

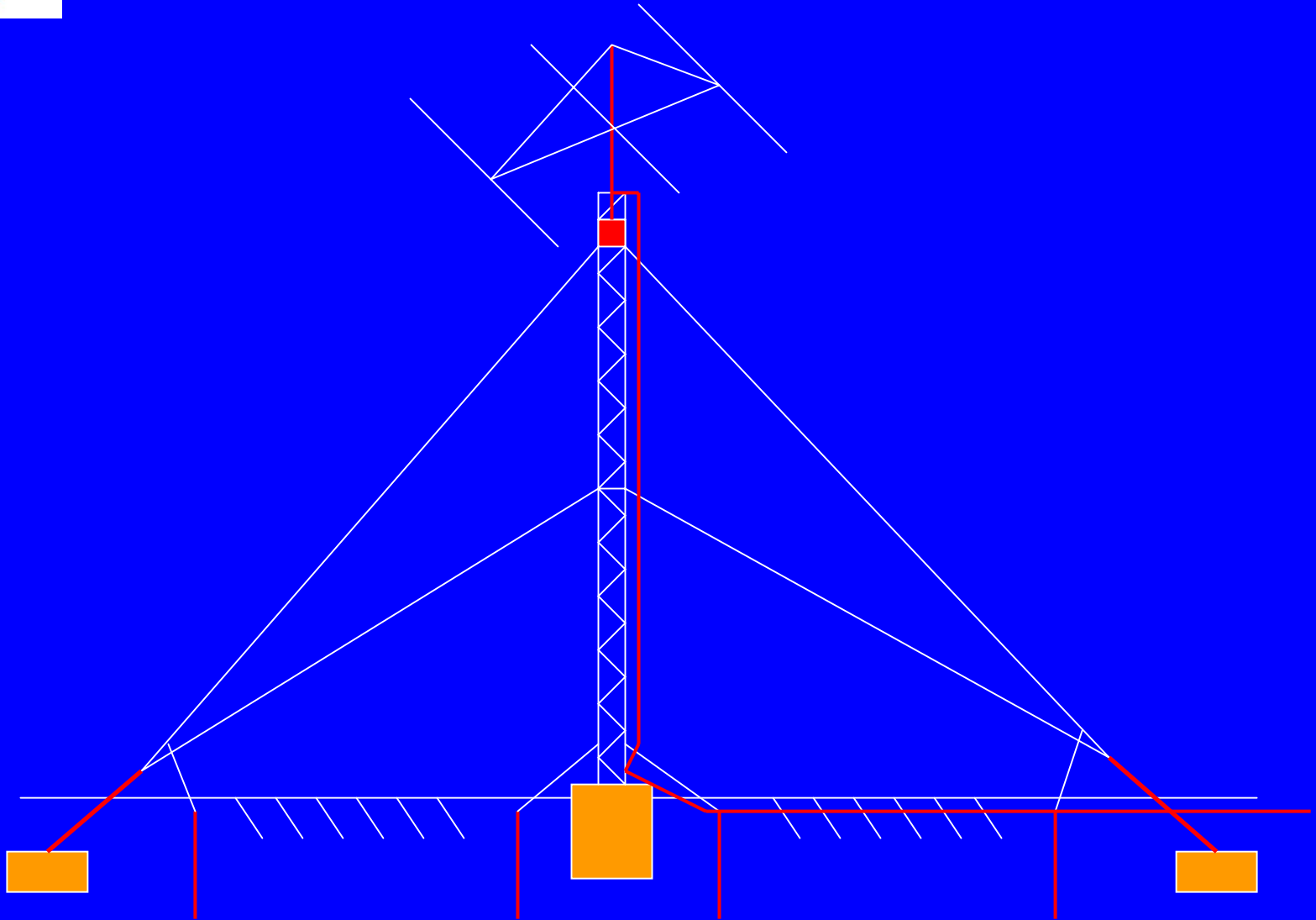
Design, Construction and Maintenance
of Antennas and Towers
for Storm Survival and Long Term Reliability

Practical Checklists of Best Practices

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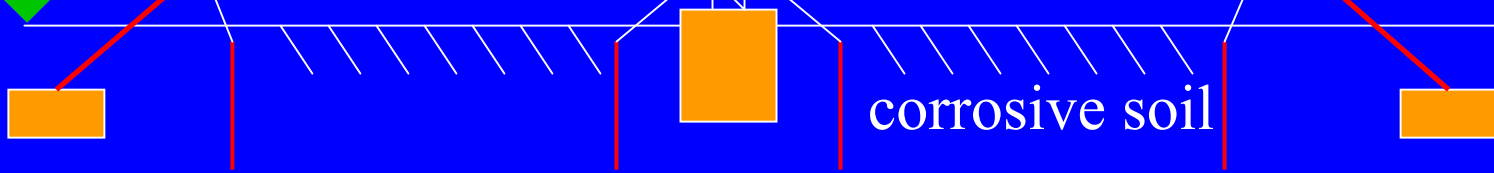
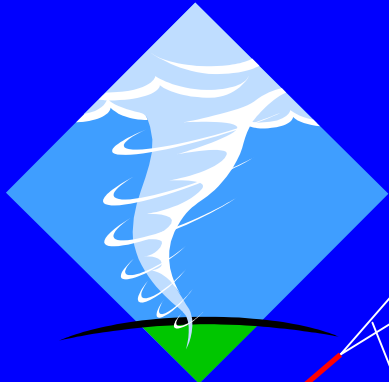
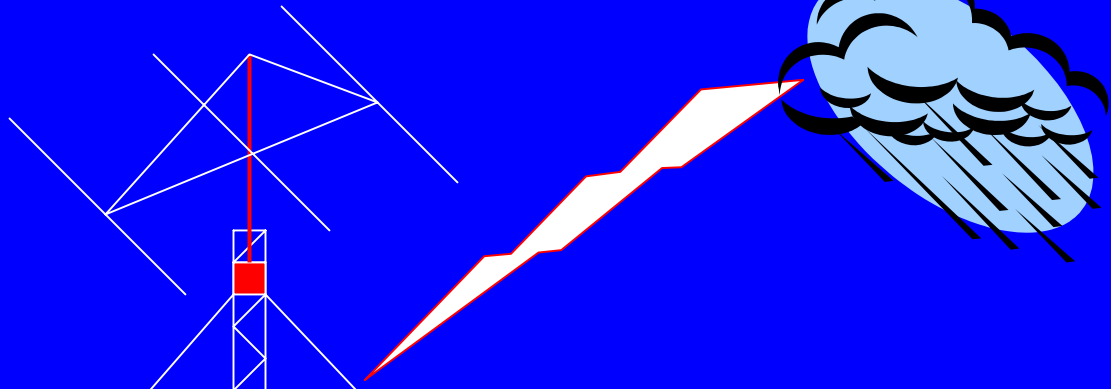
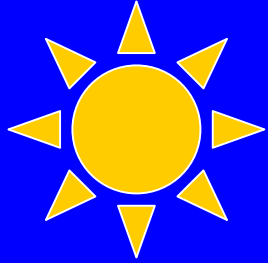


A Typical Guyed Tower and Antenna





In its Environment...



corrosive soil



Tower Sections

Design and Construction Checklist

- ✓ Adequate load capacity for current and future use
 - ✓ Antenna loads (especially unbalanced or unidirectional)
 - ✓ Transmission lines and other cables
- ✓ Adequate load capacity for environmental conditions
 - ✓ Wind loads (especially site-specific conditions)
 - ✓ Ice loads (especially site-specific conditions)
- ✓ Unidirectional or unbalanced ice and wind loads
- ✓ Corrosion protection (including site-specific needs)

Beware of used or corroded tubular tower sections



Tower Sections Maintenance Checklist

- ✓ Inspect all tower sections one year after installation
 - ✓ At least once every three years after initial inspection
 - ✓ After all very serious storms
 - ✓ After any structural damage to the tower
- ✓ Check plumb and twist of the tower
- ✓ Pay special attention to damaged, loose, missing or corroded:
 - ✓ Diagonal and horizontal trusses, welds and hardware
 - ✓ Especially near guy attachment points

Keep tubular tower weep holes clear of obstructions



Tower Foundation Design and Construction Checklist

- ✓ Use the manufacturer's recommended design
 - ✓ Provide adequate depth for local frost conditions
- ✓ The top of the foundation should be 6 inches above grade
- ✓ Tubular tower sections embedded in a concrete foundation require careful attention during construction
 - ✓ Each leg must drain into gravel at the bottom of the foundation
 - ✓ Concrete embedded tower sections are a risky practice in salt water or industrial pollution atmospheric environments

Prevent corrosion at the concrete-to-tower interface



Tower Foundation Maintenance Checklist

- ✓ Inspect at least once every three years
- ✓ Pay special attention to
 - ✓ Corrosion at the tower-to-concrete interface
 - ✓ Standing water on the foundation
 - ✓ Dirt and debris accumulation on the foundation
 - ✓ Settling or cracks

**Dirt and debris accumulation on the foundation
can lead to catastrophic tower failure**



Guy Anchor Design and Construction Checklist

- ✓ Guy anchor failure is one of the most common causes of catastrophic tower failure
 - ✓ Determine if you have corrosive soil conditions in your area
 - ✓ Adequate guy anchor depth for local soil conditions
 - ✓ Use heavy duty galvanized, forged hardware
- ✓ Use tower manufacturer's recommended guy anchor design
- ✓ Corrosive soils require guy anchor professional design
- ✓ Elevated guy anchors require professional design

Do not use light duty home owner grade hardware



Guy Anchor Maintenance Checklist

- ✓ Inspect at least once every three years
 - ✓ Dig down at least six inches to inspect for anchor rod corrosion
 - ✓ Missing hardware
 - ✓ Loose hardware
 - ✓ Corroded hardware

Anchor rod corrosion is a very serious threat to tower survival



Guy Wire

Design and Construction Checklist

- ✓ Use heavy duty galvanized, forged hardware
- ✓ Use tower manufacturer's recommended guy wire size
 - ✓ Smaller guy wire risks catastrophic tower failure
 - ✓ Heavier guy wire reduces the tower's load capacity
- ✓ Tension the guy wires to 10% of breaking strength
 - ✓ Less than 7% risks galloping of the guy wire and excessive tower movement in the wind
 - ✓ Greater than 15% risks guy wire vibration and reduced tower load capacity
- ✓ Guy wire vibration dampening hardware may be needed

Do not use light duty home owner grade hardware



Guy Wire Maintenance Checklist

- ✓ Inspect three months after initial installation
- ✓ Inspect at least once every three years after initial inspection
- ✓ Inspect after all very serious storms
- ✓ Check guy wire tension (7 to 15% of breaking strength)
- ✓ Check for
 - ✓ Damage from rubbing or chaffing of guy wire
 - ✓ Corrosion
 - ✓ Loose hardware

Significantly corroded guys risk catastrophic failure



Guy Attachment (Tower and Anchor) Design and Construction Checklist

- ✓ Guy force must be properly distributed to the tower structure
 - ✓ Use the tower manufacturer's recommended design
- ✓ Heavy duty professional grade forged, galvanized hardware
- ✓ Install turnbuckle safety wires
- ✓ Use articulated guy wire connections
 - ✓ 10 degrees of free guy wire movement in any direction
 - ✓ No chaffing or damage to the guy wire or hardware from frequent tensioning, loosening and movement of the guy wire in the wind

Use the manufacturer's recommended guy attachments



Guy Attachment (Tower and Anchor) Maintenance Checklist

- ✓ Inspect at least once every three years
- ✓ Check all guy attachment hardware
 - ✓ Missing or loose turnbuckle safety wires
 - ✓ Loose, missing or corroded hardware
 - ✓ Guy wire chaffing or rubbing
- ✓ Integrity of the tower in the vicinity of the attachments
 - ✓ Damaged tower structural components
 - ✓ Broken welds
 - ✓ Loose or missing hardware

Replace all degraded attachment hardware



Lightning Protection Design and Construction Checklist

- ✓ Use at least three ground rods at the tower foundation
 - ✓ Separated 20 feet from each other
- ✓ One ground rod at each guy anchor
- ✓ 8 foot galvanized ground rods (10 foot length preferred)
- ✓ Large diameter (2/0) solid, tinned ground wire
 - ✓ Rugged, durable connections to the tower and guys
 - ✓ Buried connections to ground rods (Cadweld preferred)
 - ✓ Buried wire between ground rods and tower foundation

Do not use braided ground wire !



Lightning Protection Maintenance Checklist

- ✓ Inspect all ground wire connections at least once every three years
 - ✓ Loose or missing hardware
 - ✓ Missing wires
 - ✓ Broken wires
 - ✓ Corrosion

**Repair all damaged or missing ground wires
or connections**



Antenna Rotator Design and Construction Checklist

- ✓ Analyze the antenna load capacity of the rotator
- ✓ Use adequate size control wire
 - ✓ Consider the total length of the control cable
- ✓ Rotator mounting hardware should be appropriate for the tower
- ✓ Use galvanized steel or stainless steel hardware
 - ✓ Use anti-galling compound for stainless steel hardware

An under rated rotator will fail prematurely



Antenna Rotator Maintenance Checklist

- ✓ Inspect three months after installation
- ✓ Inspect every three years after initial inspection
- ✓ Check:
 - ✓ Excessive mechanical play in the wind
 - ✓ Loose or missing hardware
 - ✓ Corroded hardware

**An under rated rotator will be a major
maintenance problem**



Antenna and Mast Design and Construction Checklist

- ✓ Appropriate antenna and mast for wind and ice conditions
 - ✓ Heavy duty or homebrew antenna when needed
- ✓ Use only galvanized or stainless steel hardware
 - ✓ Use anti-galling compound for stainless steel hardware
- ✓ Use vibration dampening of antenna elements to avoid premature failure
- ✓ Well designed transmission line connections to the antenna
 - ✓ Electrical and mechanical
- ✓ Well designed boom truss with professional quality hardware

Select your antenna for local wind and ice conditions



Antenna and Mast Maintenance Checklist

- ✓ Inspect at least once every three years
 - ✓ Loose or missing antenna hardware
 - ✓ Loose or missing boom truss hardware
 - ✓ Corroded hardware
 - ✓ Damage from ultra violet radiation
 - ✓ Transmission line electrical connection to the antenna
 - ✓ Transmission physical connection to the antenna
 - ✓ Damaged structural components

Transmission line electrical connections to the antenna are often damaged by wind and rain



Transmission Lines and Other Cables Design and Construction Checklist

- ✓ Select appropriate cables local ultraviolet conditions
- ✓ Use appropriate hardware for tower attachment
 - ✓ Consider local ultraviolet, wind and ice conditions
 - ✓ #12 solid insulated copper wire is a good choice
 - ✓ High quality electrical tape (Scotch 88) is a good choice
 - ✓ Electrically connect the transmission lines to tower
 - ✓ top and bottom of tower
 - ✓ Lightning protection of rotator and control cables at the tower base

Fasten cables to the tower with high quality attachments



Transmission Lines and Other Cables Maintenance Checklist

- ✓ Inspect at least once every three years
 - ✓ Loose, missing or UV damaged cable attachments
 - ✓ UV damaged cables
 - ✓ Transmission lines, cables and connectors damaged by water intrusion
 - ✓ Best inspected by using a time domain reflectometer, VSWR meter or other appropriate techniques
 - ✓ Good records are very helpful
 - ✓ Failed lightning protection

**Degraded transmission lines seriously affect
station performance**



Summary

- ✓ These checklists will help you to avoid common design and construction errors
- ✓ Inspections are an important contributor to long term tower and antenna reliability
- ✓ Conduct major inspections
 - ✓ during the first year after construction
 - ✓ every three years after initial inspection
 - ✓ After very serious storms

Inspections are a very important factor in long term tower and antenna reliability