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Command Technologies Commander HF-2500 Linear Amplifier

Mosley TA-34-M Triband Yagi Antenna

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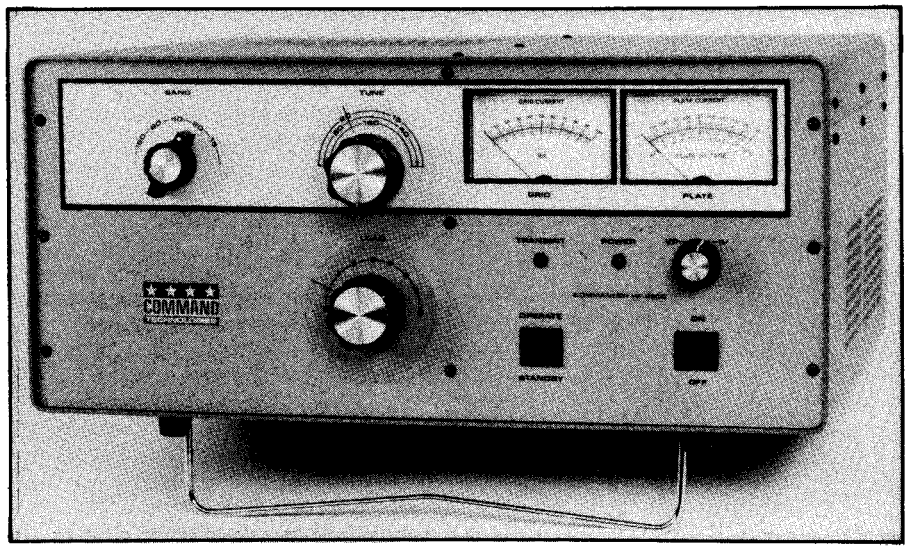

In 1973, when I became a ham, many of my friends owned Heath SB-220 amplifiers. There were a lot of more-expensive amplifiers on the market, and the more-expensive amplifiers offered more features, but you couldn't beat the price-to-performance ratio offered by the SB-220. It was a simple amplifier. You could build one from a kit in a weekend, and with a few modifications[1] it would serve you reliably for years. Many of them are still on the air today. The SB-220 wasn't the most rugged amplifier around—you couldn't put a brick on your key and walk away—but it was *good enough*. If you ran your '220 as intended, you could run the legal limit for a DX-contest weekend without a second thought. At $370, the SB-220 represented one of the best bargains in ham radio, and Heath sold them in droves.

But this is 1991. The 1.5-kW legal amateur power limit is substantially higher than it was in 1973, and $370 will buy just one of the two tubes in the Commander HF-2500 that's the subject of this review. So why all the nostalgia?

While most equipment manufacturers seem to be locked in an ever-escalating race to add features, the hams at Command Technologies have done something radical. In designing the HF-2500, they took a close look at what you really *need* in a linear amplifier. They built in excellent basic performance, reliability and ease of service—and they left out most of the gee-whiz features that are nice but not necessary.

Like the SB-220, the HF-2500 is a well-engineered amplifier that runs the legal limit and will serve you reliably for years. And like the SB-220, I think the HF-2500 is a bargain at its price: $2395. Of course, you may not think that *anything* costing $2395 is a *bargain,* but considering how it's made and how it works, I think the Commander qualifies. Unlike the SB-220, though, it comes preassembled—and you *can* put a brick on your key (using a dummy antenna) and walk away.

The HF-2500 uses a pair of Eimac 3CX800A7 triodes to effortlessly deliver 1.5 kW output on the 160- through 10-meter amateur bands. Its legal-limit power rating applies to continuous-duty modes such as RTTY as well; no time limit is specified. The power supply and RF deck are built into an attractive gray table-top cabinet that is only slightly larger than some modern transceivers. The front-panel labels are printed on durable, damage-resistant Lexan.

[1]R. Measures, "Circuit Improvements for the Heath SB-220 Amplifier," Part 1, *QST*, Nov 1990, pp 25-20; Part 2, *QST*, Dec 1990, pp 41-43.

Inside the Box

The first thing I noticed when I removed the top cover is that the interior layout is neat and clean. For me, the uncluttered interior translates to, "This is something I could work on myself if I had to." The amplifier is made up of several subassemblies, which helps keep manufacturing costs down and makes service easier.

Like most amplifiers, the HF-2500 chassis is divided in half; as you look at the amplifier from the front, the power supply is on the right side, the RF deck on the left. A partition runs down the center, adding structural rigidity and making two shielded compartments.

The tubes sit on a subchassis that covers most of the RF-deck half of the main chassis. The blower, mounted in the power-supply half of the chassis, draws air through slots in the sides and bottom of the cabinet, over the power transformer, and blows it directly into the chassis that supports the tubes. Pressurized air enters the RF chassis at the base of the tubes, is directed through the 3CX800A7 anode coolers by Delrin chimneys, and leaves through holes in the cabinet top.

Tuned input circuits (T match, Q of 5) afford good linearity and provide a good match for the exciter. The input circuitry is mounted inside a shielded box on the rear chassis wall. Relays controlled by a wafer on the band-switch shaft select the correct input network. The tuning capacitor for each input network is adjustable from the rear panel so you can fine tune the input SWR, if necessary, without opening the amplifier.

The HF-2500's massive band switch is a work of art. It has two heavy-duty ceramic sections sporting *solid* coin-silver contacts. Switch positions are included for 160, 80, 40, 20, 15 and 10 meters. Use the 15-meter position for 17 meters and the 10-meter position for 12 meters.

The tank circuit is a bit unusual. It uses a pi network on all bands to transform the plate (anode) load impedance from about 1400 ohms to 200 ohms. Then, a 4:1 transformer wound on a ferrite core makes the transformation to 50 ohms. Think of the 4:1 transformer as a broadband L coil in a pi-L network. A side benefit is that the transformer provides a dc path to ground; should the anode dc-blocking capacitors short, high voltage is shunted to ground, rather than to the RF-output jack.

Tuning and loading capacitors are both air-dielectric variables. The split-stator tuning capacitor cleverly allows smooth, broad tuning on all bands without the expense of a vacuum variable or the complexity of switching in a bunch of fixed capacitors (except on 160 meters).

FCC regulations limit the Commander's coverage to 160 through 15 meters as supplied from the factory. If you supply Command Technologies with a copy of your amateur license, they'll tell you how to add 10- and 12-meter coverage. This simple modification can be made in a few minutes and requires no special tools or soldering.

Most of the power-supply side of the chassis is taken up by the power transform-

Table 1
Command Technologies Commander HF-2500 Linear Amplifier, Serial No. 228

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 160, 80, 40, 20, and 15-meter amateur bands (10 meters included on export model).	As specified, plus 17 meters (can be modified for 12- and 10-meter operation by licensed amateurs).
Power output: 1.5 kW PEP, keyed CW or continuous carrier.	As specified.
Driving power required: 50-80 W for 1.5 kW output.	33-64 W for 1.5 kW output.
Spurious signal and harmonic suppression: Exceeds all FCC requirements.	As specified. See Fig 1.
Intermodulation distortion (IMD): not specified.	See Fig 2.
Power requirement: 220-250 V ac, 20 A max.	Not measured.
Color: Two-tone gray.	
Size (height, width, depth): 7.75 × 18 × 16 inches.	
Weight: 65 lb (with standard transformer installed).	

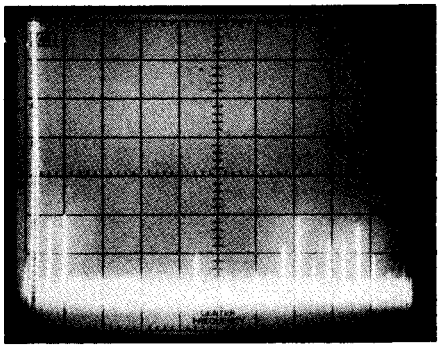

Fig 1—Command Technologies HF-2500 worst-case spectral display. Horizontal divisions are 10 MHz; vertical divisions are 10 dB. Output power is approximately 1.5 kW at 1.9 MHz. All harmonics and spurious emissions are at least 50 dB below peak fundamental output. The HF-2500 complies with current FCC specifications for spectral purity for equipment in this power-output class and frequency range.

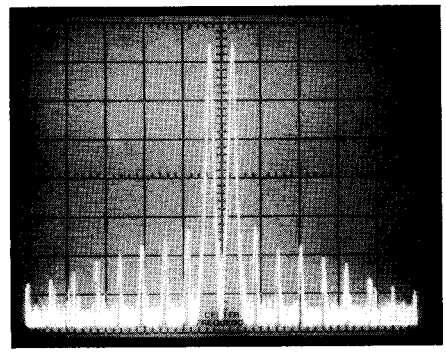

Fig 2—Worst-case spectral display of the HF-2500 during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 53 dB below PEP output, and fifth-order products are approximately 56 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The amplifier was being operated at 1.5 kW PEP output on 14.2 MHz.

er and blower. PC boards on the rear side wall and below the meters hold the control circuitry.

The standard 36-pound transformer takes 220-250 V ac input and provides 900 V ac output, which is fed to a full-wave doubler and a filter made from eight 220-μF, 450-V electrolytic capacitors. The voltage doubler, filter capacitors and bleeder resistors are located in the pressurized compartment underneath the tubes to ensure cool operation and long component life. A 29-pound Hypersil transformer is available as an option. The Hypersil transformer has the same electrical ratings as the standard unit; its main advantages are lighter weight and quieter operation (less hum) at high output.

Control Circuitry and Protective Features

The power transformer is switched on and off by a pair of solid-state relays. The relays conduct only at zero crossings of the power-line voltage, minimizing surge current while the filter capacitors charge. This method provides start-up surge protection without using a lot of parts. Resistors in the B+ and B− leads provide protection in case of a high-voltage arc.

If you're the kind of operator who waits until the last second to turn your amplifier on, you may miss a few contacts with the HF-2500. At turn-on, there is a two-minute delay while the indirectly-heated 3CX800A7 cathodes warm up. During the warm-up period, it's impossible to place the Commander in the transmit mode. The warm-up period is vital to prolong tube life.

When the top cover is removed, a switch cuts power to the primary control relays. There is no high-voltage shorting bar, though. On the review amplifier, the high-voltage meter reads zero within 90 seconds or so of powering down, so it would be difficult to remove the top cover before the bleeder resistors have done their work, unless you have already removed most of the cabinet screws (*not* a good idea). The manual warns you to wait at least an hour after turning off the amplifier before delving inside the box.

The front panel features two analog meters. The meter on the left is a dedicated 100-mA grid-current meter. The one on the right can be switched to display anode current (up to 1.5 A) and high voltage (3 kV, maximum). No capability for power-output or SWR measurement is built in. This didn't bother me because I own several power meters and have rarely used the power meters built into other amplifiers I've used. A number of peak-reading wattmeters were reviewed in February *QST*.[2]

Setup and Operation

The review HF-2500 arrived in two cartons, each weighing about 40 pounds. (The transformer is shipped separately to prevent amplifier damage during handling.) Installation of the transformer requires removing the top and bottom covers, bolting the transformer to the chassis and connecting a multipin connector. It's not difficult, but it requires some patience to get the nuts and lock washers on. As long as you have the covers removed, it's a good idea to check for parts that may have come loose, or other shipping damage.

The manual says that the HF-2500 requires 220-250 V ac at 20 A, although the primary is fused at 15 A. You supply your own power plug. There is no provision for running the amplifier on 120 V.

Rear-panel connections include UHF jacks for RF input and output, and phono jacks for ALC and TR-relay control. Your transceiver's amplifier-control line must be able to handle 12 V dc at 100 mA—well within the capabilities of most modern radios.

It takes only about 50-60 watts—½ to ⅓ the output of most modern transceivers—to drive the HF-2500 to 1.5 kW output. The manual warns, "Never operate this amplifier without the ALC connected. Most modern exciters have sufficient output power to seriously overdrive the amplifier. This may result in damage to expensive components."[3] The cathode circuit is fused for protection in the event of massive overdrive, but *heed the manual's warnings.*

It's important that you pay close attention to the grid-current meter during tun-

[2] J. Healy, "*QST* Compares: Peak-Reading MF/HF Wattmeters," *QST*, Feb 1991, pp 33-36, 63.

ing. As with other amplifiers using modern high-mu triodes, grid current can rise abruptly with small changes in power input and the settings of the tuning and loading controls. The 3CX800A7 grid is capable of dissipating only a few watts, and you can damage the tubes if you're not careful. The HF-2500 lacks a "grid-trip" circuit to put the amplifier into standby in the event of excessive grid current.

Rough Edges

We had only one problem with the review HF-2500. During testing, the power transformer failed, filling the ARRL lab with smoke. Fortunately there was no fire or damage to any of the amplifier's other components. Pat Stein, N8BRA, of Command Technologies, explained that our problem was an isolated one that he had traced to a defective batch of 25 transformers—most of which were still in his shop. He immediately shipped us a Hypersil transformer to use until a replacement standard transformer was available. Both the Hypersil and the replacement standard units have worked flawlessly.

The instruction manual could use some work. Although the 8-page manual has most of the information needed to operate the HF-2500, I'm glad that I've had previous experience with vacuum-tube power amps. Examples: I think that the tune-up instructions should include a strong caution about watching grid current, given the price of the tubes. Nowhere could I find a maximum plate-current rating, or typical current and anode-voltage values for an amplifier that is properly tuned. The manual also does not mention operation on 17 or 12 meters.

On the plus side, Command Technologies provides excellent customer telephone support to work through questions.

Summary

During two months of frequent use, the Commander HF-2500 came to be a reliable friend. I brought the rig home in time for the ARRL RTTY Roundup contest in January. The manual said 1.5 kW, continuous duty, with no specified time limit, so I dialed up 1.5 kW and called CQ on Baudot RTTY. I worked stations continuously for about three hours on 15, 20 and 40 meters—no complaints from the HF-2500. During the next couple of months, I used the amplifier extensively on SSB and CW as well. It's easy to tune and a pleasure to use.

The HF-2500 is a well-designed, well-made piece of gear. It comes with a 5-year limited warranty (100% parts and labor the first year; 50% the second year; 25% from the third through the fifth year). The HF-2500 warranty doesn't cover the tubes, which are warranted by Eimac. Through smart engineering, and by leaving out some of the bells and whistles (and making others optional, such as vacuum-relay QSK and a Hypersil power transformer), Command Technologies offers an amplifier that provides excellent basic performance at an attractive price. If you're in the market for a legal-limit amplifier, this one should be high on your list of candidates.

Manufacturer's suggested retail price: $2395; optional Hypersil transformer, add $200; optional QSK circuit, add $200. Manufacturer: Command Technologies, 1117 High St, Bryan, OH 43506, tel 800-736-0443.

[3]The amplifier's ALC circuitry protects the tubes, but it doesn't prevent the splatter that SSB overdrive causes. See R. Measures, "Amplifier-Driver Compatibility," *QST*, Apr 1989, pp 17-18, 20.

MOSLEY TA-34-M TRIBAND YAGI ANTENNA

Reviewed by James W. ("Rus") Healy, NJ2L

If you're looking for a way to make a step up from wire antennas, a low-power tribander or one or two small monobanders, and you want a single antenna that performs well on the 14, 21 and 28-MHz bands, you have a lot of choices. A single triband Yagi makes sense, because in addition to providing three-band coverage, it allows installation of a VHF or UHF beam on the same mast. A four-element design is attractive, because it's easily side mounted and rotated around a tower. All the major antenna manufacturers have at least one antenna that probably fits your size, weight and price requirements, but what of ruggedness and performance?

Unfortunately, antennas are inherently difficult to evaluate under controlled circumstances. Every antenna review is more subjective than a transceiver review, for instance, because there's no readily available comparison standard or battery of lab tests to put antennas through. Most manufacturers emphasize claimed gain, which is all but unverifiable. Gain is low on my list of priorities when I'm shopping for a tribander, because construction quality, ease of assembly and other such considerations are far more important to me than a quarter or half of an S unit of signal strength. Mechanical complexity can spell trouble for even the best electrical design. The smart money's on an antenna that will stay up for years, performing without trouble.

That's Mosley's philosophy. They elect to make antennas that are mechanically simple and rugged; all those TA-33s and CL-33s that have been up for 15 or 20 years and still work like new are testaments to the wisdom of this approach. Mosley's reputation for constructional ruggedness is well earned.

Physical Design and Assembly

The four-element TA-34 Yagi is designed to cover the 14, 21 and 28-MHz ham bands with low SWRs across these bands. It uses one trap in each element half.

The TA-34 is shipped via UPS in a seven-foot-long box. Supplied with the antenna are complete assembly instructions, stainless-steel hardware and copper lock washers, plastic caps to keep critters and wind out of the element and boom ends, and a small tube of Penetrox conductive anti-seize lubricant. The antenna's 21-foot boom is made up of three sections that are spliced with 2-foot-long inner sleeves and pinned with ¼-20 hardware. The TA-34-M, the standard model, uses a 1½ × 0.12-inch-thick boom that requires a truss to minimize sag. A larger-boom model, the TA-34-XL, which needs no boom truss, is also available.

All the TA-34's pieces are predrilled and color coded at the factory to speed assembly. Even the boom is color coded to show you where to mount each element. It took me less than an hour to assemble the antenna after removing it from the box, and all I needed to do so was a flat-bladed screwdriver and a couple of wrenches.

Mode Selection and Parasitic Elements

All of the antenna's elements are drilled for CW and SSB operation; you select which set of dimensions to use during assembly. I set the antenna up for CW, thinking that its bandwidth would be narrower than it turned out to be, as I'll dis-

Table 2
Mosley TA-34-M Triband Yagi Antenna

Manufacturer's Claimed Specifications	*ARRL Evaluation*
Antenna type: Trapped 4-element Yagi.	As specified.
Frequency coverage: 14, 21 and 28-MHz bands standard, 18/24-MHz, and 10 or 7 MHz optional.	As specified.
Boom: 21 ft long, 1.5 in. diam × 0.12 in.	As specified.
Longest element: 27 ft, 4.5 in.	As specified.
Turning radius: Not specified.	Approximately 17 ft.
Power-handling capability: 1 kW CW, 2 kW PEP.	As specified.
2:1 SWR bandwidth: Not specified.	14 MHz, 350 kHz; 21 MHz, 450 kHz; 28 MHz, >1 MHz.
Weight: TA-34-M, 58 lb; TA-34-XL, 68 lb.	

cuss a bit later. Closest to the boom in the reflector and directors are six-foot-long sections of aluminum tubing into which the element halves slide. The single **U** bolt that attaches each parasitic element to the boom holds all this together, so that each element has two thicknesses of tubing three feet out on both sides of the boom. Element sag is minimal. Cast-metal blocks with concave surfaces for the boom and elements mount between the boom and each parasitic element for a secure mechanical connection that doesn't put undue stress on the elements or the boom.

Sheet-metal screws keep the traps in place and hold the element-tip sections into the traps. Even with its lightweight boom, the TA-34-M weighs 58 pounds, partly because of the ruggedness of the elements.

The Driven Element

Much like the older Mosley TA-33 and CL-33 tribanders, the TA-34 uses dense plastic insulator blocks to support the driven-element halves on a piece of rectangular aluminum channel attached to the boom by two **U** bolts. The insulator blocks have threaded metal inserts on their concave upper sides, where the element tubing mounts to them. On their flattened bottom sides, where they mount to the aluminum channel by means of two no. 8 screws each, the blocks lack these inserts. The assembly instructions caution you to be careful to not over-tighten these screws, which would strip the blocks. Even though I paid attention to this caution, I managed to strip one of the holes. A replacement block from Mosley cost only $4.70, so I wasn't terribly upset. (If I were taking this antenna on a DXpedition, I'd get an extra insulator block or two from Mosley beforehand!)

A coaxial feed line (Mosley recommends RG-8) attaches to the driven element via the inner pair of screws that hold the element halves to the insulator blocks. One of the element halves is grounded to the boom via an aluminum strap, but the other half floats. Even though precipitation static isn't a problem in my installation (the antenna is up only 35 feet), it's a good idea to place an RF choke across the feed point to bleed potentially receiver-damaging static charges from the driven element. Mosley doesn't address this issue in their TA-34-M documentation.

No balun is provided with the antenna, so I used a choke balun (a few turns of feed line on a plastic bleach bottle), taped to the boom near the mast, to keep RF off the outside of the coax shield.

Boom-to-Mast Attachment

The TA-34-M attaches to a mast by way of its heavy-duty boom-to-mast plate and six stainless-steel **U** bolts. Four of these, along with solid, cast-metal saddles, secure the boom to the plate; the other two, using similar saddles, hold the plate to the mast. The stock **U** bolts accommodate masts up to 2 inches in diameter.

A rope truss supports the TA-34-M's boom, minimizing sag. The antenna is supplied with the rope and hardware to attach the truss to the mast three or four feet above the boom. Thimbles are included for the mast-end attachment points, but you have to tie the truss ropes to the ends of the boom before raising the antenna (no attachment hardware is provided for these ends). Although the boom-truss rope doesn't stretch or noticeably deteriorate with exposure to the elements, the frequency with which you need to adjust the truss depends on your knot-tying proficiency.

Because even the standard TA-34-M is heavy, it's important to mount the boom-to-mast plate at the antenna's balance point, or you may have trouble keeping the antenna in place while securing it to the mast. The balance point is easy to find, because the elements are almost equally spaced on the boom, but be sure to attach the feed line and recheck the balance before clamping down the boom-to-plate **U** bolts.

Performance

After installing the antenna, I was pleased to find that its SWR was low across all three bands. Because of interaction with a 40-meter dipole that was mounted close by, the SWR varied somewhat with beam headings, but was below 2.5:1 (except above 29 MHz) across all three bands in its first installation. Generally, the SWR was below 1.5:1 (even with a very short, low-loss feed line), which should please even the most finicky solid-state transceivers. When I moved the antenna to a second tower, well away from other antennas and conductive objects, the SWR curves looked even better, and had more pronounced dips.

The TA-34-M's gain compares favorably with other Yagi antennas. Its front-to-side ratios are also good, but its front-to-back is a somewhat disappointing 10 to 15 dB in most cases. A Mosley engineer told me that setting up the antenna for SSB operation would probably yield better front-to-back performance, but I didn't try this (it'd be quite difficult to do this while the antenna is on a tower). Judging by the antenna's bandwidth when adjusted for CW operation, it seems that, when it's adjusted for SSB, the TA-34 should cover the CW band segments with low SWR. So, if what Mosley tells me is correct and high front-to-back ratio is important to you, set your TA-34 for the SSB dimensions.

Options and Concerns

Several variations on the basic TA-34 are available in addition to the heavy-duty-boom version. A model with 12- and 17-meter coverage is available in standard- and HD-boom dress (TA-34-WARC and TA-34-XL-WARC). Add-on kits for 30 and 40 meters are also available. The 30- and 40-meter kits add traps, extra aluminum and extra weight to the driven element only, and are supplied with trusses to support the heavier driven-element assemblies. Only one of these two bands can be added to a TA-34. The WARC-suffix models and add-on kits for existing TA-34s provide a second driven element that functions as a rotatable dipole on 12 and 17 meters.

The review antenna was shipped missing four of its eight traps. The antenna's packaging was intact, so the traps weren't lost or removed in transit. Mosley sent replacement traps right away, but wasn't quick to accept that the antenna had been shipped without them. They pride themselves on quality control, and claim to be able to tell by weighing the packaged antennas whether even a single nut is missing. Still, everyone makes mistakes. My discussions with other Mosley-antenna owners indicate that such problems are very rare.

Two other TA-34-M users, Chet, N8RA, and Rich, K1CC, have commented that the TA-34-M's 1-1/2-inch-OD boom seems undersized for the task of supporting the antenna's four elements. Handling the antenna and watching it in a stiff breeze, and its performance through two New England winters, though, indicate that the 1/8-inch-thick boom is more than up to the task. I didn't test any of the added bands on the review TA-34-M, but if I was to add the 12/17-meter kit, or the 30- or 40-meter kit, I'd opt to replace the boom with the larger one at the same time.

Summary

The TA-34-M performs as I'd expect a 21-foot-boom tribander to. It works impressively on all three bands, faring about as well as three-element monobanders at the same height, and has great flexibility in that you can add the 12/17, 30 or 40-meter bands. In the Mosley tradition, it should be a very low-maintenance antenna for years.

I recommend the TA-34-M without hesitation. Thanks to Chet Slabinski, N8RA, Dan Street, K1TO, and Rich Assarabowski, K1CC, for their comments and assistance. All Mosley antennas are sold direct from the factory only. Manufacturer's prices: TA-34-M, $395.95; TA-34-XL, $499.95; TA-34-M-WARC, $467.95; TA-34-XL-WARC, $540.95; TA-40-KR (40 meters) or TA-30-KR (30 meters), $114.95; 34-M-WARC kit, $135.95; 34-XL-WARC kit, $140.95. Manufacturer/dealer: Mosley Electronics, Inc, 1344 Baur Blvd, St Louis, MO 63132, tel 314-994-7872.

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