

# SELF SUPPORTING TOWER INSPECTION and MAINTENANCE



*ELECTRONICS RESEARCH, INC.*

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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, improper positioning of antennas and feed lines, 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. Proper inspection and preventative maintenance is also required for the limited warranty of the structure.

This document covers the basic tower items to be inspected and maintained as well as guidelines on proper methods of inspection and maintenance. 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 documents 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 <sup>st</sup> Year (1 <sup>st</sup> Annual)	1 Year Frequency (After 1 <sup>st</sup> Annual)	After Severe Loading Condition <sup>1</sup>
Tower Shaft (Visual)	X			X
Tower Shaft (Climbing)		X	X	X
Vertical Alignment		X	X <sup>3</sup>	X
Foundations	X			X
Lighting System	X	X		X
Elevator <sup>2</sup>		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, 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.

Note 3:

Alignment checks on an annual basis can be verified by a visual check, preferably with a transit. A written record of vertical alignment should be provided every 3 years at a minimum by using a transit and documenting the results.

### **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 to see if there are any bolts, nuts, clamps, 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 appurtenances 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.
- 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 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. Look for cracks or any loose material.
- c. Inspect the soil around the foundation(s) for signs of movement or subsidence. The finish grade of the soil above the foundation(s) should be marked or otherwise referenced for positive drainage of surface water away from the foundation(s).
- 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 a check of their corrosion protection

should be made. This may involve verifying that coating systems such as galvanizing, painting, or special wrappings are in place.

### **3.3 Quarterly Obstruction Lighting Inspection**

- a. It should be verified that each light at each level is in working condition.
- b. Obstruction lighting and associated electrical systems shall be inspected quarterly in accordance with the system manufacturer's requirements and as outlined in the manufacturer's maintenance manuals.
- c. The obstruction lighting system shall also be inspected as required by federal and local government codes including the Federal Aviation Administration (FAA) and the Federal Communications Commission (FCC).

### **3.4 Quarterly Elevator or Equipment Hoist Inspection**

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

## **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 the plans 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.

### **4.2 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. 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.

The following tolerances for vertical alignment are recommended for towers:

Plumb and Straightness – One part in 1000

(The TIA/EIA-222-F standard allows one part in 400)

Twist - The twist between any two elevations should not exceed 0.5 degrees in 10 feet and the total twist in the structure should not exceed 5 degrees.

## **5.0 ITEMS TO BE INSPECTED ON 1 YEAR FREQUENCIES AFTER 1ST ANNUAL**

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.

## **6.0 ITEMS TO BE INSPECTED AFTER A SEVERE LOADING CONDITION**

“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.

## 7.0 MAINTENANCE

### 7.1 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), 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 wire initial tension should be reported to the manufacturer or tower structural engineer when the tolerance or variation of either as outlined in Section 4.2 is exceeded.

#### 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
⅝ inch – 150 ft-lb	1 ⅛ inch - 230 ft-lb
¾ inch – 170 ft-lb	1 ¼ inch - 250 ft-lb
⅞ inch – 190 ft-lb	1 ½ 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 ZRC zinc compound or approved equal. 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.

Recommended product for zinc coating repair:

Organic Zinc-Rich coating containing 95% metallic zinc, by weight in the dried film; recognized under the Component Program of Underwriter's Laboratories, Inc. as an equivalent to hot-dip galvanizing; conforming to Federal Specification DODP-21035A (formally MIL-P-21035A) for repair of hot-dip galvanizing and meeting the requirements of Military Specification MIL-P-26915A USAF Specification for Zinc-Rich Paints; as manufactured by ZRC Worldwide, Marshfield, MA or other facility having been registered to the International Organization for Standardization ISO 9001 standard for quality.

ZRC Worldwide

145 Enterprise Drive

Marshfield, MA 02050

(800) 831-3275

## **7.2 Tower Foundations**

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

a. Concrete or Grout

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.

b. Corrosion or Rust

Corrosion or rust areas found on any embedded material shall be treated as any galvanized surface as called out in Section 7.1 d.

c. Grounding

Grounding connections shall be repaired so that the conductivity of the ground system meets its original design requirements.

d. Soil

The finish grade of the soil at the pier shall be as shown on the foundation construction drawing and such that it provides positive drainage of surface water away from the pier.

## **7.3 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, specifications which are included in the Tower Light Manufacturer's Specifications, and government regulations.

## **7.4 Tower Elevator 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.

## **7.5 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.





# Annual Self-Supporting Tower Inspection

(The Quarterly Inspection must be completed in addition to the Annual)

Check One:

1st Annual Inspection

Other

Inspection After Severe Loading Condition

## CLIMBING INSPECTION OF TOWER MAST

(Circle One)

- a. Is the area free from fallen fasteners or equipment? Y N
- b. Do tower members appear to be in proper position? Y N
- c. Are appurtenances properly attached in the correct locations? Y N
- d. Are feed lines and conduits properly attached? Y N
- e. Is the tower coating satisfactory? Y N
- f. Is the mast straight? Y N
- g. Are all lights at all levels working properly? Y N
- h. Are the ground wires at the base properly attached? Y N
- i. Is the condition of the concrete base pier satisfactory? Y N
- j. Does the base foundation have proper soil cover and drainage? Y N

Comments on any items listed above answered "No"

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Other comments regarding the tower mast and base foundation

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Inspected By: \_\_\_\_\_

(print name)

\_\_\_\_\_

(sign name)

\_\_\_\_\_

(date)



### Annual Self Supporting Tower Inspection

#### TOWER ALIGNMENT

Check with transit. Two transit setups are required. Line transit parallel to one face and center on the leg. Second setup should be at 90° on the same leg. Create a sketch in the space below of the locations used for transit setup. Indicate North.

Elevation	Guy Level (Top to Bottom)	Transit #1 Tower Lays			Transit #2 Tower Lays		
		Left	O	Right	Left	O	Right
_____	1	_____	_____	_____	_____	_____	_____
_____	2	_____	_____	_____	_____	_____	_____
_____	3	_____	_____	_____	_____	_____	_____
_____	4	_____	_____	_____	_____	_____	_____
_____	5	_____	_____	_____	_____	_____	_____
_____	6	_____	_____	_____	_____	_____	_____
_____	7	_____	_____	_____	_____	_____	_____
_____	8	_____	_____	_____	_____	_____	_____
_____	9	_____	_____	_____	_____	_____	_____
_____	10	_____	_____	_____	_____	_____	_____

Approximate wind speed during measurements: \_\_\_\_\_ mph

Sketch