

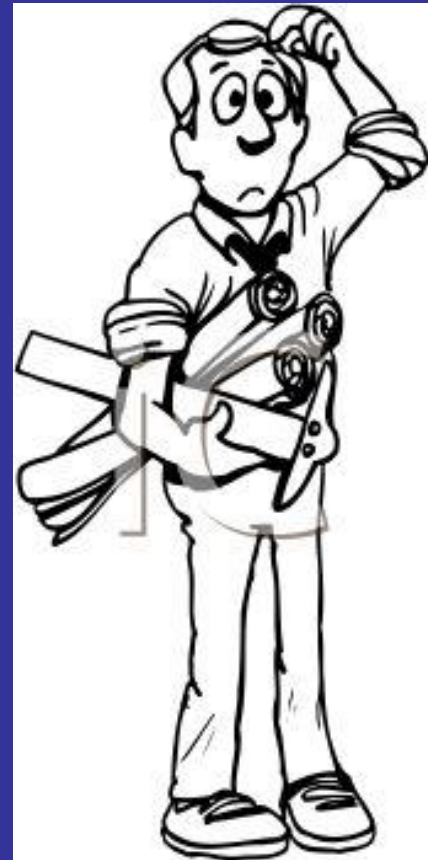
Antenna Facts, Myths & Tips

- Antenna Gain
- SWR
- Transmission line loss
- Wire Antennas
 - Build them to last

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SEDXC July 20, 2017

Tonight's Questions

- Since antennas don't amplify, where does "antenna gain" come from?
- When is SWR important?
- When is SWR ***NOT important?***



Refresher – What's a dB?

- No math necessary

dBs Add

+3 dB = times 2 (100W in 200W out)

+6 dB = times 4 (100W in 400W out)

+9 dB = times 8 (100W in 800W out)

+12 dB = times 16 (100W in 1,600W out)

-3 dB = times $\frac{1}{2}$ (100W in, 50W out)

Results Multiply

What is “Antenna Gain?”

The *ratio* of: The power radiated by an antenna to the power radiated by a reference... in a *given direction*

Commonly Used References:

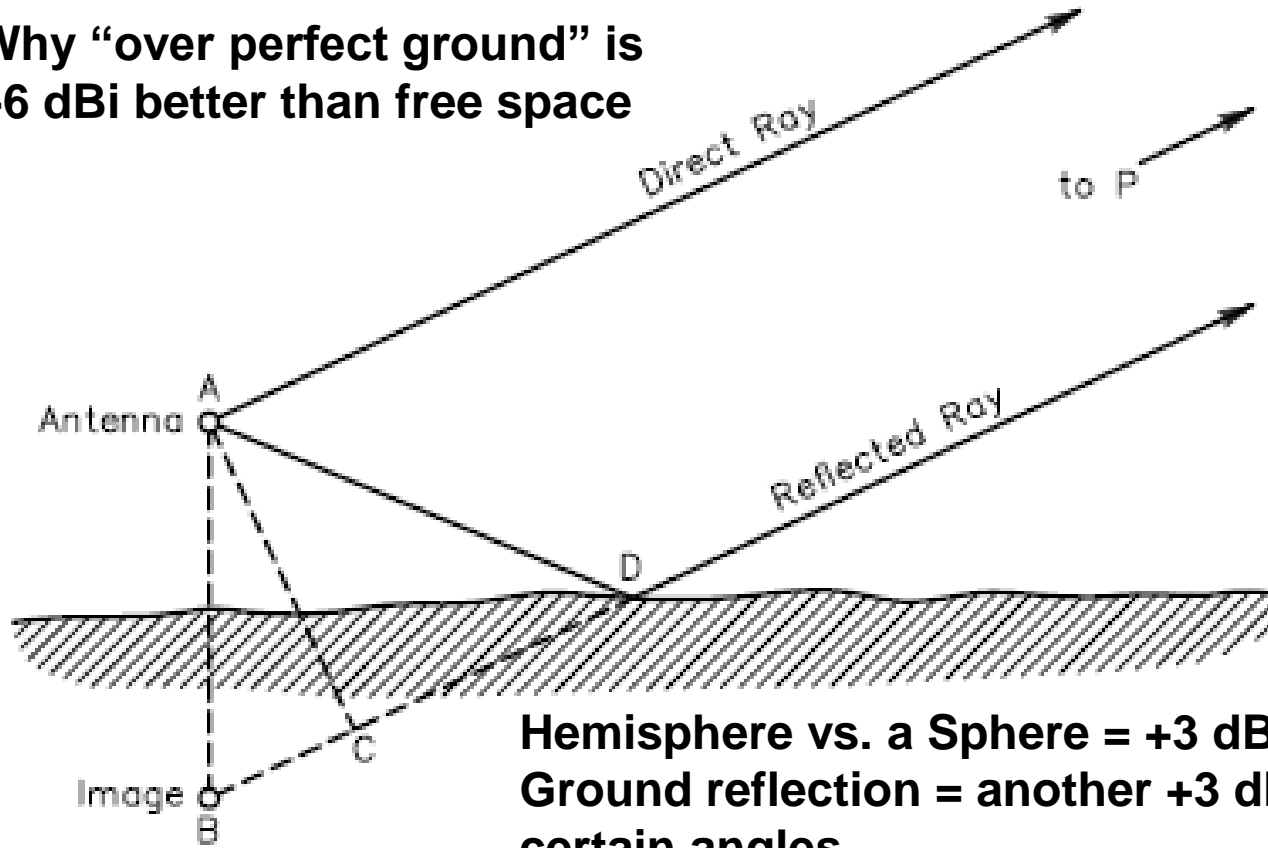
- An isotropic source – a point in free space radiating into a sphere “dBi”
- A dipole over ground “dBd”

Some Antenna Gains

- **Isotropic Radiator** **0 dBi**
- **Dipole In Free Space** **2.1 dBi**
- **Dipole – Over Medium Flat Earth** **7.1 dBi**
- **Dipole – Over Salt Water** **8.1 dBi**
- **4 El Yagi – Medium Flat Earth** **13.5 dBi**
- **4 El Yagi – Over Salt Water** **14.0 dBi**
- **Vertical – Medium Flat Earth** **4.5 dBi**

Ground reflection, Free Gain!

Why “over perfect ground” is
+6 dBi better than free space



Hemisphere vs. a Sphere = +3 dB
Ground reflection = another +3 dB at
certain angles

Gaining Gain –

- So, Where does “Antenna Gain” come from?
 - From reducing radiation in some directions and adding into some other direction
 - Can be in Azimuth, Elevation or both
 - We get this from antenna design and ground reflection

**WE GET MORE WATTS PER SQUARE METER
BY REDUCING THE SQUARE METERS**

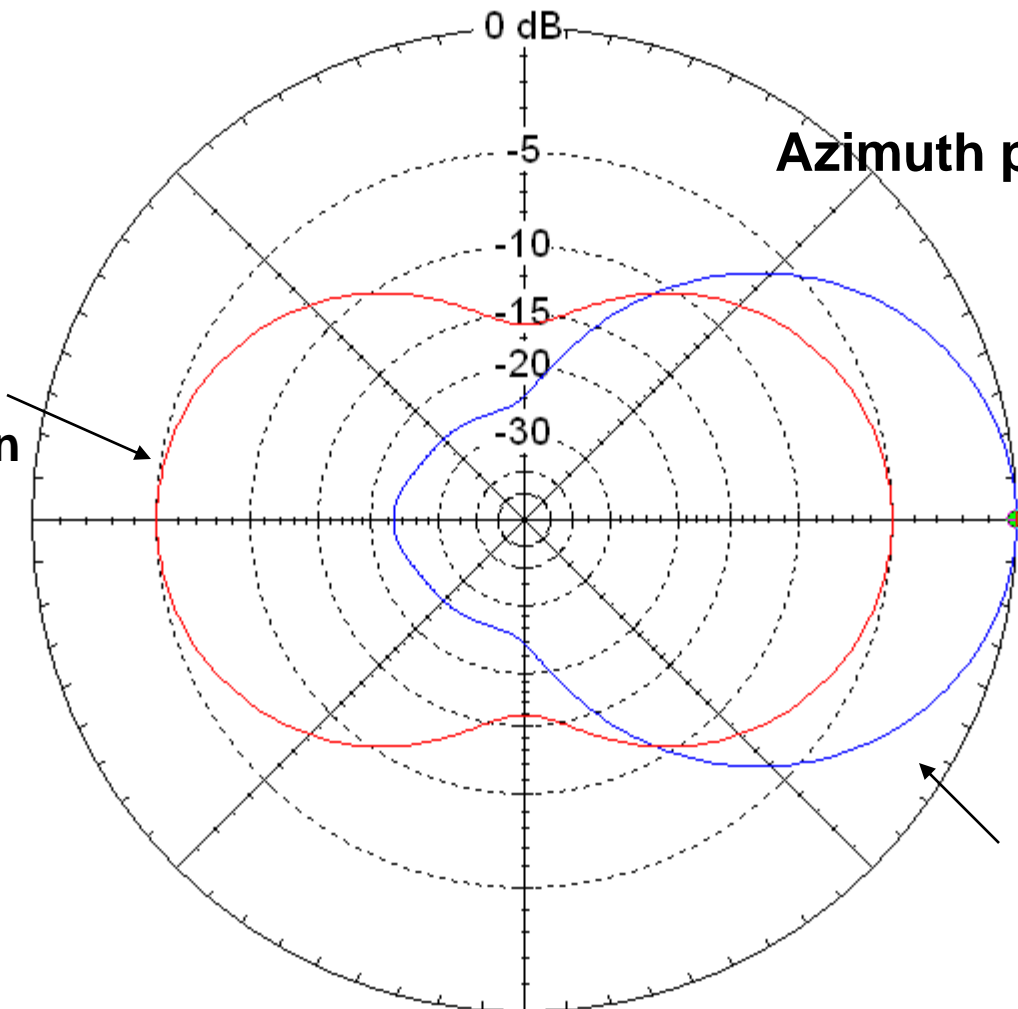
Total Field

* **Primary**

4 EL Azimuth

Dipole Azimuth

Dipole Radiation



Azimuth patterns

4 El Yagi

28.1 MHz

Azimuth Plot

Elevation Angle 25.0 deg.

Outer Ring 12.27 dBi

3D Max Gain 12.27 dBi

Slice Max Gain 12.27 dBi @ Az Angle = 0.0 deg.

Front/Back 22.73 dB

Beamwidth 64.8 deg.; -3dB @ 327.6, 32.4 deg.

Sidelobe Gain -10.46 dBi @ Az Angle = 180.0 deg.

Front/Sidelobe 22.73 dB

Cursor Az 0.0 deg.

Gain 12.27 dBi

0.0 dBmax

0.0 dBmax3D

1/2 λ above ground

Antenna Gain Summary

- **Increased gain in some direction(s) is always at the expense of lower gain in some other direction(s)**
- **Ground reflection is your friend !**
 - Carefully pick height above ground
- **Manufacturers are sneaky. They quote “dB” and don’t say dBi or dBd. Be careful !**

Understanding SWR

- **What is it?**
- **How is it measured?**
 - **Why measurements are always wrong (too optimistic)**
- **When it matters**
- **When it doesn't matter**

What is SWR?

- It's the ratio of forward power to reflected power
- The difference between the forward and the reflected power is the power delivered to the load...

The SWR You Measure is Always Wrong

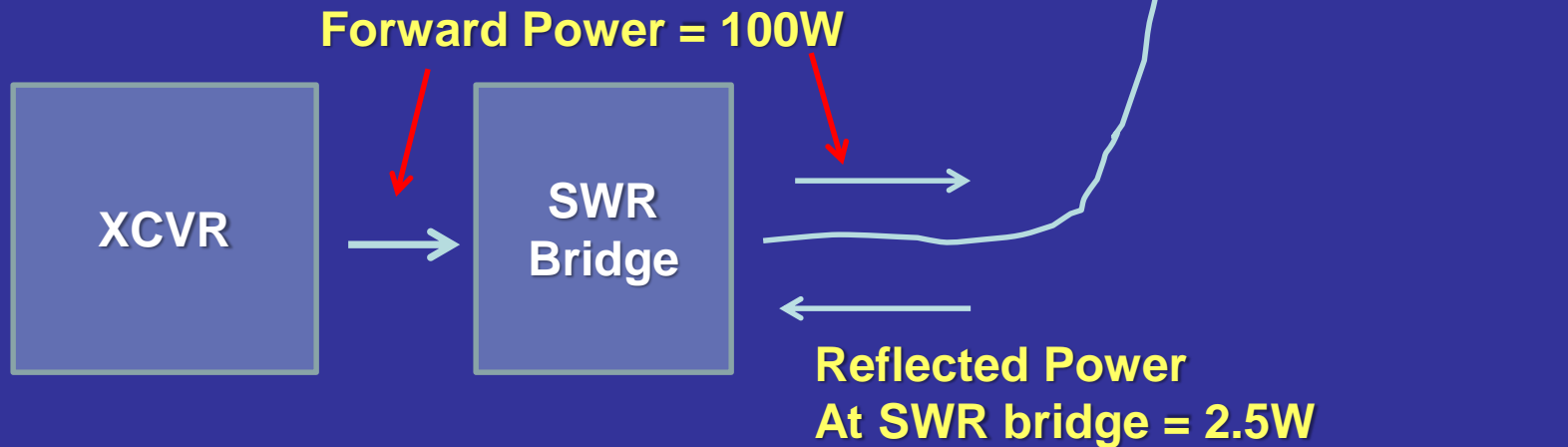
It's always too optimistic

(Except when it's 1:1)

**Measured SWR is ALWAYS
Optimistic**

Forward Power into antenna = 50W

**2:1 Antenna SWR measures 1.6:1 Due To 2-Way
Transmission Line Loss**



Transmission line loss = - 3dB which is half power

Okay, it's always optimistic

So what?

Who Cares?

When Does SWR Matter?

As Measured Day #1

- When it's Not what it Should be
 - Examples:
 - Design is for 1:1, Measures 2:1
 - Dipole should be 1.4:1, Measures 6:1, or 1:1
- When it's high enough to cause a lot of transmission line loss
- When it's too high for your rig to drive

When Does SWR Matter?

As Measured Over Time

- Going up over time: Antenna Failing
- Going down over time: Coax Failing
- Changing Summer vs. Winter (Up or Down)
 - Foliage coupling or touching = loss
- Changing with Rain or Snow
 - Failing transmission line, or connectors or coupling to objects (ALL BAD)
- Changes when you add another antenna
 - Unwanted coupling – loss and pattern changes

KEEP A STATION ENGINEERING NOTEBOOK

Transmission Line Loss (A signal Killer! – TX & RX)

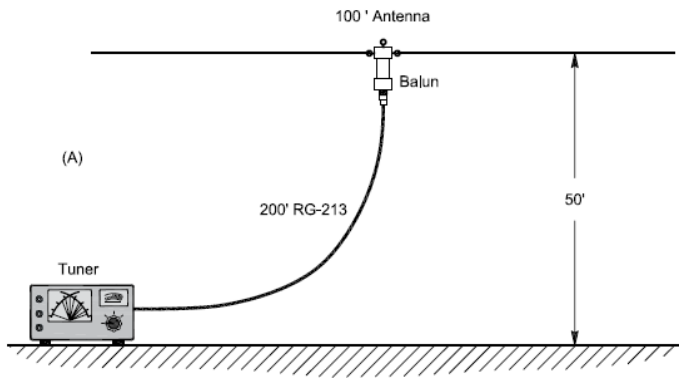
- Loss goes up with frequency
 - R/G-8X @ 14 MHz = - 1.2 dB/100ft
 - @ 144 MHz = - 4.8 dB/100ft
- Loss depends on cable type
- Loss goes up with SWR, for every cable type
 - Next Chart

Loss @ 50 MHz per 100 feet

• Coax	SWR: 1:1	3:1
– RG-8/X	2.6 dB	3.5 dB
– RG-213	1.6 dB	2.3 dB
– 7/8" Hardline	0.4 dB	0.6 dB
• Open Wire Line	0.1 dB	0.23 dB
• Ladder Line	0.5 dB	0.74 dB

Final Exam: 100 Foot doublet @ 50 ft, What's the best feedline?

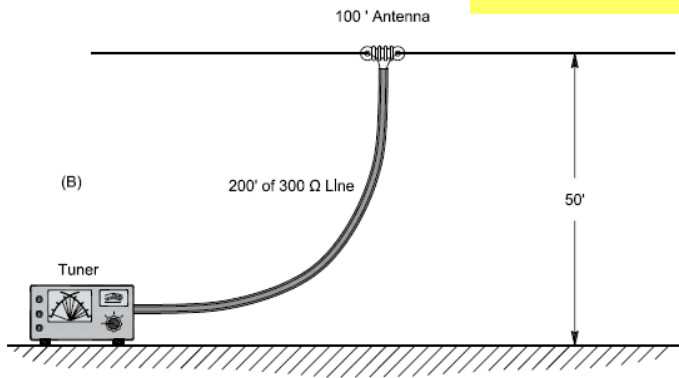
Loss



200 ft R/G-213

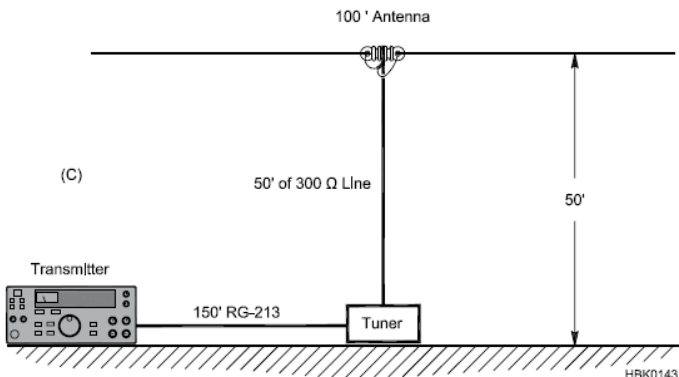
3.8MHz 8.53 dB
28.4 MHz 12.3 dB

Antenna SWR 37:1



200 ft 300 ohm line

3.8 MHz 2.74 dB
28.4 MHz 3.52 dB



50 ft 300 ohm line
150 ft R/G-213

3.8 MHz 1.81 dB
28.4 MHz 2.95 dB

SWR Myths

- Above about 2:1 SWR you can't "Get Out"
 - You can get out just fine at 20:1 with a low loss transmission line
- High SWR causes more TVI, RFI, Telephone – RFI **[Wrong]**
- High SWR causes more radiation from the transmission line **[Wrong, but more loss]**
- The reflected power is absorbed by the rig **[Wrong – it's re-reflected]**

Wire Antenna Hints & Kinks

- **Lines**
 - Dacron is BEST
 - Other synthetics may be okay – UV tolerance?
 - Weed Whacker Line – Cheap, not bad
- **Wire**
 - Flex-Weave – Very good
 - Copperweld – Very strong
 - Hard Drawn Copper (House Wire) – Okay
 - Soft Drawn Copper – No Way!

Insulators

- **Ceramic – Good for most wire**
 - If sharp edges - bad for Copperweld
 - Life > 20 years
- **Plastic – Pretty good, life ~ 10 Yrs**
- **Molded Copolymer glass filled**
 - Example: “Budwig”
 - Outstanding life and performance

Antenna Wire and Parts

- Sources

- **The Wireman**
- **HRO (many manufacturers)**
- **DX Engineering, Array Solutions**
- **Hamfests**
 - **Careful !!!! (Especially Copperweld)**
- **Internet – Lot's of places**

Tie Downs

New

@ 10 years

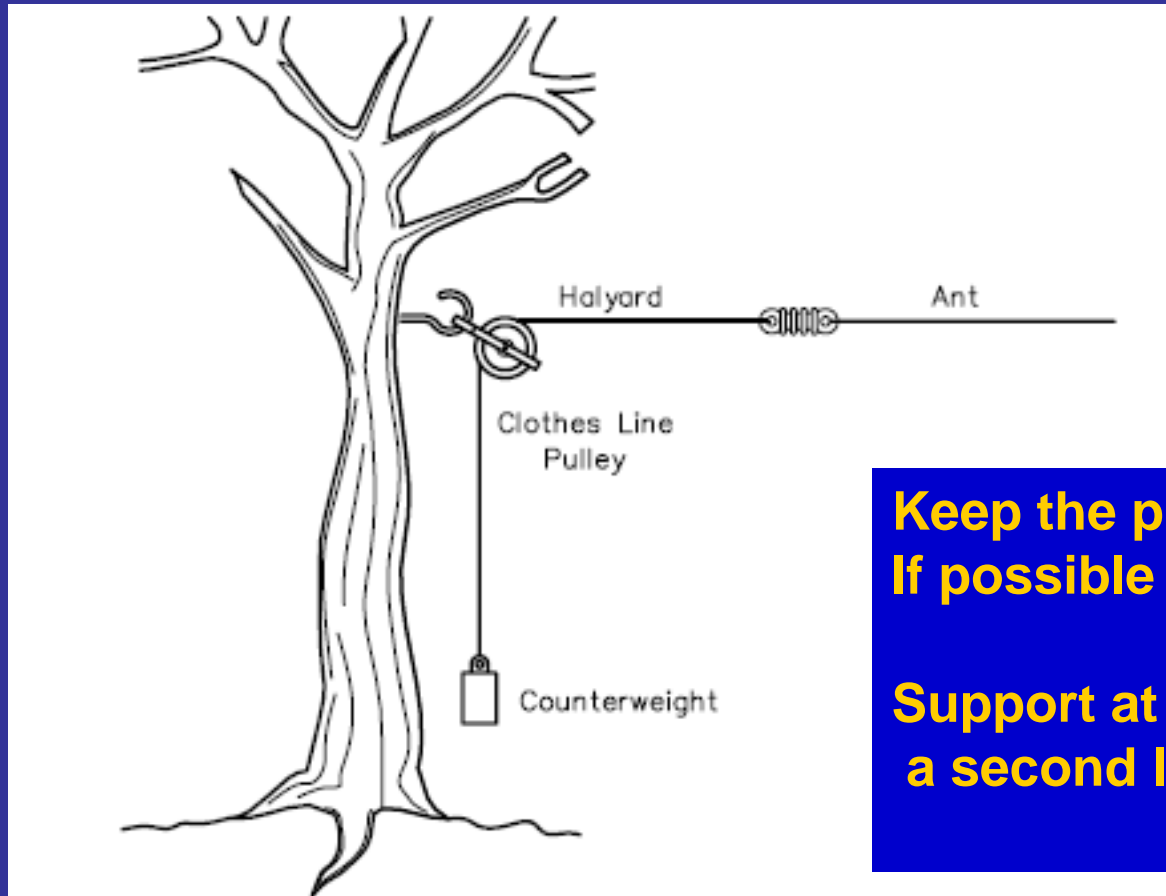
@ 5 years



**A good Tie-Down:
Clip and Eyebolt**



Tolerating Tree Sway - #1



**Keep the pulley at the ground
If possible**

**Support at high-up pulley with
a second line. No climbing!**

Tolerating Tree Sway - #2

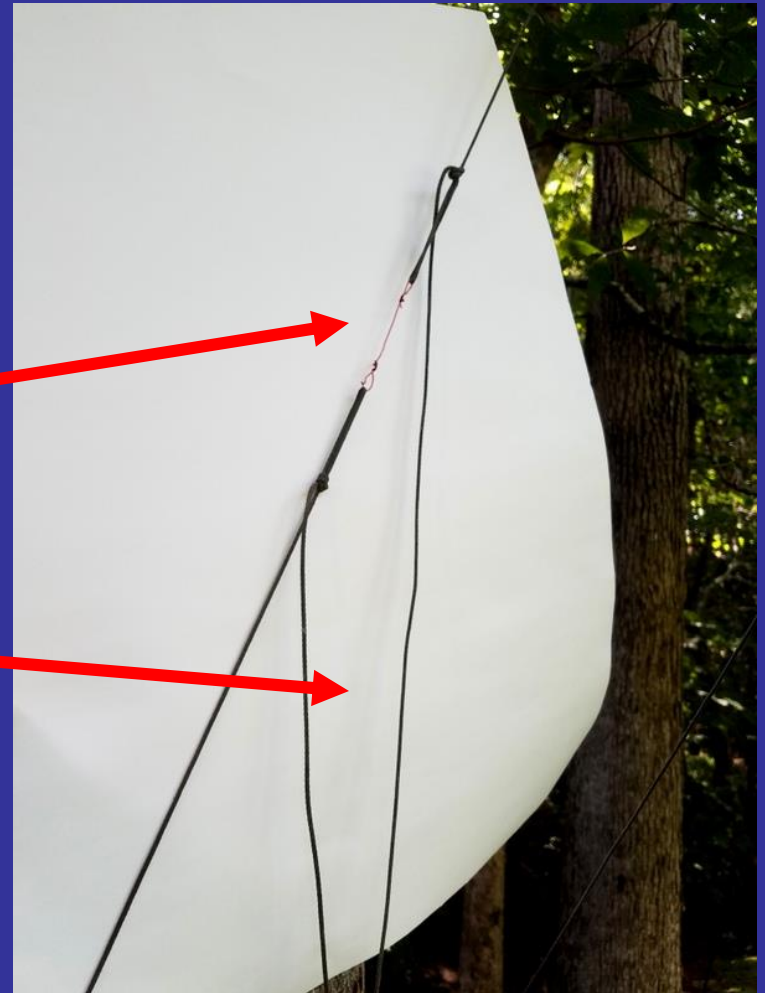


Tolerating Tree Sway - #3

The Mechanical Fuse

“Fuse” of Weak Wire

Long Loop





Thanks & 73, N4GG