Repeater operation

By Karl Shoemaker

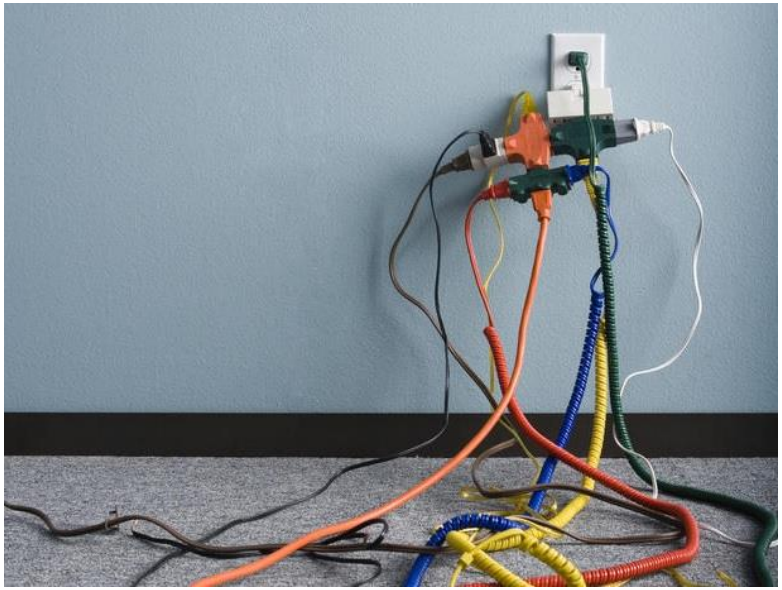
Repeater basics; components

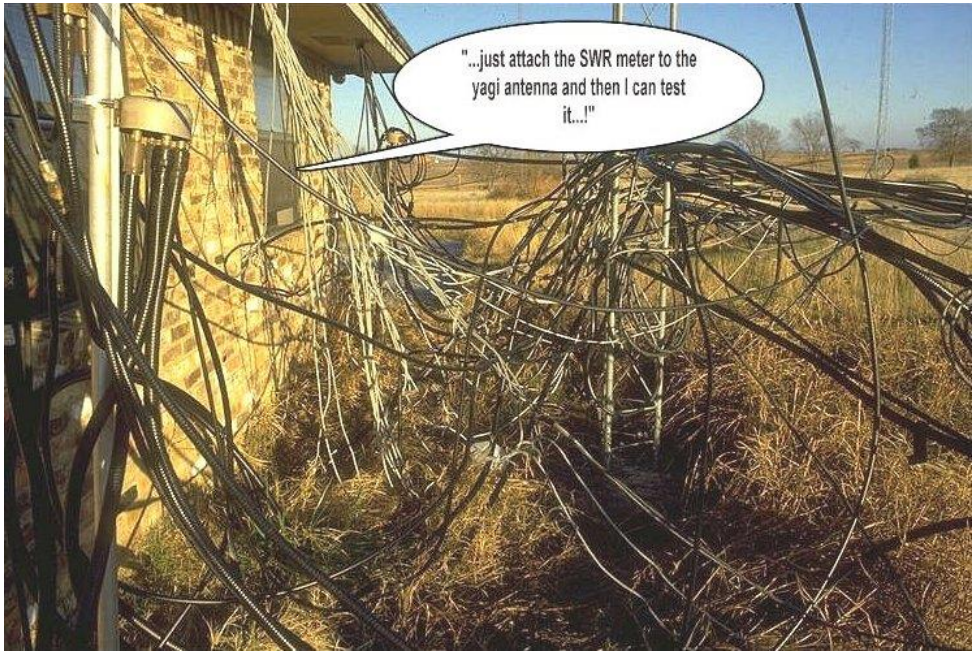
What makes up a repeater (project) ?

- Some money. Perhaps a “club” or organization to obtain funds.
- Site acquirement; MOU / Lease / other arraignments with the owner.
- RFI study and research; Frequency coordination.
- Equipment; receiver, controller, transmitter, duplexer, feed line and antenna.
- Other RFI management; RF filters(s) and isolator.
- Rack or cabinet to house the equipment.
- Tower or other structure for antennae.
- Power supply / heat considerations and design.
- Notes, Documentation and other “paper work”.

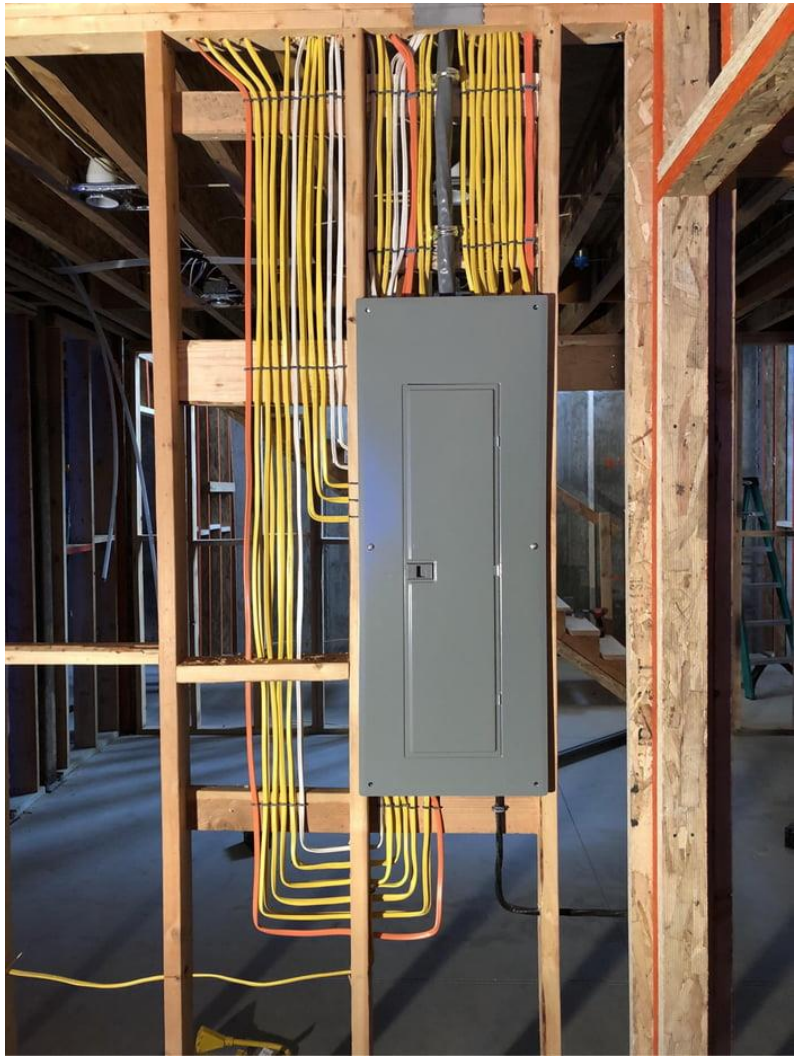
Construction practices

Bad wiring





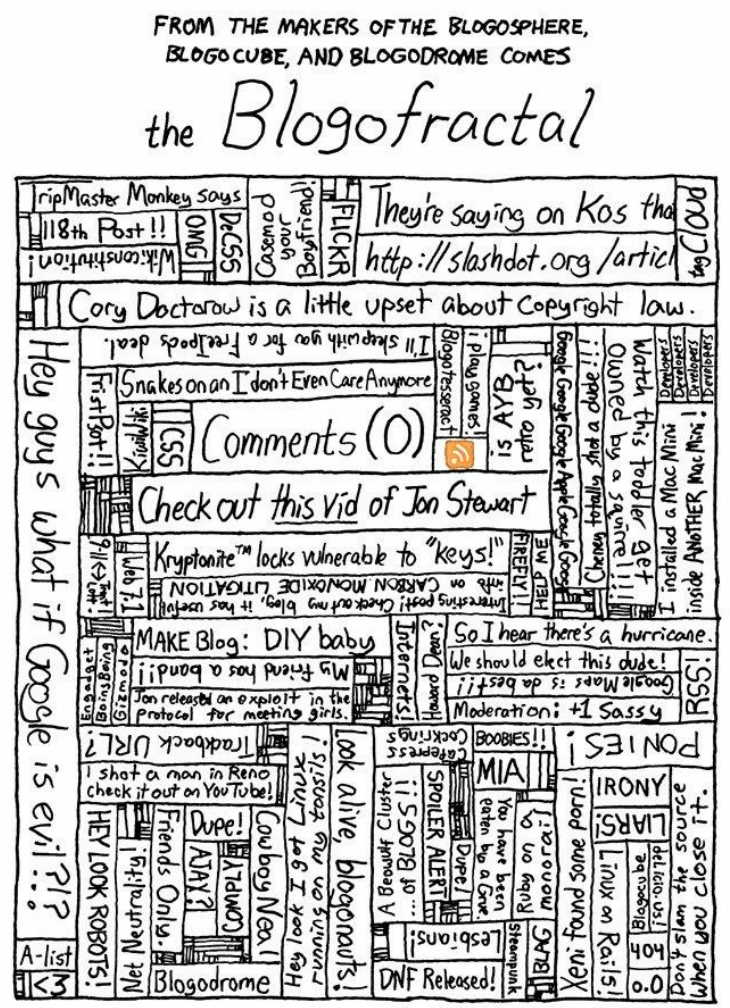
Good wiring



Documentation

Bad

Good

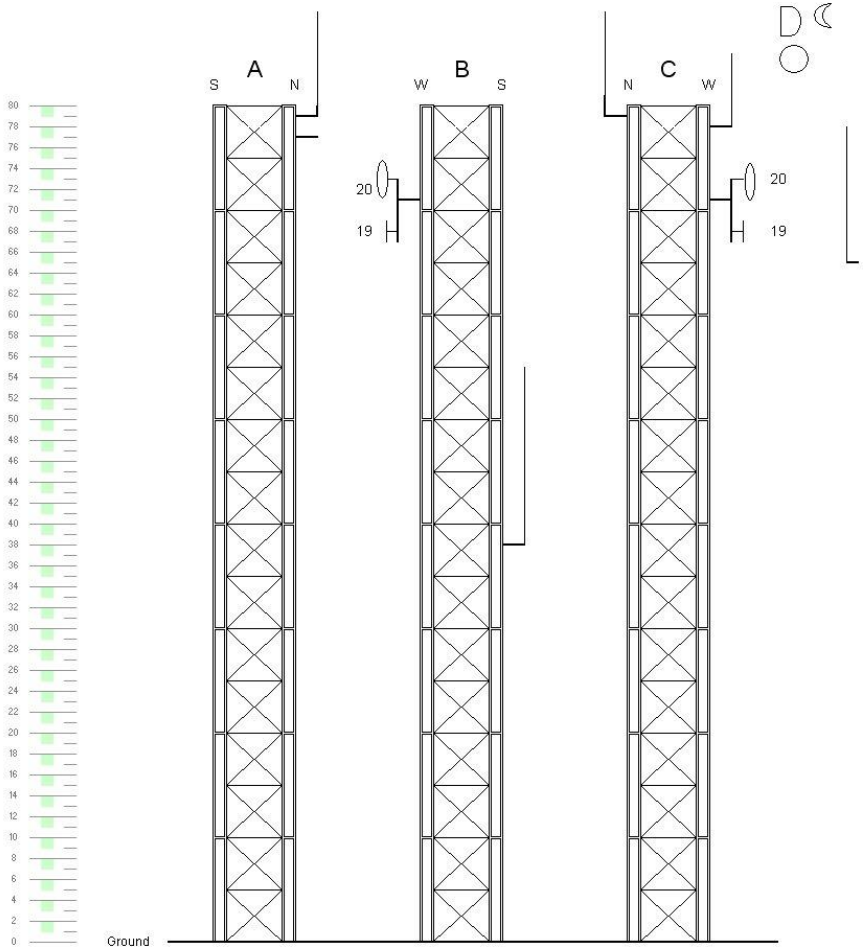


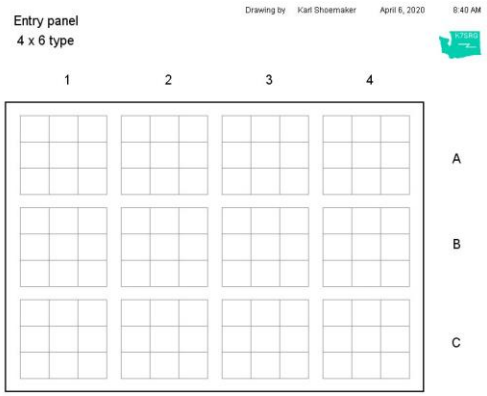
New project checklist	Site name		(your site)		
People list	Callsign	AC	Home/other	Cell	Other / email, etc.

Task	Status	Comments:
Site acquirement, admin, relations, building, land, etc.	Done	
Lease / LOA / MOU /other adim considerations		
Offer to help out with the site general maintenance		
Access procedures to site (key, comb, call-in at site, etc.	Done	
Transportation to and from site; motel arraignments, etc	N / A	
Coordination for station frequencies, station license, etc	Done	
Site directions, pictures, station manual	Done	
Neighbors/other building considerations		
FRI/RF interfacing, RF compatabilites, other		
Mounts, brackets for antennas and lines	Done	
Coax (lines)	Done	
Coax terminations	Done	
Location(s) for antennae	Done	
Antennas (main, link, etc)	Done	
Sealing for lines and entry points		
Conduit / cat walk /line entry parts-plans, etc.	Done	
Grounding		
AC power provider / account / billing etc.	N / A	
Power supply /12v /off grid sources, etc.	Done	
Cabinet/rack/mounting cans/other panels, etc	Done	
Station radio (Tx, Rx, duplexer, controller, IDer, etc	Done	

Antenna placements

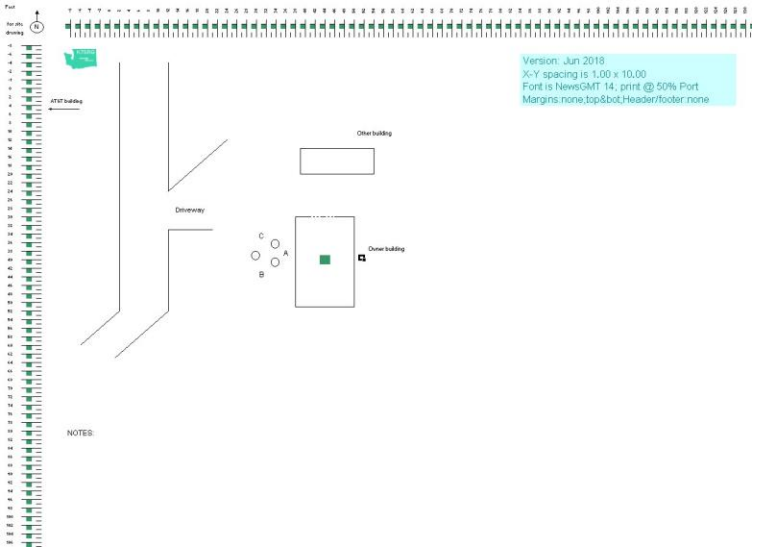
Inventory

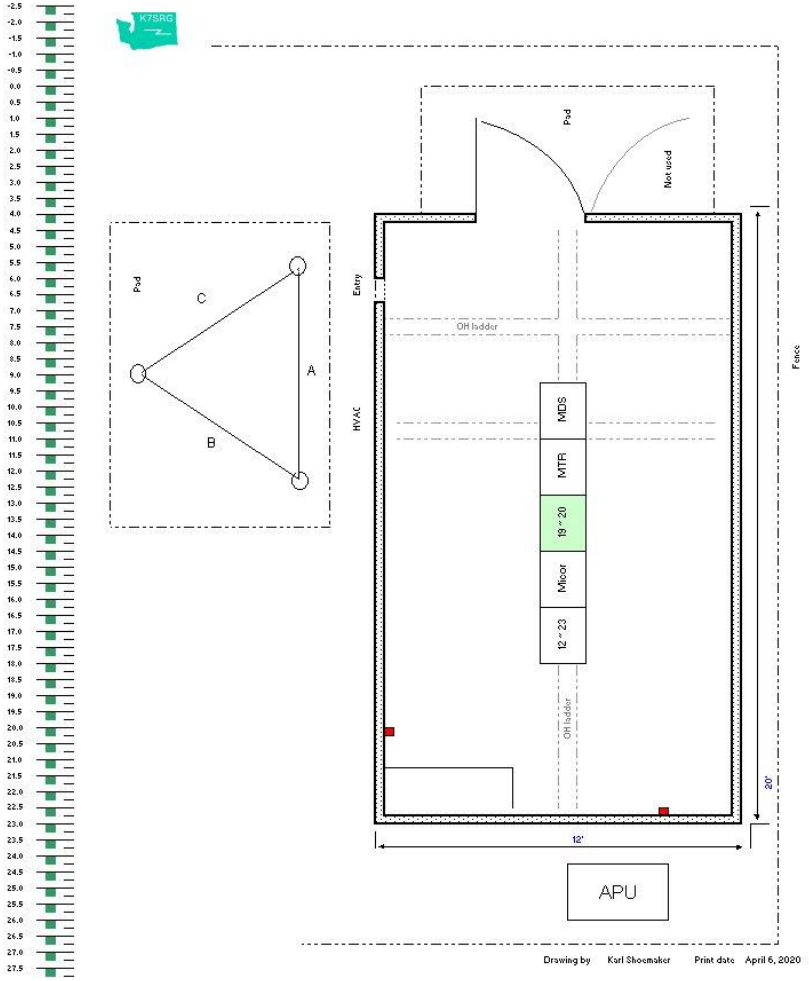


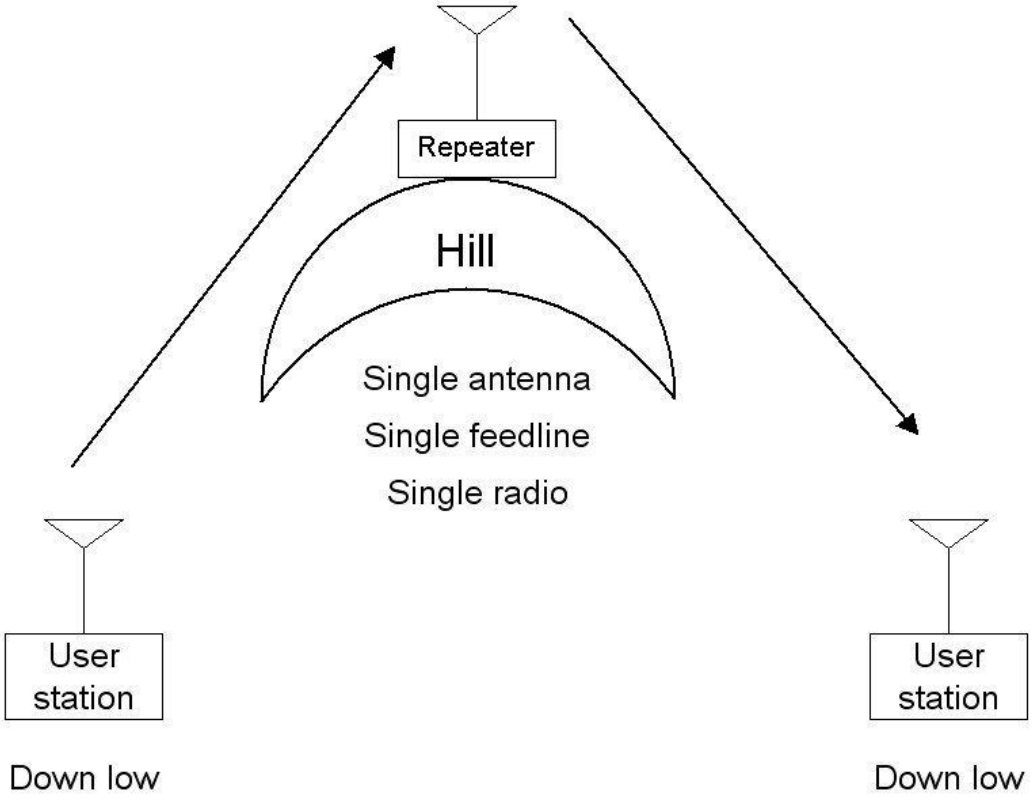


Ref v	Company or Organization / Contact Person	Station license & Class	Frequency & Tone MHz / Hz Input	Frequency & Tone MHz / Hz Output	Transmission line Type/Terminations Inside	Transmission line Type/Terminations Outside	Ant	Antenna type / Gain / Polarization	Polarization / Direction / E.R.P.	Site: Your site — Near Spokane Wa: Level / ID / Coordinates / Leg / Color
1	Tennent one			460.xxx				Stick	V True	Ft
	Person of Contact (509) xxx-xxxx	Gov							= + 57 dbm	
2	Tennent two		xxx.xxxx	xxx.xxxx				Yagi	V 100 * True	
	Person of Contact (509) xxx-xxxx	Gov							= RO	
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19	Spokane Repeater Group		TO	xxx.xxxx	LMR-400-WHT			Dipole		55 Ft
	Karl Shoemaker (509) xxx-xxxx	Amateur		Passive	UHF-M	UHF-M		0 db	= + 28 dbm	W
20	Spokane Repeater Group		xxx.xxxx	RO	LMR-400-WHT			Loop	V Omni	60 Ft
	Karl Shoemaker (509) xxx-xxxx	Amateur	CS		N-Female	N-Male		0 db	= + RO	W

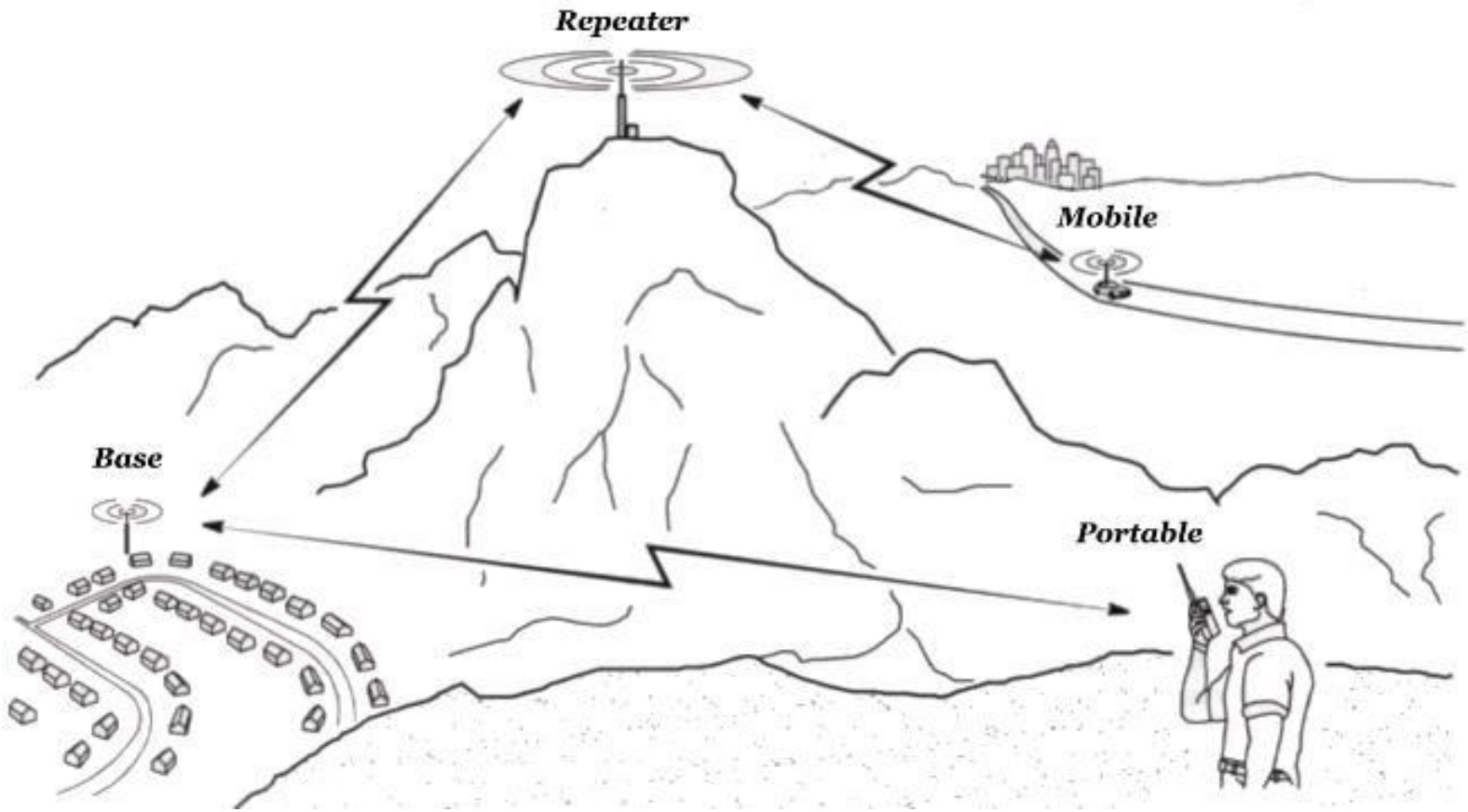
Site directions, etc.







Simple, conventional repeater. VHF radio communication is generally line-of-sight. Users are blocked by hills in many cases. A repeater will receive user #1 and pass it on to user #2 and vise-versa



Mixed operation diagram.

Equipment:

- The repeater can be commercially made and purchased. Normally, it has one receiver and one transmitter in the unit. Sometimes it includes the power supply.

- A repeater receives and transmits on the same antenna on different frequencies.

- Most duplexers can be commercially made and purchased. Use the appropriate design for the site conditions. In many cases populated sites require band-pass or band-pass/ reject modes of a duplexer (no band-reject only).

More on the duplexer:

- Primary purpose is to protect the repeater's receiver. The secondary purpose is to protect your "neighbors" (other stations at the site).
- Several RF resonant cavities make up one duplexer (singular term).
- Normally it's made up of four or six cavities. Each of these are connected to together in a form of tandem to work together.
- Normally, one side of the string of cavities is for the repeater's receiver. The other side is for the repeater's transmitter.
- The receiver side cavities are tuned to filter out the repeater's transmitter. Vise-versa; the transmitter side cavities are tuned to filter out RF energy on the repeater's receiver frequency.

Why is a duplexer important?

- The repeater transmitter typically puts out +50 dbm of RF energy.
- The repeater receiver needs to hear a signal -110 dbm of RF level.
- That’s a 160 db difference between the transmitter and receiver

That is huge !

- Why is this important to understand ?
- Let’s explore a little theory.

“ Old school thinking “

- For “old school” folks use linear measurements:
- “Watts”
- “Microvolts”

A better way of thinking

- Logarithmic scale is a better way to see the “big picture”.
- It’s great to determine subtle system gains or losses.
- Also good for establishing bench marks.
- Good for RF path analysis.

(Log (bel) based 10 (dbm)

RF level			Typical use
+	100	dbm	Radar; can be lethal
+	90	dbm	Radar; can be lethal
+	80	dbm	Radar; can be lethal
+	70	dbm	High power broadcast stations; dangerous
+	60	dbm	Medium power broadcast stations
+	50	dbm	High power LMR stations / repeaters
+	40	dbm	Medium power LMR stations, mobile radios
+	30	dbm	Low power LMR stations, portable radios
+	20	dbm	Low power LMR stations, portable radios
+	10	dbm	High power signal generator / test equipment
	0	dbm	High power signal generator / test equipment
-	10	dbm	Normal signal generator / test equipment
-	20	dbm	Normal signal generator / test equipment
-	30	dbm	Normal signal generator / test equipment
-	40	dbm	Very strong user or station signal level
-	50	dbm	Very strong user or station signal level
-	60	dbm	Medium strong user or station signal level
-	70	dbm	Medium strong user or station signal level
-	80	dbm	Medium strong user or station signal level
-	90	dbm	Medium strong user or station signal level
-	100	dbm	Weak user or station signal level
-	110	dbm	Very weak user or station signal level
-	120	dbm	Extremely weak user or station signal level
-	130	dbm	Laboratory test and measurement level
-	140	dbm	Laboratory test and measurement level
-	150	dbm	Experimental operation
-	160	dbm	Laboratory test and measurement level
-	170	dbm	Laboratory test and measurement level
-	180	dbm	Laboratory test and measurement level
-	190	dbm	Laboratory test and measurement level
-	200	dbm	Laboratory test and measurement level
-	210	dbm	Laboratory test and measurement level
-	220	dbm	Laboratory test and measurement level
-	230	dbm	Laboratory test and measurement level
-	240	dbm	Typical Earth to Moon RF level from a station.
-	250	dbm	Typical Earth to Moon RF level from a station.

Most amateur & commercial repeater operational levels

Other site RF management considerations

- Proper antenna placement.
- Your neighbors.
- Is an isolator needed? What is an isolator?
- There’s a good article on this subject by Scott Grimmett, who hold’s a degree in Science and Electrical Engineering. The document is on SRG’s web site.

Repeater bands for amateur radio:

Repeaters can be operated on several amateur radio bands:
(these are generalized for this presentation)

- 10-meters (28 ~ 30 MHz)
- 6-meters (50 ~ 54 MHz)
- 2-meters (144 ~ 148 MHz) (most common 145~147)
- 1.25-meters (222 ~ 225 MHz)
- 70-centimeter (420 ~ 450 MHz) (most common 440~450)
- 33-centimeter (900 ~ 920 MHz)
- 23-centimeter (1200 ~ 1250 MHz)
- Higher, specialized amateur bands, including laser / light.
- 2-meter band is by far the most popular band to operate.

Other considerations:

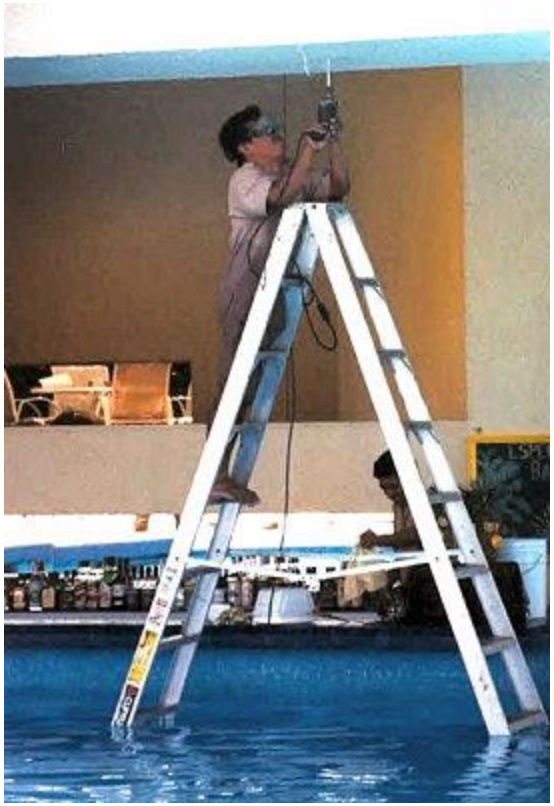
- People population in major cities and other towns.
- Radio population on mountain top sites.
- Less frequencies are available (repeater pairs).
- Alternate bands from 2-meters.
- There are many repeaters around the Spokane area.
- Several have “links”; IRLP, Echo-link, DMR / IP, etc.
- Several are analog voice.
- Does everyone “need” to have his/her own repeater?
- What about group efforts, communication and cooperation?

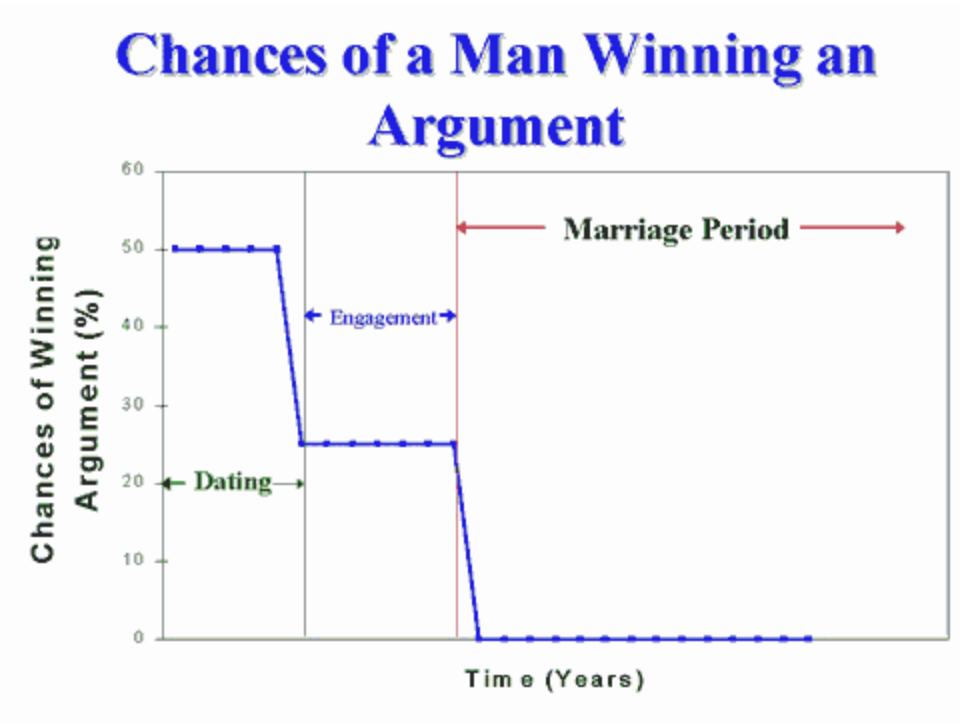
More information can be found on SRG's web site of:

http://www.srgclub.org

Or you can google on line:

- The Club's call sign of K7SRG
- The Author's call sign of AK2O




Chances of a Man Winning an Argument
Chances of Winning Argument (%)
60
50
40
30
20
10
0
Dating
Engagement
Marriage Period
Time (Years)

Questions ?