

Shively Labs[®]

Circularly Polarized FM Broadcast Antenna

Model 6815



Instruction Manual
Installation, Operation, &
Maintenance

Congratulations!

Thank you for purchasing one of the finest FM broadcast antennas on the market today. The Shively Labs Model 6815 is the top-of-the-line in its class for its simplicity, superior performance and durability.

Your purchase is backed by the best technical support in the industry. Shively is a leading manufacturer in the broadcast industry, providing an extensive range of antennas, transmission line and components. Our technical staff has a wealth of experience in the broadcast industry and is standing by to serve you in any way.

This manual is intended to give you a good basic understanding of your antenna: its proper and safe installation, startup, and operation, and troubleshooting and maintenance information to keep it working satisfactorily for years to come. *Please have everyone involved with the antenna read this manual carefully, and keep it handy for future reference.*

Meanwhile, please feel free to contact your sales representative at Shively Labs at any time if you need information or help. Call or write:

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IMPORTANT

Please read this manual in its entirety before beginning installation of your antenna!

Failure to follow the installation and operation instructions in this manual could lead to failure of your equipment and might even void your warranty!

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1

Precautions and Preparation

Precautions

WARNING

Don't expose personnel to the medical hazards of intense radio frequency (RF) radiation. Whenever working on the tower in the area of the antenna, turn off all transmitters and lock them out so that they cannot be turned on accidentally.

For reference on RF safety, see CFR 29, Section 1910.97, the OSHA standard for exposure to non-ionizing radiation.

Check the shipment.

As soon as you receive your antenna, BEFORE signing for the shipment:

- a. Check to be sure all the material has arrived.
- b. Check for evident damage to any of the boxes.
- c. If any boxes are missing, or if any are obviously damaged, describe the problem in a WRITTEN note on the shipping papers BEFORE signing them. Then call Shively right away, and we'll do everything we can to correct the situation.

Important!

Never store the antenna system outdoors, boxed or otherwise. Take pains to keep the antenna components dry. You will need to purge moisture from the interior of the antenna components before applying transmitter power, and purging will be much more time-consuming if the components get wet.

Unpacking

- a. Find Box 1; it is marked "Open This Box First." It contains the optional transformer and two copies of the installation drawing. The parts list on one sheet of the installation drawing shows what box each item is in.
- b. Then open the boxes and examine for shipping damages. File any necessary claims with the carrier immediately.
- c. If all the boxes are present and in good condition but material seems to be missing, please contact Shively Labs immediately, using the telephone or Fax number on the inside cover of this manual. For the best service, have our sales order number (S/O) handy; it's in the block at the bottom right corner of the installation drawing.
- d. Along with your antenna you will get a spare parts kit. Place this in a safe place until it is needed.

CAUTION

All contact surfaces and openings to the interior of the components are protected from contamination and from physical damage by caps and plastic bags. Do not remove this protection until ready to connect the components.

Checking the system

Shively has planned the installation of the antenna based upon information provided by you. If this information contained errors, the parts and mounting hardware will have been designed incorrectly and will cause expensive delays in installation. *Therefore, we recommend that you recheck the installation parameters during this planning stage.*

Precautions and Preparation

Check all the parts to be sure that they will fit the tower and each other. Study the installation drawings carefully to confirm that the information used in designing the antenna and mounts was, in fact, accurate.

Have a reliable tower person, familiar with antennas and coaxial line, inspect the tower and review the installation drawings before the full rigging crew arrives. If design problems are found, contact Shively Labs immediately. Pay particular attention to:

Frequency of the antenna.

- Fit of the mounts to the tower members.
- Freedom from interference by gussets, leg flanges, guys and their attachment points, tower face members, obstruction lights, and other components.
- Compatibility of transmission line and antenna input terminals.
- Location of the transmission line run relative to the antenna input terminal.
- Use of non-metallic guy sections on the tower in the region to be occupied by the FM antenna. Ensure that there are no metal guys within ten feet (three meters) of any radiator.
- The adequacy of the tower structure and guys to carry the wind-load placed upon them by the antenna, particularly if radomes are used.

You gave Shively this information at the time of purchase, but a last check at this time can catch an error, which will be easier to correct before installation begins.

Prepare the mounting location.

Remember!

It is YOUR responsibility to ensure that your installation meets all applicable codes and the centerline-of-radiation requirements of your FCC construction permit.

NOTE

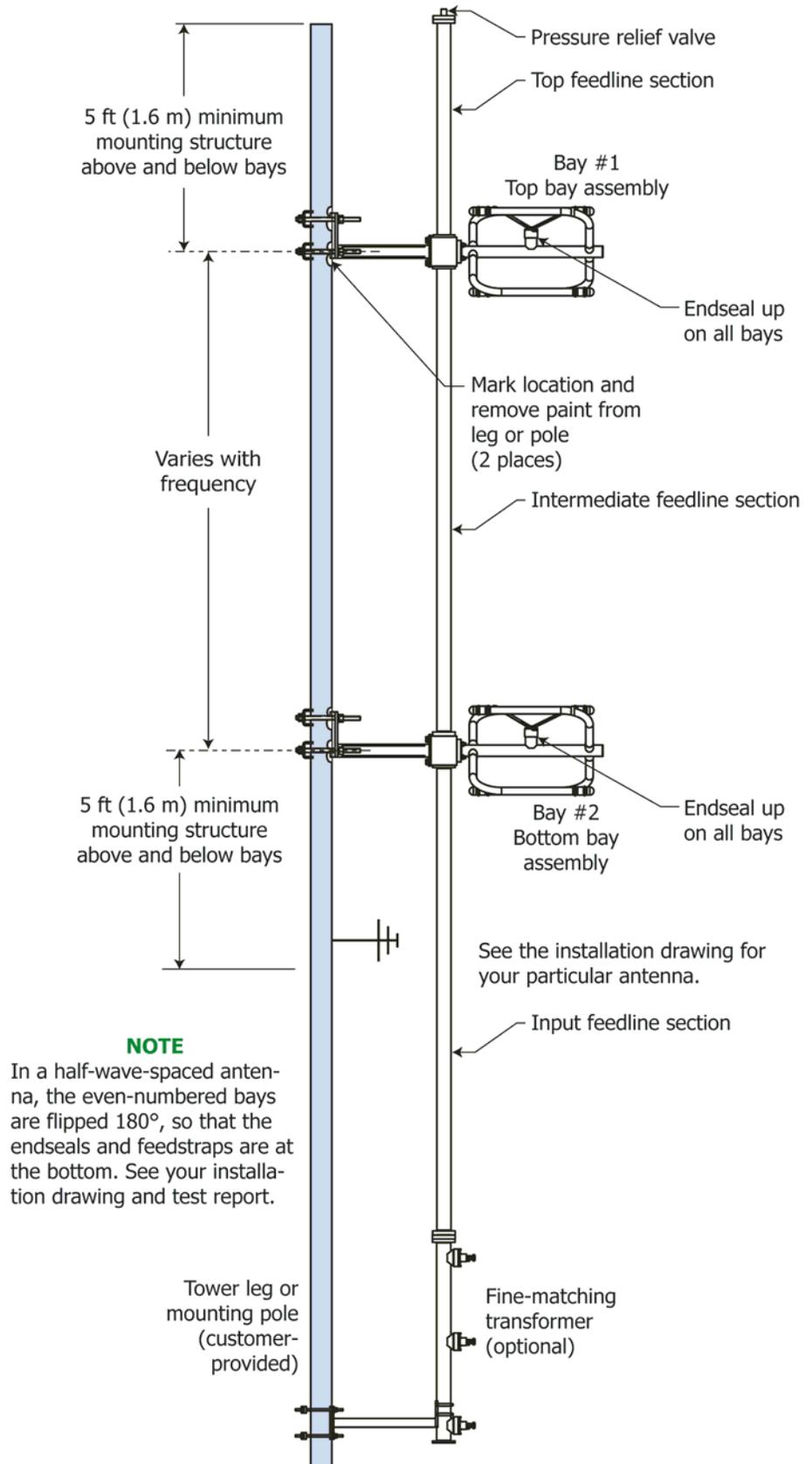
Bay spacing will be controlled by the interbay feedline length.

Prepare the tower for mounts:

- a. On the tower, starting at the top, use a steel measuring tape to find the location of each bay in accordance with the installation drawing. Mark the mount locations.
- b. Mark the specified location of any accessory mounts, such as for the transformer or special coax input line sections, to make sure they will fit as planned.
- c. Watch carefully for any interferences by tower members or guy wires which were not accounted for in the design.
- d. Where the mounts will be in contact with the tower leg(s) or mounting pole, scrape the tower paint away to ensure good electrical contact.

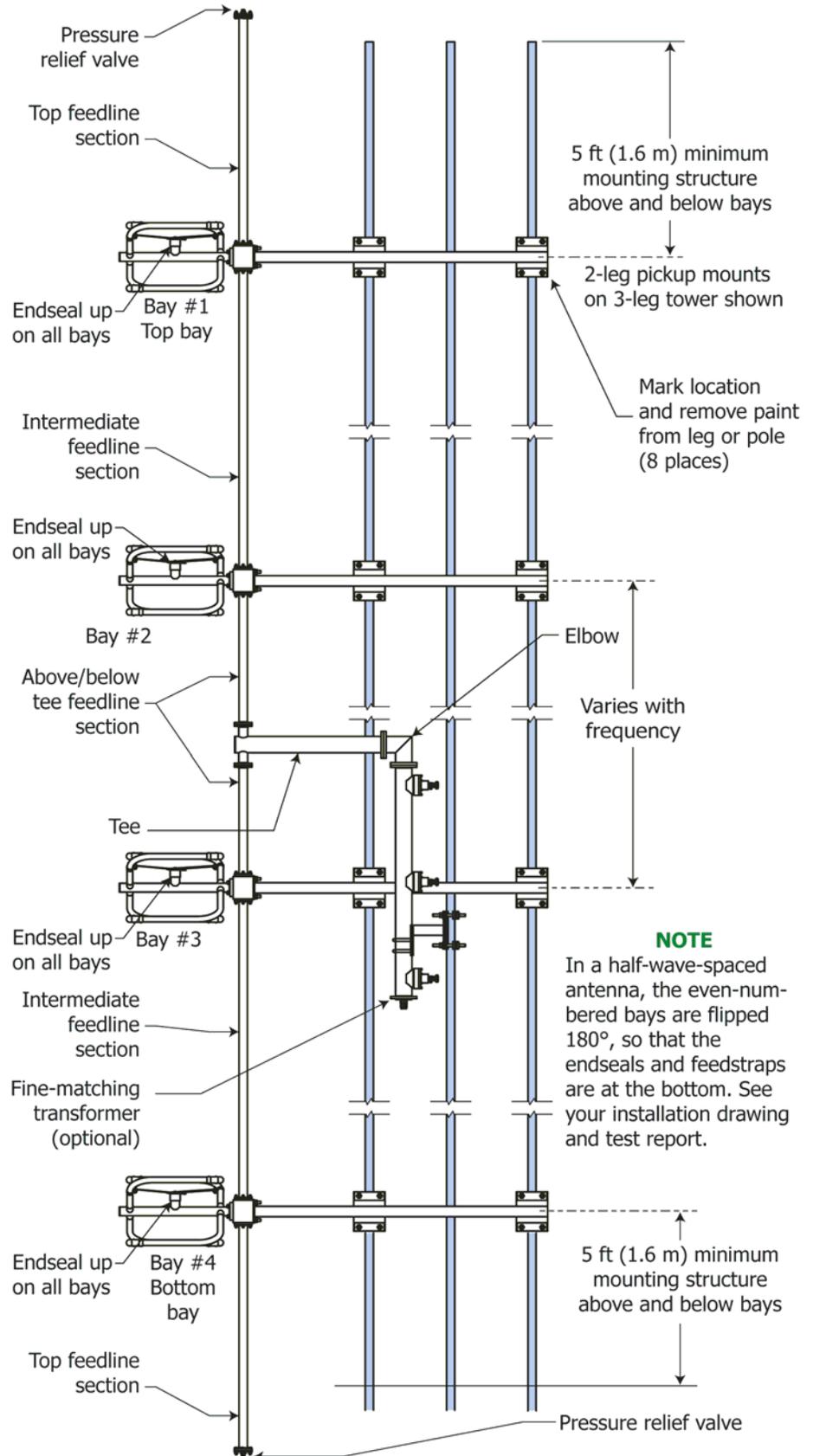
Precautions and Preparation

Figure 1. Tower layout, two-bay end-fed antenna without radomes



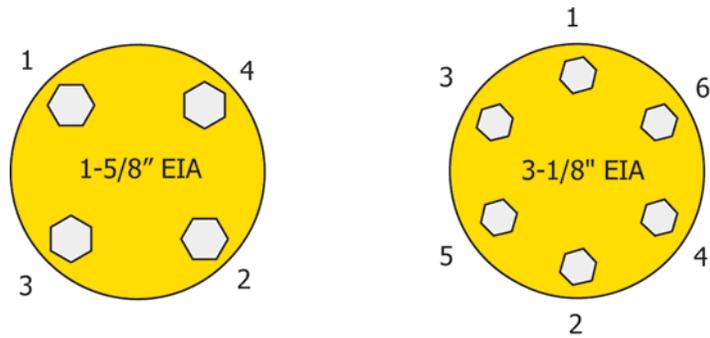
Precautions and Preparation

Figure 2. Tower layout, four-bay center-fed antenna without radomes



Flange bolt tightening

Figure 3. Flange bolt tightening sequence



NOTE

Use an anti-seize compound to minimize galling on stainless steel threads.

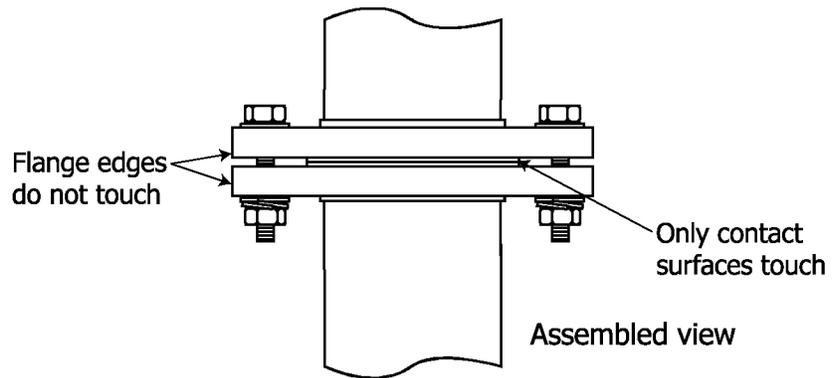
Table 1. Torque specifications

Hardware size	Torque (dry)	Torque (lubricated)
1/4-20 silicon bronze (radome flanges)	5 lb-ft (0.69 kg-m)	*** lb-ft (***) kg-m)
5/16-18 silicon bronze (1-5/8" EIA flanges)	9 lb-ft (1.2 kg-m)	*** lb-ft (***) kg-m)
3/8-16 silicon bronze (3-1/8" EIA flanges)	17 lb-ft (2.3 kg-m)	*** lb-ft (***) kg-m)
1/2-13 galvanized (tower mounts)	57 lb-ft (7.9 kg-m)	*** lb-ft (***) kg-m)

NOTE

Do not overtighten the flange bolts. Only the contact surfaces should touch, not the flange edges.

Figure 4. Feedline flange detail



2

Assembling the Bays and Feedline Sections

It will be easiest to assemble the bay radiators, the baymount blocks, the mounts, and the feedline sections before the antenna is mounted on the tower.

CAUTION

Do not attach the bays together before lifting them up the tower and mounting them (see [Figure 6](#) on page 10 and [Figure 7](#) on page 11). NEVER try to support the bays by the feedline.

Pair up the antenna bays and the baymount blocks

CAUTION

This procedure is a general guide. Assemble components exactly in accordance with your installation drawing. If you do not, your antenna may not perform as expected.

Pair up the baymount blocks ([Figure 5, 1](#) and [5](#)) and the radiator assemblies ([6](#)), using the bay number labeled on each bay and feedline section. Watch out for the following:

- Be sure the top baymount block (with the blank feedline flange) is paired with bay radiator #1 and that it is aligned so that the blank flange will point upward.
- (Center-fed antenna only) There is a second block with a blank flange. Be sure it is paired with the bottom bay radiator and aligned so that the blank flange will point downward.

Attach the bays to the baymount blocks

CAUTION

To prevent damaging the copper feedline, use clamps rather than U-bolts, and don't overtighten.

- a. Lay a baymount block horizontally, supported off the ground, with its baymount flange pointing upward.

CAUTION

All contact surfaces and openings to the interior of the components are protected from contamination and from physical damage by protective covers or plastic bags. Do not remove this protection until ready to connect the components.

NOTE

Baymount block hardware and inner conductors are shipped in place on the baymount block.

- b. Remove the protective covering from the block baymount flange.
- c. Ensure the inner conductor connector is in place in the inner conductor of the baymount flange.
- d. Remove the baymount flange hardware ([Figure 5, 3](#)) from the block.

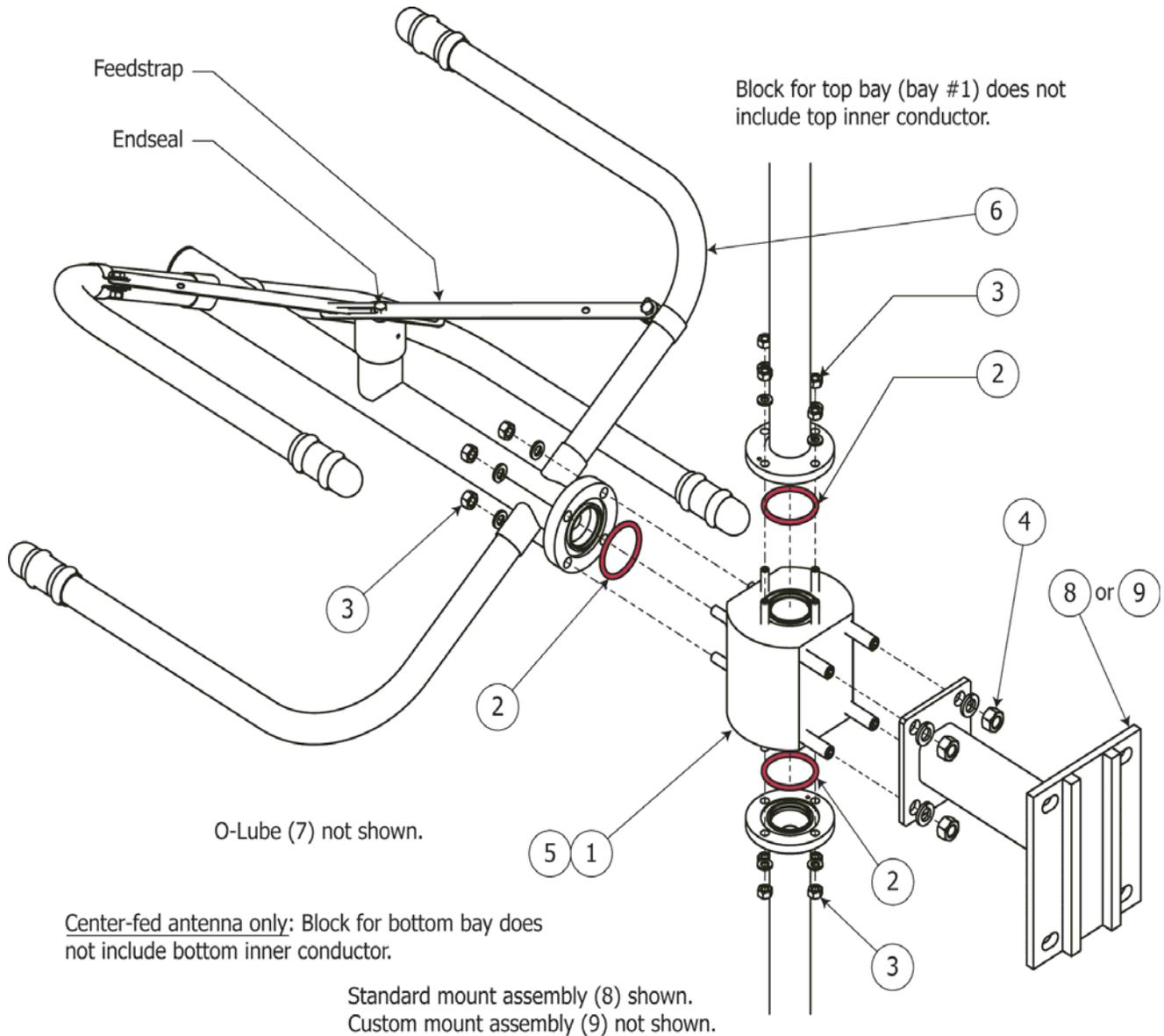
CAUTION

Lubricate the O-rings only a light lubricating coat of O-Lube (provided) or petroleum jelly; too much may hamper electrical contact and contaminate the interior of the system.

Assembling the Bays and Feedline Sections

- e. Coat the baymount O-ring (2) lightly with O-Lube (7; supplied with the antenna), then install it in the O-ring groove in the flange. Be sure it is properly seated in the groove and not pinched between the flange contact surfaces.
- f. Remove the matching radiator assembly from its protective plastic bag.

Figure 5. Antenna bay assembly



CAUTION

Bay/feedstrap orientation is critical to performance. In general, the end-seals and feedstraps in a full-wave-spaced antenna will all be oriented upward, while those in a half-wave-spaced antenna will alternate. *Install each radiator in accordance with its stenciled bay number, its marked orientation, and your installation drawing.*

CAUTION

Be sure the radiator's inner conductor fits cleanly over the baymount's inner conductor connector. If any of the fingers of the connector are forced outside the radiator's inner conductor (a "split bullet"), this will cause arcing and damage to the antenna.

- g. Carefully place the radiator into position over the flange studs and inner conductor connector on the block. Secure it in place using the flange hardware supplied with the block.
- h. First snug the flange nuts in the sequence shown in [Figure 3](#) on page 5, then tighten them in accordance with [Table 1](#) on page 5.

Attach the mounts to the baymount blocks (antennas without radomes)

NOTE

Mounts may vary from bay to bay, depending on the tower configuration. Be sure to use the correct mount for each bay, as shown on your installation drawing.

- a. Remove the mount hardware ([Figure 5, 4](#)) from the block.
- b. Using the mount hardware, attach the mount ([8](#) or [9](#)) to each block. Tighten in accordance with [Table 1](#) on page 5.

End-fed antennas

CAUTION

This procedure is a general guide. Assemble components exactly in accordance with your installation drawing. If you do not, your antenna may not perform as expected.

- a. With reference to [Figure 6](#), match up the antenna bay assemblies (assembled above) and the feedline sections, using your installation drawing and the bay number labeled on each piece (bay #1 with feedline #1, etc.).

NOTE

Watch out for the following:

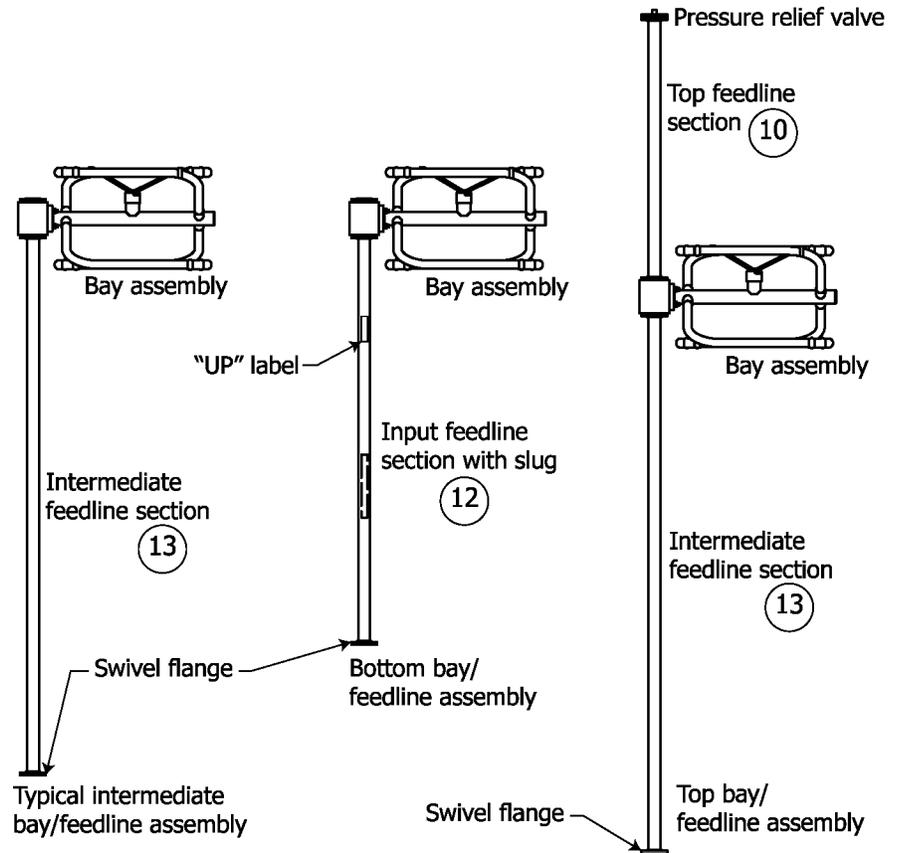
- Match the top feedline section ([Figure 6, 10](#), with outer conductor only) with bay assembly #1 and align it with the blank flange at the top of the block.
 - Match the input feedline section ([12](#)) with the bottom bay assembly and align it with the flange at the bottom of the block.
 - All intermediate feedline sections ([13](#)) are interchangeable.
- b. Remove the feedline flange hardware ([Figure 5, 3](#) or) and O-rings ([4](#) or) from the feedline flanges on each block.

CAUTION

Do not overtighten the feedline flange hardware (see [Table 1](#) and [Figure 4](#) on page 5). Only the contact surfaces should touch, as shown.

- c. Attach the top feedline section ([Figure 6, 10](#)) to the top bay assembly block's top (blank) flange.
- d. Attach the input feedline section ([12](#)) to the bottom bay assembly block's bottom flange.
- e. Attach the intermediate feedline sections ([13](#)) to each bay assembly block's bottom flange.

Figure 6. Feedline/bay assemblies, end-fed antenna



- f. Attach feedline sections as shown in your installation drawing to the other antenna bay(s) so that each bay assembly has a feedline section at its bottom, and the top bay has its top feedline section as well.

NOTE

Parasitic elements not shown for clarity. Please refer to your installation drawing for parasitic orientation and placement.

Center-fed antennas

- a. With reference to [Figure 7](#), match up the antenna bay assemblies (assembled above) and the feedline sections, using your installation drawing and the bay number labeled on each piece (bay #1 with feedline #1, etc.).

NOTE

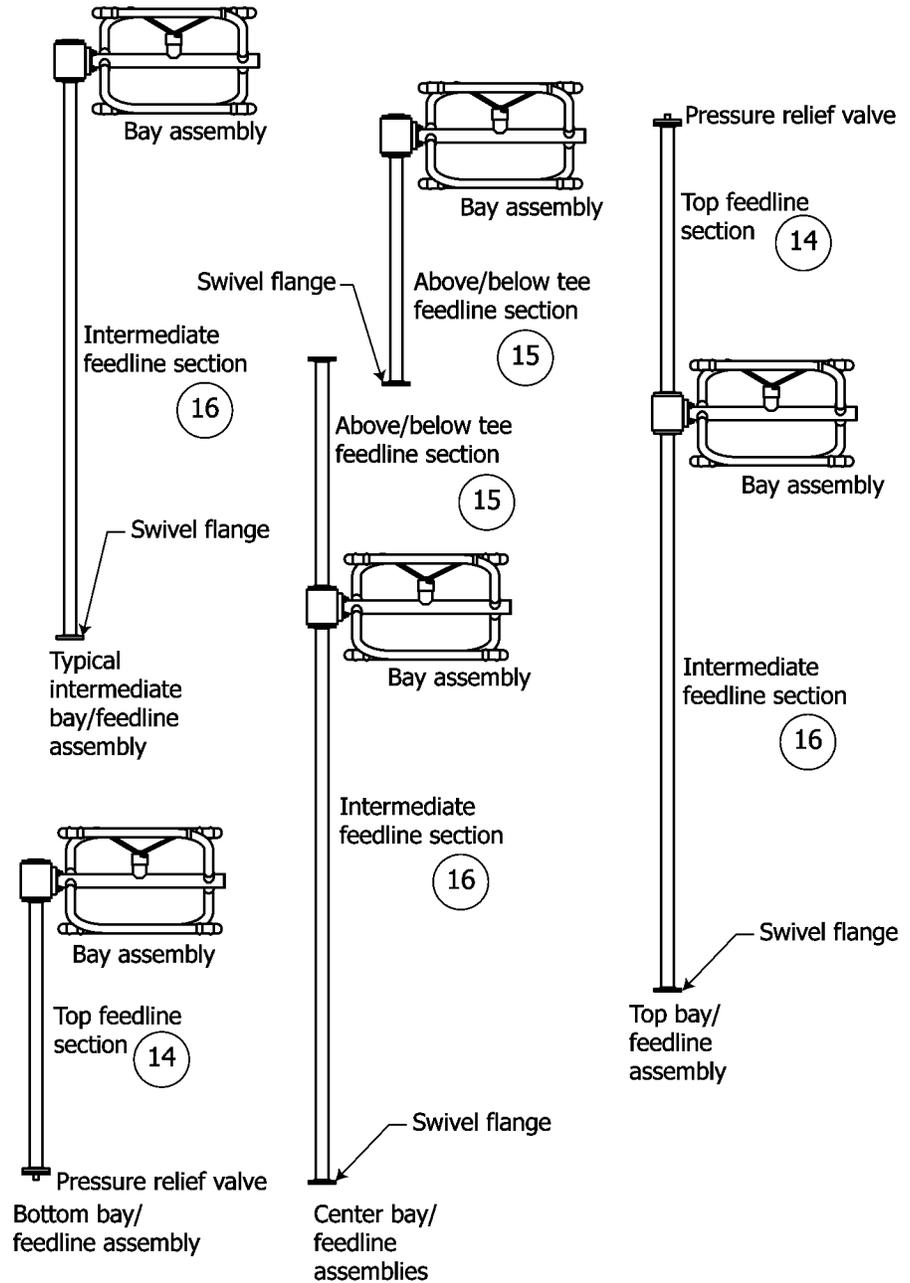
Watch out for the following:

- Match one of the top feedline sections ([Figure 7, 14](#)) with bay assembly #1 and align it with the blank flange at the top of the block.
 - There is a second top feedline section ([14](#)). Match it with the bottom bay assembly and align it with the blank flange at the bottom of the block.
 - Both "above/below tee" feedline sections ([15](#)) are interchangeable.
 - All intermediate feedline sections ([16](#)) are interchangeable.
- b. Remove the feedline flange hardware ([3](#) or) and O-rings ([4](#) or) from the feedline flanges on each block.

Assembling the Bays and Feedline Sections

- c. Attach one of the top feedline sections ([Figure 7, 14](#)) to the top bay assembly block's top (blank) flange.

Figure 7. Feedline/bay assemblies, center-fed antenna



- d. Attach the other top feedline section ([14](#)) to the bottom bay assembly block's blank bottom flange.
- e. Referring to your installation drawing, attach the "above/below tee" sections ([15](#)) to the bottom flange of the bay just above the tee and to the top flange of the bay just below the tee.
- f. Attach feedline sections as shown in your installation drawing to the other antenna bay(s) so that each bay assembly has a feedline section at its bottom, and the top bay has its top feedline section as well.

NOTE

Parasitic elements not shown for clarity. Please refer to your installation drawing for parasitic orientation and placement.

If your antenna is equipped with radomes, continue to [Mounting the Radomes](#) on page 13. If not, please proceed to [Mounting the Antenna on the Tower](#) on page 15.

3

Mounting the Radomes

If your antenna does not include radomes, skip this step and go straight to [Mounting the Antenna on the Tower](#) on page 15.

If your system includes radomes, you can most easily install them on the ground following completion of [Assembling the Bays and Feedline Sections](#).

Attach the radomes (if applicable) to the bay/feedline assemblies

Install the radome(s) as follows:

- a. Select a top radome half ([Figure 8, 21](#)) and a bottom radome half ([22](#)). The top and bottom radome halves include the pre-mounted halves of the radome formed plates ([23](#)).
- b. Using 3/8" hardware ([24](#)) threaded into the brass "nut plates" riveted inside the radome top half, attach a radome formed plate ([23](#)) to the radome top half.
- c. Repeat for the radome bottom half ([22](#)).
- d. Using 1/2" hardware ([25](#)), attach the radome back plate ([26](#)) to the radome formed plates ([23](#)). Do not fully tighten at this time.

CAUTION

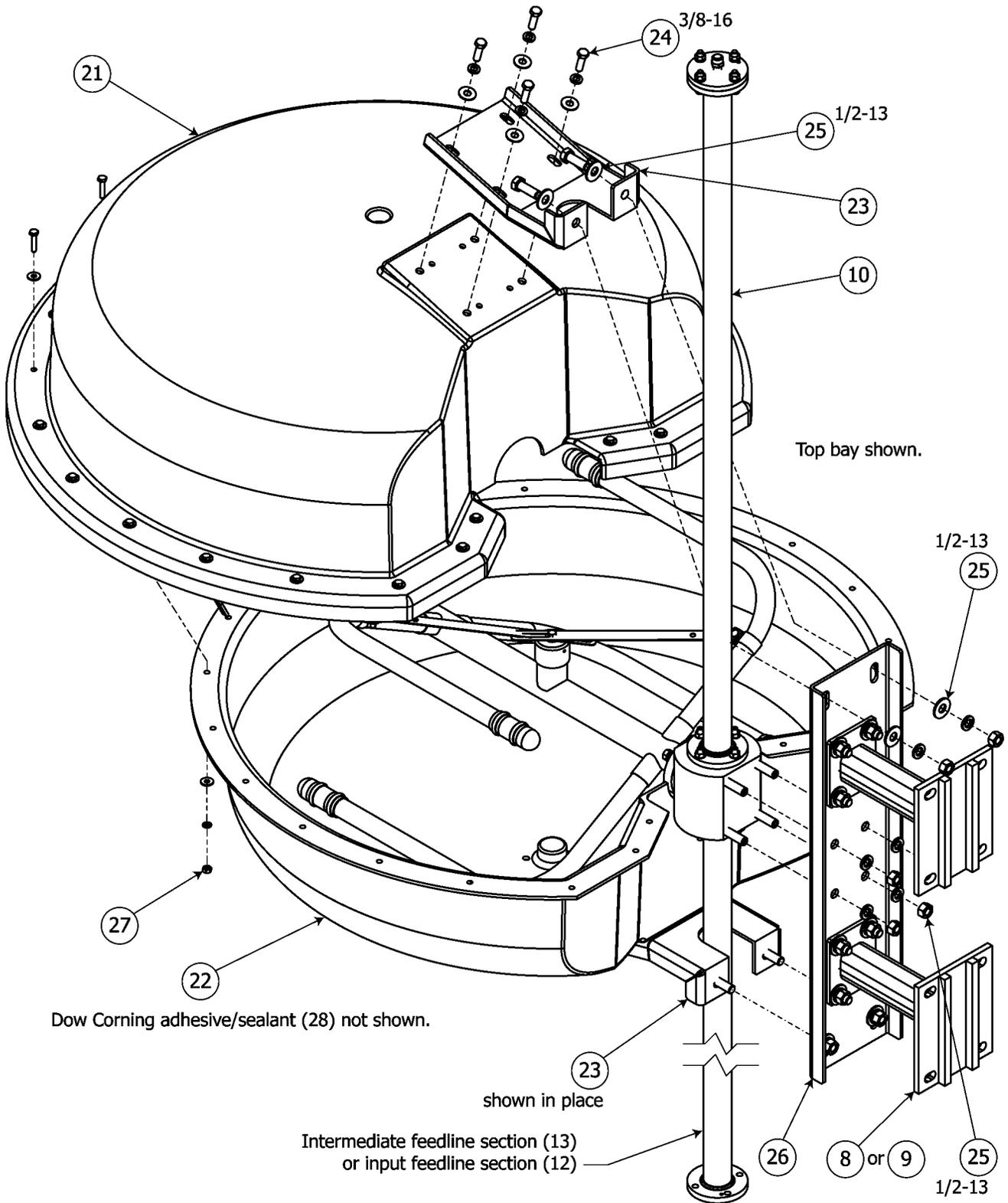
To ensure proper weather protection, be sure the top radome half, with the overlapping outer flange, is installed at the top of the bay.

- e. Fit the radome halves over the antenna bay. Using 1/2" galvanized hardware, attach the radome formed plates to the radome back plate. Do not tighten fully yet.
- f. Using the 1/4" hardware ([27](#)), attach the edge flanges of the radome halves to each other. Do not tighten fully yet.
- g. Repeat for the other antenna bay(s).

Your antenna bay/feedline/radome sections are all set. Please proceed to [Mounting the Antenna on the Tower](#) on page 15.

Mounting the Radomes

Figure 8. Radome mounting



4

Mounting the Antenna on the Tower

Precautions

WARNING

Don't expose personnel to the medical hazards of intense radio frequency (RF) radiation. Whenever working on the tower in the area of the antenna, turn off all transmitters and lock them out so that they cannot be turned on accidentally.

CAUTION

Do not attach the bays together before lifting them up the tower and mounting them (see [Figure 6](#) on page 10 and [Figure 7](#) on page 11). NEVER try to support the bays by the feedline.

CAUTION

Lubricate the O-rings only a light lubricating coat of O-Lube ([Z](#); provided) or petroleum jelly; too much may hamper electrical contact and contaminate the interior of the system.

CAUTION

All contact surfaces and openings to the interior of the components are protected from contamination and from physical damage by protective covers or plastic bags. Do not remove this protection until ready to connect the components.

CAUTION

Do not overtighten the feedline flange hardware (see [Table 1](#) and [Figure 4](#) on page 5). Only the contact surfaces should touch, as shown.

Study your antenna

Mounts vary from installation to installation, to accommodate various tower and mounting pole requirements. [Figure 9](#) shows several common configurations. Your feedline mounts may be one of the common designs shown; if they are not, they will be shown in detail on your installation drawing.

Before you begin installation, study the mounts, the mounting tower leg(s) or pole, and your installation drawing carefully, to determine which mount(s) will be used for each component.

Mount the antenna bay assemblies.

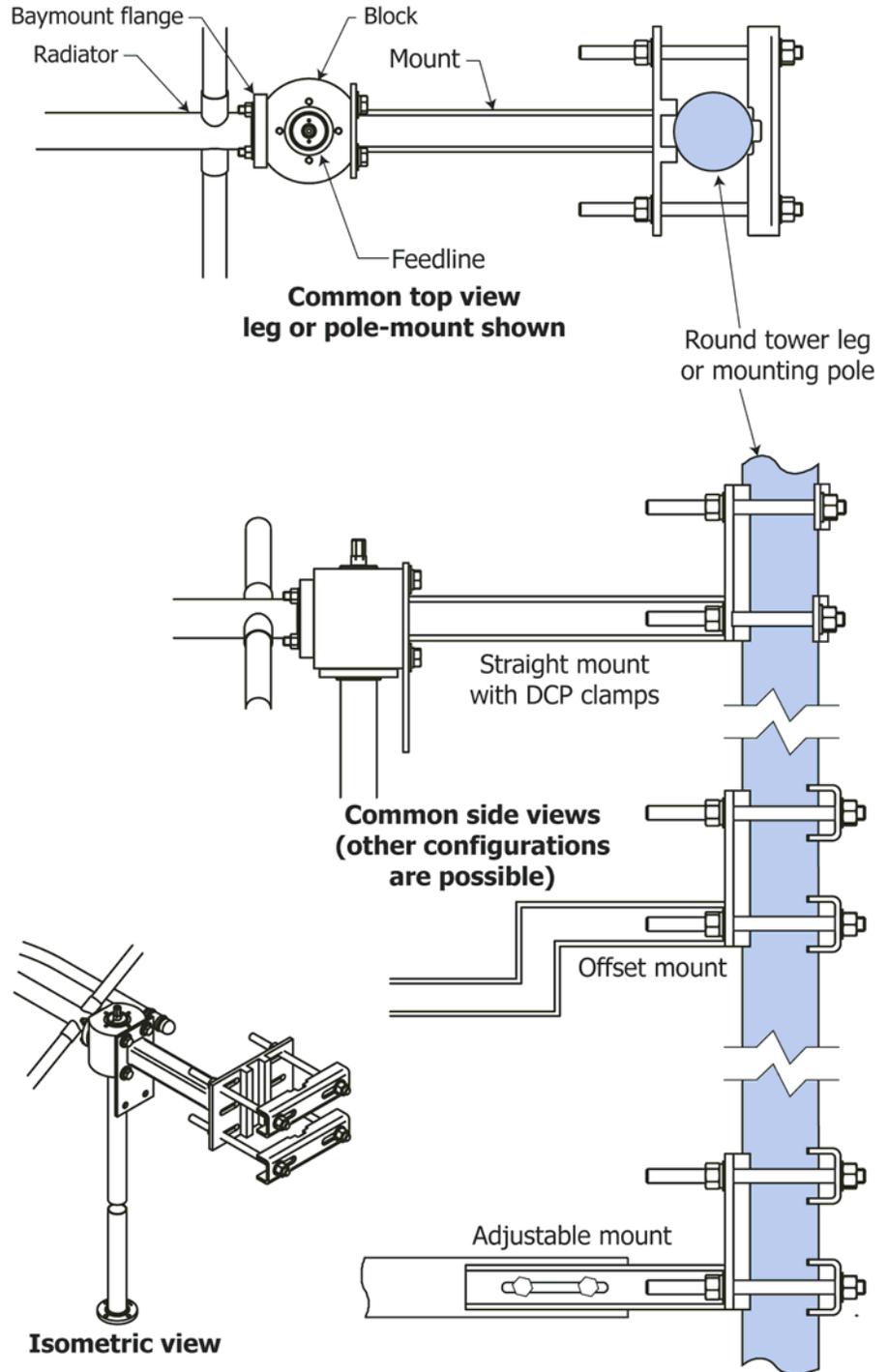
NOTE

Mount antenna bays with feed straps as shown in your installation drawing, clear of all guylines and other obstructions.

- a. Start with the bottommost antenna bay assembly. Using the galvanized 1/2" hardware included with the antenna, attach the mount ([8](#) or [9](#)) to the tower leg(s) or mounting pole exactly as shown in your installation drawing. Partially tighten the mount hardware at this time.
- b. Add the next bay assembly:
 - (1) Remove the plastic bags and/or protective covers from the flanges and install an O-ring, lubricating it with a light coat of O-Lube ([Z](#); provided with the antenna).

Mounting the Antenna on the Tower

Figure 9. Common feedline mount configurations



NOTE

In some cases, the mounts are reversible to clear tower cross-members and other obstructions.

- (2) (Radome antenna only) You will have to loosen the top formed plate ([Figure 8, 23](#)) of each bay to allow the next bay's feedline flange to get by. Tighten the flange hardware, then reposition the plate and tighten its hardware.

Mounting the Antenna on the Tower

- c. (Center-fed antenna only) When you have installed the bay assembly with the "above/below tee" section on top, install the tee ([Figure 15, 17](#)) before adding the next antenna bay assembly.
 - (1) Ensure an inner conductor connector and a lightly lubricated O-ring ([2](#)) are in place before connecting the flanges.
 - (2) Tighten the tee flanges before continuing bay assembly installation.
- d. Continue for the rest of the array.
- e. Ensure the bays are located on the mounting pole or tower leg at the locations you marked.
- f. Align the bays to the correct azimuth and align them vertically with each other, then tighten the mounting hardware to 57 ft-lb.
- g. Install the elbow ([18](#)) at the tee input flange.
 - (1) Ensure an inner conductor connector and a lightly lubricated O-ring ([2](#)) are in place before connecting the flanges.
 - (2) Tighten the flanges before continuing bay assembly installation.

Installing the optional fine-matching transformer (if applicable)

One of the unique features of Shively Labs antenna systems is the adjustable impedance-matching transformer ([Figure 15, 29 or 30](#), and [Figure 10](#)) available with the antenna. It allows the installer to compensate for changes in the input impedance caused by the installation (tower, conduit, ladder, etc.).

NOTE

The transformer may be oriented in whichever direction you wish (see [Figure 10](#)). Make it easy for yourself to reach for adjustment at startup.

Install the transformer at your antenna array input. This will be at the input flange of the input feedline section ([12](#)) on an end-fed antenna, or at the input flange of the elbow ([18](#)) on a center-fed antenna. Transformer mounts are generally similar to feedline mounts and should be installed in the same manner.

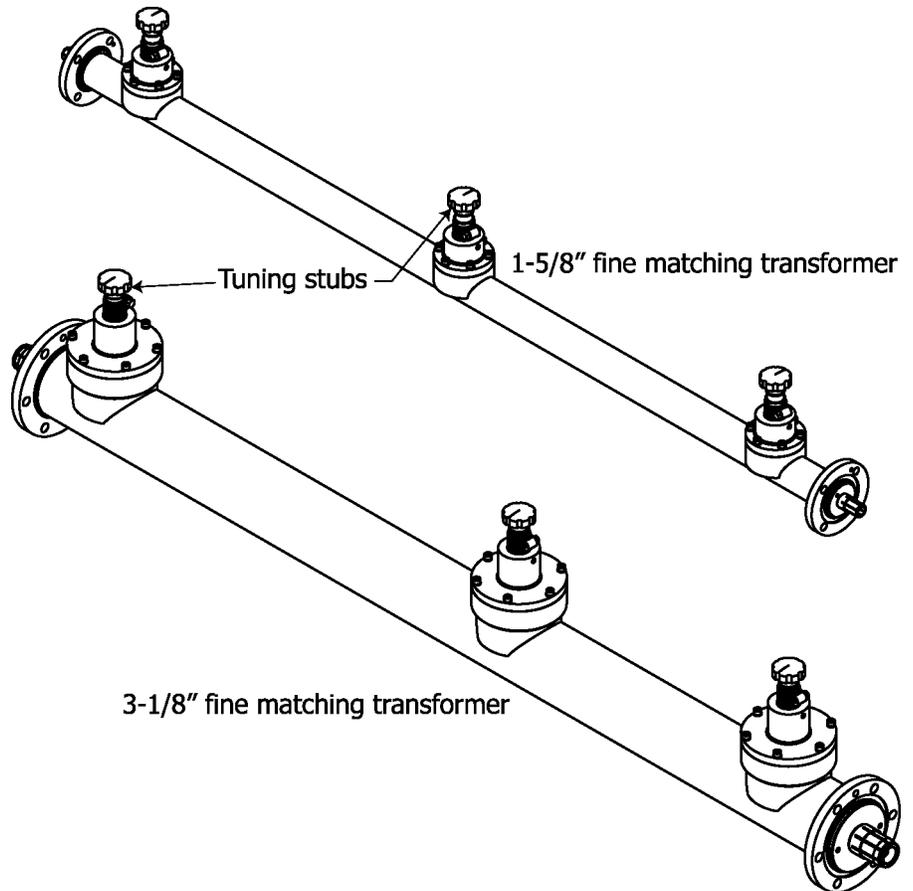
Connecting the antenna

End-fed antenna:

- a. Connect the tower transmission line to the array input. This will be at the input flange of the input feedline section ([Figure 15, 12](#)) or at the transformer ([29](#)) input flange, if applicable.
 - (1) Be sure the flange contains an inner conductor connector and a lightly lubricated O-ring ([2](#)).
 - (2) Tighten in accordance with [Table 1](#) on page 5.
- b. Tighten the transmission line supports. Do NOT allow the weight of the transmission line to hang from the antenna input.

Mounting the Antenna on the Tower

Figure 10. Fine-matching transformers, 1-5/8" & 3-1/8" EIA



Center-fed antenna:

- a. Connect the tower transmission line to the array input. This will be at the input flange of the elbow ([Figure 15, 18](#)) or at the transformer ([30](#)) input flange, if applicable.
 - (1) Be sure the flange contains an inner conductor connector and a lightly lubricated O-ring ([19](#)).
 - (2) Tighten in accordance with [Table 1](#) on page 5.
- b. Tighten the transmission line supports. Do NOT allow the weight of the transmission line to hang from the antenna input.

Antenna installation is complete. Please proceed to [Startup and Operation](#) on page 19.

5

Startup and Operation

Precautions

Important

Shively Labs will not accept responsibility for antenna failure due to operation without proper purging or positive pressure of dry air or dry nitrogen.

Pressurization

After the antenna is installed and all lines are connected, it is necessary to check the system for leaks, purge with dry gas (cylinder dry nitrogen or air from a compressor-dehydrator) to remove all moisture, and leave the system pressurized with dry gas to avoid future infiltration of moisture. These steps must be taken before RF power is applied to the system.

CAUTION

When pressurizing the system, never use a "garage" air compressor, as it will not clean the air and will blow both moisture and contaminants such as oil and graphite into the coaxial system.

Test for leaks

Pressure Correction:

where P_C = corrected
final pressure

Fahrenheit:

$$P_C \text{ (in psig)} = \frac{(P_R + 14.7)(T_1 + 460)}{(T_2 + 460) - 14.7}$$

Celsius:

$$P_C \text{ (in kPa)} = \frac{(P_R + 101.3)(T_1 + 273)}{(T_2 + 273) - 101.3}$$

P_R = final pressure as
read

T_1 = beginning tempera-
ture

T_2 = final temperature

CAUTION

Be sure to use a good quality pressure gauge which will read accurately in the 5 - 20 psig (35 - 135 kPa) range; don't depend on the cylinder gauge, which will not be accurate at a low pressure.

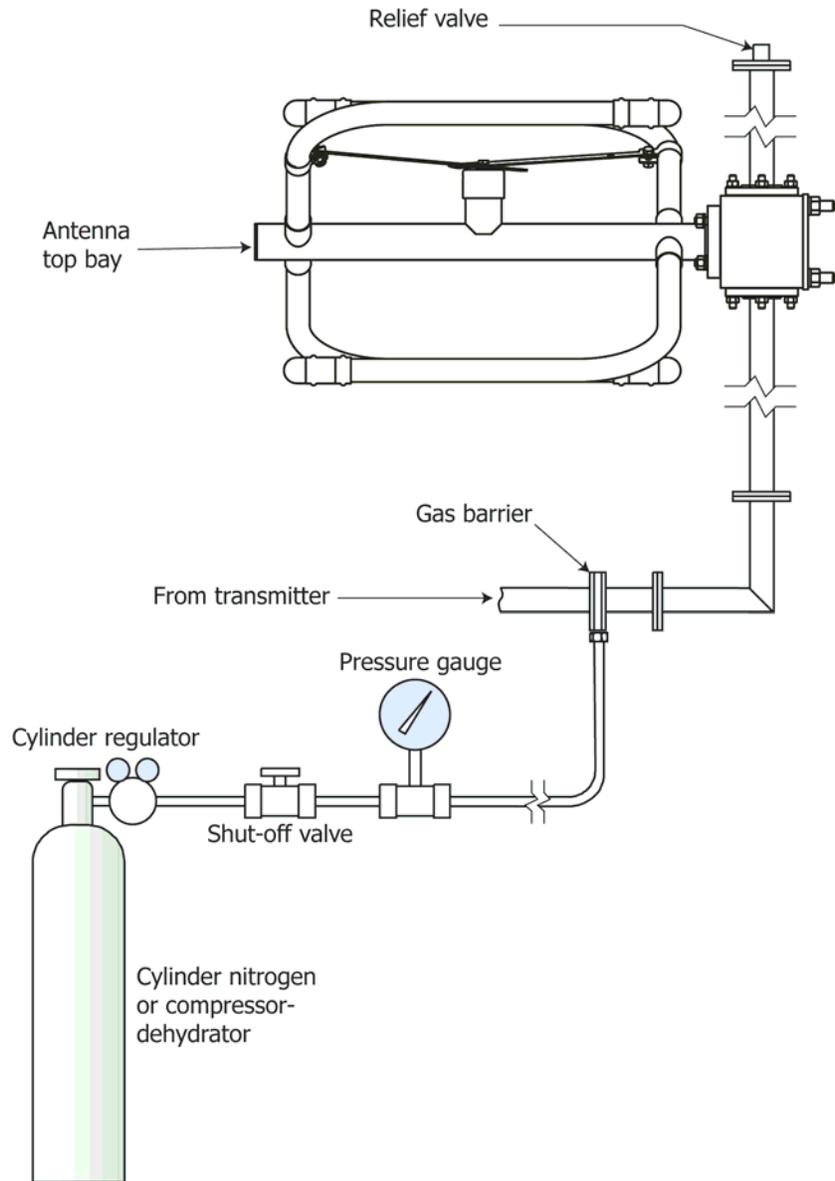
- Connect a source of dry gas (cylinder nitrogen or air from a compressor-dehydrator) to the system as shown in [Figure 11](#) on page 20.
- Pressurize the system to seven (7) psig, then close the shutoff valve. Give the system one half hour to stabilize, then record the pressure and the temperature.
- Wait twenty-four hours, then read the pressure and the temperature again and use the pressure correction formula at left to obtain a corrected pressure for comparison.
- If the system loses pressure at an unacceptably high rate, re-pressurize it, leaving the gas supply on. A rule of thumb is that the final pressure should not be less than half the initial pressure after twenty-four hours.
- Find the leak(s), using a leak detector or soap bubbles. (The most common cause of leakage is an O-ring pinched in a flange.)
- Correct any leaks that are found. Then repeat the leak test until the results are satisfactory.

Purge the system

All pressurized Shively Labs antennas have a pressure relief valve at the top of the feedline (center-fed feedlines have a relief valve at each end). This valve is set to open at about 10 psig. So, to purge the system, it is not necessary to send a worker to the top of the antenna to open a valve or loosen a flange. Simply raise the internal pressure enough to open the relief valve. When the purge is complete, lower the pressure and the valve will close.

When the system is new, and any time that it has been opened, it must be purged with dry gas before operation to eliminate moisture. The dry gas used may be dry cylinder nitrogen or air from a compressor-dehydrator.

Figure 11. Pressurized gas schematic



Purge your system as follows:

- a. If you have any liquid water in your transformer or your transmission line, use a vacuum pump to dry the transmission line and transformer. Apply as much vacuum as you can to the system and hold the vacuum for 8 hours. This should remove any liquid water. [A vacuum pump can be rented or borrowed from a refrigeration contractor.]
- b. Determine how wet the system is and thus how much purging will be required. If a system of rigid line carefully protected from weather and assembled in dry weather is average, a system exposed to moisture during storage or installation will be relatively wet. New semi-flex transmission line, delivered pressurized with dry gas, will be relatively dry; used semi-flex will be extremely wet.

Startup and Operation

- c. Determine the volume of dry gas to use for the purge. [Table 2](#) shows approximate volumes inside various coax sizes. Add the length of the antenna to the length of the transmission line to determine the overall length of the system. You may ignore the volume inside the radiators. We suggest three volume changes of dry gas for an "average" system.

Table 2. Volume of coax per 1000 feet of length

Coax Size	Volume
1-5/8"	13 cu. ft. (0.37 m ³)
3-1/8"	50 cu. ft. (1.4 m ³)
4-1/16"	90 cu. ft. (2.6 m ³)
6-1/8"	200 cu. ft. (5.7 m ³)
9-3/16"	450 cu. ft. (13 m ³)

NOTE

A standard nitrogen cylinder (9 inch diameter by 55 inches tall) contains about 200 cubic feet (5.7 m³) of gas.

CAUTION

Do not raise pressure over 20 psig (~135 kPa), even briefly. Increase pressure slowly, noting that it takes time for the entire system to fill with the new pressure and the pressure gauge to stabilize.

- d. Connect a source of dry gas (cylinder nitrogen or air from a compressor-dehydrator) to the system as shown in [Figure 11](#). Raise the gas pressure to 12 or 13 psig (83 - 90 kPa).

CAUTION

When purging, you must blow dry gas *through* the system, not just maintain a pressure. The gas *volume* accomplishes the purge.

- e. If the relief valve has opened, the nitrogen cylinder will slowly drain or the compressor-dehydrator will not shut down.

Leave the system
pressurized

After completion of the purge, reduce the supply pressure to about 5 to 7 psig, allowing the pressure relief valve to close and seal the system.

After the pressure has stabilized, keep careful note of cylinder pressure or compressor-dehydrator running time, to be sure that no large leaks have been overlooked. This is especially important immediately after installation or any subsequent opening and reassembly.

Impedance trimming (if applicable)



Your (optional) transformer can be operated at the factory setting, but it will give optimal performance on your tower if you fine-tune it after installation.

Important

In the days before the hazards of intense RF power were realized, it was common practice to have a technician climb the tower and adjust the impedance match using the transmitter as a signal source and reading the VSWR or return power on the transmitter. This practice **MUST NOT** be used, as few transmitters can be operated at a low enough power level to avoid exposing the rigger to an unsafe RF level. For reference, see 29 CFR, Section 1910.97, the OSHA standard for exposure to non-ionizing radiation.

WARNING

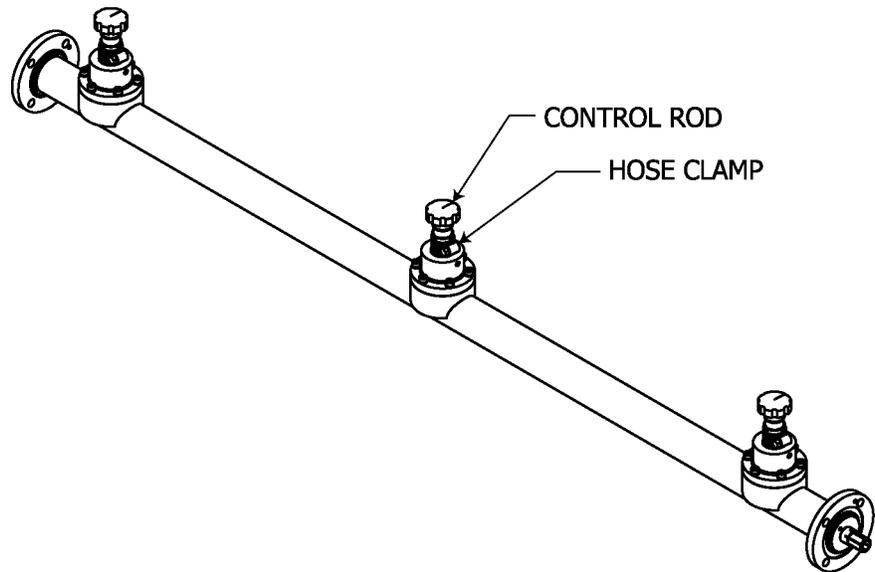
Whenever a rigger is on the tower in the area of the antenna, shut off the transmitter signal and lock and tag it out so that it cannot be turned on accidentally.

CAUTION

A high voltage standing wave ratio (VSWR) may indicate damaged transmission line or incorrectly assembled components. This condition will cause serious damage to your equipment when full power is applied.

Use low-power test equipment, such as a network analyzer or an impedance bridge, to apply power to the antenna. If you do not have access to low-power test equipment, please call Shively Labs before proceeding.

Figure 12. Impedance-matching transformer



Adjust the transformer as follows:

- Loosen the hose clamps on the control rods enough to allow the rods to move.
- Grasp one of the control rods and slide it in or out about 1/4 inch or 6 millimeters. It will move stiffly because of O-ring friction.
- Read the VSWR. If the reading went down, move the control rod again in the same direction. If the VSWR went up, move the same rod in the opposite direction. Repeat until no further improvement is seen.

- d. Adjust the second and third rods in the same manner.

NOTE

If you get "lost," return all three rods to the factory setting (all the way out) and start over.

- e. Return to the first rod, and so forth, until you have the lowest possible VSWR or return power reading. This is the optimal transformer setting at this frequency.
- f. When you have set the transformer, use a sharp point to scribe the shaft of each control rod where it leaves the flange collar. Record the settings of the control rods and file this information with this manual for future reference.
- g. Tighten the hose clamps. If the clamps are left loose, vibration may change the adjustments.

System sweep (recommended)

Shively Labs strongly recommends that you perform a system sweep of your transmission line and antenna while you have the installation crew on site. Should any problems arise later with your antenna, it will be extremely helpful to know what the system's characteristics were when it was new. We recommend you perform a system sweep after installation.

Many riggers can sweep your system after installation or recommend a contractor to perform it. Alternatively, Shively Labs makes available instructions for system sweep on our Web site, www.shively.com.

Checkout

Before beginning checkout of the antenna system, be sure the following items have been done:

- The antenna system has been installed in accordance with this manual and the installation drawing.
- The system is gas-tight and purged.
- All radiators are operating; impedance has been trimmed, and VSWR is low.
- The transformer settings and initial characterization data have been recorded.

Check the system out as follows:

- a. Bring up RF power slowly and observe transmitter readings, stability, and general operation.
- b. Run at about half power for at least an hour, reading forward and reflected power, stability, etc.
- c. If the system is stable and seems to be operating properly, bring it up to full power. Take initial readings, and repeat the readings periodically.
- d. Performance readings should not change, and there should be no evidence of heating in the antenna system.

If any problem is found, fix it now. Call Shively Labs if you need help or advice.

Operate

CAUTION

Don't exceed the rated power capacity of the antenna.

NOTE

To obtain the best performance and dependability, read and follow the maintenance and troubleshooting recommendations in [Chapter 5](#) of this manual.

Once the antenna has been installed and VSWR has been optimized, simply apply the transmitter signal. Don't exceed the rated power of the antenna.

Precautions

WARNING

Don't expose personnel to the medical hazards of intense radio frequency (RF) radiation. Whenever working on the tower in the area of the antenna, turn off all transmitters and lock them out so that they cannot be turned on accidentally.

Important

When you have had the system open for repair, you must purge it again as described in [Purge the system](#) on page 27. Never begin operating the system under power until you are sure all the moisture has been purged from it. You can do permanent damage to the entire system, including the transmitter.

CAUTION

When removing or replacing radiators on the tower, never let the weight of the radiator hang on the inner conductor without bolting. This will damage the connector and possibly the inner conductor itself. Support the weight of the radiator until the flange bolts are tightened.

CAUTION

Lubricate the O-rings only a light lubricating coat of O-Lube (provided) or petroleum jelly; too much may hamper electrical contact and contaminate the interior of the system.

Maintenance log

Shively recommends that you keep a maintenance log; in it record performance parameters such as readings of VSWR.

Such a log can be invaluable in spotting and identifying problems. [Sample maintenance log](#) on page 28 shows a suggested log form you may use if you like.

Physical inspection

The antenna system should operate for years if properly installed and maintained. Shively Labs recommends that as a minimum, the antenna should be physically inspected *at least once a year*.

In addition, inspect the antenna after severe weather events, and after climbers have been on the tower working on equipment above the antenna.

Whenever a rigger is on the tower for any reason, it is a good idea to have him check your antenna for general condition, looseness of connectors and mounts, and electrical damage.

In addition to checking the general condition of the antenna and coax:

- Replace dented, broken or bent components.
- Inspect radomes for cracks and plugged drain holes.
- Re-tighten all hardware, hose clamps, and U-bolts to installation specifications.
- Inspect hose clamps and U-bolts carefully for signs of wear or fatigue caused by vibration or tower movement.

Paint

The radiators should never be painted (a coating of paint affects VSWR), and they need no surface protection, since they are made of copper and brass. This includes Teflon or other "ice-prevention" coatings.

It is not necessary to paint the feedline, although no harm will result from doing so.

Radiator removal for repair

In some cases, a damaged radiator may be removed and returned to the factory for repair. The system can then be sealed with a pressure cap, and operation of the antenna can resume with proportional power reduction and increased VSWR.

See the Shively Web site, www.shively.com, for part numbers of pressure caps and other components.

Operating with missing bays may not be possible with some transmitters or antennas that have only a few bays, since some transmitters will not operate into loads with high VSWRs. Contact Shively Labs before attempting this process.

Return policy

When returning any material to the factory, be sure to call your sales representative and obtain a returned material authorization (RMA) number first. Use this number in all correspondence. This number helps us to track your returned item. It will expedite repair or replacement and prevent loss of your material.

Troubleshooting

Contact Shively Labs if necessary to help find the cause of your problem. Outside of 8:00 AM to 5:00 PM Eastern Time, call (207) 329-5118.

Internal arcing

The following may cause internal arcing:

- Physical damage to transmission line, feedline, or radiators. Damage may have been caused by ice, lightning, tower work, or many other factors. Damage may cause arcing directly or by allowing water inside the system.
- Missing or misaligned flange O-ring, if the system has been opened recently.
- Loss of pressurization.

Broad spectrum RF noise

This indicates that some metal components are not in good electrical contact with the tower. First, check your antenna mounts, then other tower components, to be sure that the tower paint has been scraped away and that all mounting hardware is tight.

Any metal part in poor contact with the tower will constitute a non-linear junction and cast a broad-spectrum signal. This includes antennas, transmission line, mounts, ladders, and other electrical components.

High VSWR at startup or during operation

High VSWR (Voltage Standing Wave Ratio) is caused by any factor which changes the impedance match between the transmitter and the antenna system.

Maintenance

The following may cause high VSWR:

- Wrong antenna for the application and frequency. Make sure the antenna is the correct frequency.
- Split bullet in the transmission line or in the baymount (see [Figure 1](#) on page 4). A split bullet is an inner conductor connector misaligned such that one or more of its contact arms is stuck outside the conductor instead of inside. (A missing bullet will cause infinite VSWR.)
- Radiators out of sequence (especially on a center-fed, null-filled, or half-wave-spaced system).
- Damaged feed strap(s) on a radiator. The feed strap is the stainless strip that extends outward from the end seal. The length, angle, and straightness of the feed strap are critical to the radiator's performance.
- Components of other services that have entered the RF field (later installations or broken components).
- Physical damage to the transmission line, feedline, or radiators. This may be from ice, lightning, tower work, or any other source.
- Paint applied to the radiators, possibly during a recent tower painting.

Erratic VSWR during impedance trimming

If VSWR readings during transformer adjustment as described in [Impedance trimming \(if applicable\)](#) on page 22 do not respond reasonably consistently to transformer adjustments, then either there is residual water in the transformer, or the transformer is damaged.

Follow this sequence of actions:

- a. Repeat the purging process as described in [Purge the system](#) on page 27.
- b. Try again to trim impedance.
- c. If VSWR is still erratic, Your transformer is probably damaged. Contact Shively Labs.

Change in coverage

Changes in broadcast coverage may be caused by the same factors that produce VSWR changes. If coverage seems to have changed, look for VSWR changes and use [High VSWR at startup or during operation](#) on page 26 for troubleshooting.

It is important to recognize, however, that apparent changes in coverage may be due to subjective factors or faults of the receiving equipment. Before doing more than checking the VSWR, be sure that an actual coverage change has occurred.

Pressure loss or excessive gas usage

Failure to hold pressure may be caused by the following:

- O-ring missing or poorly installed in transmission line, feedline, or baymount flange.
- Leaky end seal (see [Figure 1](#) on page 4).
- Loose connecting hardware between line segments or between the baymount and the radiators.
- Mechanical damage to transmission line, transformer, or antenna. Check for leaks using soap solution.

Sample maintenance
log

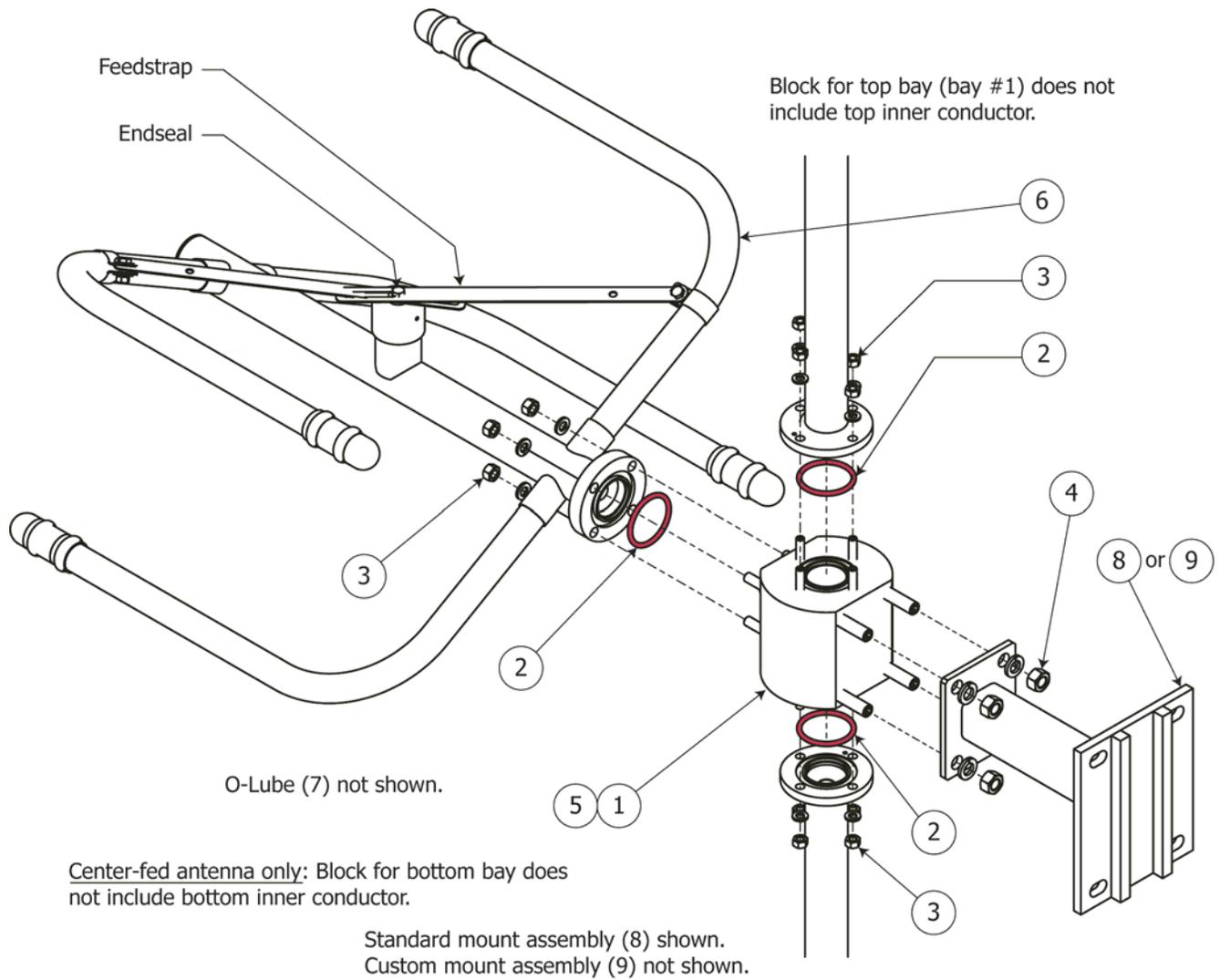
DATE	VSWR	GAS PRESS	OBSERVATIONS Visual Inspection of Antenna, Obstruction Lighting; Hardware Checked; Tower Repairs Accomplished; etc.

Table 3. Components, antenna bay assembly

Part Number	Description	1-Bay Qty.	2-Bay Qty.	3-Bay Qty.	4-Bay Qty.	5-Bay Qty.	6-Bay Qty.	7-Bay Qty.	8-Bay Qty.
1. 96385-G502	Block assembly, 6815 top bay	1	1	1	1	1	1	1	1
2. 9068-328	• Flange O-ring, silicone, 1-5/8" EIA flange	2	2	2	2	2	2	2	2
3.	• Flange hardware, 1-5/8" EIA flange	3	3	3	3	3	3	3	3
4.	• Mount hardware (4 nuts, 4 flat washers, 4 lock washers)	1	1	1	1	1	1	1	1
5. 96385-G501	Block assembly, 6815 intermediate bay	0	1	2	3	4	5	6	7
2. 9068-328	• Flange O-ring, silicone, 1-5/8" EIA flange	0	3	6	9	12	15	18	21
3.	• Flange hardware, 1-5/8" EIA flange	0	3	6	9	12	15	18	21
4.	• Mount hardware (4 nuts, 4 flat washers, 4 lock washers)	0	1	2	3	4	5	6	7
6. 96384-G501	(88 - 92 MHz) 6815 Bay	1	2	3	4	5	6	7	8
96384-G502	(92 - 96 MHz) 6815 Bay								
96384-G503	(96 - 100 MHz) 6815 Bay								
96384-G504	(100 - 104 MHz) 6815 Bay								
96384-G505	(104 - 108 MHz) 6815 Bay								
7. 94906-01	Parker O-Lube, 0.50 oz tube (not shown)	1	1	1	1	1	1	1	1
8. TBD	Mount assembly, 6815 bay standard	as req.							
9. Varies	Mount assembly, 6815 bay custom	as req.							

Parts

Figure 13. Components, bay assembly



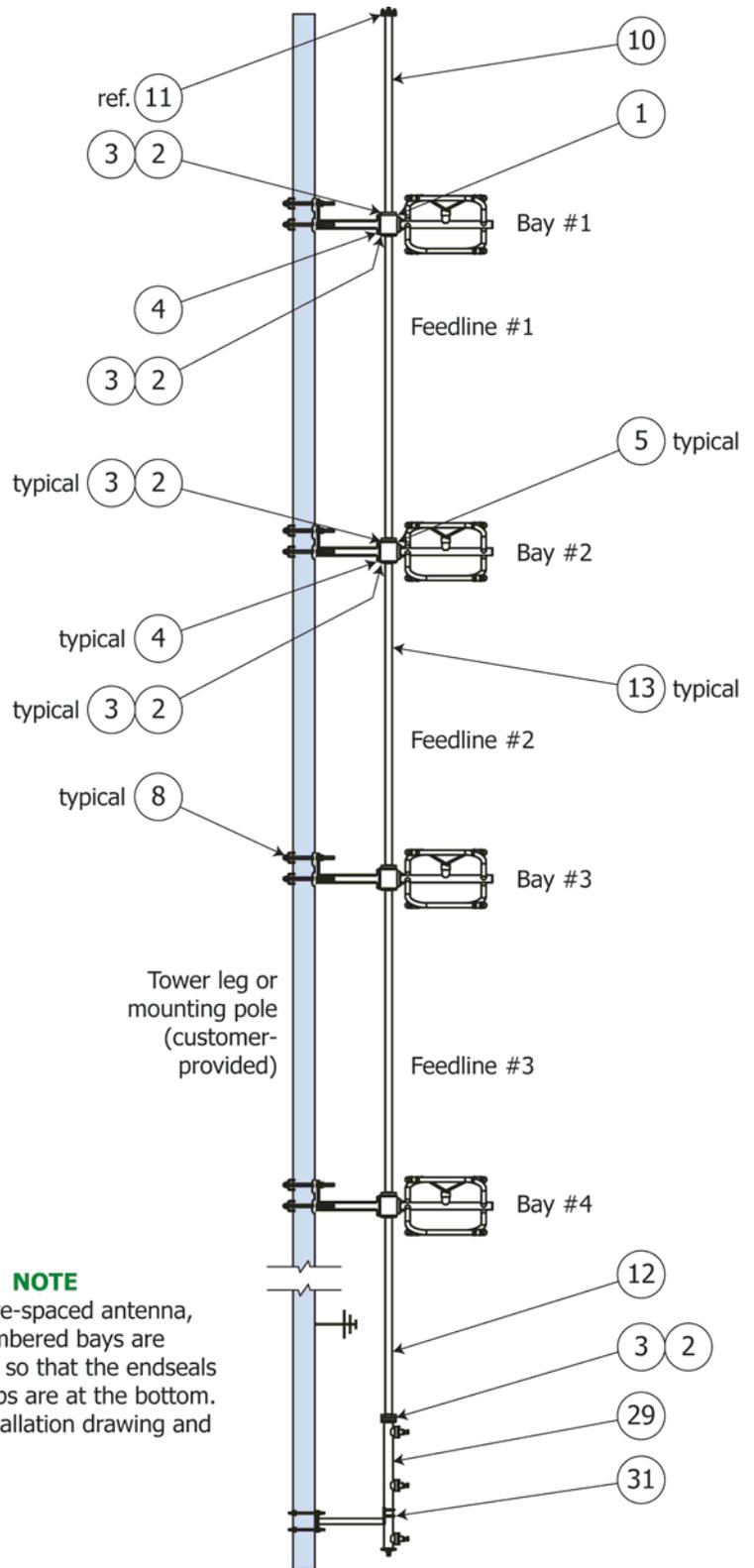
Parts

Table 4. Components, End-Fed Antenna Array

Part Number	Description	1-Bay Qty.	2-Bay Qty.	3-Bay Qty.	4-Bay Qty.	5-Bay Qty.	6-Bay Qty.	7-Bay Qty.	8-Bay Qty.
	Bay assembly, 6815 top bay	1	1	1	1	1	1	1	1
	Bay assembly, 6815 intermediate bay	0	1	2	3	4	5	6	7
10. 98104-G502-048.00	Feedline section, top, 1-5/8"	1	1	1	1	1	1	1	1
11. 52471-01	• Valve, pressure relief	1	1	1	1	1	1	1	1
2. 9068-328	• Flange O-ring, silicone, 1-5/8" EIA flange	1	1	1	1	1	1	1	1
3.	• Flange hardware, 1-5/8" EIA flange	1	1	1	1	1	1	1	1
12. 98104-G501-060.00	Feedline section, input, 1-5/8"	1	1	1	1	1	1	1	1
13. 98104-G501-xxx.xx	Feedline section, intermediate, 1-5/8"	0	1	2	3	4	5	6	7
2. 9068-328	Flange O-ring, silicone, 1-5/8" EIA flange								
3.	Flange hardware, 1-5/8" EIA flange								

Parts

Figure 14. Components, 4-bay end-fed antenna, fine-matcher, without radomes



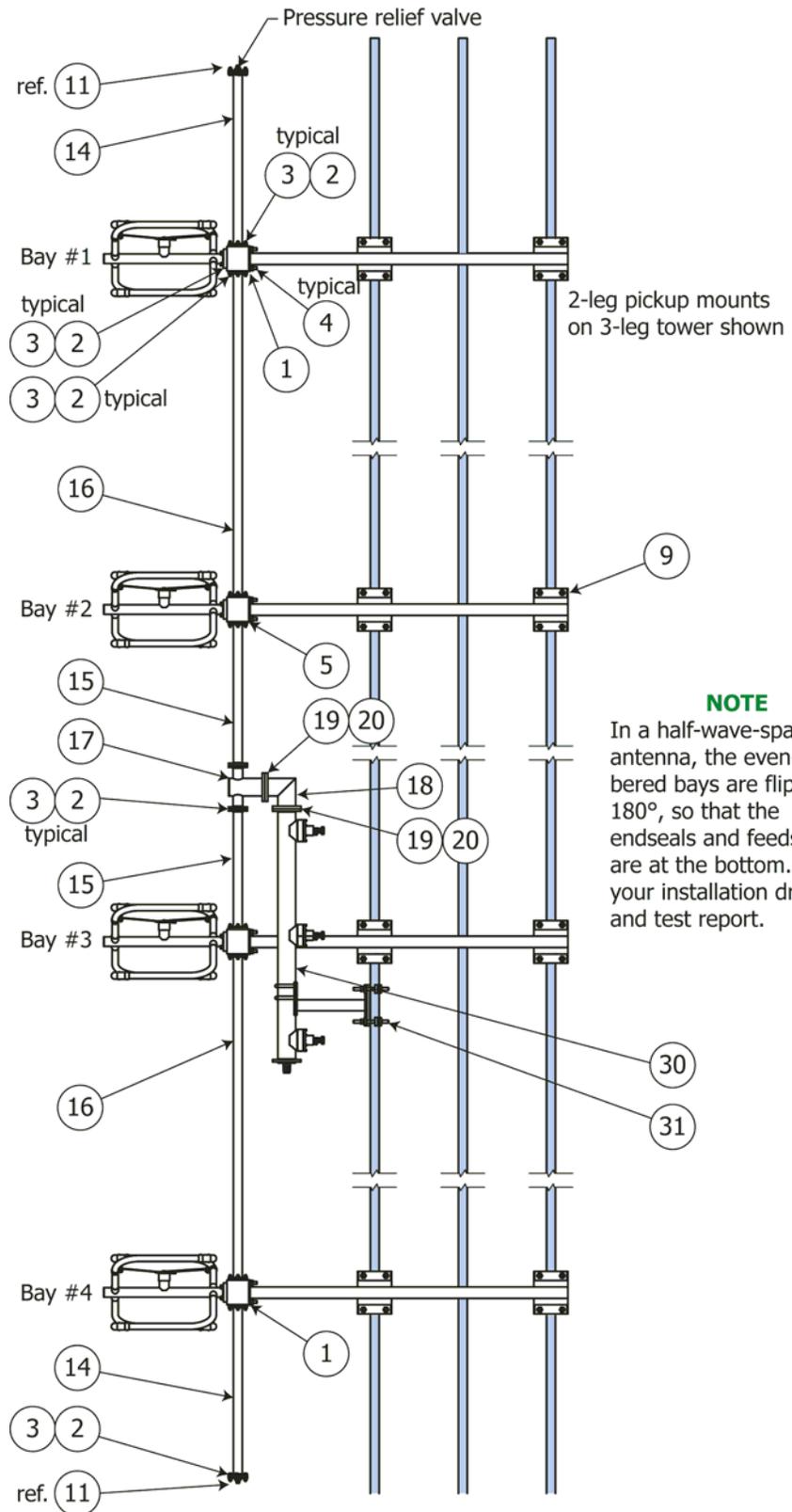
Parts

Table 5. Components, center-fed antenna array

Part Number	Description	2-Bay Qty.	4-Bay Qty.	6-Bay Qty.	8-Bay Qty.
	Bay assembly, 6815 top bay	1	1	1	1
	Bay assembly, 6815 bottom bay	1	1	1	1
	Bay assembly, 6815 intermediate bay	0	2	4	6
14. 98104-G502-048.00	Feedline section, top, 1-5/8"	2	2	2	2
11. 52471-01	• Valve, pressure relief	2	2	2	2
2. 9068-328	• Flange O-ring, silicone, 1-5/8" EIA flange	2	2	2	2
3.	• Flange hardware, 1-5/8" EIA flange	2	2	2	2
15. 98104-G503-xxx.xx	Feedline section, above/below tee, 1-5/8"	2	2	2	2
16. 98104-G501	Feedline section, intermediate, 1-5/8"	0	2	4	6
17. 52018-G503	Tee assembly, 1-5/8" - 3-1/8" flanged	1	1	1	1
18. 318F-322	Elbow assembly, 3-1/8" 4" X 4" heavy duty	1	1	1	1
19. 9068-340	• O-ring, silicone, 3-1/8" EIA flange	1	1	1	1
20. 82912-G503	• Flange hardware, 3-1/8" EIA flange	1	1	1	1
2. 9068-328	O-ring, silicone, 1-5/8" EIA flange				
3.	Flange hardware, 1-5/8" EIA flange				
19. 9068-340	O-ring, silicone, 3-1/8" EIA flange				
20. 82912-G503	Flange hardware, 3-1/8" EIA flange				

Parts

Figure 15. Components, 4-bay center-fed antenna, with fine-matcher, without radomes



Parts

Table 6. Components, radome assembly 96386-G503 (per antenna bay)

Part Number	Description	Qty.
21. 96386-G501	Radome, 6815, top half with nut plates	1
22. 96386-G502	Radome, 6815, bottom half with nut plates	1
23. 96386-04	Plate, formed, top & bottom radome	2
96386-G504	Kit, 6815 mount hardware	1
24. (3/8")	<ul style="list-style-type: none"> • Screw, hex head 3/8-16 X 1-1/4" SS • Washer, flat 3/8" SS • Washer, split lock 3/8" SS 	10 10 10
25. (1/2")	<ul style="list-style-type: none"> • Screw, hex head 1/2-13 x 1-1/2" SS • Nut, hex 1/2-13 bronze • Washer, flat 1/2" SS • Washer, split lock 1/2" SS 	14 20 32 20
26. 96386-05	Plate, formed, radome mount back	1
27. 93585-G505	Kit, 6815 radome flange hardware	1
	<ul style="list-style-type: none"> • Screw, hex head 1/4-20 x 1-1/4" SS • Nut, hex 1/4-20 SS • Washer, flat 1/4" SS • Washer, lock 1/4" SS 	26 26 52 26
28. DO 88060	Adhesive/sealant, Dow Corning (not shown) or equivalent	1

Table 7. Accessories and optional items

Part Number	Description	2-Bay Qty.	4-Bay Qty.	6-Bay Qty.	8-Bay Qty.
29. 99952-G502	Fine matcher, 1-5/8"	1	1	1	1
2. 9068-328	<ul style="list-style-type: none"> • O-ring, silicone, 1-5/8" EIA flange 	1	1	1	1
30. 99952-G501	Fine matcher, 3-1/8"	1	1	1	1
19. 9068-340	<ul style="list-style-type: none"> • O-ring, silicone, 3-1/8" EIA flange 	1	1	1	1
31. Various	Mount assembly, fine matcher	2	2	2	2
32. HPAR6815-xx.xx	Parasitic assembly, horizontal, 6815	Varies (see installation drawing)			
33. 6114-250	Clamp, high-torque hose	Varies (2 per parasitic assembly)			

Parts

Figure 16. Components, radome assembly

