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AV-18HT
"Hy-Tower" Vertical Antenna
10,15,20,40, and 80 Meters

INSTRUCTION MANUAL

General Description

The "Hy-Tower" is an omnidirectional, self-supporting vertical radiator, which operates on 10 thru 80 meters. 160 meter operation is possible with the addition of a loading coil, as shown in Figure 13. The "Hy-Tower" is now supplied with stainless steel hardware.

The use of stub decoupling systems allows band switching on 10, 15, 20, 40, and 80

The stubs isolate various sections of the vertical antenna so that an electrical 1/4-wavelength (or odd multiple of 1/4-wavelength) exists on all bands. On 20 meters, the 80-meter section acts as a 3/4-wave radiator.

The tilting base of the "Hy-Tower" allows the antenna to be completely assembled on the ground before it is raised into position. It is light enough for one person to assemble and for two people to erect.

Specifications	
Mechanical	
Total Height	53 feet (16.15m) (approximately)
Tower Construction	Galvanized steel
Wind Survival	75 mph (120.7 kmph)
Hardware	Stainless steel
Electrical	
Pattern Characteristics	Omnidirectional
Gain	Unity on 20, 40, and 80 Meters
	2dB on 10 and 15 Meters
Input Impedance	50 ohms
Input Power	1 kW AM; 2 kW PEP

Revision 3

Pre-Assembly

NOTE: When unpacking your antenna, check the inside of all tubing for parts. To conserve space, the smaller items are sometimes put inside larger pieces.

Model 18-HT-S has three (3) 8 foot tower sections and an aluminum tubing mast. For maximum security, the tower section should be set in a concrete base. The concrete must cure for at least three (3) days before the tower is set in place.

Read the instructions and study the illustrations before beginning your installation.

Qty	Type Tool	Qty	Type Tool
1	Screwdriver-flat blade	1	Open-End Wrench, 7/16"
1	Tin Snips **(or Lineman's Pliers)**	1	Ratchet handle for Socket Wrenches
1	Tape Measure, 50 foot	1	Socket Wrench, 1/2"
2	Adjustable Wrenches, 8"	1	Socket Wrench, 9/16"
1	Nut Driver, 716"	1	Open or Box End Wrench, 9/16"

The Model 18-HT -S can be used with 50 ohm coaxial cable such as RG-213/U or RG-58A/U. Coaxial cable RG-213/U (such as BELDEN 8267) is recommended for its lower line losses and higher power handling capabilities. The SWR at resonance is less than 1.2:1 and will not exceed 3.5:1 over the entire range of each band.

Find a convenient location for the 18-HTS "HyTower" antenna. It should be installed away from any power lines and should be *at least 10 feet* from any metallic structure. Be sure to allow approximately 50 feet in one direction from the base for assembly of the antenna and tower.

WARNING

When installing your system, take extreme care to avoid any accidental contact with power lines or overhead obstructions. Failure to exercise this case could result in serious or fatal injury.

Dig a hole 3 feet square by 3 feet deep for the ; concrete base as shown in Figure 1.

NOTE: The depth of the base foundation will vary depending upon climate conditions. It should extend at least 6" below the frost line. It should never be less than 3 feet.

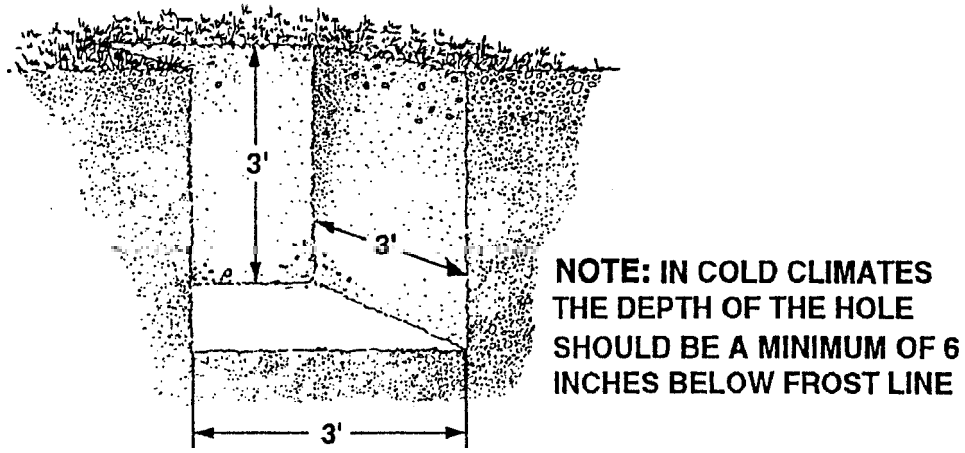


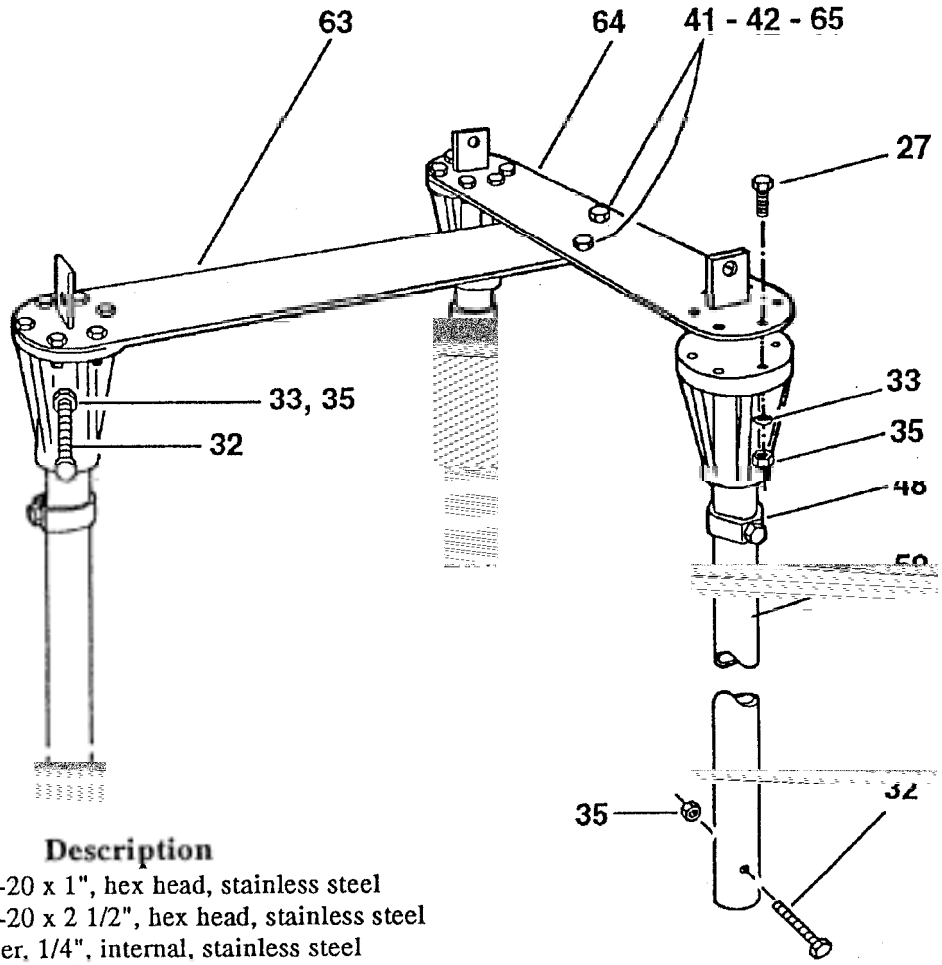
Figure 1
Base Foundation Hole

Assemble base assemblies "A" and "B" using 3/8"-16 hardware. See Figure 2.

Install the three base insulator assemblies (with pipe legs attached) on the base assemblies, using 1/4"-20 hardware. See Figure 2.

Install the Three (3) 1 1/4" compression clamps onto the pipe legs and position them near the insulators as 'shown in Figure 2. Tighten the clamps just enough to hold them in position. Refer to Figure 5 for compression clamp instructions.

Install the 1/4"-20 x 2 1/2" hex head bolts and nuts on the bottom of each base insulator assembly. This bolt will help to anchor each leg in the concrete. See Figure 2.



	Description
27	Bolt, 1/4"-20 x 1", hex head, stainless steel
32	Bolt, 1/4"-20 x 2 1/2", hex head, stainless steel
33	Lockwasher, 1/4", internal, stainless steel
35	Nut, 1/4"-20, hex, stainless steel
41	Bolt, 3/8"-16 x 1", hex head, stainless steel
42	Lockwasher, 3/8", internal, stainless steel
48	Clamp, compression, 1 1/4"
59	Base tube assembly
63	Base Assembly "B"
64	Base Assembly "A"
65	Nut, 3/8"-16, hex, stainless steel

Figure 2
Tower Base

Pour a standard mix of concrete (five parts sand, one part cement) into the hole until it reaches ground level. Vibrate the concrete during the pouring to eliminate voids.

NOTE: For extra security, steel reinforcing rods can be added to the base before the concrete is poured.

Insert the base assembly, with legs attached, into the concrete base until approximately six inches remain above the concrete, as shown in Figure 3. Position the assembly so that the tower can hinge on base assembly "A".

CAUTION

The base assembly must be assembled level so that the tower will be vertical when it is installed. Support the base assembly above the concrete in the manner shown in Figure 3 while the concrete is curing.

An easy method to ensure a level base involves using a low-cost string level. Loop a length of string through the three (3) holes on the standoffs above the two (2) base assemblies. Apply tension until taut, then tie it off. Hook the string level onto each part of the string and adjust the tower base so that each string is level.

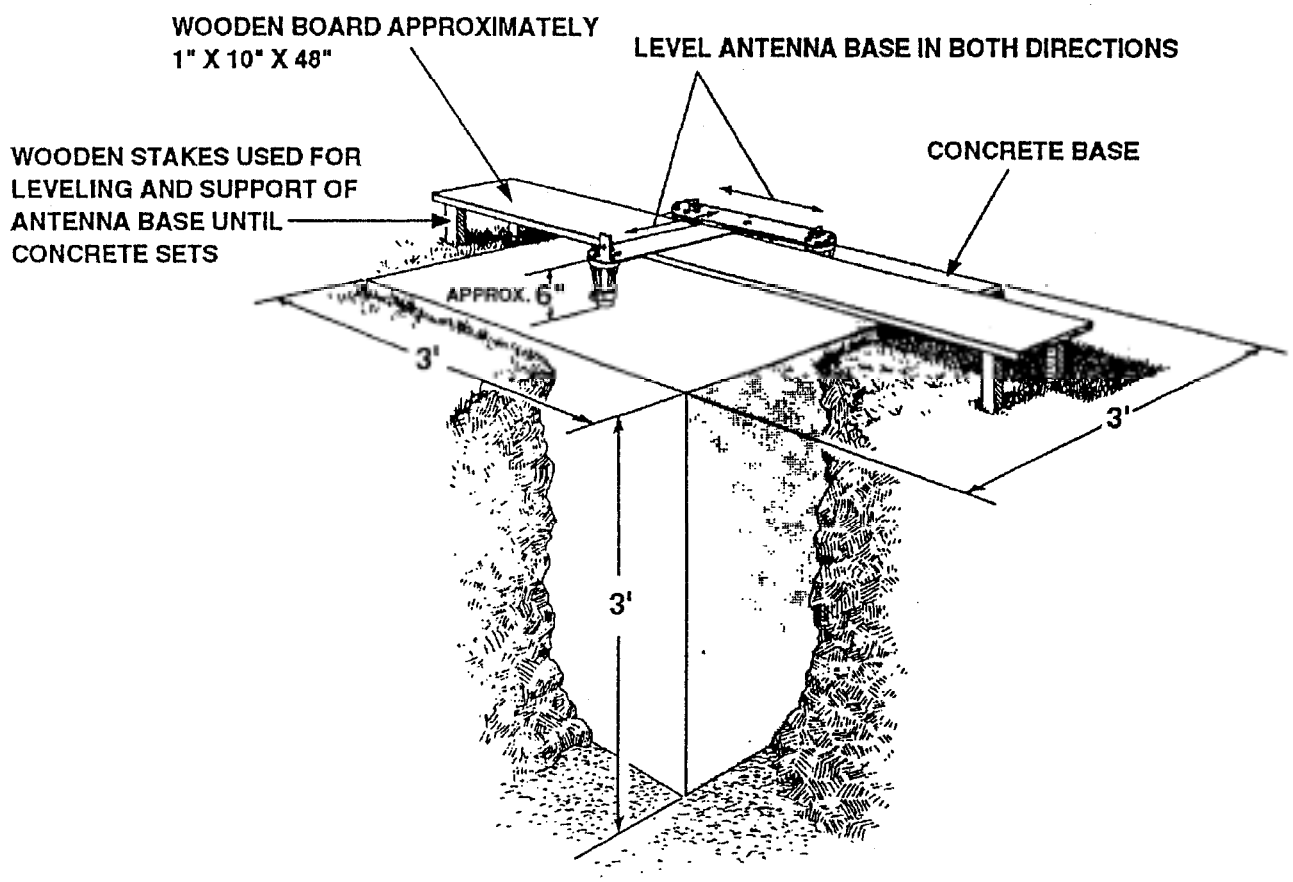


Figure 3
Tower Base Installation

Assembly of the Tower

Remove the shipping straps from the tower assembly.

Assemble the three tower sections by placing each succeeding smaller tower section into the next larger section.

Secure the tower legs using two (2) 3/8" x 3/4" hex bolts per splice. The nuts (12) and bolts (12) are packed in the carton containing tubes and hardware.

Install the tower leg hinges and braces onto two tower legs as shown in Figure 4.

Item No.	Description
15	Plate, leg backing 3/4" x 5 3/4"
16	Hinge, tower, formed
41	Bolt, 3/8"-16 x 1", hex head, stainless steel
42	Lockwasher, 3/8", internal
65	Nut, 3/8"-16, hex, stainless steel

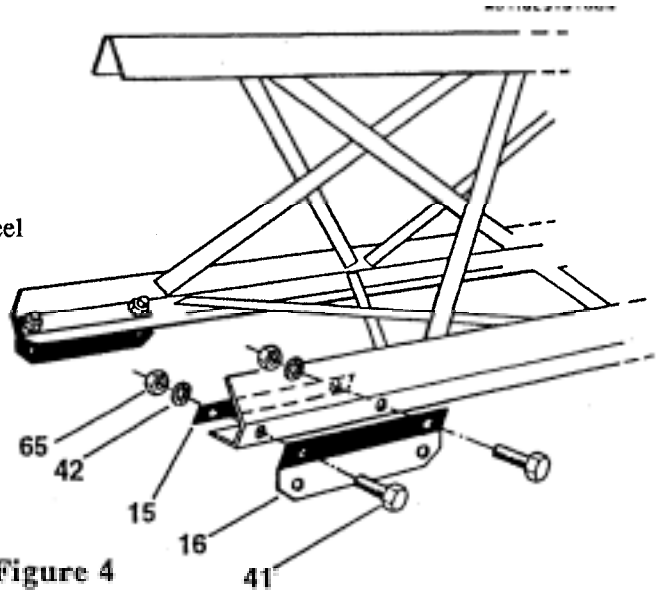


Figure 4

Tower Leg Hinge Installation

Installation of Tubing Clamps

Select the proper size tube clamp as shown in the chart. (See Figure 5B). When installing the clamps, place the clamp near the tube end with the top of the clamp over the slot in the tube as shown in Figure 5A.

After adjustment of the tubing lengths, tighten the clamp with a 5/16 inch nut driver, socket, or open end wrench until the tubing will not twist or telescope.

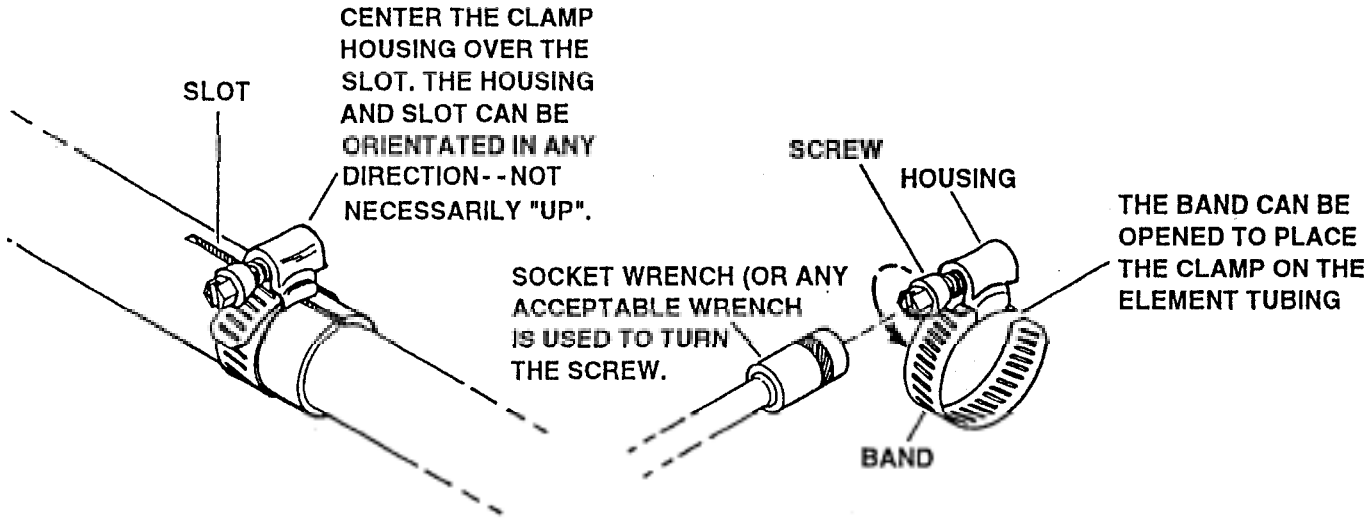
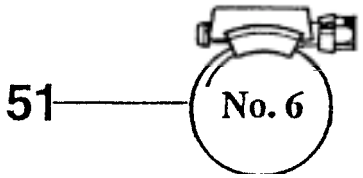
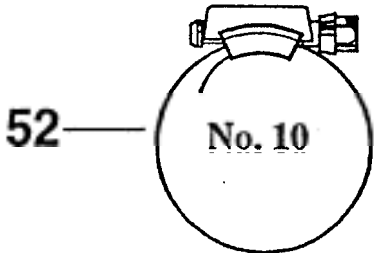


Figure 5A

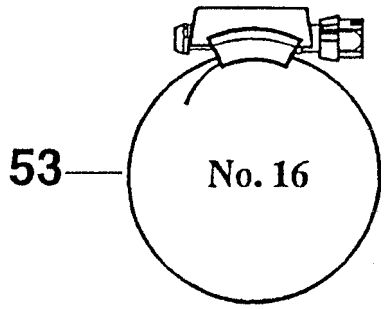
Installation of Tubing Clamps



Part No.	Description	Fits Tubing Sizes
358756	Clamp, Size #6 all stainless steel 5/16" hex head screw	7/16",1/2", 5/8" and 3/4"



Part No.	Description	Fits Tubing Sizes
358757	Clamp, Size #10 all stainless steel 5/16 hex head screw	3/4", 7/8" and 1"



Part No.	Description	Fits Tubing Sizes
358758	Clamp, Size #16 all stainless steel 5/16 hex head screw	1",11/8" and 11/4"

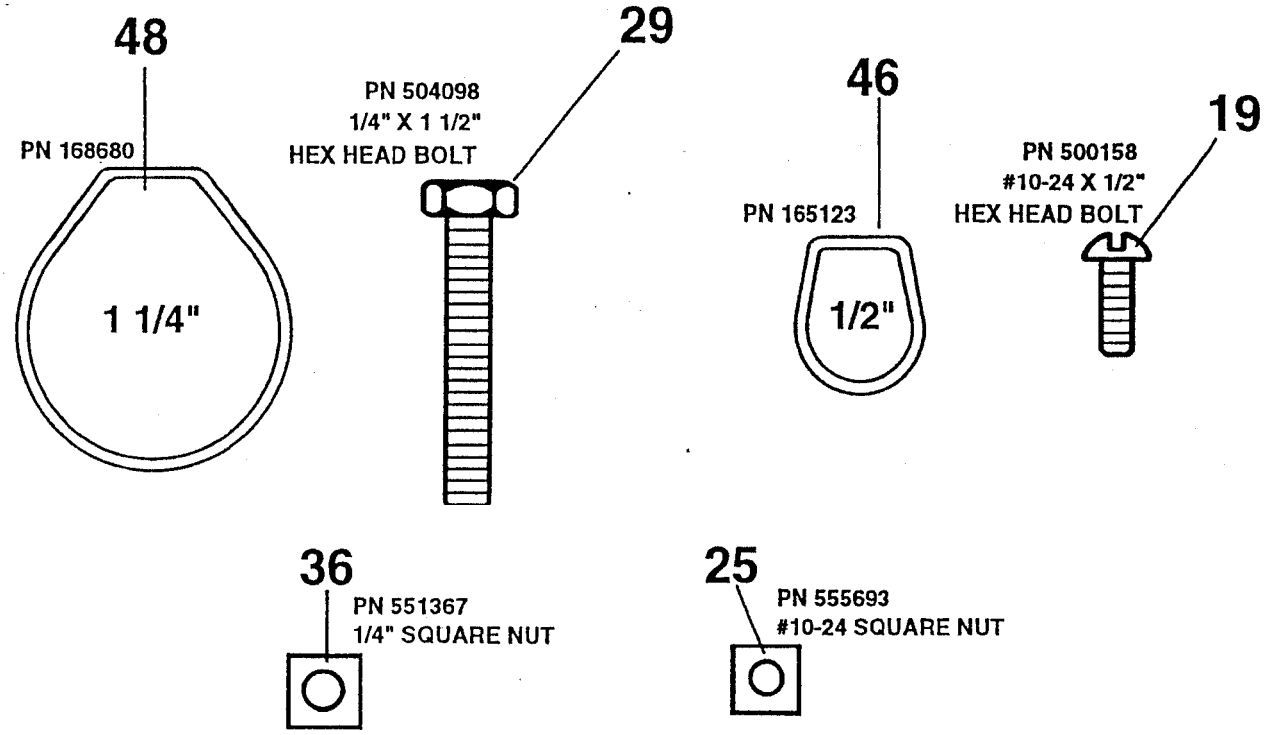


Figure 5B

Tubing and Compression

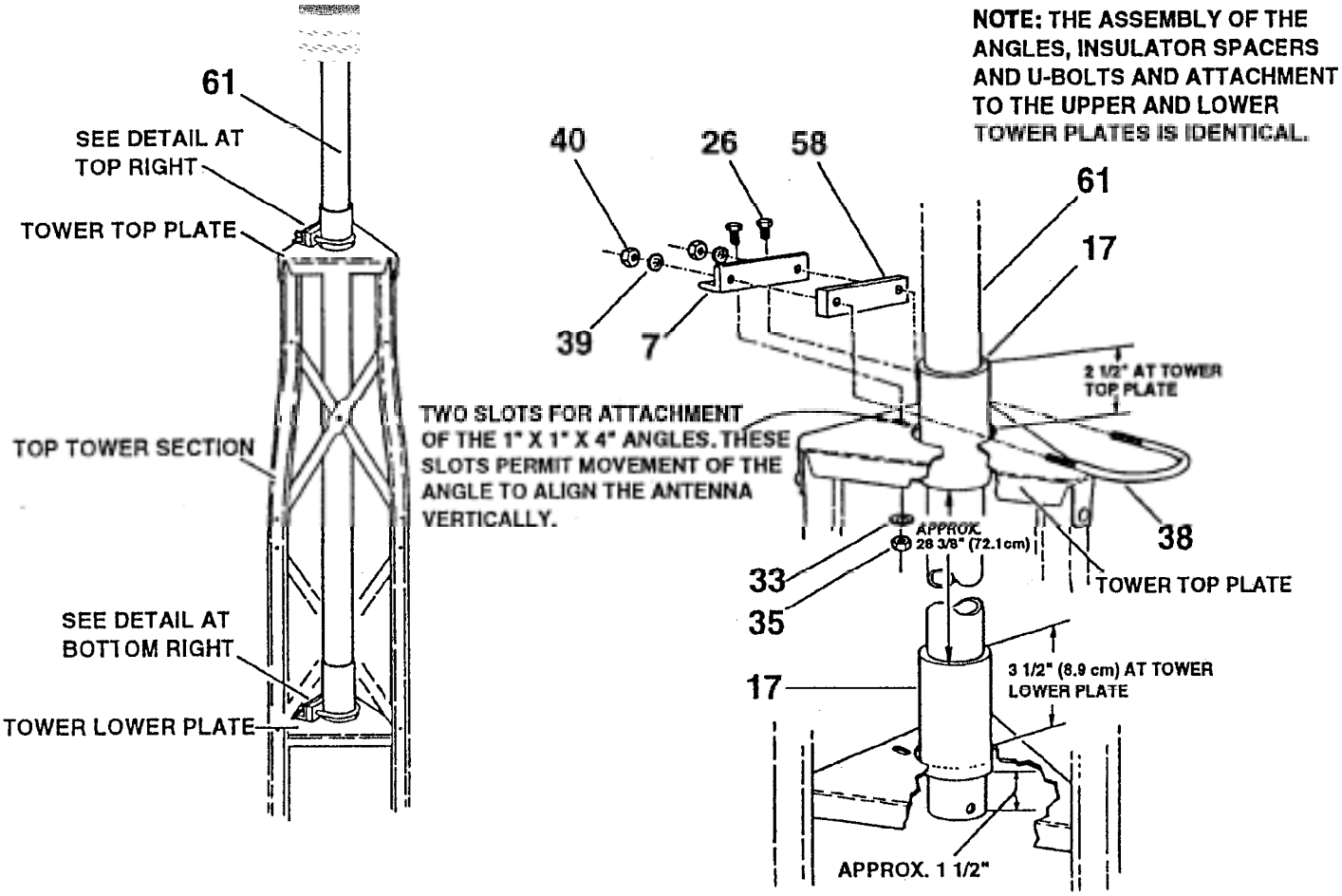
Assembly of Vertical Radiator

Attach one 4" metal angle to the lower -tower plate and one to the upper tower plate using two (2) 1/4"-20 x 3/4" screws for each angle. Do *not tighten the screws at this time.*

Select the two (2) U-bolts and spacer insulators and place them in the holes provided on the 4" metal angles attached to the top tower section. See Figure 6.

Select the 2" x 75" length of aluminum tubing and place the two (2) 2" ID x 3 7/8" insulators over the end of the tubing which has the metal sleeves inserted in it.

Adjust the insulators so that they are approximately 28 3/8" apart, with the bottom one approximately 1 1/2" from the end of the tubing (the end with the metal sleeve).



Item No.	Description
7	Angle, vertical element, 1" x 1" x 4"
17	Insulator, 2" I.D. x 3 7/8"
26	Bolt, 1/4"-20 x 3/4", hex head, stainless steel
33	Lockwasher, 1/4", internal, stainless steel
35	Nut, 1/4"-20, hex, stainless steel

Item No.	Description
38	U-Bolt, 5/16" x 3" x 3 11/16"
39	Lockwasher, split, 5/16", stainless steel
40	Nut, 5/16"-18, hex
58	Insulator, vertical element spacer, 1" x 4"
61	Assembly, tube with dowel, 2" x 75"

Figure 6

Top Element Installation

Slide the 2" x 75" length of tubing (the end with the insulators attached) through the upper and lower plate of the top tower section as shown in Figure 6. *Do not tighten the U-bolts*

Select the 2" x 51" section of tubing and slip the drilled end over the swaged end, of the 2" x 75" piece of tubing. Align the holes and secure with the 1/4"-20 x 2 1/2" screw, nut and lockwasher as shown in Figure 7.

Select the reducer clamps and install on the end of the 2" tubing, using #10 x 1/2" screws, lockwashers and nuts. *Do not tighten at this time.*

Carefully adjust the partially assembled vertical radiator until you measure 90 1/2" from the top edge of the top tower plate to the top edge of the reducer clamp. Refer to Figure 7.

Position the two insulators on the 2" tubing as shown in Figure 6, then tighten the U-bolts evenly. The insulators must be positioned as shown to properly insulate the tubing section from the tower.

Slide the metal angles in the elongated holes to position the tubing section until the tube is perfectly aligned with the axis of the tower. Tighten the screws *securely!*

NOTE: You may wish to assemble the remainder of the vertical radiator separately and install on the antenna immediately before raising the antenna to its vertical position. This will avoid allowing the tubing to droop and permanently "set" in this condition.

Select the 1 1/4" x 48" piece of tubing, mark at 9" from the end and slip it 9" into the 2" tube assembled in the tower, so that 36 5/8" (93.02 cm) remain exposed above the reducer clamp. See Figure 7.

Select a #16 tubing clamp and slip it over the end of the 1 1/4" tube. Select the 1 1/8" x 38" tube and insert it into the 1 1/4" tube so the swaged end is 33 3/4" (85.72 cm) from the end of the 1 1/4" tube. See Figure 7.

Select a #10 tubing clamp and slip it over the end of the 1 1/8" tube. Refer to Figure 5A for proper placement.

Select the 7/8" x 72" piece of tubing and slip the unswaged end into the swaged end of the 1 1/8" tube. Measure 64 1/2" (163.8 cm) from the end of the 1 1/8" tubing to the end of the 7/8" tubing. Tighten the clamp. See Figure 7.

Slip a #6 tubing clamp over the end of the 7/8" tubing. Tighten slightly.

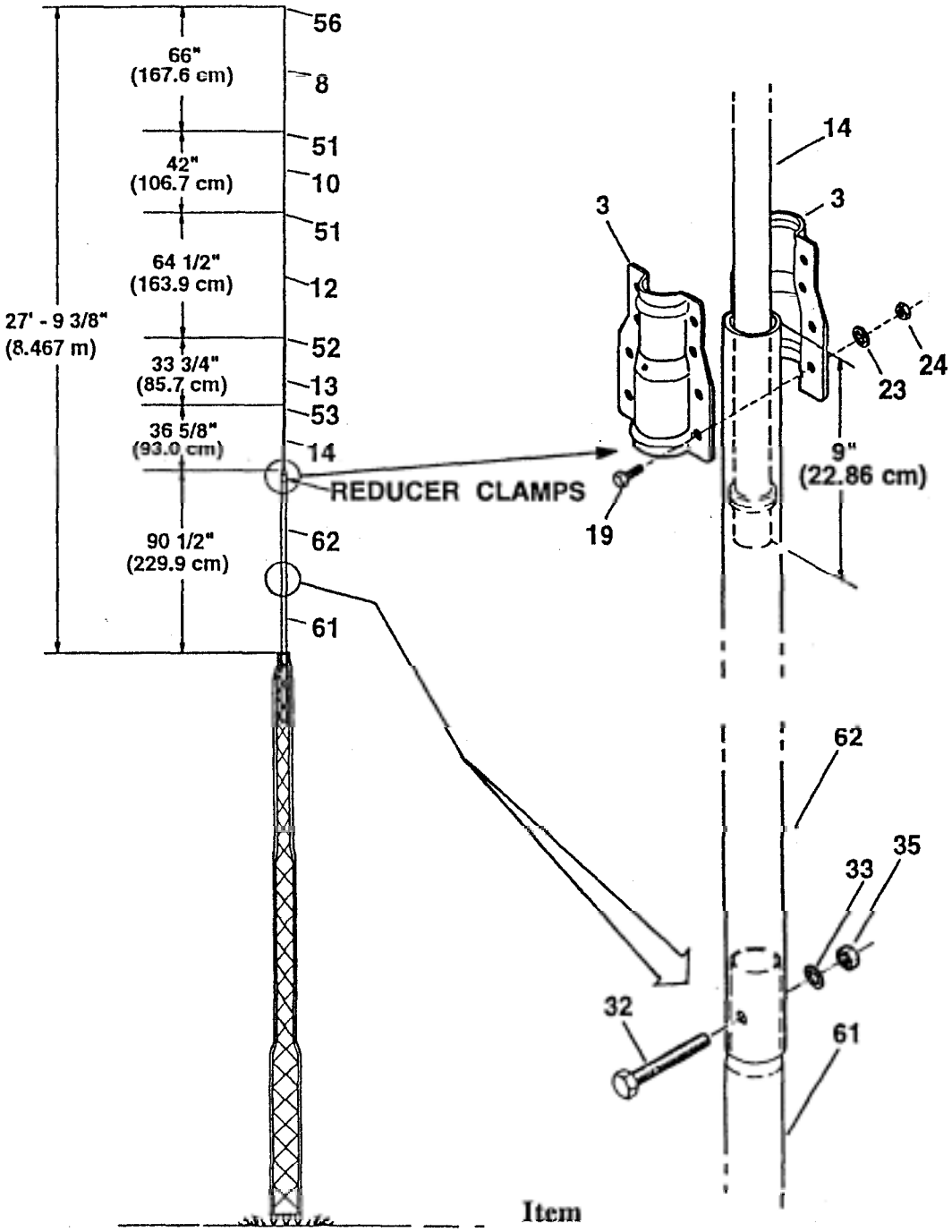
Select the 5/8" x 48" piece of tubing and slip the unswaged end into the 7/8" tubing. Measure 42" (106.7 cm) from the end of the 7/8" tube to the end of the 5/8" tube. See Figure 7.

Slip a #6 tubing clamp over the end of the 5/8" tubing. Tighten slightly.

Select the 7/16" x 68" piece of tubing and slip it into the 5/8" tube. Measure 66" (167.6 cm) from the end of the 5/8" tube to the end of the 7/16" tube. See Figure 7.

Check the overall dimension of the vertical radiator. It should be 27'9 3/8" (3.47 m) from the top of the upper tower plate to the end of the radiator. If it is not, adjust the 7/16" tubing accordingly. Now tighten the compression clamps *securely.*

Place a 7/16" caplug on the end of the vertical radiator.



Item No.	Description	Item No.	Description
3	Clamp, reducer, 2" to 1 1/4", formed	33	Lockwasher, internal, 1/4", stainless steel
8	Tube, 7/16" x 68"	35	Nut, 1/4"-20, hex, stainless steel
10	Tube, 5/8" x 48", swaged	51	Clamp, #6 tubing, stainless steel
12	Tube, 7/8" x 72", swaged	52	Clamp, #10 tubing, stainless steel
13	Tube, 1 1/8" x 38", swaged	53	Clamp, #16 tubing, stainless steel
14	Tube, 1 1/4" x 48", slotted	56	Caplug, 7/16", black
19	Bolt, #10-24 x 1/2", hex head, stainless steel	61	Tube Assembly with dowel, 2" x 75"
23	Lockwasher, internal, #10, stainless steel	62	Tube/Shim Assembly, 2" x 51"
24	Nut, #10-24, hex, stainless steel		
32	Bolt, 1/4"-20 x 2 1/2", hex head, stainless steel		

Figure 7

Vertical Radiator Assembly

Installation of 15-Meter Stub

Select a 7/16" x 60" piece of tubing and fasten one end to one leg of the base tower section using the clamps and shorting strap, as shown in Figure 8. Position the stub 67" (see Figure 16) from the bottom edge of the tower leg to the bottom edge of the 7/16" tube. Refer to Figure 8 for dimensions and Figure 10 for installation of clamps and shorting strap.

Assemble another leg clamp, insulator and splice and install the second 7/16" x 60" section of tubing onto the 15-meter stub as shown in Figure 8.

Install a leg clamp, insulator and tubing clamp

Select the 5/16"x 23" section of tubing and slip it into the 7/16" tuba. Adjust to either Phone (19") or CW (21-1/4") dimension as shown in Figure 8. Install a ½" compression clamp, line up the screw with the hole on the 7/16 tube and tighten securely.

NOTE: Typical VSWR curves are shown in Figure 16. The 10- and 15-meter stubs require two settings to cover the bands with less than 2:1 VSWR. Use the VSWR curves to help you decide which setting is best for your particular application.

Place 5/16" caplug on the end of the 15-meter stub.

Installation of 10-Meter Stub

Select the remaining 7/16" x 60" piece of tubing and fasten one end to one of the remaining tower legs, as shown in Figure 9, using a set of leg clamps and a ,shorting strap.

Position the bottom edge of the stub 160" (see Figure 16) from the bottom edge of the lower tower leg. Refer to Figure 9 for dimensions and Figure 10' for installation of the clamps and shorting strap.

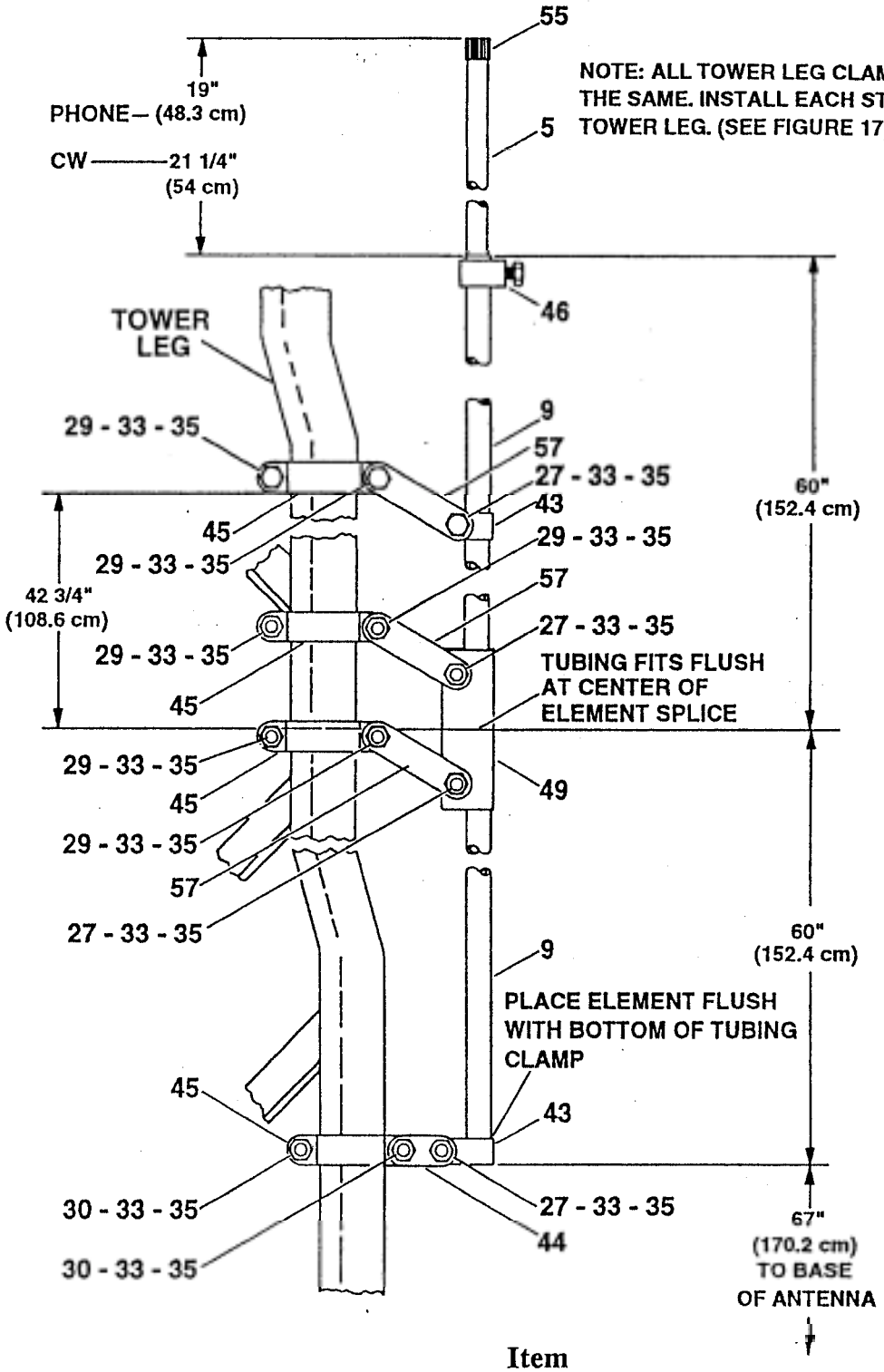
Select the 7/16" x 38" section of tubing and install as shown in Figures 9 and 10.

Install a leg clamp, insulator and tubing clamp

Select the 5/16" x 9-1/2 section of tubing and slip it into the 7/16" tubing. Adjust for Phone (3") or CW (5") dimension as shown in Figure 9. Refer to Figure 16, VSWR Charts.
Install a ½" compression clamp, line up the screw with the hole on the 7/16 tube and tighten

NOTE: The 10-and 15-meter stubs can be set independently. One can be set for CW and one for Phone, or they can both be adjusted for the same mode. If you wish to adjust a stub for any particular frequency within an band, this can be done experimentally.

Place a 5/16"caplug on the end of the 10-meter stub.

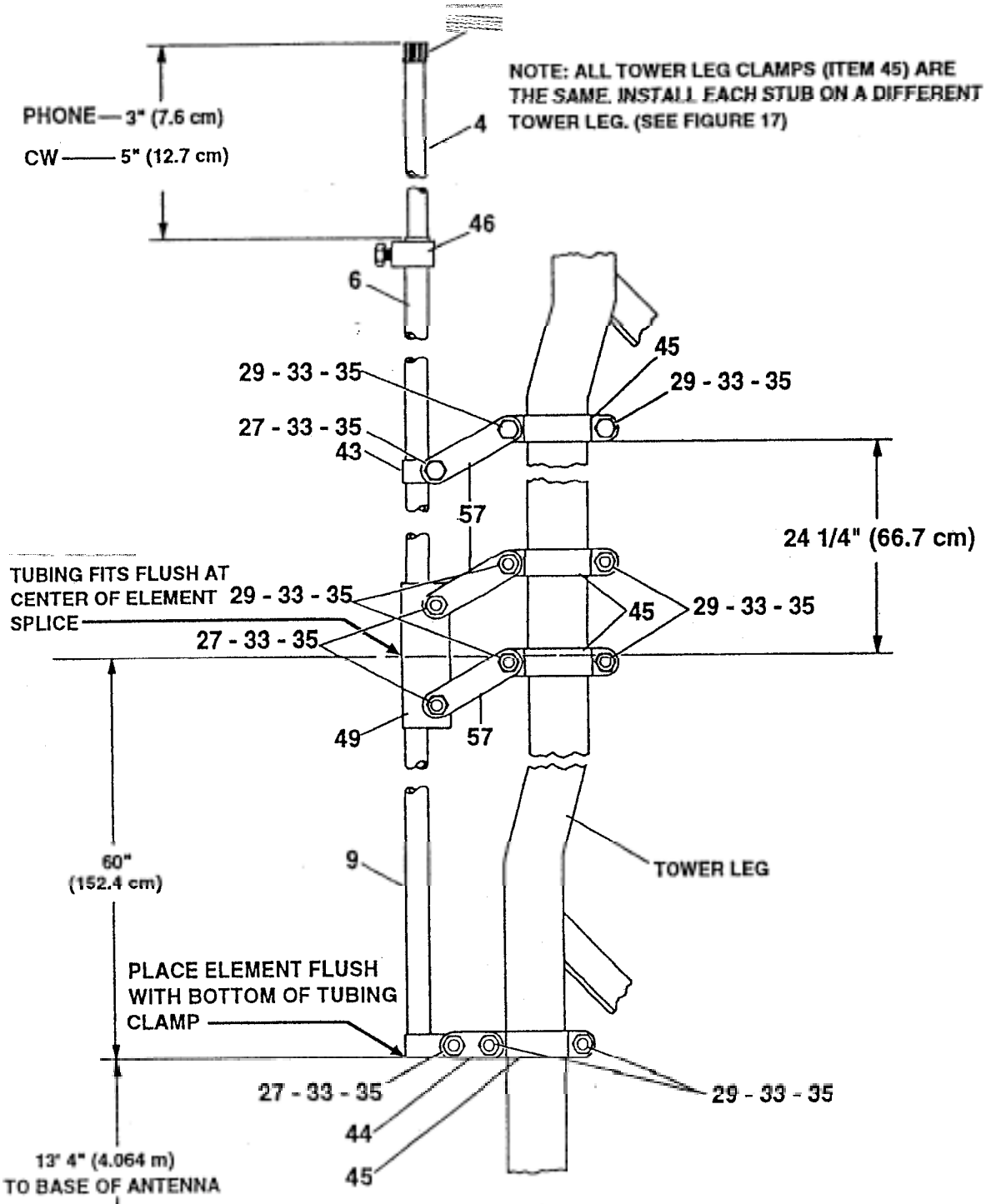


Item No.	Description
5	Tube, 5/16 x 23"
9	Tube, 7/16" x 60"
27	Bolt, 1/4"-20 x 1", hex head, stainless steel
29	Bolt, 1/4"-20 x 1 1/2", hex head, stainless steel
30	Bolt, 1/4"-20 x 1 3/4", hex head, stainless steel
33	Lockwasher, internal, 1/4", stainless steel
35	Nut, 1/4"-20, hex, stainless steel

Item No.	Description
43	Clamp, tubing, 7/16" I.D.
44	Strap, shorting, 5/8" x 1 1/2"
45	Clamp, leg, 5/8" x 3 1/2", formed
46	Clamp, compression, 1/2"
49	Element Splice
55	Caplug, 5/16"
57	Insulator, decoupling stub, 5/8" x 2 15/16"

Figure 8

15-Meter Stub

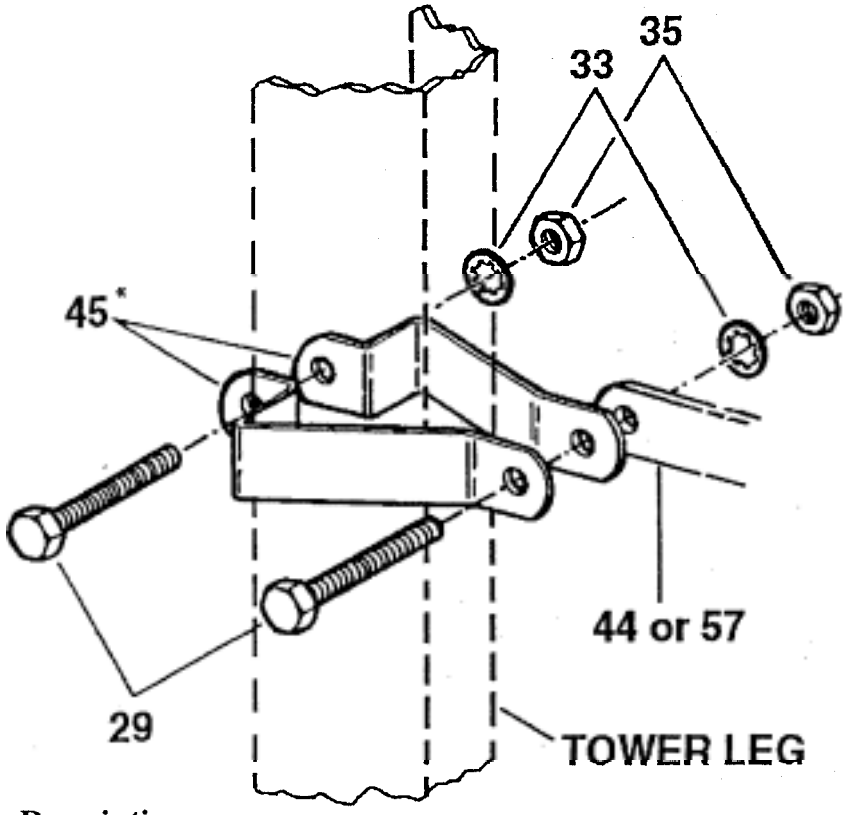


Item No.	Description
4	Tube, 5/16 x 9-1/2"
6	Tube, 7/16" x 38"
9	Tube, 7/16" x 60"
27	Bolt, 1/4"-20 x 1", hex head, stainless steel
29	Bolt, 1/4"-20 x 1 1/2", hex head, stainless steel
33	Lockwasher, internal, 1/4", stainless steel
35	Nut, 1/4"-20, hex, stainless steel

Item No.	Description
43	Clamp, tubing, 7/16" I.D.
44	Strap, shorting, 5/8" x 1 1/2"
45	Clamp, leg, 5/8" x 3 1/2", formed
46	Clamp, compression, 1/2"
49	Element Splice
55	Caplug, 5/16"
57	Insulator, decoupling stub, 5/8" x 2 15/16"

Figure 9

10-Meter Stub



Item No.	Description
29	Bolt, 1/4"-20 x 1 1/2", hex head, stainless steel
33	Lockwasher, internal, 1/4", stainless steel
35	Nut, 1/4"-20, hex, stainless steel
44	Strap, shorting, 5/8" x 1 1/2"
45	Clamp, leg, 5/8" x 3 1/2", formed
57	Insulator, decoupling stub, 5/8" x 2 15/16"

***Note**: When installing the Tower leg clamps (Item 45, PN: 163300) to the tower leg. The braces on tower leg may interfere with this installation. If so, move the leg clamps up or down to a spot where it is clear from the tower leg.

Figure 10
Tower Leg Clamp

Installation of 40-Meter Stub

NOTE: Each stub must be attached to a separate tower leg. The 40-meter stub (now being assembled) must be attached to the very top of the tower section. See Figure 11.

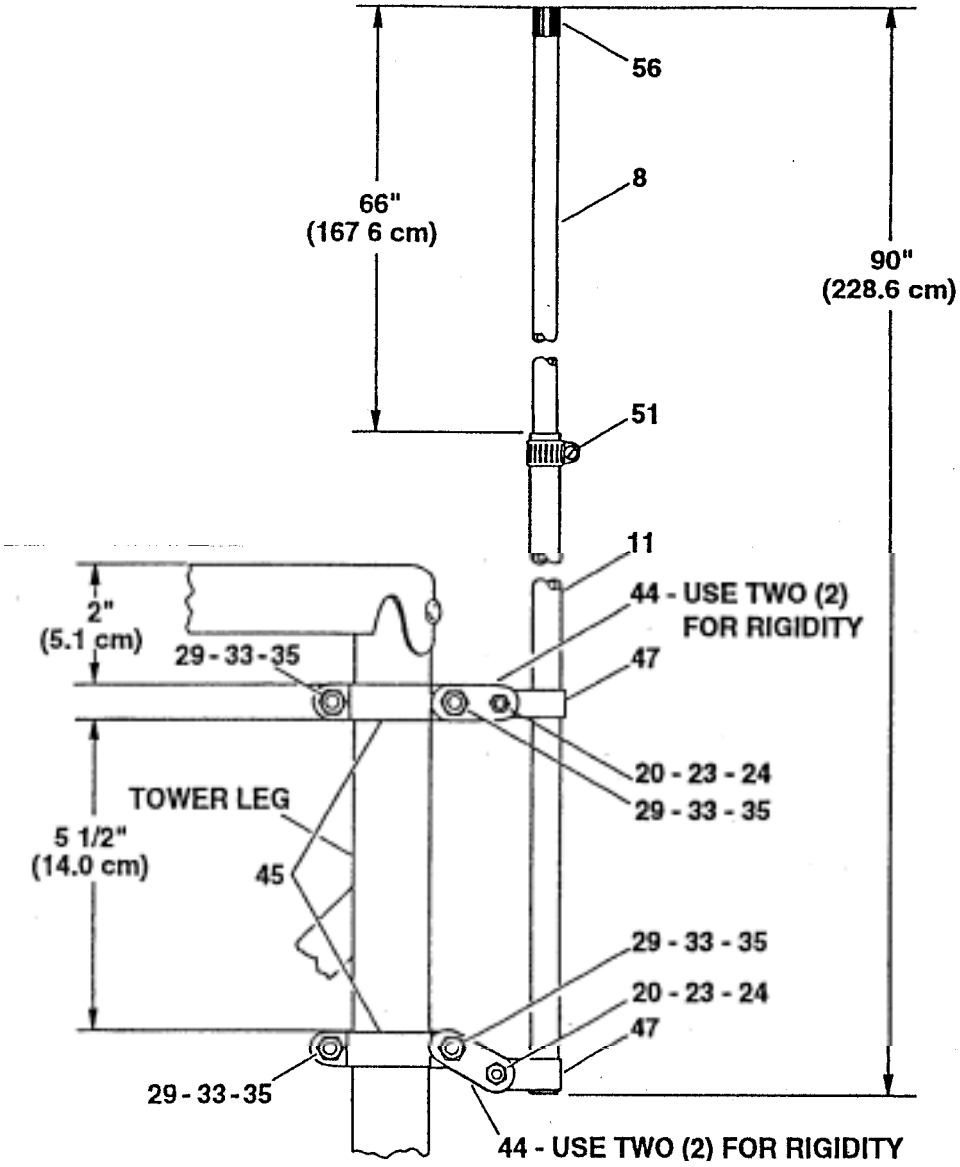
Select the 5/8" x 24" tube and install it on tower using two leg clamps and two shorting straps spaced 5 1/2" apart, as shown in Figure 11.

Slip a #6 tubing clamp onto the 5/8" tube. Tighten slightly.

Select the 7/16" x 68" tube and slip it into the 5/8" tube. Measure 90" for both Phone and CW, as shown in Figure 11, then tighten the compression clamp securely.

Place a 7/16" caplug on the top of the 40-meter stub.

NOTE: The higher tubing clamp can be loosened and the lower shorting strap hinged to bring the 40-meter stub into a vertical position.



Item No.	Description
8	Tube, 7/16" x 68"
11	Tube, 5/8" x 24", swaged
20	Bolt, #10-24 x 1", hex head, stainless steel
23	Lockwasher, internal, #10, stainless steel
24	Nut, #10-24, hex, stainless steel
29	Bolt, 1/4"-20 x 1 1/2", hex head, stainless steel
33	Lockwasher, internal, 1/4", stainless steel
35	Nut, 1/4"-20, hex, stainless steel
44	Strap, shorting, 5/8" x 1 1/2"
45	Clamp, leg, 5/8" x 3 1/2", formed
47	Clamp, tubing, 5/8" I.D.
51	Clamp, stainless steel, #6 tubing
56	Caplug, 7/16", black

Figure 11

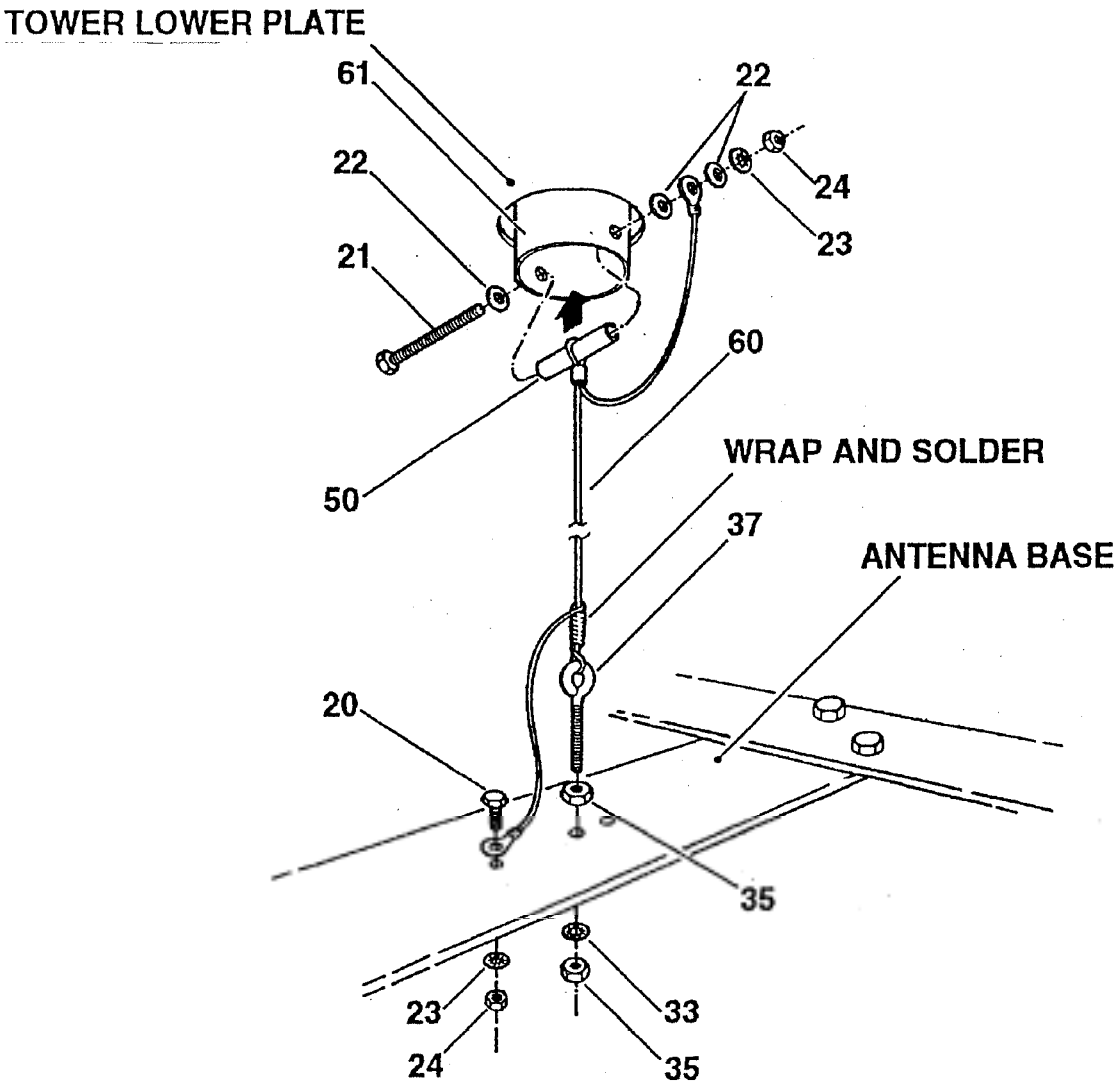
40-Meter Stub

Installation of 80-Meter Wire

Select the 80-meter wire and install it in the center of the tower with the looped end at the top of the tower.

Select the 3/8" spacer tube and attach the 80-meter wire to the 2'.' tube as shown in Figure 12.

Install the eyebolt at the tower base assembly as shown in Figure 12. Adjust for maximum height. The 80-meter wire will attach to this eyebolt after the tower is tilted into place.



Item No.	Description
20	Bolt, #10-24 x 1", hex head, stainless steel
21	Bolt, #10-24 x 2 1/2", hex head, stainless steel
22	Flatwasher, #10, stainless steel
23	Lockwasher, internal, #10, stainless steel
24	Nut, #10-24, hex, stainless steel
33	Lockwasher, internal, 1/4", stainless steel
35	Nut, 1/4"-20, hex, stainless steel
37	Eyebolt, 1/4" x 1 1/2" x 1/2"
50	Tube, spacer, 3/8" x 1 7/8"
60	80-Meter Wire Assembly
61	Tube Assembly with dowel, 2" x 75"

Figure 12

80-Meter Wire Installation

NOTE: To cover the low end of 80 meters (see Figure 12) it will be necessary to add a loading coil as previously explained and shown in Figure 13. This coil can be used to extend the 80 meter band or add 160 meter

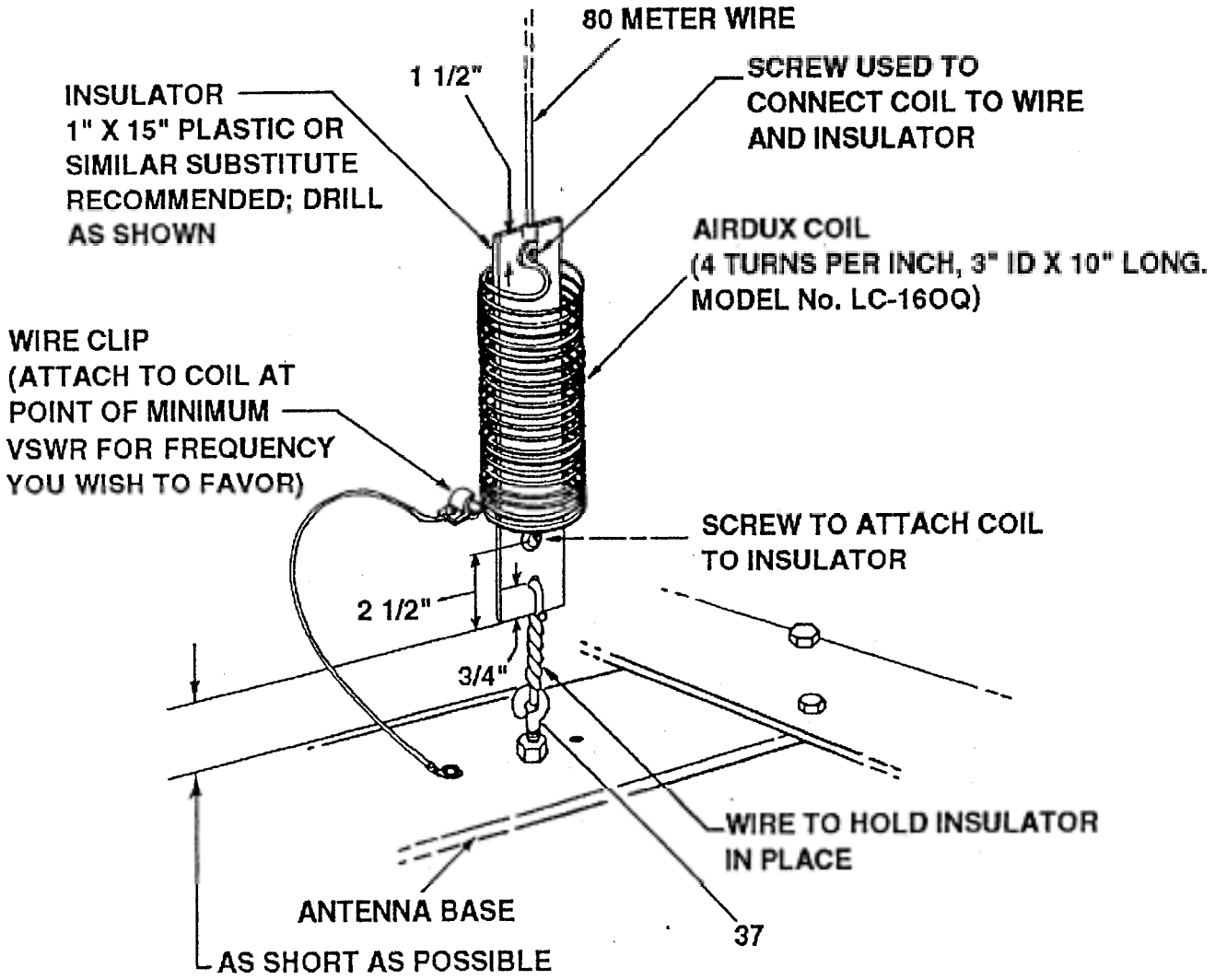


Figure 13
80 Meter and 160 Meter Coil Installation

160 Meter Operation

By adding one of two available kits, 160 meter operation can be added to the 18HT `Ey-Tower". these kits are available from
Hy-Gain, 308 Industrial Park
Road Starkville, MS 39759
USA.

Kit Number LC-160Q is a loading coil that can be added at the tower base as shown in Figure 13. This coil is four turns per inch, 3" I.D. by 10" long. After the coil is installed, the wire clip should be attached at the point that gives minimum VSWR at the frequency you wish to operate on. This coil should be bypassed when operating on 20 or 75 meters.

WARNING

When using the LC-160Q Modification Kit added to the 18-HT on 160 meters, do not exceed 150 watts output power (300 W P.E.P. out). Power levels in excess of this limit will cause the antenna to arc.

Kit Number MK-160 is a 40 meter trap and wire assembly that can be added at the top of the tower as shown in Figure 17. This kit will provide a greater band width and a higher power rating than the LC-160Q. It also provides fully automatic band switching from 160 through 10 meters.

Erection of Tower

Install the tower legs with hinges attached onto the base assembly. Do not tighten screws at this time.

WARNING

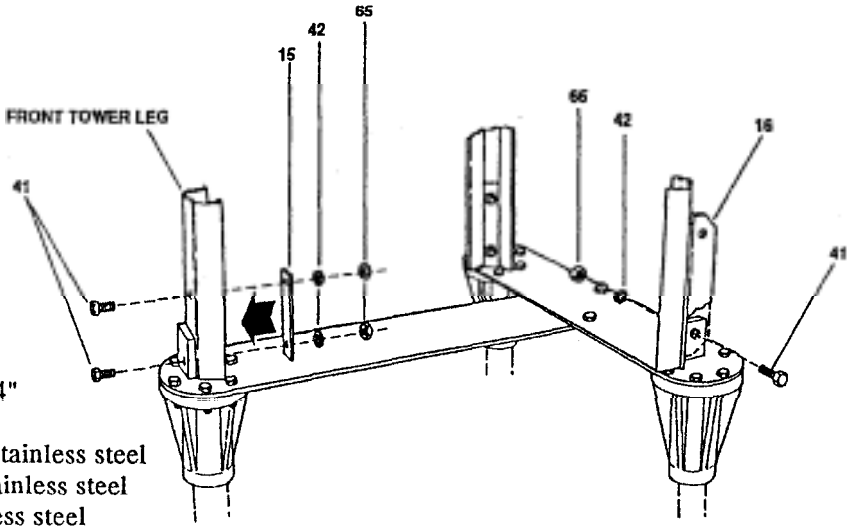
When installing your system, take extreme care to avoid any accidental contact with power lines or overhead obstructions. Failure to exercise this could result in serious or fatal injury.

Lift the antenna and walk it into a vertical position. Install the remaining leg brace and bolt the leg to the base assembly as shown in Figure 14. Tighten all screws securely.

Insert the 80-meter wire through the eyebolt installed at the tower base. Wrap the wire around itself several times to insure a good tight connection. Solder the connection for the best electrical connection.

Adjust the eyebolt until the wire is taut.

Attach the solder lug on the 80-meter wire to the tower base assembly as shown in Figure 14.



Item No.	Description
15	Plate, leg backing, 3/4" x 5 3/4"
16	Hinge, tower formed
41	Bolt, 3/8"-16 x 1", hex head, stainless steel
42	Lockwasher, internal, 3/8", stainless steel
65	Nut, 3/8"-16, hex head, stainless steel

Figure 14
Tower Leg Attachment to Base

Feedline Attachment and Grounding

Install two ground rods at each tower leg. Space them 24" from the leg with 18" between the two rods as shown in Figure 15. Use 1/2" x 8' copper clad steel rods (not supplied) for a good ground.

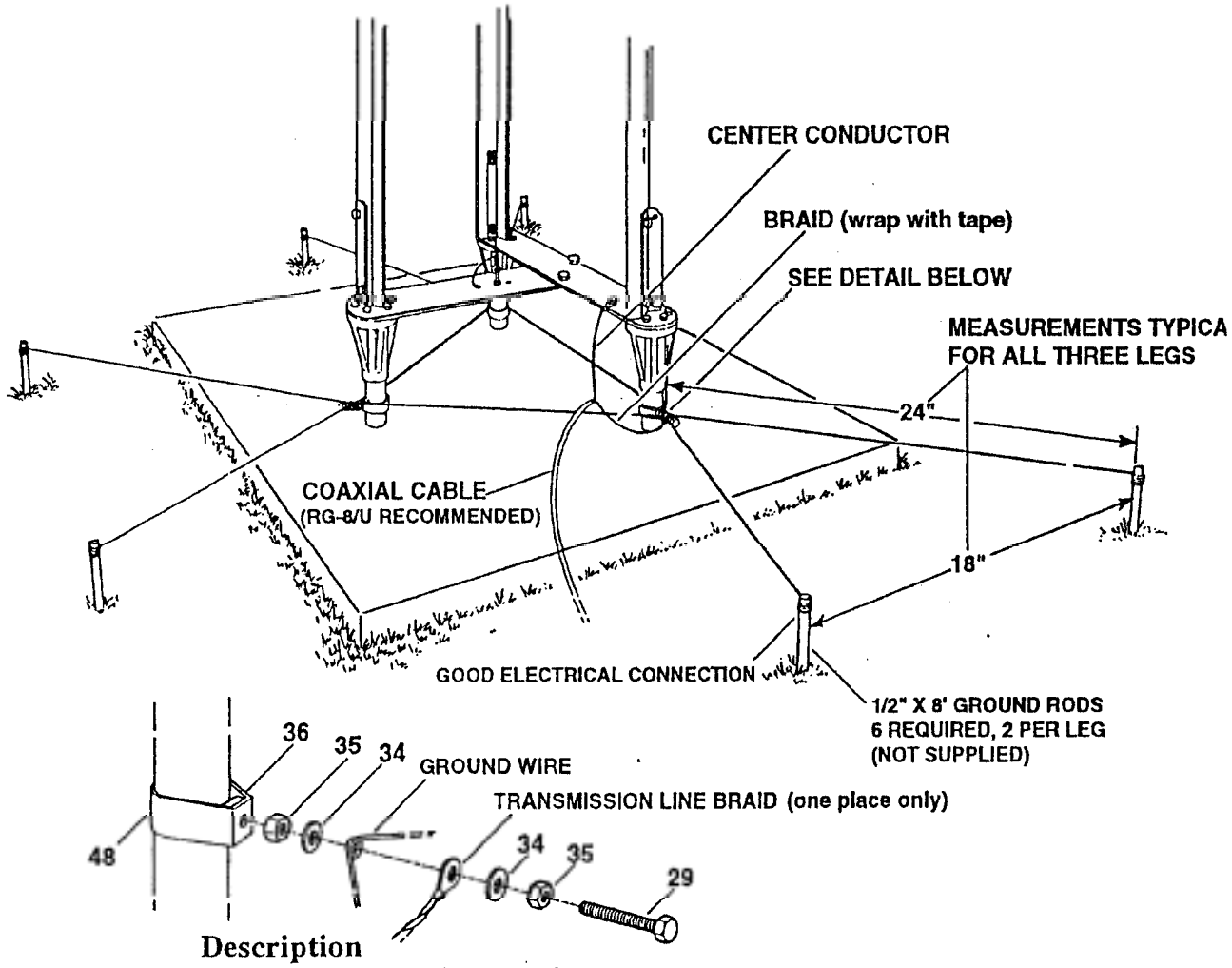
Attach each rod to a pip leg..using #10 or larger copper wire (not supplied). Now connect the three pipe legs together as shown in Figure 15.

Strip your coaxial cable and attach the center conductor to the tower base using the hole provided as shown in Figure 15. Attach the braid to a pipe leg. Cover the exposed coax cable dielectric to prevent U.V. cracking.

Weatherproof the coaxial cable using Coax-Seal© or some similar substance to prevent water from entering and ruining the coax.

The overall efficiency of the 18-HT -S can be improved by adding a radial system. The next section describes how to install a radial system.

Coax-Seal® is a registered trademark of Universal Electronics, Inc.



Item No.	Description
29	Bolt, 1/4"-20 x 1 1/2", hex head, stainless steel
34	Flatwasher, 1/4", stainless steel
35	Nut, 1/4"-20, hex, stainless steel
36	Nut, 1/4"-20, square, stainless steel
48	Clamp, compression, 1 1/4"

Figure 15

Ground Rod Installation

Installation of Radials

There is no need to make radials exactly 1/4" wavelength long for the 18-HT-S Hy-Tower. In fact, the only case where you should have 1/4" wavelength radials would be for approximately 90 radials. This differs rather dramatically from the case of a *Ground-Plane* antenna where resonant radials are installed *above* ground. Since the radials of a Ground-Mounted vertical are actually on, if not in, the ground, they are coupled by capacitance or conduction to the ground, and thus resonance effects are not important. Basically, the function of radials is to provide a low-loss return path for ground currents. The reason that short radials are sufficient, when few are used, is that at the perimeter of the circle to which the ground system extends, the radials are sufficiently spread apart. Most of the return currents are already in the ground between the radials rather than in the radials themselves. As more radials are added, the spaces between them are

Since the 18-HT -S Hy-Tower is a multi-band, vertical antenna, the radial system should be optimized on the lowest frequency you plan to use. Higher frequencies will benefit equally from the ground system, while lower frequencies will not show as much

To determine the optimum radial installation for your 18-HTS Hy-Tower, you must first decide what is the limiting factor for your

1. Cost of radial

2. Land available for radials

3. Efficiency of your antenna

Table 1 shows some various ground system configurations. System A is the least costly and the least efficient. System F is the most expensive, takes the most land and is the most efficient.

	A	B	C	D	E	F
Number of Radials	16	24	36	60	90	120
Length of each radial in wavelengths	.1	.125	.15	.2	.25	.4
Spacing of radials in degrees	22.5	15	10	6	4	3
TOTAL length of radial wire installed, in wavelengths	1.6	3	5.4	12	22.5	48
Power gain (dB) due to increased efficiency	3.0	3.6	4.0	4.7	5.2	6.0
Radiation take-off angle in degrees	30	30	30	30	28	24
Feed-point impedance in ohms with a 1/4-wave radiating element	52	46	43	40	37	35
Radial end buried	YES	YES	YES	NO	NO	NO

Table 1

Optimum Ground System Configuration

NOTE: TABLE 1 is optimized for poor earth conditions. Conductivity = 0.0001 Siemens/meter and the Relative Dielectric Constant = 7. Better earth conditions will increase the power gain and lower the take-off angle for systems A-D. Systems E and F will not be affected as much, except for additional lowering of the take-off angle by as much as 5 to 8 degrees. See pages 28-30 of "QST" June, 1985 for more information on radial systems for verticals.

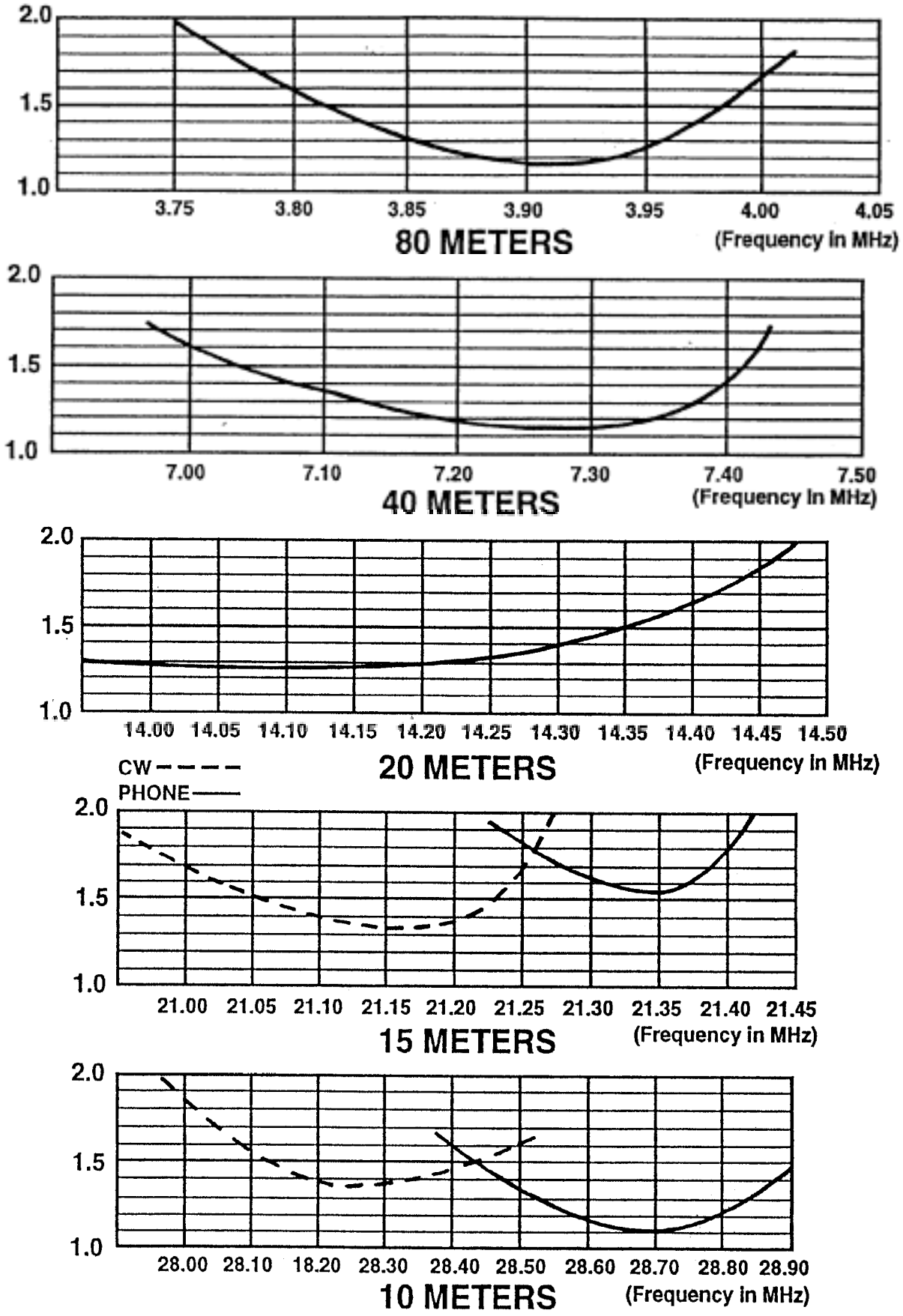


Figure 16
VSWR Charts

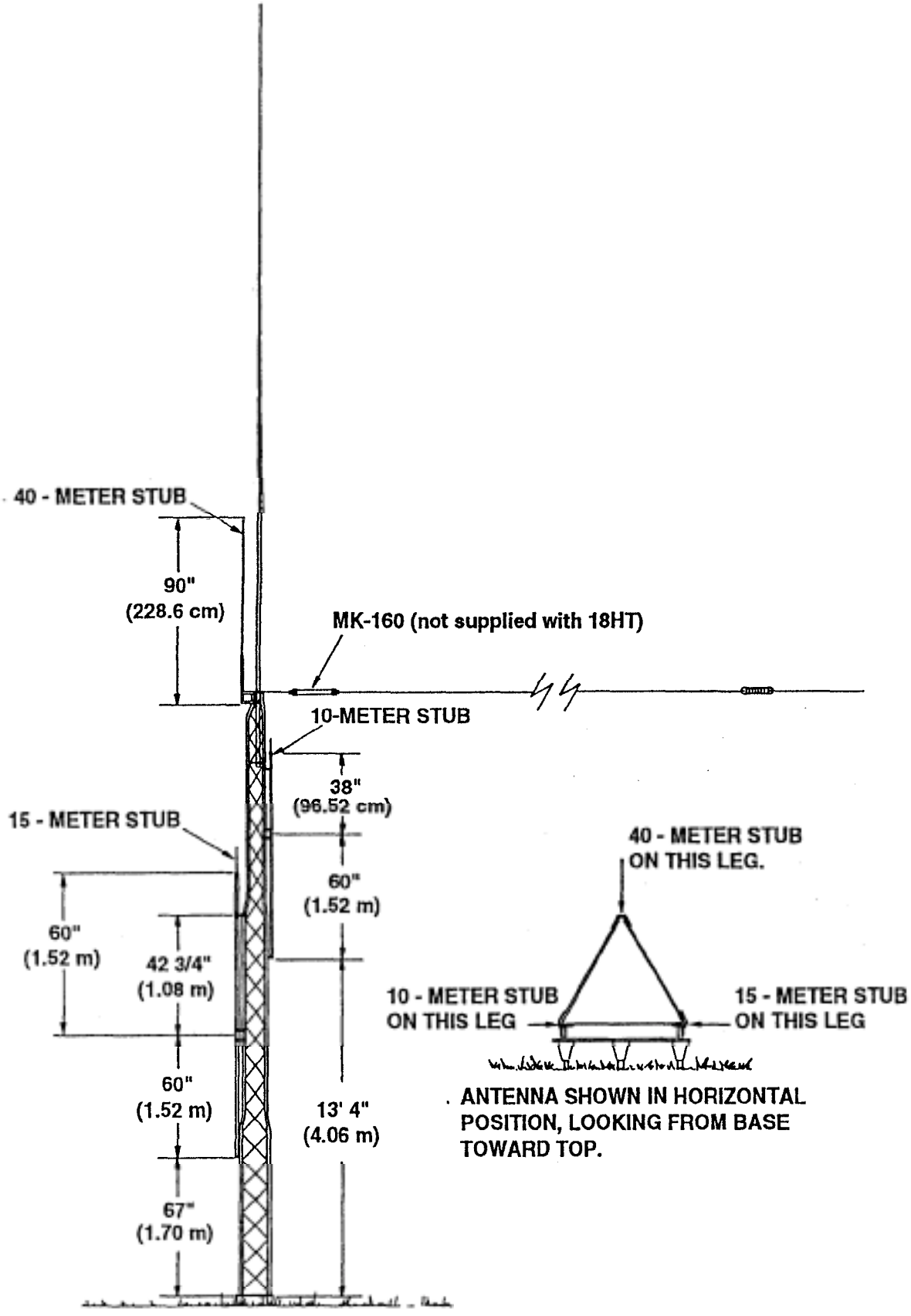


Figure 17
Overall View of 18-HT-S

PARTS LIST

NOTE: Item numbers may not necessarily be in numerical sequence and may appear more than one time, depending on how often a part is used or identical parts being placed in different parts packs.

Item No	Part No.	Description	Qty
1	879810	Tower, modified, BX-24	1
2	872077	Carton, tubing and parts	1
3	161411	Clamp, Reducer, 2" to 1 1/4",formed	2
4	170403	Tube,5/16"x 9 1/2	1
5	170416	Tube,5/16"x 23"	1
6	171500	Tube, 7/16" x 38	1
7	173305	Angle, Vertical Element, 1" x 1" x 4"	2
8	174868	Tube, 7/16" x 68"	2
9	174987	Tube, 7/16" x 60"	3
10	190000	Tube, swaged, 5/8" x 48"	1
11	190004	Tube, swaged, 5/8 x 24"	1
12	190202	Tube, swaged, 7/8" x 72"	1
13	190307	Tube, swaged, 1 1/8" x 38"	1
14	190900	Tube, slotted, 1 1/4" x 48"	1
15	381664	Plate, Leg Backing, ¾" x 5 3/4"	3
16	381666	Hinge, Tower, formed	2
17	475500	Insulator, 2" I.D. x 3 7/8"	2
18	872075	Parts Pack, 182S, Hardware	1
19	500158	Bolt, hex heal #10-24 x 1/2", stainless steel	11
20	504069	Bolt, hex head, #10-24 x 1", stainless steel	4
21	500164	Bolt, hex head, #10-24 x 2 1/2", stainless steel	1
22	561165	Flatwasher, #10, stainless steel	3
23	565697	Lockwasher, internal, #10, stainless steel	15
24	554071	Nut, hex, #10-24, stainless steel	12
25	555693	Nut, square, #10-24, stainless steel	3
26	505266	Bolt, hex head, 1/4"-20 x 3/4", stainless steel	5
27	502958	Bolt, hex head, 1/4"-20 x 1", stainless steel	28
29	504098	Bolt, hex head, 1/4"-20 x 1 ½" stainless steel	21
30	505763	Bolt, hex head, 1/4"-20" x 1 3/4", stainless steel	2
31	505737	Bolt, hex head, 1/4"-20 x 2", stainless steel	1
32	505734	Bolt, hex head, 1/4"-20 x 2 1/2", stainless steel	4
33	562961	Lockwasher, internal, 1/4", stainless steel	68
34	566344	Flatwasher, 1/4", stainless steel	6
35	554099	Nut, hex, 1/4"-20, stainless steel	72
36	551367	Nut, square, 1/4"-20 stainless steel	3
37	540066	Eyebolt, 1/4" x 1 1/2" x ½"	1
39	564792	Lockwasher; split, 5116", stainless steel	4
40	555747	Nut, hex, 5/16" - 18	4
41	505691	Bolt, hex head, 3/8"-115 it 1", stainless steel	10
42	565696	Lockwasher, internal, 3/8", stainless steel	12
65	555694	Nut, hex 3/8"-16" stainless steel	12
	872070	Parts Pack, tower section hardware	1
	565696	Nut; hex 3/8" -16, stainless steel	12
	505690	Bolt, hex head, 3/8"-16 x 3/4", stainless steel	12
	555694.	Lockwasher, internal, 3/8", stainless steel	12

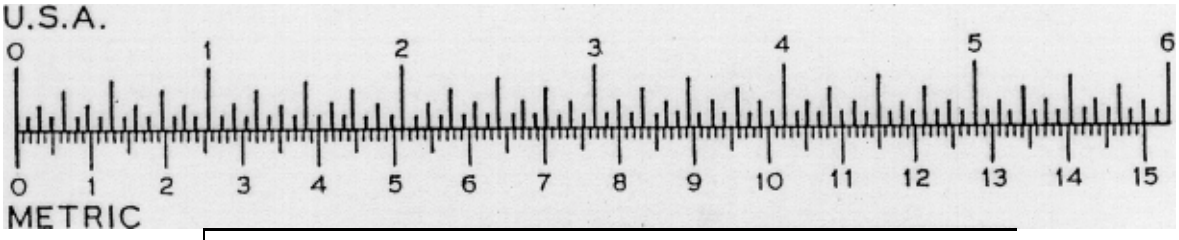
PARTS LIST (continued)

Item#	Part #	Description
	872077	Carton, tubing and parts (continued)
	872076	Parts Pack 182S, Clamps……..1
38	547225	U-Bolt. 5/16" x 3" x 3 11/16".....2
43	161851	Clamp, Tubing, 7/16" LD.....4
44	163378	Strap, Shorting, 5/8" x 1 1/2".....6
45	163300	Clamp, Leg, formed 5/8" x 3 1/2".....20
46	165123	Clamp, Compression, 1/2".....2
47	171329	Clamp, Tubing 5/8" LD.....2
48	168680	Clamp, Compression, 1 1/4".....3
49	171548	Element Splice.....2
50	173221	Tube, Spacer 3/8" x 17/8 ".....1
51	358756	Clamp, #6 Tubing, stainless steel 3
52	358757	Clamp, #10 Tubing, stainless steel 1
53	358758	Clamp, #16 Tubing, stainless steel 1
54		(Not Used)
55	765-1031	Caplug, 5/16.....2
56	455644	Caplug, 7/16", black.....2
57	465416	Insulator, decoupling stub, 5/8" x 2 15/16" 6
58	471056	Insulator, Vertical Element Spacer, l" x 4".....2
59	872451	Base Tube Assembly.....3
60	872464	Wire Assembly, 80 Meter.....1
61	872465	Tube Assembly with dowel, 2" X 75" ….....1
62	874687	Tube/Shim Assembly, 2" x 51”...….....1
63	882782	Base Assembly "B”.....1
64	882783	Base Assembly "A”.....1

Converting English Measurements to Metric
Use this scale to identify lengths of bolts, diameters of tubes, etc.. The English inch (1") and foot (1') can be converted in this way.

1 inch (1") = 2.54 cm
1foot (1')=30.48 cm

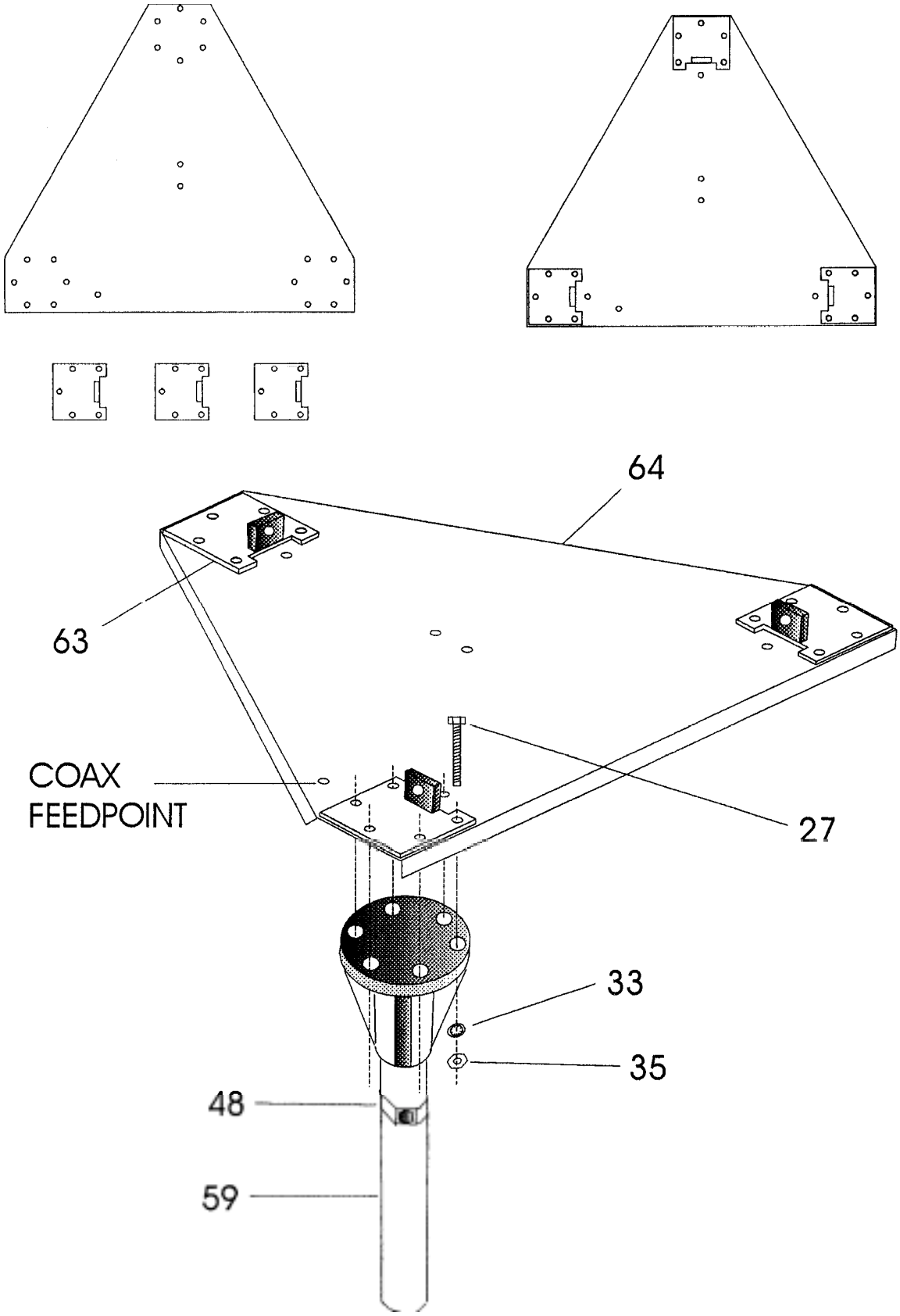
Example: 42" x 2.54= 106.7



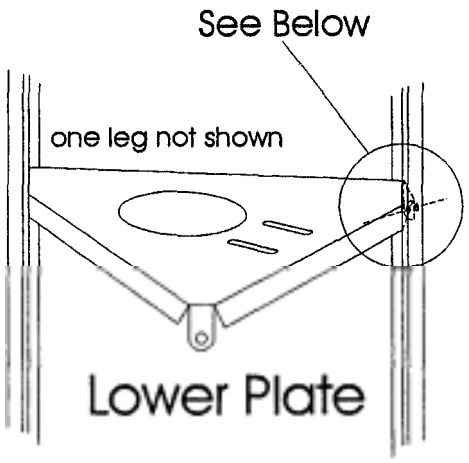
FRACTION AND METRIC EQUIVALENTS FOR ONE INCH

Fractional Inch	Millimeters	Fractional Inch	Millimeters
1/16	1.588	9/16	14.288
1/8	3.175	5/8	15.875
3/16	4.7001	1/16	17.463
1/4	6.350	3/4	19.050
5/16	7.937	13/16	20.638
3/8	9.525	7/8	22.225
7/16 -	11.112	15/16	23.813
1/2	12.700	1	25.400

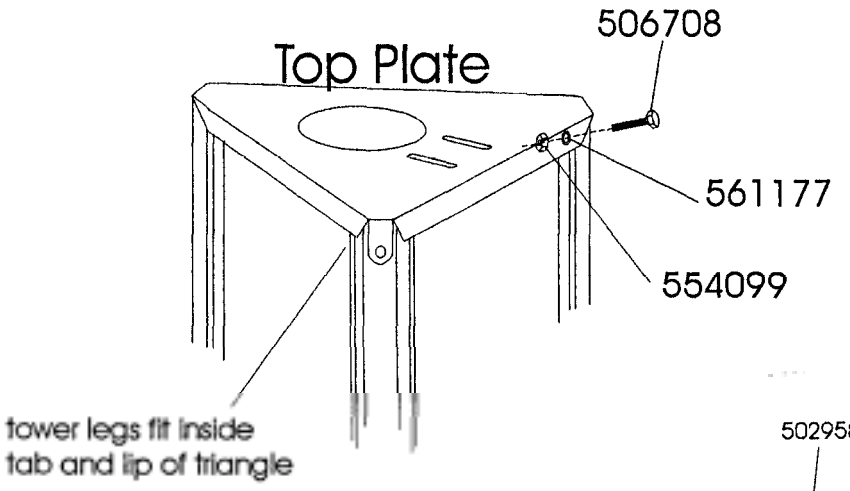
The Hy-tower base assembly has been changed, Substitute this drawing for figure 2 on page 3.



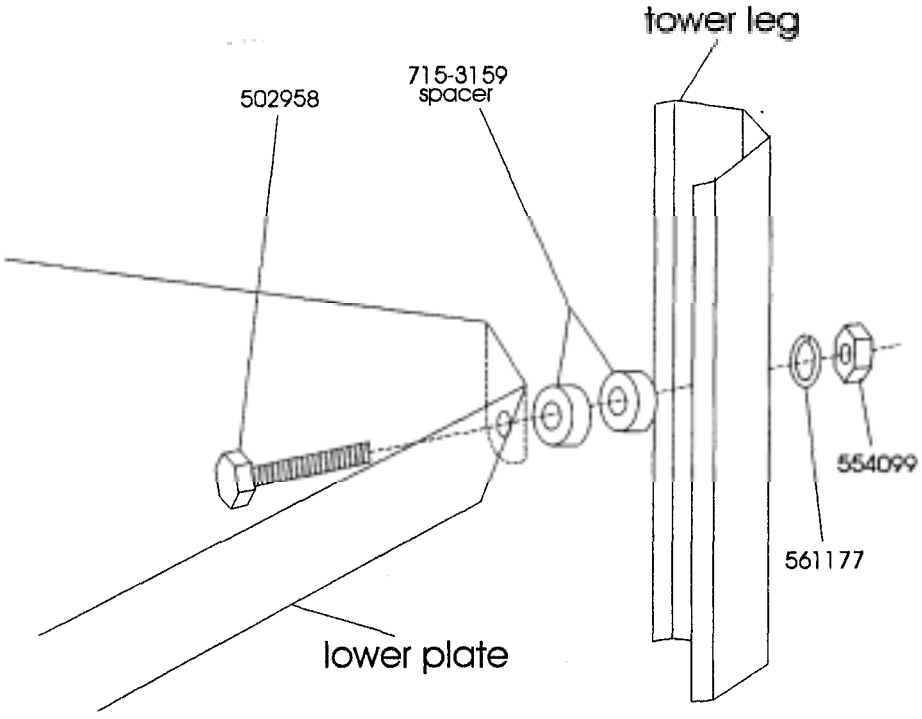
The tower plates inside the Hy-tower have been improved. The new plates are made from stainless steel, Install the lower plate as shown in the diagram, One X has been left out of the top section to allow for easy installment of the lower (larger) triangle. Install two spacers between the triangle tab and the tower leg,



The upper plate should be installed with the triangle tabs on the outside of the tower legs, Use the 1/4-20x 1/2 bolts for the upper (small) triangle, Make sure that both of the triangles are oriented the same way,



Part #	Description	Qty
502958	1/4-20 X 1 bolt	3
7153159	Spacer	6
561177	split washer	6
554099	1/4-20 nut	6
506708	1/4-20 X 1/2 bolt	3



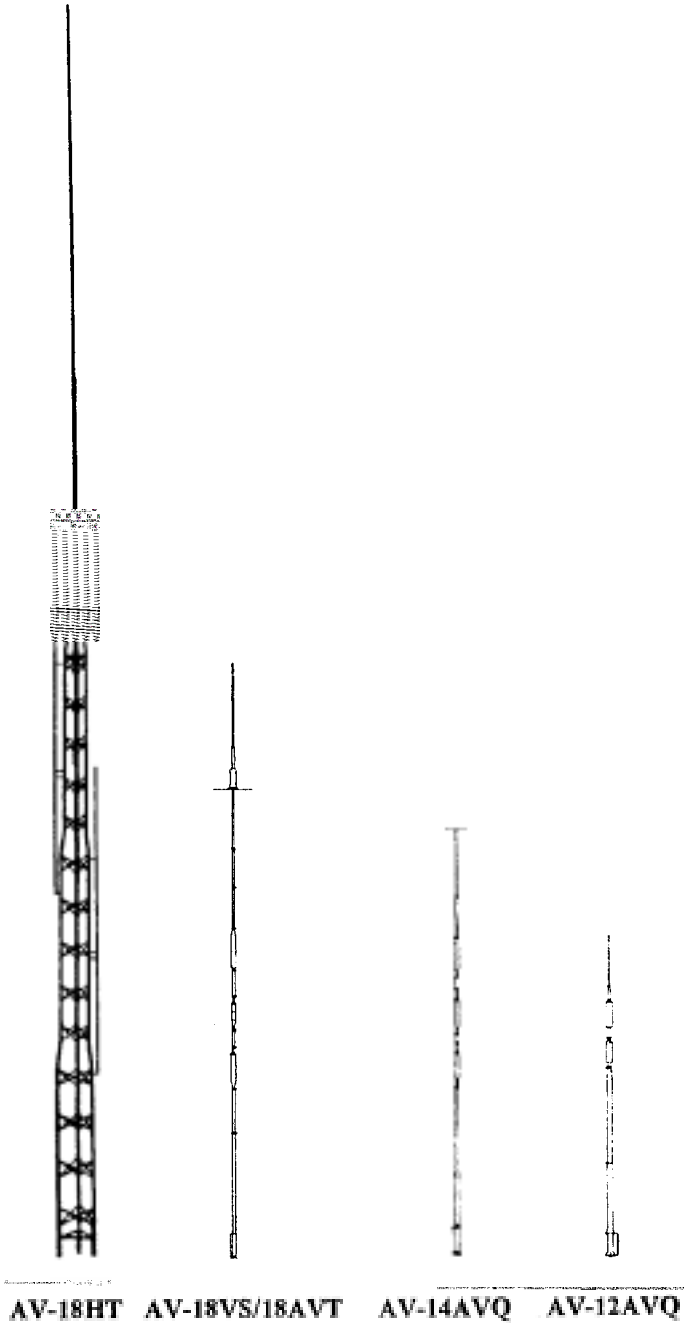
ADDENDUM

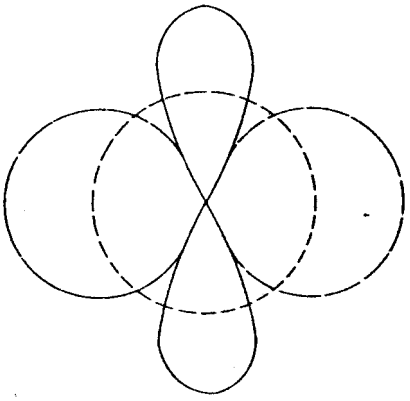
AMATEUR PHASING

ENGINEERING REPORT

PHASED MULTI-BAND

VERTICALS for ADDITIONAL GAIN and LOW ANGLE RADIATION





Phased Patterns

INTRODUCTION

The following Hy-Gain **verticals are well adapted for the phasing arrangements** shown in this reports

MODEL 18HT-S HY-TOWER

The 18HT-S is a multi-band vertical antenna with automatic band selection of 10-80 meters by means of a unique stub decoupling system. The Hy-Tower with a base loading coil operates efficiently on 160 meters. The system is foolproof, fed directly with a single 50 ohm coax. No guys are required for the 24 feet high, self-supporting tower. The top mast extends the height to 50 feet. Two units make an ideal phased array.

MODEL 18AVT/WB-S

The 18AVT/WB-S is a multi-band trap vertical for 10 through 80 meters. It is completely factory **pre-tuned and exhibits an extremely low angle** DX radiation pattern. It is easy to assemble, light weight which one man can install. A single 50 ohm coaxial feedline is required. Two or three 18AVT/WB-S's make an excellent phased array.

MODEL 14AVQ/WB-S

The 14AVQ/WB-S is a self supporting multi-band trap vertical for 10 through 40 meters and is completely factory pre-tuned. It is the world's most popular ham antenna with an overall height of 19 feet. The antenna is thoroughly weatherproofed and has a low angle DX radiation pattern. It may be ground mounted or installed on "Roof Top" with a radial system.

MODEL 12AVQ

The 12AVQ is a self supporting 13 1/2 foot multi-band trap vertical for 10, 15 and 20 meters. Completely factory pre-tuned with SWR of 2:1 or less with a low angle DX radiation pattern. The antenna has a new fiberglass impregnated styron base insulator. It may be ground mounted with earth acting as the "image antenna" or installed on the roof using a radial system.

DESCRIPTION

Increased activity on 80 and 40 meters has created a need for an antenna with power gain and directivity. Doublet and long wire antennas are no longer effective due to increased QRM. At these low frequencies, the radiation system must be lengthy and height above ground is extremely important to obtain the "low" angle of radiation needed for DX. Beams are excellent, but require a large supporting tower and "hefty" rotating system. Inverted V dipoles and slopers require a large tower and plenty of property.

The vertical "phased array", the answer for "DX" on these frequencies combine gain, directivity and low angle radiation, the three most important DX factors in a communication installation. The vertical is well known for its low angle characteristics. When you combine two identical verticals, properly spaced and phased, the resultant is a concentrated low angle of energy and a power gain. These antennas can be so arranged to give a definite effect on either one or two favorite bands or all band coverage with some pattern compromise and slight loss of gain.

The following data was experimentally derived on the Telex/Hy-Gain test range. Due to the many factors that vary and influence the performance of an antenna, such as grounding and close proximity of surrounding objects, etc., Telex/Hy-Gain cannot guarantee an installation to perform or exhibit the same characteristics as outlined in this report. However, many Amateurs are now successfully using these arrangements. Commercial broadcast stations have been using a similar phasing arrangement for years.

Part 1 - SINGLE BAND

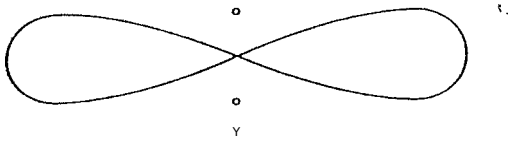
BI-DIRECTIONAL ARRAY (Four Quadrants)

THEORY' OF OPERATION

Two identical vertical antennas can be installed as a phased array. When excited by RF energy, gain is achieved by control of the directional pattern. This direction pattern control results in added gain by sharpening lobe patterns and concentrating the radiated energy at very low angles. Signal flutter is reduced and reception is vastly improved.

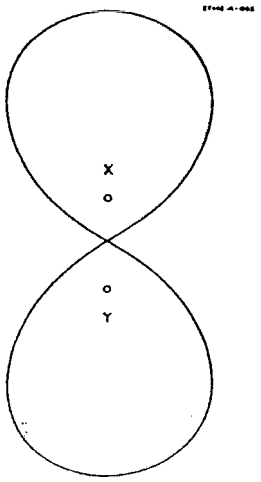
Phased arrays will reduce installation height requirements and still maintain low angle radiation.

Most effective spacing for a bi-directional array is 1/2 wave length. When two verticals are excited in phase the radiation is broadside to the plane of the verticals, offering substantial gain and bi-directional characteristics. Side nulls offer excellent signal cancellation to the undesired direction.



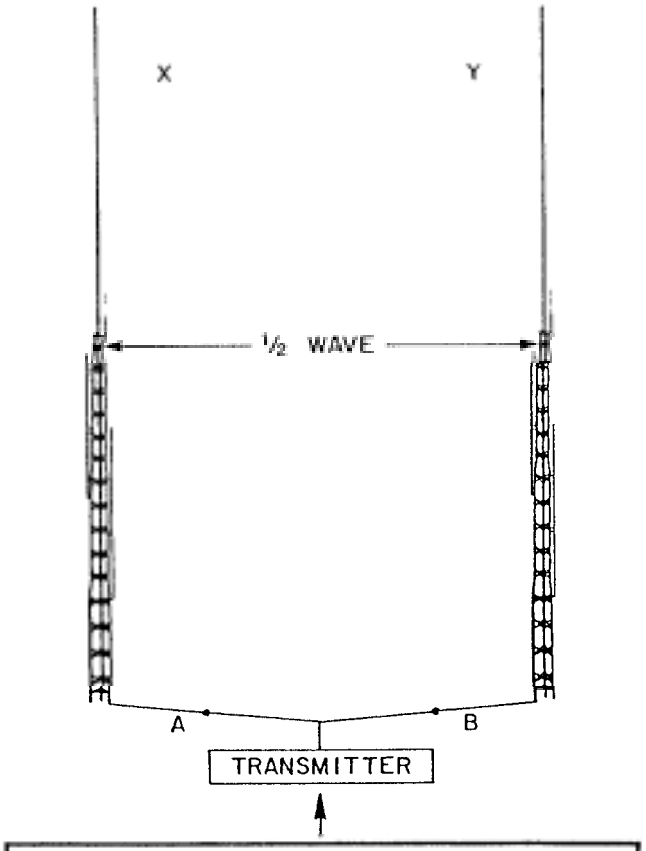
When excited "out of phase" these same verticals can be made to give an "end fire" or bi-directional pattern in the opposite direction through the plane of the verticals. This then nulls out signals in the opposite directions. More gain is exhibited by the broadside pattern over the "end fire" arrangement, but the "end fire" arrangement offers a wider frontal pattern.

Both arrangements offer an excellent advantage over a single vertical since either phasing combination exhibits noticeable signal gain with side attenuation of undesired signals. This added gain and low angle vertical directivity is the advantage of the phased array.

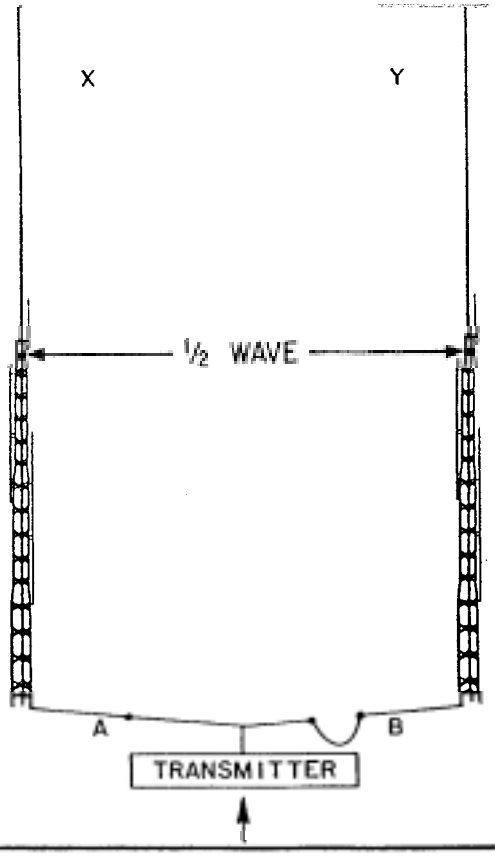


"ENDFIRE" GAIN 23 dB

Phased verticals may be spaced either one quarter wave or one half wave depending upon gain and directional characteristics. The nulls of the phased array are extremely sharp and very pronounced. Typical arrangements of phased arrays and their electrical specifications are illustrated below.



When feedline "A" is the same length as feedline "B" the currents arrive at the base of each antenna at the same time, giving the "inphase" broadside pattern.



When feedline "A" is 1/2" wave length shorter than feedline "B" the current arrives at antenna "X" 1/2 wave length sooner (180 degrees) than at antenna "Y" giving the "out of phase" end fire pattern.

Figure 1

SPECFICATIONS		
	Broadside	**End Fire**
Pattern width, half power points	60 degrees	80 degrees
Gain over single vertical	3.86 dB	2.3 dB
Side attenuation	30 dB	20 dB
Impedance	50 Ohms	50 Ohms
Directional characteristics	Bi-Directional	Bi-Directional

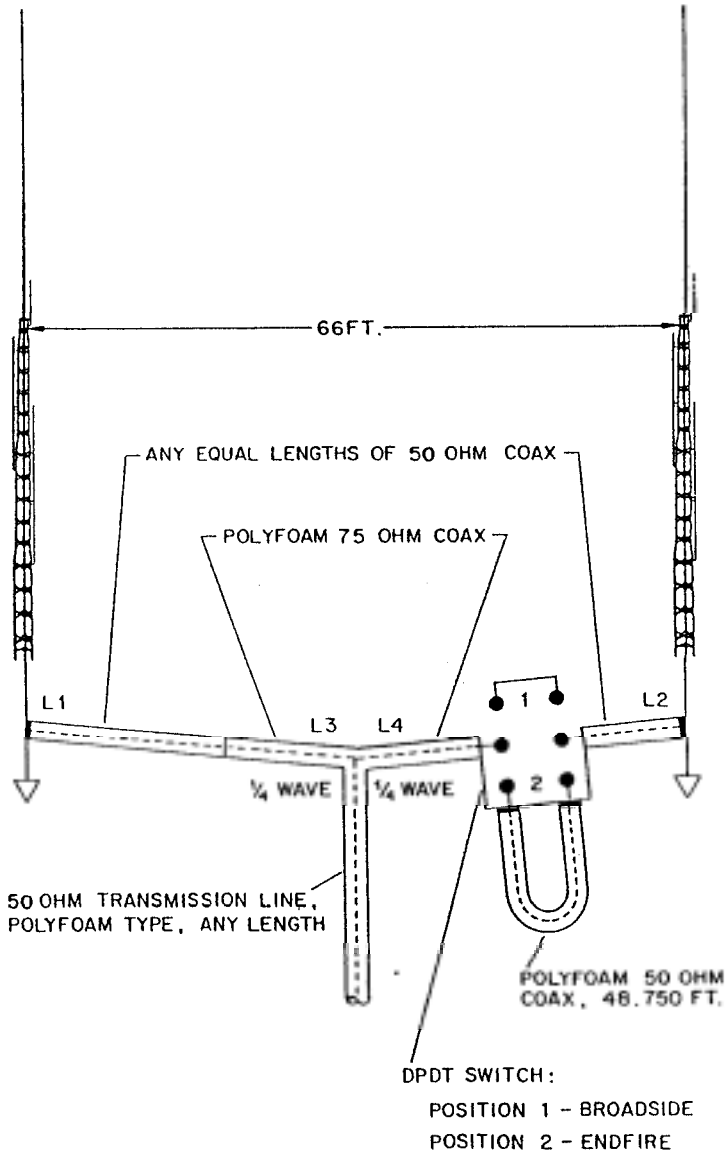
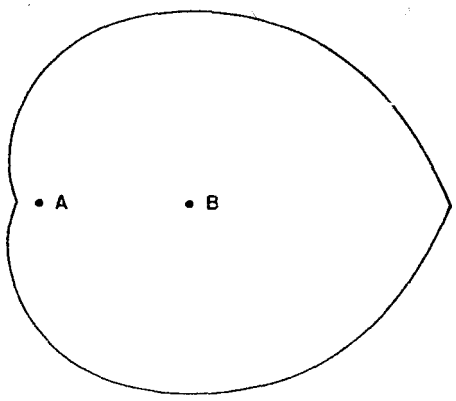


Figure 2
Typical Installation Phased (2) 18 HT 40 Meters
7200 KHz Design Frequency

CARDIOID ARRAY
(Uni-directional)

When two or three identical verticals are excited directly and fed 90 degrees out of phase with a spacing of 1/4 wave length, a cardioid pattern results. This pattern may be switched in either direction. By inserting a 1/4 wave length delay line the antenna will "fire" or be directive to that particular element. .:



TWO VERTICALS

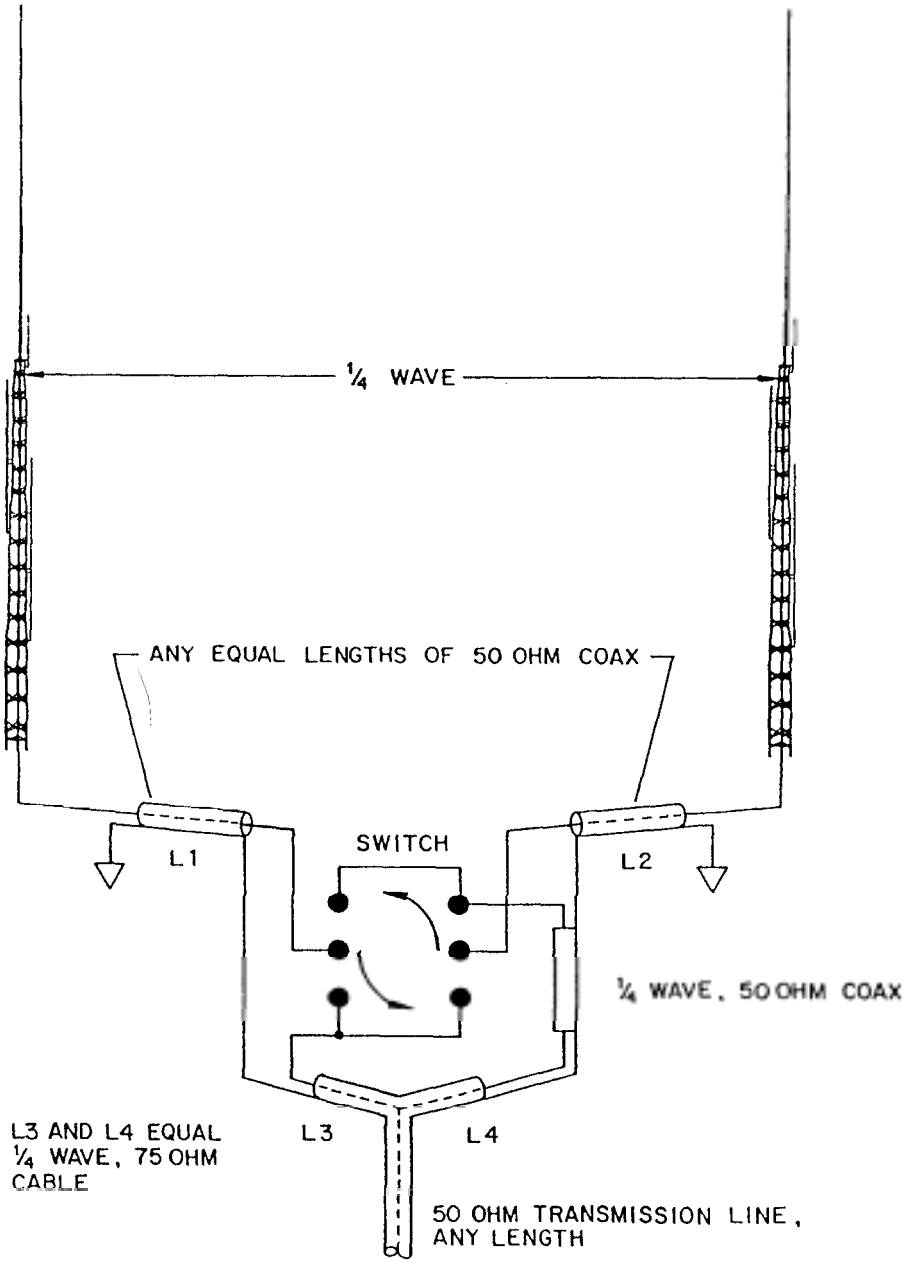
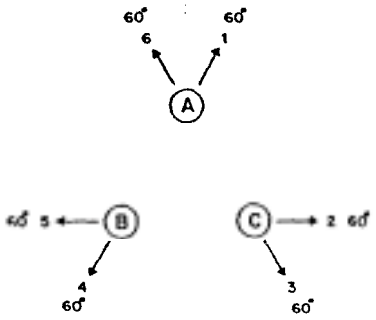


Figure 3
Cardioid-Unidirectional With Two Selectable Directions

The beam pattern for two 1./4 wave length verticals will be approximately 120 degrees. An arrangement of three switchable verticals gives a 60 degree pattern in six selectable directions.



TOP VIEW - 3 VERTICALS

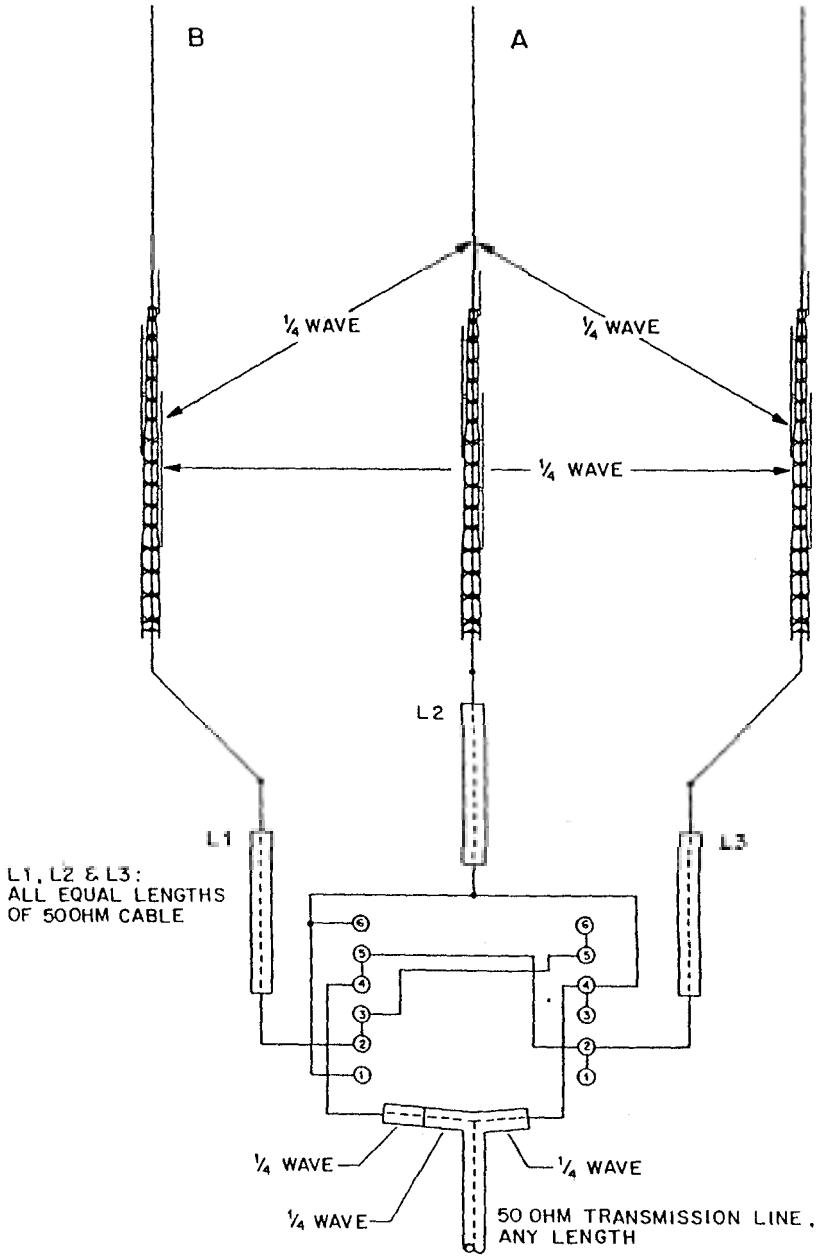


Figure 4
360 Cardioid Arrangement

ELECTRICAL SPECIFICATIONS:

	Two Phased Verticals	Three Phased Verticals
Pattern Width, half power points	120 degrees	60 degrees
Gain over single vertical	4.5 dB	4.5 dB
Side attenuation	20 dB	20 dB
Rear attenuation	30 dB	30 dB
Impedance	50 Ohms	50 Ohms
Directional Characteristics	Uni-directional	Uni-directional

VSWR: Exceptionally low SWR is present with a phased array. If phasing lines are correctly measured and the terminal impedance of each antenna is very close to 50 Ohms: Typical SWR: Broadside 1.2:1, Endfire 1.4:1, Cardioid 1.2:1.

PHASING LINES:

The 1/4 and 1/2 wave transformers, identified as L3, L4 and L5 are calculated from the lowing formula:

$$\text{1/4 wave} \quad \frac{246000 \times \text{vel.}}{\text{frequency (in KHz)}} \qquad \text{vel. factor - reg. coax.} \quad 0.66$$

EXAMPLE:

1/4 wave at 7200 KHz = 246000 / 7200 = 34.16

34.16
x.75
25.62

1/4 wave = 25.62 ft.

PART 2 - MULTI-BAND OPERATION

MULTI-BANDING

Multi-banding is easily accomplished by choice spacing two identical verticals. (refer to charts A,B, and C and associated Figures 1 through 5) Switchable 1/4 wave length and 1/2 wave length phasing cables must be employed for each band. These cables can be placed in the station in any suitable fashion along with a manual switching arrangement or relay system.

RADIATION PATTERN:

Consideration must be given to the fact that 1/2 wave spacing (optional) is ideal for phasing. When multi-banding with close and wide spacing, compromise radiation patterns must be expected. In most cases a choice spacing serves 3 bands most effectively with good directional characteristics, added gain and low angle performance.

OPTIONAL SPACING

Various antenna spacings may be selected from charts A, B, and C, for single band, duo band or multi-band arrangements. Associated radiations patterns for a specific spacing is shown in Figures 1 through 5 for each band.

If the 3/4 wave length patterns are not desirable, a single vertical only can be switched in use to obtain an omnl-directional pattern.

INSTALLATION

The vertical antenna requires a minimum amount of space. Ground mounted or elevated arrays are easily installed.

Antenna placement and orientation is a most important factor when planning maximum effectiveness is desired directions. Each vertical should be installed in the clear relatively free of surrounding objects in order to maintain its design 50 Ohm terminal impedance.

Each antenna must be mounted at the same height on or above ground and be so arranged according to their radiation pattern to offer desired directivity.

The phased array is primarily designed for long range and DX communications. In cases where close and medium distance contacts are hampered by the array's low angle characteristics and a higher angle is required, switching arrangements can select one vertical for this coverage.

SWITCHES & CONNECTORS

Low loss constant impedance type coaxial switches and connectors should be used when splicing phasing lines. B&W multi-position, single or multi-gang coaxial switches with Amphenol coaxial cable and "T" connectors are recommended.

FIELD TESTS

Actual field tests comparing one vertical to the phased array results in doubling the receivers sensitivity and offering up to 12 dB of signal increase. An attenuation of up to 30 dB is noticeable on the phased verticals with half wave spacing. With quarter wave spacing, up to 20 dB cardioid, and 30 dB front-to-back attenuation can be obtained.

"End Fire" directivity offers a larger area of radiation at slightly reduced gain as compared to the broadside arrangement. The "broadside" arrangement is recommended for communications at greater distances whereas the "endfire" arrangement would be so arranged to cover a larger area of communications. Special attention to the coax phasing line lengths and their proper placement is of utmost importance.

A. 80 meter bi-directional pattern (all SW positions 3) refer to Figure 1, Part 2 "Radiation Patterns"

NOTE: Due to close electrical spacing (1/4 wave) on 80 meters for Broadside (position 1) and Endure (position 2) the SVWR may be somewhat higher than 1/2 wave spacing. SW3 selects direction

B. 40 meters all switches in position 1 selects Bi-Directional patterns. Use SW2 for broadside (position 1) Endfire (position 2).

C. All switches in position 2 selects cardioid pattern. SW4 selects direction of cardioid pattern.

NOTE: All connecting lines are exaggerated in length. These lines must be direct and short as with any coax hook-up practice.

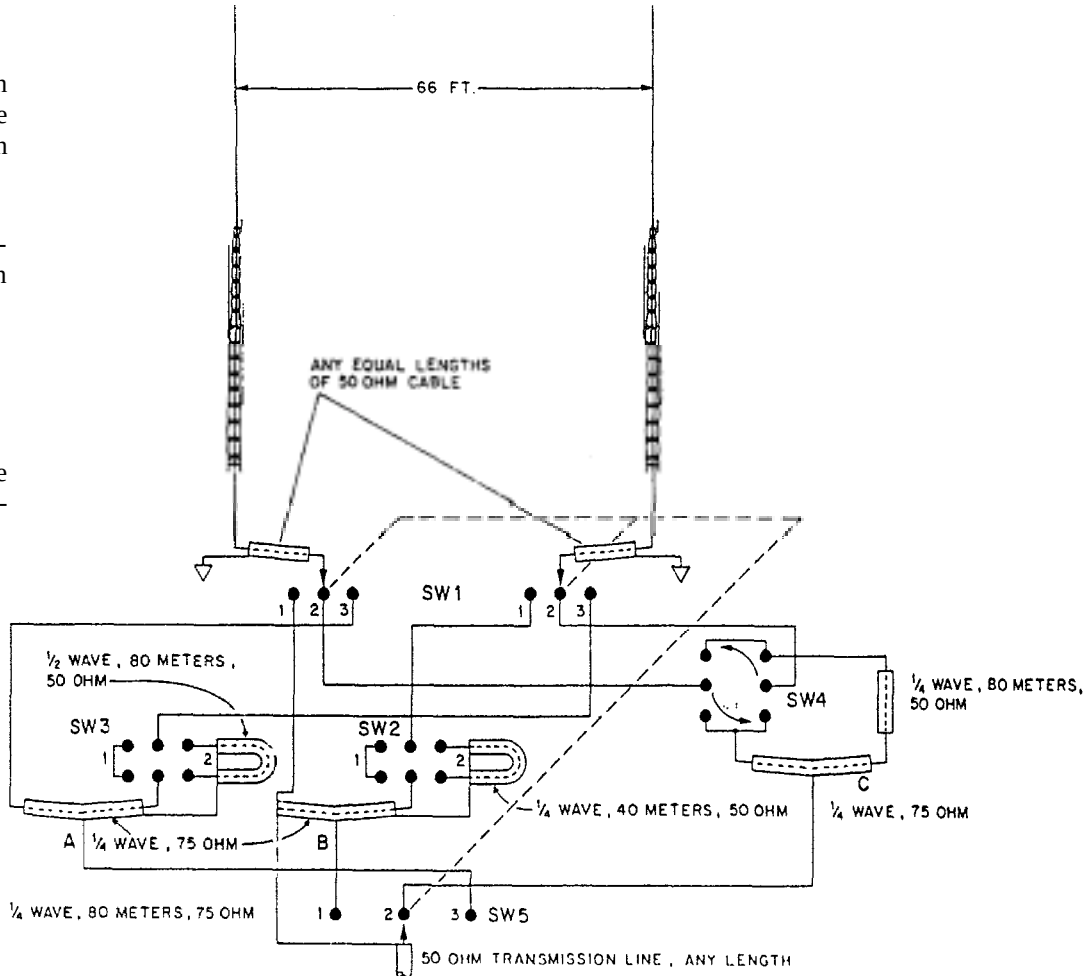
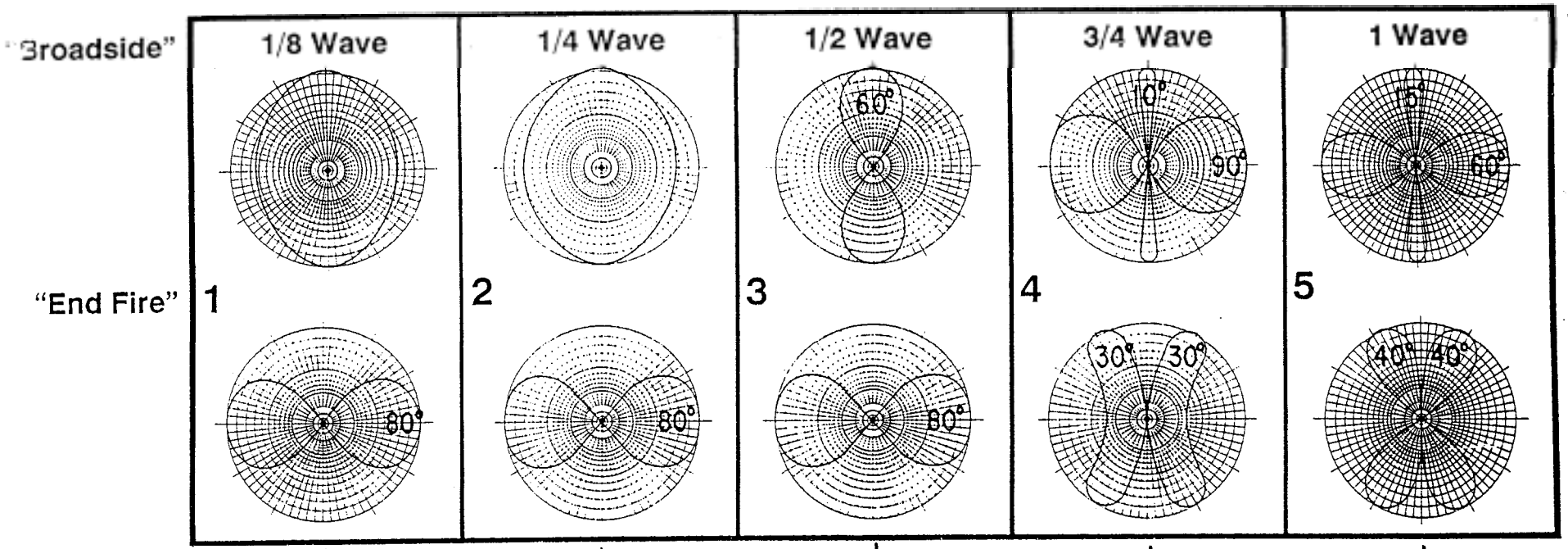


Figure 5
Typical installation (2) 18HT-S Phased for 80 and 40 Meters Selectable Broadside and Endfire Patters on 40 Meters Selectable Broadside and Endfire Patterns on 80 Meters Selectable 2 Directions Cardioid on 80 Meters



PATTERN CHART

Single Band Arrangement

	Spacing	1/8 Wave	1/4 Wave	1/2 Wave	3/4 Wave	1 Wave
A	125'			80		
	66'			40		
	33'			20		

Dou Band Arrangement

B	66'		80	40		
	33'		40	20		
	16'		15	10		

Multi-band Arrangement

C	33'	80	40	20	15	10
	66'		80	40	20	

Note: Corralate Patterns to spacing used in installation

Figure 6
Radiation Patterns - Typical Spacing For Broadside And Endfire Arrangements