

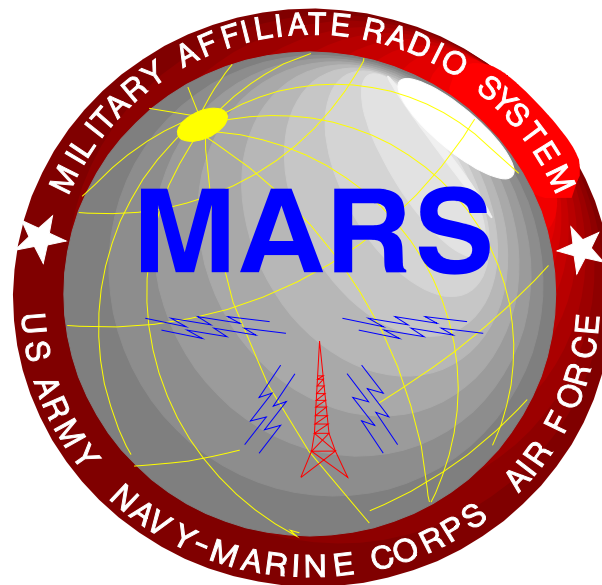


NETCOM/9th Army Signal Command



HF Training Course

Lesson 02 – HF Antennas



*311th Theater Signal Command, Ft. Meade MD
24-25 January 2004*

*John K. Scoggin, Jr.
Army MARS Automation Coordinator
Emergency Operations Officer, Eastern Area*

‘Proud, Professional, & Ready’



Antenna Selection Criteria

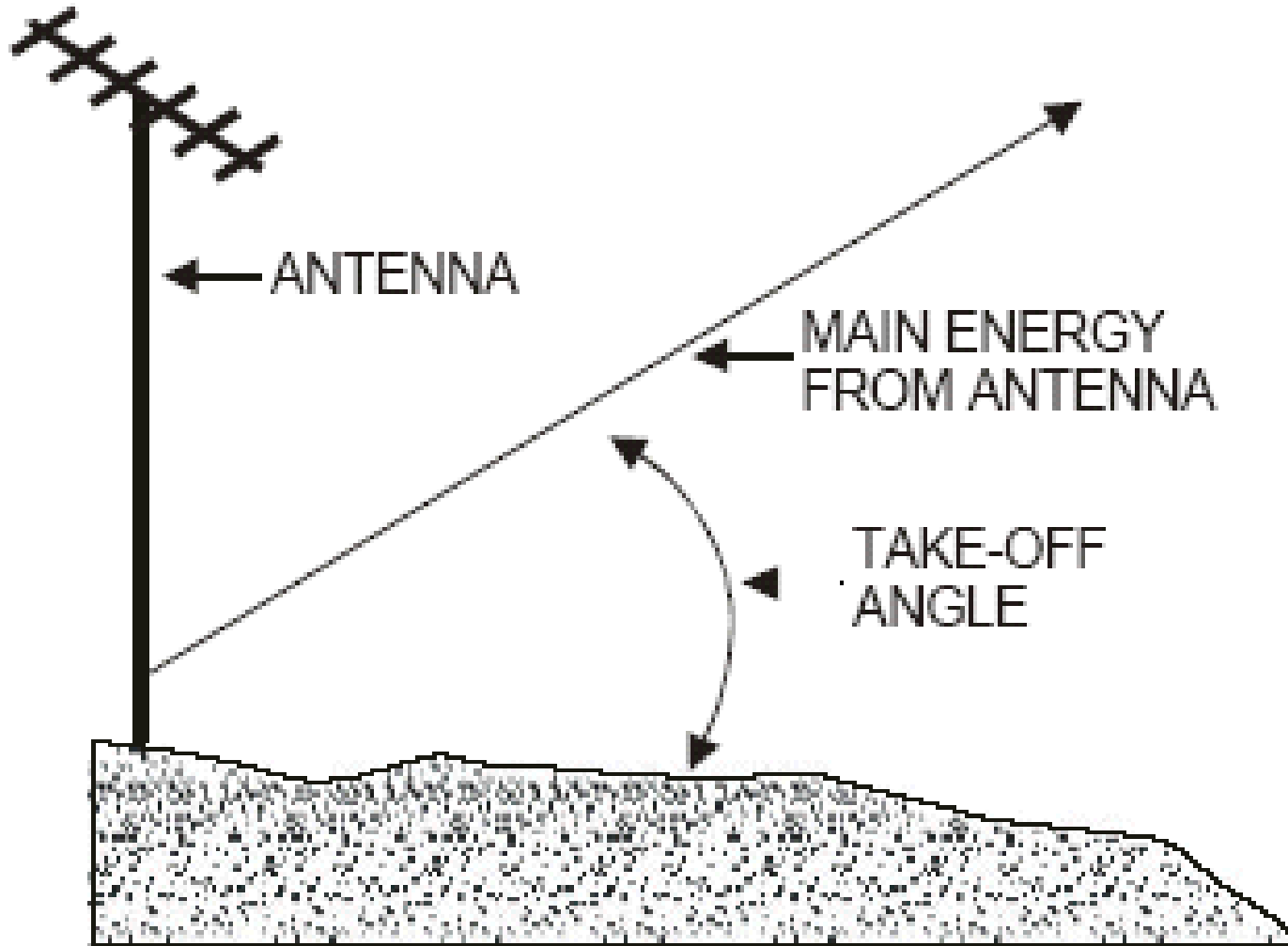
- Coverage Desired (< 30km, 30-300 km, long-haul)
- Selected Mode of Propagation
- Directional or Omnidirectional
- Polarization
- Availability of good grounds
- Ease of camouflage
- Space availability (clear of obstructions?)

	Use			Directivity	Polarization	Bandwidth				
	Ground Wave	Sky Wave								
	Short (500 Miles)	Medium (500 to 1200 Miles)	Long (1200 Miles)	Omnidirectional	Bidirectional	Directional	Horizontal	Vertical	Wide	Narrow
AS-2259/GR		X		X					X	
Vertical Whip	X			X			X		X	
Half-Wave Dipole		X X		X			X			X
Inverted Vee	X	X X		X			X X			X
Long Wire	X	X X	X	X X			X			X
Inverted L	X	X X		X X			X X			X
Sloping Vee	X	X X			X		X			X
Sloping Wire	X	X X		X X			X			X
Vertical Half-Rhombic	X	X X			X		X			X



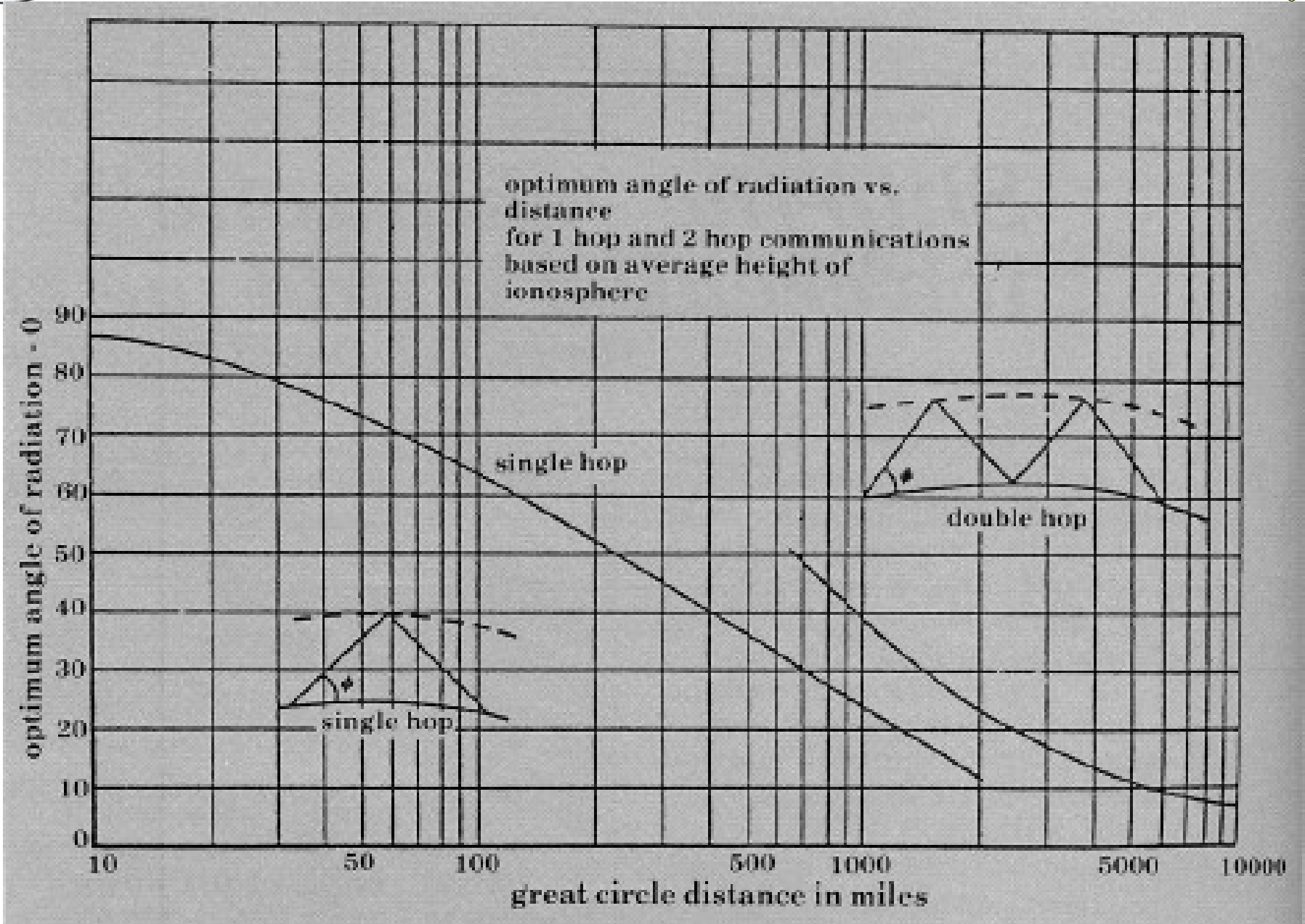
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Take-Off Angle





Range and Take-Off Angle

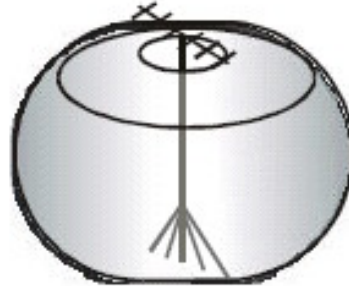




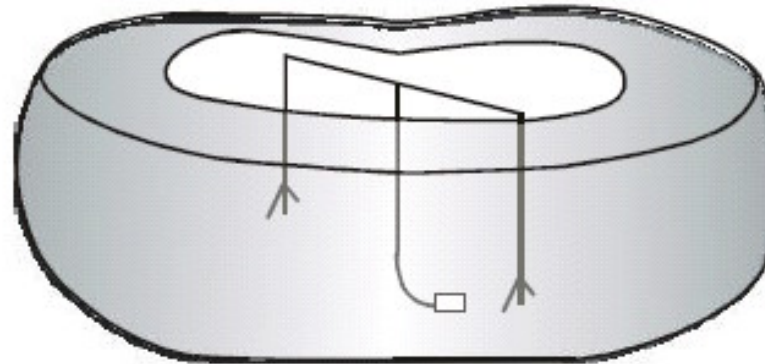
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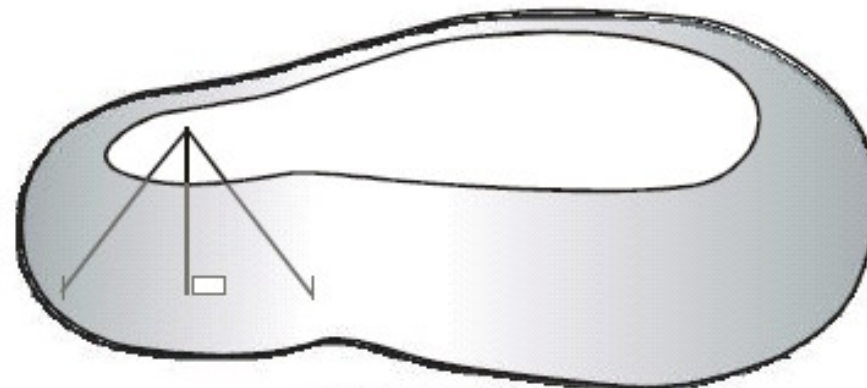
Antenna Patterns



OMNIDIRECTIONAL



BIDIRECTIONAL

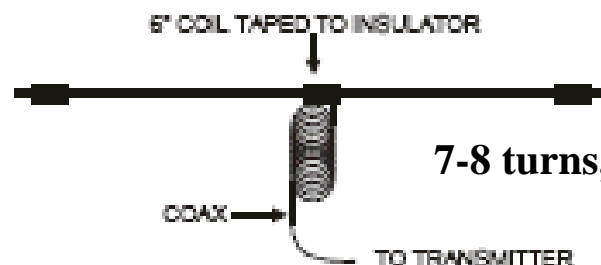
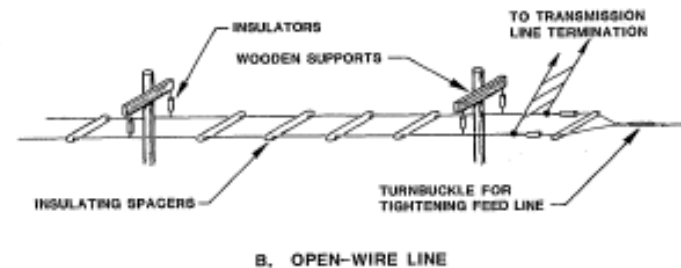
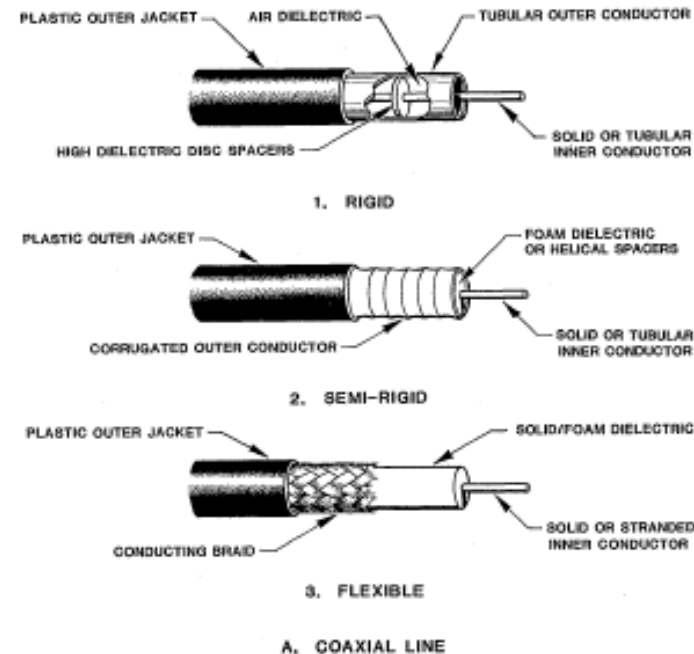


UNIDIRECTIONAL



A Word About Feedlines

- **Ideal solution depends on whether antenna is balanced or unbalanced in design**
- **Use coax for unbalanced designs (one side grounded)**
- **Use open-wire line for balanced antennas (ideal) OR coaxial cable with a balun (balanced-unbalanced transformer) (best) or by winding a coaxial choke to prevent ground currents**
- **Use an appropriate cable for the power level and loss (length)**



7-8 turns, approx 10 ft of cable

COAX

TO TRANSMITTER

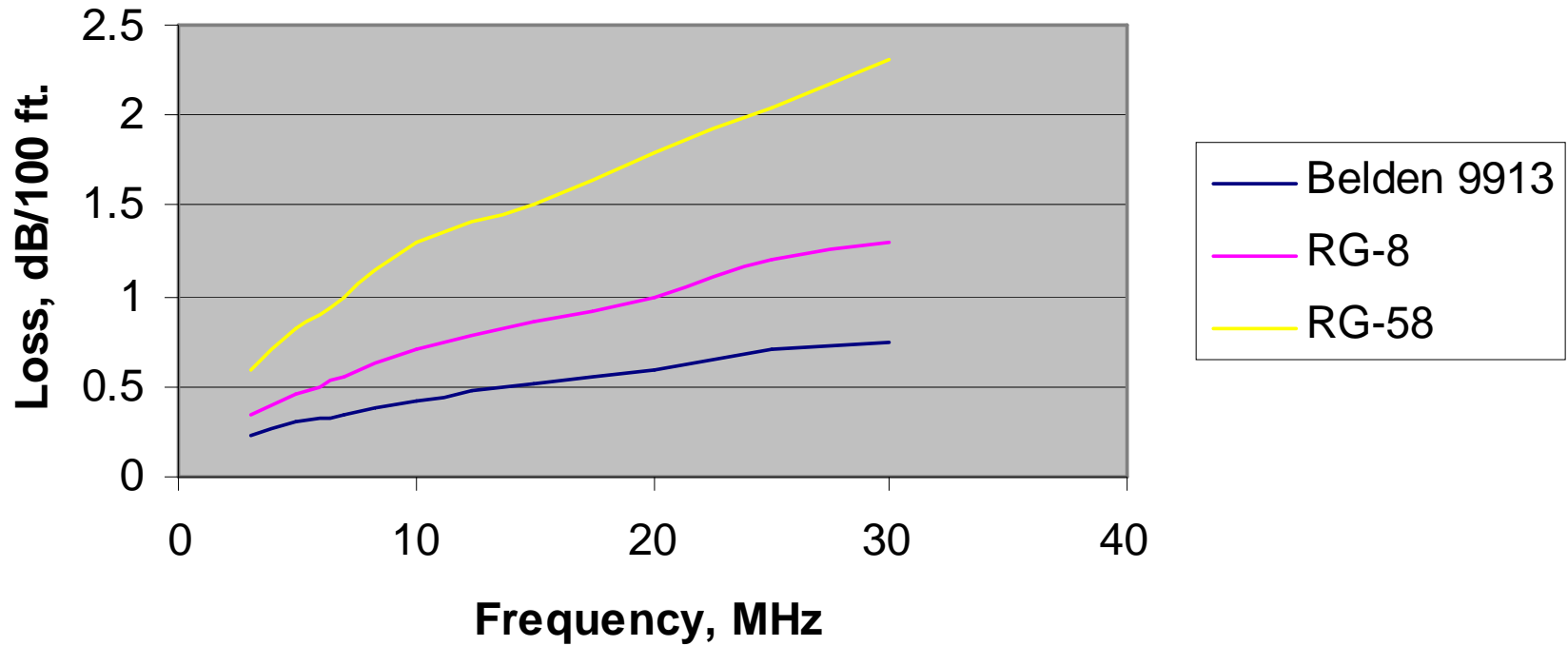


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Feedline Loss

Feedline Loss (Matched)





Standing-Wave Ratio

- **Ratio of the voltage of the reflected wave at any one point on the feedline to the voltage of the forward wave at that same point.**
- **Ideal SWR (Matched line) is 1:1**
- **The higher the SWR, the more power is lost in the feedline and more power reflected back into transmitter finals**
- **Many radios reduce power automatically at 2:1 or 3:1 SWR to save final transistors from overheating (automatic fold-back)**



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Effect of SWR Mismatch

100 ft dipole, 50 ft high, 1500W

MHz	SWR RG-8A Coax	Loss 100 ft RG-8A	Loss, 100ft 450Ω Line	Max Voltage RG-8A	Max Voltage 450 Ω
1.8	1818:1	25.9 dB	12.1 dB	1640	7640
3.8	63:1	5.7 dB	0.9 dB	1181	3188
7.1	49:1	5.8 dB	0.3 dB	981	1964
10.1	134:1	10.4 dB	0.9 dB	967	2869
14.1	6:1	1.9 dB	0.5 dB	530	1863
18.1	65:1	9.0 dB	0.6 dB	780	2073
21.1	73:1	9.8 dB	0.8 dB	757	2306
24.9	18:1	5.2 dB	0.4 dB	630	1563
28.4	65:1	10.1 dB	0.7 dB	690	2051



Manpack Antennas

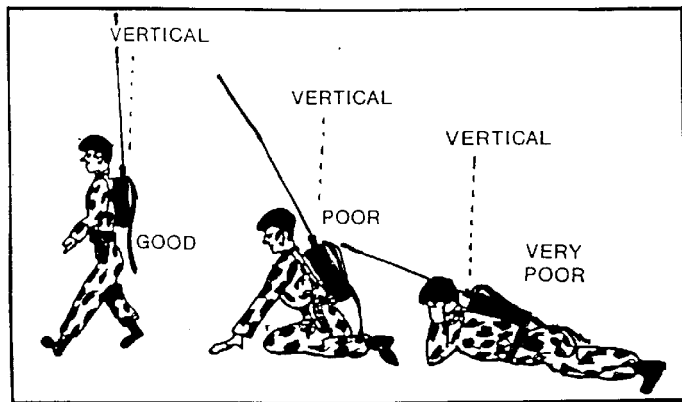


Figure 8 If Operating Ground Wave Best Results Should Be Obtained With the Whip (vertical) and Use of a Dangling Ground Plane Enhancement Tail

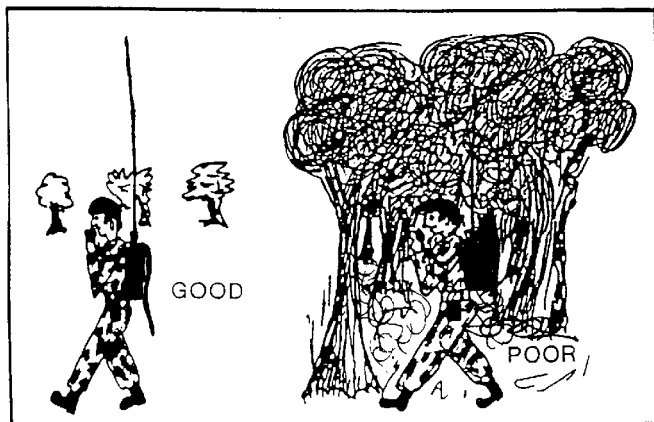
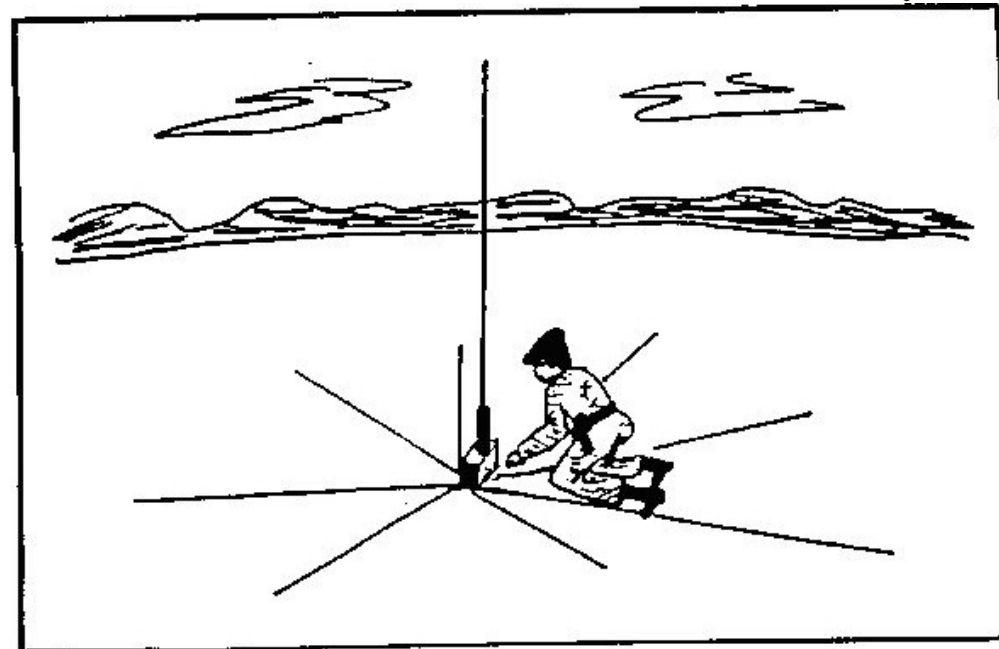


Figure 9 Where Possible Find a Clearing (no matter if ground wave or NVIS is being used)

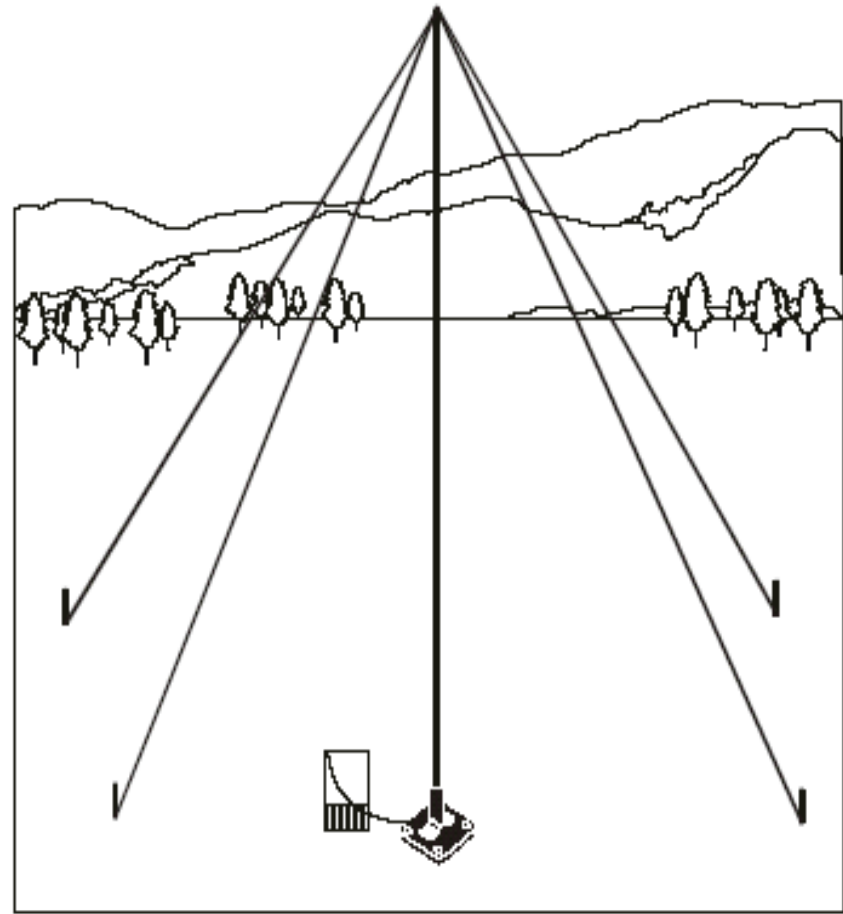


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AS-2259/GR Antenna

- Frequency range: 2 to 30 MHz
- Polarization: Horizontal and vertical simultaneously
- Power capability: 1,000 watts (CHECK MOUNTING PLATE – some are limited to 50 watts by the baluns!)
- Radiation pattern - NVIS
- Azimuthal (bearing): Omnidirectional



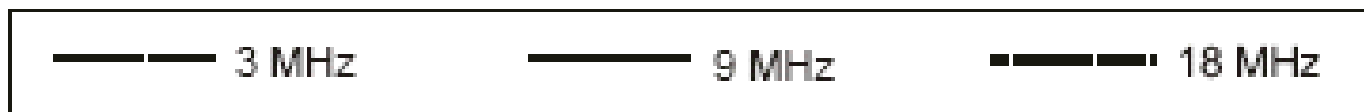
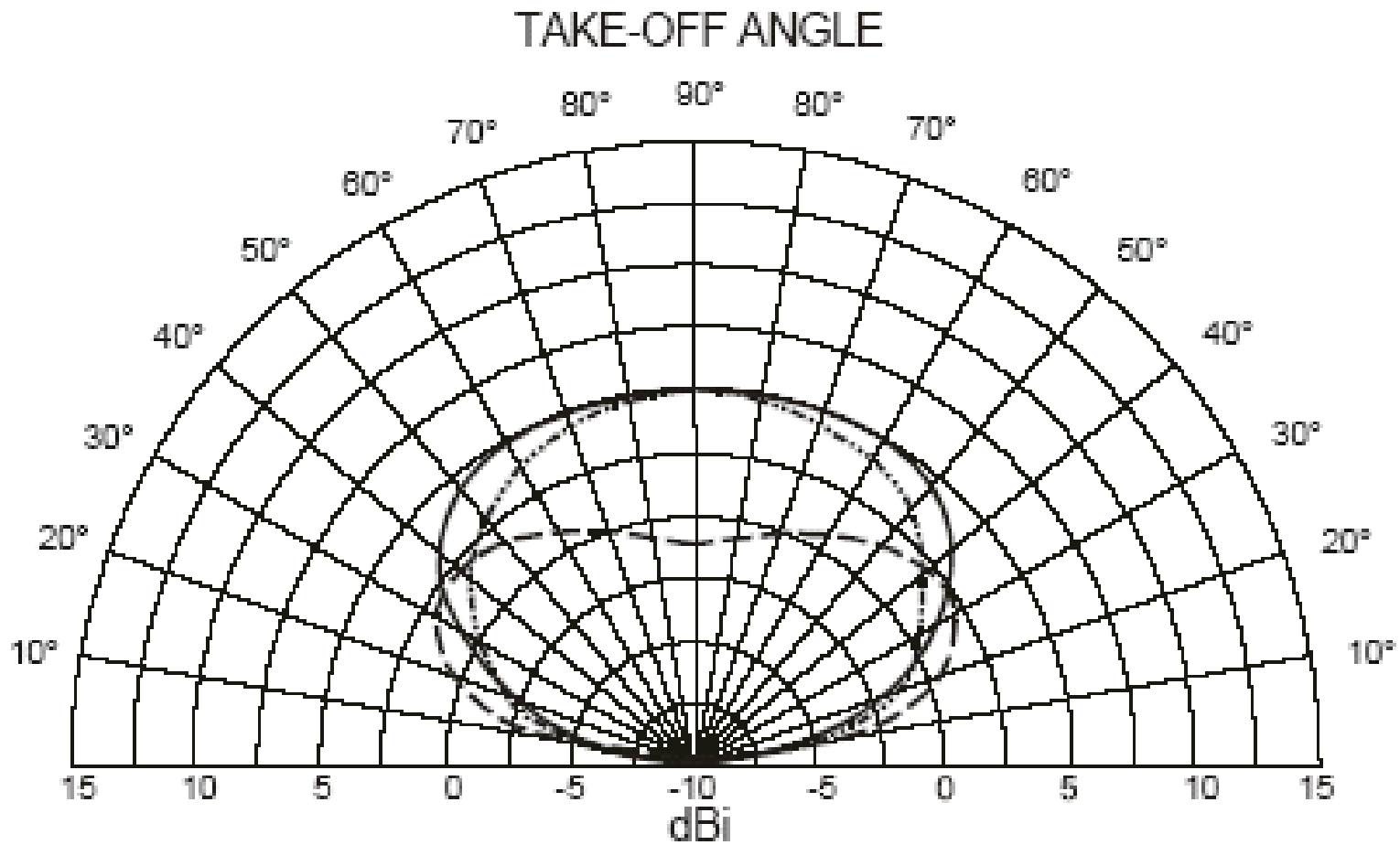


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AS-2259/GR

Vertical Radiation Pattern



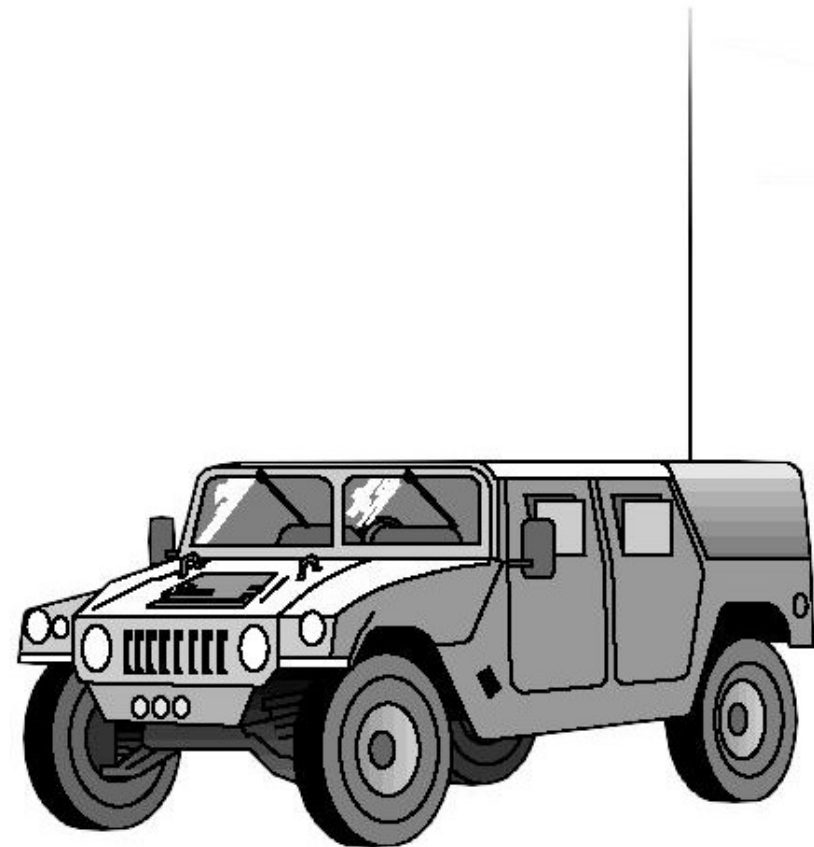


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Vertical Antennas



- **Ubiquitous in the mobile environment**
- **Majority of energy is radiated about 45 degrees to the horizon**
- **Pattern strongly affected by vehicle body**
- **Good grounding is critical**
- **OK for ground wave comms over short distances (< 30km)**
- **16/32 ft transportable units with ground radials (AT-1011/U)**
- **Requires tuner**

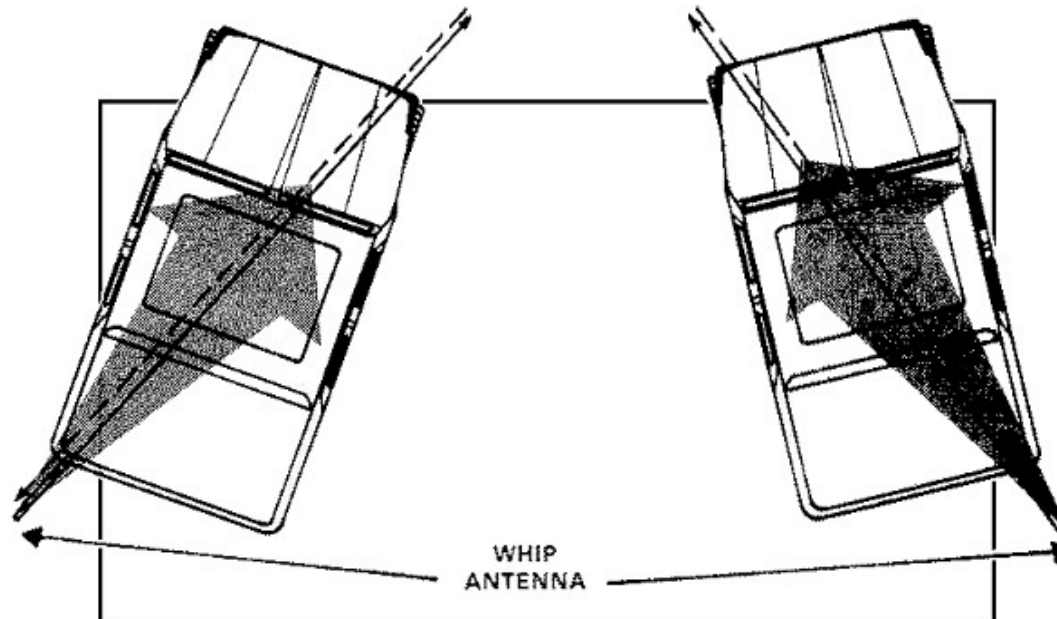
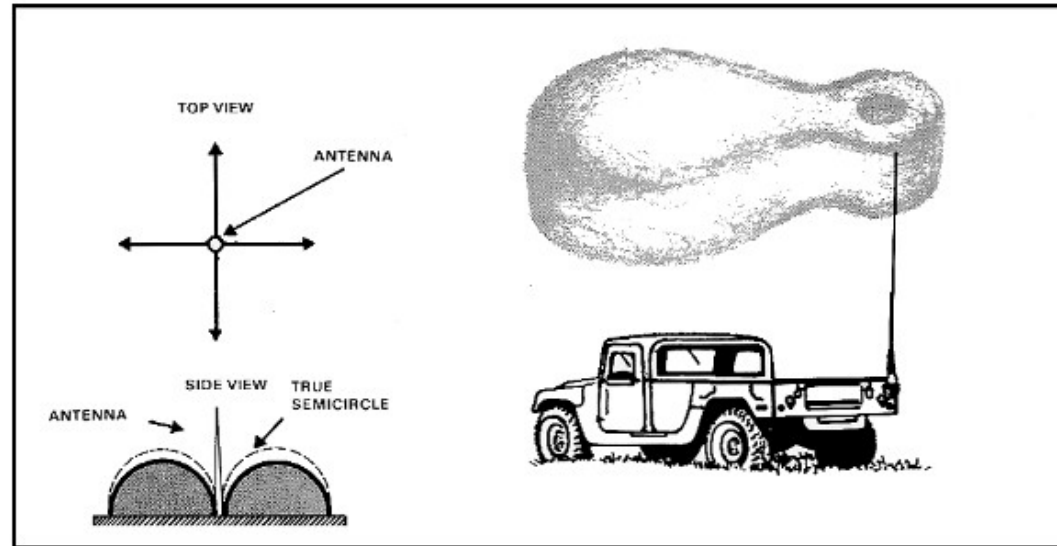




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Vehicle-Mounted Whips

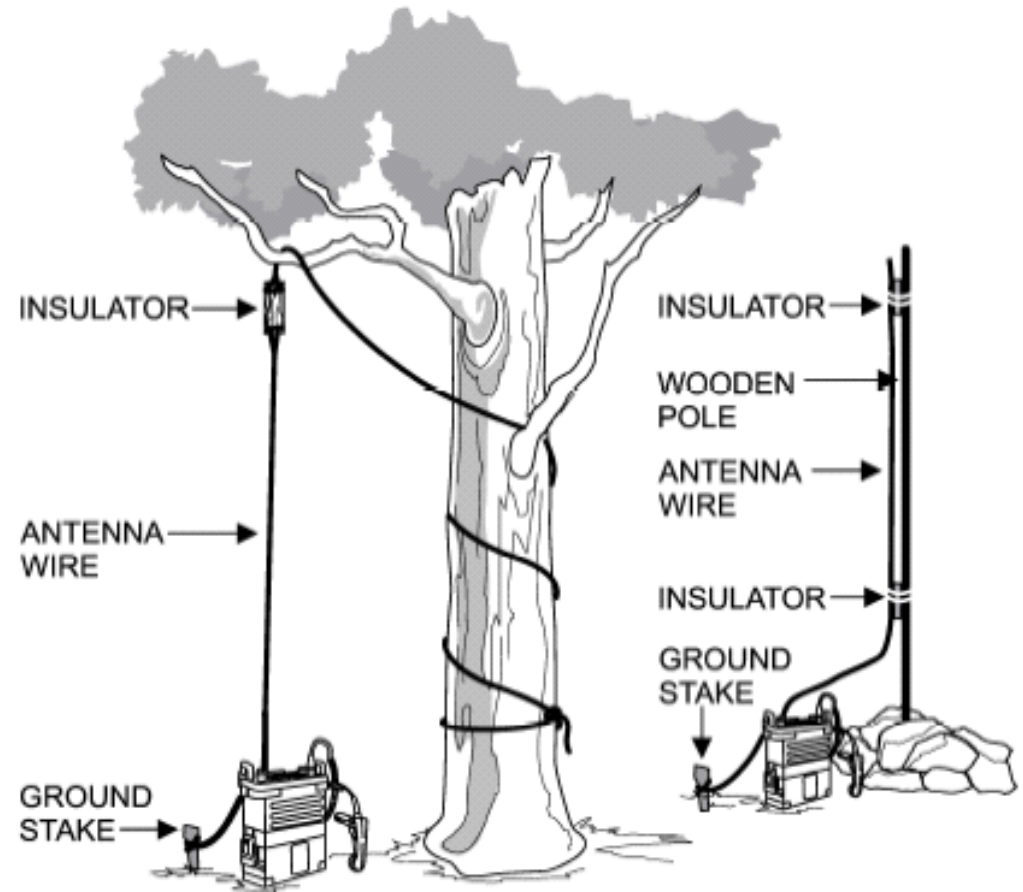
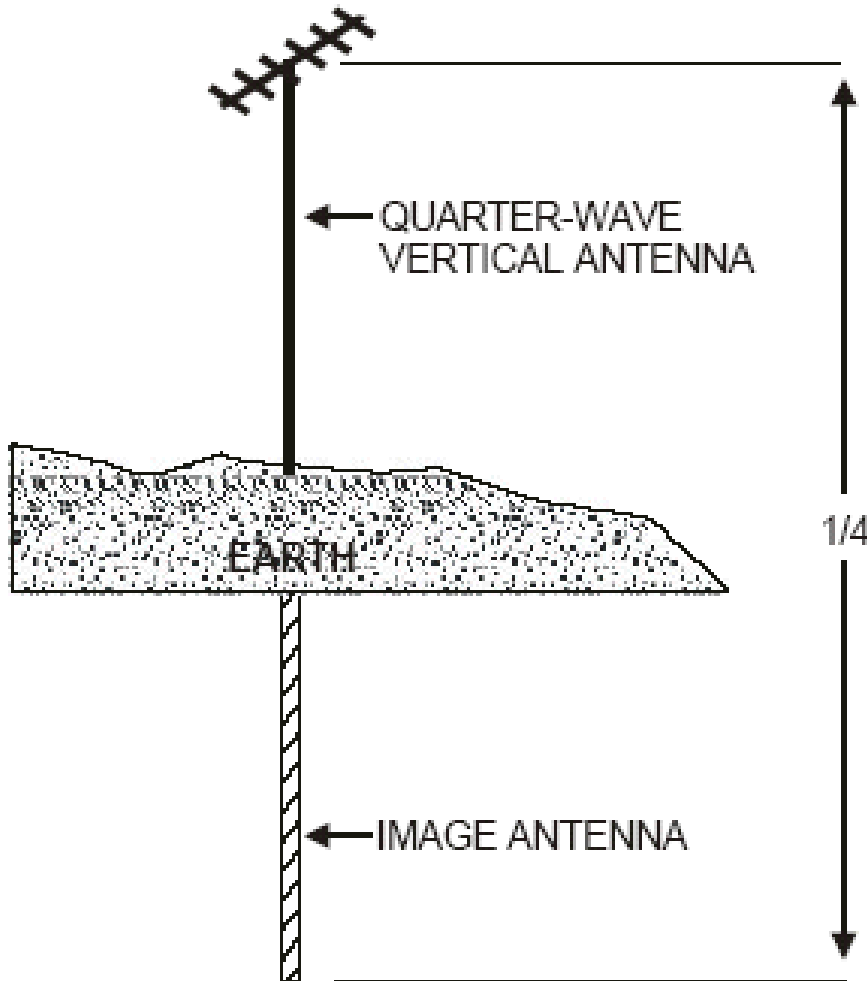




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Vertical Antenna Design

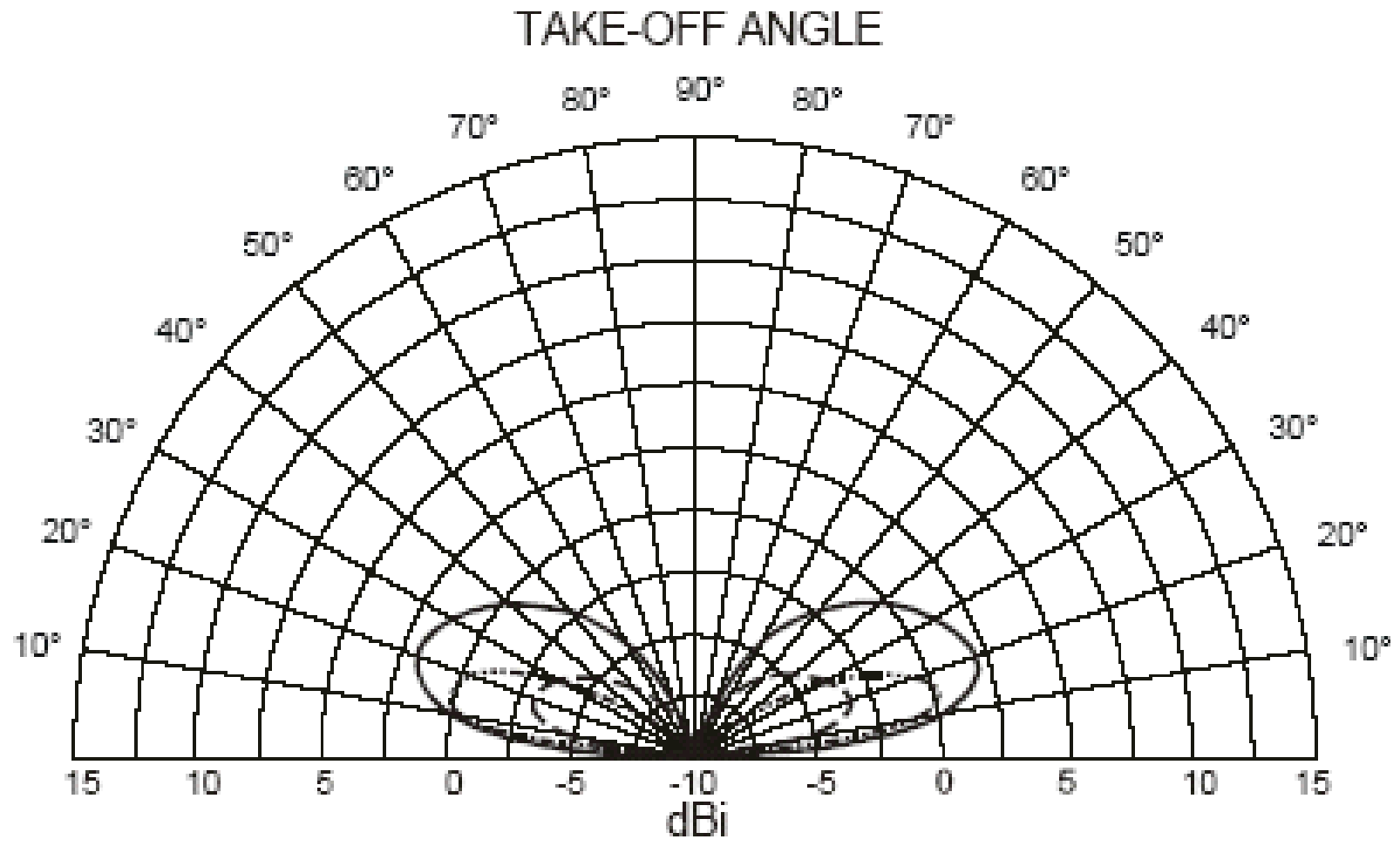




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32-ft Vertical Antenna Pattern

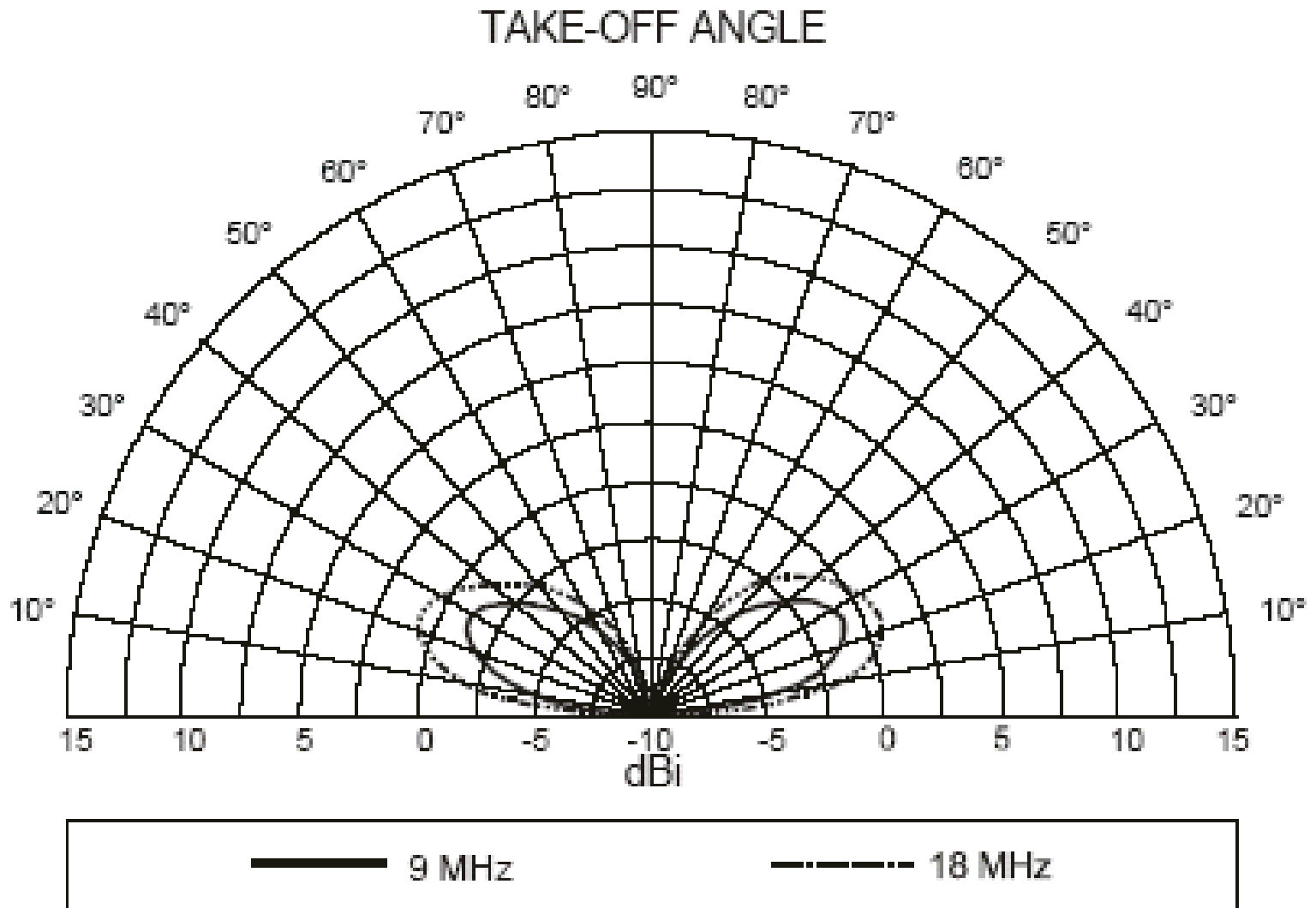




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15-ft Vertical Antenna Vertical Antenna Pattern





Using a Vertical for NVIS

USE OF WHIP-TILT ADAPTER

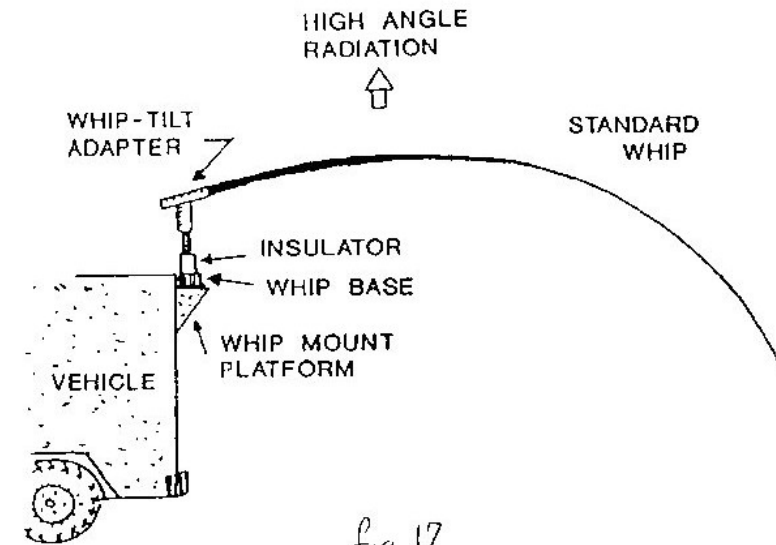
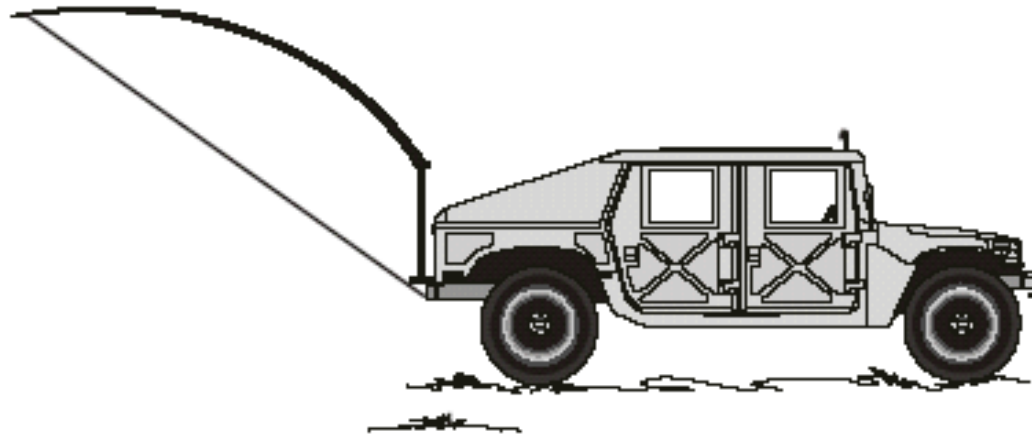
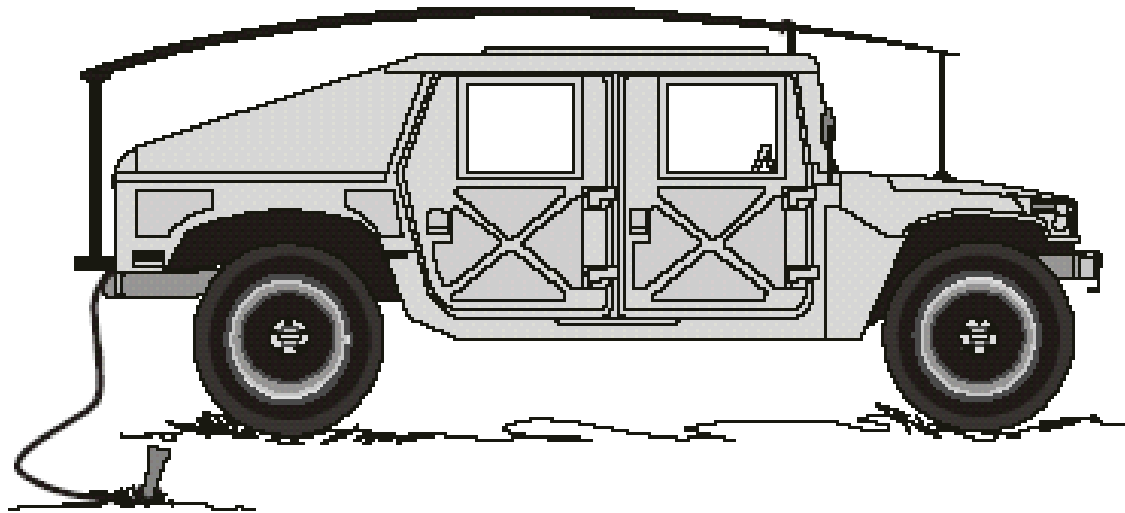


fig 17

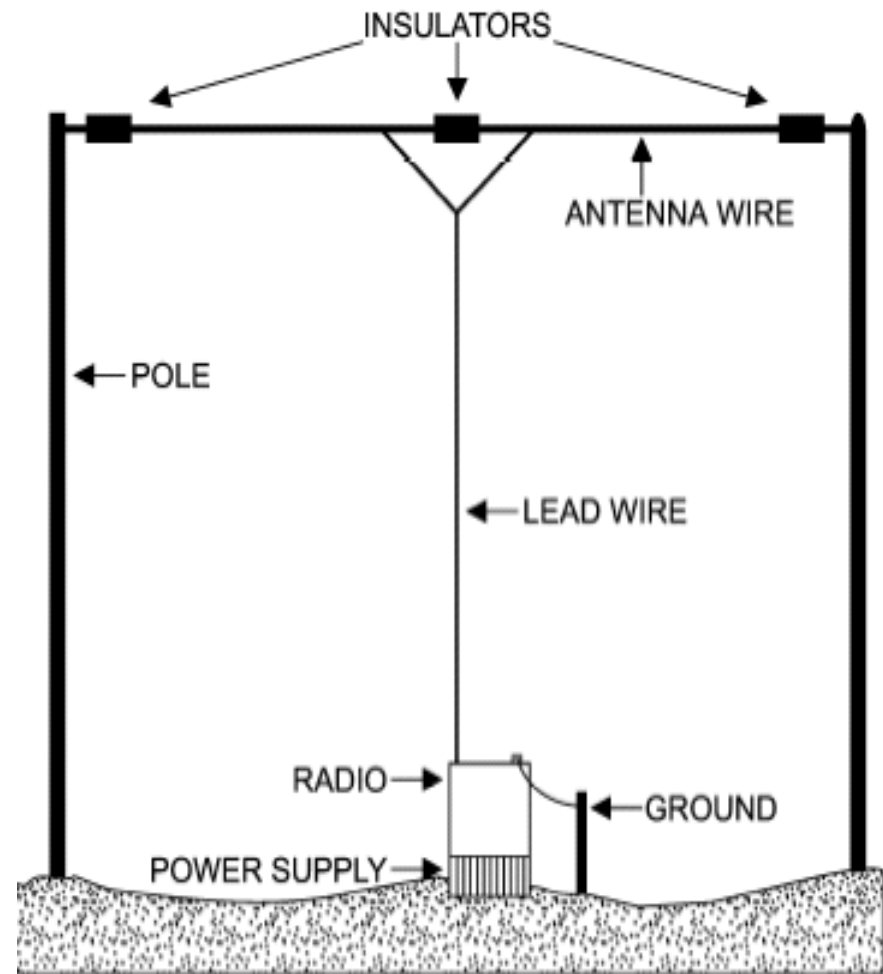




Half-Wave Dipole (Doublet)

- **Short-to-medium skywave (300-1200 km)**
- **Narrow bandwidth**
- **Mount close to ground ($1/4\lambda$) for short paths, higher ($1/2\lambda$) for medium length paths**

$$\text{Dipole length} = \frac{142 \text{ meters}}{\text{Frequency in MHz}} \quad \text{or} \quad \frac{468 \text{ feet}}{\text{Frequency in MHz}}$$



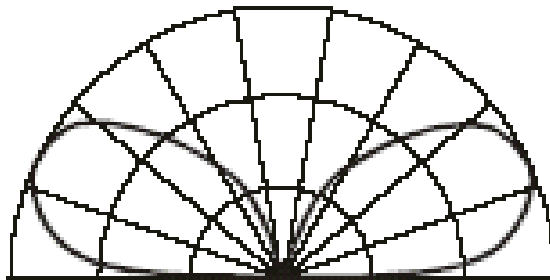


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Half-Wave Dipole

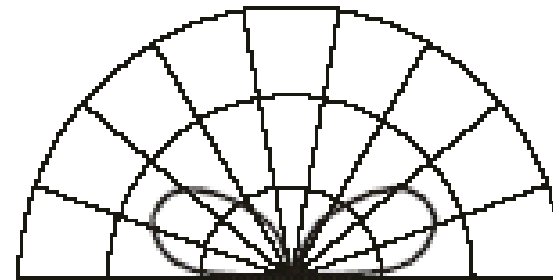


$$H = \frac{\lambda}{2}$$



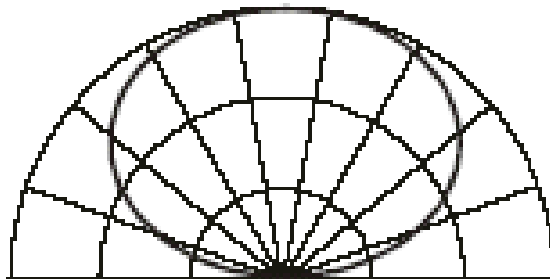
A

$$H = \frac{\lambda}{2}$$



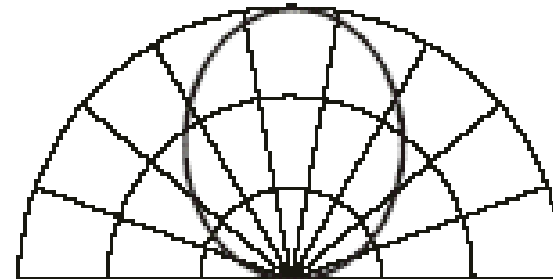
B

$$H = \frac{\lambda}{4}$$



C

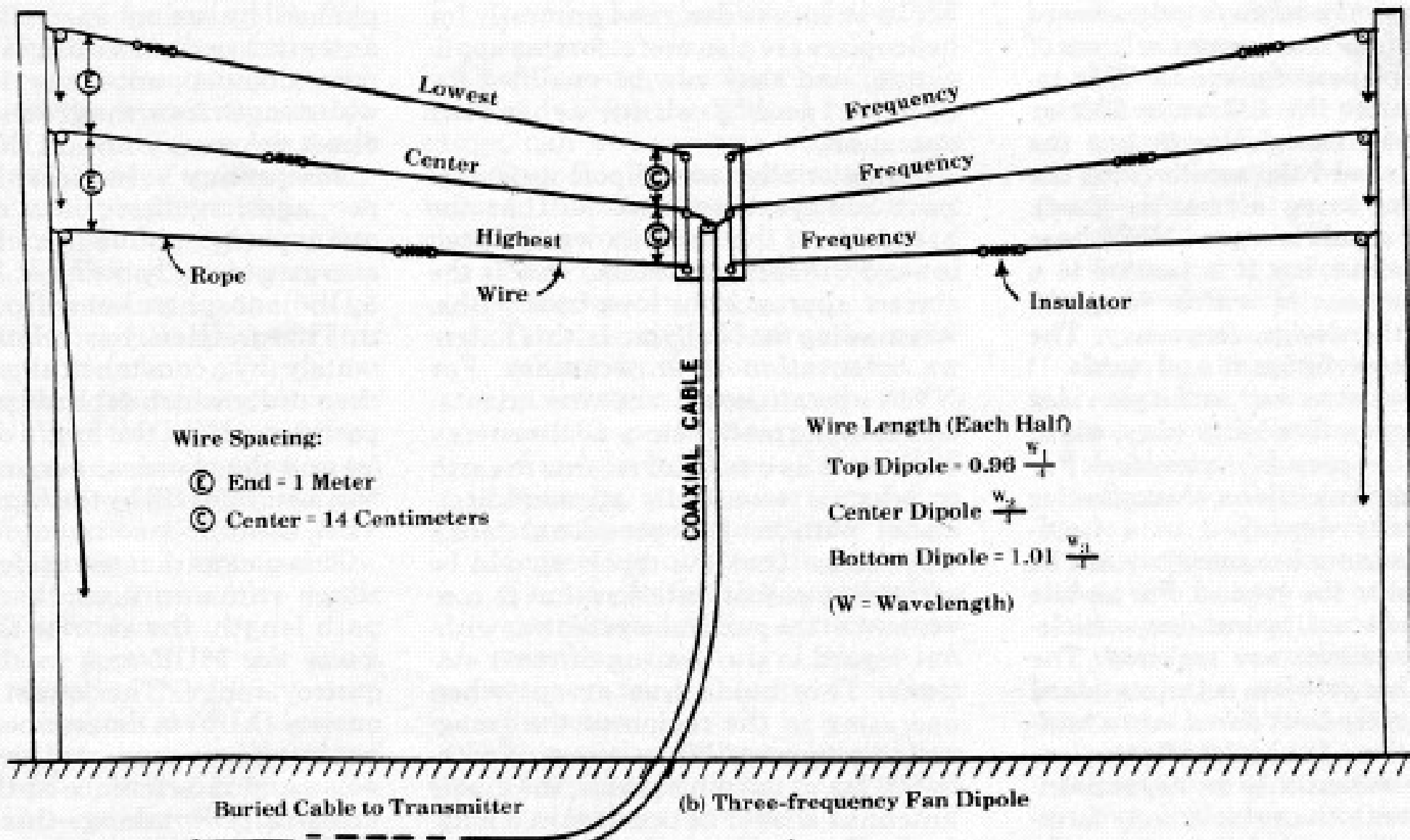
$$H = \frac{\lambda}{4}$$



D



Fan Dipole



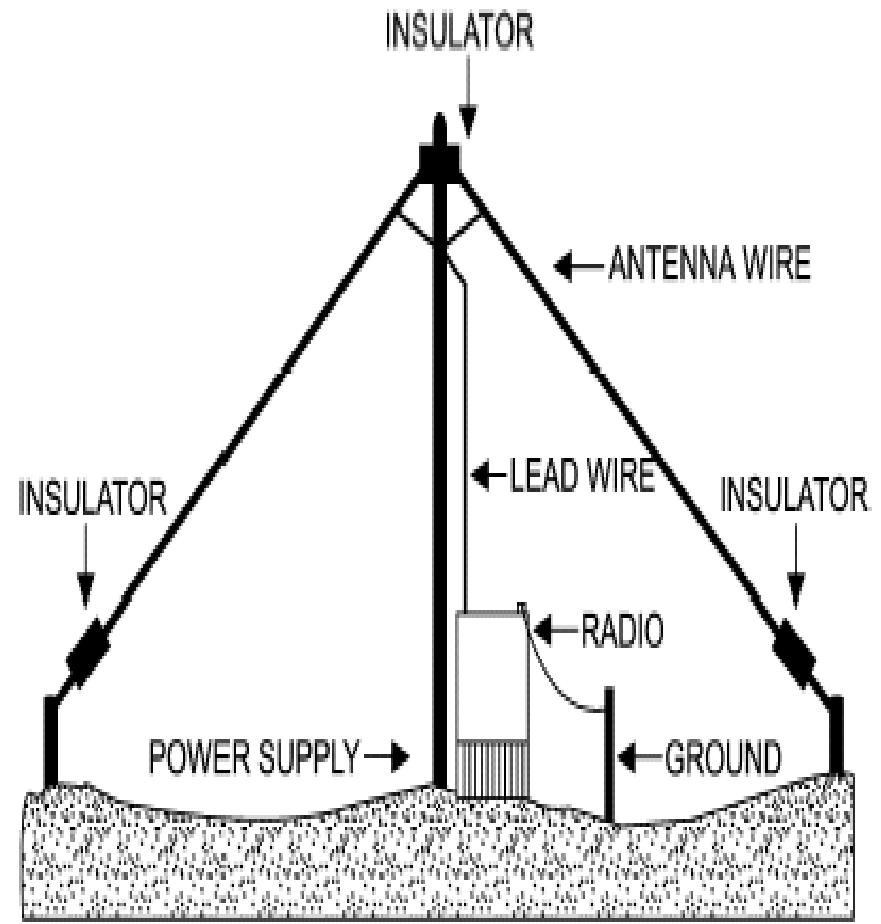


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Inverted-V Antenna

- **Less gain than a dipole, but only requires one support**
- **Combination of vertical and horizontal radiation**

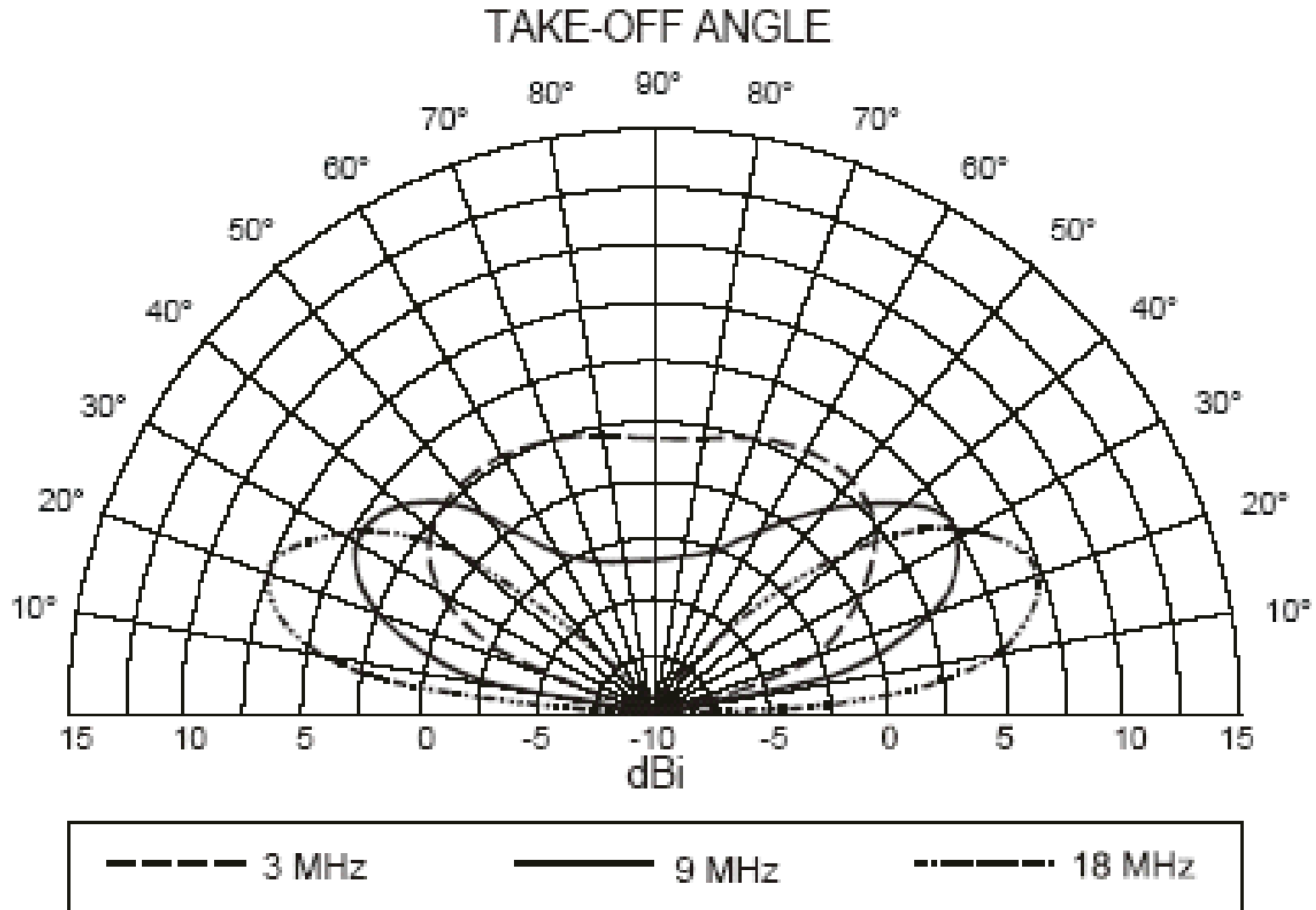




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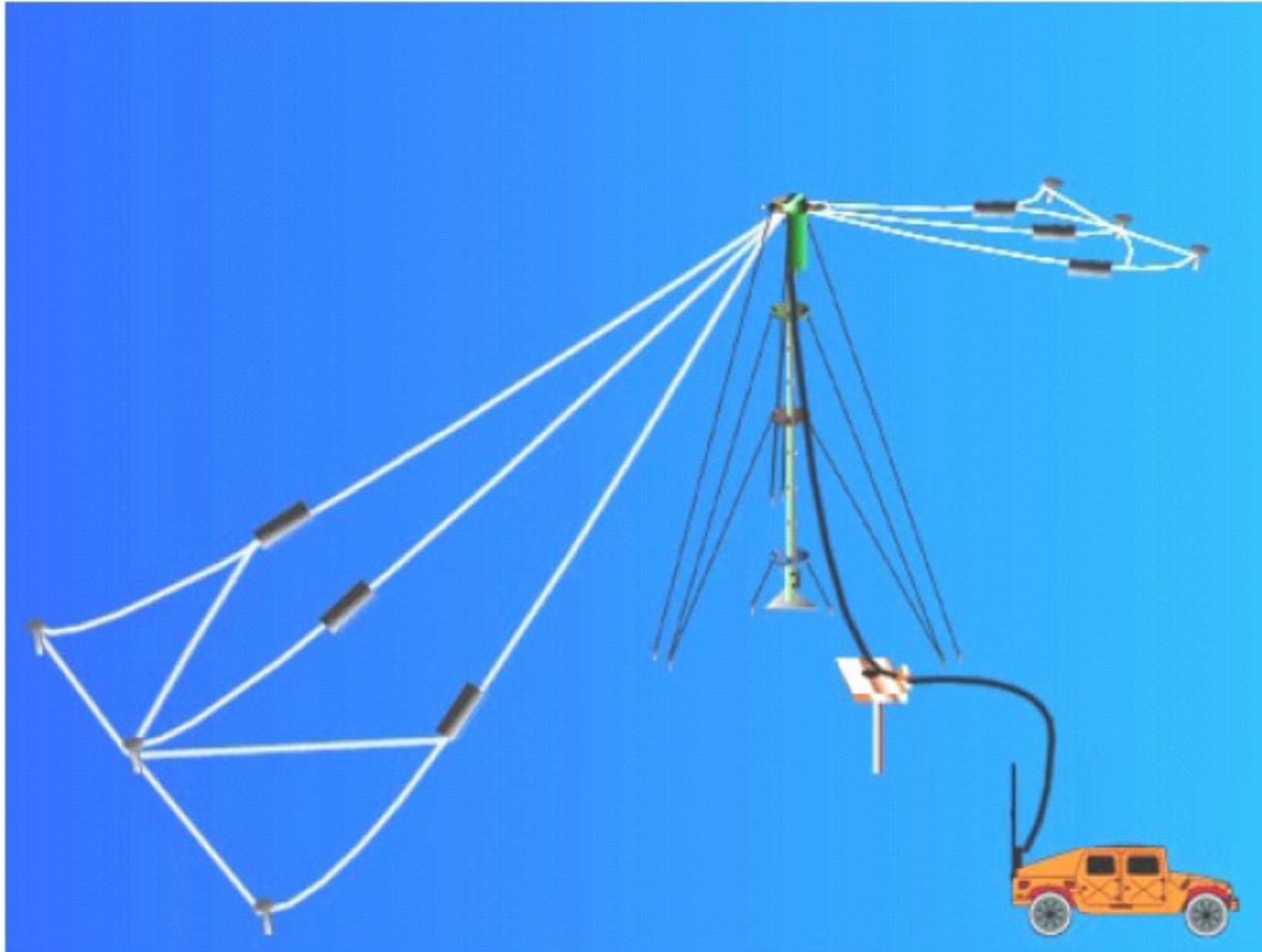
Inverted-V Vertical Radiation Pattern





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Fan-Lite Antenna



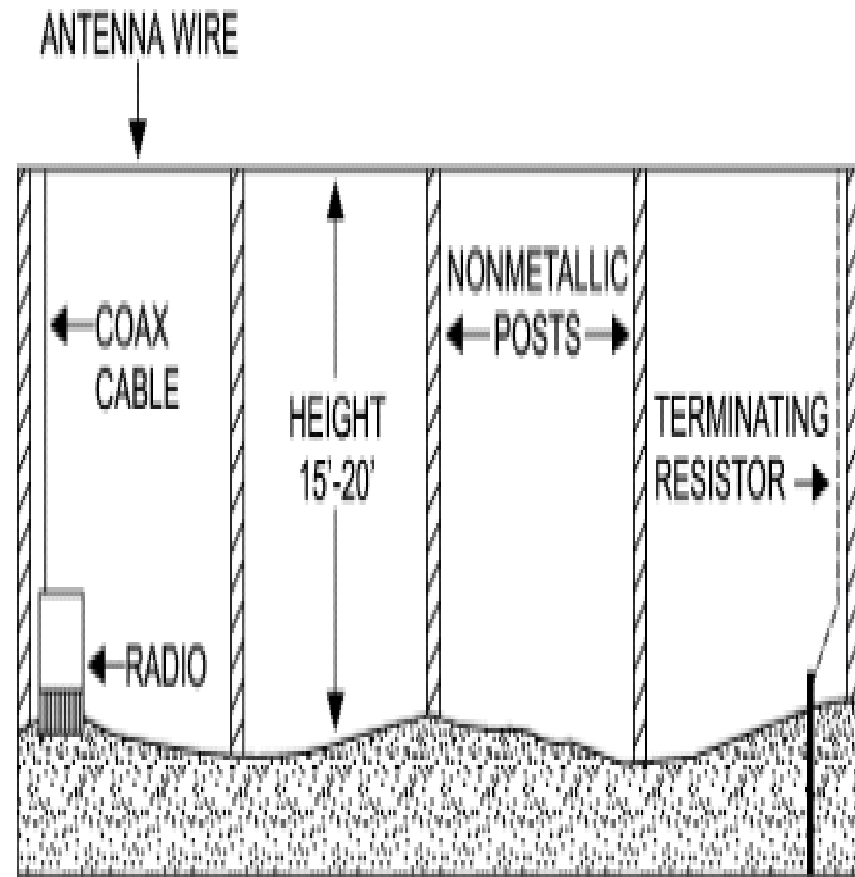


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Long-Wire Antenna

- At least $1/2\lambda$ in length, preferably 2 or more
- Longer wire, lower takeoff angle, more gain
- To make it directional, add a 600 Ω resistor (rated at half the xmit power)
- Works best with a 12:1 balun if using coaxial cable feedline





Inverted-L Antenna

- Ground wave and short-range skywave
- Omnidirectional
- Quite adaptable with existing tuners and 35-40 ft vertical height

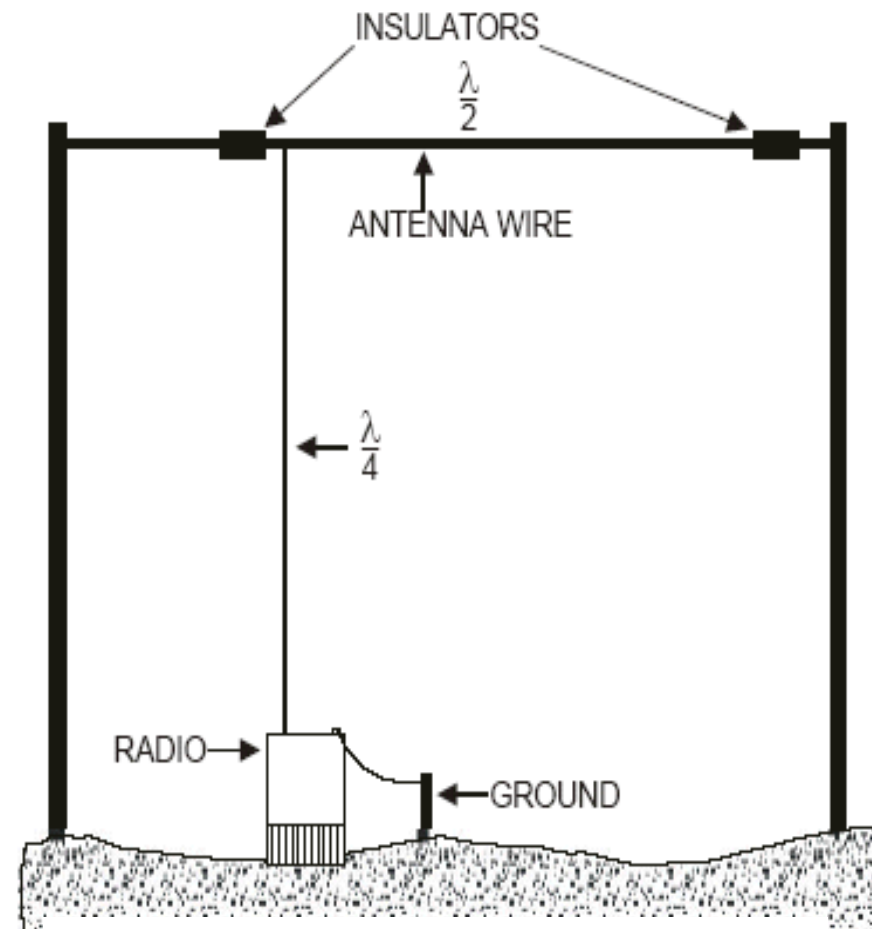


Table 4-5. Gain Versus Length.

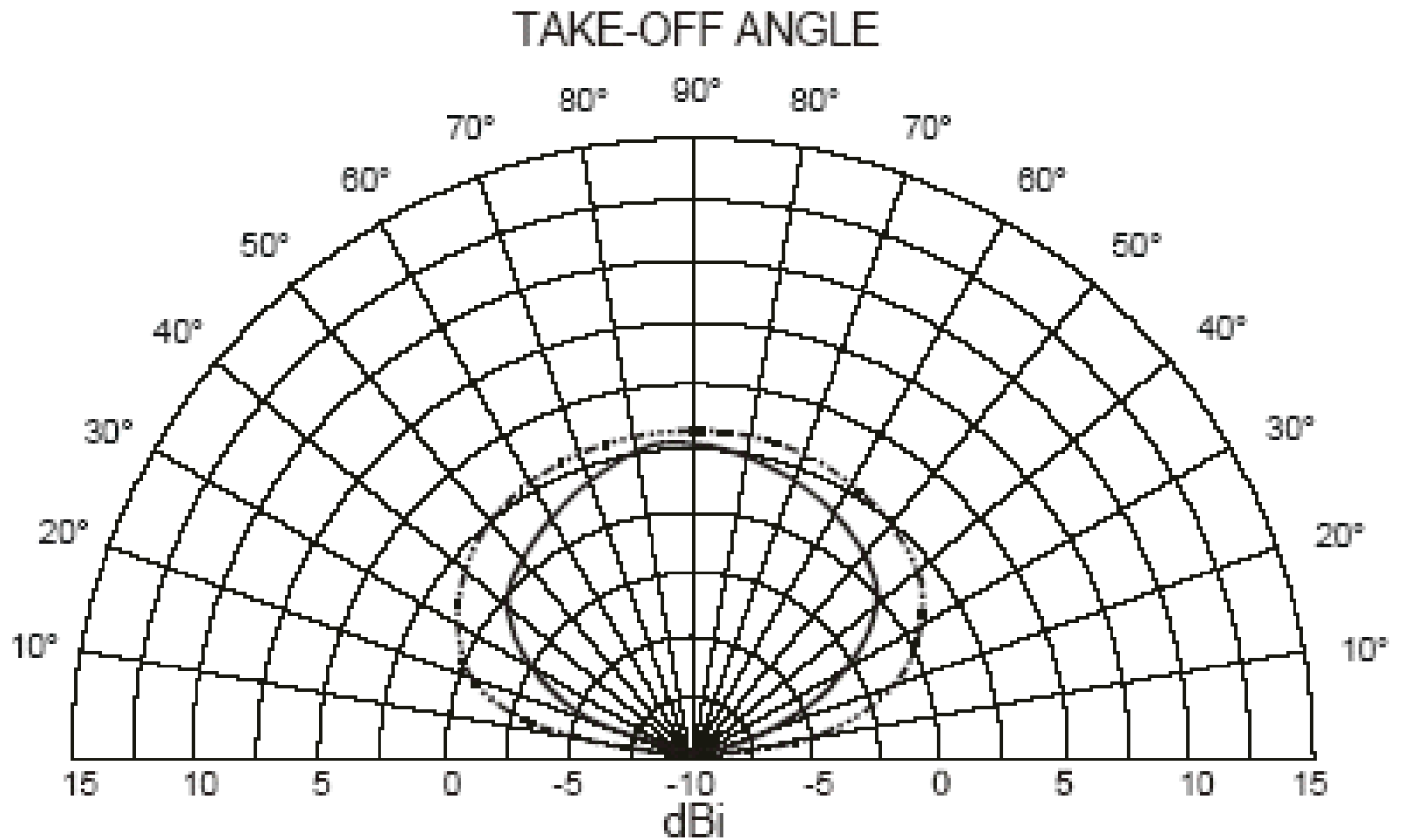
Frequency Range (MHz)	2.5 to 4.0	3.5 to 6.0	5.0 to 7.0
Horizontal Length (Feet)	150	100	80



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Inverted-L Antenna



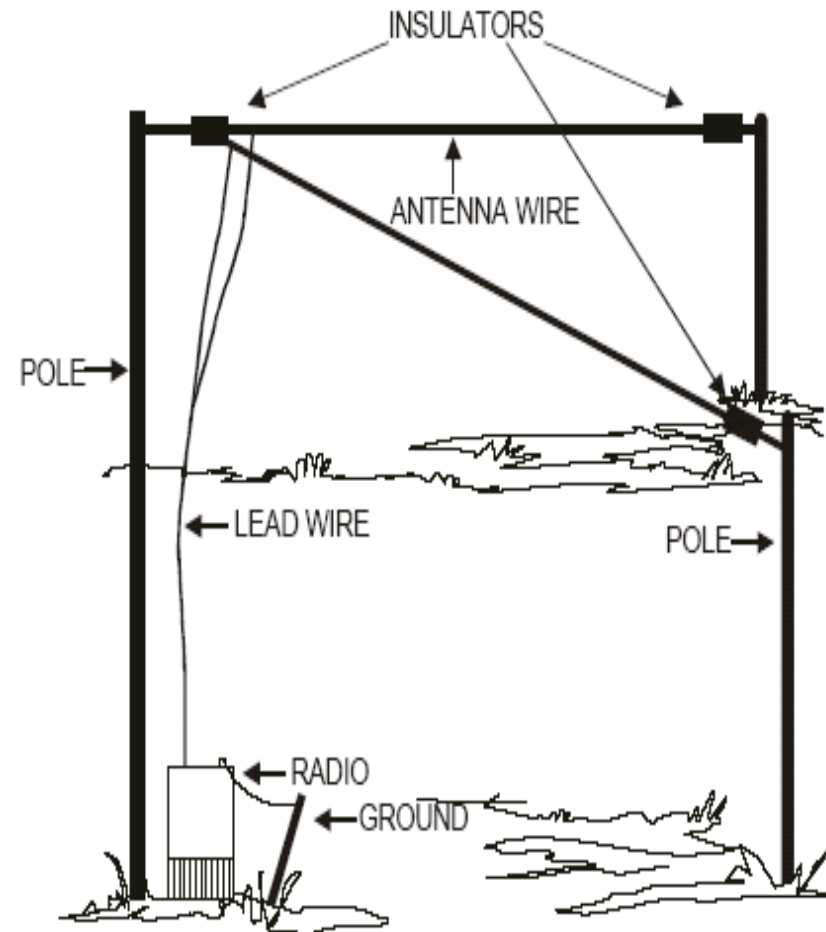


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Sloping-Vee Antenna

- **Medium- to long-range skywave propagation**
- **Antenna should be at least 1λ in length, 2 or more better**
- **To make directional, add 600π resistors on each leg.**

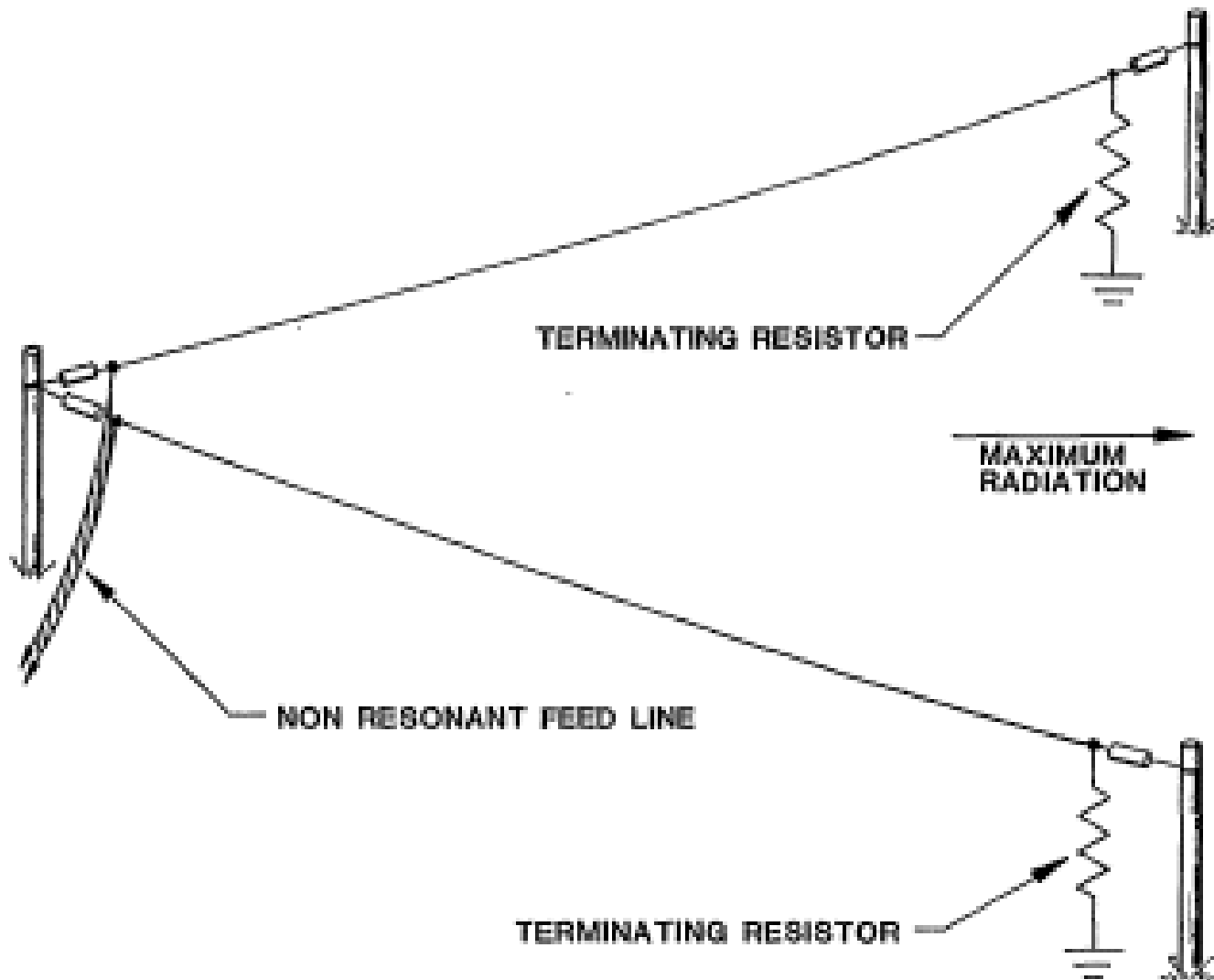




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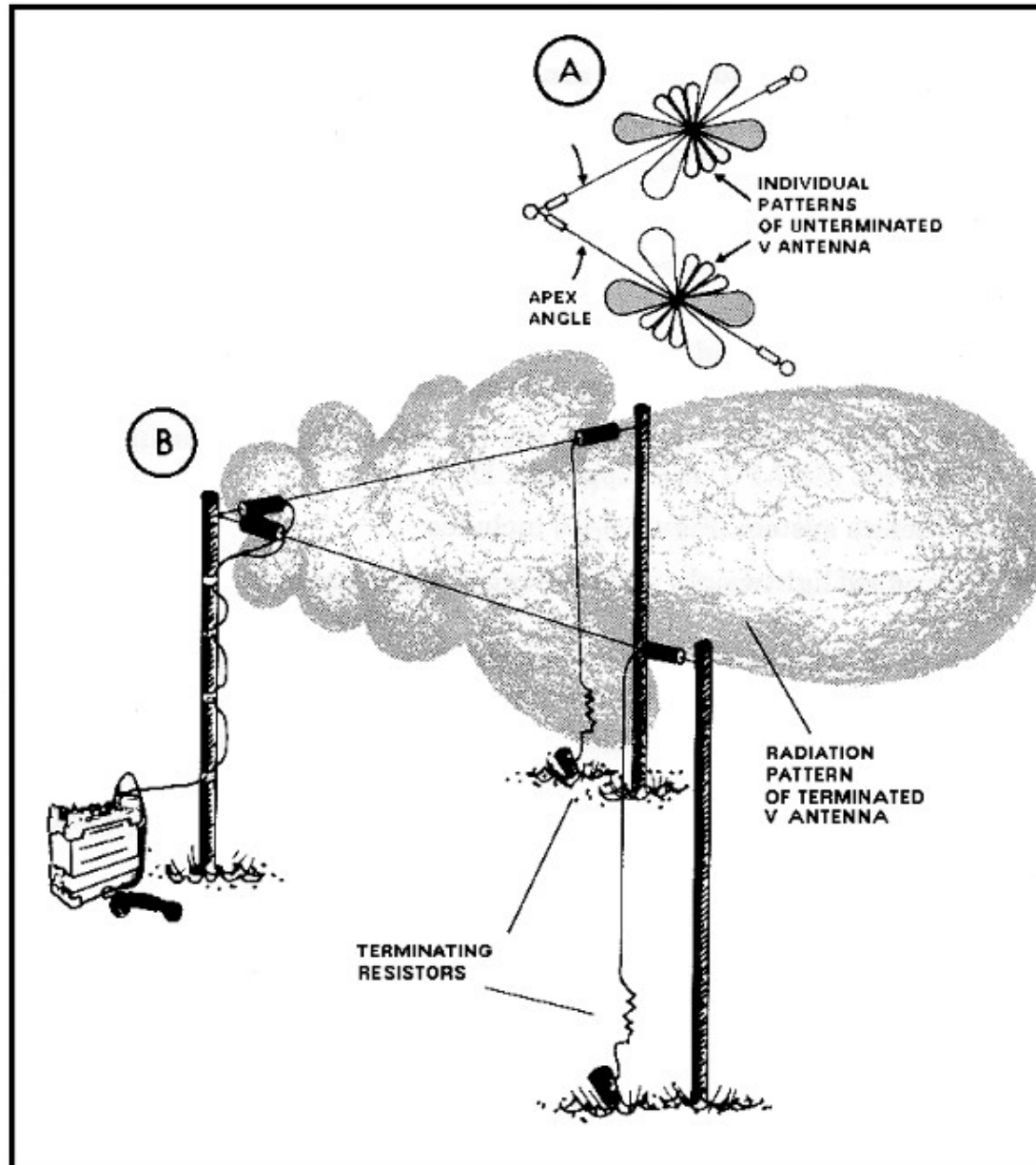


Terminated Sloping-V Antenna





Antenna Pattern – Terminated V





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Sloping-V Antenna Vertical Radiation Pattern

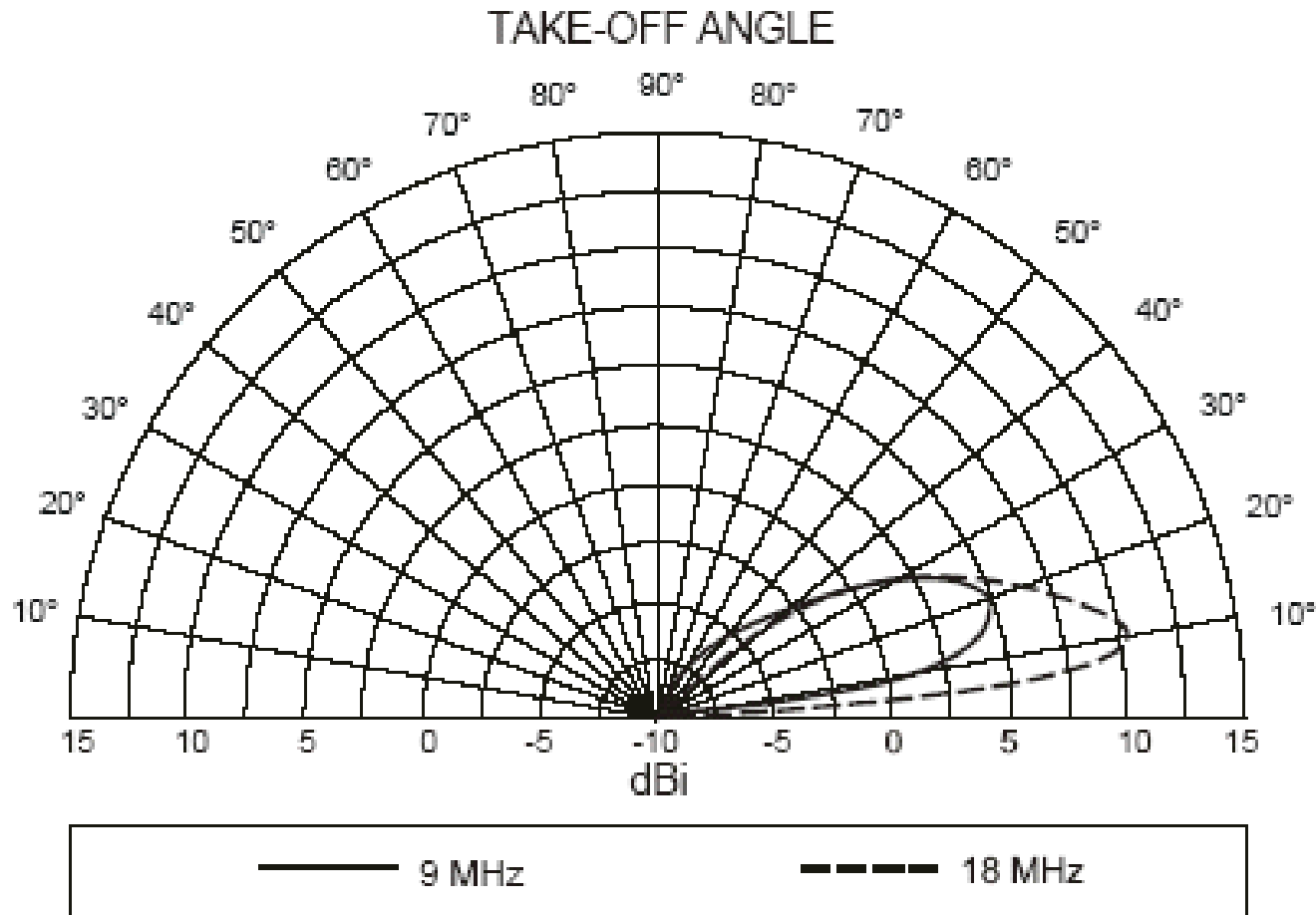


Figure 4-23. 40-Foot Sloping Vee (Vertical Pattern),
500 Feet Long, 30° Apex Angle.

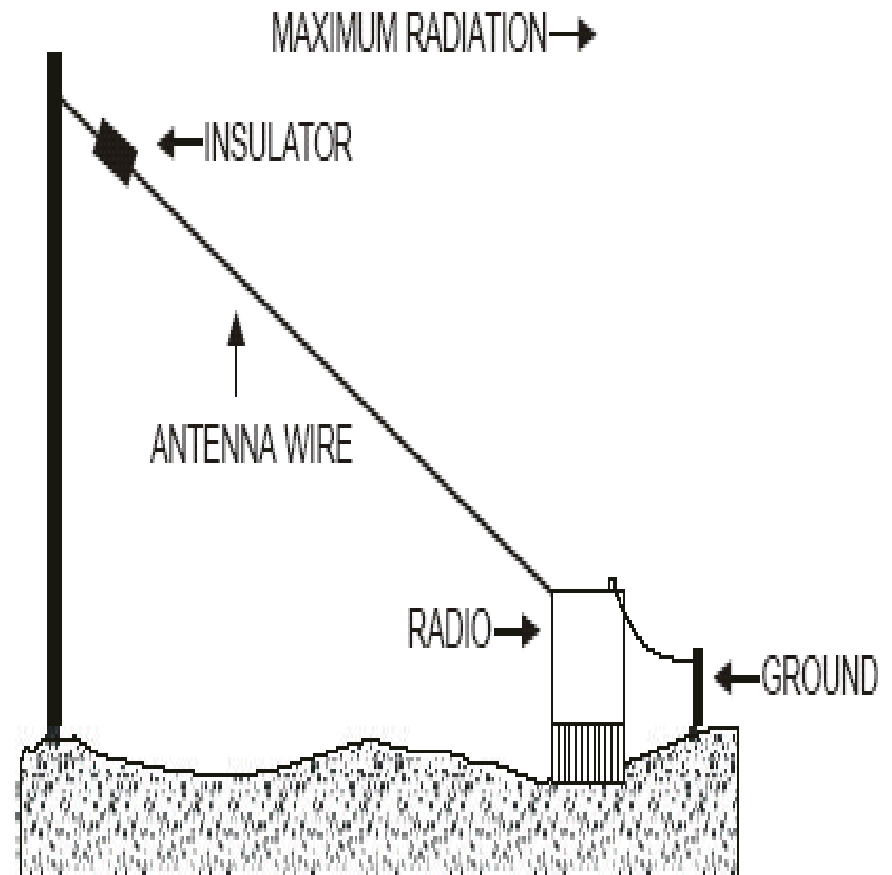


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Sloping-Wire Antenna

- **45 to 500-foot wire (longer is better)**
- **Poor performer at short lengths**
- **Can be terminated with resistor for improved tuning and directivity**

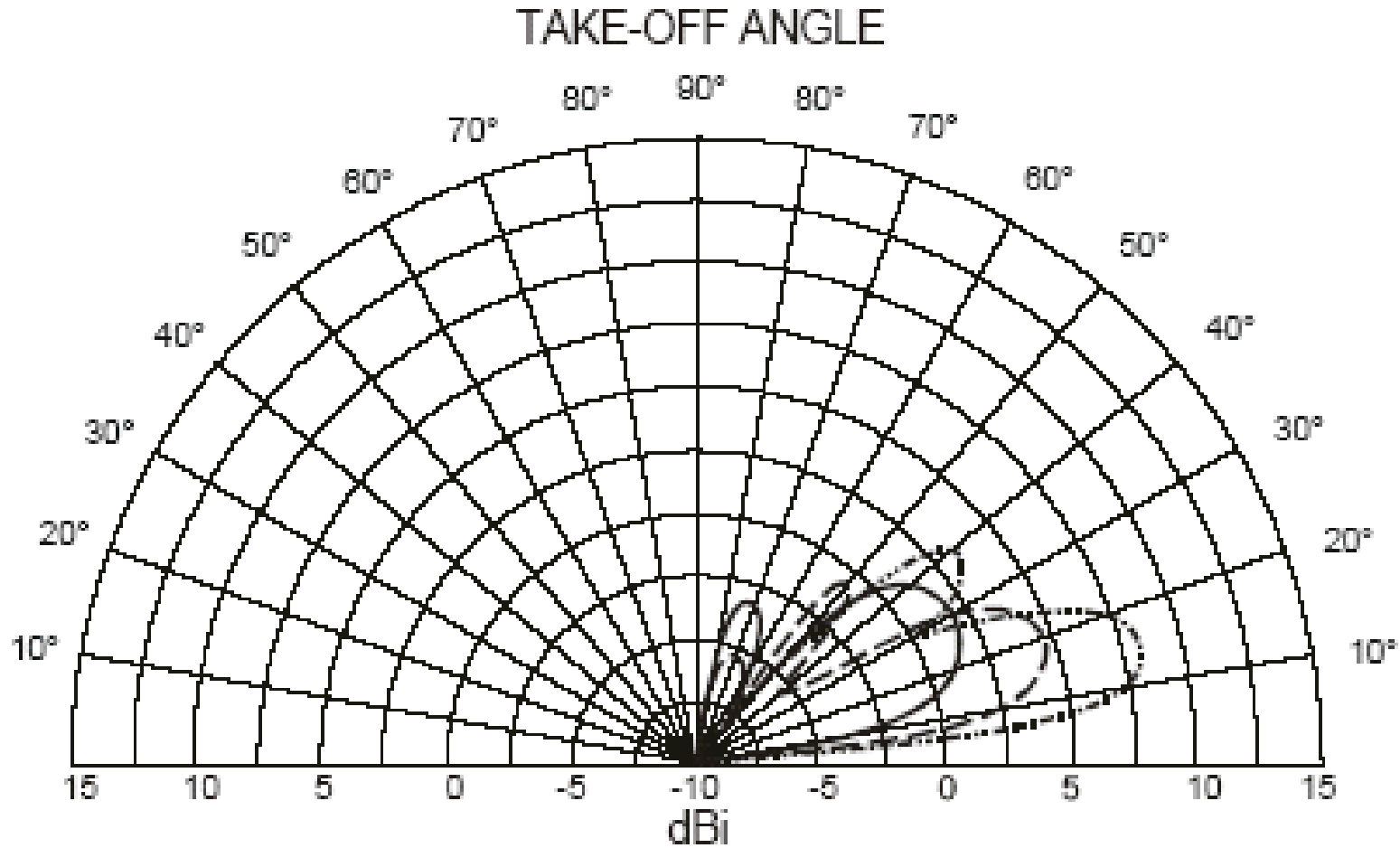




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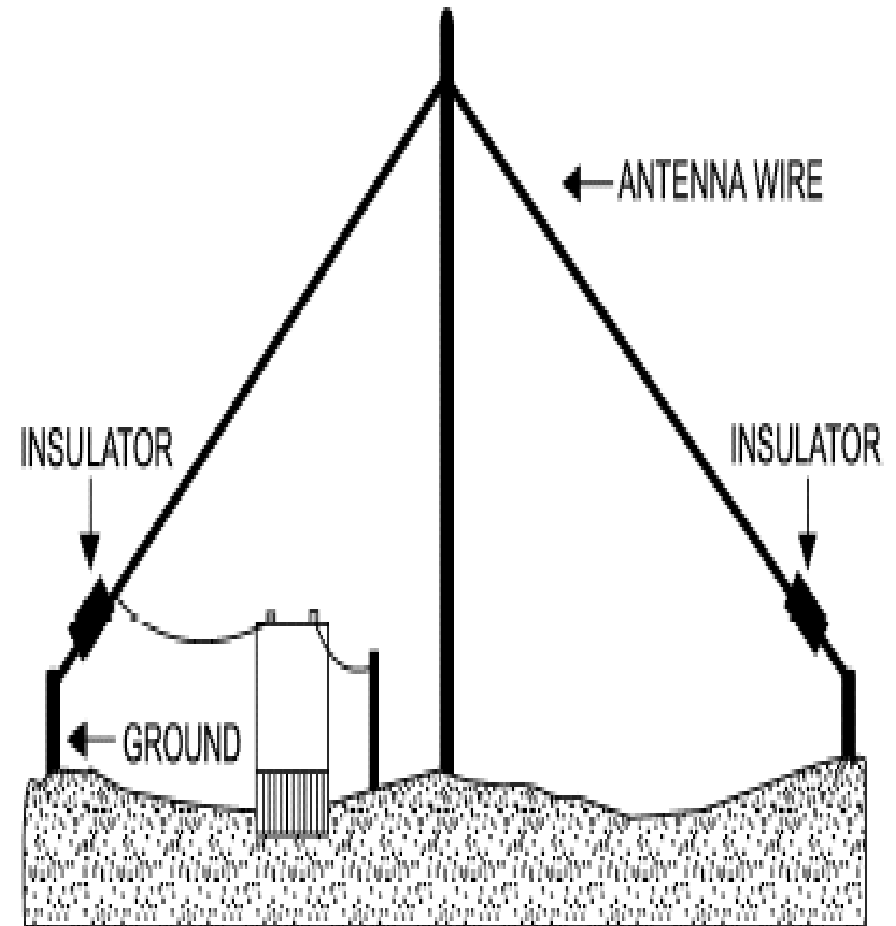
234-ft Sloping Wire Vertical Antenna Pattern





Vertical Half-Rhombic Antenna

- **Medium- to long-range skywave**
- **500 to 1000 ft lengths of great value**
- **Can be terminated for directivity**





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Vertical Half-Rhombic Vertical Antenna Pattern

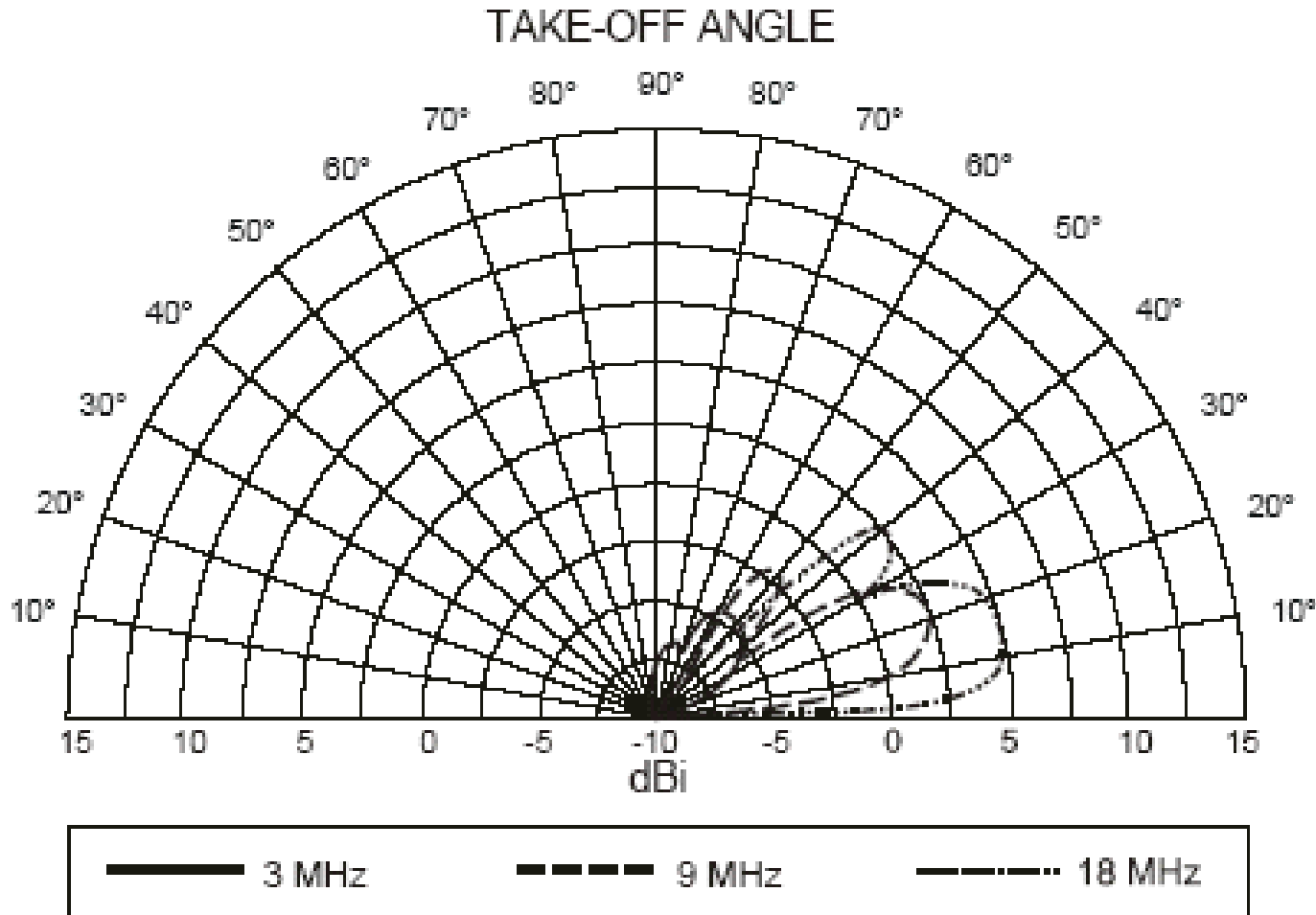
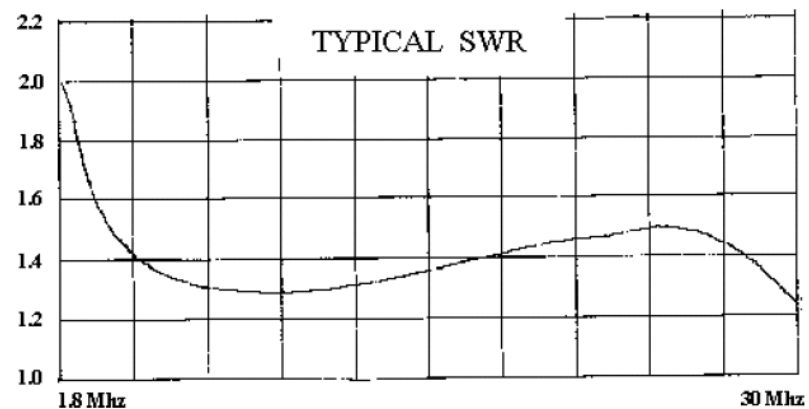
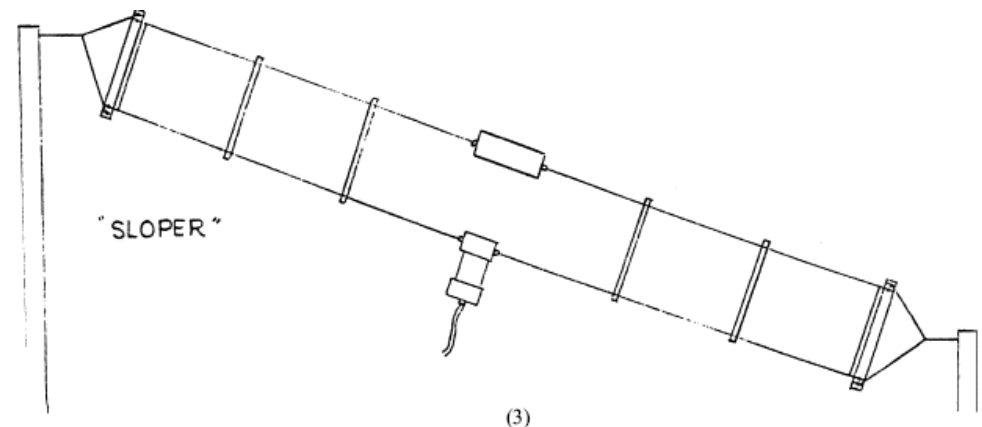
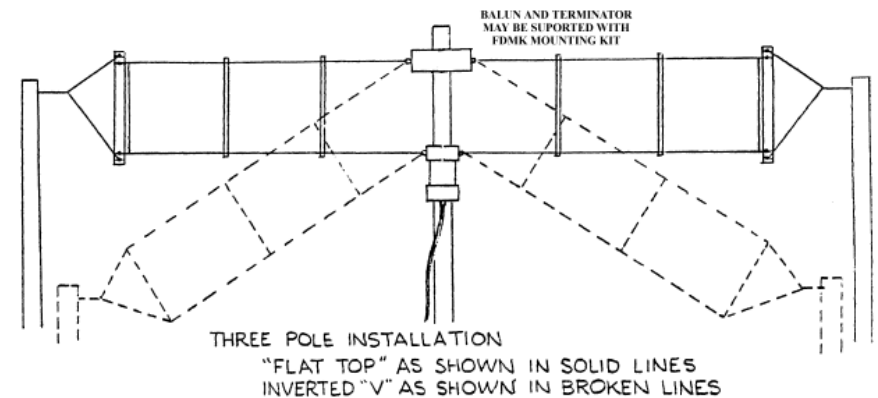


Figure 4-31. 50-Foot Vertical Half-Rhombic (Vertical Pattern),
500 Feet Long.



B&W Broadband Dipole

- Frequently found in garrison environments
- Broadband w/o use of tuners, 2-30 MHz (great for ALE or radios w/o tuners)
- Not very appropriate for portable installations (tends to form a large copper knot unless carefully stored and deployed)
- Not very efficient below 7 MHz
- Available in several lengths; original was 90 ft in length
- Can be installed as a sloper, flat top or inverted-V
- Integral balun and terminating resistor





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Flexible Antenna Kit

- **Feedline**

- 3 x 100 ft. RG-8X coaxial cable w/N-M connectors
- 2 F-F N adapters
- Adapters 2 ea. Of N-N Female, N-Female to UHF Male, BNC-Male to N Female
- Lightning/NEMP Protector w/N Female connectors (Polyphaser or Hüber-Suhner)

- **Grounding**

- 1 inch copper braid strap, 10 ft w/lugs (PRC-150 ground)
- 1 inch copper braid strap, 6 ft w/lugs (amplifier ground)
- Ground rod kit
- MK-2551 Surface Wire Grounding Kit



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Flexible Antenna Kit

- **AT-1011/U 32-ft Vertical Antenna Kit**
- **30 ea. 45 ft Radial Wires (14 AWG) w/Lug**
- **RF-382 Coupler w/Control Cable**
- **(3) pole sets (30-40 ft)**
- **Cobra Head**
- **4 ea. Insulators (plastic or ceramic dogbones)**
- **Balun, 1:1, HF Broadband (w/ appropriate power rating)**
- **2 ea. Wire, 14 AWG, 500 ft.**
- **50 ft Open-wire feeder (“Ladder Line”), 14 AWG**
- **100 ft 550 cord**
- **Electrical tape, Duct tape**
- **Basic Hand Tools, 100 ft. tape measure**

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