Amateur Use of Telescoping Masts

Do you need an inexpensive skyhook for your antenna? Here's one candidate you may have overlooked.

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One of the many pieces of equipment designed for the TV industry is the telescoping mast used to support TV antennas. In some areas more than about 20 miles from a TV transmitter (and not served by a cable TV company), these masts are used frequently.

TV telescoping masts aren't commonly used by hams. Observation and inquiry show two reasons for this: (1) a lack of knowledge of the capabilities and the limitations imposed by telescoping-mast design; (2) having had (or heard of) a bad experience with such a mast. The latter seem to stem totally from mishandling during installation, leading to mast and antenna damage and—occasionally—injuries to people. The mishandling is directly related to a lack of knowledge regarding proper installation techniques.

Mast Design Limitations

It's important to know the limitations imposed by telescoping TV mast design. One major TV mast manufacturer's flier emphasizes this by stating "Telescoping masts are not recommended for commercial or ham installations" in the specification list. The "not recommended" ignores the fact that many amateur antennas are *smaller* than some TV antennas used in rural areas and that the mast alone can be used as a vertical antenna.

None of the ads, fliers or instructions packed with a telescoping mast provide adequate information about the capabilities and limitations of its design. The most I've seen is a short note to the effect that the mast should not be used with antennas having a wind load area of more than 2 square feet. In TV antenna ads, you're told the number of elements a particular antenna has, but not necessarily its wind load area or its weight. In most amateur antenna ads, this vital information is given. Telescoping-mast fliers and instructions also omit correct installation procedures and safety procedures. About the only precaution I've seen mentioned is to "stay away from power lines."

Here, I'll explore the capabilities of telescoping masts for amateur use. I'll provide data to allow you to determine correct use in your application, up to the limit of mast capability. Proper installation and use are also covered.

Telescoping-Mast Design Principles

A telescoping TV mast is much more than a few pieces of steel tubing. It includes a number of design features to make use simple and safe. These feature areas are shown in Figure 1, starting at the top of a mast section and working toward the bottom.

There's size reduction in the top section to bring its ID to a size slightly greater than the next smaller section, which is also the next higher section when the mast is extended. Partly, this is for strength, to distribute the load from the upper section. It's also an antirattle feature, to limit noise caused by wind moving the mast.

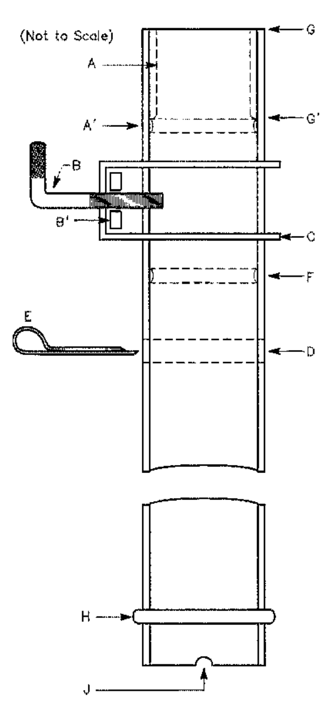


Figure 1—Major features of a single section of a typical TV telescoping mast section. See text for explanation of elements A through J.

In some designs, the top 4 to 6 inches of a section is roll-swaged to the smaller diameter as at A. In others, the swage may extend only $^1/_4$ to $^3/_8$ inch, as shown in Figure 1 at A'. In these, the swage is typically 1 to 2 inches below the top of the section.

Just below the swaged area are two holes in the section. The top one (B) is typically $^1/_4$ inch in diameter, and penetrates only *one side* of the tubing. This hole is for a clamping screw. The screw's primary use is to hold the smaller, inner-mast section in place while a new grip on this section is taken during mast erection. Secondly, the screw keeps the two sections tightly together to prevent wind noise. This screw is *not intended* to be the permanent—and only—mechanism to prevent slippage and mast collapse (more on that later).

The clamping screw (B) has some type of a support fixture. One style uses a simple strap, with a floating square nut for the mating screw. The nut is held in place by metal tabs. A second type (C) uses a flat, **U**-shaped metal sheet, with a hole on each of the **U**-shaped sides just larger than the tubing diameter. There's a captive nut (B') at the bottom of the **U**. Either type may have a small, internally threaded stud not shown here. This stud is used to mount an insulated standoff for carrying twin lead or coax, holding it away from the mast to reduce signal loss and wind-induced slapping noise.

The second, lower hole (D) is typically $^5/_{16}$ inch in diameter, and penetrates the tube completely, along the diameter. This hole accepts a large cotter pin (E), which is the support for the next-smaller mast section. (The best designs equip the cotter pin with a short chain to prevent the pin from being lost.) This pin is intended to carry *all of the weight above it:* tubing sections, rotator, antenna and guys. It's a safety feature: With overload, the pin should shear and the mast should safely telescope downward. As we'll see, this is the weak point in the design.

In designs I've seen, there's an additional, smaller-diameter swaging (F) between the two holes. The contact of this and the upper swage create a force couple, which transfers bending forces from the smaller section to the larger. It's also part of the antirattle design. Additionally, it's a safety feature (working with the next feature to be described) to prevent sliding the small section completely out of the larger one while raising the mast.

Rings are employed for attaching guy wires. Some designs make the hole diameter in a ring just greater than the diameter of the next-smaller mast section. The rings are used at the very top of a section, at G. Another design makes the hole in the ring just larger than the topmost swage outside diameter. This slides over the section, and rests on the shoulder of the swage, at G'. Another design makes the ring hole larger than the tubing. This ring is kept from sliding down the mast by a weld bead around the mast at A'. The ring located at G is the least desirable since the ring tends to jam if the mast is telescoped downward. The ring size varies with the section diameter.

There are two types of guy rings. One is a simple, flat plate, typically 1/8 inch thick. The other is thinner, with a lipped inner hole, and with the outer edge roll-crimped. It's claimed that the rolled edge eliminates the need for a guy thimble to keep the guy from chafing through. Prudence indicates the use of thimbles, which are *not* supplied with any masts I've seen.

These guy rings have holes for six guy wires, spaced as shown in Figure 2. They allow use of three sets of guys (commonly); four sets are rarely used.

Just above the bottom of the mast section, at H in Figure 1, is a weld ring. The size of this weld ring is controlled so that its outside diameter is just smaller than the inside diameter of the next-larger section. This acts with the swage of A or A' to take the bending moment when extended. It also prevents the inner tube from extending past the swage at F, preventing overextension.

At J is a pair of notches in the tube bottom. These are half circles, 5/16 or 3/8 inch across. They're intended to receive the cotter pin and prevent the mast section from rotating. The notches also distribute the shear load presented by the weight of the upper parts of the mast system.

After the sections are finished—with all holes punched or drilled and all welds made—they are hot-dipped galvanized. (Or at least, they should be!) I've seen one mast of unknown manufacture that was zinc-plated rather than hot-dip galvanized. I've been told paint-dipped masts exist. Such treatments are *not recommended*, as rust makes for a short mast life.

Mast Specifications

Telescoping masts are manufactured in three weights. The light-duty mast is formed from 18-gauge steel, which has a nominal

Glossary of Terms Used in the Tables

ALLOW—allowable load.
AREA—Section area exposed to wind.
A WND LD—allowable wind load.
BOLT LD—maximum shear load on the bolt.
COTR LD—maximum shear load on the cotter pin.
DIAM—outside diameter of a section.
GUY LEN—guy length.
GUYS—length of three guys.
GUY COMP—compressive load on a mast due to guy tension.
GUY LD—guy load.
GUY STR—guy strength.
H WND LD—horizontal wind load.
HGT—overall height.
LAT AREA—cross section of tubing.
LEN—length.
LEN 3 GUYS—length of three guys.
LEN 4 GUYS—length of four guys.
LIMT LD—section load at failure limit.
MAX AREA—maximum area of antenna and rotator.
MAST WND—mast wind load.
MAX V LD—maximum vertical load on section.
NOM WT—nominal weight of a section.
PANEL—a section of mast.
RAD GYR—radius of gyration of section.
SAFE LD—maximum safe load (with a safety factor of 4).
STAT LD—static load.
THICK—thickness of the section wall.
TRY—a trial value.
V WND LD—vertical wind load.
WIND—wind load on projected area.
WND LD—dynamic wind load.
WT—weight.
WT MAST—weight of the mast.
WT GUYS—weight of the guys.

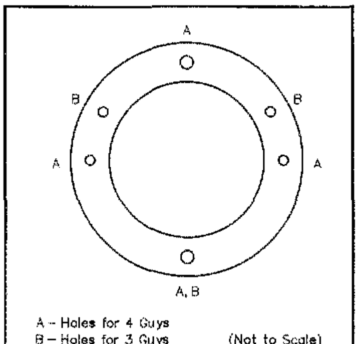


Figure 2—Top view of the guy ring plate found at the top of each section of a telescoping mast. The hole arrangement allows use of three or four sets of guys.

Table 1
Telescoping Masts

Quantity	Unit of Measure	Section 1	2	3	4	5
LEN	ft	10	10	10	10	10
HGT	ft	10	19	28	37	46
PANEL	ft	9	8	8	8	9
THICK	in.	0.05	0.05	0.05	0.05	0.05
DIAM.	in.	2.25	2.00	1.75	1.50	1.25
AREA	in.^{2}	0.35	0.31	0.27	0.23	0.19
GUY LEN	ft	25.08	29.83	36.24	43.57	51.43
LEN 3 GUYS						558.43
LEN 4 GUYS						744.57
LAT AREA	ft^2	1.88	1.67	1.46	1.25	1.04
NOM WT	lb	15	13	12	10	8
WIND	lb	37.50	33.30	29.20	25.00	20.80
RAD GYR	in.	0.98	0.87	0.76	0.66	0.55
MAX V LD	lb	4070.26	3659.60	2903.26	2176.73	1281.30
With Cotter Pins						
COTR LD	lb	745.14	745.14	745.14	745.14	745.14
LIMT LD	lb	745.14	732.14	720.14	710.14	702.14
SAFE LD	lb	186.28	183.03	180.03	177.53	175.53
With Stainless-Steel Bolts						
BOLT LD	lb	2943.75	2943.75	2903.26	2176.73	1281.30
LIMT LD	lb	2943.75	2930.75	2891.26	2166.73	1273.30
SAFE LD	lb	735.94	732.69	722.82	541.68	318.32

Characteristics of typical mast sections. At the top of the table are the dimensions and weights of the five sections of a typical 50-foot mast. Derived quantities of wind area, section radius of gyration and section strength considered as a column are shown. The bottom parts show the shear strength and safe vertical load on the section for two types of retaining pins.

thickness of 0.049 inch. The heavy-duty mast is 16 gauge, with a nominal thickness of 0.063 inch. There is also an intermediate-weight mast, which uses 16-gauge steel for the top section, and 18-gauge for all other sections. This reduces the weight and cost of the complete assembly; it does not reduce the carrying capacity of a complete "as supplied" mast appreciably, but it does reduce the safety factor.

Because it seems likely that most amateur installations need the best possible mast, only the tallest, heavy-duty type is considered here.

Section specifications from the catalog of one large manufacturer are shown in Table 1. (See the "Glossary of Terms" for an explanation of the abbreviations used.) This 5-section design is often called a "50-foot" mast, but has a maximum height of 46 feet. One foot of height is lost in the overlap between each two sections. The table gives the overall height, the section length exposed to wind, and the panel length, the distance where there is no added strength from overlap with higher or lower sections. The weight of each section and its radius of gyration is shown, as well as the projected area and the wind loading for a 20 lb/ft^2 wind. This corresponds to a wind speed of 70.7 mph. This is selected as adequate for short-term use, such as a Field Day installation. The wind loading should be increased for permanent installations. Acceptable design values are:

SE Florida, Cape Hatteras	50 lb/ft^2
SE USA coasts, some other areas	40 lb/ft^2
Rest of the contiguous states	30 lb/ft^2

Load capability data shown later is based on the 20 lb/ft^2 value.

A Standard Installation

The telescoping mast is designed to have a set of guy wires reaching from the ground to the top of each mast section. There are, of course, many mast heights, arrangements of these guys, as well as many ways of mounting antennas on the mast, and many antenna sizes. To reduce the analysis to reasonable size, a standard antenna mast installation is assumed.

We'll use a five-section mast with guys extending from the top of each section to a common point, as shown in Figure 3. Assume the common point to be located one-half of the total mast height from the base of the mast. All antenna and rotator weight is assumed to be located at the top of the mast: There are no intermediate antennas.

The standard guys are seven-strand galvanized wire common in TV installations. These guys are specified to have a tensional breaking strength of 910 lb and weigh 31.8 lb per 1000 feet. However, guy strength was found to be one of the limiting factors, so other material was also tried, as described later. Guys were assumed to be nonelastic: not changing length under load. I also assumed a negligible pre-load on the guys. Very closely, this corresponds to the precept that the guys should look tight and feel loose.

The mast is assumed to be as described in Figure 3, and to be in new condition. Lacking other information, common material strength values are used.

Basis for Analysis

The foregoing assumptions allow analysis of each mast section as if it is totally independent of the others. The basic force diagram for the top section is shown in Figure 4. The horizontal force to the left is the wind load on the antenna and rotator and on the mast section. At the right is the slanting guy tension under load. This load is resolved into horizontal and vertical components.

Additional vertical loads on the mast are the weight of the antenna and rotator, and the weight of the mast section. The wind load on the mast is resolved into two components, one-half at the upper-guy attachment point, the rest being at the next guy, and not affecting this section. The wind load on the guy is neglected. The horizontal component of guy tension is equal to the sum of the wind loads at the upper guy. The vertical component then appears as a compressive load on the mast, adding to the weight of antenna, rotator and mast section, and guy. The relation between these components are:

Compression/Wind load = Guy height ÷ Guy base. For the top section and the installation assumed, the compression is just twice the total wind load. Guy tension = SCORE (Compression × Compression +

Table 2
Telescoping Mast 2

Quantity	*Unit of Measure*	*Weight, Antenna and Rotator, lb* 10	20	30	40	50	100
WT MAST	lb	9	9	9	9	9	9
WT GUYS	lb	0.5	0.5	0.5	0.5	0.5	0.5
STAT LD	lb	19.5	29.5	39.5	49.5	59.5	109.5
MAST WND	lb	5.2	5.2	5.2	5.2	5.2	5.2
1/8-inch Steel Guy and Cotter Pin							
ALLOW	lb	175.5	175.5	175.5	175.5	175.5	175.5
GUY COMP	lb	156.0	146.0	136.0	126.0	116.0	66.0
TRY GUY	lb	174.4	163.2	152.1	140.9	129.7	73.8
GUY STR	lb	227.5	227.5	227.5	227.5	227.5	227.5
GUY LD	lb	175.5	163.2	152.1	140.9	129.7	73.8
V WND LD	lb	157.0	146.0	136.0	126.0	116.0	66.0
H WND LD	lb	78.5	73.0	68.0	63.0	58.0	33.0
A WND LD	lb	73.3	67.8	62.8	57.8	52.8	27.8
MAX AREA	ft^2	3.7	3.4	3.1	2.9	2.6	1.4
3/16-inch Dacron Line and Bolt							
ALLOW	lb	318.3	318.3	318.3	318.3	318.3	318.3
GUY COMP	lb	298.8	288.8	278.8	268.8	258.8	208.8
TRY GUY	lb	334.1	322.9	311.7	300.5	289.3	233.4
GUY STR	lb	687.5	687.5	687.5	687.5	687.5	687.5
GUY LD	lb	334.1	322.9	311.7	300.5	289.3	233.4
V WND LD	lb	298.8	288.8	278.8	268.8	258.8	208.8
H WND LD	lb	149.4	144.4	139.4	134.4	129.4	104.4
A WND LD	lb	144.2	139.2	134.2	129.2	124.2	99.2
MAX AREA	ft^2	7.2	7.0	6.7	6.5	6.2	5.0

Load and wind area spreadsheet calculation of allowable antenna area for various antenna plus rotator weights. The top part of the table shows the dead weights and mast wind loads. The lower parts combine these vectorially to obtain the allowable wind force and the antenna area, for the two types of support pins used. Note the large difference in antenna weight in the last two columns.

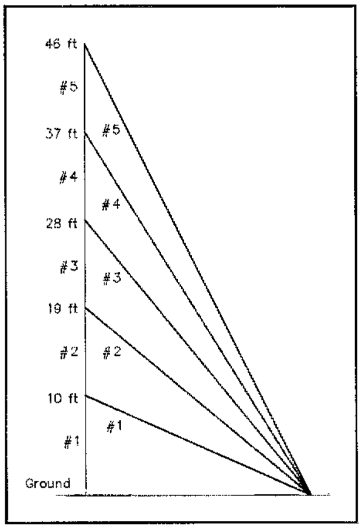


Figure 3—Assumed mast and guy installation. See text for assumption as to guy location.

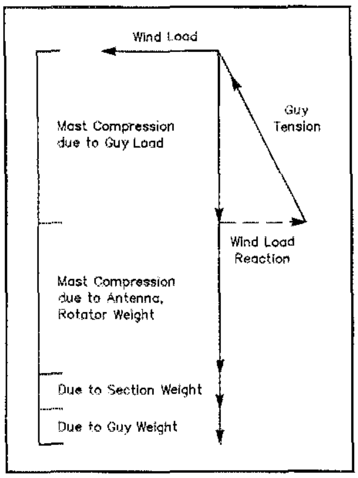


Figure 4—Load vector diagram of top mast section. Lateral wind load is opposed by horizontal component of guy tension. Its vertical component plus dead weights form the compressive load on the mast section. See text for relations.

Wind load × Wind load). For the top section, with the dimensions assumed, the guy tension is 1.118 times the total wind load.

We also need some strength values. The mast section is acting as a column under compression. Since the length/diameter ratio is 9 × 12 ÷ 1.25, or 86.4, the column is a short column. The compression strength is:

Max load = 17000 − 0.485 × length × length ÷ (RadG × RadG) for typical steels. Length is the length of the panel or part of the mast that has no overlap from another section. RadG is the radius of gyration of the section about its long axis. For the thin-wall tubing of these masts:

RadG = (OD − thickness) ÷ 2 (Eq 1)

where OD is the outer diameter of the section.

The other relation we need is the shear strength of the cotter pin. This is:

Max pin load = 15000 × Pin area (Eq 2)

For a 3/16-inch diameter cotter pin, the maximum load is 745 lb (there are two bearing points on the cotter pin, each in single shear).

The allowable working load is equal to the maximum load divided by the safety factor desired. The required safety factor is partly a matter of laws of strength loss due to deterioration, the fact that the largest load encountered grows with time, and engineering judgment. For simple structures where safety is not a direct concern, a safety factor of 4 is often used.

Allowable Section Loads

The relations just given were easily transferred to a spreadsheet for calculation (see Table 1). The last row of the top part is the maximum allowable vertical load on the section, considered as a column in compression.

The second part of this calculation sheet is for safe vertical load with cotter pins. The top row is the allowable shear load on a 3/16-inch-diameter cotter pin. Just below this is the limit load, in all these cases that of the cotter pin. The safe compression load with a cotter pin is shown next. Note that any pin must support the weight of the sections above it.

Because the cotter pin is so limiting, I calculated the maximum shear load of a 1/4-inch stainless-steel bolt as shown in the bottom three lines of the table. This assumes 30,000 lb/in^2 as the bolt strength, so be certain the bolts are *stainless steel*. This allows a load increase factor of about 4. The limit load now is the compressive strength of the top two sections, then the bolt shear strength for the lower ones.

The analysis method assumes that the wind load on the mast itself is transferred to the points of guy attachment. Under conditions of very high winds—or if an intermediate antenna is installed on the mast—bending loads may be appreciable. Analysis of the affected mast section can be made using standard pinned-and-bending relations.

Allowable Antenna Weight and Area

From Table 1, the safe total load on the mast is established by the top section: 175 lb if cotter pins are used and 318 lb with stainless-steel bolts. This safe load must be apportioned into the static and dynamic load. The static load is that due to the weight of antenna, rotator, fittings and guys. The dynamic load is the changeable part, here due only to wind load. This is a way of saying that the allowable area of the antenna goes down as the installed weight goes up.

The easy way to do the apportionment is to assume a static load, then calculate the wind load that uses up the rest of the safe load allowance, using the equations presented earlier. This is easily done by a new spreadsheet, as shown in Table 2. Here, the columns are the values that result from the assumed antenna plus rotator weight, as listed at the top of the numerical column. The top section adds the weight of the mast section and guy, giving the total static load. For convenience, the mast wind load is also tabulated here.

The next group is for the standard installation. The limit strength of the top section is given first (cotter-pin shear). This minus the static load is the allowable compression due to wind. This is converted to a trial guy load, and compared to the guy strength. The smaller is taken as the guy load. This is resolved into the vertical (compression) and horizontal (wind) components. Half the total wind load on the mast section is subtracted to give the allowable antenna wind load, which is then converted to allowable antenna plus rotator wind area.

Table 3
Sample Antenna Types, Weights and Wind Load Areas

Antenna Type	*Weight (lb)*	*Area (ft^2)*
24 el, 2 m	4.5	2.3
3 el, 10 m	9.9	2.0
3 el, 10 m	18.0	3.1
2x24 el, 2 m	21.5	4.8
6 el, 6 m	26.0	4.8
3 el, tribander	27.0	4.4
3 el, 20 m	30.0	5.5
2 el, 40 m	44.0	6.4
4 el, 20 m	55.0	8.1

For small, light, antenna/rotator combinations, the guy strength dominates the dynamic load, limiting the allowable area to 3.7 ft^2 At 50 lb of dead weight, the allowable wind area decreases to 1.4 ft^2.

Remember that the assumed wind load is only 20 lb/ft^2, two-thirds the recommended permanent installation value for most of the country. It is easy to see why these masts are limited to small antennas for long-term use.

The lower part of Table 2 examines the result of using a stainless-steel bolt, and using a guy with a breaking strength of 2150 lb. This is the value for 3/16-inch Dacron line. The strength of 1/4-inch-diameter, seven-strand wire rope with a hemp core is essentially the same. With these changes, the mast can now be used for heavier antennas of greater wind area. The capacity of the standard condition has been doubled, or nearly so.

Several points are important if this extra capacity is used. The safety factor of the entire system has been reduced from normal use factors; in particular, the mast may collapse by guy failure or bending, rather than telescoping together. Additionally, the erection becomes more difficult as size and weight of antenna increase. Extra care is needed.

To get an idea of the range of usefulness of these telescoping masts, we need to look at antenna catalogs. Table 3 presents some figures from several well-known manufacturers. To these should be added the rotator weight: 5 to 10 lb for a small unit.

For temporary use, the small antennas for 10 meters and higher bands are nicely within limits of the "out of the box" mast. But even a lightweight tribander on a beefed-up telescoping mast is pushing the safety limit. You can probably get a full-sized 20-meter Yagi, or a loaded 40-meter Yagi up for a Field Day installation, but you're likely to lose the mast and antenna if a thunderstorm comes up. For permanent installations, a lightweight 10-meter beam should have extra guy and pin strength. Smaller antennas for the higher bands are okay with the standard mast. Be careful: If you must use a large antenna, use a larger mast.

The TV mast itself can be used as a vertical antenna with no additions. Add a set of three to six wires parallel to the mast, and up to a foot or so from it, to form a cage for low loss and improved bandwidth. A bottom insulator of fiberglass cloth and resin can be used, or the cage wires can be fed as a folded dipole. A 3, 6, or even 10-foot capacity-hat is within the design capability of these masts. The usual rules about good grounds apply.

A simple installation for Field Day use replaces the top guys with a pair of 40- and 80-meter dipoles, with end cord added to keep the antenna ends as far above ground as the site permits. With a lightweight tribander at the top, scores will depend more on operators than on installation limits.

Telescoping-Mast Installation

The telescoping mast is designed to be extended in only one way. *The mast must be vertical and the lower section properly guyed before extending the upper sections.* The bad reputation of the telescoping mast is almost completely due to attempts to ignore this simple rule. If you extend the sections, mount the antenna and then attempt to raise the assembly from a horizontal position to the vertical, you'll bend the mast. You may also damage the antenna and injure someone. In fact, the mast may bend if you try to raise it to the vertical while extended, just from its own weight—even if there's nothing mounted on the mast.

The recommended safe procedure is:

• Get a firm footing. For a typical Field Day installation on dirt, this means using a steel plate, with a spike on the bottom to penetrate the earth, and a pin on the top to keep the mast from slipping sideways. Base and tripod mounts for other surfaces are available.

• Mount the collapsed mast, plumb it to the vertical, and guy it with the bottom section permanent guys. A little pre-tension on these guys is a good idea.

• Tie one or two stepladders to the mast, for further work.

• Mount the rotator and antenna, and attach cables and the guys for the upper sections. Be sure that all fastenings are properly made and that the cables and guys won't tangle.

• If the antenna is small and light and there is no wind, an experienced person can get the antenna to a height of 30 feet. For greater heights, or with wind present, two to seven people are needed. Four handle the guys, two on ladders push up the sections and one person handles the clamping screws and the cotter pin or bolt. The guy handlers should not place strain on the guys, but should be prepared to keep the mast vertical. Practicing with the mast only, with no antenna in place, is a good idea.

• Starting with the top section, push it up a foot or two and tighten the clamp screw just enough to keep the section from slipping when released. Take another grip, and raise again, repeating until the stop is reached. Slip the cotter pin or bolt in place. Carefully lower the section until it rests on the pin or bolt. Turn the section until the slots engage. Then, tighten the clamp screw sufficiently to prevent rattling (wear a pair of good leather gloves). Don't use pliers—the screw will dent and deform the inner tube enough so that it will be impossible to lower the mast later.

• Repeat for the next lower section, and so on. If the mast starts to leave the vertical, or the wind picks up, stop, tie the guys temporarily and get help.

• Don't strain, and don't take chances. Even a few pounds falling from 10 or 20 feet can be deadly.

In principle, taking down a mast is easy: Just reverse the erection steps. If the mast is badly rusted, or the sections have been deformed by bending or by excessive clamping, however, this can be a chore—even impossible. If a little work doesn't get the antenna down to ladder height, consider bringing in a crane or ladder truck.

Some Precautions to Take

Always check local building codes when considering the installation of a large antenna or high tower or mast structure. Much trouble and expense can be avoided by staying within imposed limits.

If you're going to use these telescoping masts above their rated TV antenna size and load limits, I recommend running a load analysis with the weights and dimensions involved. When doing this, include such factors as the distance from the top of the mast to the antenna mounting point, and the weight and wind area of the rotator. I recommend you *measure* the size and thickness of the mast sections. Errors in filling orders have occurred.

Remember: Safety First!

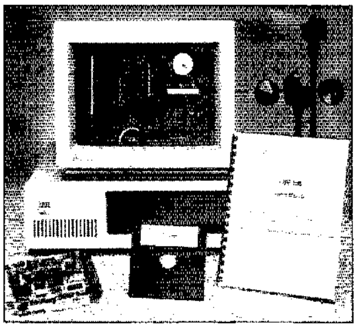
Bob Haviland was first licensed as W9CAK in 1931. He obtained his BSEE degree at Missouri School of Mines in 1939, and his Professional Engineering license in New York.

Bob was project engineer for the first radio transmission from beyond the ionosphere, in 1949, at White Sands, New Mexico, and for the first missile launching from Cape Canaveral, in 1951. He developed ablation (the use of material which goes from solid to gas state) for space-vehicle reentry protection, and initiated programs for recovery of equipment and data from space.

Bob's worked extensively on communication and broadcast satellite concepts, and played a founding role in commercial satellite communication. Between 1959 and 1972, Bob was a member of US delegations to the ITU and CCIR. He served as Chairman, subcommittee for 27 to 1215 MHz, FCC WARC Advisory Committee for Amateur Radio, 1976.

Bob is a Fellow of the Institute of Electrical and Electronic Engineers, the American Astronautical Society and the British Interplanetary Society. He holds eight US patents, and is author of many articles and 14 books, including The Quad Antenna, *CQ Publishing, 1993.*

New Products



WEATHER AND DATA MONITOR INSTRUMENTS

◊ Weather observers, repeater control ops, packet operators and other hams interested in experimentation can check and record atmospheric conditions or other environmental factors remotely by using a PC to operate a remote Environmental Monitoring System. The ENV-100 directly connects to standard 4-20 mA or 0-1 V sensors for data-acquisition applications. It accepts as many as 200 modules linked to one PC serial port. The ENV-100 is a plug-in board for IBM-compatible personal computers and can be easily customized from the keyboard, with no external power supply or other interface device. The onboard clock time-stamps data for later evaluation. It provides a standard RS-232 (EIA-232)/485 multidrop sensor-to-computer interface; programmable setpoints; uses a complete ASCII command set; supports up to six analog-to-digital channels per module; holds 16k of nonvolatile memory for data logging and independent control (32k with $49 upgrade); and comes in a compact, weatherproof case for harsh environments. The ENV-100 can operate alarms, relays and controls via TTL outputs. A four-wire cable delivers power and communications. It operates on 7-30 V dc at 10 mA. An interface kit with *SYS50* software to graphically display, store and manipulate data on a PC, an ac power pack and 60 feet of cable is available for $59.

Remote modules gather data to log information on temperature, humidity, solar radiation, rainfall and barometric pressure (ENV-50-HUM); wind direction and velocity, rainfall and temperature (ENV-50-WDT); and electrical signals of 0-10 V, 0-1 V, 0-2.5 V, 0-100 mV, -5 to +5 V, 0-100 mA and 4-20 mA (ENV-50-VOL). Retail prices: ENV-50-WDT $395, ENV-50-HUM $395, ENV-50-VOL $379, rain gauge with 60 feet of cable $85. Don Preston, SensorMetrics Inc, PO Box 1049, Lakeville, MA 02347; tel 508-946-4904.