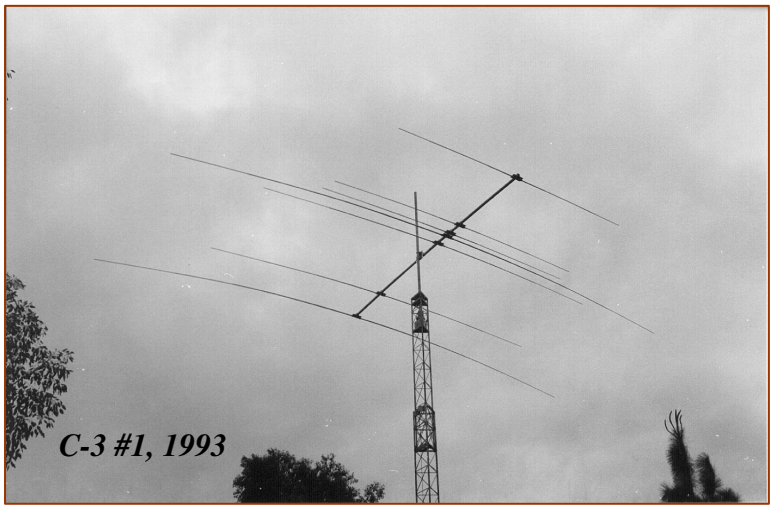
Strike Force Classic 3-Band

C-3, C-3E standard, /D and /H

20, 15 and 10 Meter (plus 17 & 12) Multi-monoband Yagi Antenna

FREQUENCY COVERAGE: 13.950-14.400; 21.000-21.450; 28.000-29.700 (VSWR <2.1:1)

Force 12, Inc.
P.O. Box 1293 Bridgeport Texas 76426
Phone: 1. 940.683-8371 Fax: 1. 940./683-8387 Email: force12.sales@mac.com



Thank you for selecting the Force 12 ***C-3*** or ***C-3E*** antenna. (The ***C-3E*** is the ***C-3*** with an added 10 meter reflector.) Developed by Force 12 to meet the need for a true high performance Yagi to cover the classic three bands (20-15-10), the ***C-3*** was introduced in 1993. It has since revolutionized multi-band Yagis and brings monoband performance. The ***C-3*** is the first multi-band Yagi to not use traps, phasing systems or log periodic designs: it is a "multi-monoband" Yagi design utilizing three monoband Yagis that share a common boom and are fed through a patented open sleeve feed system. There are no areas for high maintenance or potential loss, such as coils, traps and phasing systems. The antenna is strong, lightweight and computer designed not only for the basic electrical performance, but also computer designed for mechanical strength, durability and low profile. This is the third generation design, featuring a 4 foot package for easy transport, quicker assembly and several available upgrades:

a) The ***C-3*** boom is pre-drilled for addition of 40 meters using the EF-140S dipole with boom bracket and support. This is a high efficiency, 37' long dipole that is attached directly to the boom and fed separately. The 2:1 VSWR bandwidth is about 130 kHz and it can be set anywhere in the band (or outside the band for MARS, etc.). When ordering this conversion, please ask for the "***C-4C***." If full coverage is desired (i.e. phone and CW), a relay box that attaches right at the 40 meter feedpoint is also available. Please ask for the "40 Mtr Relay Box" when ordering.

b) The 10 meter performance can be enhanced by adding a 10 meter reflector element. This gives about .6-1 dB more gain and a tighter pattern on the band, with a F/B ratio of >20dB. This can be specified

at the time of order as the ***C-3E***, or as an upgrade by asking for the ***C-3E/C*** conversion kit.
c) The standard ***C-3*** or ***C-3E*** is rated for 80 mph. This can be extended by asking for "/D" model, which is rated for 100 mph. Further strength for extreme environments is the "/H" model, which is rated for 120 mph survival.

This manual is common to all ***C-3*** and ***C-3E*** models. The differences are covered in the text and also in the drawings. Please match your antenna to the proper drawing and appropriate instructions. The 40 meter addition (***C-4/C***) and ***C-3E/C*** are covered separately with the conversion kit instructions.

Design of the Antenna

The ***C-3*** is a multi-monoband Yagi antenna designed for direct operation in the 20, 15 and 10 meter amateur bands. It will also operate on the 17 and 12 meter bands with a VSWR that can be matched by the tuners in most rigs, or by an external tuner. The term, "***C-3***" is from "Classic 3-Band", which means the antenna is designed for the bands classically, or traditionally, covered by a "triband" antenna. These bands are the 20, 15 and 10 meter bands previously mentioned. The advent of the new 30, 17 and 12 meter bands authorized by W.A.R.C. has added the latter two (17 and 12 meter) bands into the same spectrum space as the classic tribander. There now can be several "tribanders" within this five band range, so this antenna is termed the Classic 3-Band, or "***C-3***".

The design of the ***C-3*** is a dramatic improvement in multi-band Yagi antennas over the typical methods used in past years and decades. The usual methods of covering multiple bands utilize traps in the elements, log-periodic cells, dual phased drivers, parallel-feed drivers or various combinations of these methods. The primary shortcomings of these methods are losses in the traps, complex mechanical structures with log and phased elements and other compromises to provide a 50 ohm feedpoint impedance for the 50 ohm coax feed line.

Several design features of the ***C-3*** will be described in the following paragraph. Knowing it is possible that not everyone who has acquired the ***C-3*** is necessarily familiar with Yagi antennas, or beam-type (directional) antennas, it is suggested that a good book, such as the A.R.R.L. Antenna Book be utilized for further information. Of course, one can always proceed directly and assemble the ***C-3***!

The ***C-3*** is a combination of three individual monoband beam antennas: 20, 15 and 10. The usual method for combining several monoband beams is to stack them vertically on a common mast support; however, this will not result in the best performance mainly because the antennas cannot be separated sufficiently to prevent interaction and a consequent loss of gain. The antennas affected are the higher frequency ones, namely the 15 and 10 meter ones in this case. A superior solution is to stack them horizontally in a sequential manner, so that each one will enhance the other. This is the essence of the ***C-3*** design. It was proven on several other designs and is called "forward stagger" in the patent write-up. The most complex section in the ***C-3*** is the design providing for a single feed line to excite the three antennas.

The 20 and 15 meter beams are two element Yagi designs. They are set up with the parasitic element as a reflector. The 10 meter antenna is set up with the parasitic element as a director. Referring to the ***C-3*** drawing, the forward stagger arrangement will be evident. The 15 reflector is positioned ahead of the 20 meter reflector so that the 20 reflector does not interfere with the 15 reflector operation. The 10 meter is out in front of both the 20 and 15 and makes use of their elements as "pseudo reflectors." In the ***C-3***E, there is an added, dedicated 10 meter reflector.

The single feed line is made possible through the use of an innovative "open sleeve" driver system. The 3-

band open sleeve was developed by Tom Schiller (N6BT), is covered by a U.S. Patent and licensed to Force 12, Inc. The basic open sleeve design is nothing too new, but to use it in this manner required some extra design work. The 20 meter driver element is the one to which the coax is attached and the 20 meter Yagi is designed for approximately 50 ohms at the feed point. The spacing and length of the 15 meter rear driver are adjusted to achieve 50 ohms on 15 meters and the 2:1 VSWR bandwidth covers the band. To cover the band on 10 meters required an additional 10 meter front driver. The 15 and 10 meter drivers are excited parasitically. Since the spacing is part of the feedpoint system, the VSWR will be noticed to fluctuate during windy conditions on 10 and somewhat on 15 meters. This is normal. The usual VSWR fluctuation has been noticed to be about +/- a tenth (.1).

The VSWR curves for the ***C-3*** allow full coverage. Part of the specification is that at least 100' of coax is assumed to be in use, which is a typical installation. If the VSWR is measured directly at the feed point, the 2:1 points on 15 and 10 meters will not span the entire band; however, making use of a particular phenomenon with coaxial cable, the VSWR response is flattened out slightly and the ***C-3*** covers all the bands with 2:1 or less across the band. The VSWR curves are not symmetrical, nor should they be expected to be so. For example, the lowest point on 10 meters is about 29.100 MHz. This is by design. The curve increases slower on the low side and faster on the high side. Small adjustments are provided so that the VSWR curves on 15 and 10 meters can be moved either upward or down in frequency. Doing so will not alter the forward gain or front-to-back ratio of the antenna on these bands. As a short note, a low or high VSWR does not necessarily mean that an antenna works or not. A fine book addressing this is Reflections, published by the A.R.R.L. The ***C-3*** antenna is highly efficient and does not contain any traps, which typically produce loss in the antenna. The ***C-3*** will also operate well on 17 and 12 meters, although the directional patterns will not be great, as there are no elements included to enhance the patterns for these bands. Overall, the ***C-3*** is an efficient, multi-band antenna – monoband Yagis on each band!

C-3 Specifications

Electrical

	20 Meters	17 Meters	15 Meters	12 Meters	10 Meters
Freq. Coverage	14.0 - 14.350 MHz	18.068-18.168 MHz	21.0 - 21.450 MHz	24.890-24.990 MHz	28.0 - 29.7 MHz
VSWR	1.4:1 (lowest is <1:2)	<1.4:1	1.7:1 (lowest is<1.4:1)	<1.4:1	1.9:1 (lowest is <1:3:1)
Front-to-Back Ratio	14-20 dB	16	16-20	16	15-22
Front-to-Side Ratio	>25 dB	>25	>25	>25	>24
Gain (dBi) @ 74'	12.3 – 12.6	12.5	12.3 – 12.6	12.5	12.2 – 12.6
Net Gain (dBd)	4.3 - 4.6	4.5	4.3 - 4.6	4.5	4.2 – 4.6
Maximum Power	>5 KW	>5 KW	>5 KW	>5 KW	>5 KW

Mechanical		"H"
Boom Length	18 ft.	
Number of Elements	10	
Longest Element	37 ft	
Turn Radius	20.2 ft.	
Assembled Weight	56 lbs.	60 lbs.
Wind Load	8.5 sq. ft.	8.5 sq. ft.
Wind Survival	100 MPH	120 MPH

Mechanical Overview

The mechanical design of the ***C-3*** utilizes pre-aligned element-to-boom brackets and riveted elements. The elements are positioned underneath the boom, where gravity and Sir Isaac Newton said they would like to reside. The tapered element design was done utilizing a structural engineer and specially developed software. The riveted elements can be installed temporarily for expeditions by using a rivet without the mandrel. Simply put the rivet in the hole, wrap a piece of black tape around it and it is ready to go. Disassembly involves taking the tape off and removing the rivet! Simple. The elements and boom are designed to present a low profile and withstand 80 mph winds (the boom is actually designed in excess of 100 mph). ***C-3*** antennas can be stacked to provide more potential to the station.

All the elements are insulated from the brackets and boom and the driver element is split at the center with a solid fiberglass insulator. Connection to the driver is through a pair of 10-24 stainless machine screws. **Since the driver is a balanced element and coaxial line is unbalanced, a means to choke off antenna current from the outside of the coax should be used.** Two devices are fine: one is an RF choke, made by winding several turns of the coax in a circle close to the feed point; or, a 1:1 balun can be used.

Some of the hardware is stainless steel. It is type 304, not 18-8, which is only rust resistant. The plated hardware is used for the element-to-boom bracket installation, with stainless lock washers and nuts to enable removal. Stainless U-bolts are not necessary, except in extreme environments and a preferred method is to paint these parts. Stainless hardware is easy to gall, meaning to freeze the nut on the shaft, rendering the bolt useless. If all stainless is required, please contact the factory. The entire antenna can be painted to eliminate any glint in the sun, although all methods have been employed to limit glint already. For example, the tubing is all 6061-T6, non-polished, and the brackets and plates are tumbled.

The mounting system is the easiest to use ever. Another development by Force 12, the Easy-On™ mount is so unique and useful, it is a copyrighted design. Two plates are provided and they have identical bolt patterns. They can be mounted upside-down and backwards, as they will always work properly. One is attached vertically to the mast, with a bolt through the top, center hole, being held in place by the mast and protruding outward. The second plate is attached to the boom. When the antenna is raised, the boom plate is placed over the bolt and the antenna is immediately held in place by the bolt and after the lock washer and nut are on, the antenna is secure. This eliminates the cumbersome multiple hands requirements to attach U-bolts and saddles while trying to hold the lock washers, nuts and antenna - with the wind blowing!!

On to the assembly.....

Tools required:

A. Wrenches or ratchets, used for attaching the elements to the boom and the boom to the mast.
   1. 7/16"
   2. 1/2"
   3. 9/16"

B. A 3/8" nut driver, or small crescent wrench for the feedpoint 10-24 nuts.

C. Screwdriver to back-up the 10-24 feedpoint machine screws.

D. Hand riveter, also called a "POP™", or blind riveter. These are available from the company, a local hardware store, or possibly your dealer where this antenna was purchased. This is used to secure the

element sections together. Use the smallest nozzle (tip) for the 1/8" rivets.

E. A rope to hoist the antenna into position.

F. Some patience and common sense - be careful, as antennas can come into contact with high voltage lines and they are lethal. Also, be careful installing, as towers and masts are also dangerous. Thanks

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The antenna is shipped in sub-assemblies and each assembly section is appropriately identified. There are seven (7) elements (***C-3E*** has 8 elements) and each one is divided into two (2) halves: "A" and "B". Each element is either bundled or telescoped and each element is individually labeled. The elements are identified by element number and also an "A" or "B", such as "1A", "1B", "2A", "2B", etc. The element construction is logical, because each section slides into the next and there is never the same size tubing used twice on a side! Matching up the tapering sizes for each element side is all that is required. Element #1 is the 20 meter reflector. The drawings will assist in this process. Assembly requires only that the identifications are matched. All the rivet holes are pre-drilled and will align exactly when the proper sections are matched. The driver element is split at the center and fed with 50 ohm coax through either a 1:1 balun (the Force 12 B-1), or an RF choke (i.e. 8 turns, 10" diameter circle). The boom is in five (5) sections and is marked A-A, B-B, C-C, and D-D. The boom sections slide into the matching section. Matching these sections and inserting the 1/4-20 bolts will complete the boom assembly. The aluminum mill markings are left on the tubing. If it is desired to remove them, most solvents will wipe them away. Any markings made at the Force 12 factory will quickly fade.

Assembly Instructions:

NOTES:

1) Although the entire antenna has already been pre-assembled, it might be a good idea to double-check the measurements, especially on the elements. Please let us know if there are any discrepancies. Thanks.

2) When using the hand riveter, please be sure the smallest nozzle is in the tool. Sometimes with a larger nozzle, the mandrel of the rivet can get crooked within the tool, which can result in breaking the mandrel before the rivet is "popped." The smaller nozzle also makes a smooth finish on the rivet head.

3) The "A" and "B" halves of the elements are arbitrarily marked, so they do not need to be matched for a particular side (i.e. all half-side "A"'s on a certain side of the boom). The markings are simply for ease in assembly.

4) The PVC element insulators may or may not be already installed on each element. There are two sizes (in diameter) of PVC and they are easy to relate to each element. Slide the appropriate size over the element and center it on the largest tubing in the element (which will be the center piece). The longer pieces go on the non-driver elements. The drivers use two short pieces and they go on both sides of the center insulator, just outside of the 10-24 machine screws.

5) The NOALOX anti-oxidant compound comes with a brush so that a thin coat can be applied to the tubing without getting the NOALOX on your hands.

I. ELEMENT ASSEMBLY

_____00) NOTE: this entire antenna has already been assembled at the factory. This is how the holes get drilled and how the sub-assemblies are made. This means that every piece will align properly, provided that they are being assembled in the right position.

_____a) It should never be necessary to drill a hole for a rivet, or bolt.

_____b) Each element is dis-assembled and separately bundled, so working with one element at a time is the best method. This will ensure that only the parts for a particular element are available for assembly at one time.

_____c) Please check the measurements and the element positions to double check us at the factory. It is rare that a marking mistake is made, but it can happen.

___0) Each element is tapered and the taper runs smaller towards the tip. Each section slides into another and to ensure a nice fit, the larger one is crimped/swaged to reduce its size slightly. This means that one end of each section is crimped/swaged and the reduced size of one end can be clearly seen. Only the tip is not done in this manner, since it is the end of the element.

_____a) NOTE: on rare occasions, thicker wall tubing is used and it is not crimped/swaged. Please check for proper alignment of the drilled holes. Also, the end that goes to the outside (towards the tip) has the holes drilled closest to the end of the piece.

_____b) Please be sure that the non-crimped/swaged end goes into the crimped/swaged end of the larger piece.

_____c) If the rivet holes do not align, please check to be sure the section is oriented properly and that the correct side (A or B) is on the correct side. It should not be necessary to drill any holes.

_____d) Thanks.

_____1) Lay out the element assembly sections for element #1 (the 20 meter reflector).

_____a) Side A

_____b) Side B

_____2) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____3) Starting at the tip, slide the tip into the next larger section and align the rivet holes.

_____a) Insert the supplied 1/8" rivets into all rivet holes. It is important to insert all the rivets before any are pulled; otherwise, there is a possibility that the other holes might not align properly. To lessen this possibility, the holes are drilled to the actual rivet size (1/8"), which makes for a tight alignment and snug hole. If at any time it becomes necessary to remove a rivet, use an 1/8" drill and use the hole at the center of the rivet as the hole guide. Even if the hole is enlarged, the closed-end rivets will fill in the hole when they are pulled.

_____b) Pull each rivet with the hand riveter. The mandrel of the rivet (the "shaft") is inserted into the riveter and the handles of the riveter are squeezed. Sometimes, a complete squeeze of the riveter will not "pop" the rivet and release the mandrel. If this occurs, release the pressure on the riveter and push it back down over the mandrel (which will now be sticking out farther).

_____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets. By starting at the tip, managing the element is physically easier.

_____4) Double check that both sides "A" and "B" have been fully assembled.

_____**5)** **Lay out the element assembly sections for element #2 (the 15 meter reflector).**
- _____a) Side A
- _____b) Side B

_____6) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____7) Starting at the tip, slide the tip into the next larger section and align the rivet holes.
- _____a) Insert the supplied 1/8" rivets into all rivet holes.
- _____b) Pull each rivet with the hand riveter.
- _____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.

_____8) Double check that both sides "A" and "B" have been fully assembled.

_____**5)** **Lay out the element assembly sections for element #2 (the 15 meter reflector).**
- _____a) Side A
- _____b) Side B

_____6) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____7) Starting at the tip, slide the tip into the next larger section and align the rivet holes.
- _____a) Insert the supplied 1/8" rivets into all rivet holes.
- _____b) Pull each rivet with the hand riveter.
- _____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.

_____8) Double check that both sides "A" and "B" have been fully assembled.

_____**9)** **If you are assembling a *C-3* (not a *C-3E*), please go to STEP 14.**
- _____a) These steps are for a ***C-3E***, assembly of the 10 meter reflector.

_____**10)** **Lay out the element assembly sections for element #2A (the 10 meter reflector** *C-3E***).**
- _____a) Side A
- _____b) Side B

_____11) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____12) Starting at the tip, slide the tip into the next larger section and align the rivet holes.
- _____a) Insert the supplied 1/8" rivets into all rivet holes.
- _____b) Pull each rivet with the hand riveter.
- _____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.

_____13) Double check that both sides "A" and "B" have been fully assembled.

_____14) Lay out the element assembly sections for element #3 (the 15 meter rear driver).
- _____a) Side A
- _____b) Side B

_____15) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____16) Starting at the tip, slide the tip into the next larger section and align the rivet holes.
- _____a) Insert the supplied 1/8" rivets into all rivet holes.
- _____b) Pull each rivet with the hand riveter.
- _____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.
- _____d) NOTE: the initial proper rivet holes for the tip have one hole outside the .500" section. Double check the drawing to ensure the proper holes are used. The outside hole and inside hole are used for making slight VSWR adjustments if needed to shift the curve up or down.

_____17) Double check that both sides "A" and "B" have been fully assembled.

_____18) Lay out the element assembly sections for element #4 (the 20 meter driver).
- _____a) Side A
- _____b) Side B

_____19) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____20) Starting at the tip, slide the tip into the next larger section and align the rivet holes.
- _____a) Insert the supplied 1/8" rivets into all rivet holes.
- _____b) Pull each rivet with the hand riveter.
- _____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.

_____21) Double check that both sides "A" and "B" have been fully assembled.

_____22) If the center section is not already assembled:

_____a) Remove the 10-24 machine screw from the center section that does not have the fiberglass insulator.

_____b) Insert this section over the fiberglass insulator until it butts against the internal stop. This will align the hole in the tubing and the insulator. Note that there is also an alignment mark.

_____c) Re-insert the 10-24 machine screw through the center tubing, which will now pass through the inserted fiberglass insulator. Secure as on the other element half, with a split lock washer and nut. The flat washer and another split lock and nut secure feed line.

_____23) Lay out the element assembly sections for element #5 (the 10 meter front driver #1).

_____a) Side A

_____b) Side B

_____24) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____25) Starting at the tip, slide the tip into the next larger section and align the rivet holes.

_____a) Insert the supplied 1/8" rivets into all rivet holes.

_____b) Pull each rivet with the hand riveter.

_____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.

_____d) NOTE: the initial proper rivet holes for the tip have one hole outside the .500" section. Double check the drawing to ensure the proper holes are used. The outside hole and inside hole are used for making slight VSWR slewing adjustments if needed to shift the curve up or down.

_____26) Double check that both sides "A" and "B" have been fully assembled.

_____27) Lay out the element assembly sections for element #6 (the 10 meter front driver #2).

_____a) Side A

_____b) Side B

_____28) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____29) Starting at the tip, slide the tip into the next larger section and align the rivet holes.

_____a) Insert the supplied 1/8" rivets into all rivet holes.

_____b) Pull each rivet with the hand riveter.

_____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.

_____d) NOTE: the initial proper rivet holes for the tip have one hole outside the .500" section. Double check the drawing to ensure the proper holes are used. The outside hole and inside hole are used for making slight VSWR adjustments if needed to shift

the curve up or down.

_____30) Double check that both sides "A" and "B" have been fully assembled.

_____31) Lay out the element assembly sections for element #7 (the 10 meter director).

_____a) Side A

_____b) Side B

_____32) Apply NOALOX to the end of each section that will slip into another. This should be a thin coat, spread evenly along and around the portion that is inserted into the larger tube.

_____33) Starting at the tip, slide the tip into the next larger section and align the rivet holes.

_____a) Insert the supplied 1/8" rivets into all rivet holes.

_____b) Pull each rivet with the hand riveter.

_____c) Slip each section into the matching larger tubing, as in the prior step and secure with the rivets.

_____34) Double check that both sides "A" and "B" have been fully assembled.

II. BOOM ASSEMBLY

_____1) Lay out the five (5) boom sections in the assembly sequence (A-A, B-B,C-C,D-D) and note their engraved alignment marks.

_____2) Lubricate the portions that will slip into the splices.

_____3) Slip the first section into the matching splice, align with the marks and secure with 1/4-20 bolts and ny-loc nuts.

_____a) Drop the bolts in from the top. In case the nuts ever come off, the bolts will hold the boom.

_____b) ***Tighten the nuts until snug. It is not necessary to crunch the boom.*** (Tightening too much will make the boom extremely difficult to take apart.)

_____4) Slip the section from the above step into the section B-B and secure as before.

_____5) Continue matching the sections together until the boom is complete.

_____5a) Note that there is no truss cable for this boom.

_____6) Attach one of the Easy-On™ mounting plates to the boom using a pair of 2" U-bolts and saddles, using split lock washers and nuts.

_____a) Position it flat against the boom, at about the center of the boom.

_____b) Tighten the nuts enough to hold it in position.

_____c) It might get moved later for better balance, for installation, or for actual mounting to the mast. This provides the most convenience.

_____d) NOTE: that the other Easy-On™ mounting plate is attached similarly to the mast

during installation.

III. MOUNTING THE ELEMENTS TO THE BOOM

_____1) The element mounting plates are on the underside of the boom. The elements are always installed on the underside of the mounting plate with the rivets pointing down. This will prevent any water from sitting in the rivets, although there is no hole actually going through the rivets. The elements are insulated from the plates with standard PVC tubing. The PVC is shielded from direct sunlight by the element plate. The long term test on the PVC has been running successfully for more than 10 years, so there should be little or no concern for the longevity of the PVC insulators.

_____2) Two methods are suggested for element mounting:

_____a) Placing the element on the underside of the plate and then sliding the U-bolts over the PVC, up through the plate.

_____b) Inserting the U-bolts through the plates first (with washers and nuts very loose) and then sliding the element through the pair of U-bolts.

_____c) Note that this element mounting method makes it easy to mount elements on the boom while the antenna is on the tower, as might be required in some installations.

_____3) Select the mounting method that best meets your installation needs.

_____4) The element mounting plates are already aligned at the factory, so element alignment is quite simple. The way an element can get slightly out of alignment is if the U-bolts are not equally tightened (can be noted by more threads showing on one side than the other).

_____a) The elements should be visually checked to be as parallel as possible, especially in the driver area (10 Mtr drivers #1 and #2). There is a slight amount of alignment possible with the clearance between the PVC insulator, the U-bolts and the length of the slots in the element brackets.

_____5) NOTE: there are two (2) sizes of U-bolts to hold the elements to the boom.

_____a) The larger ones are for the 20 meter elements.

_____b) The smaller ones are for the 15 and 10 meter elements.

_____6) Use the following procedure with all but the driver element (20 meter driver, element #4):

_____a) With the nuts still loose on each plate, align the element so that:

_____a1) the rivets are pointing downward.

_____a2) the slot in the PVC insulators are downward.

_____a3) the PVC is centered on the element mounting plate, with the U-bolts over the PVC (not touching the aluminum element).

_____b) Now the nuts can be tightened. It is only necessary to tighten them until the element does not rotate with hand pressure, then about a half-turn more.

_____c) Double check that the split lock washers under the nuts are compressed.

_____7) Use the following procedure with the 20 meter driver (element #4):

_____a) With the nuts still loose on each plate, align the element so that:

_____a1) the rivets are pointing downward.

_____a2) the slot in the PVC insulator is aimed at the gap between the U-bolt and the element.

_____a3) the PVC is centered on the element mounting plate, with the U-bolts over the PVC (U-bolts not touching the aluminum element).

_____b) The 10-24 machine screws are at about a 45 degree angle (so that attachment can be made easily). Double check that the screws are pointing in the best direction for feed line/balun attachment (usually towards the mast).

_____c) Now the nuts can be tightened. It is only necessary to tighten them until the element does not rotate with hand pressure, then about a half-turn more.

_____d) Double check that the split lock washers under the nuts are compressed.

IV. ATTACHING THE FEED LINE and MOUNTING TO THE MAST

_____0) NOTE: there are several alternate methods for mounting this antenna. Please see the last section for other suggestions.

_____1) There are two (2) Easy-On™ mounting plates and they are identical. One attaches to the mast and the other attaches to the boom. They are held together in final installation by several 5/16" hex bolts going through both plates.

_____a) The Easy-On™ mounting plate that attaches to the boom has already been installed, with the nuts slightly tightened.

_____b) The Easy-On™ mounting plate that attaches to the mast is attached with one (1) of the 5/16" hex bolts (**with a lock washer under the head**) inserted from the mast side of the plate **before** the plate is secured with a pair of 2" U-bolts and saddles.

_____b1) This makes the bolt protrude outward from the top, center hole of the mast-mounted plate. The mast holds the bolt in place and it will not fall out.

_____b2) A hole in the Easy-On™ mounting plate on the boom will align with this bolt and the antenna is slipped onto the bolt, thereby quickly relieving the weight of the antenna from the installer.

_____b3) A lock washer and nut on the top, center bolt will secure the antenna while the corner bolts are added.

_____c) Mount the Easy-On™ mounting plate on the mast as described above and note the correct position of the single 5/16" x 1" bolt through the top, center hole in the plate.

_____2) This antenna was designed for use with either a split coax and RF choke feed line, or a 1:1 balun. Some baluns, such as the large W2DU, have the effect of adding length to the driver element. If it is noticed that the VSWR curve on 20 mtrs is low in frequency and a balun is being used, it might be necessary to shorten the driver tips by drilling out the rivets, pushing in the element, drilling new holes through the tip and inserting new rivets. The VSWR curve for 15 and 10 can be adjusted independently of 20 mtrs.

_____a) If a balun is used, such as a ***FORCE 12 B-1***, attach the leads to the screws as above and plug the feed line into the other end of the balun.

_____a1) **NOTE: trim the balun leads to 2 - 2 1/2" before putting on the lugs. The balun lead length adds to the driver element length, so not trimming the leads will cause the feed points to be resonate low of the band(s).**

_____b) If coax is used directly, split about 3" of the coax and solder the round terminals to the coax. Wind the coax into an RF choke by making 8 turns of about 10" diameter

and tape or otherwise bind the coil together so that it cannot come apart.

_____c) Secure with flat washer, split lock and nut.

_____d) Dress the coax and feed line assembly neatly to the boom, towards the mast.

_____3) BEFORE raising the antenna into position, review what is going to happen and then proceed carefully.

_____a) It is recommended that a simple harness attached to both sides of the mounting plate be used to lift the antenna into position. This harness will keep the antenna from rocking and will make it easier to balance. The pull rope is then attached to the center/balance point of the harness.

_____b) The boom can be positioned for best balance at this time. Simply loosen the nuts and position as necessary.

_____c) NOTE: it is not necessary to crunch the nuts on the U-bolts holding the boom to the extent of deforming the boom material; just enough to hold it from rotating.

_____4) BEFORE raising the antenna into position, be ready with the lock washer and nut to thread onto the top, center bolt.

_____a) Have the remaining 5/16" bolts, lock washers and nuts ready to place through the corner holes.

_____b) NOTE: there are four (4) 5/16" bolts included. Although one in the top, center hole, plus one in each lower corner adds up only to three (3), the fourth is included just in case the top, center bolt was not installed. This will enable the plates to be attached in all four (4) corners and still be secure.

_____5) Raise the antenna into position and slip the Easy-On™ mounting plate on the boom over the top, center 5/16" bolt on the Easy-On™ mounting plate attached to the mast. Place a lock washer and nut on this bolt and the antenna will be initially secured to the mast and the weight will be removed from the installer.

_____a) Place the two (2) remaining lower corner bolts through both plates from the mast side and leave the nuts somewhat loose to enable alignment of the other bolts.

_____b) The bolts will now form a triangle pattern.

_____c) Place the fourth bolt through one of the top corner holes and secure with a lock washer and nut.

_____d) Double check that the antenna is parallel to the ground (if it is off balance, it will tilt) and tighten all 5/16" bolts to secure the two plates together.

_____6) The boom can be positioned as necessary for balance and orientation by loosening the U-bolts holding it to the plate.

_____a) Double check antenna balance and alignment.

_____7) Neatly dress the feed lines to the mast, making sure there is sufficient coax to coil around the mast if a rotator is used.

_____8) Check the VSWR on other antennas in the area (i.e. on the mast) to be sure this antenna has not de-tuned them. If the VSWR has not changed, the interaction is minimal, but the front-to-back ratio of the other antenna(s) might have been lessened.

V. FINAL VSWR CHECK

_____1) If the VSWR curves are low for all the bands, please check to be sure the leads on the balun (if used) were trimmed to 2 - 2 1/2" before attachment to the lugs and the antenna. These leads add length to the driver element(s).

_____2) In the event that either 15 or 10 meters VSWR curves are not where desired, they can be shifted slightly by using the provided adjustment holes.

_____3) It was noted during assembly of the 15 mtr rear driver and both 10 mtr front drivers that there are additional holes that can be used for riveting the tips to the .500" sections. The proper initial settings are to have one hole exposed.

_____4) Double check that the tips are correct.

_____5) NOTE that the U-bolts and saddles holding the boom to the mounting plate can be loosened to allow the elements to be rotated downward and possibly reached from the ground.

_____a) Note also that the tips can be held temporarily in place using tape.

_____6) If the VSWR curve is lower than desired, the frequency of the appropriate band must be raised. This is done by shortening the tips for that band.

_____7) If the VSWR curve is higher than desired, the frequency of the appropriate band must be lowered. This is done by lengthening the tips for that band.

_____8) If 15 mtrs is low (needs to be raised), drill out the rivets in the tip with an 1/8" drill and slide the tip in so that the hole farthest out on the tip is now aligned with the outside hole in the .500" section. The tip will now have been shortened about .750" and the frequency will be raised. Re-rivet the tip. Do the same to the other 15 mtr rear driver tip.

_____a) If 15 is high (needs to be lowered), use the same procedure, but pull the tip outward until the next holes align.

_____9) 10 mtrs is moved in a similar manner, except that one driver at a time should be changed.

_____a) It is recommended that the front driver #1 be changed first.

_____10) The above should enable positioning the VSWR curve as desired.

_____11) 20 mtrs should not need any adjustment.

_____12) If a long feed line is used, the VSWR response might be broader than specified. The longer length of coax adds a small amount of loss, which "flattens" out the response. This should not be confused with the situation when changing the coax length changes the actual VSWR reading. This indicated that there is current flowing on the outside of the coax and the RF choke/1:1 balun are not working properly.

_____13) Operation on 17 mtrs is possible using a tuner. The tuners in most transceivers will usually match the ***C-3*** on 17 mtrs. Operation on 12 mtrs is also possible, although the antenna is

much more reactive and the tuner might not be able to match it properly.

VI. FINAL CHECKOUT

_____1) Apply power and have fun.

VII. ALTERNATE MOUNTING METHODS

_____1) The antenna can be assembled on the tower, such as when having a guyed tower. This is possible because the element-to-boom brackets are pre-aligned and the elements can be attached at any time and they will always be straight. To do this, suspend the boom at its center and position it so that the front of the boom (element #7 end) is aimed up and also that the front half of the boom is slightly on one side of the tower and the rear half (element #1 end) is slightly on the other side of the tower. Raise the boom until the front is just clearing the top of the tower. Attach elements on the rear half (elements #1 and 2), being sure that they are still on the other side of the tower from the element #7 end. The boom is now "tail heavy." Now, add element #7 and raise the antenna higher until the next set of element-to-boom brackets clears the top of the tower. These elements can now be added (elements #3,4,5 & 6). The antenna will now want to rotate horizontally on its own, so let gravity assist. Rotate the boom until the elements are almost vertical, then swing the boom until the rear elements clear the guy wires. At this point, the antenna can be made horizontal and it is clear of the tower and above the guy wires. Attach the balun and coax and mount the antenna to the mast.

_____2) The ***C-3*** can be assembled in sections and then mounted, such as when using a tilt-over tower. The center section of the ***C-3*** needs to be secured to the mast first. Then each side can be attached in any convenient manner.

Notice.....

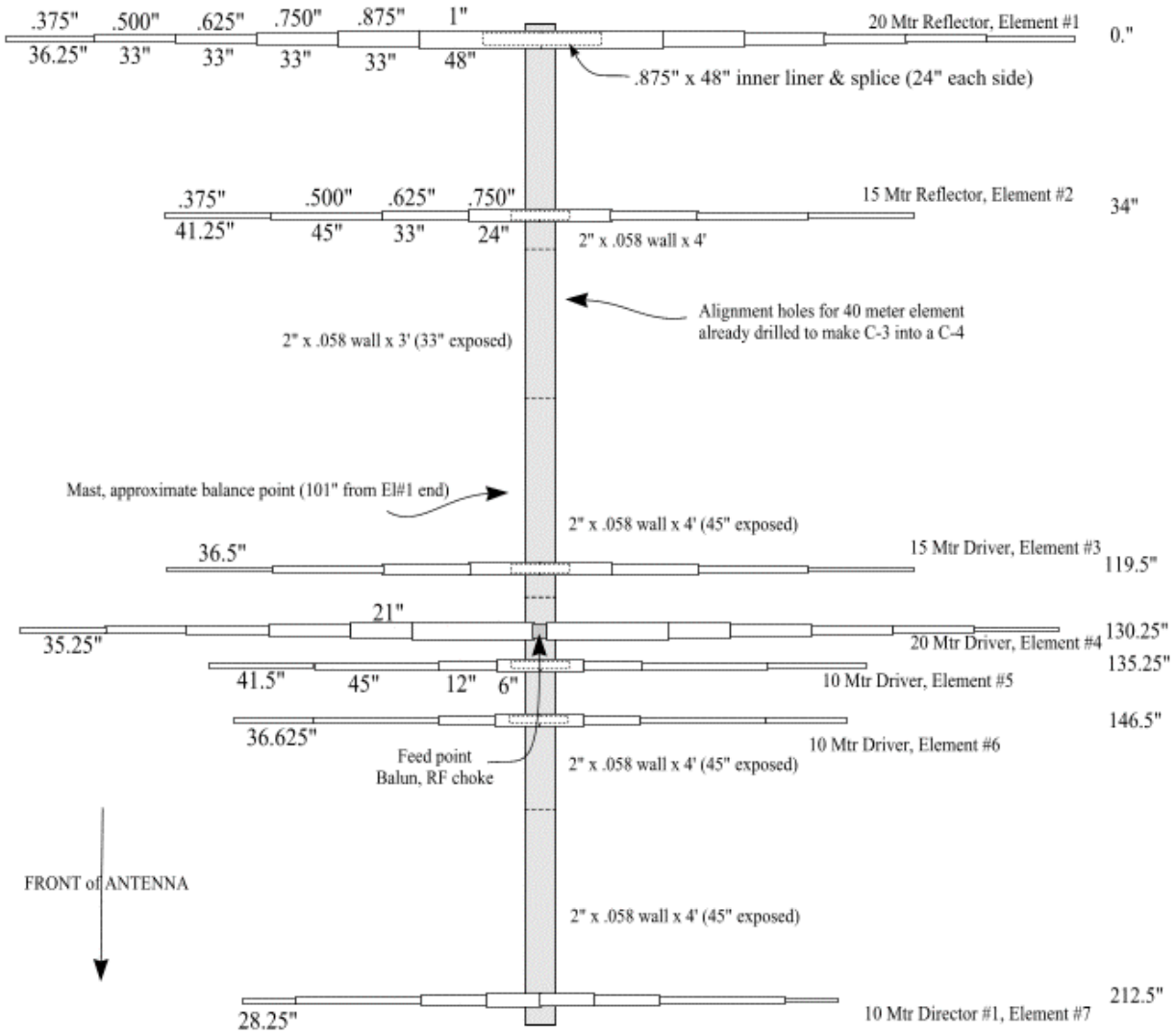
PLEASE BE CAREFUL AND DO NOT LET THIS ANTENNA COME INTO CONTACT WITH POWER LINES OR OTHER DANGERS. YOU CAN BE INJURED OR KILLED BY IMPROPER HANDLING OF THIS ANTENNA.

Thank you for selecting our product. We hope you enjoy using it.

Force 12

C-3

7 Element, 20-15-10 (17 & 12 secondary) Multi-Monobander



Boom is 18' x 2" OD

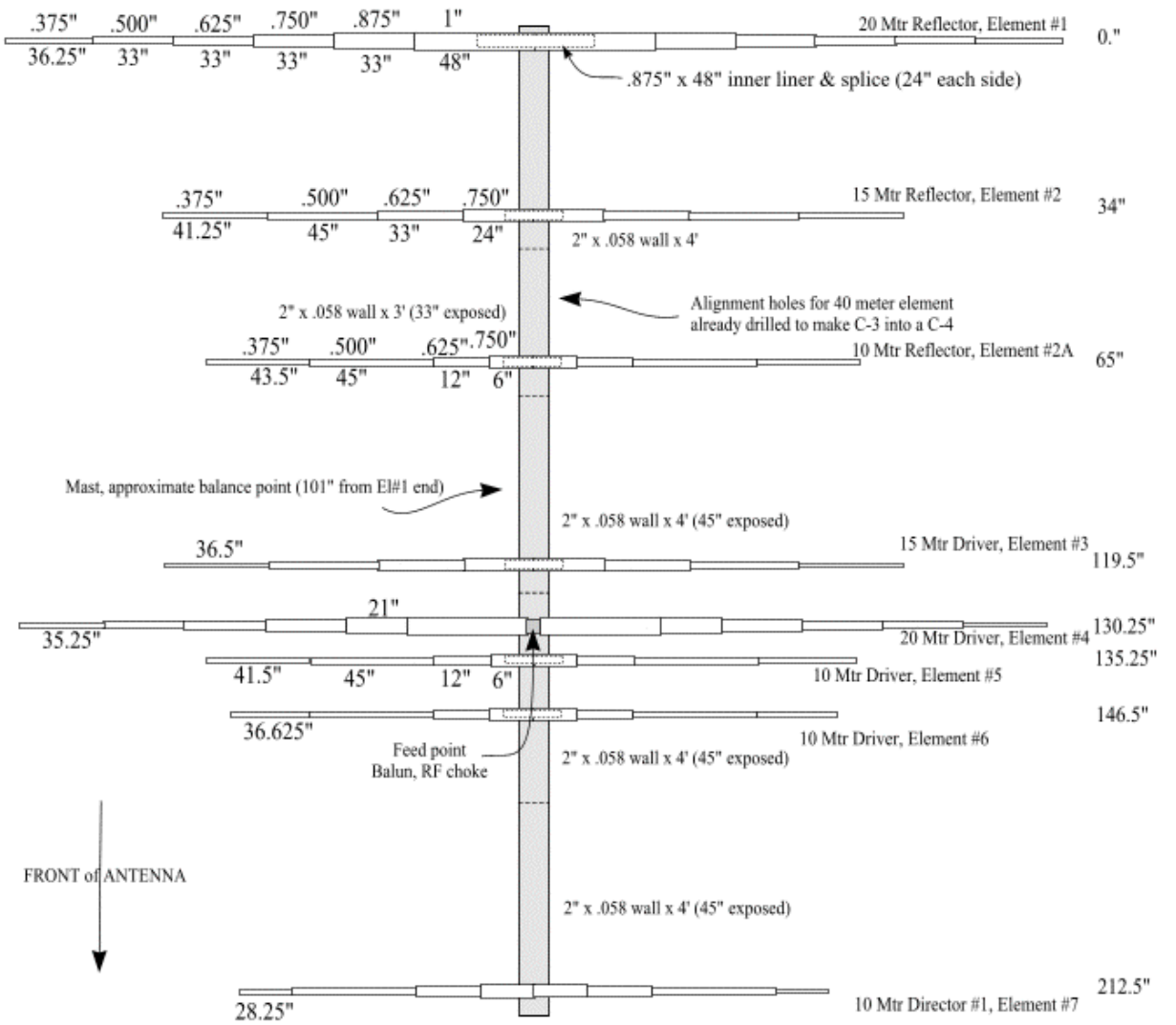
Note: 20 mtr element brackets are 4"x8"
all others are 3"x6"

Windload: 5.6sqft
Weight: 32 pounds
Power Rating: 5KW
Boom Length : 18'
Turning Radius: 19.8'
Wind Survival 80 mph (std)

Feed system: 1 feedline with 1:1 balun or RF choke
Direct 50 ohm feed

C-3E

7 Element, 20-15-10 (17 & 12 secondary) Multi-Monobander



Boom is 18' x 2" OD

Note: 20 mtr element brackets are 4"x8"
all others are 3"x6"

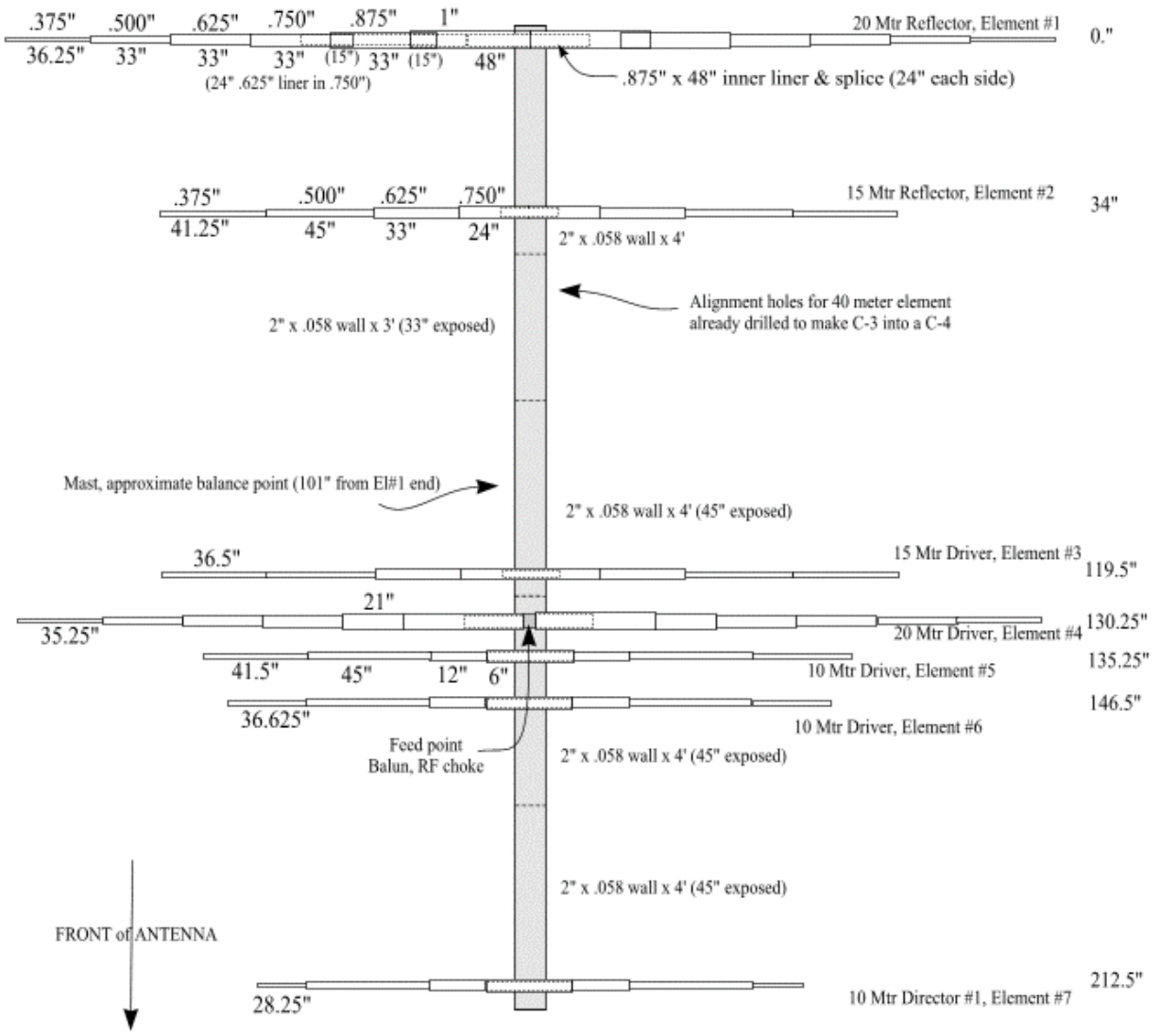
Windload: 5.9sqft
Weight: 34 pounds
Power Rating: 5KW
Boom Length : 18'
Turning Radius: 19.8'
Wind Survival 80 mph (std)

Feed system: 1 feedline with 1:1 balun or RF choke
Direct 50 ohm feed

Force 12

C-3/D

7 Element, 20-15-10 (17 & 12 secondary) Multi-Monobander



Windload: 5.6sqft
Weight: 34 pounds
Power Rating: 5KW
Boom Length : 18'
Turning Radius: 19.8'
Wind Survival 100 mph

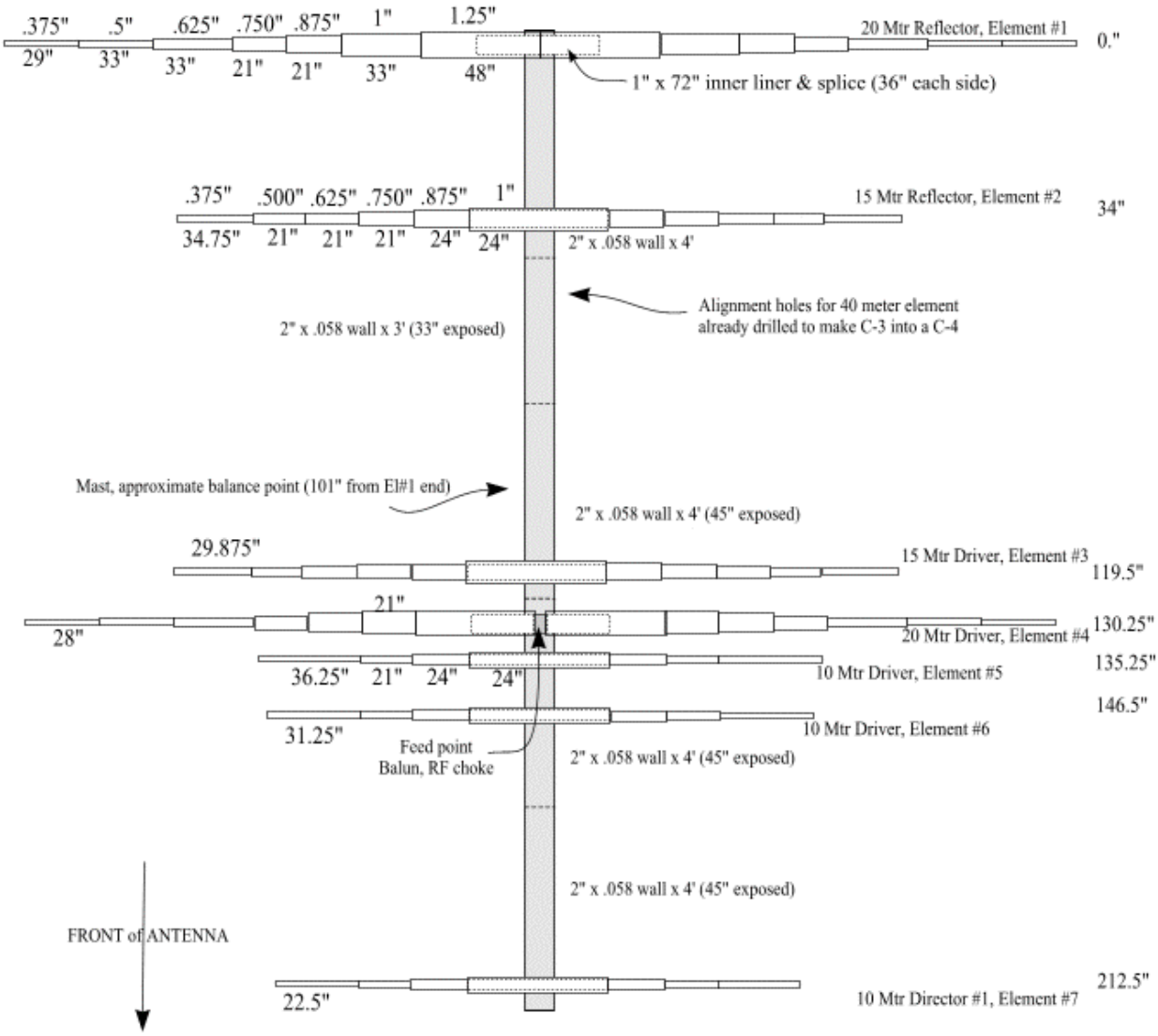
Feed system: 1 feedline with 1:1 balun or RF choke
Direct 50 ohm feed

Note: 20 mtr element brackets are 4"x8"
all others are 3"x6"

Force 12

C-3/H

7 Element, 20-15-10 (17 & 12 secondary) Multi-Monobander



Windload: 7.5sqft
Weight: 51 pounds
Power Rating: 5KW
Boom Length : 18'
Turning Radius: 19.8'
Wind Survival 120 mph

Feed system: 1 feedline with 1:1 balun or RF choke
Direct 50 ohm feed

Note: 20 mtr element brackets are 4"x8"
all others are 3"x6"

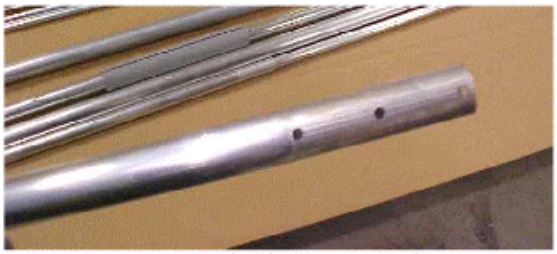
TYPICAL ELEMENT BUNDLE, ALL ELEMENTS
(Model XR-5 shown)

INDIVIDUAL ELEMENT BUNDLES
(Model XR-5 shown)

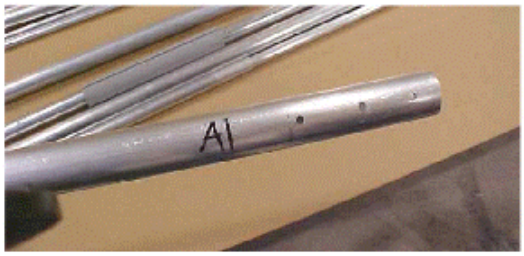
"A" and "B" MARKINGS ON ELEMENT PIECES
"A1" & "B1" identify they are part of element #1.

Force 12

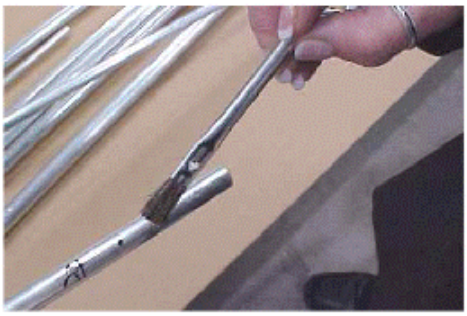
Element Assembly Example



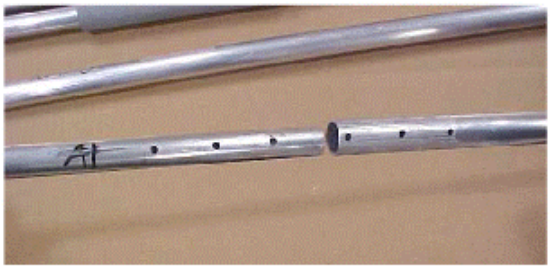
Swaged Element End
(swager marking lines and rivet hole is close to end of piece)



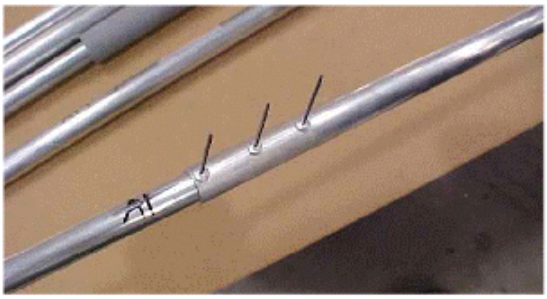
Non-swaged Element End
(no swager marks and rivet hole is not close to end of piece)



1) Apply Noalox with brush

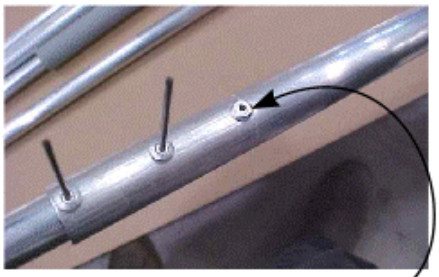


2)Insert tube into matching piece

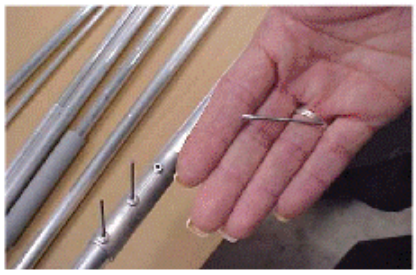


3) Insert all rivets before riveting

4) Slide rivet tool over mandrel and pull ("pop") the rivet



5) Pulled rivet is on right



6) Mandrel removed from rivet tool

RIVET TOOL
NOZZLE
<--Wrong one on left - hole is too large
Correct on right - small hole fits mandrel -->
(rivet shown dropping into nozzle)

Force 12

Element Assembly Example

Removing a Properly Installed Rivet

RIVET TOOL
NOZZLE
<--Wrong one on left - hole is too large
Correct on right - small hole fits mandrel -->
(rivet shown dropping into nozzle)

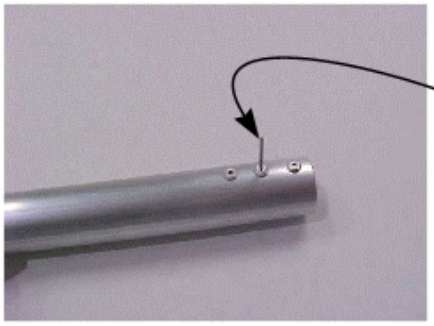
To Remove a Rivet
(that has been properly installed)

___1) Use 1/8" drill bit
___2) Run drill slowly until rivet head comes off
___3) Remove rivet head from drill tip
___4) Drill through hole

Force 12

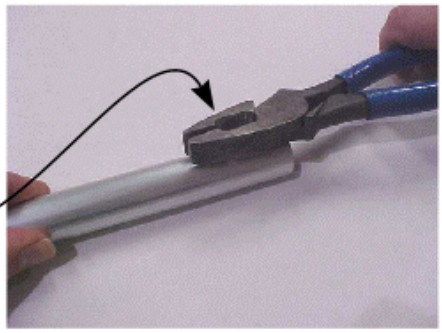
Element Assembly Example

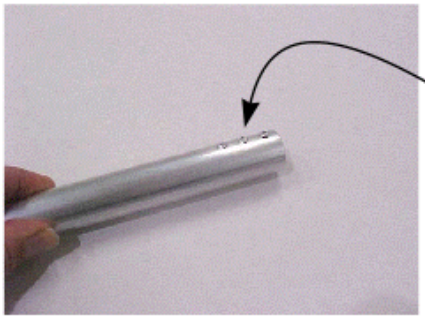
Removing a Rivet with a Broken Mandrel



___1) Broken mandrel

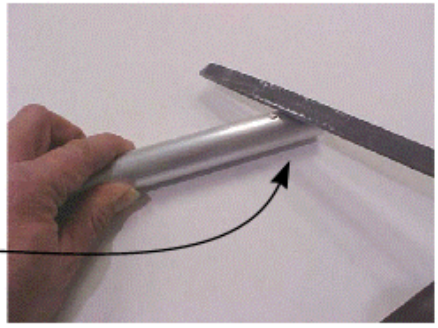
___2) Cut mandrel close to rivet head

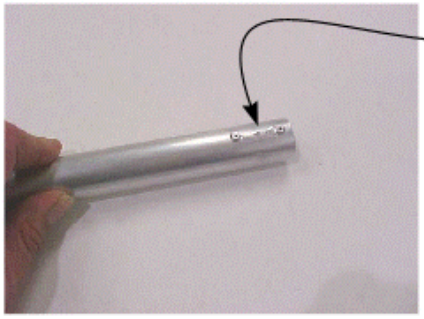




___3) Mandrel is now cut

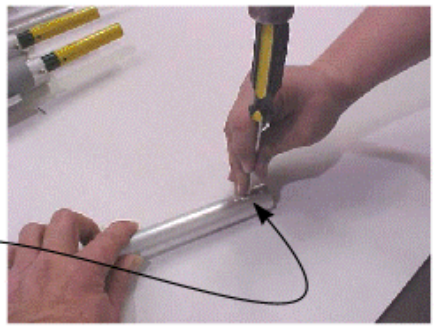
___4) File mandrel AND rivet head flush with tubing



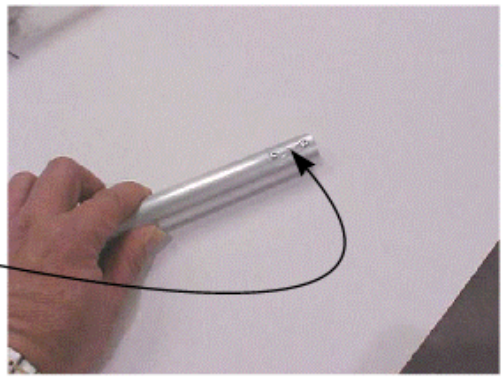


___5) Rivet head and mandrel filed off flush with tubing

___6) Punch rivet through with pointed tool (and hammer)

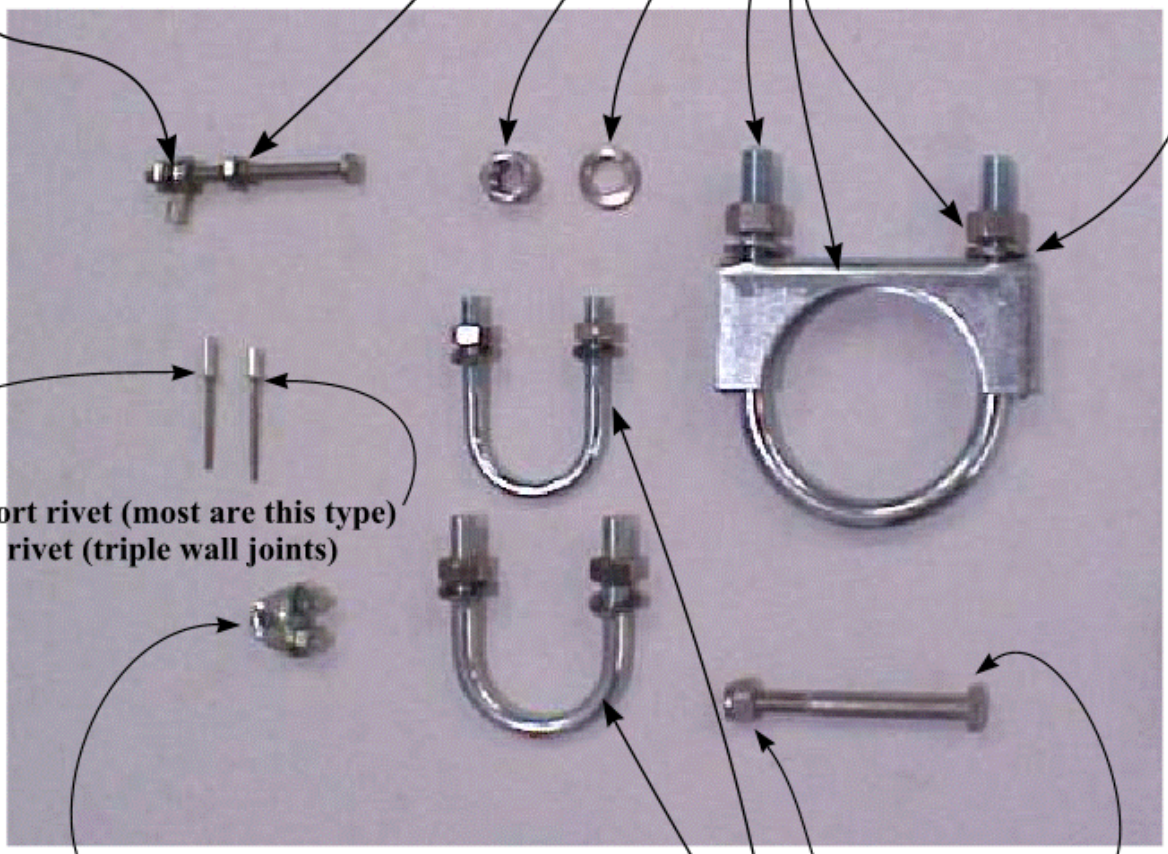


___7) Hole is now clear for new rivet.



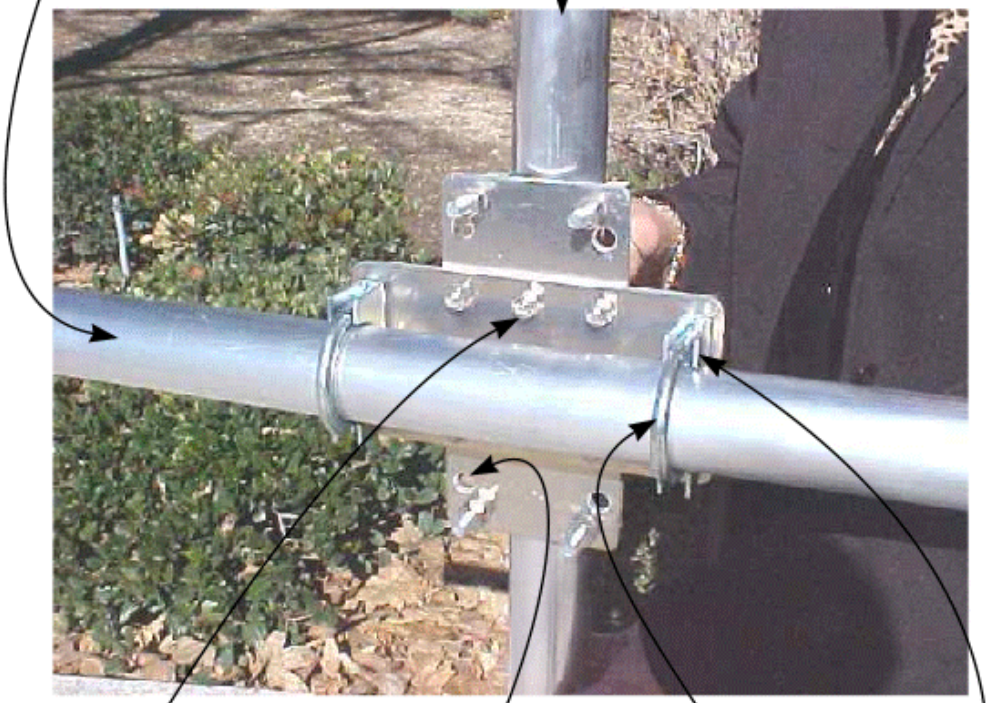
Element Assembly Example

Typical Parts

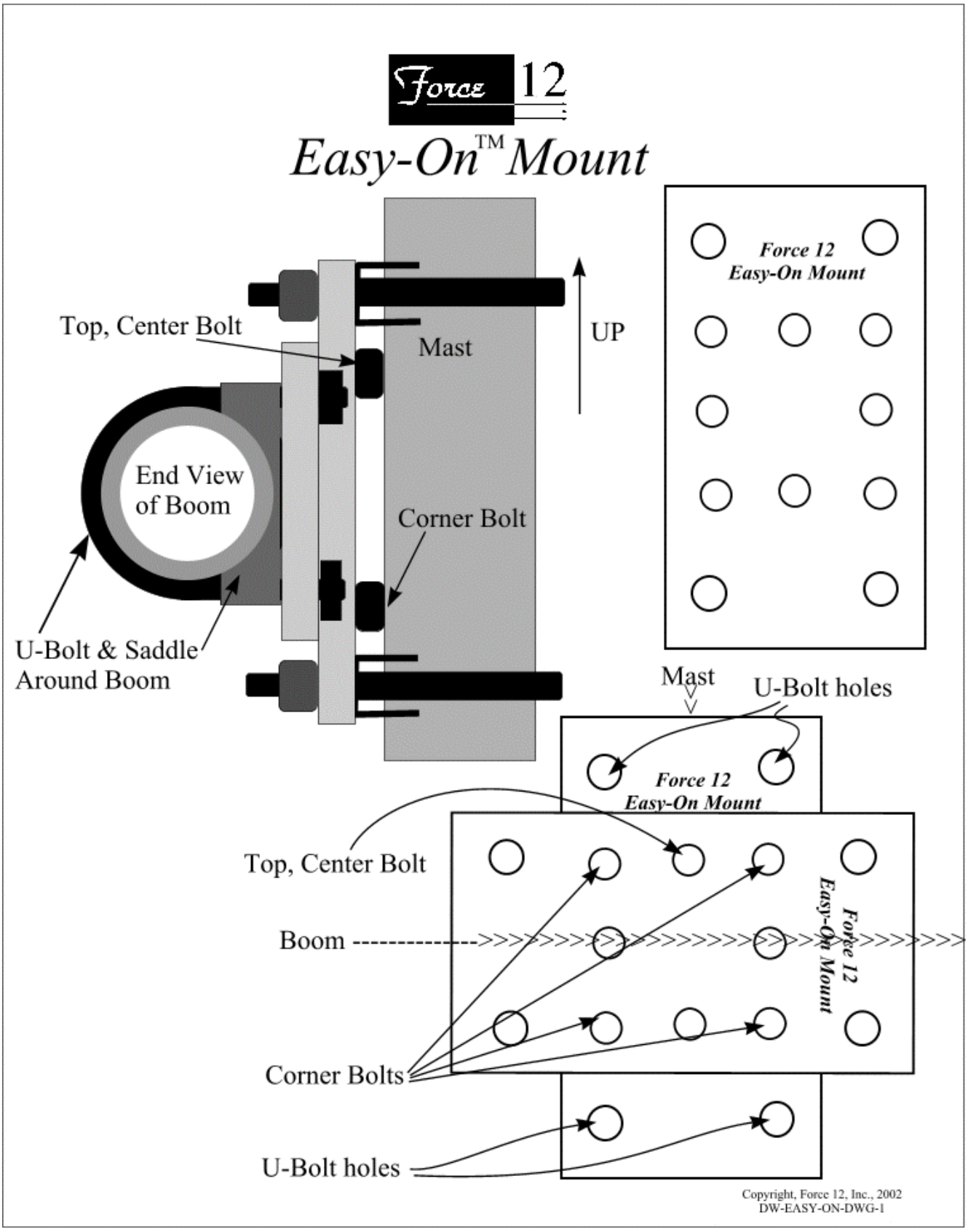


Force 12

Photo of Easy-On™ Mount



(Note: in this example, extra holes have been drilled for 2 1/2" U-bolts / 2 1/2" mast)


Force 12
Easy-On™ Mount
Top, Center Bolt
Mast
UP
End View of Boom
Corner Bolt
U-Bolt & Saddle Around Boom
Force 12 Easy-On Mount
Mast
U-Bolt holes
Force 12 Easy-On Mount
Top, Center Bolt
Boom
Force 12 Easy-On Mount
Corner Bolts
U-Bolt holes
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DW-EASY-ON-DWG-1

NOTES……..