

TOWER INSPECTION and MAINTENANCE

Guyed Tower

For: Great American Insurance Co.

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1.0 INTRODUCTION

The serviceable life of a tower can be drastically altered as a result of inadequate care and maintenance. Any structure that is continually exposed to the forces of nature and a corrosive atmosphere could deteriorate beyond acceptable limits rendering the structure to limits less than the original design intended. Loose members, inadequate guy tensioning, improper positioning of antennas and feed lines, improper damping, etc. can also result in a structure which will not have its intended structural strength. Proper inspection and preventative maintenance is necessary to preserve the integrity of the structure, reducing the probability of mishap or possibly catastrophic failure.

This document covers the basic tower items to be inspected and maintained with guidelines on proper methods of inspection and maintenance included. It is not intended to be all-inclusive and should be expanded where found necessary or desirable. The manufacturer's requirements and suggested procedures for inspection and maintenance shall be included where applicable. Requirements from local or state authorities as well as the interests of insurance carriers shall also be adhered to.

Inspection forms are necessary to document all items of inspection along with their frequencies. The dates of inspections with the signature of the persons performing inspections shall be included. Inspection forms and other document shall be reviewed by management and kept on file. Items found needing repair or replacement shall be recorded. These items should either be repaired immediately or a schedule of importance with proposed dates of completion be established by management.

2.0 INSPECTION FREQUENCIES

The following chart is a summary of minimum inspection frequencies recommended.

Local climate and environmental conditions should be taken into consideration and adjustments made accordingly.

Item	Quarterly	After 1 Year (First Annual)	1 Yr. Frequency After 1 st Annual	3 Year Frequency After 1 st Annual	After Sever Loading Condition (Note
Tower Shaft (Visual)	X				X
Tower Shaft (Climbing)		X	X		X
Vertical Alignment		X		X	X
Guy Lines (Visual)	X				X
Guy Lines (Check Init. Tension)		X		X	X
Foundations	X				X
Obs. Lighting	X	X			X
Elevator ^(Note 2)		X	X		X
Guy Line Damper	X (Visual @ Ground)	X		X	X

Note 1:

Severe loading conditions can be interpreted to be any condition, which subjects the tower and/or supported equipment to high or unusual stresses. Such occurrences include, but are not limited to, sustained wind velocities in excess of 60 MPH, significant ice accumulation, seismic action, galloping guy lines, flooding, etc. Major additions, modifications, or changes in the type and location of equipment erected on the tower will require structural verification and may require special inspection.

Note 2:

In addition to the elevator or equipment hoist maintenance inspection procedures required by the manufacturers, all local and state inspection procedures shall be followed.

3.0 ITEMS TO BE INSPECTED QUARTERLY

3.1 Quarterly Tower Shaft Inspection

The tower shaft shall be visually inspected at least once every three months (quarterly) or after any severe loading condition. The intent of this inspection is to view the tower shaft from the ground, or by elevator if provided, and to verify the following:

- a. Look around to see if there are any bolts, nuts, clamps or other tower or appurtenance parts that have become loose and fallen to the ground, or any evidence that this has occurred on the tower.
- b. Verify that members and appurtenance up the tower look to be in place. This can be accomplished by use of a transit or binoculars. If the tower is equipped with an approved elevator this visual inspection should preferably be conducted while riding up and down the elevator
- c. Verify that all equipment such as antennas, transmission lines, or other appurtenances are positioned at their specified locations and in accordance with the approved tower loading plans and specifications. Verify the type, location, and mounting details are indicated in the inspection report and on the tower's approved inventory listing, or on as-built drawings.
- d. Visually inspect the tower component coating systems (galvanizing or paint) for any signs of deterioration or spots of local corrosion.
- e. Look up the tower and verify that the mast looks straight and is not excessively leaning or is out-of-straightness a noticeable amount.

3.2 Quarterly Guy and Guy Anchor Inspection (for guyed towers)

- a. Visually look at the guy lines to make sure they are in place at the anchor and at the tower. Look at their sags from the anchor to the tower and verify that they look reasonably consistent at each anchor point. This will give an indication if one or more lines have become significantly loose compared to the other guy lines.
- b. Make a visual and physical inspection of each guy line for high frequency vibration. These vibrations can be detected by grasping the strand approximately 2 to 3 feet away from the guy anchor socket and feeling any rhythmic vibrations or jerks on the line, and by listening to any sound frequencies given off from the wires. Inspect the socket at the Hairpin Socket, ESCO Socket, Rocket Socket or Turnbuckle. Make sure safeties are in place, if provided, and that the threaded portions of the fasteners are not backing off. Any anchor nuts and their lock nuts should be securely in place to prevent loosening. The use of spray paint or tape at the threads of these connections can be used as a gage to easily determine if movement has occurred.
- c. All guy lines should be inspected for broken individual wires in the outer layer of the guy strand. A broken wire may be the result of a fatigue break and will likely occur at the closed strand bridge socket at the guy anchor or at the open strand socket at the connection to the tower. The top and bottom 5 feet of guy strand should be inspected for fatigue wire breaks when possible.
- d. Check for signs of corrosion at the point where the strand enters the socket, corrosion of the socket, or corrosion of guy strand wires.
- e. Inspect closed bridge socket “U” bolts, ESCO socket connections, turnbuckles, or shackles for any deterioration, including corrosion.
- f. The guy pins or bolts used as pins at the guy anchor assembly and the guy pins of the open strand socket at the tower attachment plate shall be inspected for any signs of

movement or rotation. Verify that all cotter pins and guy pin bolts are in place and in good condition.

- g. All lighting grounding connections should be inspected to insure that they comply with the approved grounding system design plans and are properly connected. Inspect connections of ground wires where possible to determine if they remain tight and to see if any visible corrosion or wear is occurring.
- h. Anodes for special corrosion protection shall be visually checked to verify their caps are accessible and their connection wires are in place.

3.3 Quarterly Foundation Inspection

- a. The surface of all concrete above grade shall be visually inspected for cracks chips, spalling or other visible signs of damage.
- b. Check the condition of grout under any plates.
- c. Inspect the soil around the guy anchors and the center pier for signs of movement or subsidence. The finish grade of the soil above the guy anchors and center pier should be marked or otherwise referenced for positive drainage of surface water away for the guy anchor assemblies and center pier.
- d. Guy anchor assemblies, anchor bolts, plates, rods and embedded material shall be verified that they are sufficiently above grade to prevent excessive corrosion. If steel materials are not above grade then check of their corrosion protection should be made. This may involve verifying coating systems such as galvanizing, painting, or special wrappings are in place.

3.4 Quarterly Obstruction Lighting Inspection

- a. It should be verified that each light at each level is in working condition.

- b. In addition, obstruction lighting and associated electrical systems shall be inspected quarterly in accordance with the system's manufacturer requirements and as outlined in their maintenance manuals. They shall also be inspected as required by federal and local government codes including the Federal Aviation Administration and the Federal communications Commission.

3.5 Quarterly Elevator or Equipment Hoist Inspection

- a. Tower elevator or equipment hoist systems shall be visually inspected quarterly of all items outlined in their respective maintenance manuals. In addition, they shall be inspected as required by state and/or local governmental codes.

3.6 Quarterly Guy Line Damper Inspection

- a. The location and number of all vibration dampers, high and low frequency, should be in accordance with the approved drawings. The conditions of each vibration damper and condition of all safeties and connection hardware for this equipment should be checked.

4.0 ITEMS TO BE INSPECTED ANNUALLY

4.1 Annual Tower Shaft Inspection

The tower shaft shall be thoroughly inspected by climbing from bottom to top on an annual basis. This inspection shall include the following:

- a. All items listed in the quarterly visual inspection of the tower shaft (Section 3.0).
- b. Verify that locking devices are provided where required, that pins for pin-lock-nuts be engaged, and that the connections are at least snug tight. If plans to have minimum bolt tensions specified, then a spot check of these bolts with a calibrated torque wrench is the preferred method of verification. Bolts for tower members and appurtenances on the tower shall be inspected.

4.1.1 Vertical Alignment

The vertical alignment and straightness of the tower shaft should be checked on a day with little or no wind using a properly adjusted surveyor's transit. Two (2) transit setups are required. One setup is with the transit line parallel to one face of the tower and centered on a tower leg and the second setup shall be with the transit 90 degrees to the same tower leg. Two (2) sets of the readings shall be made at each set-up. The first reading shall be taken with the scope in its normal position; the second reading with the scope inverted and then rotated 180 degrees. The mean of the two readings shall be taken as the final reading.

- a. The following tolerances for vertical alignment are recommended for guyed towers:

Plumb – One part in 2000 (1 inch for 240 feet).

Linearity – The absolute difference between readings at successive guy points shall not exceed one part in 1200 (1 inch for 200 feet).

(The above-recommended tolerances are more stringent than those specified in the EIA/TIA 222-F Standard).

4.2 Annual Guy Line Inspection

a. Guy Line “Initial Tension” check:

The initial tension in the guy lines shall be checked on a calm day. Only the guy lines on the guy radial indicated in the “Guy tension Data” section of the plans need be checked. The initial tension in the guy lines can be determined by direct readings from hydraulic gages or load cells or dynameters. It is also satisfactory to check tensions with the sight intercept distance method with a calibrated guy tension transit. All recorded readings shall include guy tension or sight intercept distance, the date and time the readings were made, the temperature, and the direction and velocity of the wind. Initial tension determined by hydraulic gages or load cells shall be subject to verification by the sight intercept method. A variation of \pm - 5% from the guy line initial tension as shown in the Guy Tension Data section is acceptable.

4.3 Annual Guy Line Damper Inspection

- a. High frequency guy line dampers shall be checked by verifying that they are located in their manufacturer’s proper spacing on the guys and in their designated positions. The number of dampers on each line shall be verified and all parts shall be checked for their proper positioning.
- b. Low Frequency Vibration Dampers or Suppressors shall be lowered to the ground and inspected; this can normally be accomplished in conjunction with guy wire initial tensioning since the low frequency dampers have to be disconnected at the ground to properly check wire tensions.

5.0 ITEMS TO BE INSPECTED ON 1 & 3 YR FREQUENCIES AFTER 1ST ANNUAL

5.1 After First Annual Inspection

Items inspected after the First Annual Inspection are the same as the items listed under the Annual Inspection Section (Section 4.0) with frequencies as listed in the inspection frequency chart.

5.2 After Severe Loading Condition Inspection

“After Severe Loading Condition Inspections” can be interpreted to be any condition that subjects the tower and/or supported equipment to high or unusual stresses. Such occurrences include, but are not limited to, sustained wind velocities in excess of 60 MPH, significant ice accumulation, seismic action, galloping guy lines, flooding, etc. Major additions, modifications, or changes in the type and location of equipment erected on the tower will require structural verification and may require special inspection.

6.0 MAINTENANCE

6.1 Tower Shaft

a. Deficiency and Modifications

All defective items found during any inspection of the tower shaft, whether visually or physically determined, shall be recorded. A schedule to repair or fix items that cannot be corrected during the inspection shall be immediately set up. Items not immediately corrected should be discussed with the Owner, Structural Engineer, and/or Manufacturer to determine the critical nature of the deficiency and to help assure adequate and proper responses are made to all critical items. A qualified structural engineer employed by the Owner, shall be notified of any physical defects such as bows, bends, cracks, breaks, deterioration, missing, or any other deformity of any major tower shaft member such as the tower legs, struts (horizontal support members), diagonals and any redundant members. No modification to the tower shaft, such as removal of any member or fasteners (bolts), or drilling, cutting, welding or otherwise altering any tower member, shall be done without with out approval and supervision of a qualified structural engineer.

b. Vertical Alignment

Adjustments to the tower vertical alignment and the guy line initial tension should be reported to the manufacturer or tower structural engineer when the tolerance or variation of either as outlined in Section 4.1.1 a. and b. is exceeded, and a plumb and tension of the tower scheduled.

c. Erection Bolts and Fasteners

The tower structural member connection bolts should be ASTM A325 galvanized bolts with lock nuts and shall be tightened so that all bolts have equal tension. The self-locking hex shall have a minimum of one bolt thread projected beyond the locking wire or if a lock washer is used one thread above the nut. With the lack of other documented information, at minimum, bolt torques should meet the following criteria:

½ inch – 110 ft-lb	1 inch – 210 ft-lb
5/8 inch – 15- ft-lb	1-1/8 inch – 230 ft-lb
¾ inch – 170 ft-lb	1-1/4 inch – 250 ft-lb
7/8 inch – 190 ft-lb	1-1/2 inch – 300 ft-lb

These torques are the minimum to be accepted with bolts designed for bearing type connections and allowed only with nut locking devices. For friction connections, or AISC fully tensioned connections, higher initial tensions will be required. For torques or tightening of other bolts the manufacturer or structural engineer should be consulted.

d. Corrosion

1. Galvanized Members

Areas of corrosion on galvanized members should be thoroughly cleaned of all corrosion by wire brushing. The surface should then be coated with a ZRC type zinc compound. It should be painted or epoxied with a coating similar to what is in place over the zinc coating.

2. Non-Galvanized members

In some cases tower members or bolts may be used which are not galvanized. These members shall have an alternative coating. If deterioration of this coating system is occurring, it should be repaired by

properly preparing the surface and recoating with the same, or acceptable, similar coating. It is best to consult the manufacturer for appropriate repairs to these items.

6.2 Guy Lines

a. Deficiency

All defective items found during any inspection of the guy line, whether visually or physically determined, shall be corrected as soon as practical.

b. Corrosion

Guy lines with any sign of surface corrosion shall be treated with a special coating. These coatings should be approved by the manufacturer and applied in an approved manor.

c. Initial Tensions

The initial tensions in all guy lines shall be adjusted when the initial tensions are not within the tolerance outlined in Section 4.2.a. The vertical alignment of the tower and antenna shall be adjusted as needed in conjunction with the initial tension adjustments.

d. High Frequency Vibration Dampers

Damaged high frequency vibration dampers shall be replaced as soon as possible. They should be located and positioned as shown on the erection drawings.

6.3 Tower Foundations

a. Deficiencies

All defective items found during any inspection of the foundations or discovered at any other time shall be corrected.

b. Center Pier Concrete or Grout

1. Cracking, spalling, peeling, crazing and efflorescence shall be repaired with cement grout or an approved epoxy resin agent with a minimum compressive strength of 4000 psi. To protect newly repaired surface areas from moisture and chemicals, a penetrating sealant should be applied.
2. Corrosion or rust areas found on any embedded material shall be treated as any galvanized surface.
3. Grounding connections shall be repaired so that the conductivity of the ground system meets its original design requirements.
4. The finish grade of the soil at the center pier shall be shown on the foundation construction drawing and such that it provides positive drainage of surface water away from the center pier.

c. Guy Anchors

1. Cracking, spalling, peeling, crazing and efflorescence of the guy anchor shall be repaired with cement grout or an approved epoxy resin with a minimum compressive strength of 4000 psi. To protect newly repaired surface areas from moisture and chemicals, a penetrating sealant should be applied.
2. Corrosion or rust areas on the guy anchor assembly or any other embedded material shall be treated as any galvanized surface.
3. Grounding connections shall be repaired so that the conductivity of the ground system meets its original design requirements.
4. The finish grade of the soil at the guy anchors shall be shown on the foundation construction drawing and such that it provides positive drainage of surface water away from the anchor. All guy anchor assemblies including the guy pins shall be above finish grade. All soil

used to restore the finish grade to the required elevation shall be similar to the original soil and shall be compacted.

6.4 Tower Obstruction Lighting

All defective items found during a routine inspection or discovered at any other time shall be corrected as soon as possible in accordance with the tower lighting manufacturer's instructions and specifications which are included in the Tower Light Manufacturer's Specifications.

6.5 Tower elevation or Equipment Hoist (If Applicable)

The tower elevator shall be maintained in accordance with the instructions and specifications which are included in the Tower Elevator Maintenance Manual.

6.6 Corrosion Protection Anodes (If Applicable)

Anodes installed as cathodic protection and/or as tower grounding shall be checked and replenished with magnesium if found low. Any broken or damaged connections shall be repaired as soon as practical.