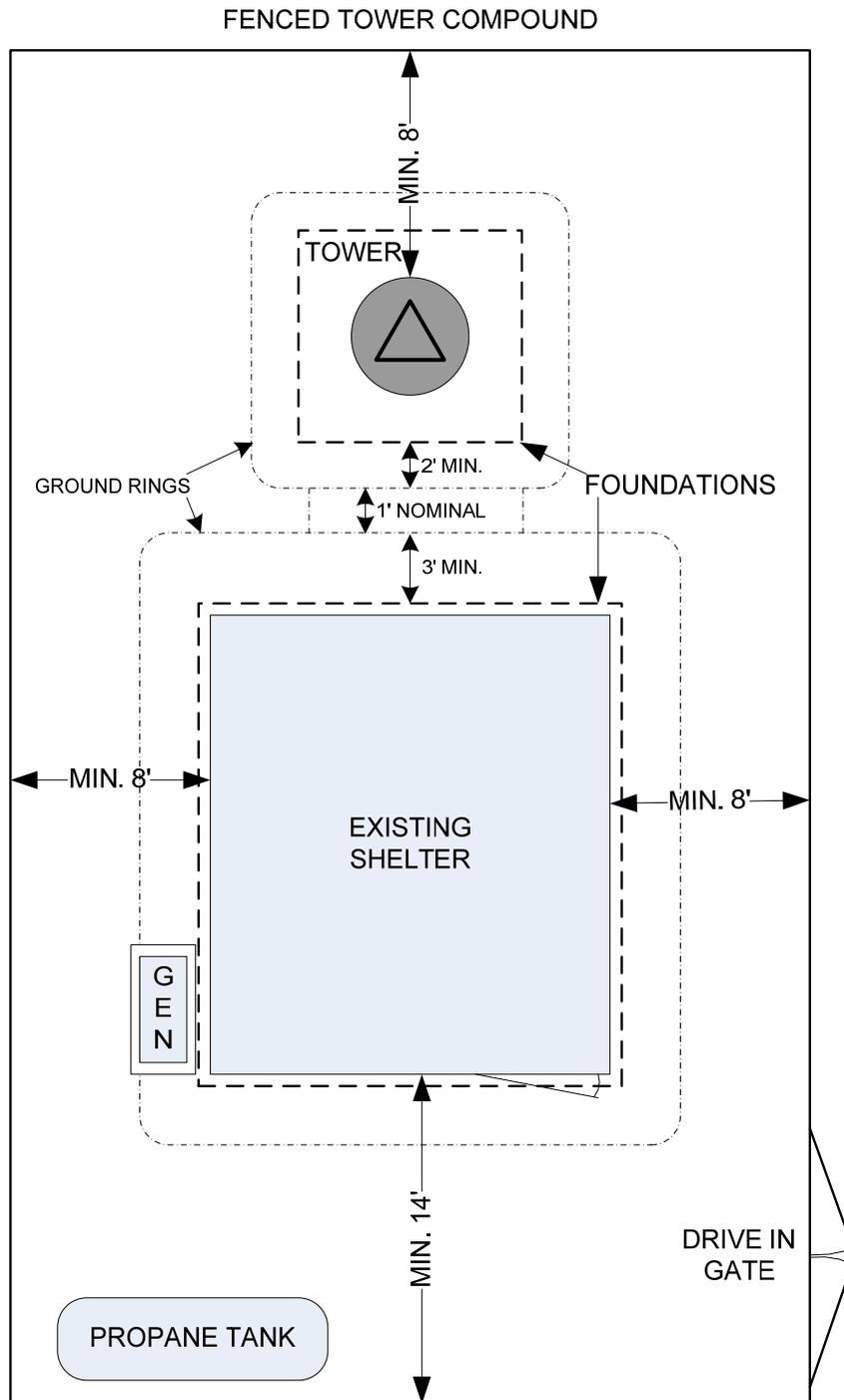


FIGURE 1. ANTENNA PLACEMENT DIAGRAM

# TOWER SITE FENCED AREA TYPICAL DIMENSIONAL REQUIREMENTS



NOTE: Drawing is not to scale. All required items are not shown, this drawing is only to provide information on basic requirements and general dimensional requirements.

FIGURE 2. FENCED AREA