N6RO 10/6/80m Tower Upgrade Project

Gary NA6O,

Ken N6RO,

and Team RO

June, 2022

The contest stations of Ken, N6RO

- **1952-1969: In NY and TX, SO contests, manual SO2R**
- **Arrived CA 1969, connected with W6OAT and M/M team K6EBB**

1970 @HRO

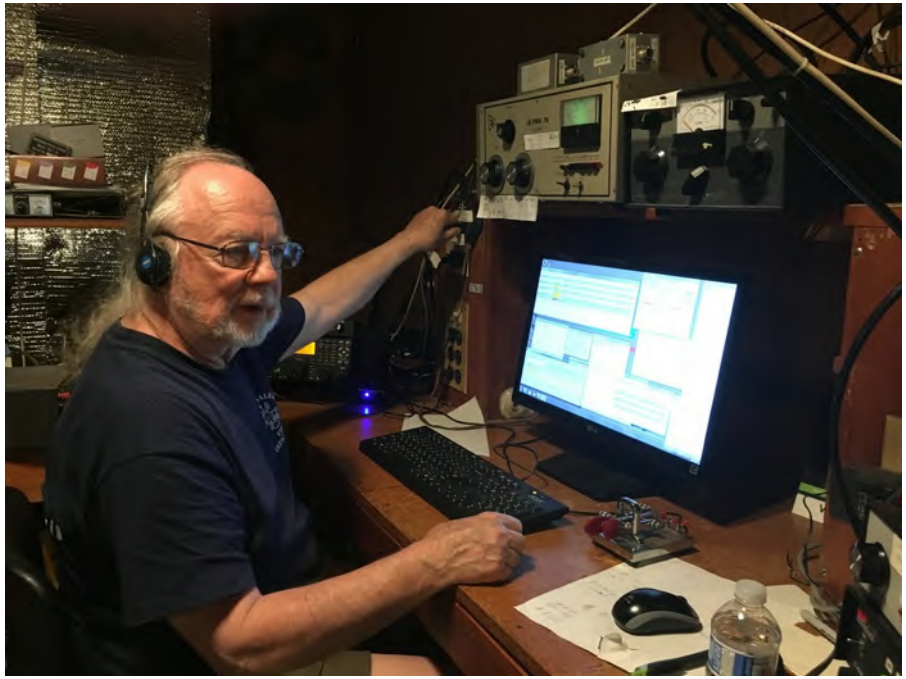
K6AHV – W6RJ
W6PAA – N6RO
K6EBB

- 1970: Built a station in Belmont, CA (with N6BV and W6OWQ)
- 1974: Moved to San Jose, built 3 towers for M/M on a 75 x 100 lot!
  - Ops: N6IG, N6NE, WB6SHD, N6TU, N6KT, W1ARR and others
- 1978: Bought the Oakley property, 10 acres, built house and barn
- 1979: Installed 3 135' Rohn 45 towers, 70' crankup, 96' Rohn BX
  - Rohn BX replaced by 110' R45 in 2006, blew down in 2011 (failed guy anchor), replace with 83' R45
  - Always planned to extend that 83' tower...
- Today: We finally did it!
  - Extended to 135', added an 80m dipole, Phillystran guys, and more

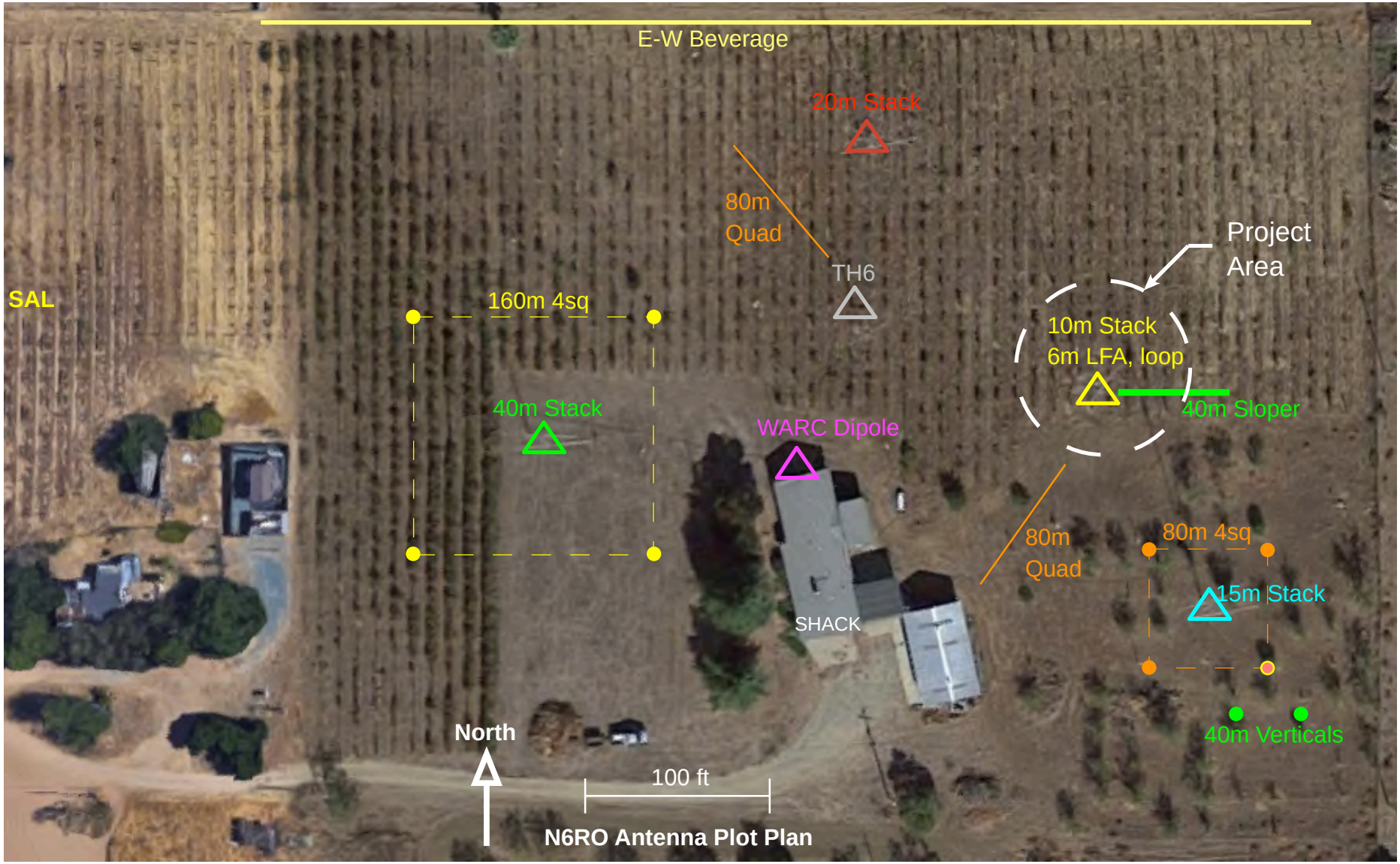
Let's take a look at the station today, and the upgrade project

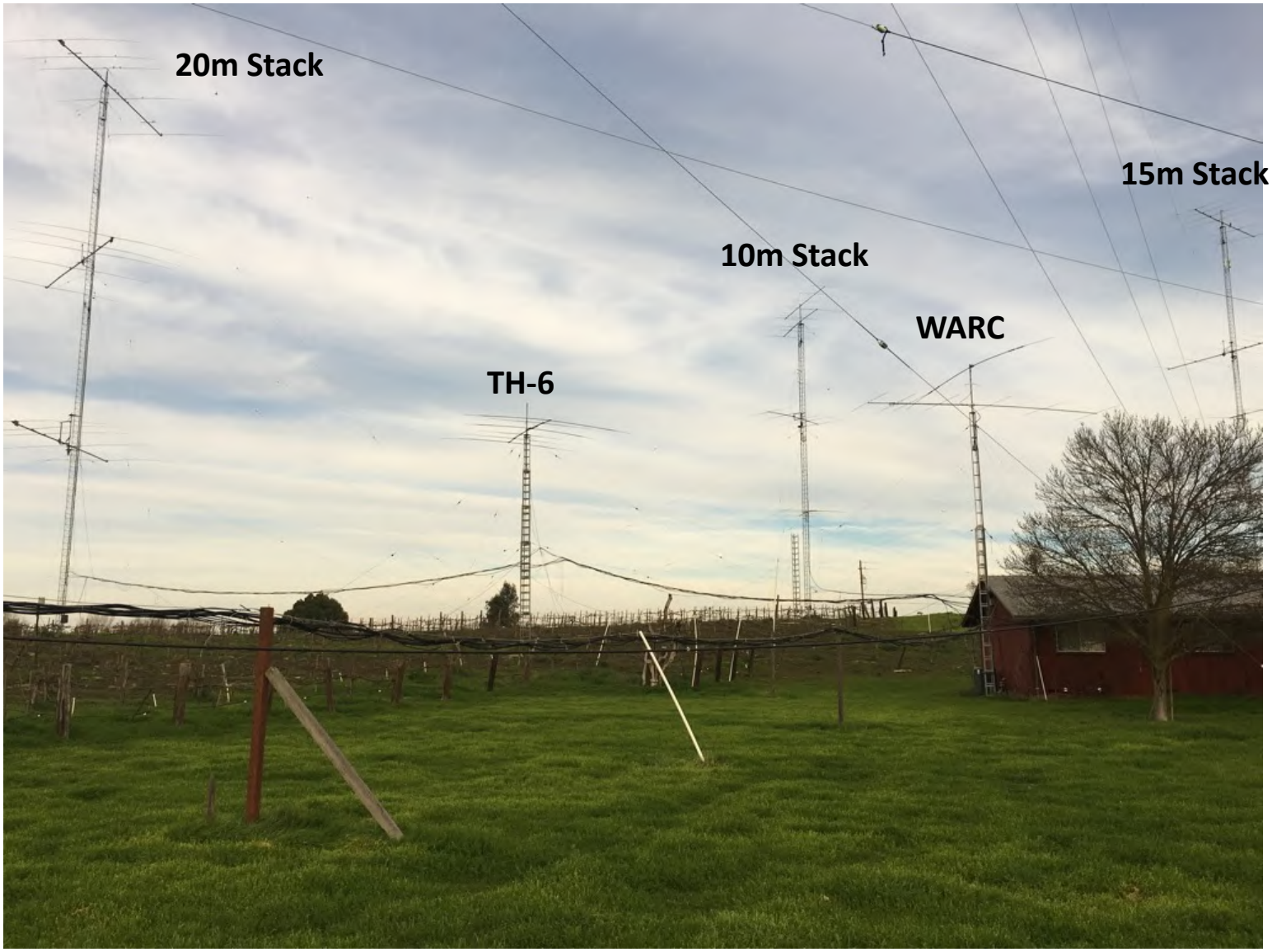
Quick tour of the N6RO super-station

- Located in Oakley, CA
- Built and operated by countless well-known contesters
- Dedicated to multi-operator contesting
- Motto: You can never have too many antennas!



Ken, N6RO, at the helm


E-W Beverage
20m Stack
80m
Quad
TH6
Project
Area
SAL
160m 4sq
10m Stack
6m LFA, loop
40m Sloper
40m Stack
WARC Dipole
80m
Quad
80m 4sq
15m Stack
SHACK
North
100 ft
40m Verticals
N6RO Antenna Plot Plan


20m Stack
15m Stack
10m Stack
WARC
TH-6

40m stack

Surrounded by 160m wire 4-square

...These are two of the most capable antenna arrays on the West coast

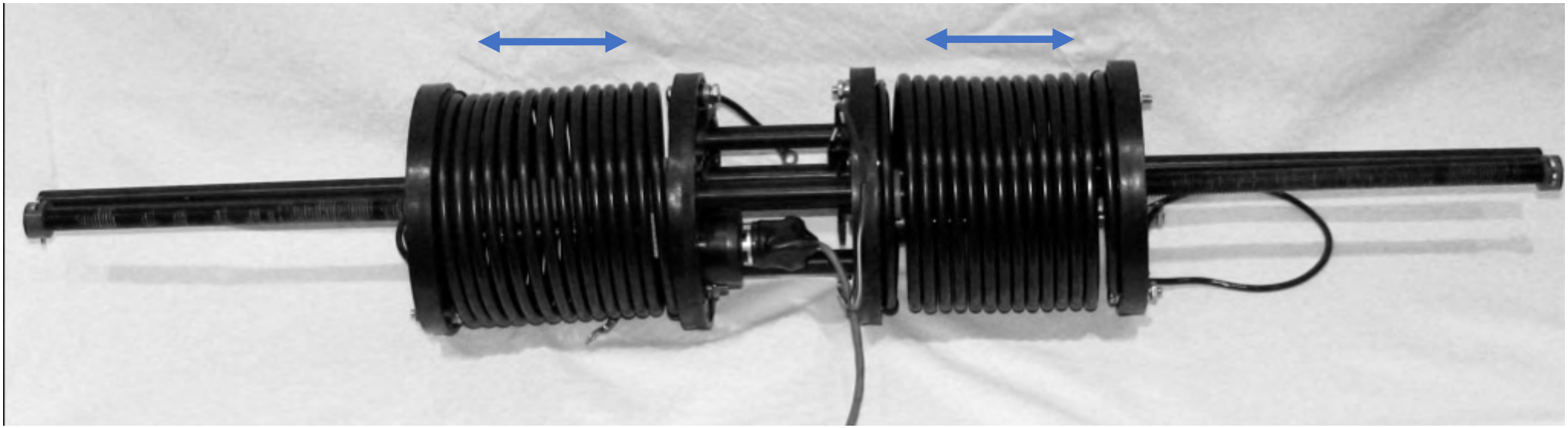

Six stations, no waiting!
2X Flex 6600, 4X K3, +VHF
Five have remote access
NCCC

Current project goal:
Extend tower, add 80 m rotatable dipole

- What: JK Antennas JK801, with Tornado Tuner to cover whole band
- Height: Just above 1/2 wavelength, at 145 ft
- How: Extend 83-ft 10m/6m tower by 50 ft

How the Tornado Tuner works

- Loading coils compressed by a small dc motor (12 V, 1 A)
- Pulse counter for position
- We use a Green Heron RT-21 rotator controller

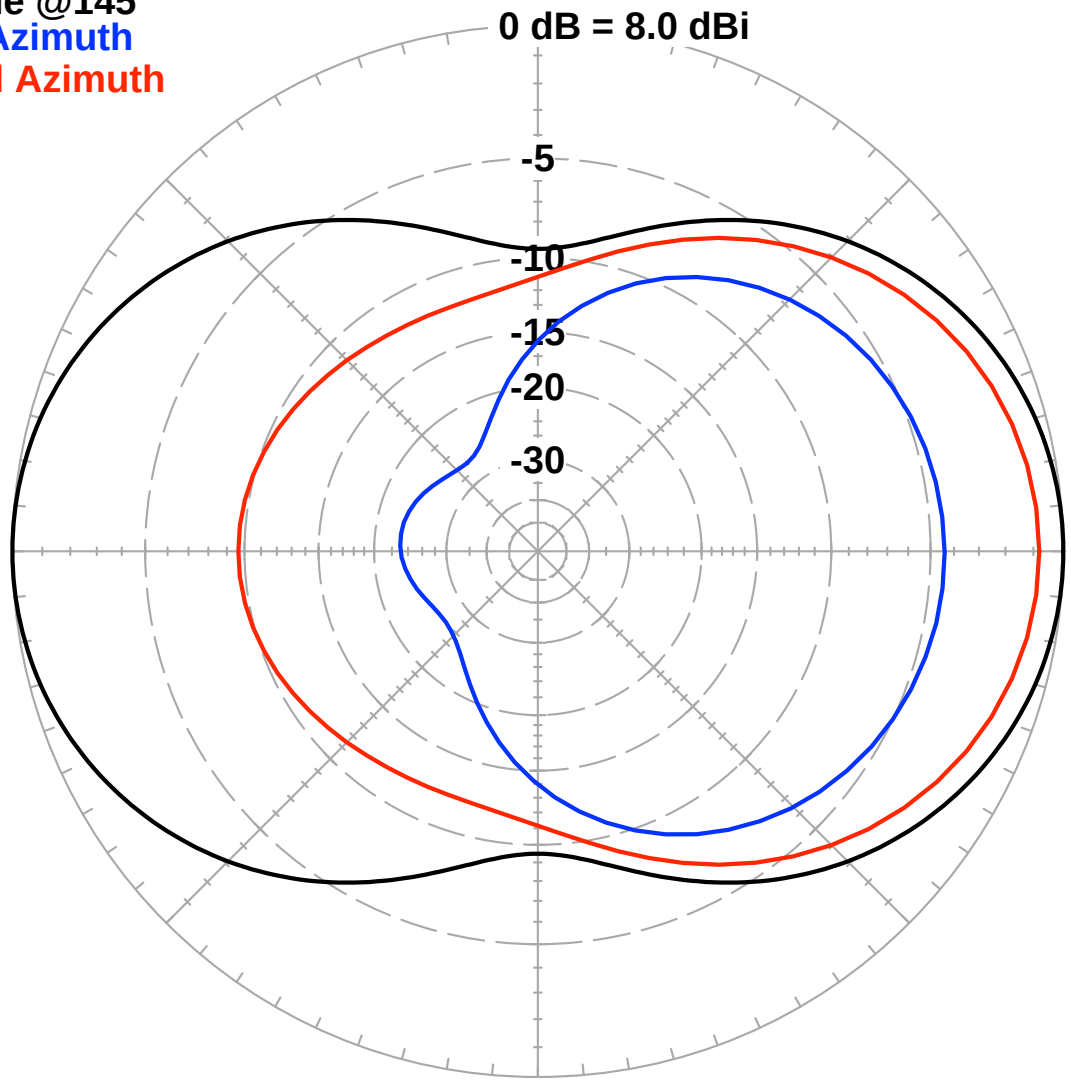


Why a high 80m dipole?

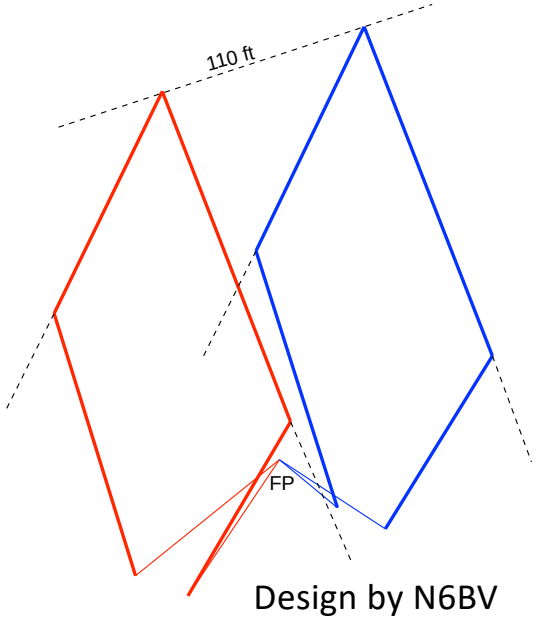
- It's a highly predictable antenna
- Mechanically much easier than a Yagi... Goes up easy, stays up.

- Let's compare it with existing N6RO 80m antennas:
  - 4-square (V polarized)
  - Bidirectional quads (H polarized)
- Expectation
  - Good gain vs. 4-square due to ground enhancement
  - Relatively low receive noise, likely similar to quads

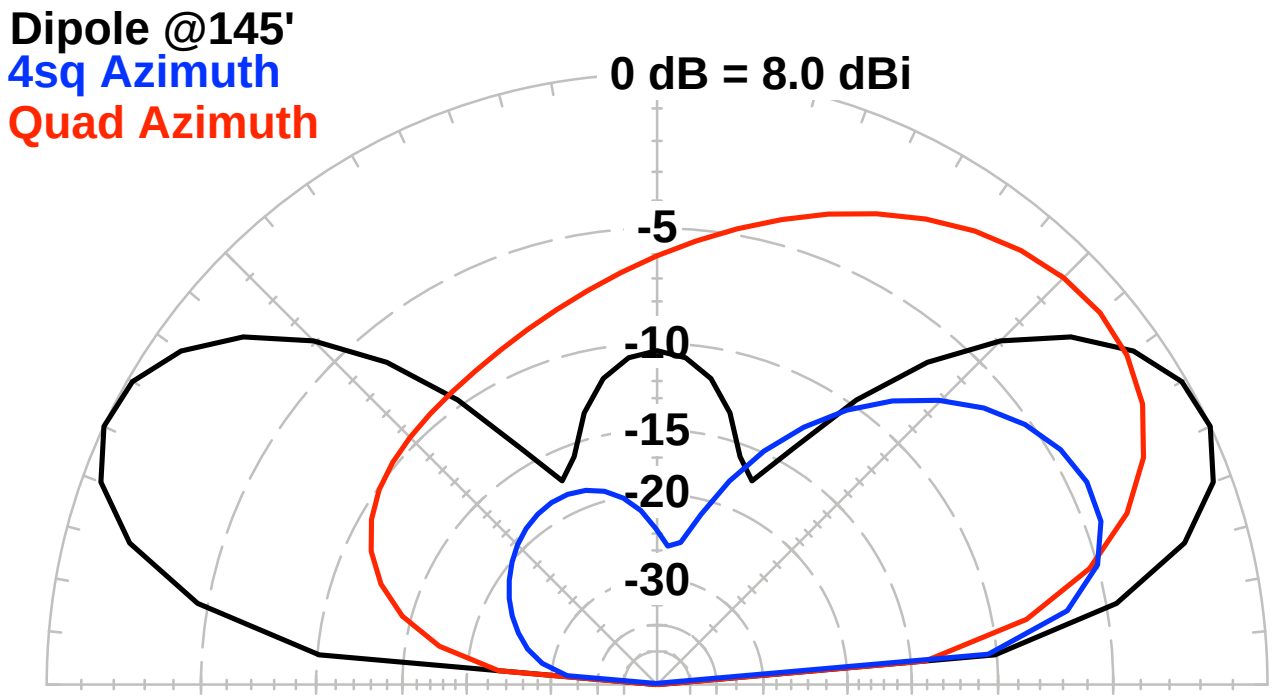
Dipole @145'
4sq Azimuth
Quad Azimuth



Quad consists of two wave 1/2-wave wire loops



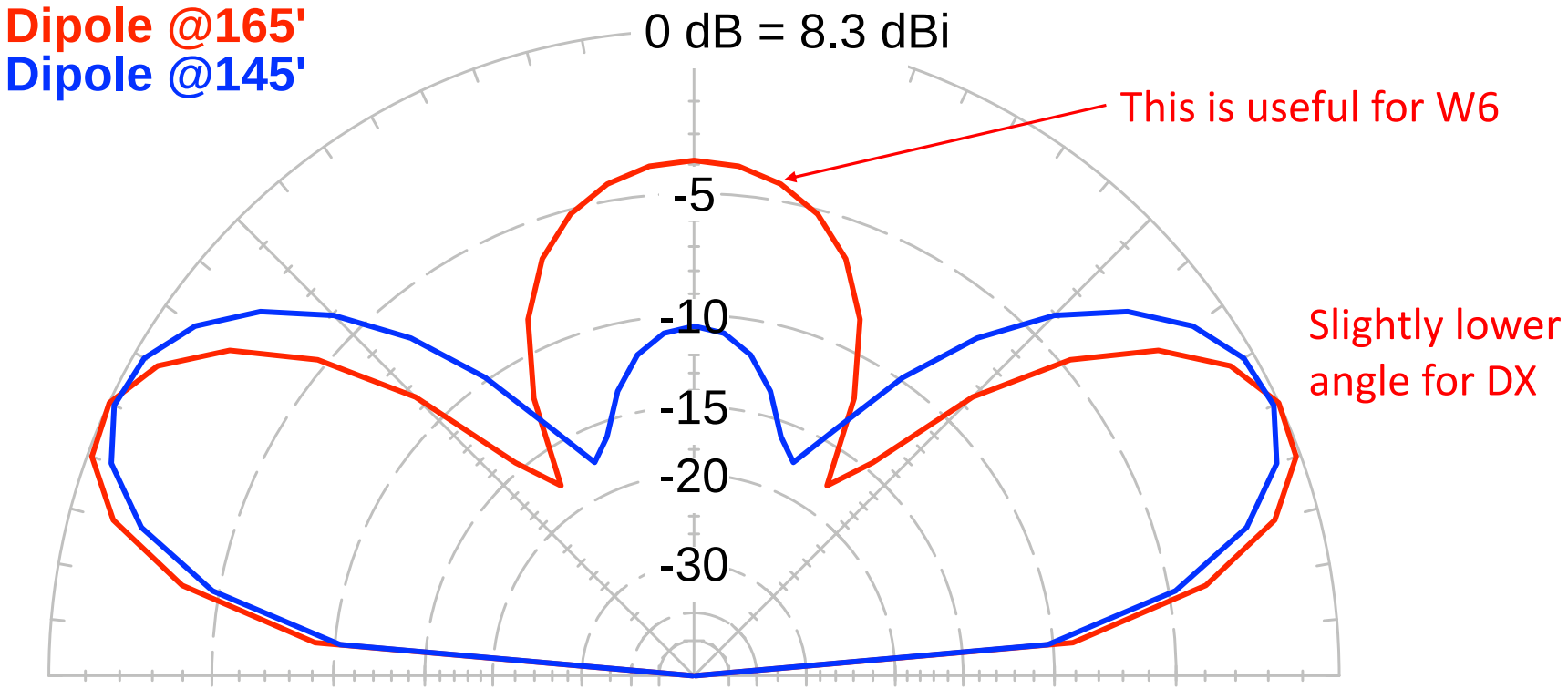
Design by N6BV



Here are some real-world observations:

- **The 4-square consistently out-performs the quad, especially for DX**
- **Quad is quieter on receive**
- **Directionality is helpful for QRM reduction in major contests**

But wait, there's more... The tower is on a small hill, ~20 ft high, so maybe it's like this:



Here's our build team

- Ken, N6RO - Station owner and financier
- Gary, NA6O - Station engineer
- Hector, XE2K/AD6D - Tower Buster
- Nahum Ruiz and sons Luis & Ricardo - Heavy labor
- Greg, KK6PXT – Tower ground crew lead
- Kevin Reasoner
- Roberto, K6KM
- David, W6DMW
- Chris, N6WM
- John, WX6G

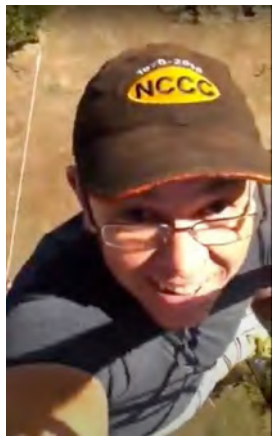
Planning took several months... after years of consideration

- Review objectives and make tradeoffs
  - Antenna types, quantities and heights
  - Switching options
  - Control and cabling complexity
  - Tower height, guying issues
- Locate possible hardware sources
  - Tower sections, mast, rotators, guy hardware, cable, etc.
  - Don't specify something you can't get... Supply chain issues!

Existing 83' 10/6m tower, built in 2011

Search "N6RO" on YouTube

Up the tower: N6WM and N6ML

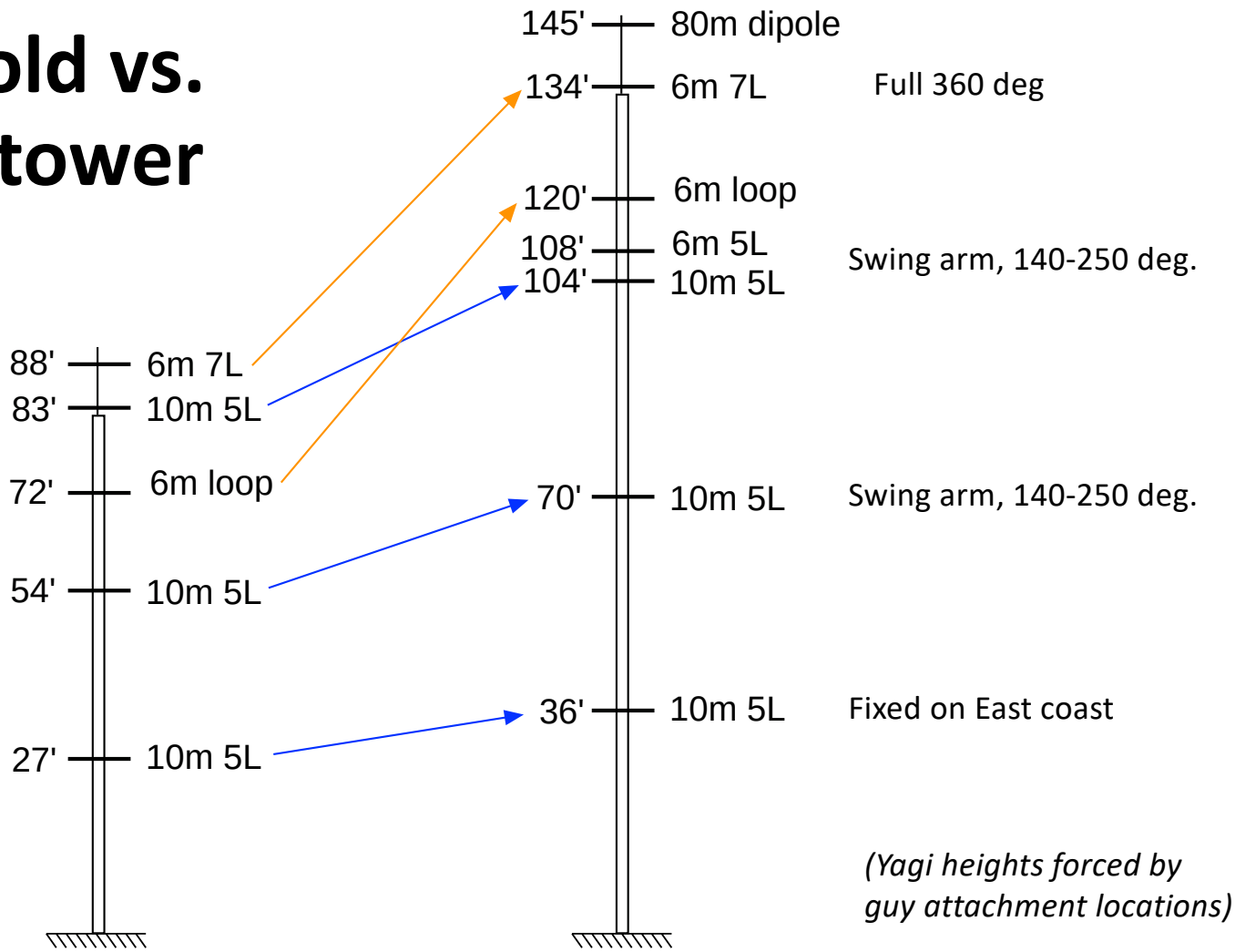


Team RO ground crew:

N6BV, K6AW, N6RO, K3EST

Holy cow, three CQ Contest Hall of Fame members

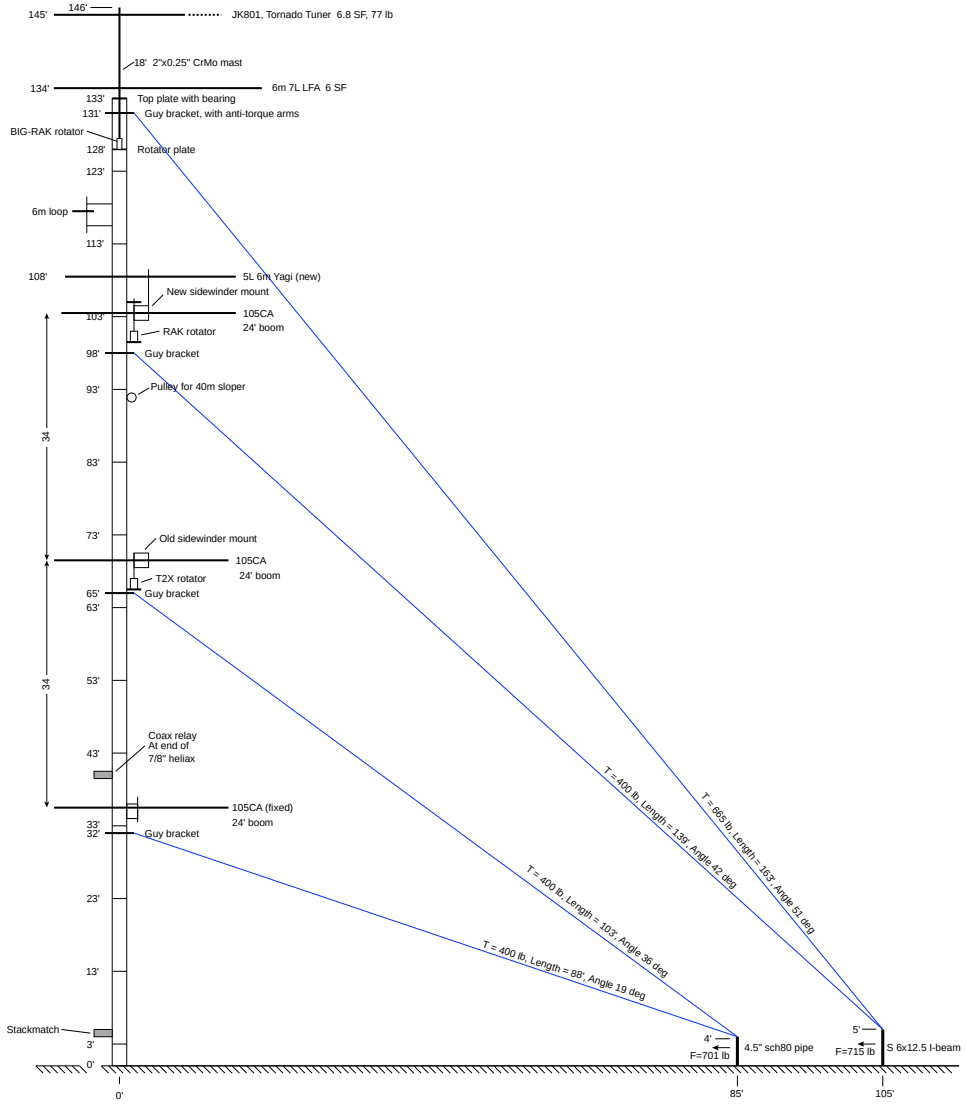
Compare old vs. upgraded tower



Tower elevation drawing

- Everything to scale
- Check guy clearance
- Design cable & guy lengths
- Verify parts list

An important lesson I learned long ago:
"Engineers communicate with drawings."



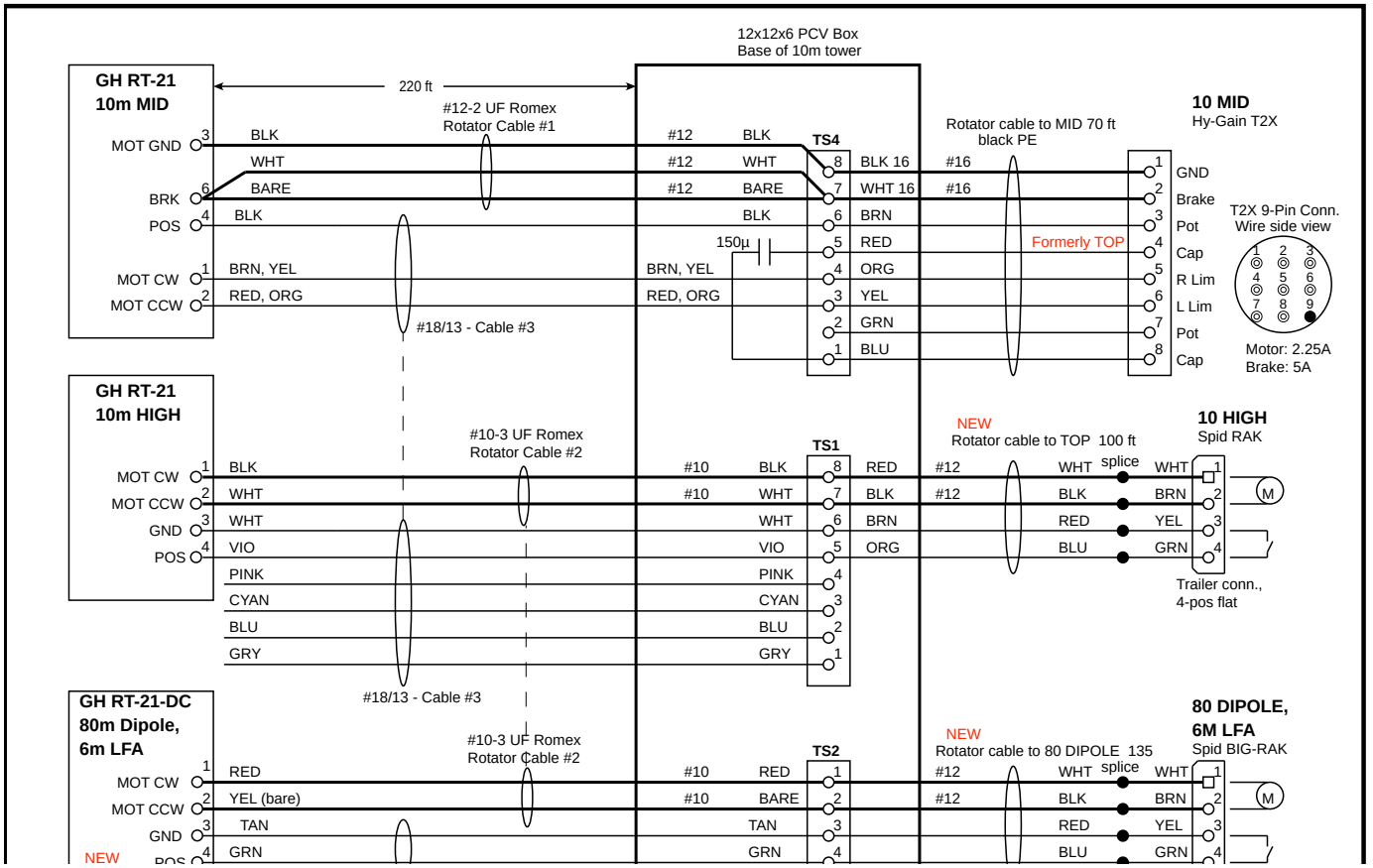
Parts list spreadsheet

- **A.K.A. the shopping list**
- **Did we miss anything?**
- **Who actually has it in stock?**

ITEM			NEED	HAVE	ORDER	SUPPLIER	Status
Phyllystran 1000' 1/4"			1000'		1000'	DXE	
Phylly terminations			24		24	DXE	
1/4" EHS			1000'		1000'	DXE	
Coax for JK 801	LMR 400		350'		500'	DXE	
thimbles 3/8 ?			24			DXE	
turnbuckles 1/2"			12	9	3	DXE	
2" bearing	TB-3		2	1	1	DXE	
802 Insulators			24	24			onsite or tower

Cabling diagrams, drawn before construction

- **Identifies every wire, cable, and terminal**
- **Makes fabrication and trouble shooting easy**



Cable fabrication list

Prefabricate and test nearly everything before construction

Cable List		NA6O 5-18-22						
N6RO 10/80 Tower Upgrade								
Antenna	**FROM**	**TO**	**Length**	**Cable Type**	**New?**	**Notes**	**Loss**	**@MHz**
80 Dipole @145'	Ant feed	Tower top	28	400MAX	Y	Ant pigtail, rotator loop	0.08	4
	Tower top	shack	350	LMR400	Y		0.9	4
	Tornado	Tower top	28	4/c rotator	Y	Tornado pigtail, rotator loop		
	Tower top	Term box @3'	132	4/c rotator	Y			
	BIG-RAK @129'	Term box @3'	130					
6m LFA @134'	Ant feed	Tower top	8				0.07	50
	Tower top	Coax relay @36'	105				0.9	50

Label everything
Cap and seal all connectors

Two new guy anchors were needed

Digging crew... Amazingly clean 3 x 3 x 5 ft holes

Nahum, Luis and Ricardo

Rebar cages

KK6PXT, N6RO, and Kevin

KK6PXT recommended the concrete pump...
He and Kevin helped with the pour

6" I-beam, 5' up. Good for 2500 lb horizontal load

Construction was 4 long, hot days, ~200 MH

Step 1:

Remove EVERYTHING

Antennas,
Cables,
Old tape....

Step 2:

Repair and test everything

Step 3:

Prep and install new guys

Phillystran at the tower,
EHS at the ground

PHILLYSTRAN

Aramid fiber,
Polyurethane jacket

Step 4:

Add 5 sections of tower

(Don't forget to check and straighten any bent legs)

Anti-torque arms on the top section

Fireman Greg at the capstan winch

It's precarious up there...
Leave this to the experts, folks


Hoisting a set of guys


Pulley on the mast, to lift
all the antennas


Receiving a swing arm

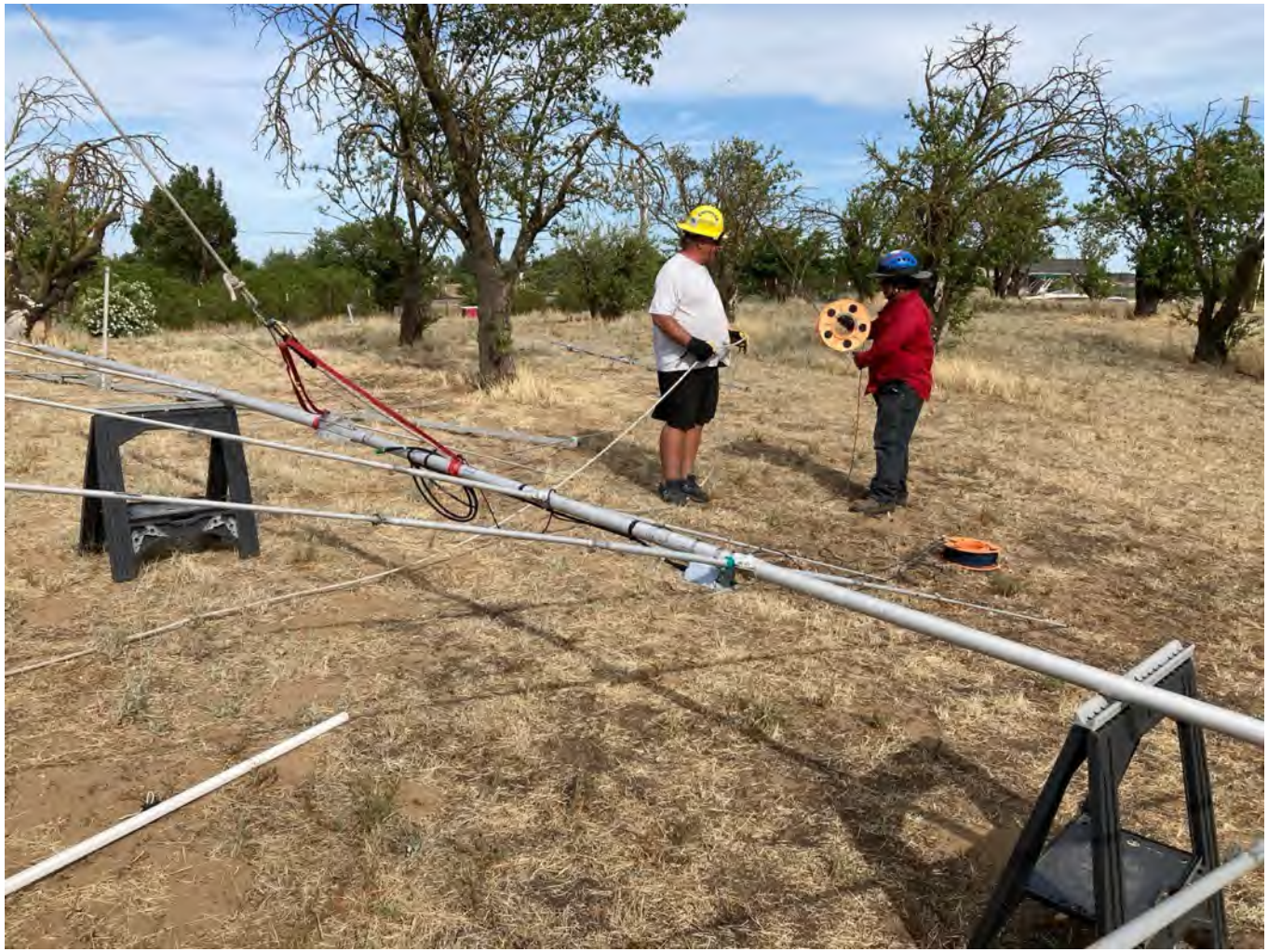

Whole tower, ready to accept antennas

Step 5:

Add antennas by *tramming*

Antenna is lifted with a yoke at the balance point, and one or more tag lines to maintain orientation

Winch does the work, but the ground crew has to finesse it. We got yelled at (a lot).



80m dipole ready for tramming. All extra items are clipped on for immediate use rather than hoisting separately.

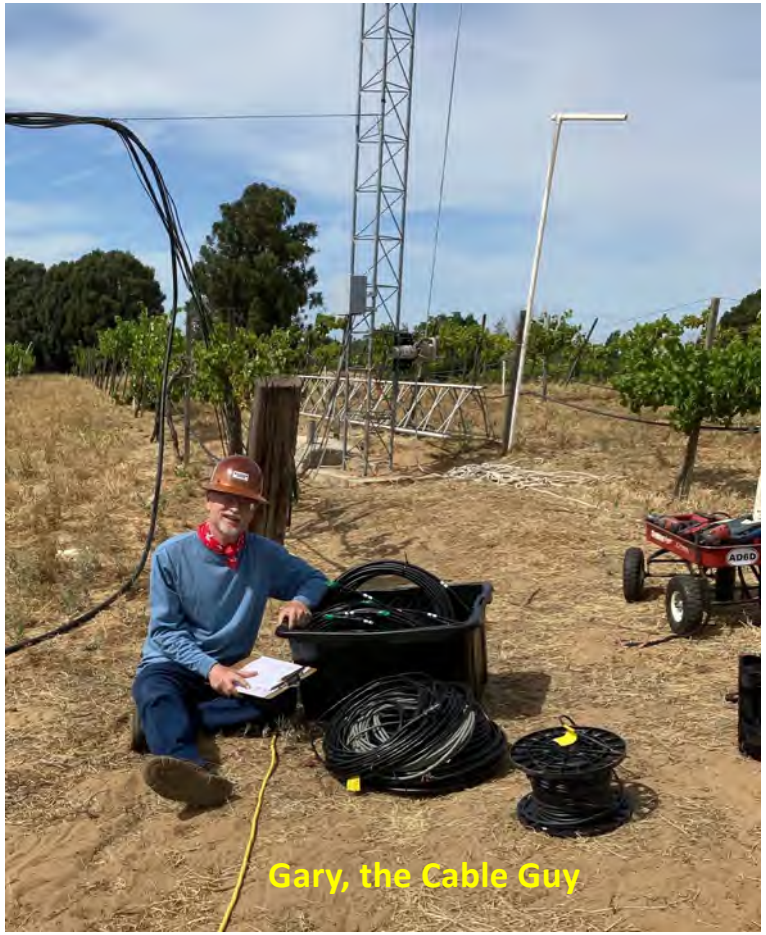
Trammed it all the way to the top, with nobody up there.

A very smooth operation. Hector knows exactly how to do this sort of procedure.

"It looks a lot smaller, way up there"

One by one, over 2 days, up they go.
Wind was a factor in the afternoons!

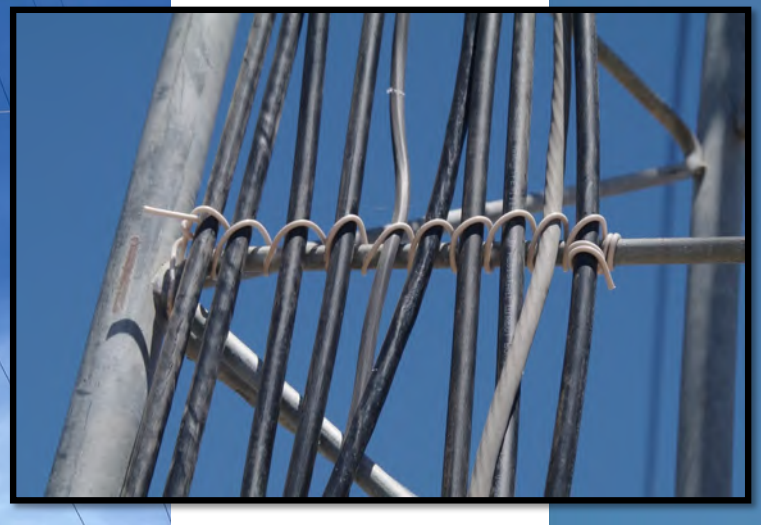
Step 6: Cables. Hoist, connect, weatherproof, tie down



Gary, the Cable Guy

Cables laid out straight, lasso ends with a sling

No tape, just #14 solid wire to lace cables in place. This looks more like a commercial tower.



Step 7. Wired to print.

From shack on the left, from tower on the right
Easy to work on, easy to test
Sealed to keep the black widows out
Stackmatch at ground level

Finished guy anchor, properly safety wired

10m, 70' level
Turned by a T2X


10m and 6M5, 103' level
Turned by a Spid RAK


JK801 at 145' and 6m 7-element LFA at 134'
Turned by a Spid BIG RAK

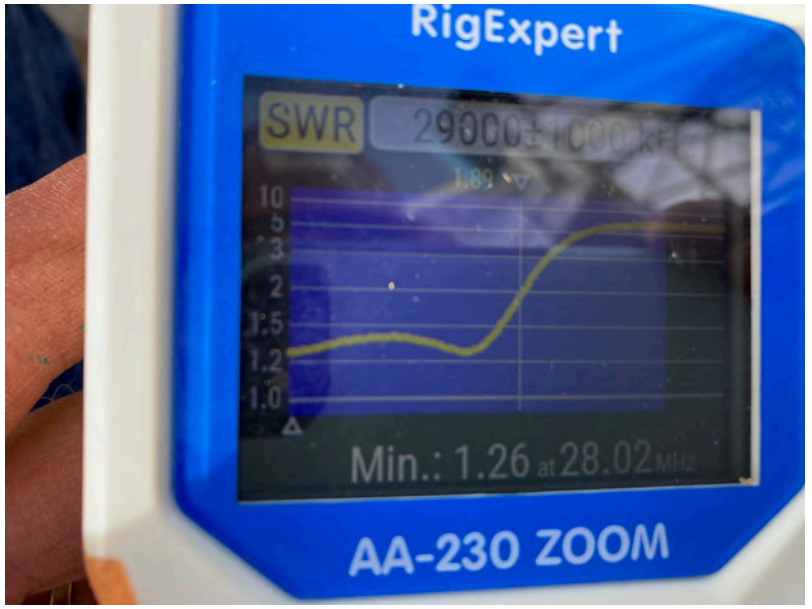
And there it is.

Also: Heavy rust noted on tower legs

- Due to partial burial in ever-moving sand
  - Same thing that brought down the old Rohn BX!
- Emplace rebar
- Apply 8-10" concrete overlay
- Surveillance and maintenance is required!

So... did it work?

- All of the Yagis are fine
- 6m "stack" tested in VHF contest
- Tornado tuner was initially stuck
  - "Bumping" with a power supply fixed it
- Dipole is the first tunable antenna at N6RO, new procedures needed especially for remote operation



Not much time to test it yet, but let's hear from Ken as to how the Dipole plays...

Lessons learned

- **A complete, detailed design is very valuable**
- **Prefabricate and test every possible thing**
- **Never re-install an old item without a full inspection, adjustment, and testing**
- **Invest in new hardware, preferably stainless steel (with anti-seize) wherever possible**
- **Understand the chain of command: The climber is the captain**
- **Test *everything* on the tower before your climber leaves**

Ref: *Up the Tower* by Steve Morris, K7LXC. www.championradio.com


And yes, there will be more antennas