Principles of Station Design:

The NØYY Experience

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NØYY

This Presentation

- This is a summary of my approach to putting NØYY on the air after retirement and a move to Virginia

- Chapters
    - Getting Started
    - Antenna Considerations
    - Station Architecture
    - Ergonomics

While everyone has different perspectives, this is a collection of the principles I used for my station build.

Before you Start…

- What are you trying to accomplish?
- Can you describe success?
- Do you have a plan to achieve success?
  - Financial?
  - Time?
- Can you manage trade-offs?
- Can you implement incrementally?
- Are you a tinkerer? New things? New Buttons?

Is your station "designed" or is it a "work in progress"?

Getting Started – First Steps

- What do you have? – Take inventory
- What do you need? – Make an *honest* list?
- Are there "hard to change" elements of the build?
    - Do you have a room for the station?
    - Is concrete poured for the antenna towers?
- Can you manage "creeping features"
    - It's OK to execute your build in phases, but describe the phases!
    - As you build Phase 1 make sure you can accommodate Phase 3 and 4

Designed vs Work in Progress

- A “work in progress” approach is quicker for some initial capabilities
  - Good for when you don’t have all the answers
  - Good for when you are in a learning phase
  - Should be avoided when it is chosen because you have not thought about the impact
- A designed approach is methodical and limits the “do overs”
  - Less costly in both time and money

I’ll paraphrase the old quality adage:
“You never have the time or money to do it over!”

Station Goals

- My Operating Goals
  - DX Honor Roll
  - 5-band WAZ
  - 10-band DXCC
  - 10-band WAS
  - CW / SSB / RTTY / Digi
- My Contest Goals
  - Competitive entry in SS
  - NAQP 700+ QSOs (all modes)
  - CQWW 2000+ QSOs
  - ARRL DX 2000+ QSOs
  - 160M Contests
    - ARRL
    - CQ CW
    - CQ SSB
- My Station Goals
  - SO2R / Redundant implementation
    - Single Radio Backup in case of failure
    - Independent antennas for failure recovery
  - Ergonomic design
  - AI Digital Voice Keying
- Future Growth
  - Remote Operation
    - Is your station the "Server" that others access?
    - Is your station the "Client" that accesses other stations?

Basic Station Description

- 160M-6M – CW/SSB/RTTY/Digi
- Single Tower focus
  - 160M Inv-L
  - 80M Inv Vee
  - 40M Rotatable Dipole
  - 40M Low Dipole
  - 20/15/10 Bencher Skyhawk
  - 6M Omni (Stacked HO Loops)
  - 6M Yagi
- Backup Antenna
  - HyGain 18HT Vertical

It took me a while to come to this description. I started with GRAND plans!

Requirements – High Level

- 160M – 6M
- CW / SSB / RTTY / Digi
- SO2R
    1. Backup in case of rig failure
    2. Dual band monitoring
    3. Contesting in SO2R class
- Single Tower Antenna System
- All band vertical
    1. Backup in case of primary antenna failure
    2. Integrated for SO2R operation
- High Power
- Fully automated control
- Follow ergonomic guidelines
- Only principal equipment on work surface
    - All other equipment to be under work surface on shelves or mounted on the underside of the work surface

The Starting Inventory

- Elecraft K4D
- Elecraft K3 (w/N6TV S-Box)
- Elecraft P3 w/SVGA
- Elecraft K-Pod
- Flex PGXL (SO2R)
- Flex TGXL (SO2R)
- Dunestar 600 BPF (2)
- DXDoubler (SO2R Controller)
- WinKey USB
- DCU-3 Rotor Control (T2X Rotor)
- T2X Rotor
- Bencher ST-1 Single Lever Paddle
- Astron RS-35M (2)
- Astron RS-20M
- Astron RS-12M
- Bose QC-2 Headphones
- Sennheiser Headphones
- Antlion ModMic Microphone
- Geekom i7-12650H (Station)
- GMKtec i5-12450H (Control)
- 27 in Displays (3)
- Trylon T600-64
- Skyhawk
- Cushcraft D40 Rotatable Dipole

What's Missing from the List?

- Antenna Switching
- 6M Antenna
- Station Automation
- 2nd Antenna System
- Receive Antenna System
- Uninterruptable Power Supply
  - Radios today are computers with radio functionality – they do not like power failures e.g. brown outs, drop-outs, bouncing re-start cycles

- Future functionality
  - Remote operations

Station Control Items - Options

SO2R

MicroHam

- micro2R (µ2R)

TopTen Devices

- DXDoubler w/USB

YCCC

- SO2R
- SO2R Mini

DXEngineering

- RigSelect Pro

Remote Control

Green Heron

- Rotor Control
- GHEverywhere

Hamation

- Hamtronics 2x8 Matrix
- Hamtronics RC-5 (2)
- Hamtronics MD-12 (2)
- Hamtronics RC-16 (2)

Freq-EZ

- Software based station automation

MicroBit

- RemoteRig (RRC-1258MkIIs)

ANTENNAS

A Review of My Goals

- Looking back on my goals I needed a compliment of antennas for the following:
  - 160M-to-6M
  - Both DX and Domestic contests
  - Automatically selected from the still undefined station automation
  - A 2nd antenna for SO2R and redundancy

The Proposed Antenna Compliment

- Main Tower
  - 160 InvL
  - 80 Inv Vee
  - 40 Rotatable Dipole
  - 40 Low Inv Vee
  - 20/15/10 Skyhawk
  - 6 Omni
  - 6 Yagi

- HyGain HyTower Vertical
  - 80M – 10M
  - Options
    - MK-160 Add-on
    - MK-17 Add-on
  - Proposed Configuration
    - 80M-10M + WARC
    - No 160M

The System Baseline:Trylon T600-64

- What can we do if the T600-64 is the basis of the single tower solution?
  - Is 64 feet the right height for the Skyhawk?
  - Is 72 feet the right height for the rotatable dipole?
  - Is 60 feet the right height for the 80M Inv Vee?
  - What is the optimum height for a 6M antenna?
    - Height for E_s? Height for F2?
  - What is the optimum height for <500mi coverage on 40M?

A Quick and Dirty Analysis

- Modeling a single tower that covers 160-6M is a challenge – there are interactions everywhere!
- What I really wanted was a “back of the envelope” analysis
- I used a report by Edmund Laporte to get some basic info (http://www.vias.org/radioanteng/radio_antenna_engineering_03_06_02.html)
- I prepared a quick table that established λ (ft) vs frequency to view a graphic of dipole radiation patterns (see next slide)

		λ (in feet)															
Band	**Freq**	0.125	0.15	0.2	0.25	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.25	1.5	1.75	2
160	1.830	68.6	82.4	109.8	137.3	164.8	219.7	274.6	329.5	384.4	439.3	494.3	549.2	686.5	823.8	961.1	1098.4
80	3.550	35.4	42.5	56.6	70.8	84.9	113.2	141.5	169.9	198.2	226.5	254.8	283.1	353.9	424.6	495.4	566.2
40	7.050	17.8	21.4	28.5	35.6	42.8	57.0	71.3	85.5	99.8	114.0	128.3	142.6	178.2	213.8	249.5	285.1
20	14.030	9.0	10.7	14.3	17.9	21.5	28.7	35.8	43.0	50.1	57.3	64.5	71.6	89.5	107.4	125.4	143.3
15	21.050	6.0	7.2	9.5	11.9	14.3	19.1	23.9	28.6	33.4	38.2	43.0	47.7	59.7	71.6	83.6	95.5
10	28.050	4.5	5.4	7.2	9.0	10.7	14.3	17.9	21.5	25.1	28.7	32.2	35.8	44.8	53.7	62.7	71.7
30	10.1	12.4	14.9	19.9	24.9	29.9	39.8	49.8	59.7	69.7	79.6	89.6	99.5	124.4	149.3	174.1	199.0
17	18.9	6.6	8.0	10.6	13.3	16.0	21.3	26.6	31.9	37.2	42.5	47.9	53.2	66.5	79.8	93.1	106.3
12	24.6	5.1	6.1	8.2	10.2	12.3	16.3	20.4	24.5	28.6	32.7	36.8	40.9	51.1	61.3	71.5	81.7
6	50	2.5	3.0	4.0	5.0	6.0	8.0	10.1	12.1	14.1	16.1	18.1	20.1	25.1	30.2	35.2	40.2

The process was to identify the desired dipole radiation pattern from the graphic and then establish the antenna height from the table.

Note: The table is a based 1005 is a full wavelength. $1005/f_{MHz}$ provides the height of 1λ. That is then multiplied for the increments of height. e.g. ¼ λ is 0.25, ½ λ is 0.5, etc.

For example: a dipole at ½λ on 40M would be 71.3 ft in height for the lowest take-off angle and cleanest pattern.

Another example: at 65 ft on 20M is 0.9λ which would yield a 16 degree take off angle with a of compromised high angle radiation as opposed to 1λ.

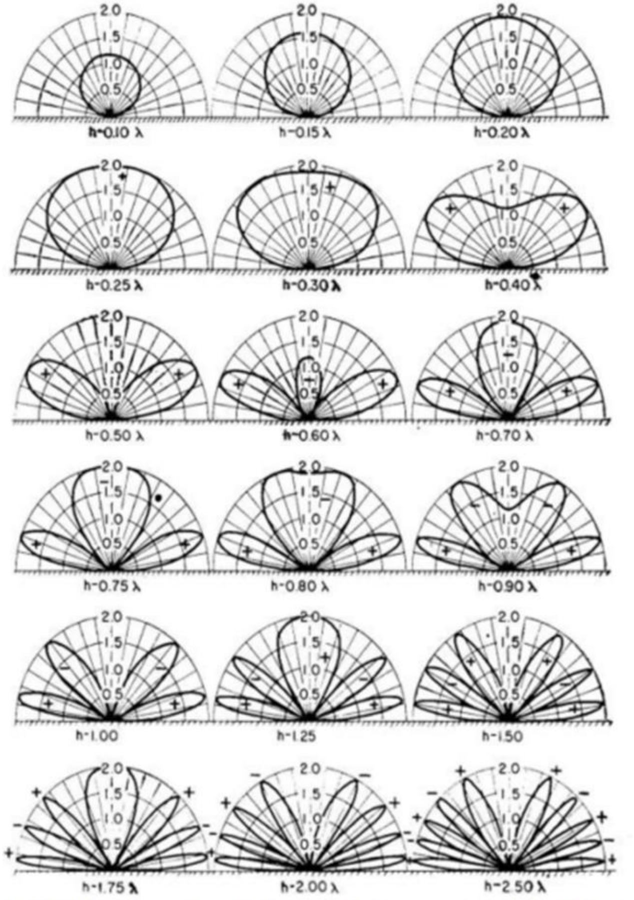
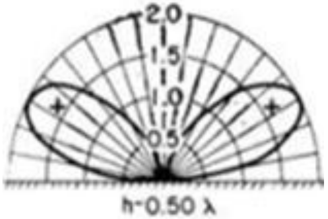
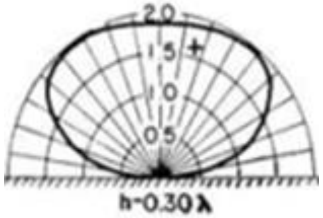


FIG. 3.15. Vertical polar radiation diagrams in the plane normal to a horizontal dipole antenna. (From RAF Signal Manual)

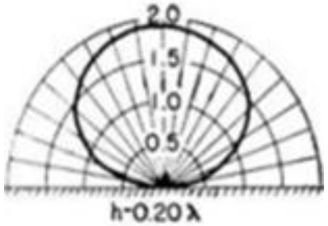
Some Answers…



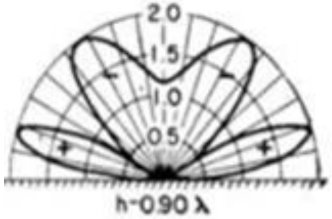
40M Rotatable Dipole @ 72’
(Focused pattern – TOA = 31°)



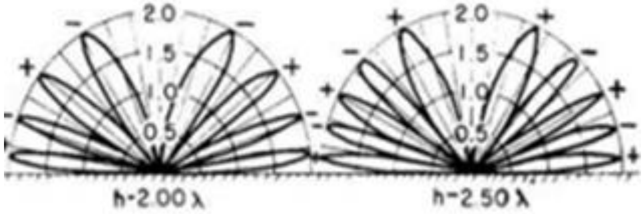
40M Dipole @ 43’
(Optimized for <500 mi)



80M Inv Vee @ 62’
(High Angle, Minimum Loss - but does not consider the vertical component of an Inv Vee)



Skyhawk @ 65’
(High Angle compromise, TOA = 18°)



6M Dipole @ 45’
(TOA = 7°
Too many lobes and nulls)

This is a problem! Can we consolidate the lobes and eliminate some of the nulls? Stay tuned…

Another Assessment: HFTA Figure of Merit

- HFTA describes a “Figure of Merit” (FOM) based on path performance for different antennas at different heights
- For this “simple” assessment a flat terrain was considered
- Conclusions
    - 20M – the FOM is comparable to single antennas at a variety of heights – stacks out-perform the Skyhawk @ 64’
    - 15M – the FOM is comparable to single antennas at heights below 90’ – stacks out-perform the Skyhawk @ 64’
    - 10M – the FOM is comparable to single antennas at heights below 100’ – stacks out-perform the Skyhawk @ 64’

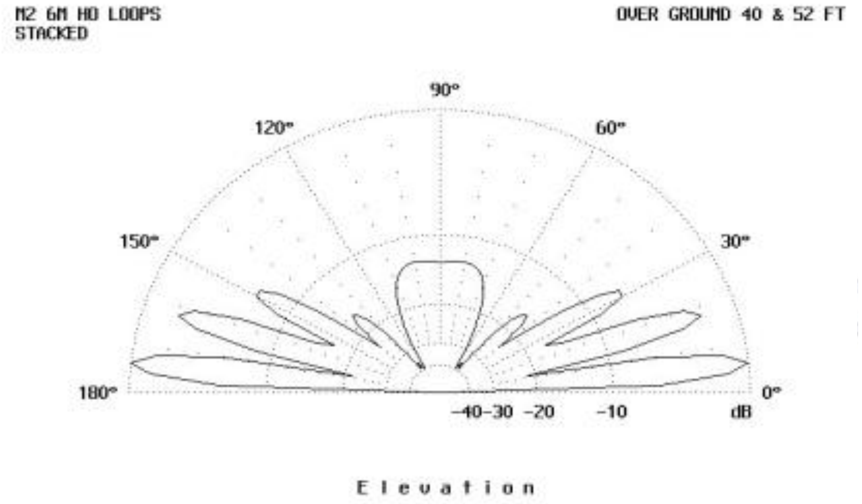
Figure of Merit

Band	Ant Config & Height	# of Elements	Africa	Asia	Europe	Japan	Oceania	South America	United States
20	64	3	10.2	8.7	11.7	11	10.1	12	10.7
	140	5	13.2	12.6	12.9	13.2	12.5	12.8	12.1
	130	5	13.2	12.5	12.9	13.3	12.5	12.9	12.4
	120	5	13.1	12.3	12.9	13.3	12.5	13	12.7
	100	5	12.7	11.6	13	13.1	12.3	13.2	13
	90	5	12.3	11	13	12.8	12	13.2	12.9
	80	5	11.7	10.3	12.9	12.4	11.6	13.1	12.7
	70	5	11	9.5	12.6	11.8	11	12.9	12.7
	60	5	10	8.4	12	11	10.1	12.3	12.7
	140/90	5	14.5	14.8	15.4	15.8	15.1	15.5	14.5
	130/90	5	15	14.8	15.6	16	15.2	15.8	15
	120/90	5	15.4	14.7	15.8	16	15.3	16	15.4
	120/72	5	15.1	14	15.4	15.5	14.8	15.6	14.7
21	64	3	11.4	10.8	11.8	11.4	10.2	12.2	12.9
	100	5	12.9	13	12.6	12.5	12.6	13	12.3
	90	5	12.8	12.7	12.7	12.5	12.2	13.1	12.7
	80	5	12.6	12.3	12.8	12.5	11.7	13.2	13.2
	70	5	12.2	11.6	12.8	12.4	11	13.2	13.9
	60	5	11.6	10.7	12.6	12.1	10.1	13	13.9
	100/60	5	15.2	14.9	15.2	14.9	14.4	15.6	15.1
28	64	4	12.6	12.3	12.9	13.4	12.4	13	11.4
	100	5	12.7	12.7	13.4	13.1	12.4	12.9	11.8
	90	5	12.6	12.7	13.3	13.4	12.5	13.1	11.6
	80	5	12.6	12.5	13.1	13.5	12.5	13.1	11.3
	70	5	12.5	12.2	12.9	13.4	12.3	13	11.5
	60	5	12.3	11.7	12.7	13	11.9	12.8	12.5
	50	5	11.7	10.9	12.3	12.3	11.1	12.7	13.7
	40	5	10.7	9.6	11.5	11.1	9.8	12.4	14.5
	30	5	8.9	7.6	10	9.2	7.8	11.3	14.1
	100/60	6	16.5	16.5	17	17.4	16.5	16.5	12.7

The Skyhawk @ 64’ is an acceptable solution for domestic and international contesting

Problem Solving: 6M Lobes and Nulls

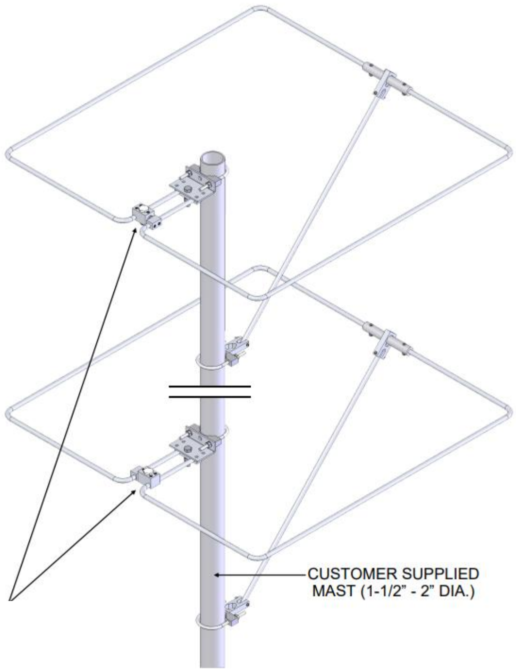
- If one dipole is good, maybe two are better!
- A folded dipole forms the square loop
- Loops are fed out of phase
- Here is a solution that provides:
  - Lobe and null consolidation
  - Omni directional coverage
    (No rotor required!)
  - 10.5dBi gain @ 6° take-off-angle
  - Small, lightweight
  - Antenna Center = 46’ (near optimum)



2 STACKED 6M HO LOOP PERFORMANCE

HEIGHT ABOVE GROUND	GAIN	ANGLE OF RADIATION
8 FT AND 18 FT	8.03 dBi	17°
8 FT AND 20 FT	8.47 dBi	16°
20 FT AND 32 FT	9.96 dBi	10°
40 FT AND 52 FT	10.54 dBi	6°

0.6λ Spacing
(12.1 feet)



https://www.m2inc.com/content/PDF%20MANUALS/HO-LOOPS/6MHOLOOPMAN03-W.pdf

What’s Left?

- SO2R / Backup Antenna – HyGain HyTower
- 160M InvL
- 80M Inv Vee
- 40M Low Dipole
- 40M Rotatable Dipole
- Rx Antenna

HyGain HyTower Perspectives

- HyTower was the first antenna installed
- Thirty-six 36’ radials buried to a common ground plate
- Modified base insulators to resolve destructive arcing to ground
  - Caused by thru-bolt to aluminum concrete stub
  - Replaced by epoxied fiberglass rod in original insulator and inserted into 1in hard-drawn steel tubing in the concrete base
- Entered into service November 2023

Initial Observations

- Great performer on 80/40
- Good performer on 20M
- Passable on 15/10
- Narrow VSWR – requires antenna tuner for most bands
- Works on WARC Bands with Tuner

- 80M base inductance – 3 segments
- 40M & 20M OK with stub adjustment
- Other bands including WARC need matching network at the antenna base to avoid shack RFI

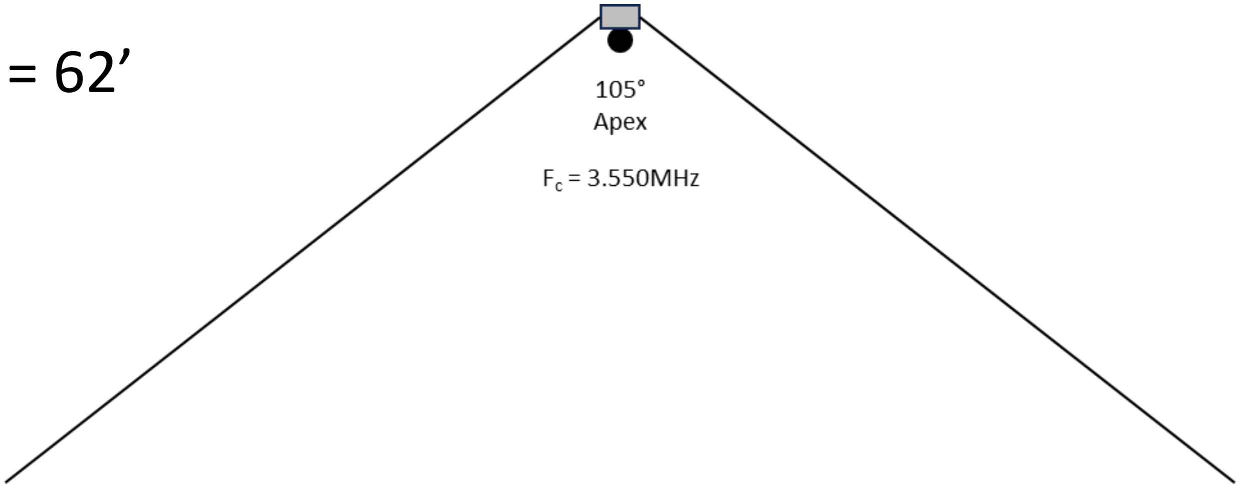
The HyTower will be a good fit as a back-up / SO2R antenna, a low-band vertically polarized antenna, and a WARC solution

160M InvL w/Folded CounterPoise

- The 160M InvL is a well described antenna
- The FCP is also well described by K2AV
    - https://k2av.com/
- The goal is to minimize loss and optimize performance
- The solution will also include segment switching for 1.800 to 1.900 coverage with less than 1.7:1 VSWR

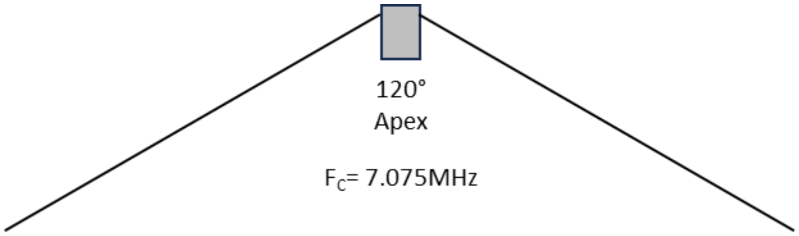
80M Inv Vee Description

- Installed height = 62’
- Apex = 105°
- F_C = 3.550MHz



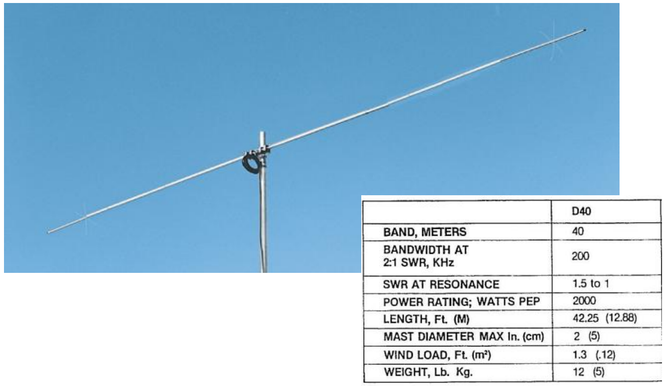
40M Low Dipole Description

- Installed height = 42’
- Apex = 120°
- F_C = 7.075MHz



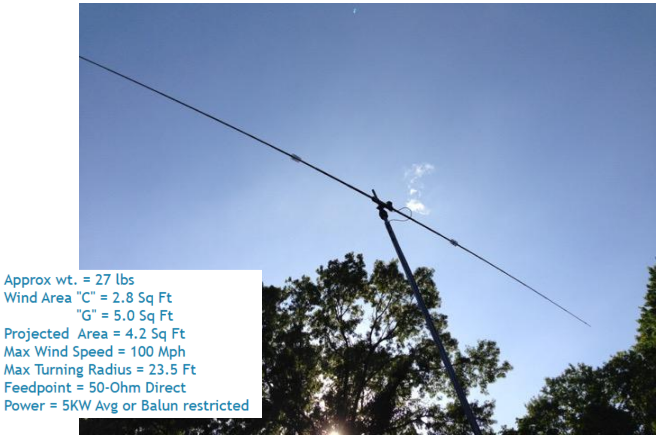
40M Rotatable Dipole

- Cushcraft D40 dipole
  - Current item was ruggedized but the loading element was lossy
  - Bandwidth was narrow
  - Interaction on 15M when D40 was parallel to the Skyhawk elements
  - Replaced by JK-401

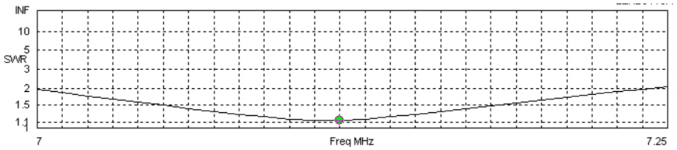


	D40
BAND, METERS	40
BANDWIDTH AT 2:1 SWR, KHz	200
SWR AT RESONANCE	1.5 to 1
POWER RATING; WATTS PEP	2000
LENGTH, Ft. (M)	42.25 (12.88)
MAST DIAMETER MAX In. (cm)	2 (5)
WIND LOAD, Ft. (m²)	1.3 (.12)
WEIGHT, Lb. Kg.	12 (5)

- JK-401
  - Loading coils are very robust
  - No interaction on 15M when placed parallel to the Skyhawk elements
  - Wider bandwidth



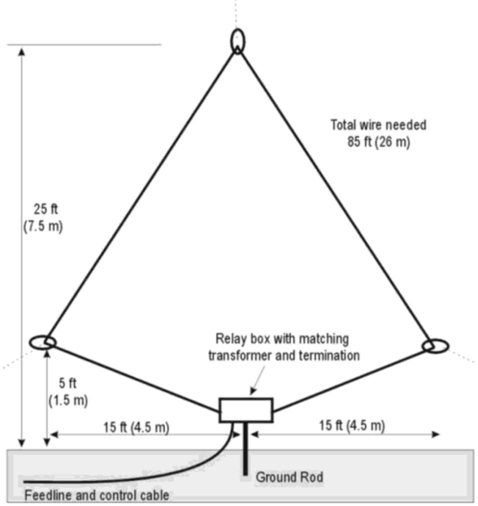
Approx wt. = 27 lbs
Wind Area "C" = 2.8 Sq Ft
"G" = 5.0 Sq Ft
Projected Area = 4.2 Sq Ft
Max Wind Speed = 100 Mph
Max Turning Radius = 23.5 Ft
Feedpoint = 50-Ohm Direct
Power = 5KW Avg or Balun restricted



Receive Antenna – K9AY

- K9AY Terminated Loop Rx Antenna
- Presents cardioid pattern in four directions.
- AS-AYL-4 consists of two units
  - Control box
  - Outdoor direction-switching relay box
- Control Box
  - 15 dB preamplifier
  - Bandpass filtering for the 160- and 80-meter bands
- The Rx antenna is installed from Mid-October through the end of March.

Model AS-AYL-4 — 4-way K9AY Loop System



Tower Loading Analysis – Reference Failure Load

Trylon Titan Wind Load Analysis

Wind Load 3' abve tower top

HEIGHT	MODEL	Wind Load (sqft) No Ice			Wind Load (sqft) 1/2" Radial Ice		
		70 MPH	85 MPH	100 MPH	70 MPH	85 MPH	100 MPH
64’	T600	70	40	15	36	6	-
72’	T500	45	22	6	24	1	-

Reference Bending Moment - T600-64 100MPH No Ice

Moment = F*Length (ft)

A	P	Cd	Bending Moment
15	40	0.67	26934

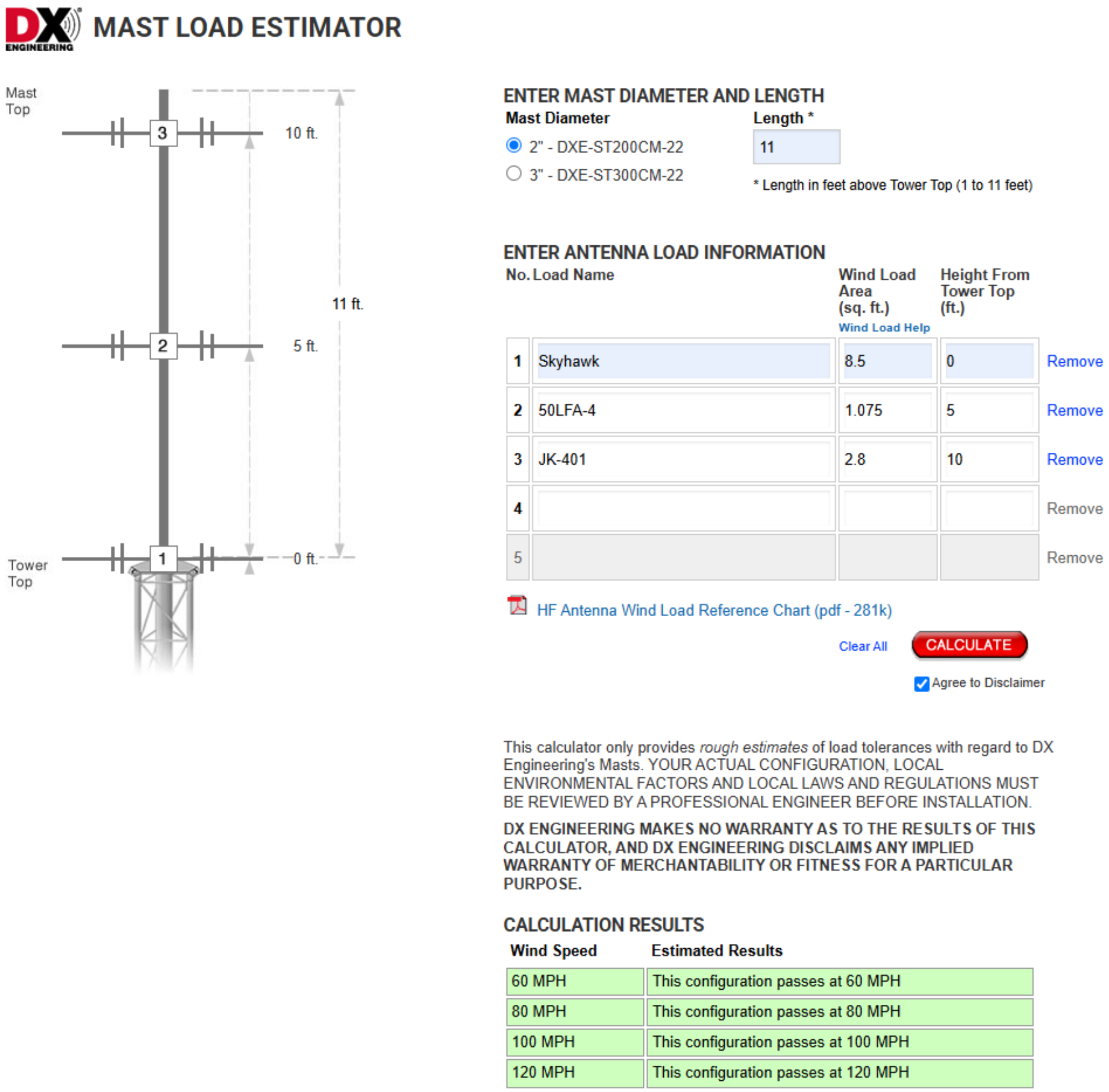
With a 15 sq ft antenna load 3 ft above the top of the tower the reference bending moment is 26,934 lbft at 100 MPH

Tower Loading Analysis: With Antennas

		Wind Pressure (lbs)			Drag Coefficient	F (lbs)		
Antenna	Area (sqft)	P @ 70MPH	P @ 85MPH	P @ 100MPH	Cd	70	85	100
Skyhawk	8.5	19.6	28.9	40	0.67	111.6	164.6	227.8
50LFA4	1.075	19.6	28.9	40	0.67	14.1	20.8	28.8
JK401	2.8	19.6	28.9	40	0.67	36.8	54.2	75.0
			4' spacing	5' spacing				
			14693	14693				
			1973	2002				
			5440	5590				
		Compare to 26934	22107	22286				

@ 100 MPH with antennas mounted the bending moment does not exceed the tower failure moment (20% safety factor)

Mast Loading Results



MAST LOAD ESTIMATOR

ENTER MAST DIAMETER AND LENGTH

Mast Diameter
● 2" - DXE-ST200CM-22
○ 3" - DXE-ST300CM-22

Length *: 11

* Length in feet above Tower Top (1 to 11 feet)

ENTER ANTENNA LOAD INFORMATION

No.	Load Name	Wind Load Area (sq. ft.) Wind Load Help	Height From Tower Top (ft.)	
1	Skyhawk	8.5	0	Remove
2	50LFA-4	1.075	5	Remove
3	JK-401	2.8	10	Remove
4				Remove
5				Remove

HF Antenna Wind Load Reference Chart (pdf - 281k)

Clear All CALCULATE

☑ Agree to Disclaimer

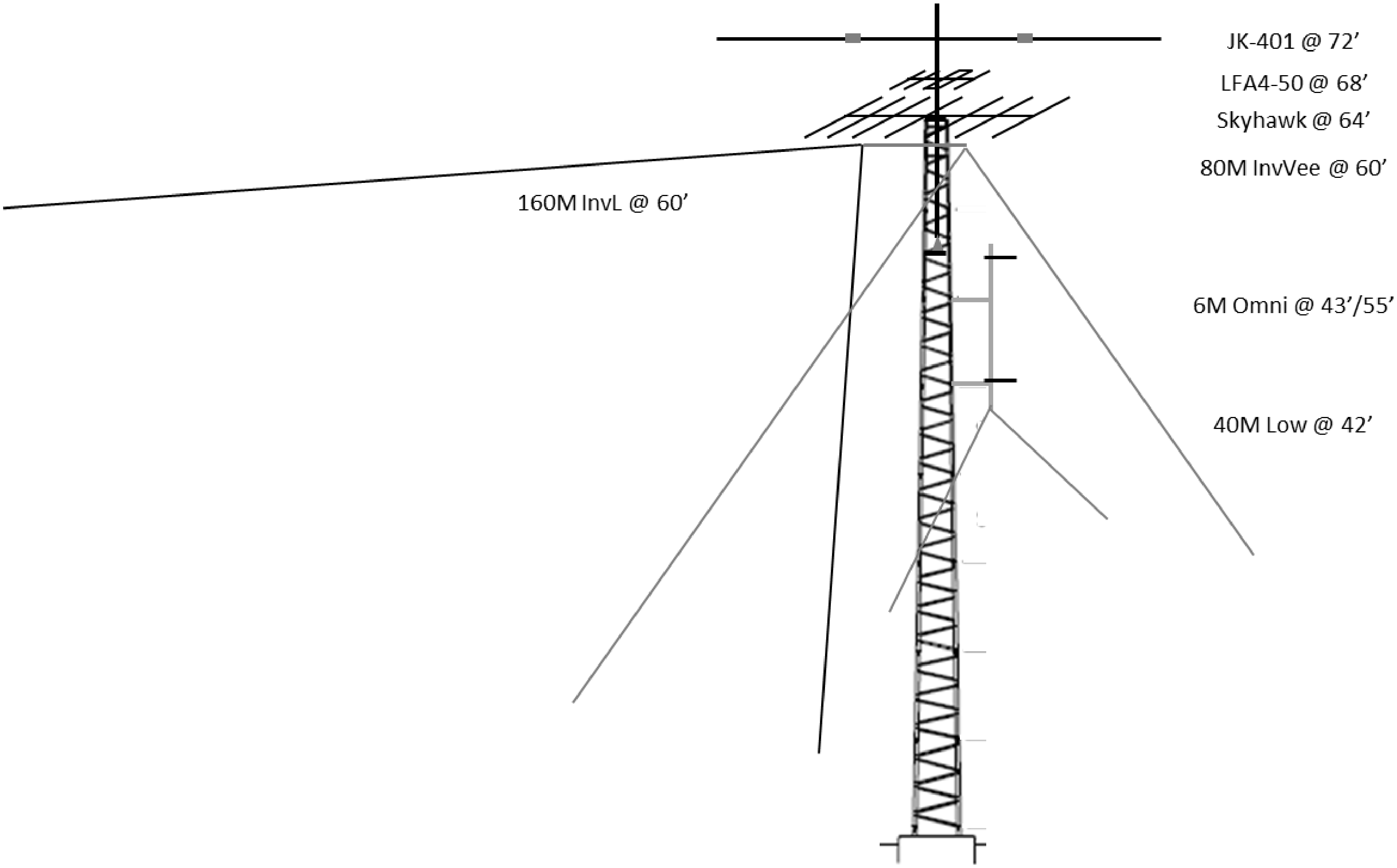
This calculator only provides *rough estimates* of load tolerances with regard to DX Engineering's Masts. YOUR ACTUAL CONFIGURATION, LOCAL ENVIRONMENTAL FACTORS AND LOCAL LAWS AND REGULATIONS MUST BE REVIEWED BY A PROFESSIONAL ENGINEER BEFORE INSTALLATION.

DX ENGINEERING MAKES NO WARRANTY AS TO THE RESULTS OF THIS CALCULATOR, AND DX ENGINEERING DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

CALCULATION RESULTS

Wind Speed	Estimated Results
60 MPH	This configuration passes at 60 MPH
80 MPH	This configuration passes at 80 MPH
100 MPH	This configuration passes at 100 MPH
120 MPH	This configuration passes at 120 MPH

Final Tower Configuration



JK-401 @ 72’

LFA4-50 @ 68’

Skyhawk @ 64’

80M InvVee @ 60’

160M InvL @ 60’

6M Omni @ 43’/55’

40M Low @ 42’

Antenna Placement

STATION ARCHITECTURE

Some Basics to Start - Power

- Power sources and distribution are common to the entire station design
- I chose independent power supplies for each radio and added a two more for robustness
  - A third power supply for all the station accessories
  - A homebrew 19VDC analog power supply for the station computers
- And two uninterrupted power supplies – one for each radio
  - All power supplies for radios and accessories are connected to one of the two UPS

Today's high-performance transceivers are really computers. No computer likes brown-outs, power surges, fluttering restoration of power. This was the protection of my investment!

What is Station Automation?

- A simple description – “Push one button and many things happen”
- Establishing a “one button” approach has many benefits
    - It’s like muscle memory – it does the same thing every time
    - Removes the risks of “forgetting something” in the heat of a contest
    - Is more important in more complex stations
    - Can get you out of an unintended situation
- Most happens within the radio and flows through the system

The Smart Radio

Bandpass Filters

160M Tuning

HyTower Tuning

Control Inputs
- Buttons
  - Touch / Hold
- Switches
- Logging Program
- Remote Control
- USB
- RS-232

Automation Protocols
- BCD – Band Data
- RS-232 – Frequency Data
- TCP – Radio Control
- USB – Radio Control
- Others?
- Proprietary?

Radio A

160M InvL
80M Inv Vee
40M JK-401
40M Low
HyTower
Skyhawk
6M Omni
6M Yagi

Radio B

Keyer

T2X Rotor

How do you get the radio to talk to all the peripheral devices?
Who does the translation between protocols?

Some Limitations to Consider

- The radio has limited I/O
- Typically:
  - (1) RS-232 port
  - (1) BCD port (Band Data)

- Peripherals are hungry for connections – as an example:
  - K4D has a single RS-232 port
  - Equipment wanting an RS-232 port – PGXL, TGXL, band specific fixed-tune networks – that’s 3 – need to fan out!

Finding a Solution that Works with All the Protocols

- I did an exhaustive search to find a solution that would work with:
  - RS-232
  - BCD
  - CI-V
  - USB
  - Frequency to relay control
  - BCD to relay control

I only found one source that would do what I wanted – Hamation!

Hamation’s Product Line

- Products
    - CR-5 CAT Router
        - (1) RS-232 in
        - (3) RS-232 out
    - MD-12 Band Decoder
        - Built-in USB interface
        - RS-232, CI-V and band data interfaces
        - USB connection to Flex SDR radios
        - Generates Icom CI-V data stream from Non-Icom radios
        - Generates Yaesu & Kenwwod data stream from Icom radios
        - Bi-directional band data interface
        - Automatic antenna selection for each band
        - Exchanges information among Hamation products using ShackLan interface
- (cont)
    - RC-16 Relay Controller
        - 16 relay contact outputs
        - Relay contacts can swith to either ground or up to 4 different voltage sources
        - 8 antenna configurations per band for up to 4 radios plus RX antennas
        - 12 bands plus 8 custom frequency segments
    - 2x8 Antenna Switch
        - 1500W
        - >60dB port-to-port isolation
        - Unselected ports are grounded
        - Mechanically prohibits multiple radios accessing the same antenna
        - Can be daisy chained if more antenna selection is necessary
        - Also comes in a 4x8 configuration

**Hamation developed the software-based control and controllers for ArraySolutions*

Hamation

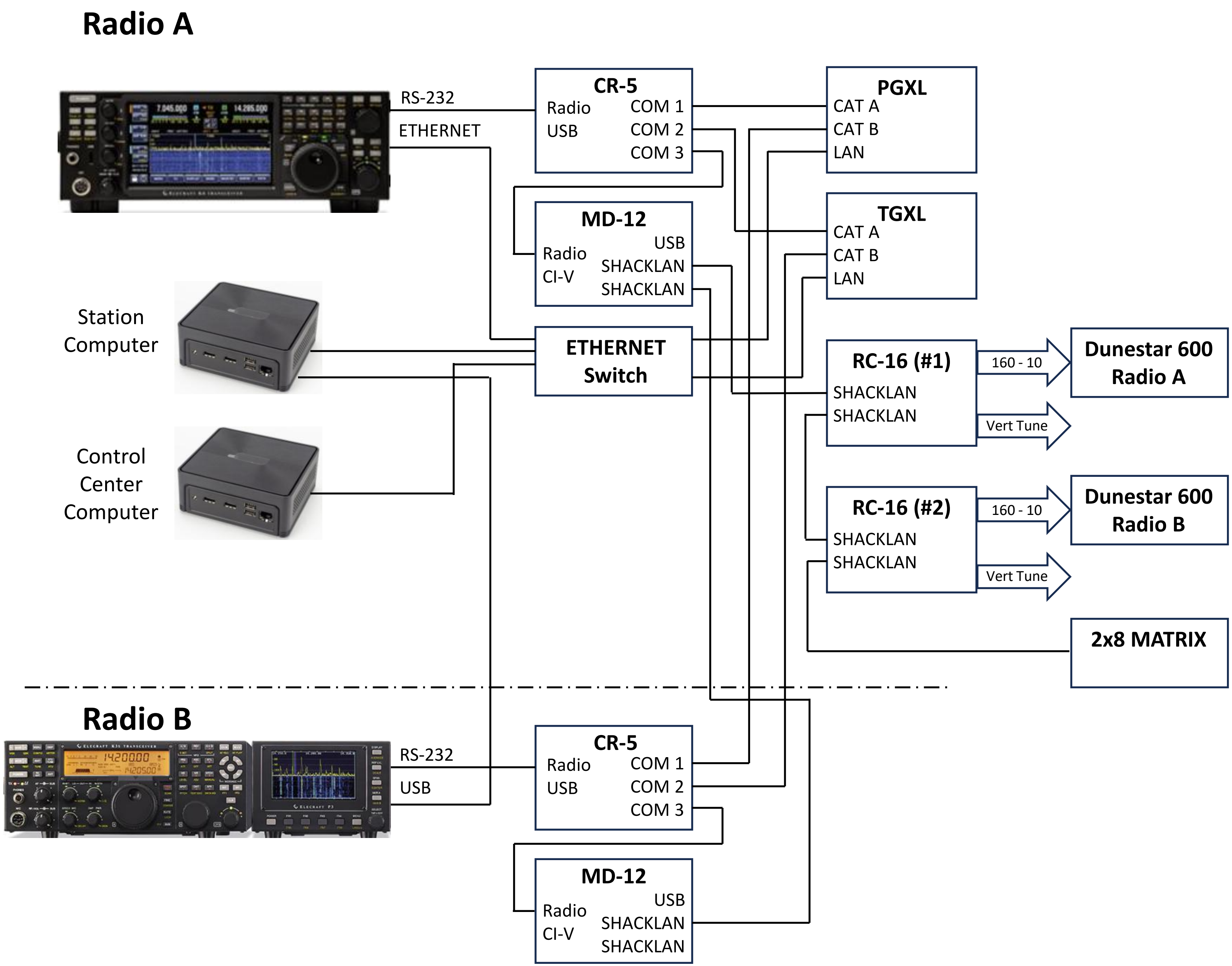
- I was familiar with the 2x8 Antenna Switch and manual switches when I designed the antenna panel at PJ2T
  - The PJ2T system was a five station M/M design with manual antenna selection for both the 2x8 antenna matrix and StackMatch switching system
  - All the manual controllers are addressable for interfacing to the 2x8 switch using the ShackLan control network
    - ShackLan is an RS-485 serial communications protocol used for industrial applications – it worked very well in an RF rich environment

But my desired application is very different –
I want a smart switch that follows me!

NØYY System Automation Description

- The Requirements
  - Read my operating frequency and select the correct the fixed tuning networks for the 160M InvL and HyTower as I change frequency
  - I wanted automatic band selection of antennas when I switched bands
    - But I had multiple antenna choices for several bands! I need manual control – but I wanted the manual selection to be cleared when I changed bands
  - I need BCD control of the Dunestar 600 Filters
  - I need RS-232 for control of the PGXL and TGXL both of which are configured for SO2R
  - I needed the SnackLan control network to reduce cabling costs from the shack to the main tower and the HyTower
  - I need the K4D and the K3 to be transparent to the automation – there is a gotcha hiding here…
  - I need to eliminate small switches that get forgotten in the heat of battle!

Here's what it looks like!


Radio A
RS-232
ETHERNET
CR-5
Radio
USB
COM 1
COM 2
COM 3
PGXL
CAT A
CAT B
LAN
MD-12
Radio
CI-V
USB
SHACKLAN
SHACKLAN
TGXL
CAT A
CAT B
LAN
Station Computer
ETHERNET Switch
RC-16 (#1)
SHACKLAN
SHACKLAN
160 - 10
Vert Tune
Dunestar 600 Radio A
Control Center Computer
RC-16 (#2)
SHACKLAN
SHACKLAN
160 - 10
Vert Tune
Dunestar 600 Radio B
2x8 MATRIX
Radio B
RS-232
USB
CR-5
Radio
USB
COM 1
COM 2
COM 3
MD-12
Radio
CI-V
USB
SHACKLAN
SHACKLAN

Hamation to the Rescue!

- With all of the moving parts in the system there was a requirement to have insight into the system status
- Hamation had already thought of that and has an application – Control Center – that both provides more than a passive status monitor of the system, but also provides an active method of selecting non-automatically selected antennas
  - For example, when I am on 40M the auto select is the JK401 rotatable dipole – but I can manually select the low 40M dipole or the HyTower for a vertically polarized alternative!
  - But wait – there's more – I can select multiple antennas at once – e.g. I could select both the rotatable dipole and the low dipole on 40M to improve my footprint
    - I still need to verify the VSWR impact
- I have a small touch screen that displays Control Center as well as Rotor Control, and status monitors for the PGXL and TGXL. I use a stylus to select non-auto select antennas and point the antenna

So About that Gotcha…

- The K3/P3 consumes the radio’s RS-232 port – I needed a way to get access to the RS-232 port for the station control
- N6TV has a product – The S-Box – that provides some fan out so that I could interface the K3/P3 pair to the Hamation CR-5 CAT Router to provide RS-232 to the PGXL and TGXL
  - The S-Box also has an FSK interface so operating RTTY with FSK was easy

One Last Thought About Station Automation

- One of the most common radio complaints is the nested functions on the front panel controls
- The solution is to create a way to consolidate those multiple button pushes into a line of software called a “macro”
- There are alternatives to consider for creating macros and ways to interface to the radio
- My approach will utilize the work done by Dave, NK7Z for both the K4D and the K3/P3
  - https://www.nk7z.net/building-a-k4-external-keypad/

Final Design Notes

- Heat
  - I recognized there was minimal clearance between the shelf and the work surface where the radios were placed
    - I added two fans to the underside of the shelf to draw air in from the front and exhaust upward behind the monitors
    - These are variable speed, very quiet 12VDC Noctua fans
- Noise Generation
  - I eliminated ALL wall warts from the station
  - I have a separate Astron RS-12M analog power supply to power station accessories
    - Monitors
    - USB hub
    - Network switch
    - Hamation antenna automation
    - DXDoubler SO2R controller
  - I built an analog 19VDC power supply for the two station computers – one for the station, another for control

STATION ERGONOMICS

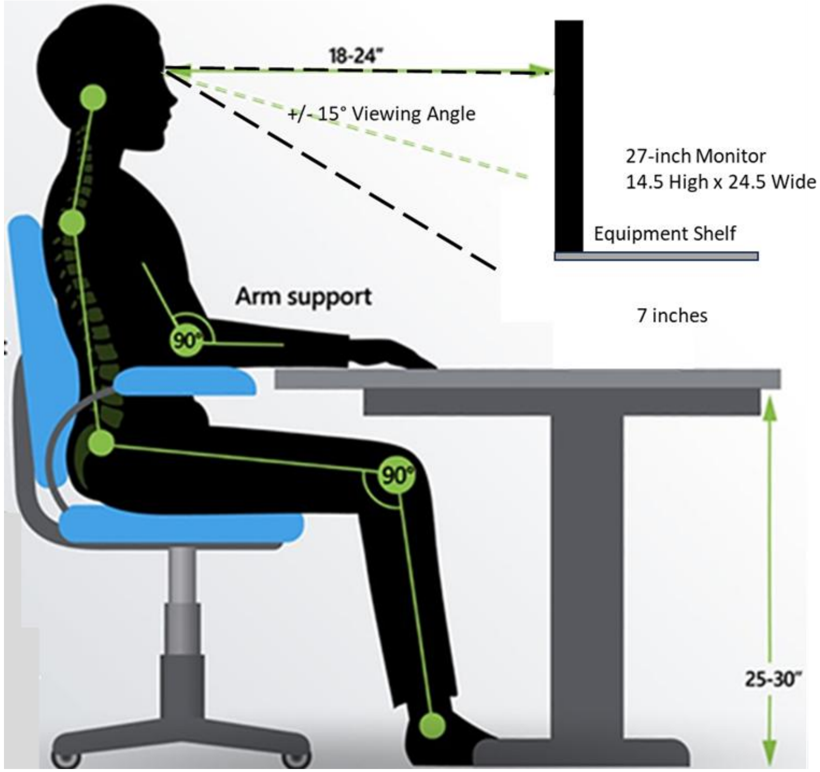
Ergonomics

- I described my operational and technical approach to station design – now its time to interface the human into the described system
- Everyone’s approach to ergonomics will be different, but I wanted to capture a set of reference points
- I will also describe my personal drivers so that you can make your own decisions about an approach tailored to you

This part of the presentation draws from my stand-alone presentation – Station Ergonomics: What? Why? How?

Tailoring the Viewing Profile of the Work Zone

- This is an example of allowing the monitor to be raised while meeting the viewing profile
  - Repeated information entry e.g. logging should be in the lower half of he display
  - Status information should be in the upper half of the display



This allows equipment to be placed below a monitor

Some Goals for Laying out the Operating Position – a Personal Perspective

- No wires on the surface – headphone and mic wires should be routed under the work surface
- There were two exceptions
  - The cable for the keyer paddle (short and dressed to the rear)
  - K-Pod – USB cable for the K4 / RJ-12 cable for the K3 dressed to the rear)
- Wireless keyboards and mice are preferred
- Radios to the right and left sides of the keyboard for access
- No Radio behind the keyboard! Only Items requiring minimal access should be behind he keyboard

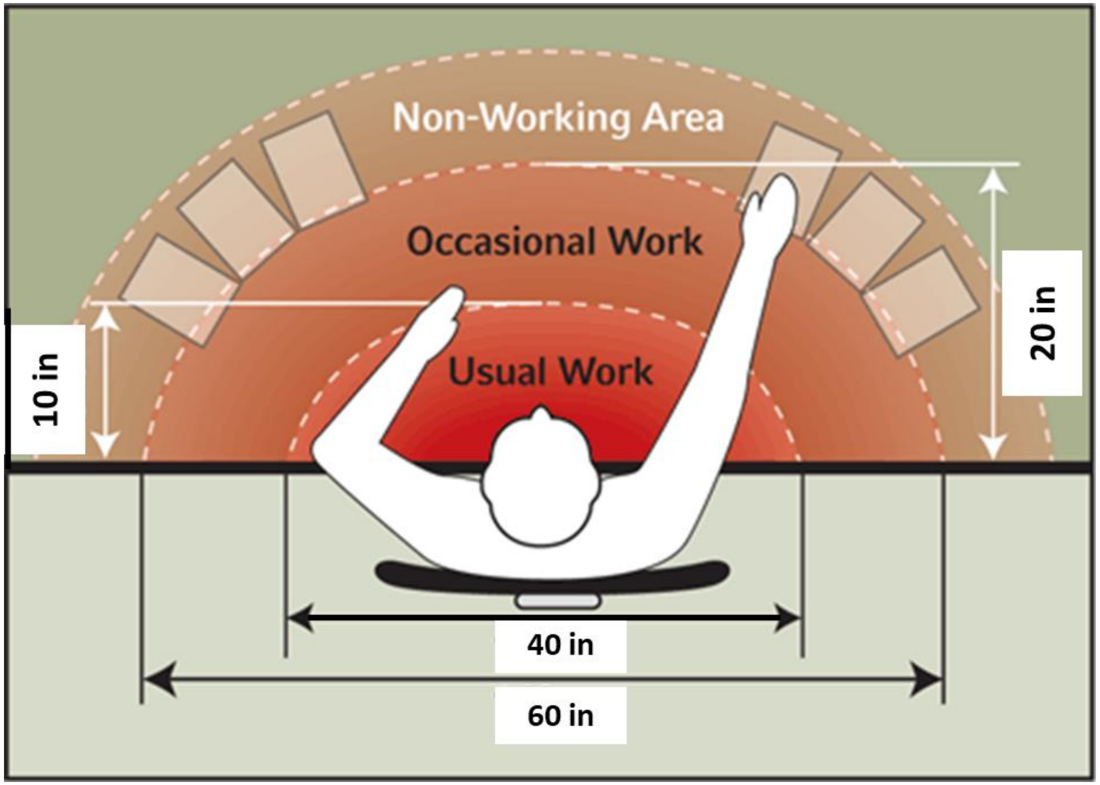
Some Goals for Laying out the Operating Position – a Personal Perspective (cont.)

- Your focus is "…hands on the keyboard" so minimize or eliminate paper, pens/pencils, etc.

- Avoid stacking equipment!
  - Simplifies maintenance
  - Maintains equipment value by minimizing scratches
  - Establishes a "…place for everything and everything in its place"

- Only place equipment that requires frequent touching at the operating position – all other equipment will be placed below the work surface
  - Use remote control displays for the antenna selection control, amplifier, tuner, and rotor

The Ergonomics of the Work Surface

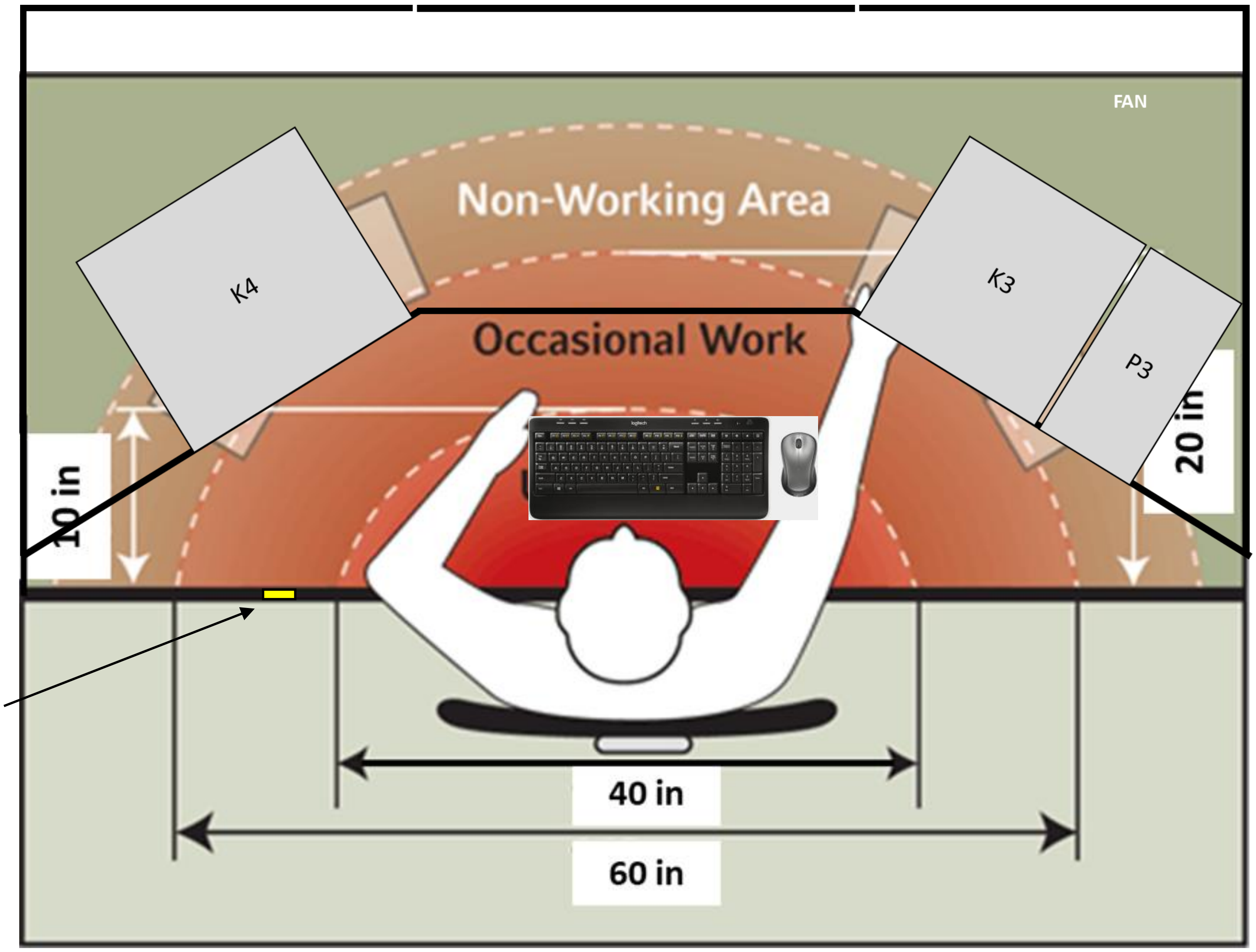


Note the position and relationship of the chair, body, and work surface edge. This is important to recognize full support of the wrists and forearms. It is also important to observe that typical mouse movement will transition from Usual to Occasional work zones.

Work Zones (*Reach Radius*)

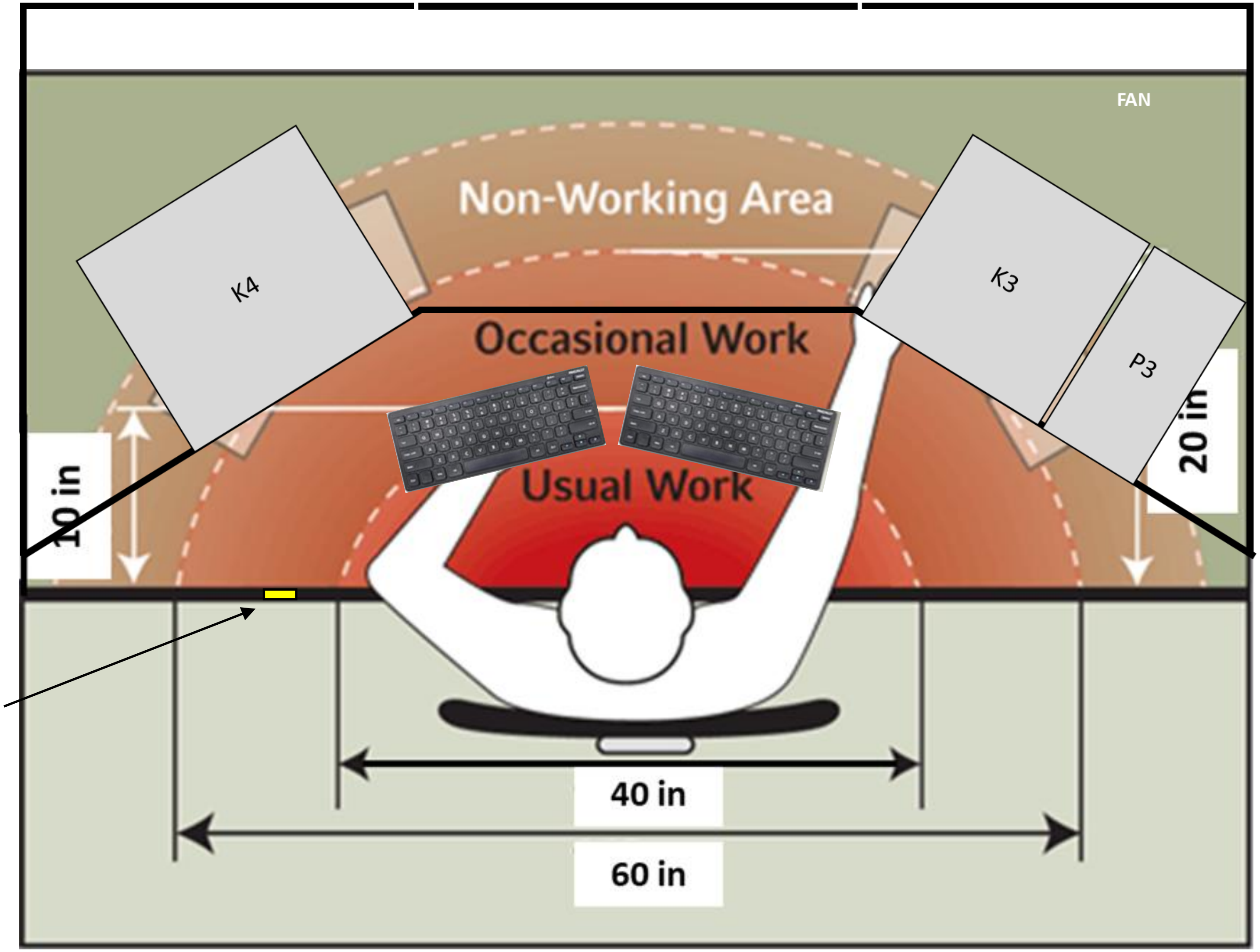
- Usual *(Keyboard / Mouse)*
- Occasional *(Radio Controls)*
- Non-Working *(Observe)*

Basic Radio Layout – Superimposed Over Ergonomic Work Zones



Headphone / Mic access under the work surface

Basic Radio Layout – Superimposed Over Ergonomic Work Zones (2 Keyboard Option)

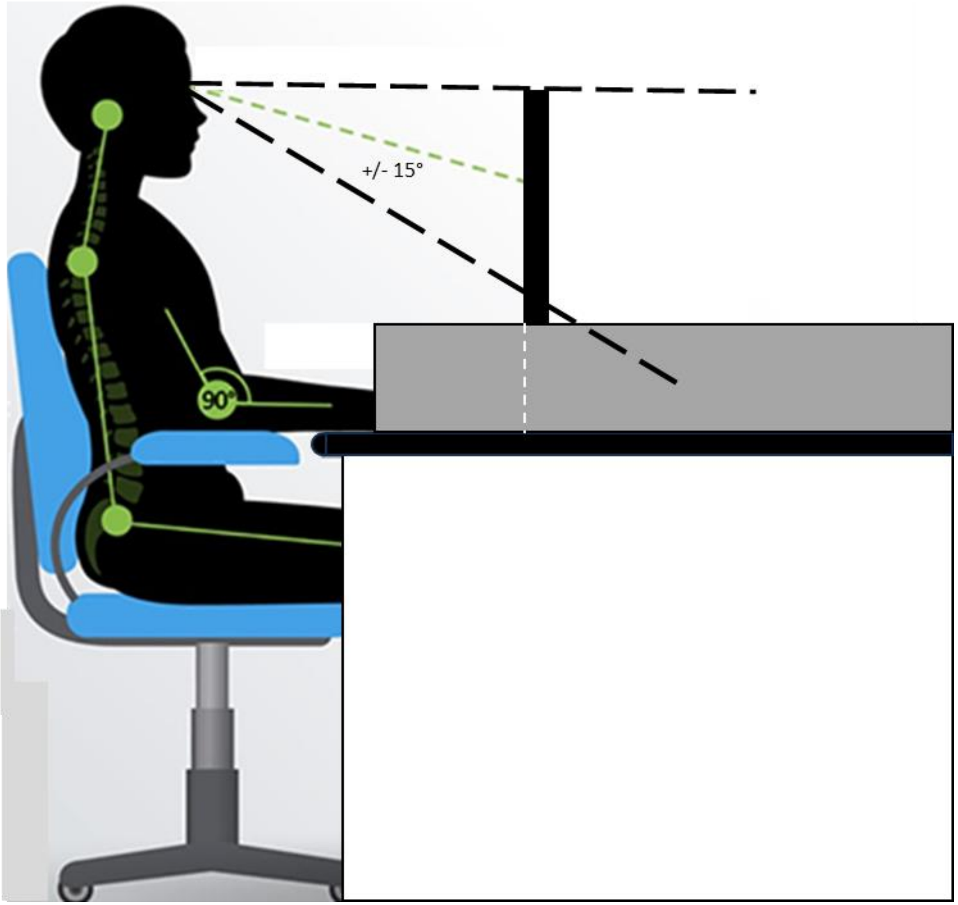


2 Mini Keyboard alternative (Macally – RFCOMPACTKEY)

Headphone / Mic access under the work surface

Operating Position Viewing Angle

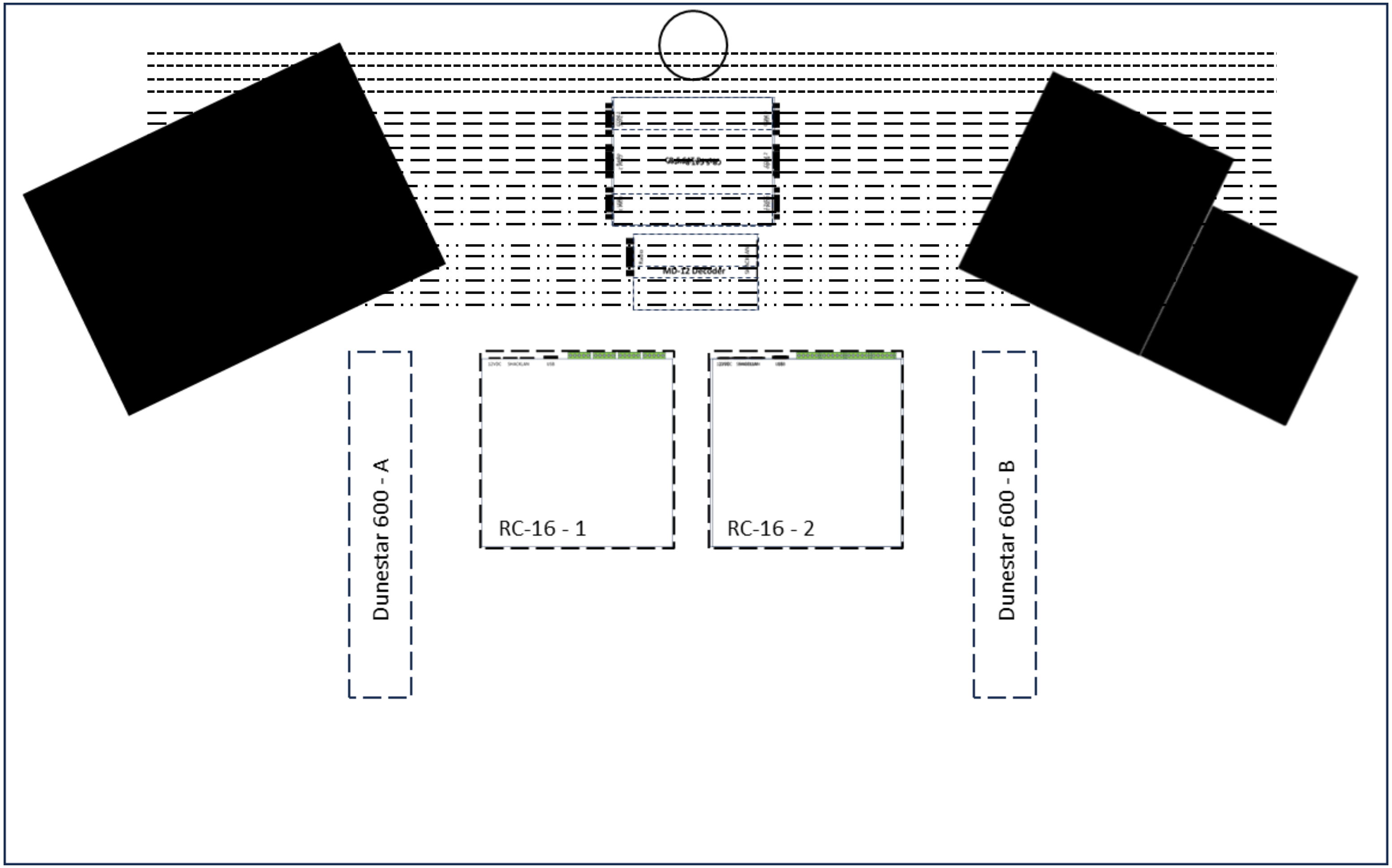
- Using the ergonomic guidelines the viewing angle is consistent with the monitor raised by the 7-inch height of the equipment shelf



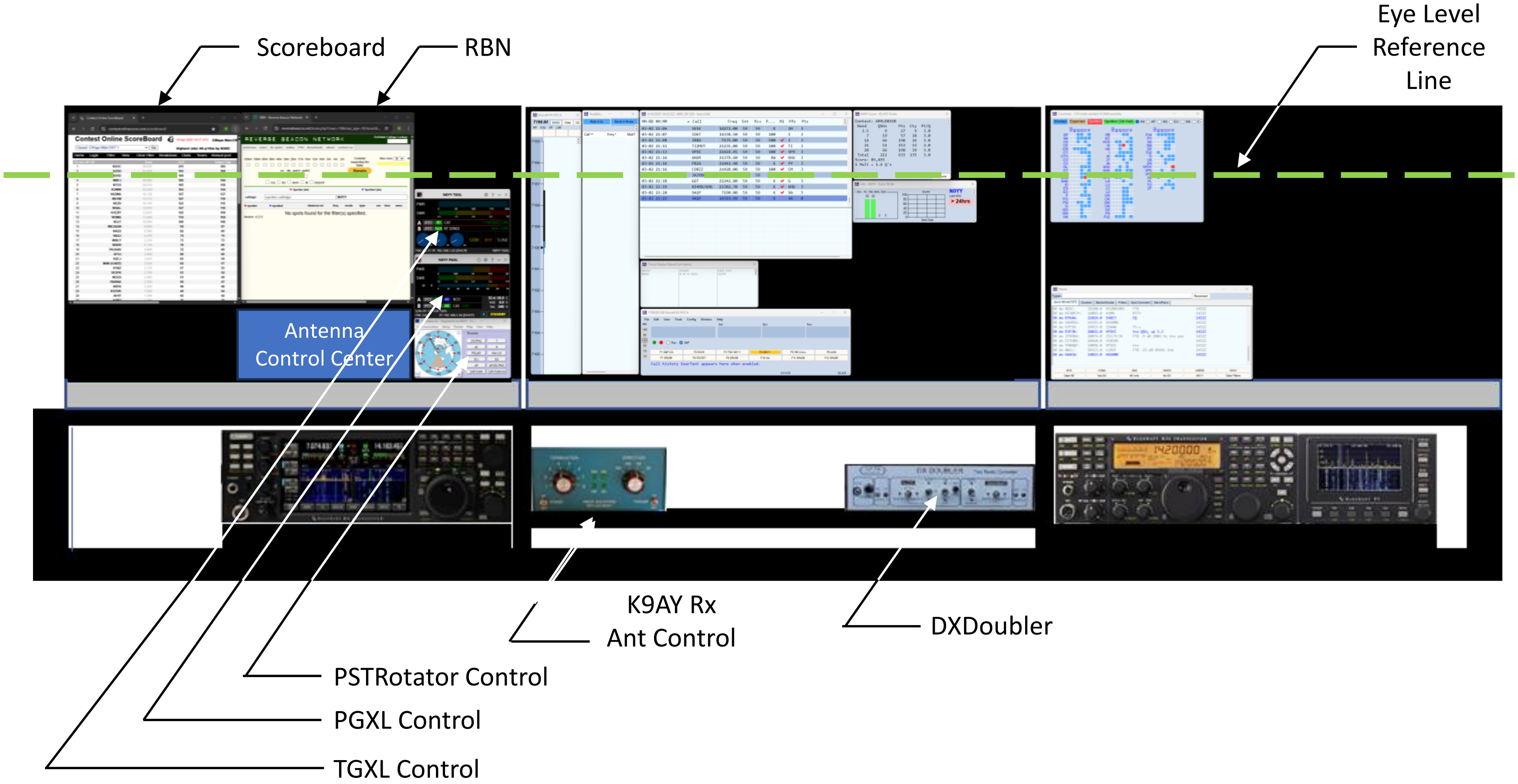
Equipment Layout

Equipment Layout – Below Work Surface

- Example of equipment mounted below work surface
- Wiring is secured under work surface with screw mounted cable clamps
    - Segregated by RF / Network / Control / Audio



Display Layout - Example



Scoreboard

RBN

Eye Level Reference Line

Antenna Control Center

K9AY Rx Ant Control

DXDoubler

PSTRotator Control

PGXL Control

TGXL Control

Only radio controls, K9AY Control, and DXDoubler Control are above the work surface

The Chair

- I chose the Secretlab Titan EVO
- Choice of other contesters e.g. K9CT
- Options selected
  - Black SoftWeave Plus Fabric
  - Small (≤5’6”|<200 lbs)
  - Regular (5’7” – 6’2” | <220 lbs)
  - XL (5’11” – 6’9” | 175 – 395 lbs)
- I am planning on two additional mods
  - Rollerblade casters – they allow an additional 1.3 inches in chair height (you can always lower the chair)
  - I am going to block the rear seat to base by about a ¼ inch to allow a small amount of “forward tilt” when fully seated. Without this you lean forward and lost some of the lumbar and shoulder support.

Looking Forward

I have two future projects that I plan to explore in this station build

1. I want to develop an AI / cloned voice library for contest use and integrate it in the system
2. I want to understand and potentially implement remote operations. There are two approaches to consider
    1. Having others access my K4 station – be the host for a M/S operation
    2. Being able to use my K4 to access another station to be part of a contest team

Summary

- Hopefully others will find this helpful when planning their station upgrades
- I also thought that the antenna selection process and mechanical assessment might be helpful to others.
- As a contester, sitting in a less-than-optimal position for extended periods of time can be difficult. Having the equipment well placed, monitors positioned for relaxed viewing, with an uncluttered work space a new seating capability should help limit any discomfort.