TOWER TALK

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AN INTRODUCTION TO TOWERS – PART 1

by John White VA7JW

and

CANADIAN REGULATIONS – PART 2

by Ed Frazer VE7EF

23 Feb 2017

NEW HF OPERATORS

ARRL Contest Update Newsletter, Jan 2017

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If you're considering putting in your first tower this spring or summer, it's definitely not too early to begin the project. As a large station investment, first steps include **determining what your goals** are, and having a **good idea of the antennas** you'll be putting up, since that **determines tower ratings**. Depending on where you live, **Amateur Radio towers may be regulated by building codes, municipal codes, homeowner associations, or CC&Rs (Covenants, Conditions, and Restrictions). It's best to understand what you can and can't do before you start**. Talk with other Amateurs in your local radio club, use radio club resources, Always verify information to make sure it's current and applicable to your situation.

So You Want a Tower

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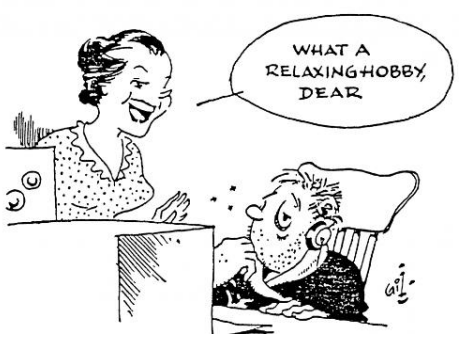
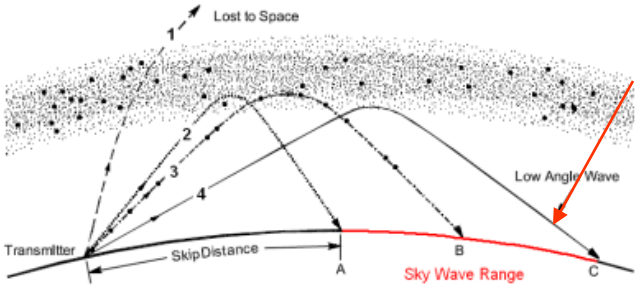
- There are good reasons to have a tower …
- Improve Transmit and Receive capability
- Cast a signal over a great distance – and that requires an antenna at height to achieve range
- Utilize a GAIN antenna to focus the energy
- Have the Gain antenna rotatable over 360 deg to cover the world
- Now we're talking DX capability …..

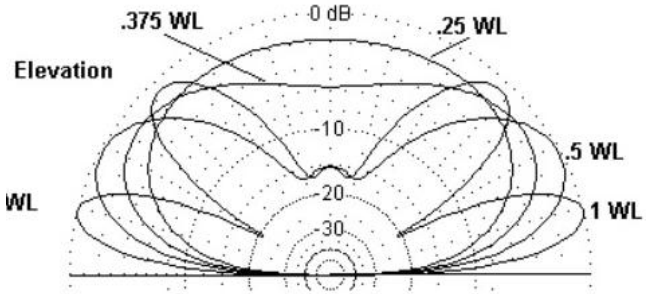


Skip

- Distance is achieved via **skips** due to the effect of Ionospheric refraction



- Longer skip is realized by raising the antenna height above ground to achieve a lower angle of radiation from the antenna



- Half wavelength multiples above ground produce a family of low angle lobes. Half wave is good start

Tower Height

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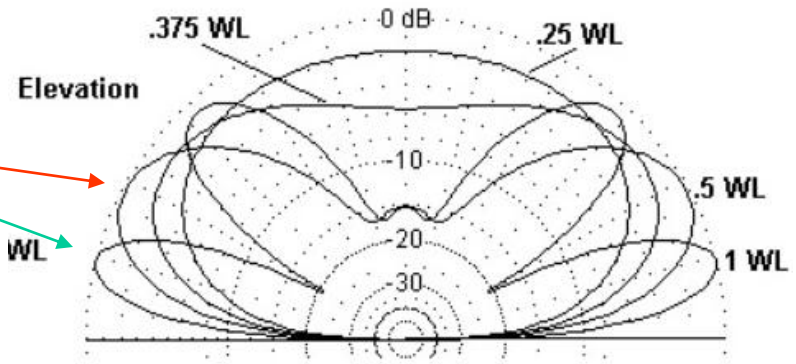
- How high up should the antenna be above ground
- Typically 0.5 to 1 λ for low angle of radiation
- DX often worked on 20 m and up (17, 15, 12, 10m)



- A half wave length at 20m is ~ 33 ft, < 15 M CPC limit, not a difficult antenna height to achieve.
- One wave length at 20m / 66 ft limit may be difficult for residential areas but may be possible

Tower Types

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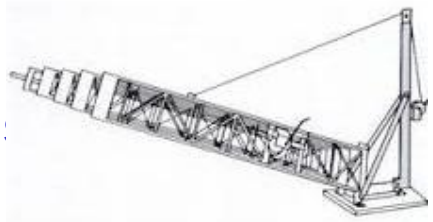
- Free standing lattice work

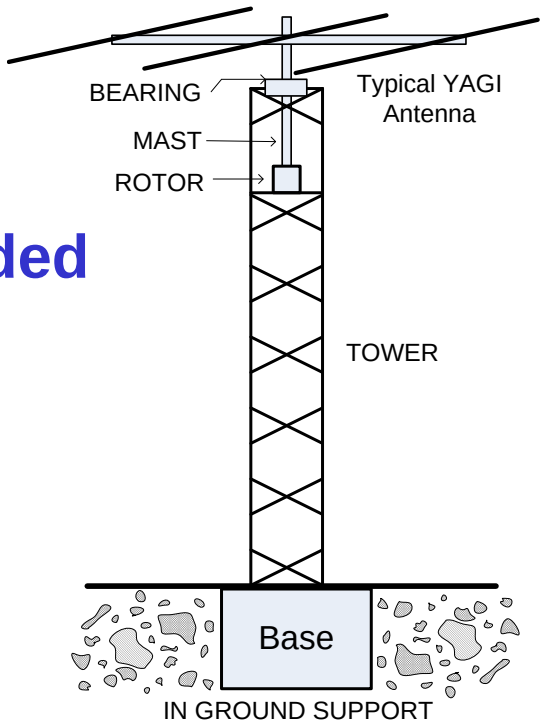
- Guyed Lattice work
- Crank up / Tilt over,
  - nesting lattice work section
  - avoids high climbing



- Tubular – usually crank up
  - house bracketed support

Typical Tower System

- Base, upon which the tower sits”
- Typical Lattice work tower
- Free Standing or Guy Wires as needed
- Rotator to turn mast / antenna
- Pipe mast supports Antenna
- Lateral Bearing prevents sideways motion of pipe Mast
- On top - Antenna typical 3 band yagi, or other



Tower Responsibilities

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- For personal safety, must have and know how to use approved climbing equipment
- Must have confidence in the tower as you will be climbing it many times; <u>Maintenance</u> will be a regular obligation.

- Suggest Insurance – personal injury, property damage, damage or loss of the structure
- Must have all required permits in order

Antenna Equipment

- Antenna 20/15/10 m bands
  - 3 element multiband yagi
  - 35 lbs. / 95 mph survivable

- Mast
  - Galv. steel schedule 40 ERW pipe; Fencing material purchased locally. 2” x 6’ Sched 40 (wall thickness)
- Lateral Bearing
  - Strengthens mast in tower

- Rotor
  - Typical in-tower mounting, rotor sits on a plate in the mast; controller in shack

Wind Loading

- Wind is the biggest concern in terms of tower failure; wind alone can topple a tower
- Wind pressure exerts a force over the “solid” area of the tower and equipment on the tower
- Wind pressure increases as the square of the wind speed.
- i.e. Wind speed rises by 2X, say 30 mph to 60 mph, wind force on tower structure is 4X Greater
- These forces are referred to as WIND LOADING

Added Equipment

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- The tower alone has its own wind loading spec's.
- Mast and Rotator in/on tower add to wind loading
- Anything else to include ? – VHF / UHF antennas like to be high up and often placed on tower. Wind loading is now greater
- All "extras" must be included in your tower requirements when discussing with vendor as to which tower configuration will best and safely meet your installation

Historic Wind Data

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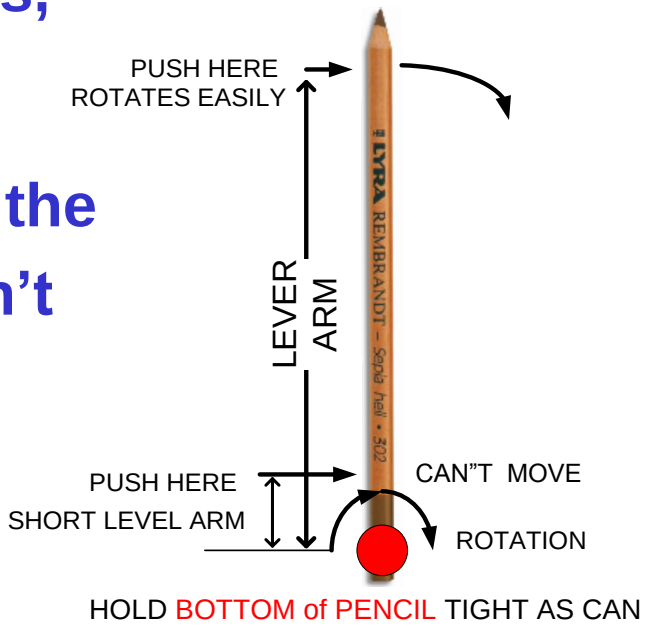
- The Strength of your desired tower, must be commensurate with the Max Historical Wind Speed data on record
- VANCOUVER DATA
  - Environment Canada: since 1992 **82km/hr (51 mph)**
  - Wikipedia: Hurricane Frieda 1963 **93 km/hr (58 mph)**
- The tower Vendor needs this information in order to specify the correct tower (strength) for the wind load, taking into account additional equipment loading

So What Happens?

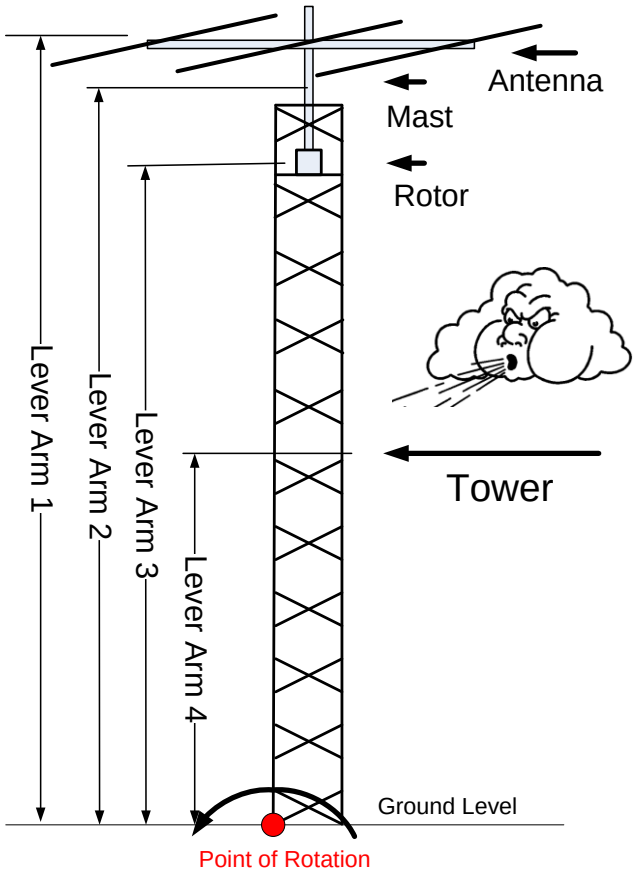
- Hold a pencil between two fingers, at the very end, very tight.
- With other hand / finger push on the very bottom where gripped. Won't move.
- Now push at the top end. Can't stop it from "rotating".



- No leverage at bottom, big leverage at top. Force applied at top is "multiplied" by length of lever arm

Effect on Tower

- Wind is blowing on the various component areas on the tower as well as the tower itself
- Each component has a lever arm, all different
- Adding up all forces due to the lever arms is considerable
- Net result is that the tower wants to “rotate” at ground level



What Restrains It ?

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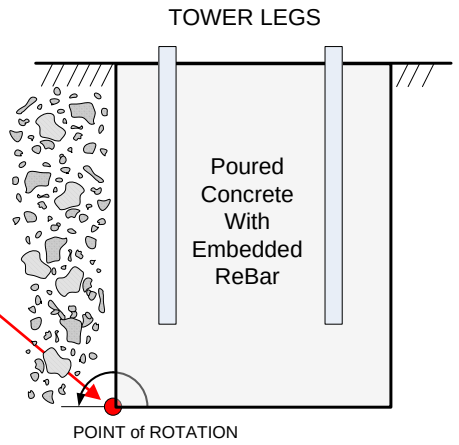
- Some towers are rated as Self Supporting, meaning they are built strong enough to support themselves at a rated wind speed as well as a specified amount of additional equipment mounted on the tower
- Self supporting towers require a large block of concrete to be poured in ground, where the tower is mounted. Tower legs are embedded in the re-enforced concrete.
- It is the <u>strength of the ground soils that restrain</u> the applied wind forces to ensure no Base movement takes place

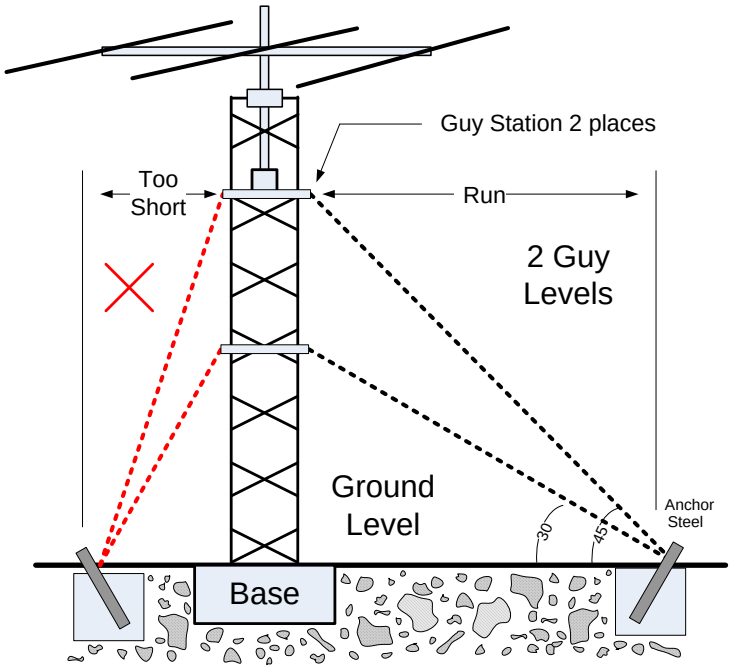
Self Supporting Base

- A Self Supporting concrete tower base has to be substantially embedded in the ground as it must not MOVE
- The tower wants the base to rotate about the red point
- The strength of the soil has to be determined to be certain it is strong enough to overcome the Rotational forces exerted by the tower, on the Base.



Guyed Towers

- Guyed towers negate the need for large concrete bases although a concrete slab would still be used to take the weight & stabilize the base from any Lateral motion.
- Note that Triangular towers require 3 guys whereas Square towers require 4 guys.
- Guy wire angle must allow for an adequate “Run” length



Guy Wires

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- The Guy Wire needs to be load rated; clothesline wire is not suitable! Tighten guys with turnbuckles at anchor point to recommended tensions.
- Guy Station brackets prevent guy tension from bursting tower

- Needs to be adequate space to accommodate guy wire “Run” i.e. 45 degree. Not less than 30 degree.
- Must have substantial anchoring the ends. Concrete block. Building structure, BIG tree

House Bracketed Tower

- For lighter duty towers, the tower can be attached to a building structure for support.
- A moderate in-ground concrete base is required to keep the bottom of the tower from wanting to move or rotate
- Building attachment brackets are commonly offered by tower manufacturers
- Height above the top bracket has to be disclosed and endorsed by the tower vendor

Lightning Protection - Ground the Tower

- Tall metal structures are lighting rods
- Safety requirements dictate the direct diversion of lighting current directly to earth.
- Recommend a direct to ground connection from each leg of tower well into the ground (> 8 ft).
- Ground wire minimum # 6 AWG stranded copper
- Should be Integral to a planned, station equipment, grounding system you your Safety.

Vendor Requirements

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- Do a Vendor search to acquaint yourself with possible sources of supply (Appendix 1 on …)
- Vendor means the tower manufacturer – not the retail supplier.
- List your requirements for the tower Vendor
- Vendor needs to know this in order to specify the correct sizing of the tower per your needs
- The Vendor will determine best choice of tower for your equipment profile, which includes MARGIN.

Simple Starter

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- Consider a house bracketed installation – Slide #19
- Choose tower of perhaps 10m / 30 ft, under the 5m limit
- A 3 Element Tri-band Yagi with Rotor
- Guy Wires probably not needed
- Simple Concrete base
- Low relative cost

- Tower Information in Appendices' at end of slide show

Tower Questions

- 5 Minute Break Tower questions only.
- More time at the end of the Presentation.
- On to Part 2 – Canadian Reg's and Politics.

Tower Talk – Part 2

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Canadian Regulations and the Politics of Towers

- Presented by Ed Frazer VE7EF

Canadian Regulations

- Radio spectrum and towers are regulated by the Federal Government, formerly “Industry Canada”
- IC is now called “Innovation, Science, and Economic Development Canada”, (ISED)

  Spectrum Management and Telecommunications branch

- *Amateur Radio* is a subset of the Spectrum branch

Amateur Radio is Regulated

- Activity is Governed by federal documents
  - RIC-1: Guide for Accredited Examiners
  - RIC-3: Information on the Amateur Radio Service
  - RIC-7: BASIC Qualification Question Bank for Exams
  - RIC-8: ADVANCED Qualification Question Bank
  - RIC-9: Call Sign Policy and Special Event Prefixes
  - RBR-3: Identification of Radio Stations (formerly RIC-4)
  - RBR-4: Standards for the Operation of Radio Stations in the Amateur Radio Service (formerly RIC-2)
  - *What does RIC and RBR mean?*

Other Regulations

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- Amateur Radio is also affected by regulations applicable to *all* radio installations
  - Safety Code 6
  - Environmental Assessment
  - Aeronautical Safety
  - Antenna Support Structures, CPC-2-0-03

  - *What does CPC stand for?*

Tower Regulations

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- **CPC-2-0-03 Issue 5 2014**

  Title: "Radiocommunication and Broadcasting Antenna Systems"

- **Mainly aimed at Cellular, Broadcast and Industrial users**
- **Ham radio must also comply, with exceptions**
- **Essential to understand all parts of the CPC**

CPC-2-0-03 Summary

- Procedure for installation of tower over 10 m high (Sections 1 to 5)
- Specifications that apply to ALL users (Section 7 and Appendix)
- Exclusions if structure is less than 10 m high (Section 6)

CPC-2-0-03 Section 1

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- Introduction
  - Antennas are essential, but should be deployed with consideration of local surroundings.
  - Minister has absolute authority to authorize or deny a tower. Proponents must follow the process
  - Applies to all proponents, including Amateur Radio
  - Process Overview

CPC-2-0-03 Section 2

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- **INDUSTRY CANADA ENGAGEMENT**
  - **Proponents must contact local IC office**

CPC-2-0-03 Section 3

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- **USE OF EXISTING INFRASTRUCTURE**
  - **Proponents MUST explore possibility of sharing a near-by tower structure** (except amateur radio)

CPC-2-0-03 Section 4

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- 4.2 IC'S DEFAULT PUBLIC CONSULTATION PROCESS
  - If LUA does not have a process, Default Process to be followed, including:
  - PUBLIC NOTIFICATION
  - RESPONDING TO PUBLIC
  - PUBLIC REPLY COMMENTS

CPC-2-0-03 Section 4

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- **4.3 CONCLUDING CONSULTATION**
  - IC to determine when consultation is completed with LUA and Public

- **4.4 POST-CONSULTATION**
  - Construction must be completed within three years of conclusion of consultation

CPC-2-0-03 Section 5

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- **DISPUTE RESOLUTION PROCESS**
  - **Where parties reach an impasse, IC will make a final decision**

- **Section 6: Covered later**

CPC-2-0-03 Section 7

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- Applies to ALL proponents, including Amateur

- 7.1 RF EXPOSURE LIMITS
  - RF level at property boundary must meet Safety Code 6

- 7.2 RF IMMUNITY: RF emission is clean

CPC-2-0-03 Section 7

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- 7.3 PROXIMITY TO BROADCAST TOWER
  - Proponent must advise Broadcasters if tower will be over 30 m
- 7.4 ENVIRONMENTAL ASSESSMENT
- 7.5 AERONAUTICAL SAFETY

CPC-2-0-03 Section 6

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- **Exclusions**

"The following proposals are excluded from Land-Use Authority and Public consultation"

- **New antenna systems where height is less than 15 m above ground**
- **Modifying an existing antenna system if increase is less than 25%**
- **"It may be prudent for Proponent to consult even though the proposal meets the Exclusion"**

Recommendations - 1

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- Advise your RAC Director and consult with RAC Tower Committee.
  - Considerable experience available
- Do not contact LUA directly (Have a friend ask if a formal protocol exists)
  - If you contact LUA directly, you are considered to have consulted LUA and must follow LUA protocol
- Advise local IC office of intent for tower

Recommendations - 2

-.-. --.- -.. . ...- . --... -. ... .-.

- Notify your neighbours (r = 3x15m) with an information package; answer any questions. Follow timing in IC Default Protocol
- Info Package: What is ham radio and its variations; Federal legislation; why is a tower required; be accurate in submission – no exaggeration
- Keep a detailed record of your consultation
- You are informing - not asking for permission
- When above completed, notify IC Office of intent to proceed

References

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- **Articles in TCA Magazine**
- Marcel Mongen VA3DD, RAC Honorary Legal Council "Some Practical Considerations..." Sept/Oct 2016 TCA
- Tim Ellam VE6SH, President of IARU in Letter to Editor, Nov/Dec 2016 TCA
- Marcel Mongen VA3DD, response to Ellam, Nov/Dec 2016 TCA

Questions - Regulations

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- 5 Minute Break for Questions Regulations Only
- Open session Questions after
- Thanks for Attending …..

- Appendices' are attached for further information.
- Presentation will be posted complete with the appendices' Contact Ed VE7EF (ve7ef@shaw.ca) and John VA7JW (va7jw@shaw.ca) if further questions.

Appendix 1
Some Vendors

- Wade Antenna, Canadian, very popular, good value
- Explore this site. installation instructions here. www.wadeantenna.com > Towers > scroll to DMXHD-48N > Details > DMX Self Supporting Tower Installation Instructions. Become acquainted with the process and specs.

- US Towers, US
- http://www.ustower.com/wp-content/uploads/2014/05/USTHamCatalog.pdf

- DX Engineering, US – Many Selections

https://www.dxengineering.com/search/department/towers

- TashTowers US – SteppIR supplier

http://www.tashtowers.com/

Appendix 2 Soils

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- When installing a Base for a self supporting tower, the strength of the soil is an extremely important parameter to take in to account. Get a professional opinion.

- Authors soil conditions were Hardpan. This is a fine grained, highly compacted, dense, glacial clay, impervious to water. Strength about 2000 lb/sq-ft.

- ⚠ Fraser Valley flood plain soils would be a poor choice as the soils are not compacted and may be water saturated resulting a very low strength. An embedded Base would not be a good choice. Suggest using a guyed tower or possibly the house bracketed design.

Appendix 3 Tower Material Considerations

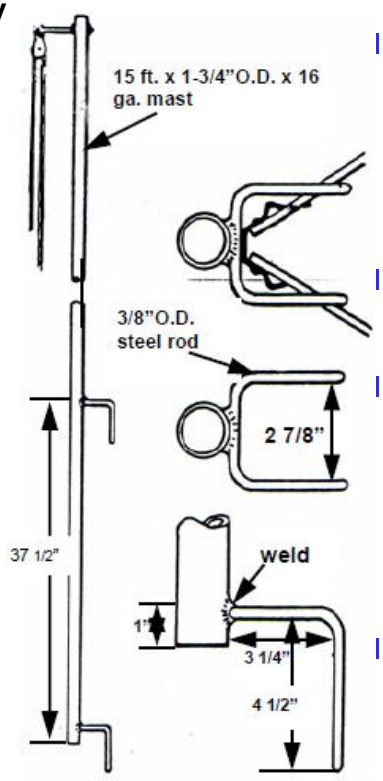
- Tower / Antenna structure has to be engineered to remain in place over years to come, so ask after..
- Tower material – typically either Aluminum or better > Galvanized steel
- Use Vendor hardware. Specialized section bolts
- Fasteners Galvanized, **(not bright zinc plated!)**
- Grease fasteners with Never-Seize paste
- Grease tower joints with same - prevents corrosion seizure upon future disassembly
- Grease all moving parts, Pulley, Bearings, ETC

Appendix 4
Construction Notes

- If building a lattice work tower, it will be delivered in sections, typically 8 foot. May be Heavy.
- You will be climbing the tower as it is assembled
- Will have to lift and place “next” section on top of existing built sections.
- You will need a Gin Pole to lift and place the new section. Repeat until built.
- Rotor, mast and antenna have to be lifted and placed. Install coax, & rotor wire and Antenna,
- You need a buddy with you on the tower and 2 or 3 or more on the ground

Appendix 5 Gin Pole

Rope over Pulley



Legs

- Typical Gin Pole for Lattice Style tower
- Usually custom / home made of pipe and rebar for Legs. Custom dimensions to fit tower sections.
- "Legs" placed over lattice
- Sections hauled up by ground crew using rope via top end pulley

- Once section installed. lift pole off, move up ready for next section

Appendix 6
A Good Book

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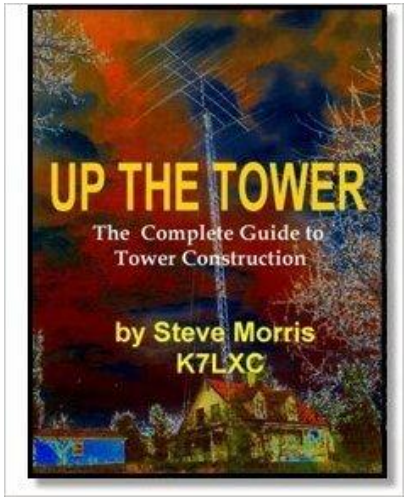

- "Up the Tower"
- The Complete Guide to Tower Construction
- By Steve Morris, K7LXC
- Available at Universal-Radio.com $29.95 USD + shipping