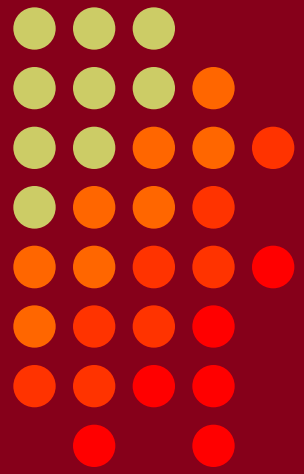
CTU Presents

Design Approach & Lessons Learned in Building my New Contest Station

Randy Thompson, K5ZD



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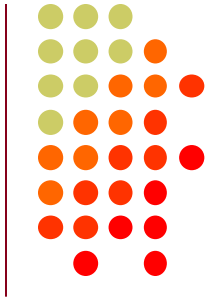
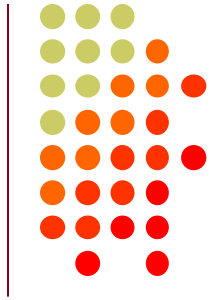
Background



- **After 32 years in MA, we decided to move to southeast Ohio**
- **Hilly terrain, some great radio locations**
- **Difficult to find hilltop property or flat areas**
- **Unknowns: line noise, deed restrictions, zoning bylaws**

This presentation goes through the design process I followed for the new station

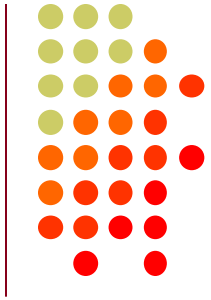
Goals



- Be “loud enough”
  - Contesting
  - DXing
- SO2R capable – one antenna per band
- Minimize expense – use hardware I already owned
- Downsize to more maintainable setup

1. Site Eval

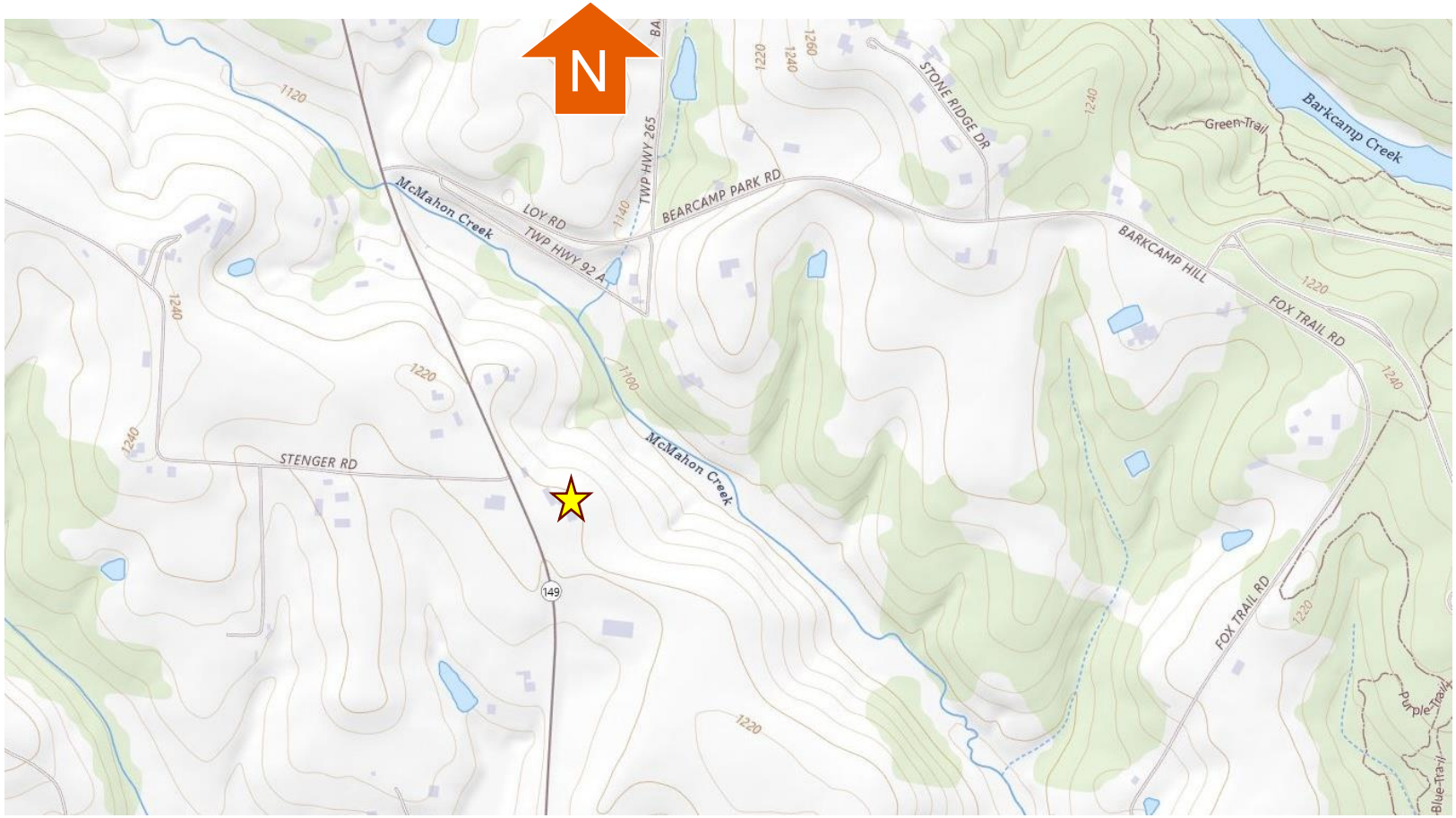
Regulations



- Check deed restrictions or HOA
  - Almost impossible to overcome
- Check zoning bylaws
  - I was not inside a town so only had to follow state building codes
- Check FAA height restrictions
  - Local airports 5 miles and 8 miles away. No height impact

Look at the topology

Maps at: https://www.usgs.gov/programs/national-geospatial-program/topographic-maps



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Where will the towers fit?

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Summary

- Only 1.5 acres available
  - Land slopes down to northeast making it difficult to use half of the lot
- I can fit two towers with guy points out 80’
  - Potential for 100’ tower height
- Positioned towers for maximum separation

2. Antenna Selection

What directions are important?

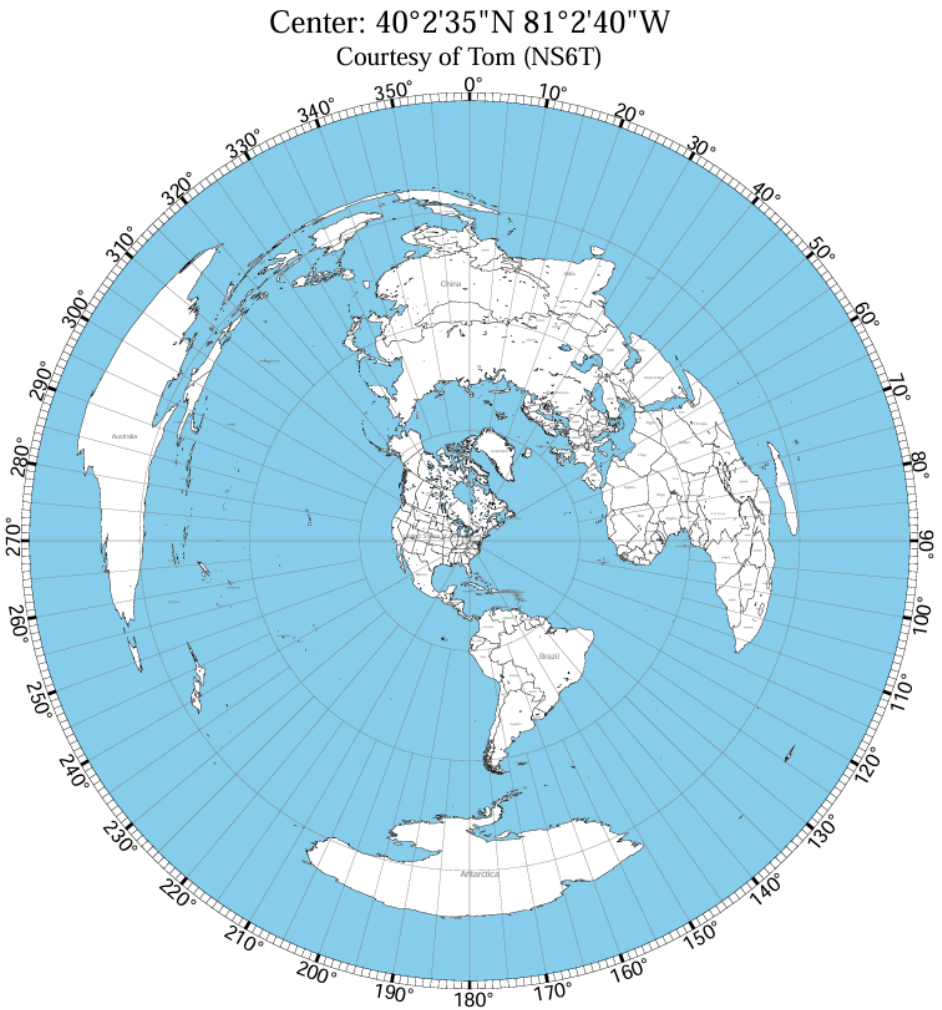
Get free map from
https://ns6t.net/azimuth/

Continent Coverage

	Heading
Europe	40-60
Japan	330
South America	135-180
Oceania	240-310

Primary Target

	Heading
Frankfurt	47
Tokyo	330
Sao Paulo	145
Sydney	270



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Get Terrain Data

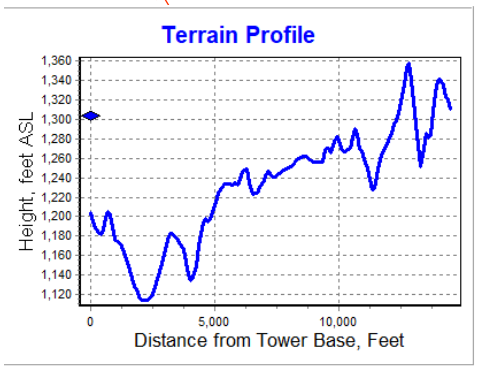
- Plot the terrain in each direction from the tower locations
- K6TU offers free service that will produce terrain distance/height for anywhere in USA

https://paas.k6tu.net/terrain-data/

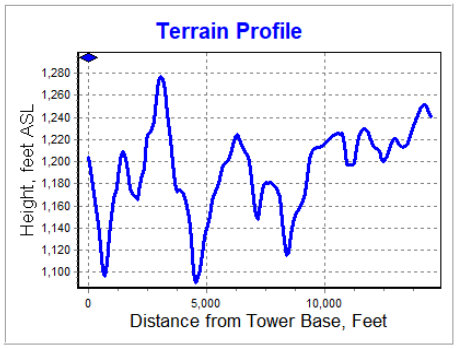
- Result is a zip file containing terrain data for 360 degrees in 1-degree increments

Terrain Data for Target Directions

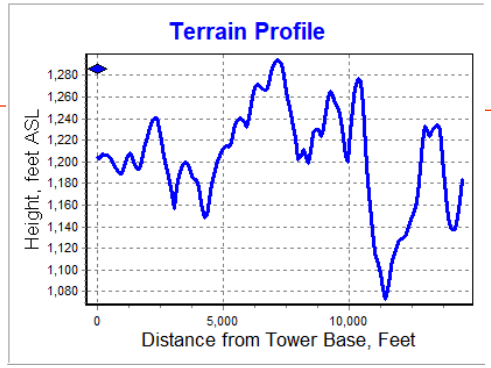
330 degs

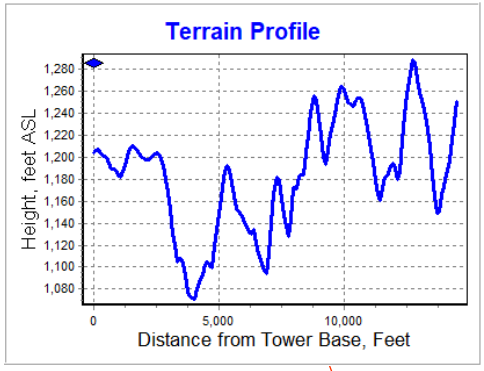


47 degs



270 degs





155 degs

Each chart shows terrain over first 15,000 feet

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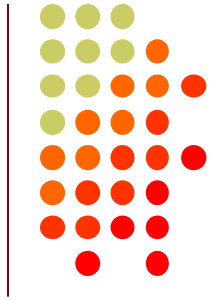
Modeling - HFTA

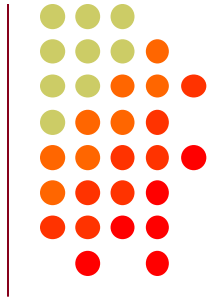


HFTA (High Frequency Terrain Assessment) is a modeling tool that transforms raw terrain data into actionable insights for HF antenna planning. Developed by Dean Straw N6BV

- **Terrain-aware antenna modeling** — Integrates elevation data to show how hills, slopes, and valleys shape radiation patterns.
- **Takeoff angle prediction** — Identifies the most effective angles for DX communication from a specific site.
- **Multi-antenna comparison** — Allows side-by-side evaluation of different antenna heights, types, and placements.
- **Integration with NEC models** — Uses NEC-generated antenna patterns as inputs for terrain-modified results.
- **Graphical output** — Produces elevation profiles, gain plots, and angle-of-arrival charts for clear visualization.

Available on the CD included with ARRL Antenna Book

How HFTA Works

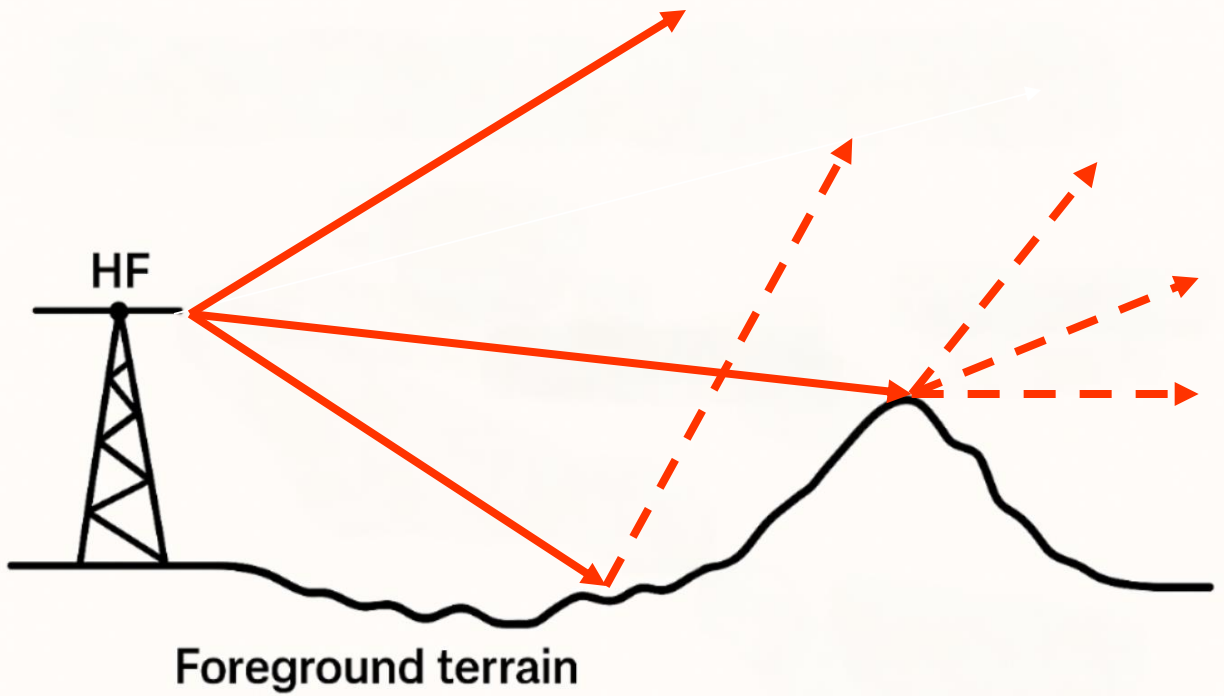


- HFTA models horizontally polarized HF antennas and computes their elevation radiation pattern based on the effects of:
  - Foreground terrain shape (up to ~10,000 ft out)
  - Ground reflections
  - Diffraction over hills and ridges
  - Antenna height and stacking
  - Frequency
  - Ground conductivity and dielectric constant

Ray tracing

- Direct ray from antenna to horizon
- Reflected rays from the terrain
- Diffracted rays over hills and ridges

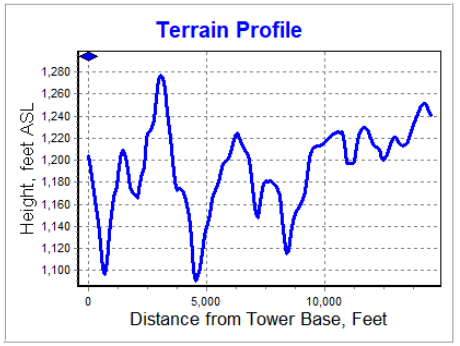
The combination of these rays produce the actual elevation pattern, showing lobes, nulls, and gain at specific takeoff angles.

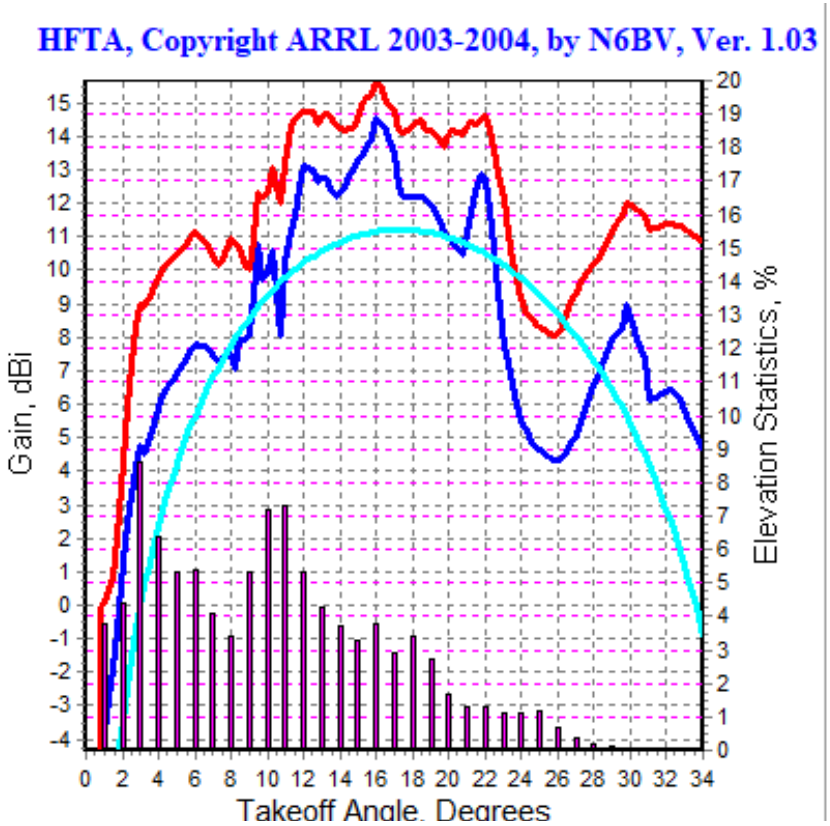


All rays are along a single vector.

Example HFTA Output

40 meters
2-el at 90’/50’





Freq. = 7.1 MHz
Max. Gain: 15.7 dB

NOR-47.PRO
90 ft
2-Ele.
Fig. of Merit: 10.1

NOR-47.PRO
90/50 ft
2-Ele.
Fig. of Merit: 12.3

FLAT.PRO
115 ft
2-Ele.
Fig. of Merit: 8.5

Elev. Statistic
W8-OH-EU.PRN

Print | Out File | Close

90’ 2-el

90’/50’ stack

115’ 2-el over flat ground

Probable arrival angle EU-W8

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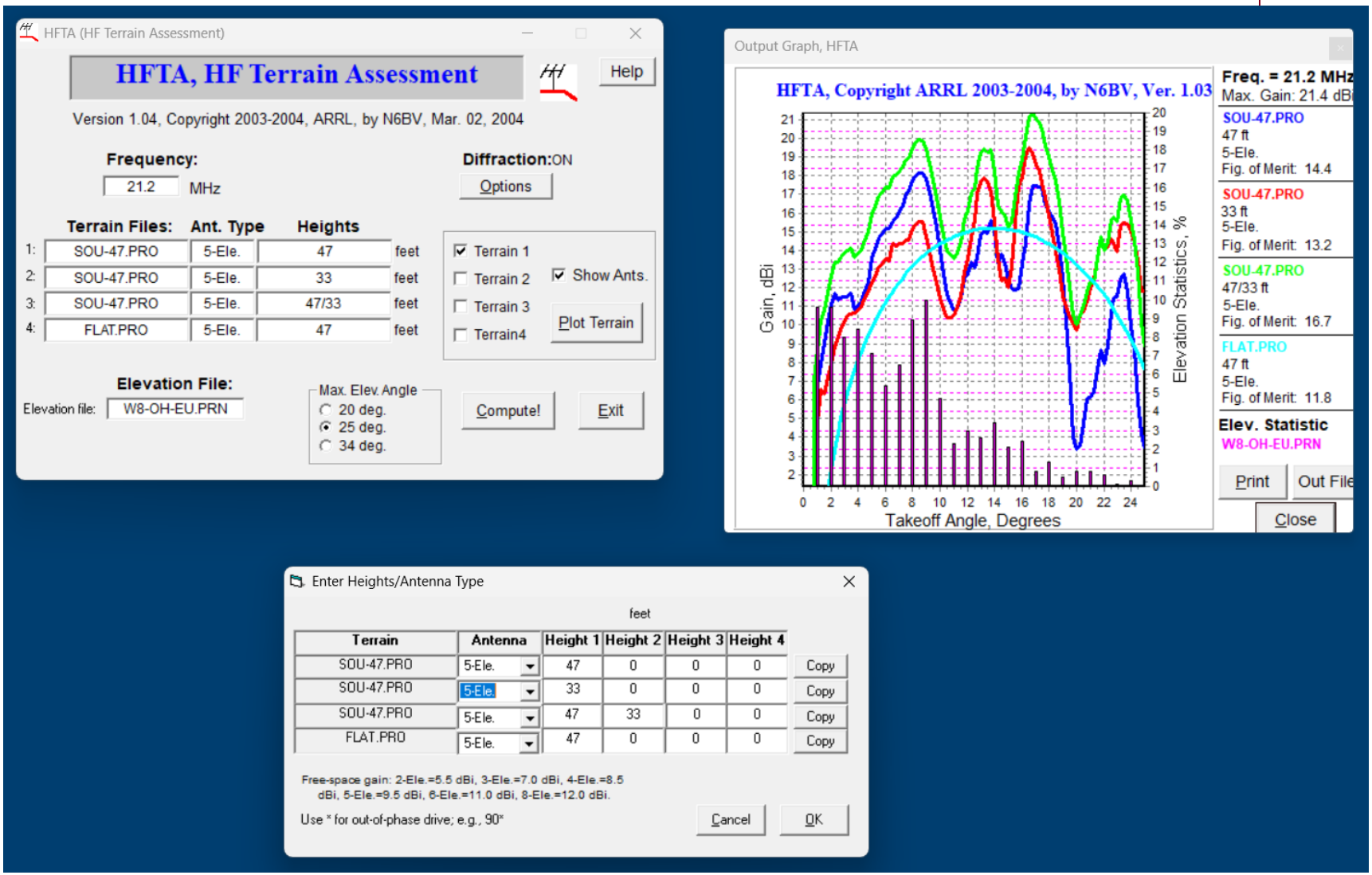
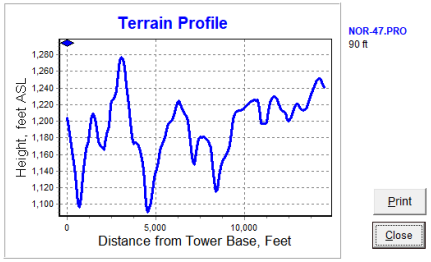
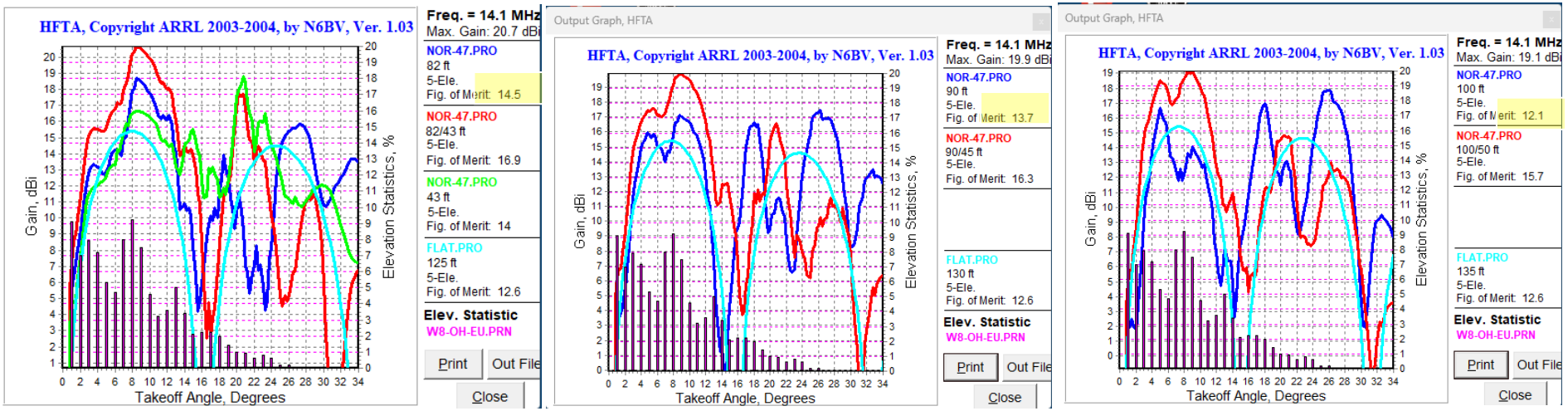
HFTA Configuration



North Tower – 20 meters
NE 47º Europe



5-el at 82’/43’ 5-el at 90’/45’ 5-el at 100’/50’



The gain and elevation angle coverage was best at 82’!

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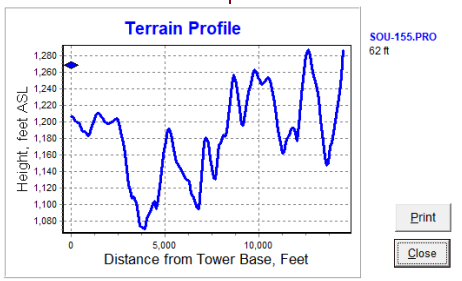
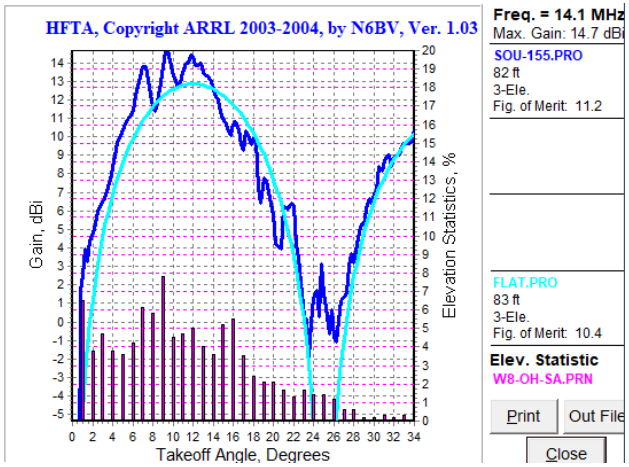
South Tower – 20 meters
S 155º South America

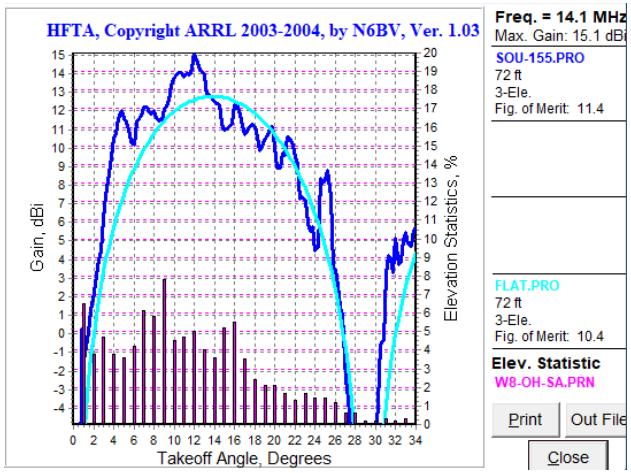


Flat ground for first 2000’

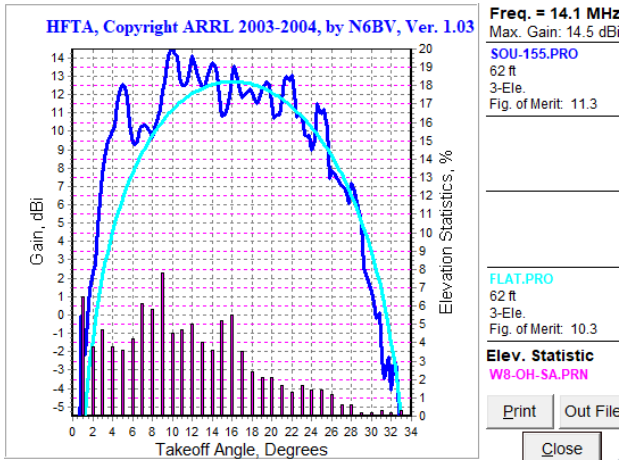
C31xr (3-el) at 82’



C31xr (3-el) at 72’



C31xr (3-el) at 62’



Small variations between flat ground and terrain

72’ was ‘better’ than 82’ or 62’

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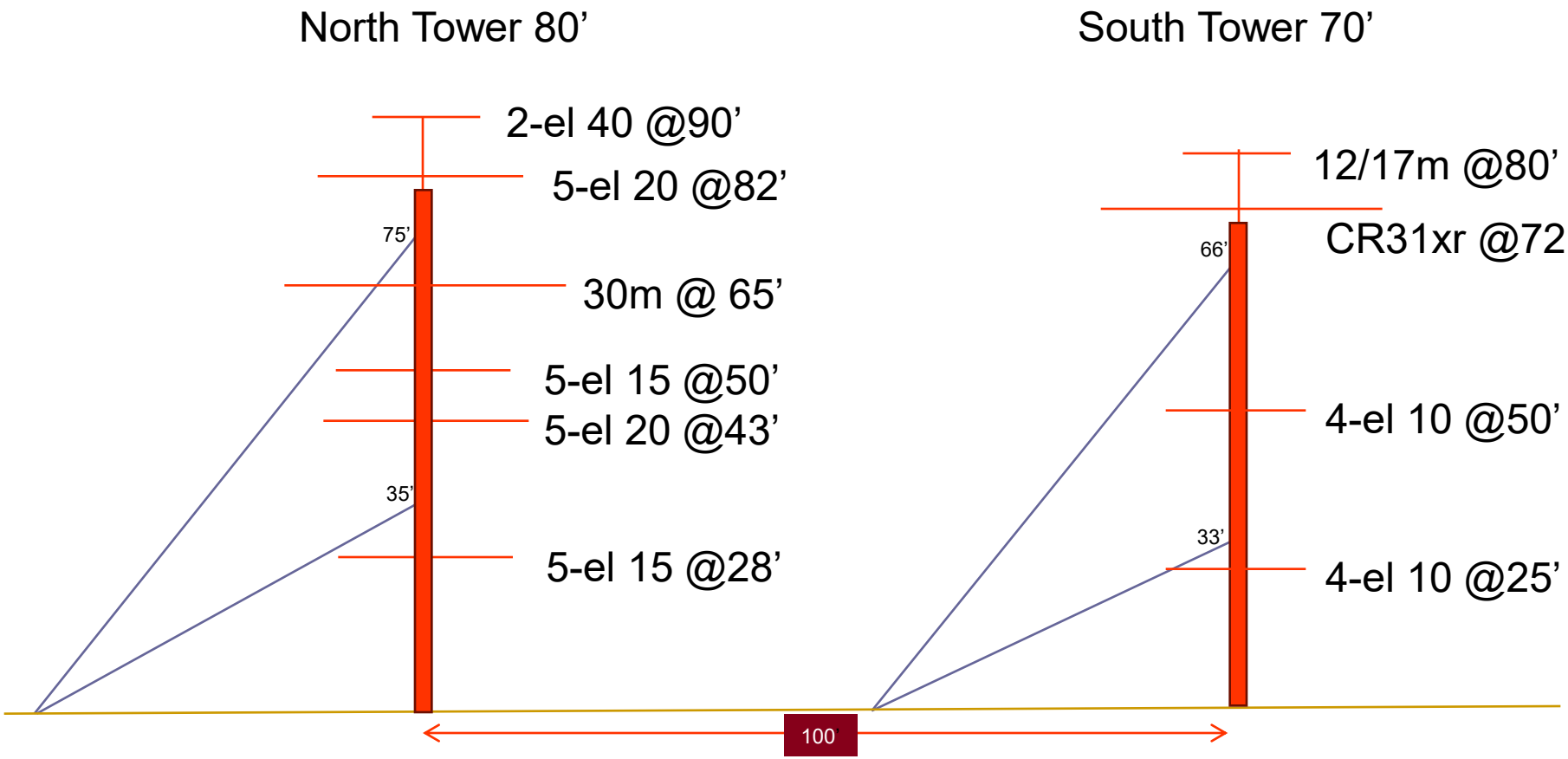
The model is not the reality.

HFTA is the best tool we have to evaluate antenna heights and potential performance

Antenna heights must be balanced against guy wire positioning

Design 1



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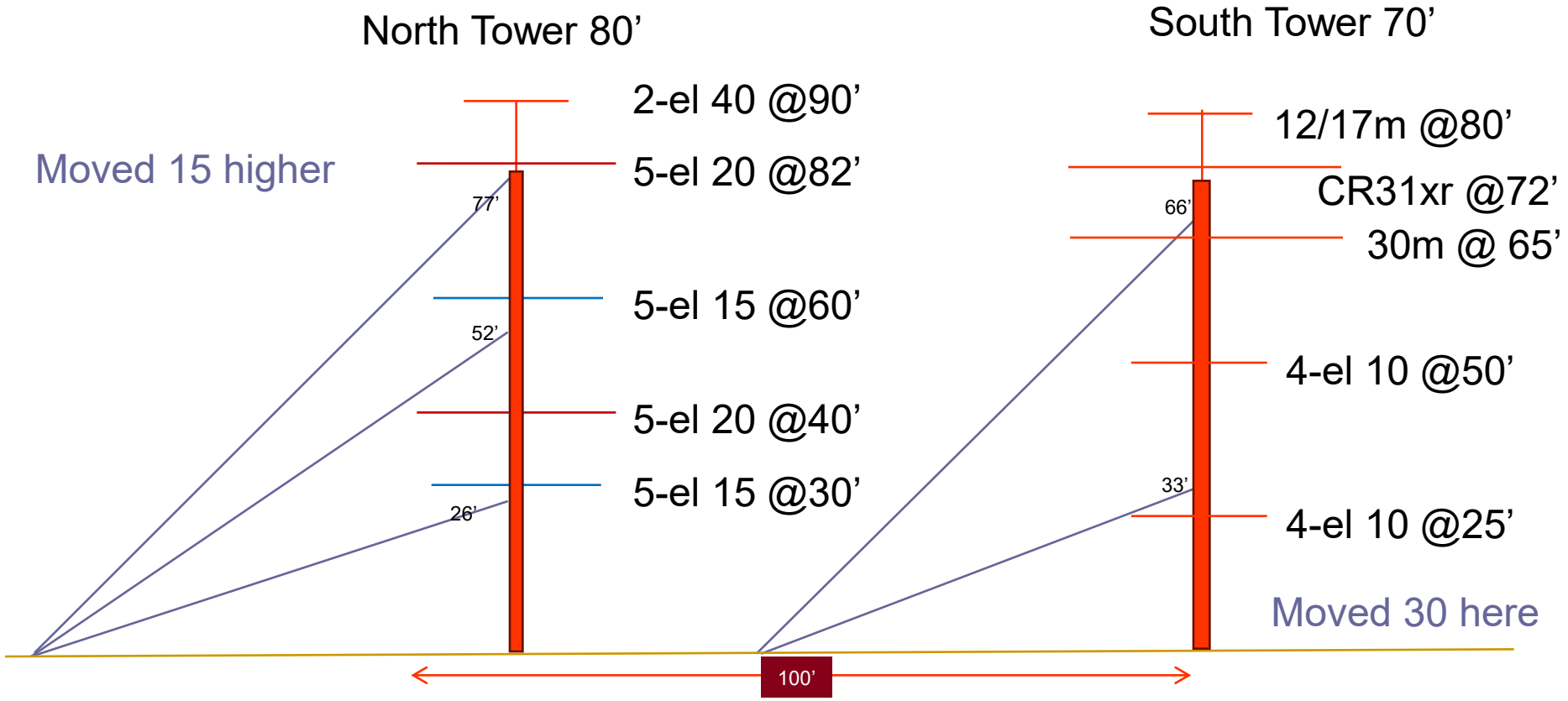
Design 2



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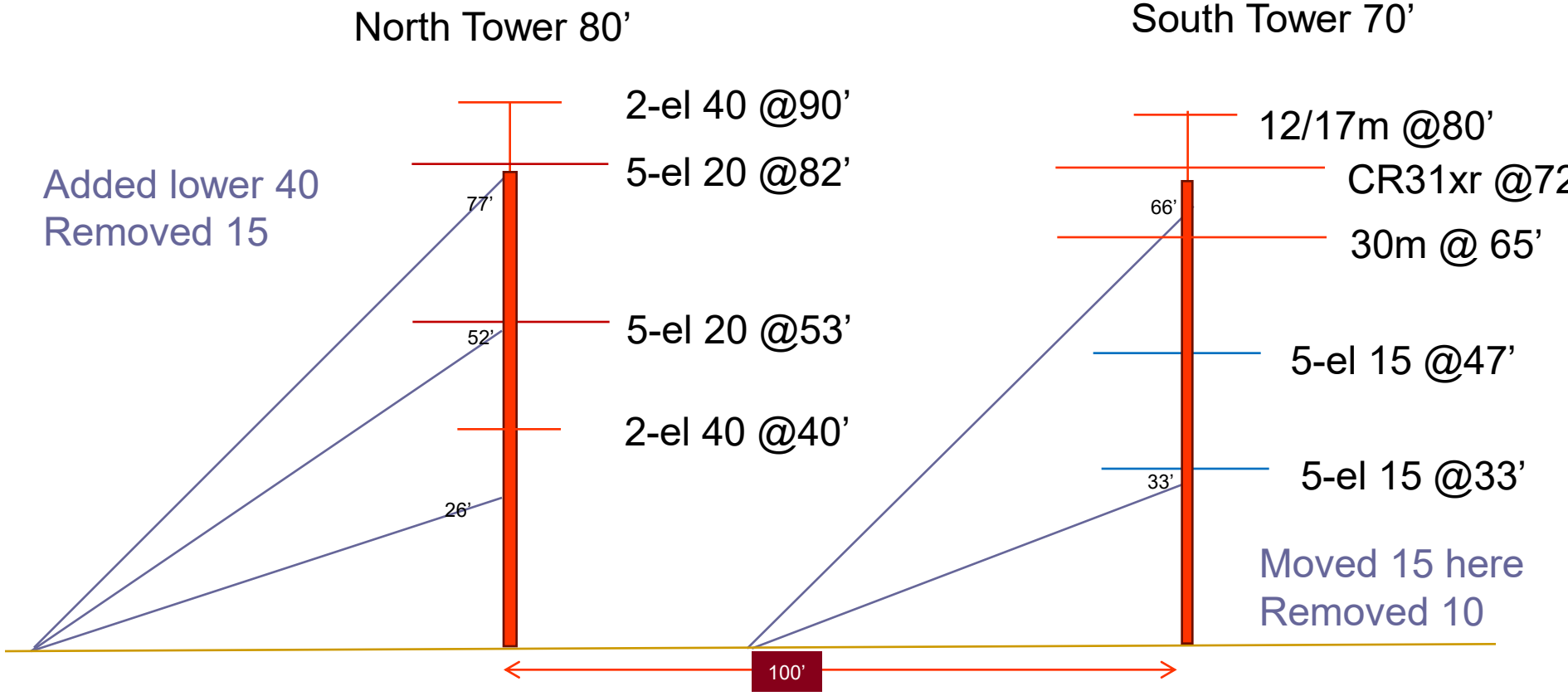
Design 3 (final)



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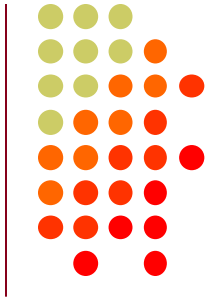
Trade Offs

- Didn't like fitting 15m close to 20m and 40m antennas on North tower
- Moved 15m stack to South tower and removed lower 10m stack
- Decided not to invest heavily in 10m. Will use C31xr tribander as only 10m antenna
- 40 and 20 stacks are a bit too close, but no choice with only 80' tower



3. Build

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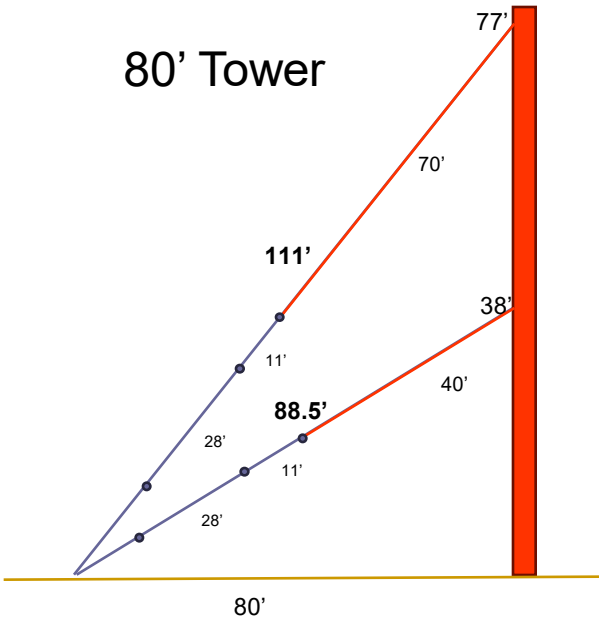
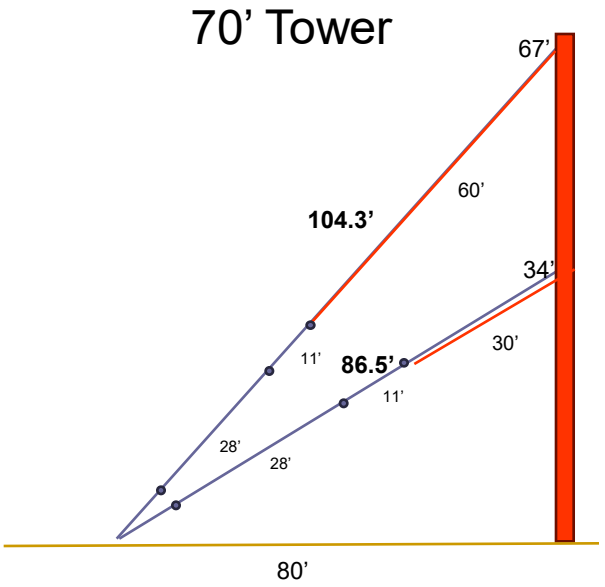
Guy Wire Lengths (original)

- I had Phillystran and wanted it down to 30’ level on tower
- Steel guy wire lengths based on analysis by N2IC in NCJ Nov-Dec 2015 (recommended <11’, 25-30’, >45’)





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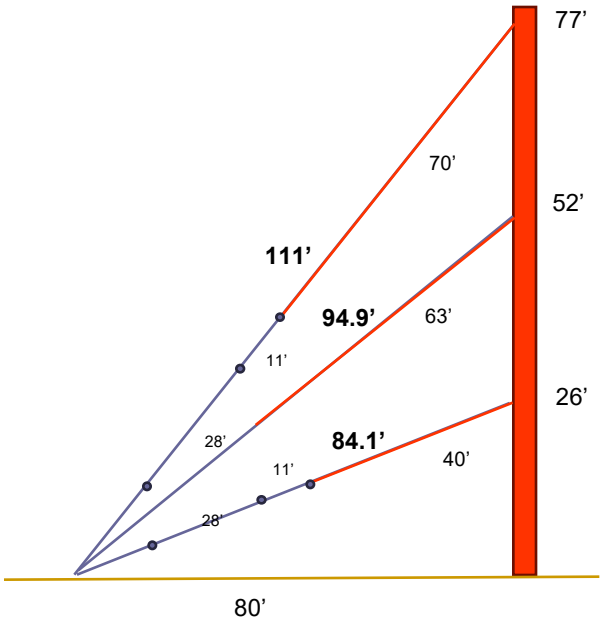
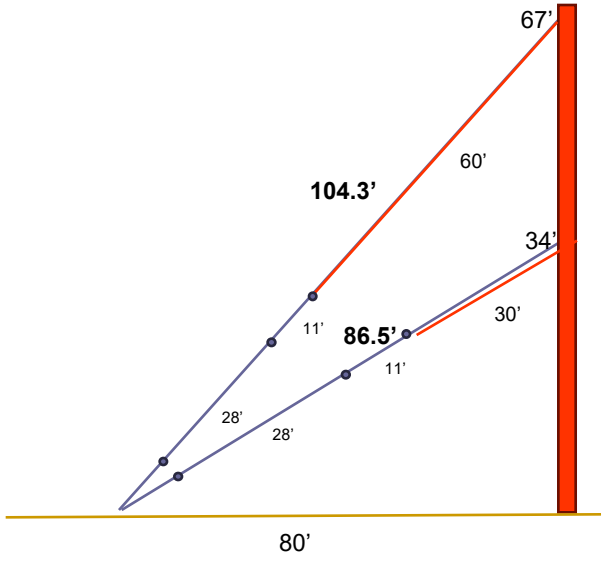
Guy Wire Lengths (Final)

Added third guy on 80’ tower to support stresses of 2-el 40m Moxon and 5-el 20m Hygain

80’ Tower



70’ Tower



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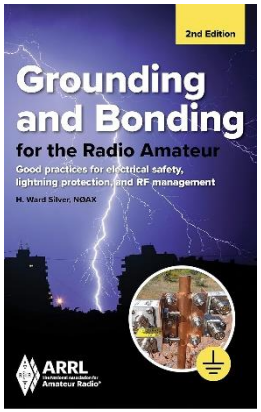
Feedlines

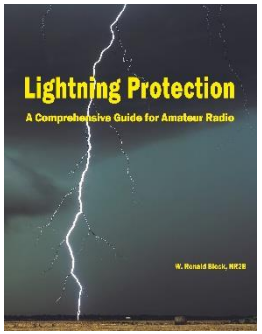
- Stacking switches on tower. Home run for each band.
  - Maximum flexibility in SO2R
  - Easier to use stubs to reduce interference

- Minimized use of 75 ohm CATV hardline. Too hard to deal with transformers at each end.

Grounding and Bonding

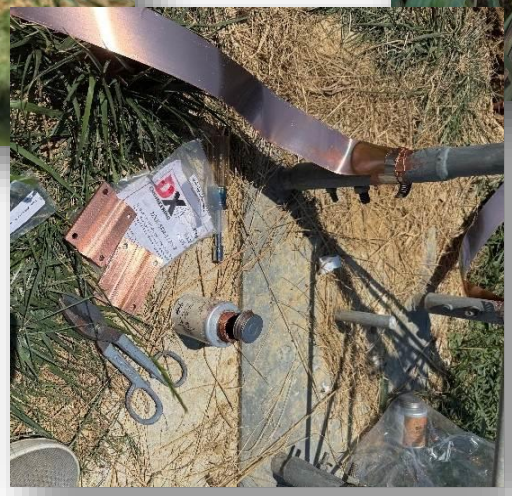
- Two excellent reference books:
  - *Grounding and Bonding for the Radio Amateur*, Ward Silver, N0AX. Published by ARRL
  - *Lightning Protection - A Comprehensive Guide for Amateur Radio,* Ron Block, NR2B. *Available at https://www.wrblock.com/book*





Tower Grounding

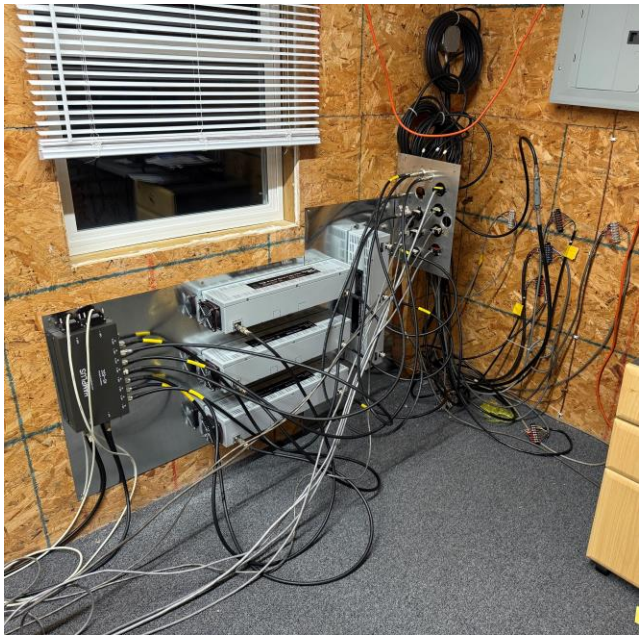
- Ground rods and copper strap around base of each tower



Station Bonding

- Single entrance panel for all feedlines and control cables
- Entrance and electrical panel all bonded to common ground system
- Galvanized Steel sheet metal for bonding panels

https://www.lowes.com/pd/IMPERIAL-24-in-x-3-ft-Galvanized-Steel-Sheet-Metal/3234805



Stacks

- 15m sidemount rotary @ 47’, fixed NE @ 33’
  - Some stacking diversity, most useful when need to beam NE and W in afternoon
- 20m 5-el rotary @ 82’, 5-el fixed NE at 53’
  - Slope helps these appear higher. More diversity than I had expected. Great for beaming NE and W
- 40m 2-el Moxon @ 90’, 40-2CD @ 40’, dipole @ 27’
  - Moxon has been real winner. Moxon + 40-2CD best for Europe. All 3 great for domestic contests

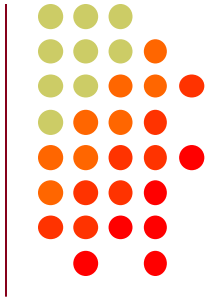
Low Bands

- 160m inverted vee with top at 68’
  - Was hoping to shunt feed tower on 160, but not enough height and the stacked antennas
- 80m inverted vee with top at 78’
  - Covers 3500 – 3800 by using coax matching tricks
    - Frank Witt, AI1H. “A Simple Broadband Dipole for 80 Meters.” QST, September 1993.

As Built

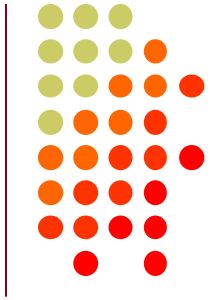
4. Lessons Learned

Lessons



- Band pass filters
  - Blew a K3 front end when 20m Yagi pointed south and C31xr pointed to JA. Direct into each other 100’ apart.
  - Stubs worked for most bands, but not between a monobander and the tribander
  - A band pass filter would have probably saved the radio
- Need more access to the tribander
  - Added high power triplexer and band pass filters

Lessons

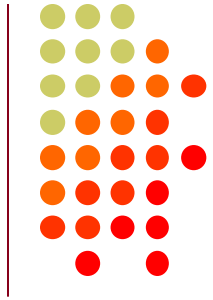


- Need south tribander for quick direction changes. Spent too much time waiting for C31 to turn
  - Future add TH7 or other tribander fixed south
- Complicated manual antenna switching resulted in hot switching relay failure
  - Next investment is for antenna switching automation (follow radio)

Lessons

- Don’t put 20 and 40m on same rotator
  - I should have done 20/15 and 40/10
- WARC bands are on shared coax runs, which complicates antenna selection
- Interaction between C31xr and Cushcraft A3S WARC band antenna
  - They work, but I can tell the C31 does not have the pattern it did in MA

To Do



- Find line noise sources
- Turn WARC and C31 90 degrees to minimize interaction
- Antenna switching automation
- South tribander
- Finish station equipment bonding

Early Results

Contest	Category	Score	QSOs	Result
CQ WW RTTY 2025	SOAB HP	4,894,188	3004	#2 World, W8 record
ARRL SS CW 2025	B	181,220	1066	claimed
CQ WW CW 2025	SOA AB HP	9,392,191	4049	claimed
CQ WPX RTTY 2026	SOAB HP	6,475,478	2431	claimed
ARRL DX CW 2026	SOAB HP	6,284,886	4486	claimed

Has already surpassed all expectations!

Every station site is unique.

Put up what you can.

Continuous improvement.
Keep the things that work.
Replace the things that don't.

Questions?

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