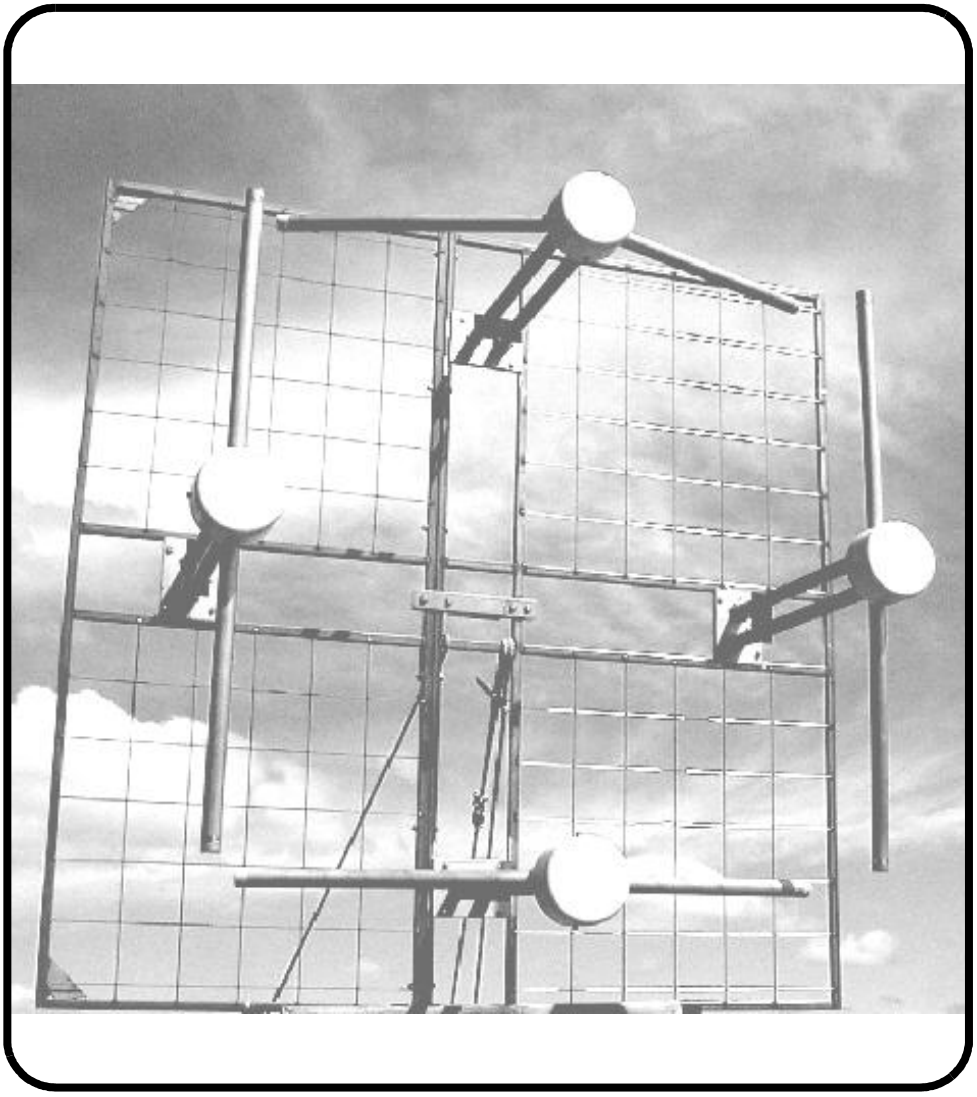
Shively Labs®

FM Broadband Panel Broadcast Antenna

6016 Series



Instruction Manual
Installation, Operation, & Maintenance

Congratulations!

Thank you for purchasing one of the finest FM broadcast antennas on the market today. The Shively Labs 6016P antenna is widely recognized as the top-of-the-line in its class for its 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!

Table of Contents

Chapter 1 Preparing for Installation 1
Receiving 1
Unpacking 1
Check the System 2
Chapter 2 Installing the Panel Mounts 3
Before Beginning Panel Mount Installation: 3
Installing the Panel Mounts on the Tower 3
Installing the Horizontal Panel Supports on the Panels 5
Chapter 3 Installing the Radiators and Radiator Feeds 6
Before Beginning Radiator Installation: 6
Radomes 6
Installation of Radiators Fed by Flex Coax 6
Installation of Radiators Fed by Rigid Coax 8
Before Beginning Hybrids and Feed Coax Installation: 8
Installing Hybrids and Feed Coax (if applicable) 9
Chapter 4 Installing the Panels on the Tower 11
Before Beginning Panel Installation: 11
Installation Procedure 11
Chapter 5 Installing the Feed System 12
Before Beginning Feed System Installation: 12
Installation Procedure 13
Chapter 6 Pressurization and Startup 14
Before Beginning Pressurization: 14
Pressurization Procedure 14
Step 1. Leak Testing 14
Step 2. Purging the System 16
Step 3. Leaving the System Pressurized 17
Before Beginning Intial Characterization: 17
Initial Characterization (recommended) 18
Step 1. Transmission Line VSWR Reading 18
Step 2. Transmission Line TDR Reading 18
Step 3. System VSWR Reading 18
Step 4. Checking Radiator Function 18
Checkout 19
Chapter 7 Operation 20
Precautions 20
The Antenna 20
Chapter 8 Troubleshooting 21
Precautions 21
Internal Arcing 21
Broad Spectrum RF Noise 22
High VSWR at Startup or during Operation 22
Erratic VSWR 23
Change in Coverage 23
Pressure Loss or Excessive Gas Usage 23

Table of Contents (continued)

Chapter 9 Maintenance 25
Precautions 25
Maintenance Log 26
Physical Inspection 26
Paint 26
Radiator Removal for Repair 26
Troubleshooting 26
Return Policy 26
Sample Maintenance Log 27

List of Illustrations

Figure 1 Typical Panel Installation on Tower, Overall Side View 3
Figure 2 Typical Panel Mount Installation on Tower 4
Figure 3 Typical Horizontal Panel Support Details 4
Figure 4 Typical Radiator Installation 7
Figure 5 Flange Bolt Tightening Sequences 10
Figure 6 Feedline Flange Detail 12
Figure 7 Pressurized Gas Schematic 15

List of Tables

Table 1 Minimum Bending Radii, Semiflex Coax 8
Table 2 Torque Specifications, Flange Bolts 10
Table 3 Volume of Coax per 1000 Feet of Length 16
Table 4 Troubleshooting Internal Arcing 21
Table 5 Troubleshooting High VSWR 22
Table 6 Troubleshooting Pressure Loss or Excessive Gas Usage 24

1 Preparing for Installation

Receiving

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

a. Check to be sure all the material has arrived.

NOTE

The box number and the total number of boxes are marked on each box; for example, “Box 2 of 5” means “box number 2 of a total of five boxes.”

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 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 shop 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.

Check the System

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.

Shively's factory designer 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.*

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.
- Availability of proper electrical service for deicers, if applicable.
- The adequacy of the tower structure and guys to carry the windload 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.

2 Installing the Panel Mounts

Before Beginning Panel Mount Installation:

Mounting systems for panel antennas can be complex and will vary with the panel style and the tower style. Figure 1 shows an overall view of how the pieces fit together. In general, there are two major sets of components: the panel mounts, which you will attach to the tower (Detail in Figure 2 on page 4), and the horizontal panel supports, which you will attach to the panels (Detail in Figure 3 on page 4). When the panel is lifted into place on the tower, you will secure the panel supports to the panel mounts.

CAUTION

Before you begin, study the installation drawing carefully. The illustrations in this manual show typical details, but antennas vary due to pattern requirements and tower designs, so you must go by the installation drawing for the actual configuration of your antenna.

Installing the Panel Mounts on the Tower

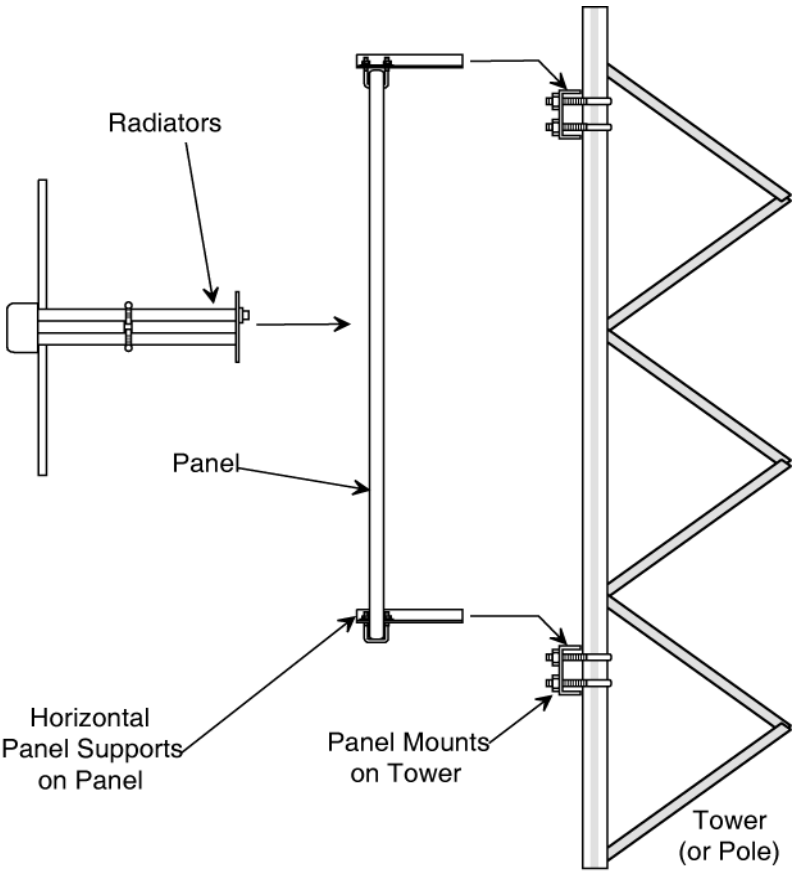

Figure 1. Typical Panel Installation on Tower, Overall Side View

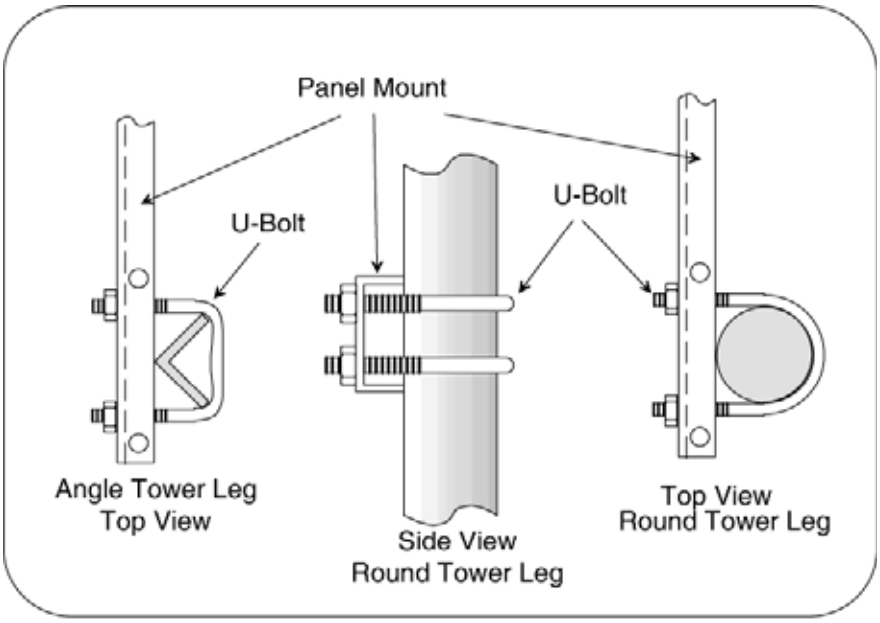

Figure 2. Typical Panel Mount Installation on Tower

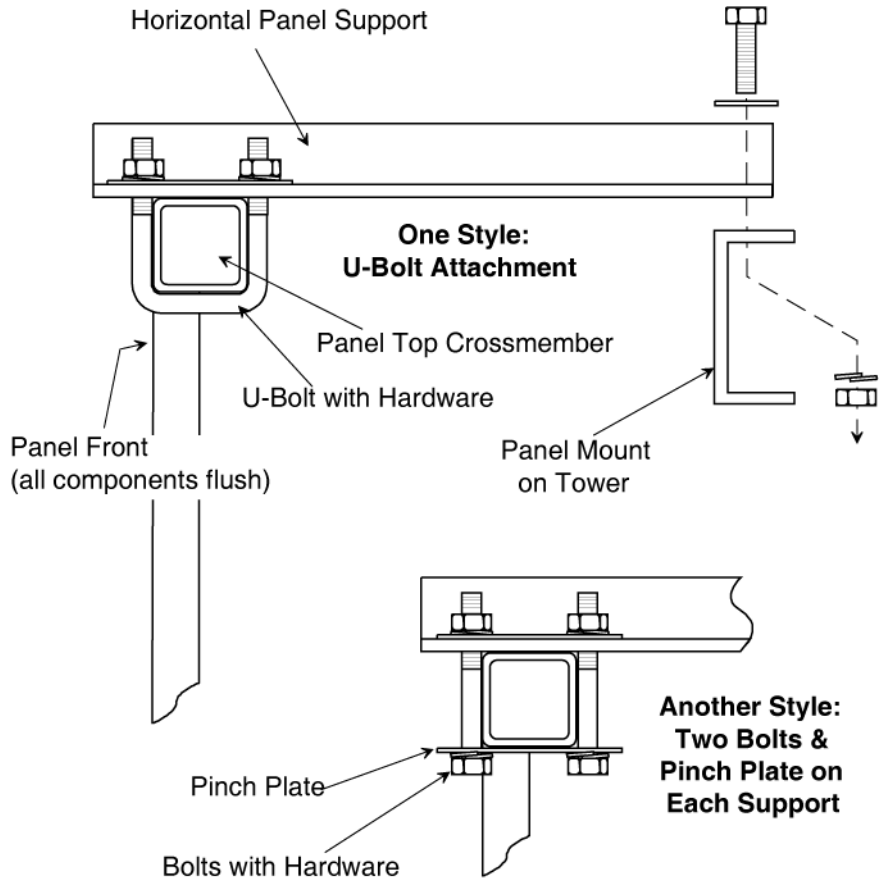

Figure 3. Typical Horizontal Panel Support Details

a. Starting at the top of the antenna, use a steel measuring tape to find the location of each panel mount per the installation drawing. Mark the panel locations on the tower legs.

b. While working down the tower, watch carefully for any interferences by tower members which were not accounted for in the design.

c. Mark the location on the tower of any accessory mounts, such as for the tee, power dividers, or special coax line sections, to make sure they will fit as planned.

d. If any problems appear during this process, please call Shively Labs and discuss them with the installation designer.

CAUTION

If you don't get good electrical contact between the mounts and the tower, the antenna may not perform as designed, and may produce stray signals that will interfere with other services on the tower.

e. To ensure good electrical contact between the support pipe and the tower, scrape the tower paint away at the panel mount locations. If you don't, the antenna may not perform as designed, and may produce stray signals that will interfere with other services on the tower.

f. Install the panel mounts as shown in the installation drawing and Figure 2 on page 4.

g. When all panel mounts are in place, sight along them vertically to make sure they are aligned before tightening them.

h. Repaint the tower where you removed the paint in step e.

Installing the Horizontal Panel Supports on the Panels

Important

Never step on the panel directly. If you must get on top of the panel to install parts, use a wide plank or a sheet of plywood to distribute your weight.

CAUTION

It is critical that you identify the front and back of the panel correctly. On the FRONT of the panel - the face that will point away from the tower - the welded components are aligned flush with each other and form a flat surface.

a. Lay a panel front-down on blocks.

NOTE

Various designs (Figure 3 on page 4) use U-bolts or bolts and pinch-plates to secure the panel to the span brackets. Your installation drawing will specify which design your antenna uses.

b. Attach a pair of horizontal panel supports to the top square-tube crossmember of the panel as shown in Figure 3.

c. Repeat step b for the lower horizontal panel support of the panel, then for the other panels.

3 Installing the Radiators and Radiator Feeds

Before Beginning Radiator Installation:

Important!

Antenna orientation is critical to performance. *Install each radiator in accordance with its stenciled bay numbers and its "up-arrow" sticker.*

CAUTION

Radiators and panels are marked with their respective face and level numbers (eg: 1B for level 1, face B, where level 1 is the top-most level). Other components may also be match-marked, usually hand-written in black permanent marker. Watch carefully for match-markings, and assemble components in accordance with match-markings. If you don't, the antenna may not perform as expected.

CAUTION

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

NOTE

Keep the plastic protectors in case you ever need to return components for repair.

CAUTION

There is a radome over the end of the radiator. Do not remove it. You will break the seal and may damage components inside.

CAUTION

Do not use silicone grease on an O-ring, as this will soften the silicone O-ring.

Use only a light lubricating coat of petroleum jelly (provided); too much may hamper electrical contact and contaminate the interior of the system.

Be sure the O-ring is properly seated in its groove and not pinched between the flange contact surfaces.

Radomes

Model 6016 radiators include radomes. See your installation drawing for details of your system. Radomes have been installed at the factory, with no field assembly required (see Figure 4 on page 7).

Installation of Radiators Fed by Flex Coax

If your installation drawing shows flex coax feeding into the bases of the radiators, use this procedure. If your radiators are fed by rigid coax, go to Installation of Radiators Fed by Rigid Coax on page 8.

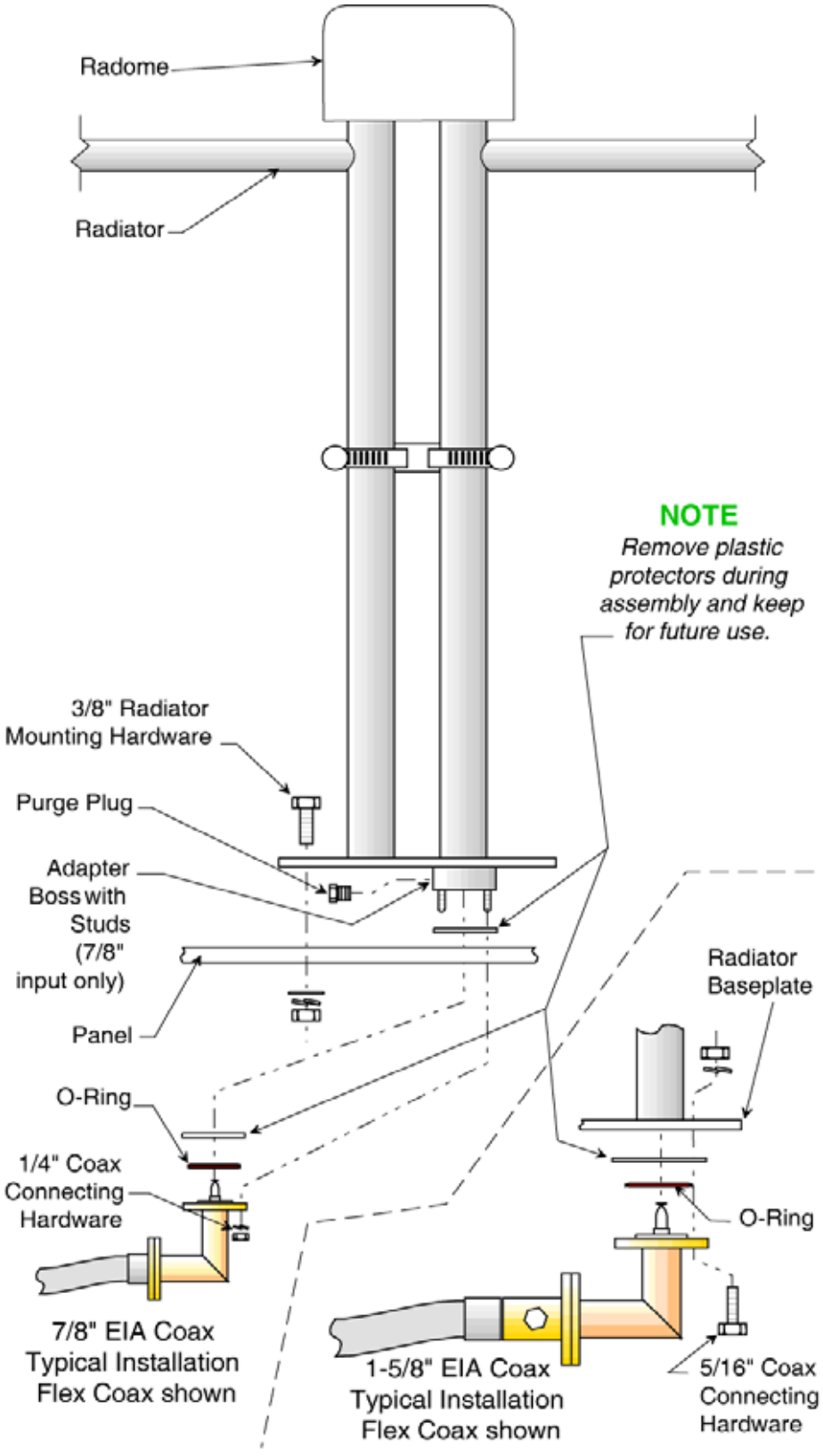

Figure 4. Typical Radiator Installation

Figure 4 on page 7 shows a couple of typical configurations. Each installation is different. Your exact arrangement is shown on the installation drawing you received with your antenna.

Assemble the radiators and attach them to the panels according to the following guidelines:

a. Lay the panel face-up on blocks.

CAUTION

Be sure the UP-arrows on the radiator and the panel agree.

b. Attach the radiator to the panel, using the 3/8” hardware provided.

Installation of Radiators Fed by Rigid Coax

If your installation drawing shows rigid coax feeding into the bases of the radiators, use this procedure. If your radiators are fed by flex coax, go to Installation of Radiators Fed by Flex Coax on page 6.

Figure 4 on page 7 shows a couple of typical configurations. Each installation is different. Your exact arrangement is shown on the installation drawing you received with your antenna.

Assemble the radiators and attach them to the panels according to the following guidelines:

a. Lay the panel face-up on blocks.

CAUTION

Be sure the UP-arrows on the radiator and the panel agree.

b. Attach the radiator loosely to the panel, using the 3/8” hardware provided. Leave some play in the mounting bolts until the rigid coax is installed.

Before Beginning Hybrids and Feed Coax Installation:

CAUTION

The specific lengths of your flex cables are required to maintain proper system phasing. Often cables will be longer than needed merely to reach the antenna inputs. This is normal and necessary.

CAUTION

Semiflex cable has a minimum bending radius, specified by the manufacturer. Bending it too sharply will damage the cable. See Table 1 for the various sizes.

Table 1. Minimum Bending Radii, Semiflex Coax

Cable Size	Radius
1/2"	5" (127 mm)
7/8”	10” (254 mm)
1-5/8”	20” (510 mm)
3”	30” (762 mm)

CAUTION

Stressing a coax connection after assembly can detune the system. Therefore, never make a connection and then bend or twist the cable.

Likewise, do not use the connector and flange to force the coax into shape. Form the coax to the desired shape before attaching it and align the connection properly, then make the connection.

Finally, in the case of rigid coax, always assemble the RF components (ie: hybrids, power dividers, coax, and radiators) before tightening their respective mounting bolts.

Installing Hybrids and Feed Coax (if applicable)

In some installations, a hybrid is used on each panel to create a 90° phase shift and -3dB power division. This is usual in circularly polarized antennas and less common in vertical-only or horizontal-only systems.

Install the hybrid and the coax feeds from the hybrid to the radiators according to the following guidelines:

a. Remove the plastic protectors from the components as you assemble them according to the installation diagram. Keep the hardware securing the plastic protectors and the O-ring to connect the components.

b. Lubricate the O-ring lightly and insert it into the groove in the coax flange.

CAUTION

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

CAUTION

Be very careful to connect each hybrid port to the correct radiator.

c. Assemble the hybrids, tees, loads, and feed coax as shown in your installation drawing.

d. Use the hardware from the protective covers to attach the components. Table 2 on page 10 shows torque specifications for the various size flange bolts. Figure X shows the flange bolt tightening sequence for each coax size.

e. After all RF components (ie: power dividers, hybrids, radiators, rigid coax) have been connected to each other, tighten the mounting bolts securing the RF system to the panel.

f. Coil excess flex cable or drape it along a tower member or the back of the panel and secure it using the cable clamps provided to prevent chafing or other damage to the cable.

Table 2. Torque Specifications, Flange Bolts

Transmission Line Size	Bolt Size	Torque	
7/8"	1/4-20	7 ft-lb	9 N-m
1-5/8"	5/16-18	12 ft-lb	16 N-m
2-1/8"	3/8-16	21 ft-lb	28 N-m
3-1/8"	3/8-16	21 ft-lb	28 N-m
4-1/16"	3/8-16	21 ft-lb	28 N-m
6-1/8"	3/8-16	21 ft-lb	28 N-m

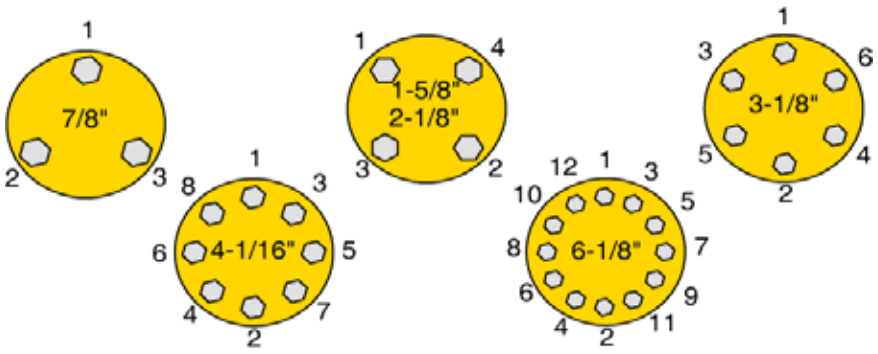

Figure 5. Flange Bolt Tightening Sequences

g. When cables pass within four inches (100 mm) of each other, use a hanger kit with threaded rod and nuts to separate them and prevent chafing. See tech sheet "ts-cable_securing," provided with your antenna or available on Shively Labs web site "www.shively.com."

4 Installing the Panels on the Tower

Before Beginning Panel Installation:

CAUTION

Never lift the panel assembly by the feedline, the radiator, or the radome. Lift by the horizontal panel supports.

Steady the panel assembly as you lift, to prevent damage to components.

CAUTION

The contact surfaces of the components are protected by plastic protectors from contamination and from physical damage. Do not expose these surfaces until you are ready to connect the coax to them.

Installation Procedure

Install the panels on the tower, starting with the level "1" panels at the top of the array.

Bolt each panel's horizontal panel supports to the panel mounts on the tower and tighten it before installing the next panel.

5 Installing the Feed System

Before Beginning Feed System Installation:

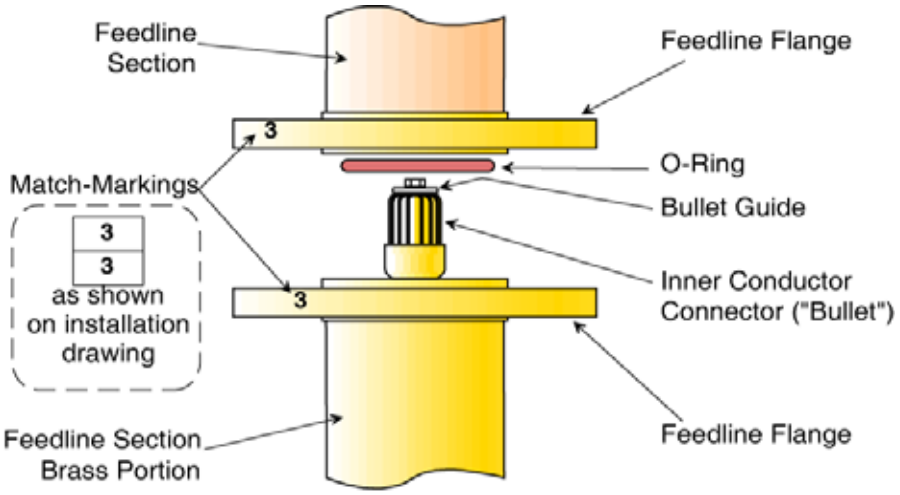

Figure 6. Feedline Flange Detail

CAUTION

Components MAY be match-marked with their respective face and level numbers (eg: 1B for level 1, face B, where level 1 is the top-most level. Markings are usually hand-written in black permanent marker. Watch carefully for match-markings, and assemble components in accordance with match-markings. If you don't, the antenna may not perform as expected.

CAUTION

The feedline inner conductors include "bullet guides" (see Figure 6) to help prevent split bullets. Be sure the bullet guides are in place before assembly.

CAUTION

Semiflex cable has a minimum bending radius, specified by the manufacturer. Bending it too sharply will damage the cable. See Table 1 on page 8 for the various sizes.

CAUTION

Do not use silicone grease on the O-rings, as this tends to dissolve the silicone O-ring.

Use only a light lubricating coat of petroleum jelly; too much may hamper electrical contact and contaminate the interior of the system.

Be very careful that each O-ring is seated in its groove and not pinched between flange contact surfaces, as this will cause a leak in the system and will be expensive to find and repair.

NOTE

Keep the hardware securing the plastic protectors. It will be used for the final connections.

Installation Procedure

Install the feed system and its mounting brackets as shown on the installation drawing. Follow these guidelines:

a. Remove the plastic protector from the semiflex coax. Don't lose the harware or the O-ring.

b. Lubricate the O-ring lightly and insert it into the groove in the coax flange.

CAUTION

Stressing a coax connection after assembly can detune the system. Therefore, never make a connection and then bend or twist the cable. Likewise, do not use the connector and flange to force the coax into shape. Form the coax to the desired shape before attaching it and align the connection properly, then make the connection.

c. Use the hardware from the protective cover to attach the coax to the appropriate components. Table 2 on page 10 shows torque specifications for the various size flange bolts.

CAUTION

The specific lengths of your flex cables are required to maintain proper system phasing. Often cables will be longer than needed merely to reach the antenna inputs. This is normal and necessary.

d. Coil excess flex cable or drape it along a tower member and secure it thoroughly. Use round member standoff kits and cable hangers supplied with your system as necessary to prevent chafing or other damage to the cable.

e. When cables pass within four inches (100 mm) of each other, use a hanger kit with threaded rod and nuts to separate them and prevent chafing. See tech sheet "ts-cable_securing," provided with your antenna or available on Shively Labs web site "www.shively.com."

6 Pressurization and Startup

Before Beginning Pressurization:

Important

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

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.

Be sure to use a good quality pressure gauge which will read accurately in the 10 - 20 psig range; don't depend on the cylinder gauge, which will not be accurate at a low pressure.

Do not over-pressurize the system; it takes time for the entire system to fill with the new pressure and the pressure gauge to stabilize.

CAUTION

If all moisture is not removed from the interior of the system, it will condense when the weather cools. The condensed moisture (water) will cause arcing and permanent physical destruction of the coaxial system, including the transmitter output network.

CAUTION

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

CAUTION

Never operate the antenna system without proper purging and constant positive dry gas pressure.

CAUTION

Although initial characterization is at your discretion, we strongly recommend it as the best way to identify both initial problems and possible future system damage.

Pressurization Procedure

After the antenna is installed and all lines are connected, it is necessary to check the system for leaks, purge with dry gas 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.

Step 1. Leak Testing

a. Connect a source of dry gas (cylinder nitrogen or air from a compressor-dehydrator) to the system as shown in Figure 7 on page 15.

b. Be sure to include a good quality gauge which reads accurately in the 5 - 20 psig (35 - 135 kPa) range; don't depend on the cylinder gauge, which will not be accurate enough in this pressure range.

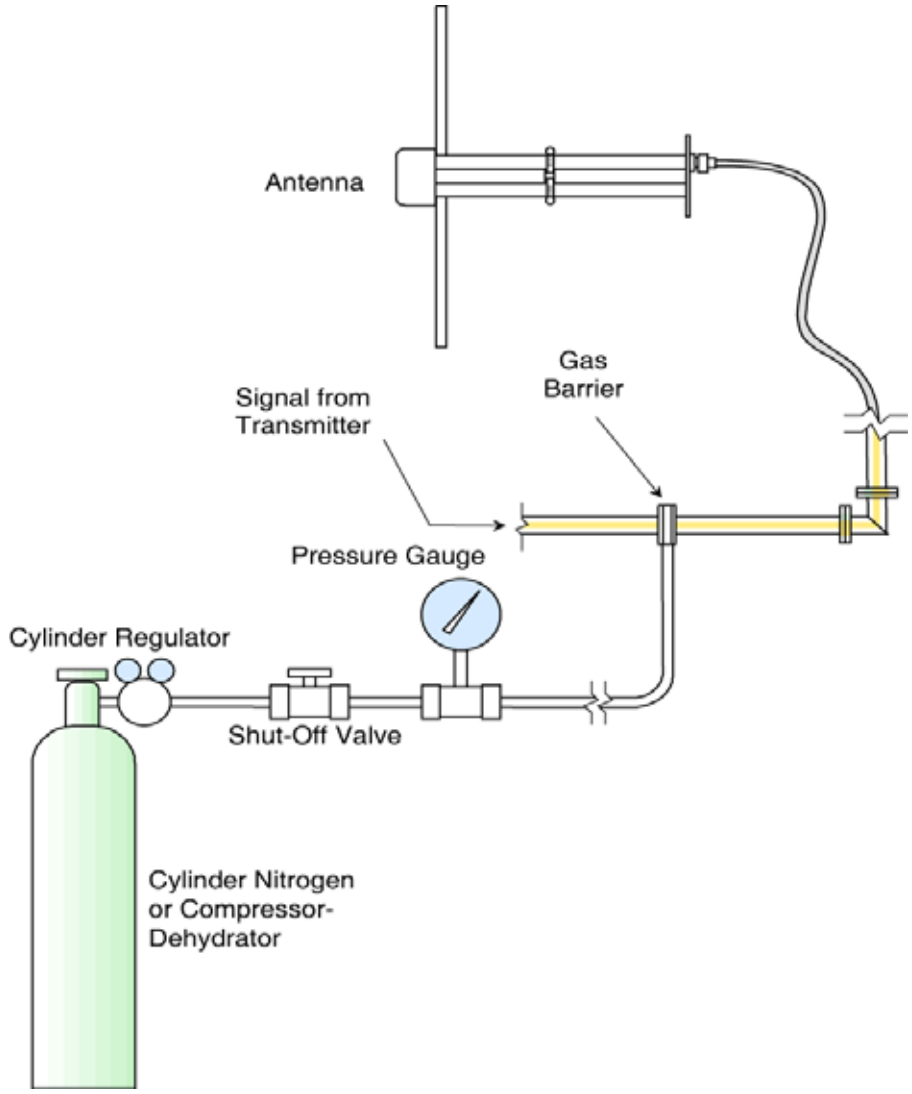

Figure 7. Pressurized Gas Schematic

Pressure Correction:

where PC = corrected

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

final pressure, psig

P_R = final pressure as read, psig

T_1 = beginning temperature, degrees F.

T_2 = final temperature, degrees F.

c. Pressurize the system to eight (8) psig, then close the shutoff valve. Give the system one half hour to stabilize, then record the pressure and the temperature.

d. Wait twenty-four hours, then read the pressure and the temperature again and use the formula in the sidebar to obtain a corrected pressure for comparison.

e. 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.

f. 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.)

g. Correct any leaks that are found. Then repeat the leak test until the results are satisfactory.

Step 2. Purging the System

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. Shively Labs suggests three volume changes of dry gas for an "average" system.

Purge your system as follows:

a. Determine how wet the system is. 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.

Important

Never apply transmitter power while the antenna is under vacuum.

b. 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.]

c. Determine the volume of dry gas to use for the purge.

d. Table 3 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.

Table 3. 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 (2.6 m^3) of gas. Shively Labs Models 1235 and 2577 compressor-dehydrators will provide about 12 cubic feet (0.34 m^3) per hour; the Model 1234 about 78 cu ft (2.2 m^3) per hour.

e. Connect a source of dry gas (cylinder nitrogen or air from a compressor-dehydrator) to the system as shown in Figure 7.

f. Raise the gas pressure to 12 or 13 psig (83 - 90 kPa).

g. Have a rigger go up the tower and loosen (do not remove) the purge plug at the base of each radiator for 7/8" coax feed, or at the coax termination for 1-5/8" feed (see Figure 4). This will be the point where purge gas exits the system.

Remember

It is critical to blow dry gas *through* the system, rather than merely maintain a pressure; the gas volume accomplishes the purge.

h. When the calculated amount of dry gas has been blown through the antenna system, maintain gas flow while you have the rigger re-tighten the pipe plugs in the radiators. Gas flow should stop as the plugs are tightened.

Step 3. Leaving the System Pressurized

After completion of the purge, reduce the supply pressure to about 5 to 7 psig.

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.

Before Beginning Intial Characterization:

Although initial characterization is at your discretion, we strongly recommend it as the best way to identify both initial problems and possible future system damage.

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.

To test and adjust VSWR safely, use low-power test equipment, such as a network analyzer or an impedance bridge. If you don't have access to low-power test equipment, please call Shively Labs before proceeding.

WARNING

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

Low-power test equipment should be used to prevent excessive radiation exposure to the person doing the adjusting.

CAUTION

A high transmission line VSWR may indicate damaged transmission line and is likely to cause problems in the future, including serious damage to your equipment.

Initial Characterization (recommended)

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 the tests in this section after installation.

Step 1. Transmission Line VSWR Reading

The first step is to characterize the transmission line by itself

a. Briefly disconnect the transmission line from the antenna system input. Seal the antenna system input to prevent the entry of moisture.

b. Terminate the coax transmission line in an instrument-quality 50-ohm load.

c. Measure and record the voltage standing wave ratio (VSWR). File this information with this manual for future reference.

d. The VSWR of the transmission line should be within the manufacturer's specifications. If it is, proceed. If not, you should call the manufacturer before connecting the antenna. Problems must be worked out with the design engineer on a case-by-case basis.

Step 2. Transmission Line TDR Reading

With the transmission line still terminated in 50 ohms, make a time domain reflectometer (TDR) plot. Label and file the plot with this manual.

Step 3. System VSWR Reading

You tested the VSWR of the transmission line alone. Now test the VSWR of the system as a whole.

a. Remove the load and connect the transmission line to the transformer input, with an O-ring to seal the connection.

b. Repeat the purge process after sealing the line, in accordance with Purging the System on page 16.

c. Measure VSWR. VSWR at this point should be below 1.2 : 1.

d. Record the reading and file it with this manual.

If VSWR is not satisfactory, check to be sure all the radiators are functioning (see below). If they are, call Shively Labs to help identify the problem.

Step 4. Checking Radiator Function

Again using the low-power test equipment to provide a signal to the antenna and read VSWR, have the rigger detune each radiator in turn. The simplest way to detune a radiator is to short across its uprights, for instance with a screwdriver or wrench.

If you have radomes, you don't need to remove each radome to detune the radiator. Have the rigger take a three-foot-square section of chicken wire or a similar metal mesh and place it on the top of each radome in turn, or simply place his hand in the same spot on the flat surface of each radome in turn.

Each time, a deflection in VSWR should be apparent. The deflection for various bays should be similar, but not necessarily identical.

If the VSWR of the array does not change when a radiator is detuned, that bay is not functioning. Check to be sure the radiator was installed properly, including the inner conductor connector.

If you cannot find the problem, please call Shively Labs before proceeding.

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.
- All radiators are operating and VSWR is within specification.
- The initial characterization data have been recorded.
- The system is gas-tight and purged.

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.

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.

7 Operation

Precautions

The broadcast industry has recently recognized the potential medical hazards of intense radio frequency radiation. Don't expose personnel to personal harm. For reference, see CFR 29, 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 and lock it off so that it cannot be turned on accidentally.

CAUTION

Never operate the antenna system without proper purging and constant positive dry gas pressure. Shively Labs will not accept responsibility for antenna failure after operation without proper purging or positive pressure of dry air or dry nitrogen.

CAUTION

Don't leave the de-icer on for extended periods when the weather is above 60° F (16° C); it may overheat and be damaged.

The Antenna

Once the antenna has been installed and tested according to this manual, simply apply the transmitter signal. Don't exceed the rated power capacity of the antenna.

To obtain the best performance and dependability from your Shively Labs antenna, read and follow the "maintenance" section of this manual.

8 Troubleshooting

Precautions

WARNING

Troubleshooting should be performed only by personnel experienced in RF systems and familiar with this equipment.

WARNING

The broadcast industry has recently recognized the potential medical hazards of intense radio frequency radiation. Don't expose personnel to personal harm. For reference, see CFR 29, Section 1910.97, the OSHA standard for exposure to non-ionizing radiation. Whenever a rigger is on the tower in the area of the antenna, shut off the transmitter and lock it off so that it cannot be turned on accidentally.

CAUTION

Whenever you have the system open for repair, you must purge it again as described in Purging the System on page 16. 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

VSWR does not change of its own accord. If you find you must repeatedly readjust the transformer to correct the VSWR, find and correct the problem quickly. Otherwise, you will almost certainly burn up your antenna and damage your transmitter. Look for the cause in the following table.

Internal Arcing

Look for the cause of internal arcing in Table 4.

Table 4. Troubleshooting Internal Arcing

Possible Causes:	Cures:
Physical damage to transmission line, feedline, or radiators.Damage may have been caused by ice, lightning, tower work, or many other factors.	Locate the damage. Replace damaged components.
Damage may cause arcing directly or by allowing water inside the system.	Purge the system after repair, in accordance with Purging the System on page 16.
Missing or misaligned O-ring, if the system has been opened recently.	Locate the O-ring leak, using soap solution. Replace the O-ring if damaged.
Loss of pressurization.	Locate the leak. Re-purge in accordance with Purging the System on page 16 and restore 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

(may interfere with other services on the tower)

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

Look for the cause in Table 5.

Table 5. Troubleshooting High VSWR

Possible Causes:	Cures:
Wrong antenna for the application and frequency. Occasionally a customer provides wrong data to Shively or buys a used antenna designed for another application.	Contact your sales representative at Shively Labs.
Split bullet in the transmission line or in the baymount (see Figure 6 on page 12). 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.)	Replace the inner conductor connector. It may also be necessary to replace the inner conductor section if it has been damaged.
Mismatched assembly of the antenna. The bays must be paired properly with their respective feedline sections, and the assembly must be exactly as shown in the installation drawing.	Reassemble according to the installation drawing.
Radiators out of sequence (especially on a center-fed, null-filled, or half-wave-spaced system).	Assemble the antenna exactly as shown in the installation drawing and as marked.
Damaged feed strap(s) on a radiator. The feed strap is the brass strip that extends back from the end seal. The length, angle, and straightness of the feed strap are critical to the radiator's performance.	Try to bend the feed strap back to its original shape and angle per the test report in your documentation package. It's brittle and may break; if it does, replace it.

Table 5. Troubleshooting High VSWR (continued)

Possible Causes:	Cures:
Components of other services have entered the RF field (later installations or broken components).	Remove broken components. Rearrange tower components as necessary to correct the VSWR problem.
Physical damage to the transmission line, feedline, or radiators. This may be from ice, lightning, tower work, or any other source.	Replace damaged components.
Paint has been applied to the radiators, possibly during a recent tower painting.	Remove the paint from the radiators.

Erratic VSWR

If VSWR readings flucutate, then either there is residual water in the system, or system components are damaged.

Follow this sequence of actions:

a. Repeat the purging process as described in Purging the System on page 16.

b. Try again to trim impedance.

c. If purging does not correct the situation, you may have liquid water in your transmission line. Use a vacuum pump to dry the transmission line. [A vacuum pump can be rented or borrowed from a refrigeration contractor.]

d. Hold as much vacuum as you can for 24 hours, then check VSWR again.

e. If VSWR is still erratic, 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 22 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

If your system will not hold pressure as described in Leak Testing on page 14, look for the cause in Table 6.

Table 6. Troubleshooting Pressure Loss or Excessive Gas Usage

Possible Causes:	Cures:
O-ring missing or poorly installed in transmission line, feedline, or baymount flange.	Find the leaky O-ring using soap solution. Replace the O-ring.
Leaky end seal (see Figure 4 on page 7).	Replace the leaky end seal.
Loose connecting hardware between line segments or between the baymount and the radiators.	Tighten loose connections when found.
Mechanical damage to transmission line, transformer, or antenna. Check for leaks using soap solution.	Replace damaged components.

9 Maintenance

Precautions

WARNING

Maintenance should be performed only by personnel experienced in RF systems and familiar with this equipment.

WARNING

The broadcast industry has recently recognized the potential medical hazards of intense radio frequency radiation. Don't expose personnel to personal harm. For reference, see CFR 29, Section 1910.97, the OSHA standard for exposure to non-ionizing radiation. Whenever a rigger is on the tower in the area of the antenna, shut off the transmitter and lock it off so that it cannot be turned on accidentally.

CAUTION

When you have had the system open for repair, you must purge it again as described in Purging the System on page 16. 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

Do not use silicone grease on an O-ring, as this will soften the silicone O-ring.

Use only a light lubricating coat of petroleum jelly (provided); too much may hamper electrical contact and contaminate the interior of the system.

Be sure the O-ring is properly seated in its groove and not pinched between the flange contact surfaces.

CAUTION

Be sure to reduce transmitter power in proportion to the number of bays removed. All the power will be directed to the remaining bays and may otherwise burn up the radiators.

CAUTION

When installing a pressure cap on a baymount flange, be sure that the pressure cap is recessed to clear the feedline inner conductor.

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 27 shows a suggested log form you may use if you like.

Physical Inspection

The antenna system should operate for years with no problem. However, any time you have a rigger up on the tower, it's a good idea to have him check for general condition, looseness of components, and electrical damage. During this inspection, all mounting, flange-connection, and electrical hardware should be tightened.

Keep an eye on dry gas usage. A sudden increase in usage indicates a leak in the system. Troubleshoot per Chapter 8.

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

If a radiator is damaged, it may be possible to operate the system at reduced with several panels disconnected until repairs can be made. Your options and the correct procedure will vary from system to system. Please call Shively for advice if this occurs.

Troubleshooting

Troubleshoot the antenna system as described in Chapter 8.

Return Policy

When returning any material to the factory, be sure to call your salesman and obtain an authorized return (AR) 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.

Sample
Maintenance Log

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