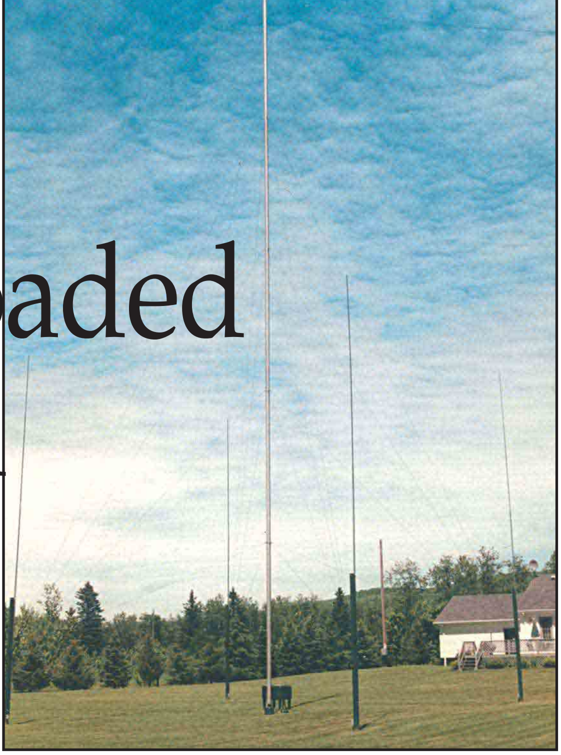
By Dave Bowker, K1FK

A 75 foot Top Loaded Vertical Antenna



Some ideas and techniques for constructing and installing a large vertical element antenna system for 160 and 80 meters.

I have used this 75 foot top-loaded vertical ground plane antenna for several years now. The construction and installation techniques described can be adapted to similar designs.

Main Element Construction

The main element is constructed of 5 inch diameter (0.08 inch wall thickness) aluminum irrigation pipe, an 80 meter trap, four sloping top loading wires for 160 meters, and a four-point guy system that enables the element to be erected safely by a single person. Four 30 foot lengths of pipe are required—three to construct the main element and splices, and one for use in erecting the completed assembly. Two 30 foot lengths and a 15 foot length of pipe comprise the main element structure for an overall height of 75 feet. Top and side views are shown in Figure 1.

The lengths of irrigation pipe are modified for splicing sections together by removing the end couplings from each end with a hack saw.

The splice couplers, consisting of 48 inch long doublers made from the same pipe, are prepared by removing a ½ inch wide linear strip along the length of the section. The coupler is compressed to a smaller diameter by hose clamps, lubricated liberally with WD-40 and driven 24 inch into one end of the main element using a sledge and a piece of wood to protect the driven end of the doublers as shown in Figure 2. The clamps are progressively loosened and moved towards the driving end as the coupler is inserted into the main element.

After insertion into the main element, the coupler is riveted into place using eight ⅛ inch pop rivets spaced equally around the circumference of the element and spaced ½ inch from the end, as shown in Figure 3. Another set of eight rivets is placed 22 inches from the end of the main element to secure the lower end of the coupler to the main element. Finally eight rivets are placed linearly along the coupler seam, four equally and alternately spaced along each side of the seam.

The other end of the coupler is compressed with the hose clamps and the next main element section is driven onto it until the two main element sections mate. The riveting procedure described above is repeated to finish the spliced joint. Details of the rivets placed along the coupler seam can be seen in Figure 4.

Trap Construction

The trap serves to decouple the 160 meter top loading wires from the main element on 80 meters and allows the element to function as a 75 foot vertical on that band. The trap is constructed of a 12 inch length of 4 inch Schedule 80 CPVC pipe (outside diameter = 4½ inch) wound with 7¾ turns of PVC jacketed RG-213 coax.[1] Schedule 80 CPVC pipe is required for its mechanical properties (greater wall thickness) to support the top loading wires which also function as top guys. If only Schedule 40 PVC pipe is available, two pieces may be used, one slit and formed into a doubler similar to the doublers used to splice the main element sections, and bonded into place with CPVC cement.

[1]Notes appear on page 39.

A ½ inch diameter hole is drilled into the top of the form approximately 1½ inches down from the top to anchor the top end of the coax winding. Starting with an 11 foot length of coax, wind 7¾ turns onto the form and mark the position where the bottom of the winding will be terminated, remove the coax and drill another ½ inch hole to terminate the bottom of the winding. Prepare one end of the coax by stripping 4 inches of insulation from it and extracting the inner conductor from the braid as shown in Figure 5. Insert this end into the bottom hole of the form so ½ inch of insulation protrudes inside the form and tightly wind the 7¾ turns toward the top of the form. Insert the top end of the coax into the terminating hole and pull taut. Cut the coax inside the top of the form so 4½ inches remains and again remove the winding from the form and prepare the remaining end of the coax as described above.

The coax is now ready to be permanently wound onto the form using CPVC cement to bond each turn to the form as it is applied. Insert one end of the winding into the bottom termination hole with ½ inch insulation protruding inside the form and apply a liberal amount of cement in a strip about 1 inch wide around the circumference of the form and wind two turns tightly, holding in place while the cement sets. Continue this process until the top of the form is reached but do not cement the top turn to the form. Insert the top end of the winding into the top termination hole.

Temporarily connect the coax leads inside the form to effect a parallel tuned trap and check for resonance around

3.6 MHz using a grid drip meter, adjusting the spacing of the top turn to achieve resonance in this frequency range. Once resonance is achieved, the top turn may be cemented in place. Check for final resonance then apply several liberal coats of CPVC cement over the entire coax winding and seal the termination holes in the form as shown in Figure 6.

The trap leads are permanently connected and soldered inside the form, wrapped with PVC electrical tape and given several coats of CPVC cement. The

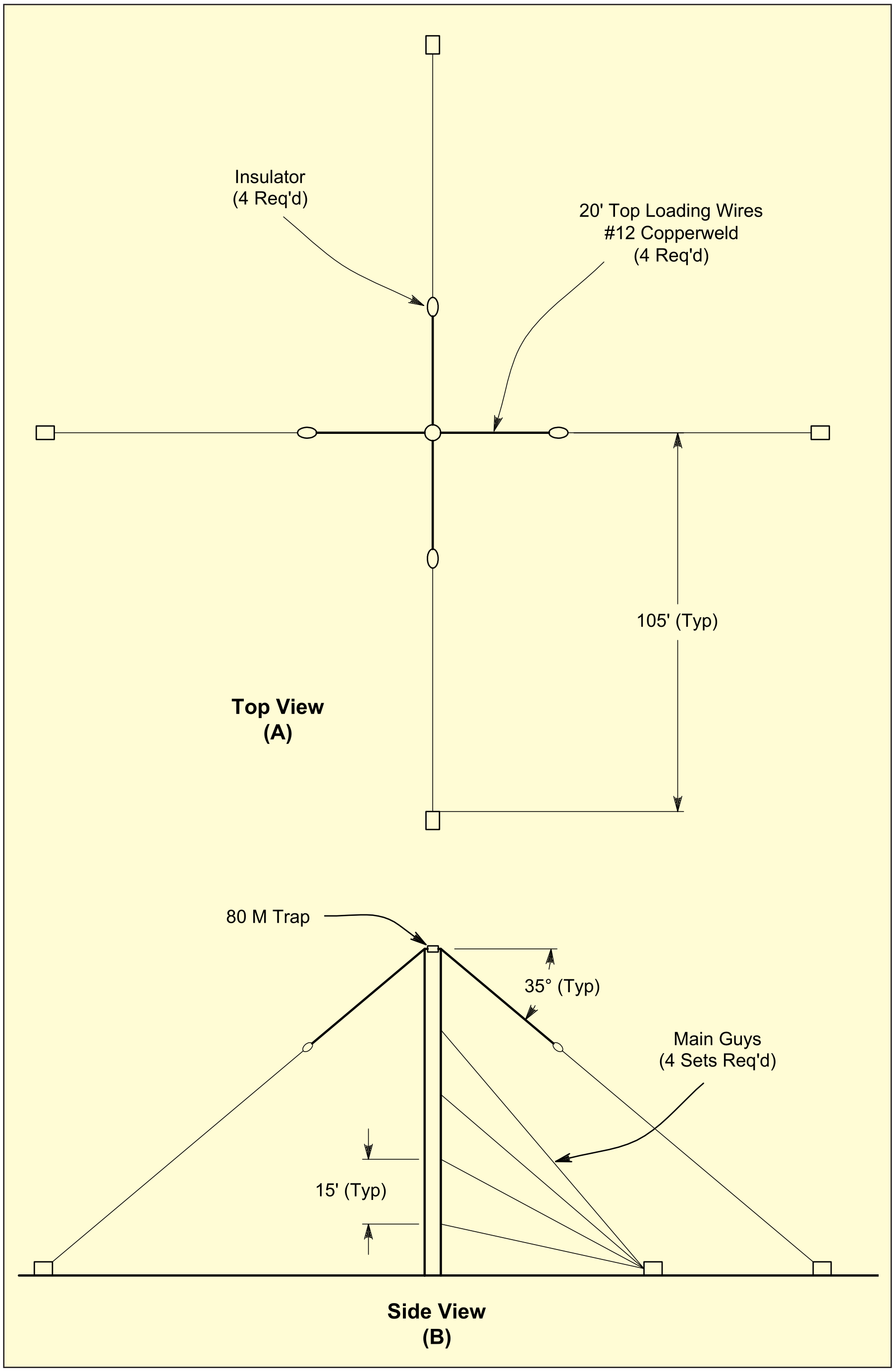


Figure 1—Top view (A) and side view (B) of the vertical antenna.

Figure 4—The guy clamp attached to the main element.

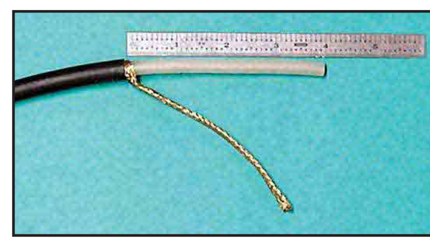


Figure 5—Preparation of the coax trap ends.

Figure 6—Completed 80 meter trap assembly ready to install.

Figure 2—The doubler ready for insertion into the main section.

Figure 3—The doubler riveted into place.

Figure 7—The 80 meter trap installed on the main element.

bottom of the trap is connected to one of the three bolts which will attach the trap to the inside of the main element. Four leads of flexible braid are soldered to the top of the trap. Four 1/4 inch diameter holes are drilled 3/4 inch from the top of the form to four eyebolts that secure the top loading wires. Another hole is drilled next to each eyebolt to pass a lead from the top of the trap and connect to each loading wire.

The trap is bolted into the top of the main element, leaving a spacing of approximately 1 inch between the bottom of the trap winding and the top of the element, as shown in Figure 7. An aluminum cover is installed over the top end of the trap to prevent rain, snow and bird droppings from entering into the element connections. The trap-to-element joint is sealed with RTV adhesive.

Guy Brackets

Four sets of guy brackets are constructed from 0.040 inch 6061-T6 or equivalent aluminum sheet and stainless hardware as shown in Figure 8. Each bracket consists of four sections configured to support the cable thimbles to prevent chafing of the 3/16 inch double braided black Dacron rope guys. The brackets are attached to the main element at 15 foot intervals. After aligning and bolting into place with the bracket bolts, eight rivets are installed to prevent slippage of the bracket—shown in Figures 4 and 8.

Top Loading Wires

The top loading for 160 meters is constructed from four thimbles inserted into the eyebolts, four lengths of #12 copper weld wire and four end insulators. The trap leads are silver soldered to the loading wires, leaving sufficient slack in the flexible leads to facilitate movement without breaking during installation. The wires are cut to length and insulators attached. The exact length of the loading wires depends upon several factors, including their slope angle as shown in Figure 1, the surge impedance of the main element and ground system parameters. The lengths may need adjustment during installation and testing to bring the element into resonance at or near the 160 meter band.

Information for calculating top loading and loading wire length for various configurations is available in the amateur antenna literature.[2] The exact frequency of resonance is not critical. The base impedance of the final installation will be measured. An L network is designed and adjusted to match the final base impedance to the 50 Ω transmission line.

Base Insulator, Guy Anchors and Guy Lines

The vertical requires four guy anchor points arranged in a square and four sets of main guys constructed of 3/16 inch double braided black Dacron rope. Each of the guys must be adjusted to precise lengths to facilitate raising the element to the vertical position. The top set of guys holding the 160 meter top loading wires should be anchored at a distance from the center of the square which will maintain the proper angle. For a 35° angle this distance will be 105 feet, as shown in Figure 1.

The base insulator pier must be located in the center of a square, the corners being the guy anchors. The location of the guy anchors relative to the insulator pier can

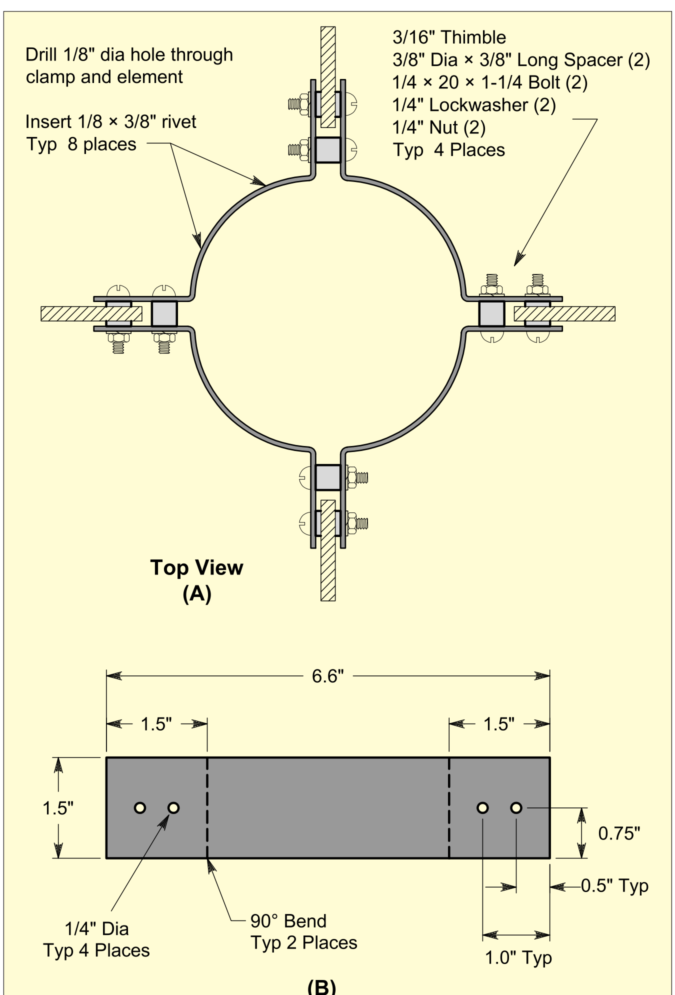


Figure 8—Guy clamp assembly details. At A, top view of complete guy clamp assembly. At B, guy clamp section flat pattern layout (four required per clamp assembly).

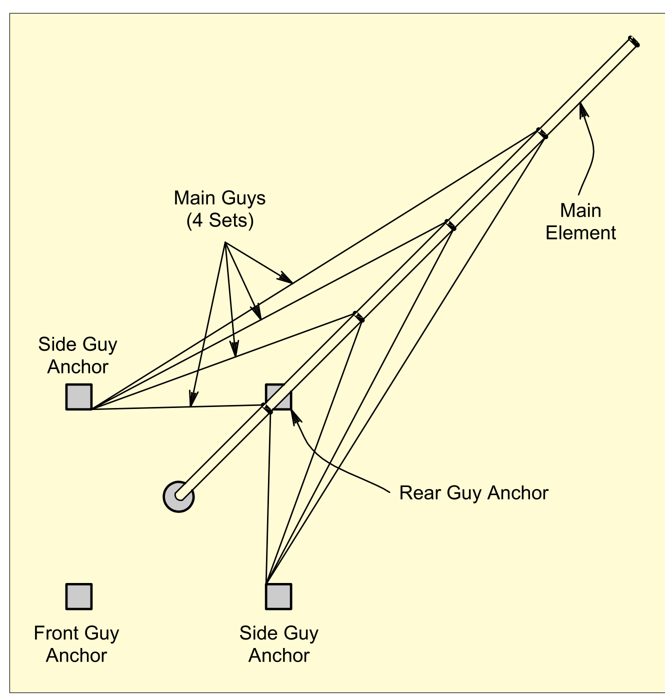


Figure 9—Layout for cutting and attaching guys. Top loading wires and guys are attached, but are not used for raising the element. They are not shown here. Only the side guys are shown to enhance clarity. The front and rear guys are the same length as the side guys.

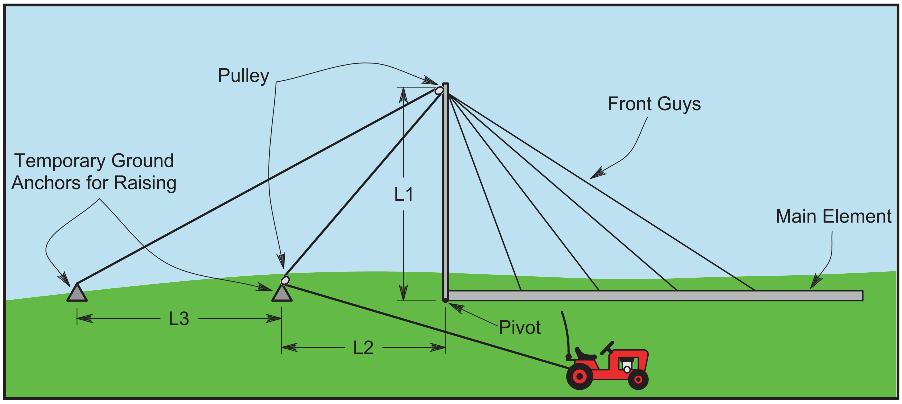


Figure 10—Layout of derrick for raising the element. L1=the length of the derrick boom. L2=L1. L3=any length greater than L2.

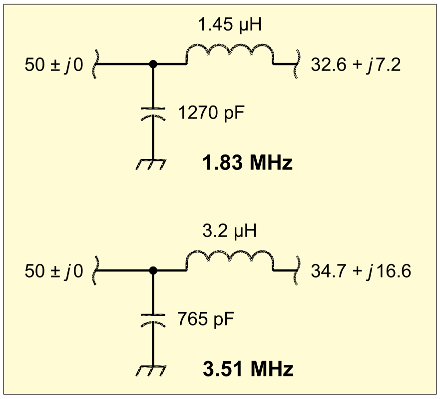


Figure 13—Typical L network values for matching.

Figure 11—Raising the element.

Figure 14—L-network for 160 meters (right of center) and 80 meters (far right of center).

Figure 12—Two views of the pivot fixture for positioning the base insulator.

be any convenient distance. The length of each guy may be calculated—alternatively, the base of the main element may be positioned over the insulator pier with the element laid across one of the guy anchors. Each guy rope is attached to the element and stretched taut to the side anchors as shown in Figure 9. The front and rear guys are cut to the same lengths as the side guys and the rear set of guys is attached to its respective anchor. The front set of guys will be attached to the derrick boom at a distance equal to the distance from the pier to one anchor. The top loading wires and guys are attached to the trap but are not used for raising the element to the vertical position.

The base insulator I used can be seen just below the pivot fixture in the right side photo of Figure 12. It consists of a surplus porcelain insulator and a machined aluminum plate upon which the main element rests. A substitute insulator can be made from a 4 inch length of 2 inch diameter (or larger) Schedule 80 CPVC pipe and two end caps.

Installation

The element is raised using a derrick, a 2:1 mechanical advantage block and tackle, a pivot fixture and a garden tractor. The derrick boom length should be at least equal to half the length of the main element and arranged to pivot with the element at the base insulator pier. Figure 10 illustrates the mechanical arrangement of the derrick boom, block and tackle, and garden tractor.

The derrick boom is guyed to the two side guy anchors for lateral stability during erection. The front guys are attached to the derrick boom at a distance up the boom equal to that from the base insulator pier to the front guy anchor. Figure 11 shows the actual raising of the element in progress.

Once the element is vertical (and the derrick boom horizontal), the front guys are removed from the derrick boom one at a time, starting with the lower guy, and attached to the forward guy anchor. After all guys are secured to their respective anchors, two hydraulic jacks are placed under the pivot pin, the pivot fixture is unbolted from the base insulator pier, and the main element is raised with the jacks sufficiently to permit the pivot fixture to swing out to the side while the base insulator is bolted into place. The jacks are then lowered to position the element onto the insulator and the pivot pin is removed. See the photos in Figure 12.

Matching Network

After the main element and ground system installation is completed, the feed point impedance is measured at the center of the operating frequency range on both bands. An L-network is designed, fabricated and installed at the base of the element for each band. Design of the L-networks may be accomplished with the aid of formulas in *The ARRL Antenna Book*[3] or readily available computer software.

The ground system consists of 120 1/4-wavelength radials laid in the sod. My ground scheme also takes advantage of the additional ground system of my 40 meter phased array, that consists of an additional 120 1/2-wavelength radials under each element. The two ground systems are bonded together wherever they cross and form a very low loss system. The measured feed point impedance of my vertical working against this ground system is 32.6 + j7.2 at 1.83 MHz and 34.7 + j16.6 at 3.51 MHz. The networks required to match these impedances to the characteristic 50 ± j0 impedance of the feed line are shown in Figure 13.

Completing the installation, the matching networks are contained in the same doghouse as the phasing and matching networks for my 40 meter phased array and Beverage switching components. They are shown on the right side of the doghouse in Figure 14. Vacuum variable capacitors and vacuum relays are used for reliability under extreme environmental conditions.

Acknowledgments

Thanks to Tony Trice, WØTY, for his suggestions in fabricating the splice couplers and review and critique of the manuscript.

Notes

[1]Belden 8267 or equivalent. Coaxial trap construction details can be found in Chapter 7 of the latest edition (20th) of *The ARRL Antenna Book*, p 7-15.

[2]*ON4UN's Low-Band DXing*, Third Edition, The American Radio Relay League, 1999, §3.6.3. Available from the ARRL Bookstore for $28 plus shipping. Order no. 7040. Telephone toll-free in the US 888-277-5289, or 860-594-0355, fax 860-594-0303; **www.arrl.org/shop/**; **pubsales@arrl.org**.

[3]*The ARRL Antenna Book* is available from the ARRL Bookstore for $39.95 plus shipping. Order no. 9043. Telephone toll-free in the US 888-277-5289, or 860-594-0355, fax 860-594-0303; **www.arrl.org/shop/**; **pubsales@arrl.org**.

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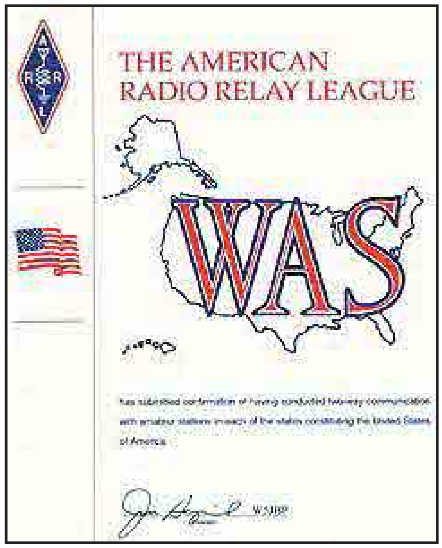
STRAYS



◊ The Worked All States award is given for submitting confirmations from all 50 states. Aside from the basic certificate for any combination of bands/modes, specialty certificates are issued for a variety of different bands and modes such as Satellite, 160 meters, SSTV, Digital and each VHF band. Available endorsements include CW, Novice, QRP, Packet, EME and any single band. The Digital and Phone awards are available for the various modes. They will be dated but not numbered. Cards are checked by a volunteer ARRL HF Awards Manager affiliated with ARRL Special Service Clubs (although QSL cards can be checked at HQ, absent an awards manager). To encourage increased activity and station improvement throughout the bands, the 5-Band WAS certificate (and plaque) is available for working all states on 5 amateur bands (except 10/18/24 MHz). Cards for 5BWAS can be checked by your local HF Awards Manager or at ARRL HQ.

QST congratulates...

◊ The Shenandoah Valley ARC 10 meter AM net, which has operated continuously since 1947. The net meets Sundays at 12:30 PM Eastern Time on 29.200 or 29.205 MHz. *—Warren Rudolph, W4OHM, Winchester, Virginia*

◊ Dick Beaton, N7RB, of Helena, Montana, who celebrates 70 years as an Amateur Radio operator this month. At age 86, Dick is active on CW using the faithful J-36 semi-automatic key, and is also on PSK31. You will find him almost daily on 20 meters typing away on PSK31, and he has served as a Volunteer Examiner since the program's inception. *—Bill Erhardt, K7MT, Helena, Montana*

◊ Chuck Rexroad, AB1CR, of Bolton, Connecticut, who has been named Technician of the Year for 2003 IBM Software Group Americas Field Sales.

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◊ The Society of Amateur Radio Astronomers (SARA), the largest Amateur Radio astronomy organization in the US, has more than 100 members who are licensed hams. With this in mind, SARA offers a new award specifically designed to encourage contacts between its licensed members and other amateurs. Basic requirements to earn the SARA ON THE AIR (SOTA) Award include working *10* SARA-ham members using any mode and any amateur frequency, and get their SARA membership number. "Waterhole" frequencies of ±15 kHz from the well published QRP frequencies will serve to collect SARA hams into a general area to help those chasing this award. There is no cost for the award, certificate, or its preparation.

Individuals or clubs who receive this award will have their call sign (ham) or name (SWL) posted on the SOTA award page for all to see. Full details can be reviewed at **www.K5DZE.net**.*—Bob Patterson, K5DZE*

WALTER SHARP JR

Congratulations! **When Christopher and Kandis Sharp were married recently near Lancaster, Pennsylvania, the wedding party included (from the left) proud father of the groom Tom, WA9OXY; the bride; the groom, KC7PCX; Jesse Harrison; David, KC7TYG; Nicholas, KC7SKK, and Charles, KC7OVX. Each of the men in the photo is also an Eagle Scout.**