FWS-11 OPERATING MANUAL

Revision 4.3
P.N.: 700-FWS11

July 1995
\PRODUCTS\FWS11\MANUAL\REV4P3

FCC Warning

This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

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1. INTRODUCTION

HOW TO USE THIS MANUAL

This manual is arranged by task or operation, such as initial check-out before going to the field, setting up the data logger, operating and troubleshooting. In general, look at the type of operation you want to do and refer to that section of the manual. If you find a common task missing, please let us know so that it may be included in future versions of this manual.

In certain instances, you will be required to look at a computer screen and make choices or enter a command. In this manual, these menu selections or required responses will be `in this style of type` to indicate what is seen on the screen.

This manual has also been updated to include a section on the LDS software and laptop or palmtop computer combination used to set up and communicate with a data logger. It does not include a section on the optional RD-05 display unit since this device has been discontinued. If are using an RD-05 display, refer to the manual that came with it or call FTS Forest Technology Systems for help.

You MUST HAVE a display device - LDS and computer, or RD-05 - in order to install and set up your FWS-11 data logger in the field. Although the data logger can be set up remotely from an office computer using WEATHER PLUS, this manual describes installation procedures using portable computers or displays.

Please note that tasks not included in this manual are those relating to telemetry equipment and WEATHER PLUS software. For these, please refer to the manuals for those systems.

THE PARTS THAT MAKE UP AN FWS-11 FIRE WEATHER STATION

The core of the FWS-11 Fire weather station is the FWS-11 data logger itself. Connected to this are the battery pack, the optional "data display" using the LDS Local Display Software with a laptop or palmtop computer, the various sensors (wind, rain, etc.), and the optional telemetry devices. See Figure 1-1 for a block diagram of the electronics. These are mounted on a mast system that supports the various sensors as well as the data logger. A typical setup is shown in Figure 1-2.

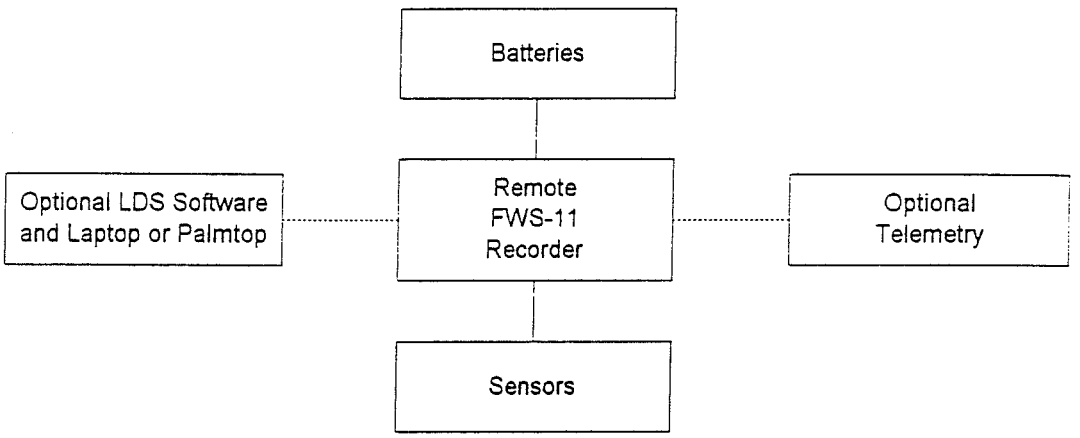

Figure 1-1

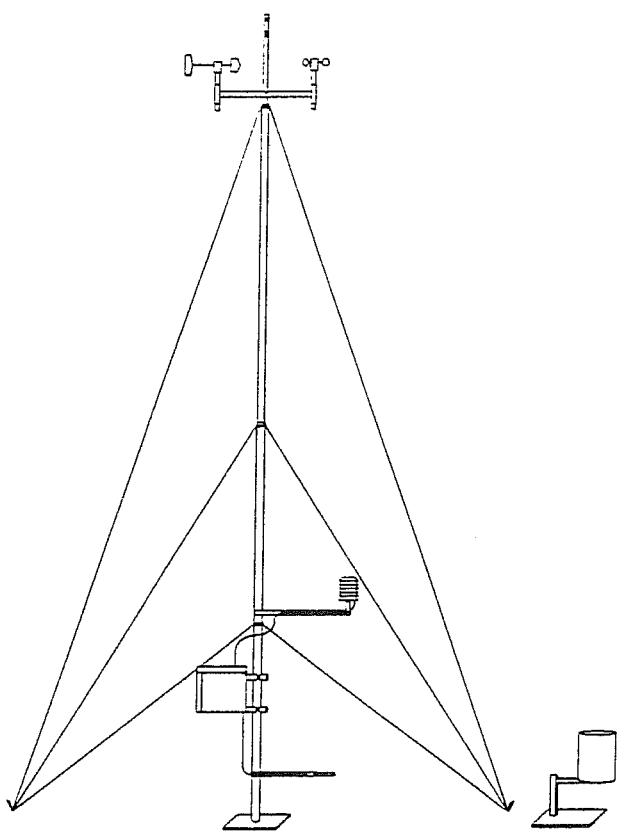

Figure 1-2

2. BASIC FUNCTIONS

DATA LOGGER AND SENSORS

The FWS-11 data logger is designed to automatically record weather data and present it in a form suitable for the maintenance of fire weather records. It is a compact, easily installed system which requires little training of the user for correct operation. The stored data can be extracted through a palmtop data display unit, a laptop computer or sent through a telemetry system to any desired location within radio or telephone range. For field site setup, either a palmtop data display unit with LDS Local Display Software or a laptop computer running WEATHER PLUS is required.

The data logger registers the temperature, humidity, wind speed, wind direction and rainfall of your chosen site. In addition, fuel moisture and fuel temperature can also be monitored with the optional fuel stick sensor. Every hour, the data logger measures and stores the temperature, humidity, wind speed, wind direction and rainfall. Once a day, the data logger saves the maximum and minimum of both the temperature and the humidity and the fuel stick moisture and temperature (assuming a fuel stick is attached). Newer Version 2.24 recorders can also record hourly fuel stick temperature and moisture along with the maximum wind speed.

These sensor inputs can be stored in data files produced by WEATHER PLUS software, depending on the file template chosen. For instance, the Canadian FWI Fire Weather Indices template will show temperature, humidity, wind speed and direction, and rain; American NFDRS templates show these values plus fuel stick readings and maximums and minimums.

When the data logger is powered up and the time and date are set, the data logger is synchronized on the following hour for reading, processing, and storing sensor data. During the first (fragmentary) hour before synchronization, sensor data is collected and adjustments are then made on the hour. For instance, some events such as wind speed and wind direction are discarded since these readings will be inaccurate. From this point on, sensor data is collected normally as described in the sub-section on sensor readings.

The data logger can be powered by the battery module, which provides 12 volts from 8 "D" cells, for up to 5 months in stand-alone operation. With an external solar power supply or AC power, the "D" cells will act as backup in the event of a power failure. In this case remote communications to the data logger will be lost, but the weather information will still be recorded.

The solid state memory of the data logger is powered by a 3.5 volt Lithium Chloride cell. This battery is good for at least 5 years. Thus, information storage within the data logger can be maintained even when it is disconnected from all power sources. This means that the data logger can be removed from its site, transported, and hooked to a computer for data retrieval.

SENSOR READINGS

Sensor data is stored in non-volatile memory for every hour of every day up to 62 days. The 63rd day's data will be written over the first day's data. If the data logger is called for data within 62 days, no data will be lost to the user. Calls made farther apart than 62 days will result in the loss of the user's weather information.

Sensor readings are taken at varied intervals and some are manipulated by the data logger to derive another output, such as peak wind speed. The chart below shows the readings taken at particular times.

5 Second Readings Taken:

Wind Speed	Used to determine the peak wind speed.
Wind Direction	Used to determine the "average" wind direction.

10 Minute Readings Taken:

Wind Speed	10 minute average.
Wind Direction	Most common direction over the last 10 minutes.
Air Temperature	Used to determine maximums and minimums.
Air Humidity	Used to determine maximums and minimums.

Hourly Readings Stored:

Air Temperature	A single reading on the hour.
Air Humidity	A single reading on the hour.
Maximum Air Temperature	The highest of the 10 minute readings.
Minimum Air Temperature	The lowest of the 10 minute readings
Maximum Air Humidity	The highest of the 10 minute readings.
Minimum Air Humidity	The lowest of the 10 minute readings.
Fuel Temperature	A single reading on the hour.
Fuel Moisture	A single reading on the hour.
Rainfall	Over previous hour. Reset to zero after storing.
Peak Wind	Over previous hour. Reset to zero after storing.
Average Wind Speed	Most recent 10 minute average.
Wind Direction	Most recent 10 minute average.

Current Weather Readings:

Time of Request	
Air Temperature	Taken at that time.
Air Humidity	Taken at that time.
Average Wind Speed	Most recently completed average.
Wind Direction	Most recently completed average.
Peak Wind	The peak since the hour.
Rain	Total since the hour.

Wind Direction

The data logger reads the wind direction every 5 seconds and keeps track of how often a particular direction is sensed. The direction with the highest count is taken as being the valid value. The Wind Direction is not a true average, but is the most frequently occurring direction over a 10 minute interval. The first 10 minute interval begins exactly on the hour. If a Current Weather call was placed for wind direction at 12:17, the most recently completed "average" would be returned. In this case, it would the reading logged for 12:00 to 12:10.

Wind Speed

The data logger reads the wind speed every 5 seconds. Every 10 minutes an average is taken of the readings and kept until the next 10 minute interval has elapsed. If a Current Weather call was placed for wind speed at 12:17, the most recently completed "average" would be returned. In this case, it would the reading logged for 12:00 to 12:10.

Peak wind speed is taken from the 5 second wind speed readings and is the highest reading stored since the beginning of the hour. If a Current Weather call was placed for peak wind speed at 12:17, the returned information would be the highest wind speed sensed up to the hour 12:17.

NOTE: Both the average wind speed and peak wind speed are reset to zero at every hour. If the local wind speed is low, a Current Weather call made immediately after the hour is likely to return a wind speed of zero. If there have been any counts from the wind sensor during this short period, the returned value will be 1 mph (1.6 kph). This is due to a 1 mph offset value in the formula used in the data logger to convert sensor counts to wind speed readings. If the wind speed reading looks unreasonable, allow a 10 minute period to elapse before calling for current weather, or call for stored data and read the hourly data.

Rain

Each tip of the rain bucket is counted during the hour and totaled at the end of the hour. This count is reset each hour after storage. The totals for each hour are summed for the 24 Hour Total rainfall, typically 13:00 to 13:00. Each tip of the bucket is counted as 0.01 inch.

Each hour that the bucket tips once or more than once, it is considered as a rainfall duration of 1 hour.

Since the rain count is reset at the hour, a Current Weather call immediately after the hour may result in a reading of zero. If this seems unreasonable, wait a few minutes and call again, or check the stored hourly data.

Fuel Stick

The 1 Hour fuel stick reading is a calculated value derived from within Weather Plus as are the 100 Hour and 1000 Hour readings. The 10 Hour reading is a direct sample from the fuel stick.

BATTERY UNIT

The battery unit holds eight alkaline "D" cells to power the data logger in the event of failure of the main power. These are adequate for two months of recording. The battery life depends on the temperature of the site (battery life is shortened at low and high temperatures) and how long they have been sitting unused (shelf life). If

telemetry is installed, the data logger will be powered from the solar panel of the telemetry, and the battery unit will then act as a backup (for the data logger and its sensors only) in case of solar panel failure.

OPTIONAL LDS SOFTWARE WITH PALMTOP OR LAPTOP COMPUTER

LDS or Local Display Software consists of a connecting cable and software program that interface your laptop computer with the weather data logger. It is designed to allow a user to view current and stored data, and access the internal station and sensor information essential for proper site installation. The same functions are useful in troubleshooting.

The LDS package can also be acquired along with a Hewlett-Packard palmtop computer. This full-function computer is shirt pocket size and so is highly portable and easily protected from the elements.

MAST AND SUPPORT SYSTEM

The mast system holds the data logger off the ground, as well as supporting the wind sensors and the temperature/humidity sensor assembly. If telemetry is installed, it is attached to the mast as well. The data logger is easily attached to the mast, as it comes in several separate pieces which are simply placed in an outer support shell. This shell is lightweight and can be installed by one person.

TELEMETRY

Telemetry consists of three parts: a software package called WEATHER PLUS which controls the telemetry system, the RM4000 radio modem for transmitting data over radio links, and the TM telephone modem for transmitting data over public telephone lines. The TM can connect to an RM4000 for a combined radio and telephone linkage. This allows the user to use the phone system as far as it allows and then proceed from there with radio to the weather data logger (see Figure 2-1).

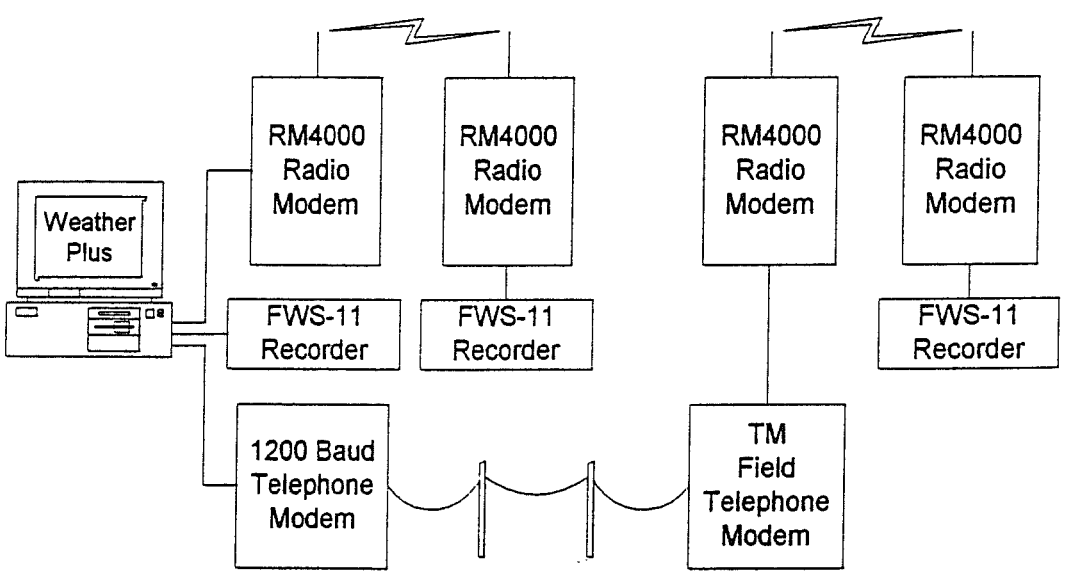

Figure 2-1

WEATHER PLUS SOFTWARE

WEATHER PLUS software runs on a PC or compatible computer and can maintain weather records for the various stations in your network. Once the network is set up, you can gather data from your stations using the station names, and WEATHER PLUS will automatically translate this into the correct calling sequence and get the data for you, then store it on the computer. In addition, the stored data can be translated into a form that allows it to be used by other programs, such as spreadsheets. The stored data can be viewed, edited, printed and graphed.

TM TELEPHONE MODEM

This telephone modem is packaged in a waterproof case for use in the field. A regular commercial modem is used at the computer. Using this modem you can transfer data from an attached weather data logger, or go to a radio link to gather data by radio. It is necessary to have a private line (single-user, as opposed to a party line) to use the modem (this applies to all normal modems, not just the TM). The TM uses the regular public telephone system.

RM4000 RADIO MODEM

This is a radio modem that uses your existing voice radio network or a dedicated data channel with its own frequency to transfer the data from the weather stations back to your office. The RM4000 can be connected to a TM telephone modem for a more cost-effective system if your recorders are a long way from your office.

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3. BATTERIES

CARE AND MAINTENANCE

Replace batteries when voltage drops to less than 10V. The unit will continue to work properly until about 7.5V. Data will not be stored at less than 7V battery voltage. A voltage reading can obtained through the LDS and laptop.

1. In order to replace the batteries in the battery pack, remove the twelve hex socket screws with a 5/32" hex key (one is available with the optional tool kit) and carefully lift the bottom plate out of the battery pack. It may be necessary to pry gently to release the o-ring seal. This plate has the batteries attached to it, so it will be heavy.
2. Place the plate down carefully with the batteries exposed. Examine the humidity indicator in the shell, if it shows a humidity of more than 10%, replace the desiccant package attached to the end of one of the battery holders.
3. Remove the old batteries and carefully check all the battery holder terminals for corrosion. Clean the holders carefully, if any corrosion is found.
4. Install fresh alkaline "D" batteries, taking care to get the polarity of the batteries correct.
5. Place the plate back on the shell, making sure that the cable is routed out of the way and does not get caught between the plate and the shell.
6. Install and tighten all the screws gradually in an alternating cross-pattern, to ensure an even lid seal.

NOTE: **Use only alkaline batteries!** The reasons for this are as follows: First, the alkaline batteries are least prone to leaking if left in the unit while discharged - battery leakage damage is not covered under warranty (You should not leave the batteries in the unit if storing it for long periods). Second, the alkaline batteries have the longest life over the widest range of temperature. Third, alkaline batteries perform best under the varying current loads of sensor reading or data transfer. Fourth, they have the longest shelf life, which means that the time since manufacture is of less concern, and also that in stations with telemetry, they will be able to sit unused for months and still be able to take the load if the solar panel should fail.

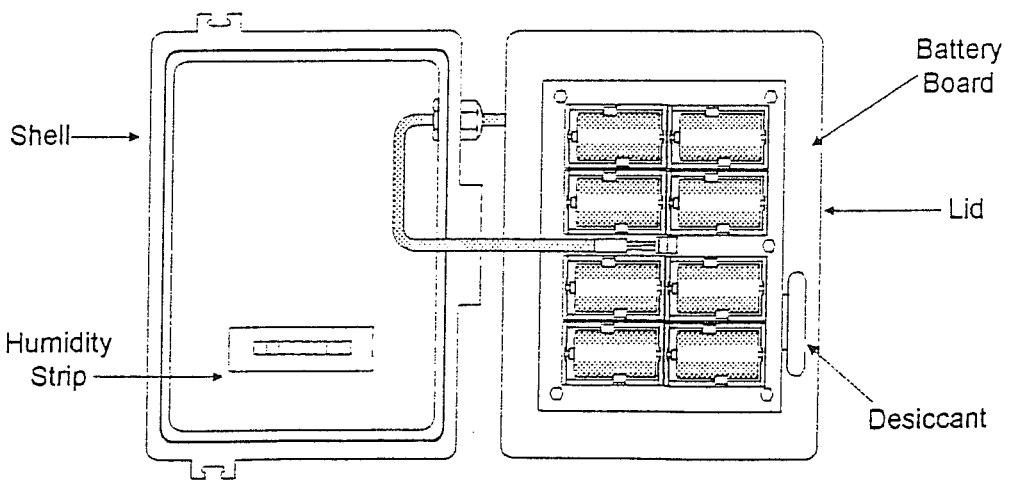

Figure 3-1

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4. INSTALLATION

EQUIPMENT CHECK

OBJECTIVE

This pre-installation equipment check section is intended to guide you through removal of the FWS-11 from its packing cases and initial setup on a bench or table to verify correct operation before on site installation.

If problems are suspected anywhere during the following procedure, refer to the **TROUBLESHOOTING** chapter.

PROCEDURE

1. If you have the optional FWS-11 shipping case, open it and note the positions and packing methods of the various components (Figure 4-1).

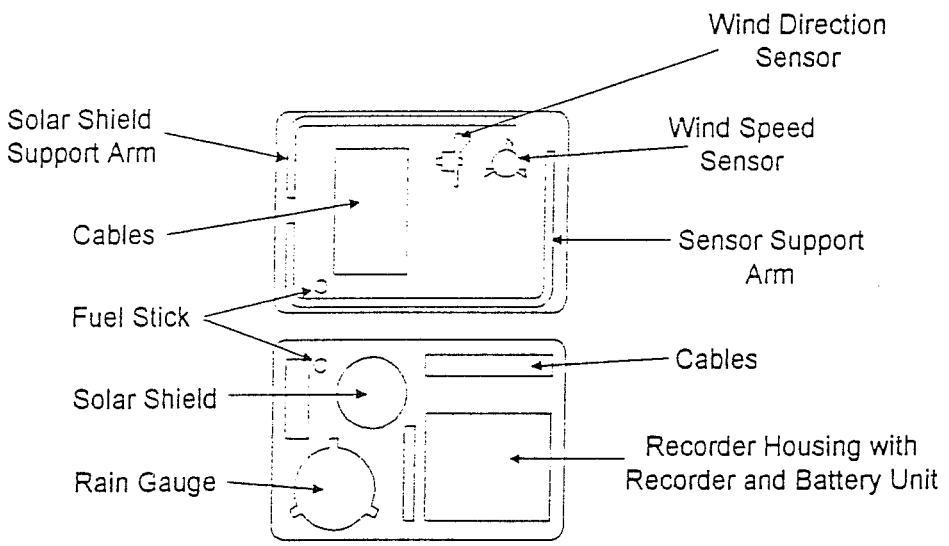


Figure 4-1

2. Remove the data logger and battery unit from inside the shell and set them side by side on the bench.
3. Install 8 alkaline "D" cells in the battery unit (refer to the **BATTERIES** chapter for detailed instructions). Make sure all the batteries are installed with the correct orientation. Incorrect orientation will shorten the field life of the battery pack and could also lead to leakage of the batteries. Damage caused by battery leakage is not covered under warranty. Place the data logger on a table with the connectors facing up.

Please note that the connectors on the data logger each have a colored ring and are labeled with their function. Also note that there are three different sizes of connectors. Each connector has a different pin configuration, to reduce the chance of erroneous connection. Be aware, however, that it is possible with

sufficient force to mis-mate some of the cables with the wrong data logger connector. This may damage the connector and require that the connector be replaced. Careful attention to the connector size and color code will guarantee the correct connections for the various sensors.

4. Place a laptop or palmtop computer using the LDS software next to the data logger.

5. Find the LDS cable and connect one end to the serial port of the computer. The other end of the cable has a military style connector with an orange color-coding band. Connect this end of the cable to the orange color-coded connector on the data logger marked "Display".

6. Connect the green color-coded battery pack cable to the green color-coded connector on the data logger marked "Battery". The data logger should now be powered up and running, although there are no outward signs at this point.

7. Turn on the laptop or palmtop computer and make the current directory the one with the LDS software. For example, you might enter the commands:

   C: ↵

   CD\LDS ↵

   LDS ↵

   to consecutively change to the C: drive, change to the LDS (default) subdirectory, then start the LDS software.

8. You will then see a screen that will resemble Figure 4-2.

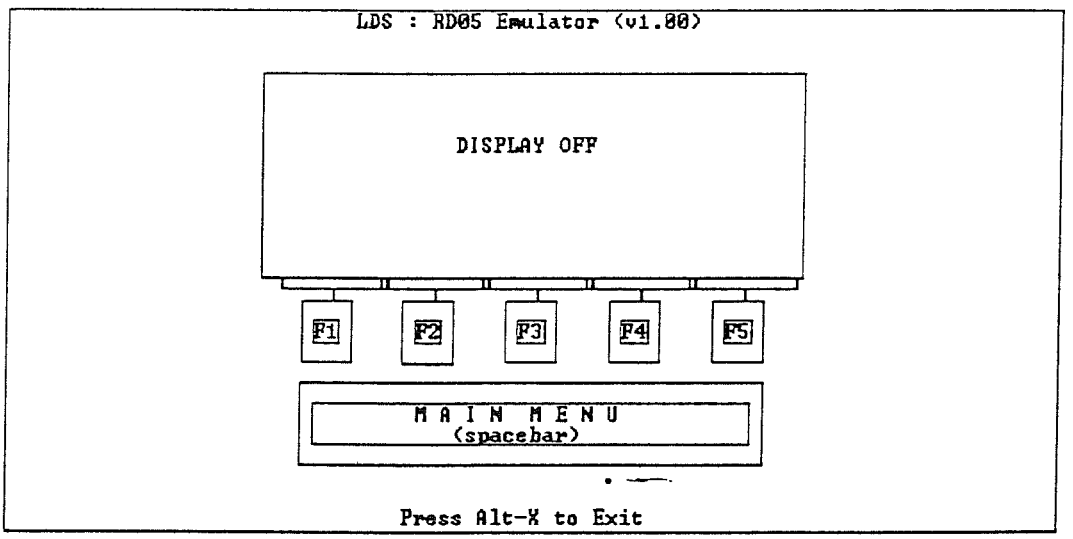


Figure 4-2

9. The window shown in the middle of the screen is the local display window. This is where information received from the FWS-11 is displayed. Initially the message "DISPLAY OFF" will appear in the display window. Press the keyboard Spacebar to start communication with the FWS-11 and bring up the Main Menu.

10. Set the time (see the SETTING THE TIME section of the **OPERATING INSTRUCTIONS** chapter).

11. Connect the Temperature/Humidity sensor to the data logger.

12. From the main menu, select "Current Weather". If you get a value of temperature near what you expect, then the temperature is working (remember to allow for the sensor coming from a cold shipping case, or similar factors). If you get -60C^0 or -76F^0, or +60C^0 or +140 F^0, consult the Temperature sensor section of the **TROUBLESHOOTING** chapter.

13. Look at the humidity reading. The humidity sensor responds more slowly than the temperature sensor, so the difference from the expected value will be larger. Values near 0% or 100% should be considered suspect on first try.

14. If you want, leave the Temperature/Humidity sensor connected while you test the others. You can then check the value again at the end of tests to achieve a more accurate appraisal.

15. Connect the rain gauge to the data logger and remove the top (funnel and tube section) of the rain gauge.

16. Inside the rain gauge, remove the tape or elastic bands used to restrain the tipper bucket during shipping.

17. Select the "Current Weather" option again and note the rain reading. Tip the tipper bucket to the opposite side and press any one of the Function keys to get a fresh sample reading. The rain should have increased by 0.01". If this is not the case, refer to the **TROUBLESHOOTING** chapter.

18. Connect the wind direction sensor and again select "Current Weather". You should get a reading in degrees under "Current direction" (ignore the average values, they require at least 10 min. to have elapsed before a reading appears). If you get "no vane" with the sensor connected, refer to the **TROUBLESHOOTING** chapter. Note that you will have to press a Function key to get another sample if you change the direction. Make sure that the directions increment correctly as you rotate the vane (0, 45, 135, 180, 225, 270, 315 increasing as the vane is turned clockwise).

19. Connect the wind speed sensor. To test this, you will need to select "Technical Menu", then from this menu, select "Technical Info". What you want to look at is the "Wind Count". Note the value of this count, then rotate the anemometer once. Press a Function key to get a new sample. The count should have gone up by one digit if using a plastic wind speed sensor, by two digits if using a metal sensor.

20. If you are using a fuel stick, connect the fuel stick interface cable to the data logger, then connect the electronic fuel stick sensor. Select "Current Weather" and observe the readings for fuel temperature and moisture. Faulty readings would be temperatures at -60C^0 or -76F^0, or +60C^0 or +140 F^0; or fuel moistures near 0% or 25%. Note that the fuel moisture will change slowly because of the 10 hour time constant of the fuel stick.

The above instructions for wind direction, wind speed, and fuel stick are based on the assumption that your data logger is already setup for the correct type of sensor you will be using. If this is a new installation or there have been sensor changes - such as from plastic to metal wind sensors - refer to the USING THE TECHNICAL MENU section in the chapter titled **OPERATING INSTRUCTIONS**.

21. If you are using the telemetry, test procedures are outlined in the telemetry manual.

22. Repack the pieces back into the shipping case. Be sure to re-attach the elastic band or other restraint to the tipper bucket of the rain gauge.

The FWS-11 fire weather station should be located in a large open area, clear of obstructions that would degrade wind and solar exposure. The solar exposure must allow the station to receive full sun for the greatest possible number of hours per day during the fire season. The station should be located away from sources of dust and surface moisture. The station should ideally be situated on level ground; when situated on a slope, the exposure must be southern or western. The site should have a low vegetation cover representative of the bioclimatic region's typical natural fuel bed.

To review the source documentation for site selection, refer to the following.

In the United States:

- Fire Weather Observers Handbook (FWOH)
- Weather Station Handbook - An Interagency Guide for Wildland Managers

In Canada:

- Weather In The Canadian Fire Danger Rating System (BC-X-177)

  Published by: Environment Canada

The following is a brief summary of the general rules that govern the location of a standard fire weather station

1. Locate the station in an area that is representative of the conditions existing in the general area of concern. Take in to account vegetation cover type, topographic features, elevation, climate, and local weather patterns.
2. Select a site that will provide for long-term operation and a relatively unchanged exposure. Consider site development plans which may include: roads, buildings, and parking areas. Account for ultimate obstruction by growth of vegetation; station security and maintenance access.
3. Arrange the station so as to give data that is representative of the local area. Consider exposure requirements for each of the fire weather sensors in relation to; prevailing winds, wind obstructions, movement of sun, topography, vegetation cover, and nearby reflective surfaces.

The following situations should be *avoided* when selecting a station site

1. Sources of dust such as roads and parking areas. If unavoidable the station should be located a least 100 feet on the windward side of the source.
2. Sources of surface moisture such as irrigated lawns, pastures, gardens, lakes, swamps, and rivers. If unavoidable the station should be located several hundred feet to the windward side of the source.
3. Large reflective surfaces such as white painted buildings. Other natural reflective sources such as lakes, ponds, canals, and large rock formations. If unavoidable the station should be located on the north side far enough away so as not to be artificially shaded or influenced. Generally a distance equal to the height of the reflective surface of 50 feet, whichever is greater.

4. Extensive paved or black-topped areas. If unavoidable the station should be located at least 50 feet to the windward side of the source.

5. Large buildings, trees, and dense vegetation. Locate the station at least a distance equal to the height of the obstruction. For large tree stands a distance of ten times the average stand height would be optimum.

6. Distinct changes in topography such as hummocks, gullies, peaks, ridges, steep slopes and narrow valleys.

OBJECTIVE

The station will be set up by erecting the mast, fastening the various sensors and the data logger to it, then verifying the operation of the data logger and sensors.

For both safety and ease of installation, two people are required to set up the station. Please review all instructions before proceeding with actual assembly.

Tools Required

Tools:

Sledge hammer

10 foot step ladder

Compass

Side cutters

Torpedo level*

Safety goggles*

Leather palmed gloves*

Standard screw driver*

Needle nose pliers*

5/16" nut driver*

1/2", 7/16", 9/16", and 3/4" combination wrenches*

5/32" Allen (Hex) key*

Instruments:

DVM (multimeter)

Battery load tester

Laptop or Palmtop with LDS or Weather Plus software (Or: Remote Display unit)

LDS cable

Consumable Items:

Zap straps (Cable ties) 5 to 10 inch*

Electricians tape*

Spare nuts, bolts, and clamps*

Heat shrink tubing

An optional tool kit containing all of the above marked with " * " is available from FTS. A bag of spare consumable items is also included with the tool kit.

1. Bolt the base plate to the bottom section of the mast and lay the mast on the ground with the base plate in the location where the mast will stand (see Figure 4-3). Use the included spikes to secure the base to the ground.

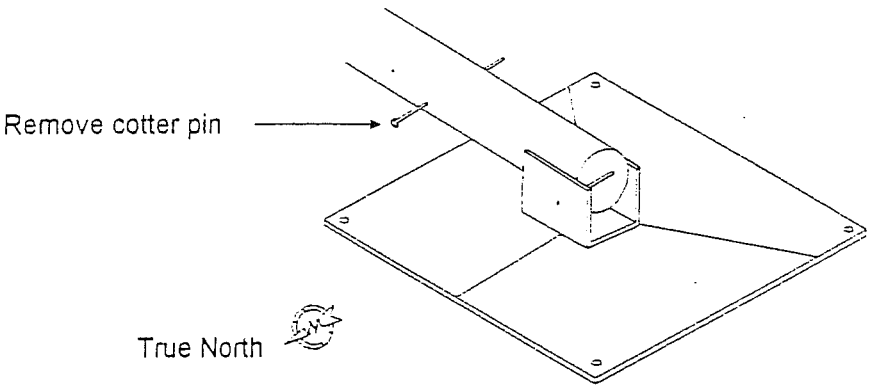


Figure 4-3

2. Remove the bag of hardware taped to the top of the mast.
3. Unbolt and remove the mast extension located inside the top section of the mast.
4. Remove cotter pin from bottom of the mast.

PLEASE WEAR SAFETY GOGGLES WHEN HAMMERING IN STAKES.

5. At a distance of 15 feet North of the mast base, drive in a stake.
6. Move 120 degrees away and drive in another stake, 15 feet from the mast base. The scribed lines on the mast base are 120 degrees apart and will help locate the proper placement for the stakes and guy wires.
7. Repeat for the third stake. Your mast and stakes should now look something like Figure 4-4. If this process is done as is described here, there will be no guy wire shadow across the solar panel when it is mounted and facing South.

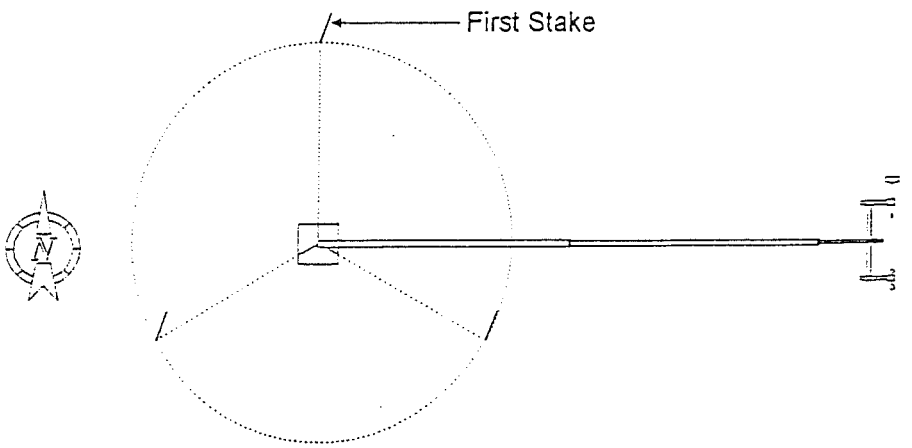


Figure 4-4

PLASTIC WIND SENSORS

If you have purchased metal wind sensors please skip ahead.

1. Place the WD-11 Wind Direction Sensor on its mounting post on the shorter side of the sensor support arm so that the alignment marks are lined up (see Figure 4-5).
2. Place the WS-11 Wind Speed sensor on its mounting post on the taller side of the support arm (see Figure 4-5).

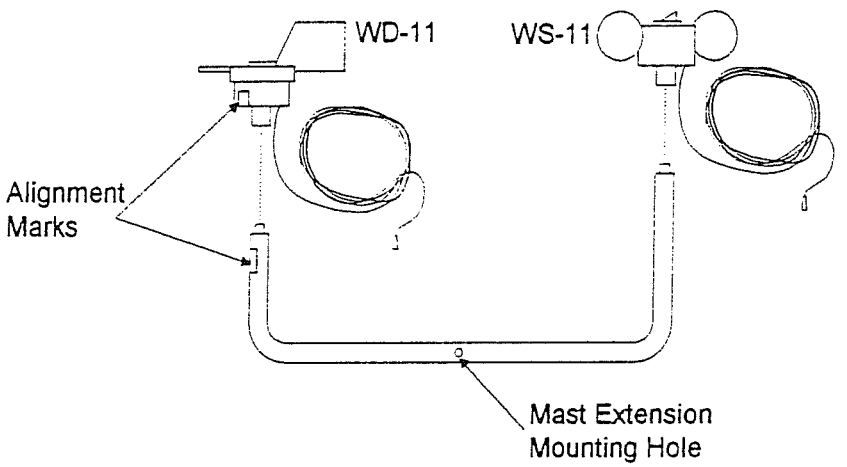


Figure 4-5

3. Insert retaining bolts through the sensors and mounting posts to lock the sensors in place
4. Tape the cables as shown in Figure 4-6.
5. Proceed to ERECTING MAST section of manual.

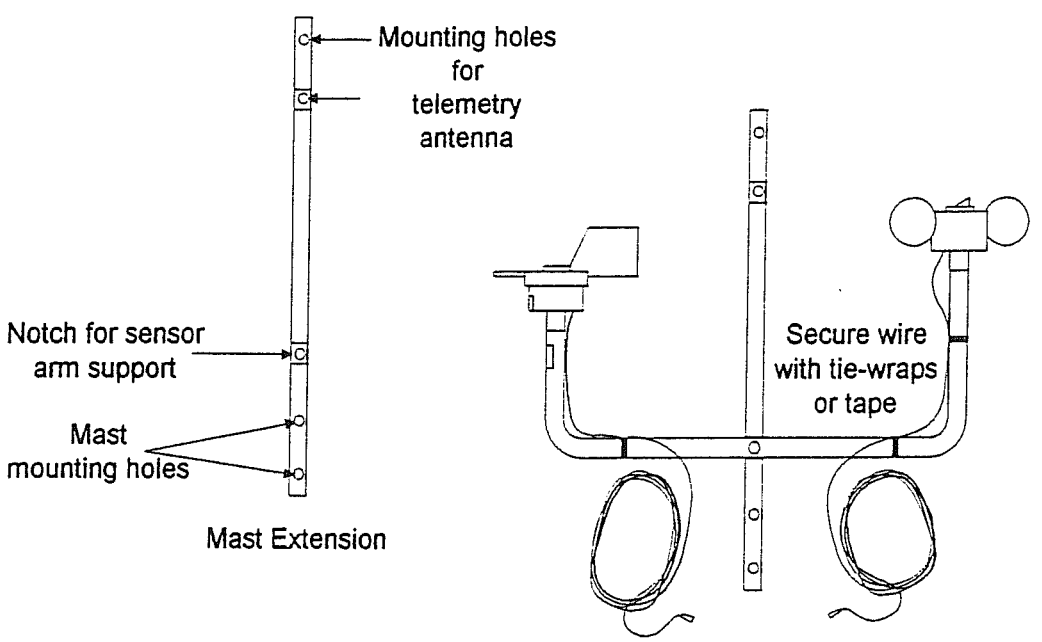


Figure 4-6

METAL WIND SENSORS

1. Insert the wind direction sensor into the mounting collar at the labeled end of the sensor support arm. Note that the bottom hole is drain hole and should be left exposed below the sensor mounting collar.
2. Insert lower bolt into the mounting collar and thread into sensor. This ensures correct alignment of the sensor.
3. Thread upper bolt into the mounting collar and tighten against sensor. There is no hole in the sensor for this bolt.
4. Insert wind speed sensor into the sensor mounting collar on the other end of the sensor support arm
5. Make sure the drain hole in the sensor is below the mounting collar of the support arm.
6. Thread upper and lower bolts into support arm and tighten against sensor. There are no bolt holes in this sensor.

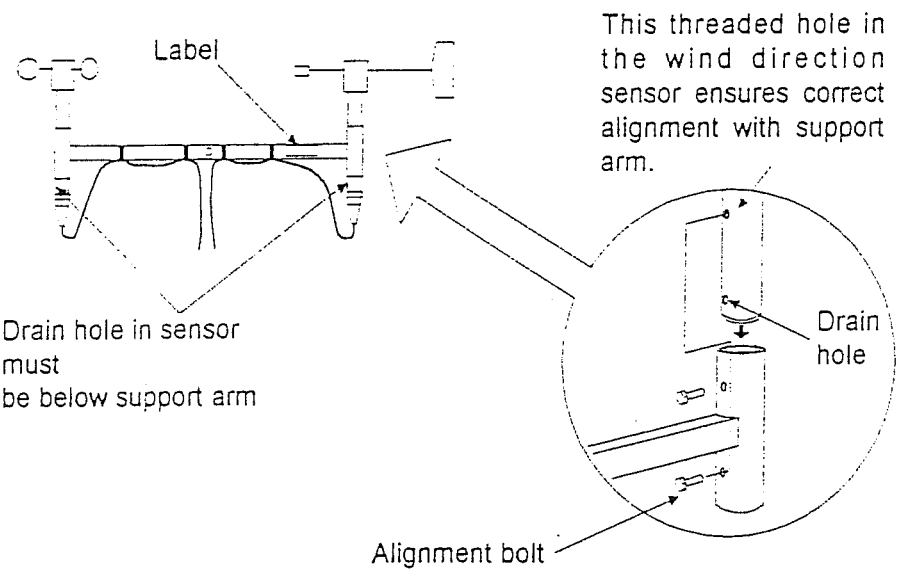


Figure 4-7

ERECTING THE MAST

1. Place a box or solid object under the top of the mast so that it is kept off the ground. This is to allow connection of the wind sensor assembly and to protect the wind sensors from damage.
2. If you are installing radio telemetry , refer to the telemetry manual at this point for antenna installation.
3. Attach the sensor support arm to the mast extension rod, if you have not done so already.
4. Slide the assembled sensor support and mast extension into the top section of the mast and bolt it in place.
5. Attach the lowest guy wires to the "second" and "third" stakes, double looping the wire and loosening the turnbuckle as shown in Figure 4-8.

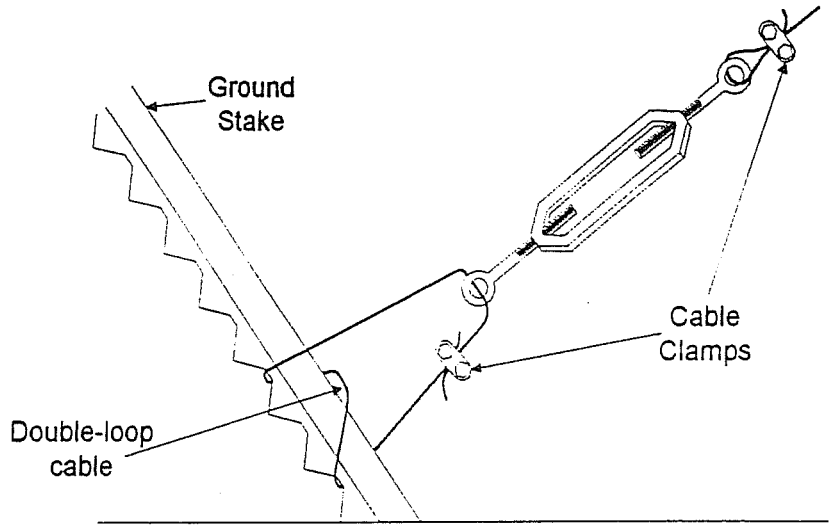


Figure 4-8

6. Stand on the base of the mast and raise the mast toward the original, "first" stake. The remaining guy wire can then be pulled to this stake.
7. Use the level and the turnbuckles to make final adjustments to the tension of the lowest guy wires and to keep the mast vertical.
8. Erect the ladder and align the wind sensor arm to true North/South, with the wind direction vane on the North end.
9. Unroll the guy wires on the top section of the mast, taking care to avoid kinks. If you are using the 10 meter mast which has 3 sets of guys, this should be done to the middle and top sets of guy wires.
10. If this site uses solar power, use the stainless steel hose clamps on the back of the solar panel to attach the it to the upper section of the mast.
11. USING GLOVES, raise the top mast section about 3' and lock it into position by lightly tightening the circular locking clamp. This is a temporary position.
12. Tape the wind sensor wires (and the antenna cable, if used) to the top section of the mast.

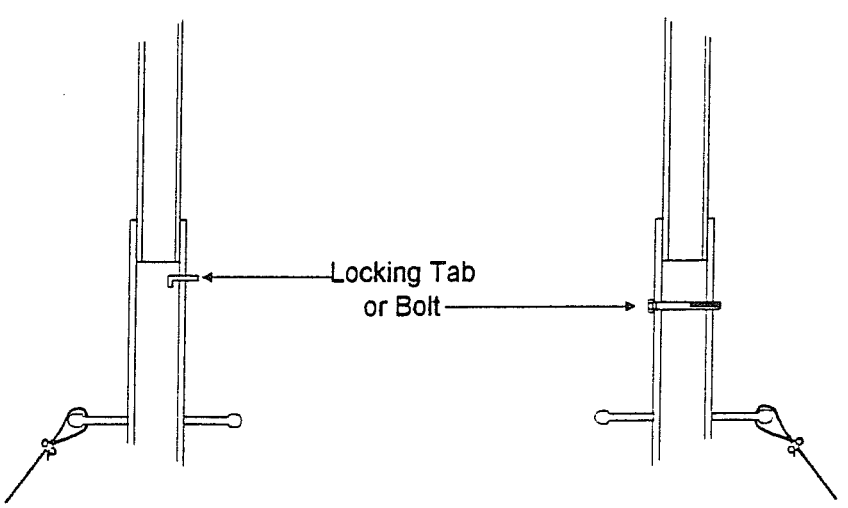


Figure 4-9

13. Release the circular locking clamp and continue raising the upper mast section until it clears the locking tab hole in the top of the next lower mast section.

14. Insert the locking tab or bolt provided into the hole and allow the mast to drop down on to the locking tab. See Figure 4-9.

DO NOT USE THE CIRCULAR LOCKING CLAMP TO PERMANENTLY SUPPORT THE MAST SECTIONS! This clamp is only used to prevent the mast sections from rotating.

15. Tape or cable-tie the cables both above and below the joint between the two mast sections. Remember to allow some slack here (see Figure 4-10).

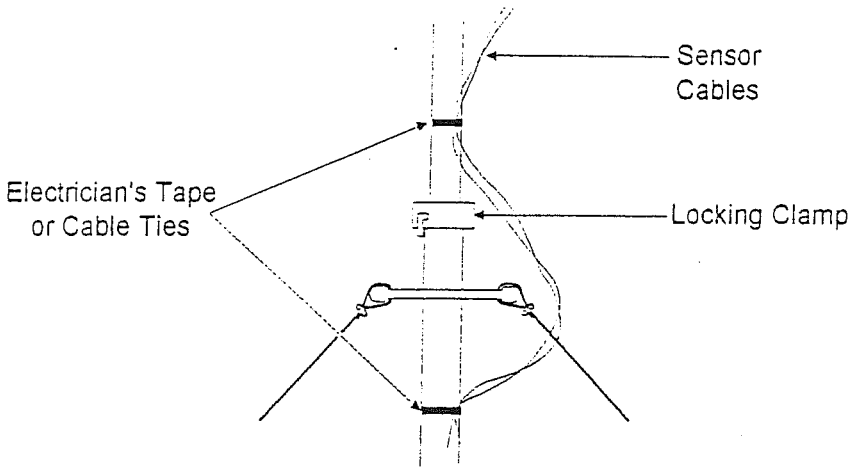


Figure 4-10

16. Check the alignment of the wind sensor arm by standing at a point south of the mast and observing the alignment of the wind arm. Remember to allow for magnetic deviation from true north when using a compass. The arm should run North-South with the wind vane on the North end.

17. Rotate the mast base until the correct wind sensor alignment is achieved. Drive the large spikes through all four holes in the mast base to prevent any further movement.

18. Tighten the circular locking clamp after the wind sensors are aligned properly.

19. Secure the top set of guy wires in the same fashion as the lower set. Make sure the upper section of the mast is vertical.

20. Make sure you do not over-tighten the mast cables as this can cause buckling of the upper mast section.

21. Take some mechanics wire and loop it through the turnbuckles as shown in Figure 4-11. This will prevent the turnbuckles from unwinding due to vibration of the guy wires in high winds.

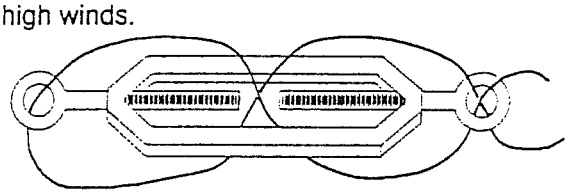


Figure 4-11

If installing telemetry, please refer to the telemetry manual for mast installation instructions.

If installing a solar battery pack, refer to the installation manual for the device you are using.

1. Locate the upper and lower mast clamps for the data logger. Bolt these loosely to the mast with the clamp tongue in the lower position. At this point they should both slide up and down the mast. See Figure 4-12.

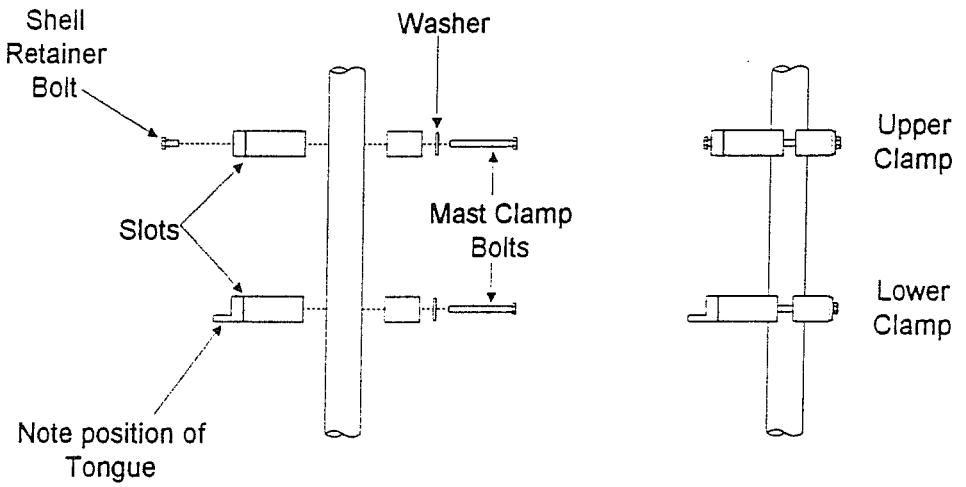


Figure 4-12

2. Slide the upper clamp up to about chest height with the slots for the data logger shell on the north side of the mast. Tighten the mast clamp bolts firmly. Note that you will have to tighten the bolts alternately to avoid binding.
3. Now make sure that the two slots are clear and unscrew the shell retainer bolts (not the mast clamp bolts). Remove any dirt or debris from the slots.
4. Take the empty support shell and hang it on the upper clamp, using the upper opening in the shell. The shell should drop into the slot in the upper clamp. If it doesn't, check that the retainer bolts have been withdrawn and that the shell has not been bent or damaged in that area. Also check that no dirt has become lodged in the slots.
5. Screw in the shell retainer bolts. These should go in all the way with just finger tightening. If not, shift the shell slightly so that the holes in the shell line up with the bolts. Do not tighten these with a wrench at this time.
6. Now slide the lower clamp up into the lower section of the support shell and tighten the all the mast clamp bolts firmly. See Figure 4-13.
7. Tighten the shell retainer bolts. They do not need to be very tight, just enough so that they will not work loose.
8. Take the data logger and place it into the shell with the connectors facing down and the tab at the rear towards the mast (see Figure 4-13). Note that the "ears" on the case of the data logger fit around the guides inside the shell and rest on stops at the bottom of the guides. The tongue at the back of the data logger rests on the tongue on the lower clamp. Make sure the data logger is resting securely on all three supports!
9. Install the battery case in similar fashion, with the flat cover plate downwards. The guides are used as before, but the battery case is supported by the data logger. The cable from the battery case is fed down past the back of the data logger to hang down below.

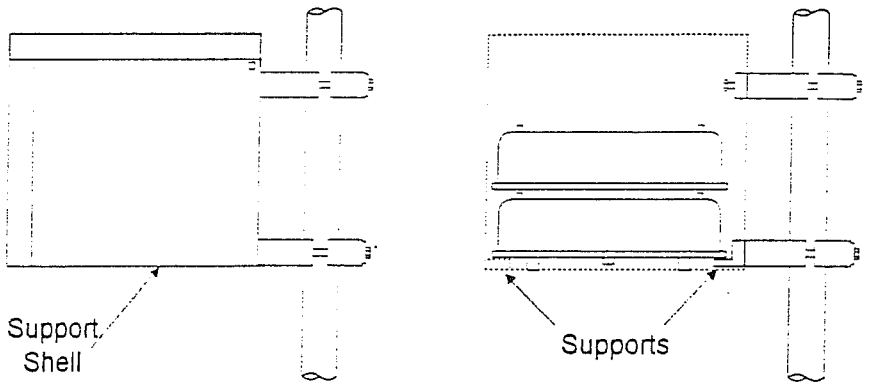


Figure 4-13

10. Plug the LDS cable into the palmtop or laptop computer and the data logger. The cable is color-coded orange and is plugged into the data logger connector marked "DISPLAY".
11. Connect the battery cable from the battery case to the data logger's green color-coded connector marked "BATTERY".

With all the bayonet style connectors on the data logger, it will be necessary to rotate their bodies to engage the keyways before attempting to turn the locking ring. In all cases the widest keyway is to the back (mast side) of the connector.

12. At this point, the data logger is turned on and working, although you have not connected any sensors to it yet.
13. Place the computer in a convenient location and invoke the LDS software. Press the Spacebar to bring up the Main Menu.
14. Tilt the computer display for best viewing. You should have a list of options presented to you (Figure 4-14).

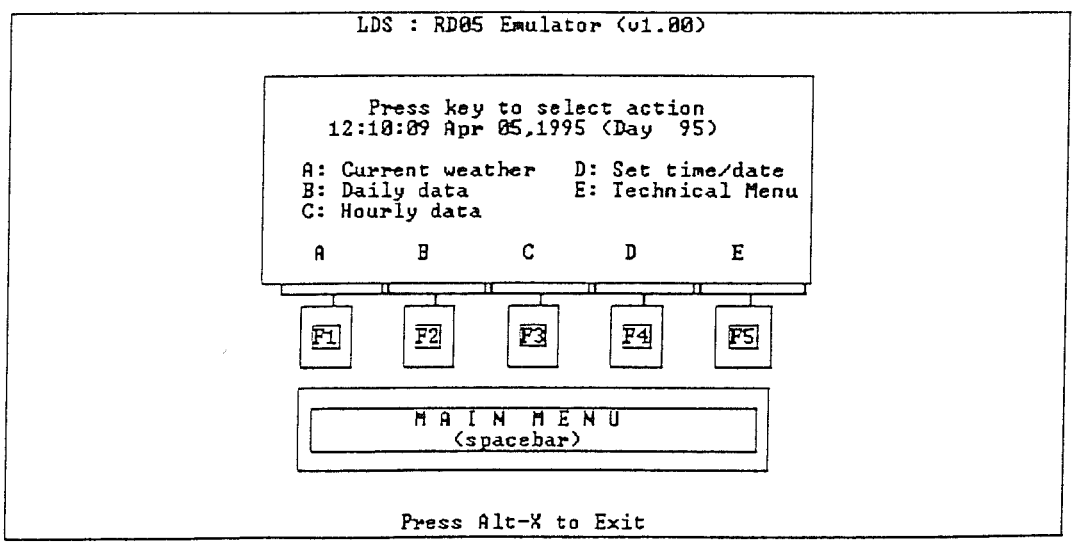


Figure 4-14

15. Set the station time (see the SETTING THE TIME section of the **OPERATING INSTRUCTIONS** chapter).
16. Connect the wind direction and wind speed sensors to their appropriate inputs.
17. Verify proper operation of the wind sensors as described in the EQUIPMENT CHECK section of the **INSTALLATION** chapter.

An ideal installation places the Temperature/Humidity sensor between (1 to 1.3 M) from the ground in Canada, and between 6 to 8 feet in the United States. Both standards recommend installation on the side of the mast or tower that provides the best exposure to the prevailing winds at each site.

Note that permanent installations in areas where the snowfall can exceed the normal installation height will require an alternative mounting method - such as higher on the mast - to prevent data loss.

Best operation is achieved when the sensor support arm has been properly leveled.

1. Place the solar radiation shield onto the support arm (this arm is similar to the plastic wind sensor's support arm but shorter) and insert the retaining bolt through its base.
2. While one person supports the sensor end, another can attach the support arm to the mast with the clamp bolts. Exact positioning of the device is not critical though the above recommendations should be observed when possible. See Figure 4-15.

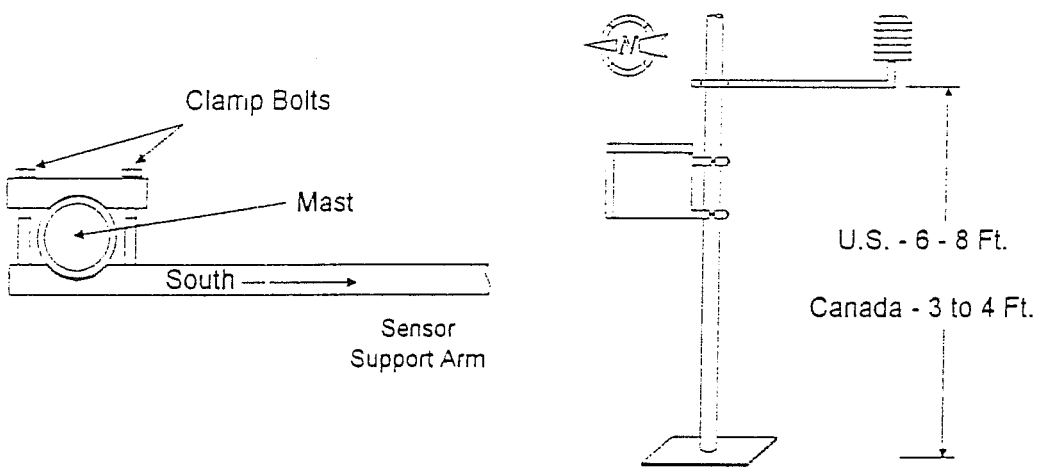


Figure 4-15

3. Tape the cable to the support arm and the mast.
4. Connect the cable's connector to the data logger.
5. Use the "Current Weather" option in the LDS software to look at the temperature and humidity readings. They should be approximately correct (laying sensors on the ground or in their case will cause them to be at a different temperature than the air). Faulty readings to look for are -60C^0 or -76F^0, or +60C^0 or +140 F^0 on temperature, or humidity readings near 0% or 100% (unless the site warrants it - 100% during installation in the rain, for example).

1. Put the rain gauge on firm level ground away from guy wires and brush to avoid drips and debris entering the funnel. The rain gauge can also be mounted on a wooden post with a square piece of plywood screwed to the top to raise the gauge above high grass or brush that may fall into it and affect its accuracy.
2. Remove the housing of the rain gauge, exposing tipper bucket and bubble level.
3. Remove any restraints from the tipper bucket.
4. Loosen level adjustment screw #1 (see Figure 4-16) and rotate pivot until approximately level.
5. Loosen level adjustment screw #3 (see Figure 4-16) and center bubble in level using level adjustment screw #2.
6. When bubble is centered tighten level adjustment screws #1 and #3.
7. Anchor the gauge with spikes driven through the holes in the base, or rocks and other heavy objects piled onto the base.
8. Connect the armored cable to the data logger.
9. Use the LDS software and computer to look at the rain count under the "Current Weather" menu. Each time the tipper is moved from one side to the other, the rain count should increment by 0.01 (you must press any one of the Function keys to see the updated data).
10. Put the housing (funnel and tube section) back on the gauge and secure the latches.
11. Bury or otherwise arrange the cable so that humans or animals will not trip over it.

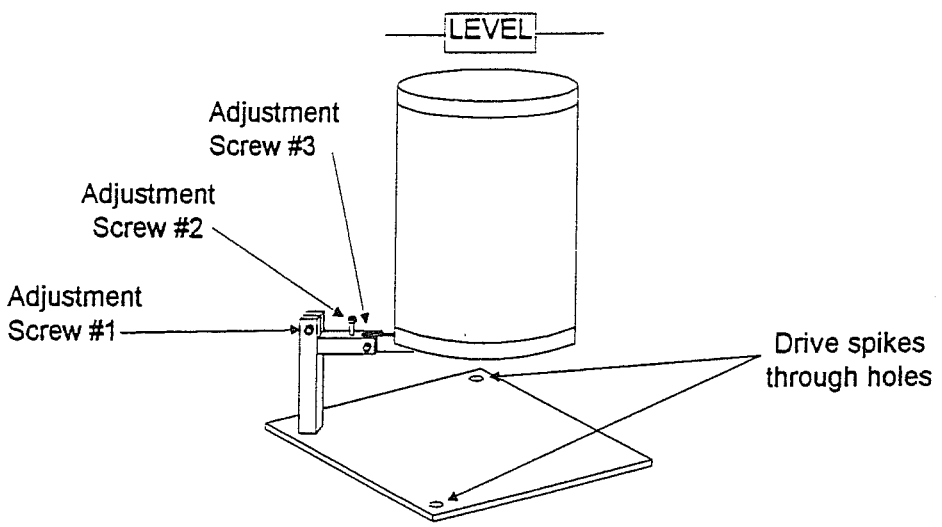


Figure 4-16

FUEL STICK INSTALLATION

The Fuel Temperature/Fuel Moisture sensor is best situated on the South side of your mast or tower where it can take advantage of the effects of solar heating without obstruction. The sensor should be installed 10 - 12 inches (30 cm) above the ground or a fuel bed representative of local fuels.

If a natural fuel bed is to be used, care must be taken by the installers of the site so as not to destroy the local material. If representative fuel is not available nearby, then a fuel bed must be constructed and placed correctly as part of the site installation.

1. Clamp the fuel stick support to the mast so that the fuel stick will be at the proper height above the fuel bed. See Figure 4-17.
2. Connect the fuel stick to its cable and fasten both securely to the fuel stick support.
3. Connect to the data logger and use the LDS software to verify a reading under "Current Weather". Note that the fuel moisture has a 10 hour time lag, so the initial reading will not be correct, it just verifies that it is working. Faulty readings -60C^0 or -76F^0, or +60C^0 or +140 F^0 for temperature, and near 0% or 25% for moisture.

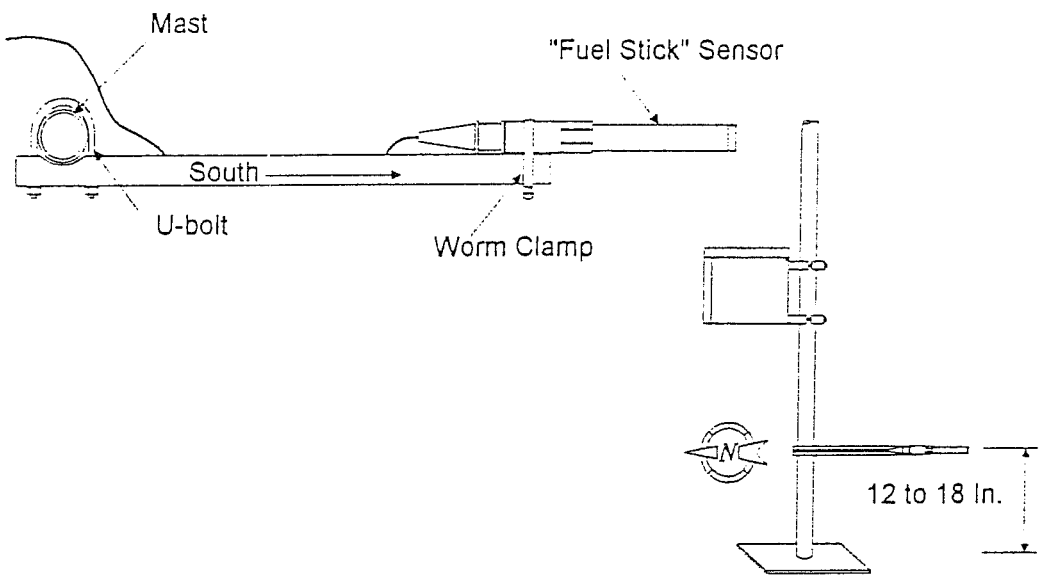


Figure 4-17

1. Put the caps on any unused connectors. This is very important! If a cap is not used, moisture in the air combined with voltages present on the pins causes corrosion of the connectors and conduction paths are created between pins. These conduction paths will cause incorrect readings if a sensor is connected to them at a later date. If this happens the connector must be replaced and this is not covered by your warranty.
2. If you are using telemetry, connect the telemetry cable to the data logger. The battery voltage should now read about 13.8V when "Current Weather" is selected in the LDS software.
3. Check that the wind sensor arm is aligned correctly to true North.
4. Check to see that the wind speed sensor is rotating freely when any wind is blowing.
5. Check that the mast is vertical and that the guy wires are tightened correctly.
6. Verify that the guy wire clamps are tightened adequately.
7. Dress the cables so that any extra is looped and taped out of the way of passing animals.
8. Recover all the tools used and place them back into your tool kit.
9. Clean up all cut off mast cable ends, electrical tape, wrappers and packing materials.

5. TOWER INSTALLATION

OBJECTIVE

This chapter on permanent tower installations is included because many of the issues covered are quite distinct from a temporary or long-term telescopic mast installation. Due to the variety of tower types, there are demands made on the creativity and mechanical abilities of the equipment installer. The information in this chapter is intended as a general guideline and not intended to cover all possible situations.

Specific requirements for proper functioning of the weather recording equipment are pointed out in the following sections of this chapter as well as in other chapters of this manual. Otherwise, the installer is free to view this chapter as generalized advice based on reasonable experience with tower installations.

It is recommended that you read the chapter on lightning protection before performing a tower installation. If lightning protection is an issue in your area, it will be helpful to be aware of the requirements and plan for them before installing the weather equipment.

Wear safety equipment such as a hard hat, gloves and climbing belt when working on towers!

WIND SENSORS AND ANTENNA

Detailed instructions on the assembly of wind sensor support arms are provided under Chapter 4 - Mast and Wind Sensor Installation. Wind sensors should be assembled as in Figure 5-1. The telemetry antenna is attached to the top of the mast extension . If you have telemetry, refer to the Telemetry Installation manual for this step.

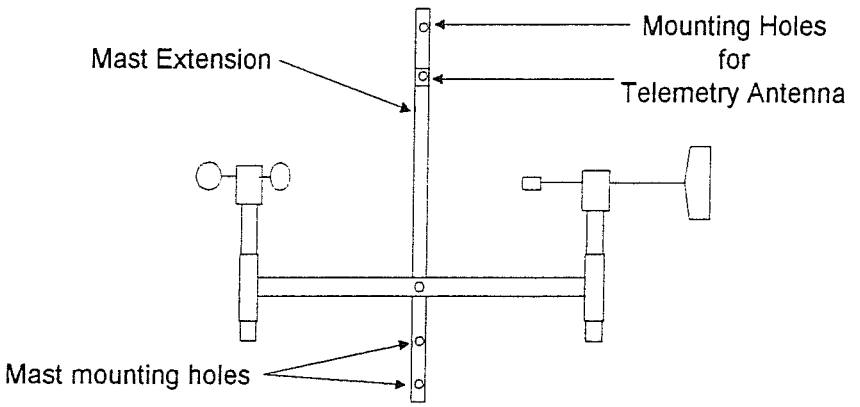


Figure 5-1

MOUNTING ON TOP OF TOWER

1. For tower-top mounting, a piece of 1.5 in. to 2 in. diameter galvanized pipe cut to about 30 inches long is required. This pipe "extension" must have two holes drilled close to one end. These 1/4 in. holes must have the same spacing as the mast mounting holes located at the bottom of the wind sensor mast extension. This pipe extension can be manufactured by the equipment installer, or purchased from FTS Forest Technology Systems.
2. Slide the mast extension down inside the pipe extension and bolt the wind sensor support assembly to the pipe using the bolts supplied with the mast extension. See Figure 5-2.

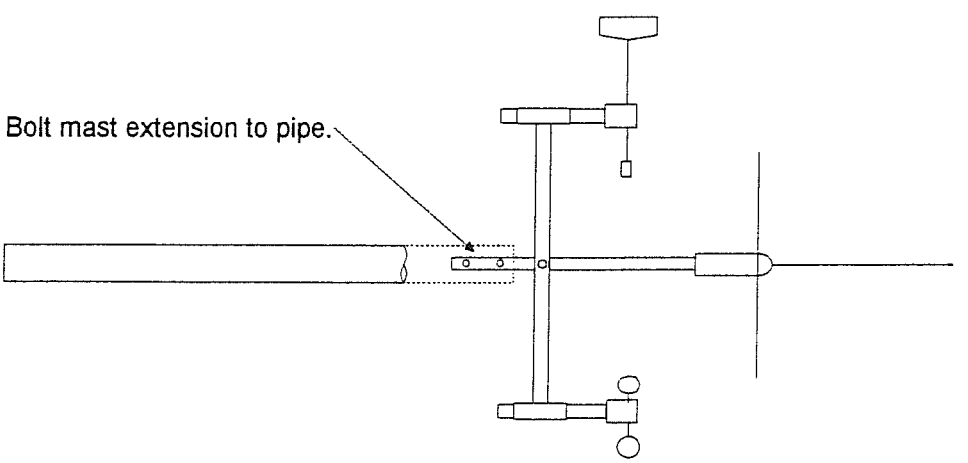


Figure 5-2

MOUNTING ON TOP OF TOWER

1. For tower-top mounting, a piece of 1.5 in. to 2 in. diameter galvanized pipe cut to about 30 inches long is required. This pipe "extension" must have two holes drilled close to one end. These 1/4 in. holes must have the same spacing as the mast mounting holes located at the bottom of the wind sensor mast extension. This pipe extension can be manufactured by the equipment installer, or purchased from FTS Forest Technology Systems.
2. Slide the mast extension down inside the pipe extension and bolt the wind sensor support assembly to the pipe using the bolts supplied with the mast extension. See Figure 5-3.

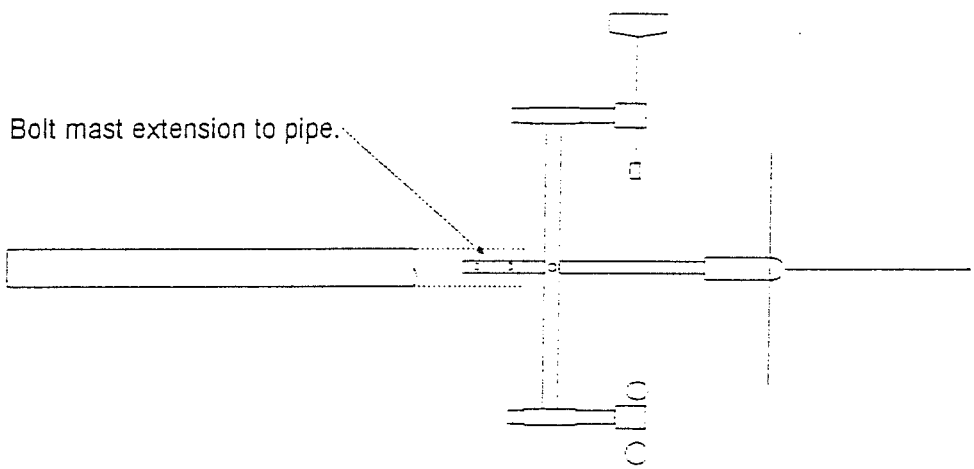


Figure 5-3

3. If you do not require a telemetry antenna, the recommended assembly configuration is shown in Figure 5-4. This configuration allows the mast extension to accept, or act as, a lightning rod.

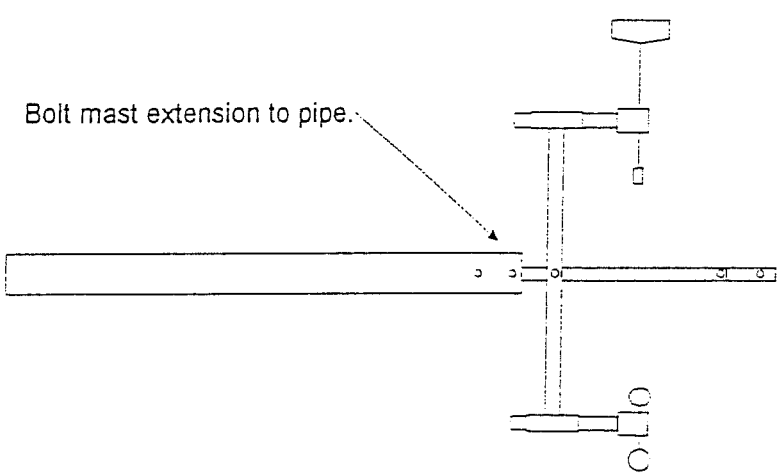


Figure 5-4

4. Most towers have a pair of collars or U-bolt clamps attached near the top. These are used to clamp the pipe extension into place. See Figure 5-5. If there are no collars for center mounting, the pipe extension can be attached to one of the tower legs with large stainless steel hose clamps.

5. Be sure to leave the pipe extension loosely but safely clamped until you can align the wind sensors correctly. Do this by turning the pipe extension until the north mark on the support arm is lined up to **True North**. You may require the help of someone using a compass and standing some distance from the tower.

The metal in the tower will affect the accuracy of a compass if you are standing too close. Get at least 30 feet away from the tower and any vehicles in the area in order to correctly align the wind sensors.

6. Finish by firmly clamping the pipe extension in place.

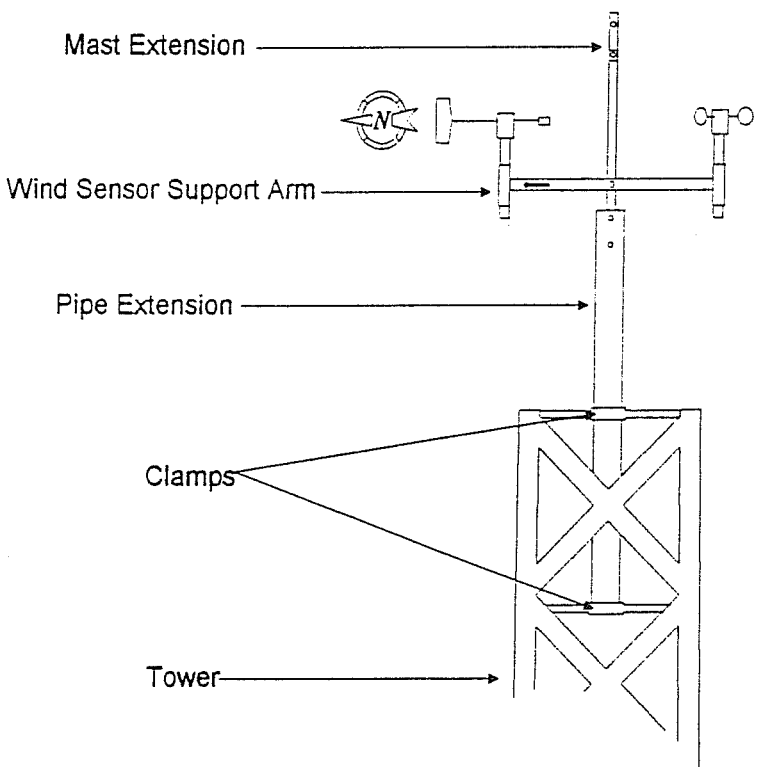


Figure 5-5

MOUNTING ON SIDE OF TOWER

On pre-existing towers of considerable height, it may be desirable to mount the wind sensors part of the way up as long as the sensor assembly is clear of interference from trees or other obstructions. This may require some creative metal work.

The only restriction is the need to ensure that the wind direction sensor can be properly oriented toward True North.

1. Use a pipe extension assembly similar to the one described in the section on tower top mounting. Although it is not critical, in this case the pipe can be shorter than 30 inches and the mast extension mounting holes can be closer to the middle of the pipe than the top. See Figure 5-6.

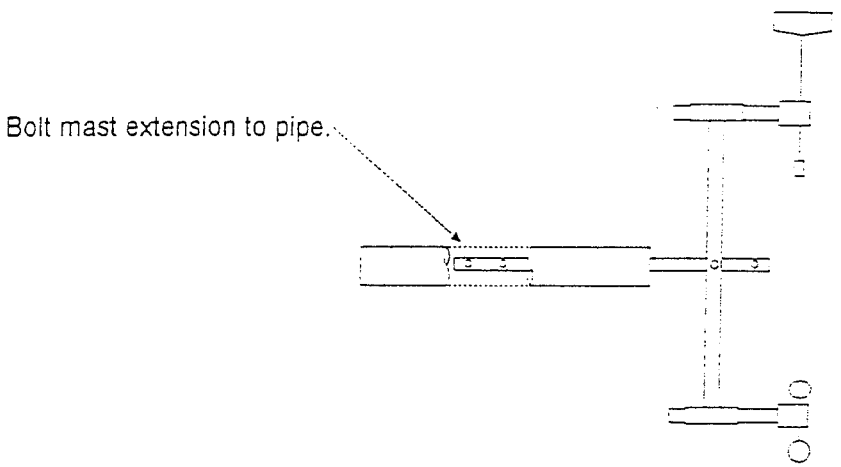


Figure 5-6

2. Use angle iron to fashion a support bracket that can be bolted to the legs of the tower. This assembly can be welded or bolted together, but should be made of galvanized metal. See Figure 5-7.

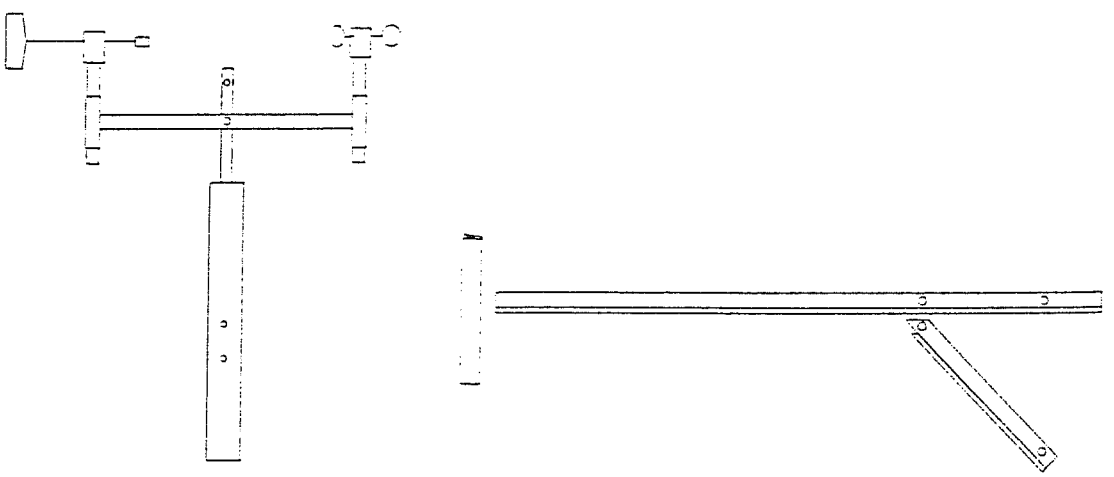


Figure 5-7

3. Construct the angle iron support bracket so that the pipe extension is about 4 feet from the tower. This should be sufficient more most towers. The general rule is to place the wind sensors twice the tower width away from the tower.

   Weld a vertical section of angle iron to the support bracket. The pipe extension can be clamped to this upright piece with either U-bolts or hose clamps. See Figure 5-8.

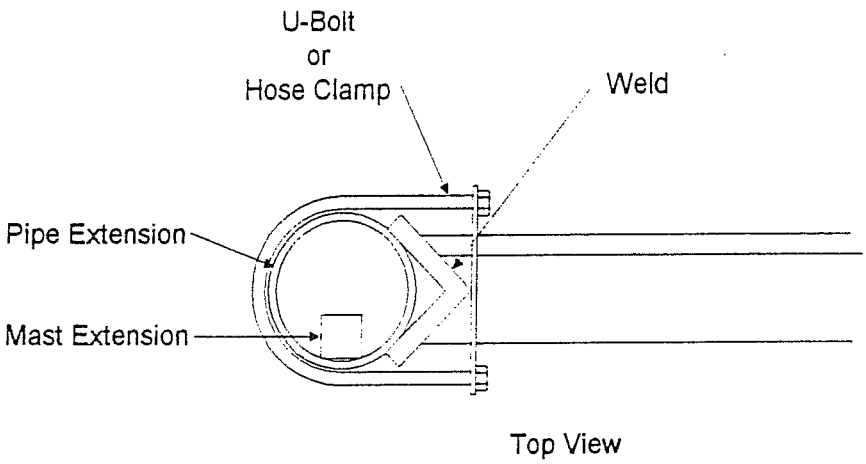


Figure 5-8

3. When the support bracket is assembled and the pipe extension and wind sensors are held in place, turn the wind sensor assembly so that it is correctly oriented toward True North. This may require the help of a person on the ground using a compass and standing some distance away from the tower.
4. Tighten the U-bolts or hose clamps firmly so that the wind sensors are held in alignment.
5. Attach the wind sensor cables and leave a drip loop below each sensor. Tape or tie wrap the cables to the support bracket and the tower. Figure 5-9 shows a completed assembly.

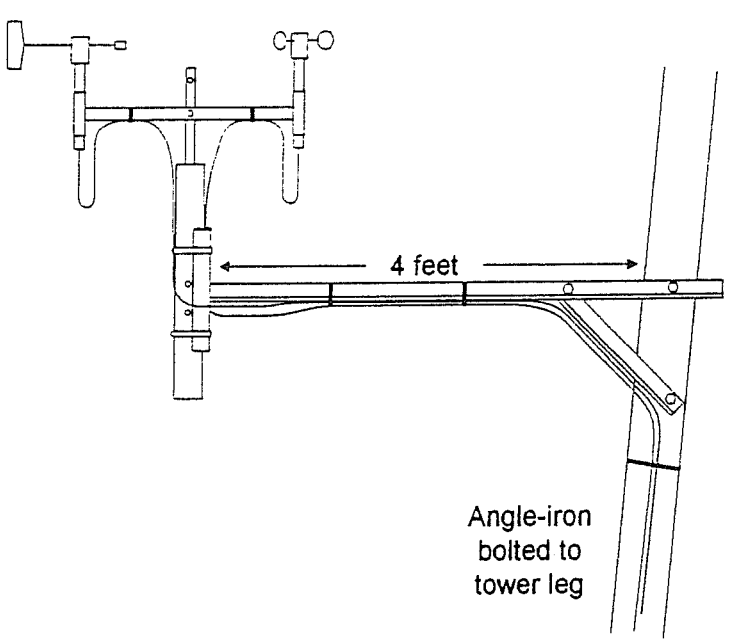


Figure 5-9

LIGHTNING ARRESTOR JUNCTION BOX

The LA-WD/WS lightning arrestor and junction box is designed to reduce the damage induced by lightning or heavy static charges to the wind sensors and cables. and the inputs of the weather data logger.

The lightning arrestor is typically installed under certain conditions:

- Heavy lightning or static discharge in the area.
- Very tall towers that would require custom cable lengths for the wind sensors.
- A requirement for long cable runs from the wind sensors to the weather data logger location, such as a nearby office.

1. The junction box is attached to the tower by means of the hose clamps provided, or through drilling holes in the tower legs and cross-members and bolting the box securely to it.
2. Typically, 25 or 35 foot cables are provided with the wind sensors. The cables for the wind sensors will require a drip loop directly below the wind sensor, then they must be securely taped or strapped to the sensor support arms. This means that the LA-WD/WS will be mounted fairly close to the wind sensor support arms.
3. The wind sensor cables are plugged into the military style connectors on the right side of the lightning arrestor. Take careful note of the number of pins on the lightning arrestor connectors and the wind sensor connectors and make sure they match up correctly. It is possible to unintentionally force these connectors together even when the pins do not line up.

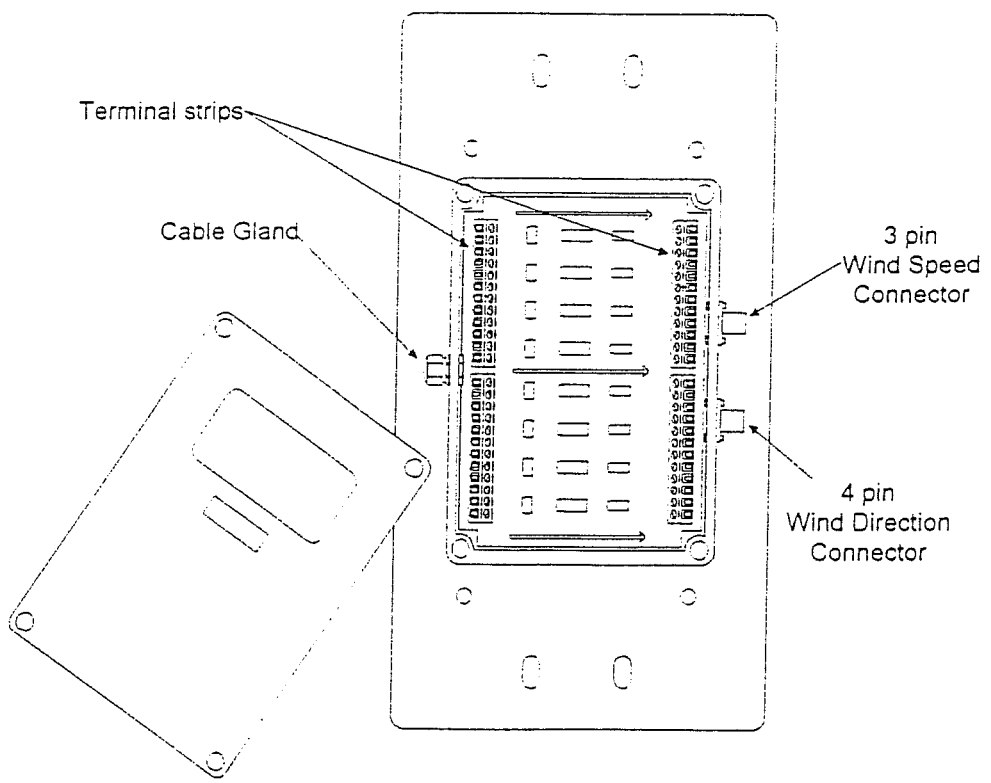


Figure 5-10

4. An additional custom length cable - without connectors - must be provided to run from the lightning arrestor to a simple junction box for connection to the FWS-11

data logger. This method is used whether the data logger is installed at the bottom of the tower or in a nearby location such as an office or an enclosure mounted on a post. The custom-length cable is fed into the cable gland on the left side of the lightning arrestor box (See Figure 5-10, above) and is attached to the terminal strips on the left.

5. Note carefully the letter designations of each wire coming from the wind sensor connectors. You will need to connect a wire from the custom length cable to a matching terminal on the left side. For example, if there is a green wire attached to location "B" on the right terminal strip, you must attach a green wire from the custom length cable to location "B" on the left side, and so on. Custom cables provided by FTS Forest Technology Systems will have matching colors to aid in installation. See Figure 5-11.

WRITE DOWN THE COLOR AND LOCATION OF THESE WIRES. You must make the corresponding attachments at the junction box at the other end.

6. Observe the arrows and notations on the circuit board of the lightning arrestor. The "IN" side is the side nearest the data logger, it is not the sensor input side. This may seem confusing until you consider that the sensor operating signals and voltages are provided *to* the sensors *from* the data logger.

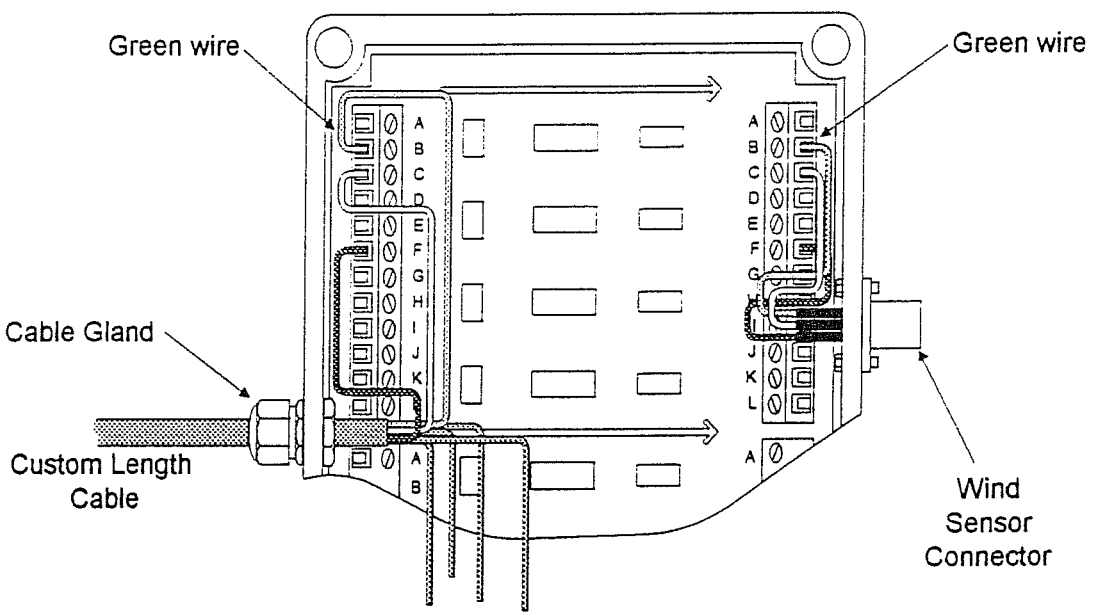


Figure 5-11

7. Run the custom cable down a tower leg. Tape or strap it every few feet.

8. Figure 5-12 shows an installation using two types of junction boxes, the lightning arrestor and a standard junction box. The custom cable must be run from the lightning arrestor into a standard junction box (containing terminal strips) that may be located near the data logger, or placed so that another long run of cable is routed to the data logger through underground pipes or through building walls. There are a sufficient number of terminal strip locations in the junction boxes to accommodate several other sensors in addition to the wind sensors. This provides flexibility in sensor and data logger placement.

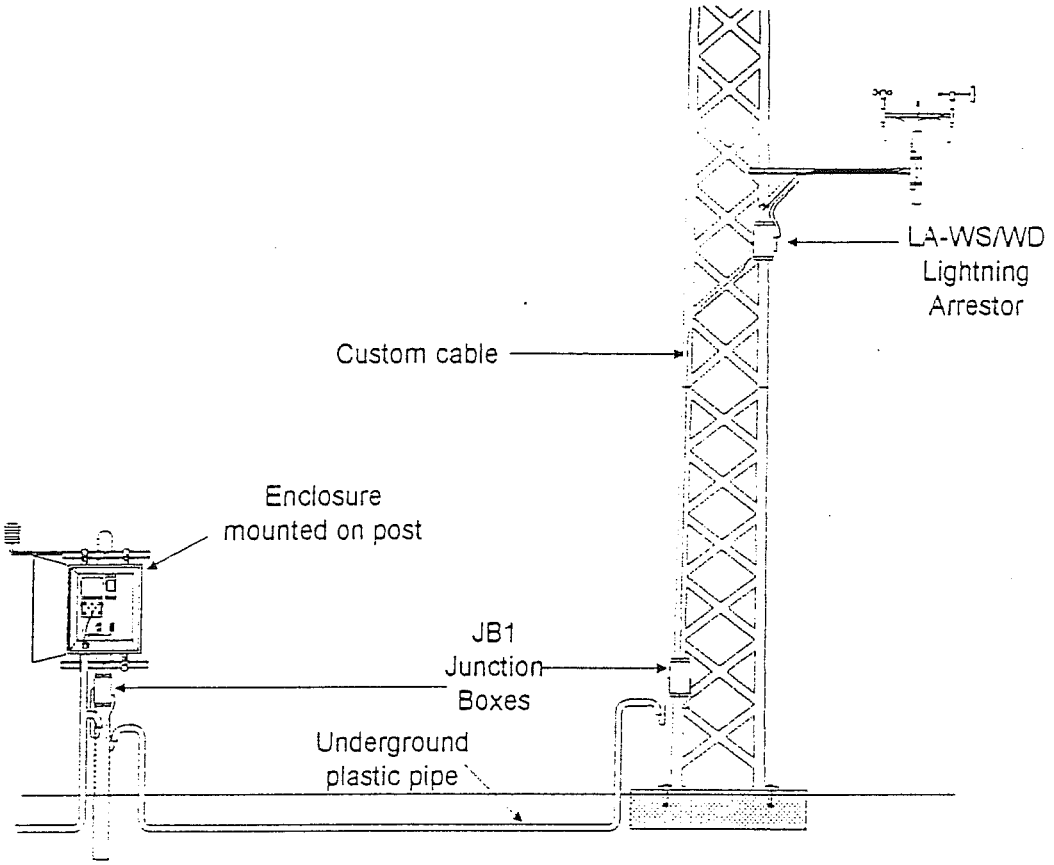


Figure 5-12

9. Provide drip loops where any cable enters or exits the junction boxes or lightning arrestor. In the above example, plastic pipe is used to route the cable underground. Provide drip loops at the entry and exit to this pipe, too.

10. Figure 5-13 shows a simple connection diagram for the LA-WS/WD lightning arrestor, custom length cable, and a standard junction box. The color-coding of the wires are typical of cables provided by FTS Forest Technology Systems.

    On the left of the diagram are boxes that represent the cables that have a connector to mate with the proper wind sensor on one end, and a connector to mate with the lightning arrestor on the other.

    Then there are the colored wires that run inside the lightning arrestor from the wind sensor connectors to the terminal strips marked with appropriate letters.

    The color code of the custom cable is in the center of the diagram. This cable enters the lightning arrestor and junction box through the black water tight cable glands.

    The standard junction box terminal strip is indicated on the right. The are no specific notations on this terminal strip, so any location can be used for any wire. Just make sure that the cables with connector to match the data logger (boxes at far right in the diagram) mate up with the correct colored wire from the custom cable.

11. It is often easier to visualize the connections if you lay all the pieces out on a convenient floor and familiarize yourself with them before assembly in the field.

12. Under low to moderate threat from lightning strikes, bolting the lightning arrestor junction box to the tower will provide a sufficient ground. However, if the lightning strike threat is fairly high, then a bare copper cable called a Downconductor must be attached to the lightning arrestor junction box and run down the tower to a ground. For more detailed information, see Chapter 8 - Lightning Protection.

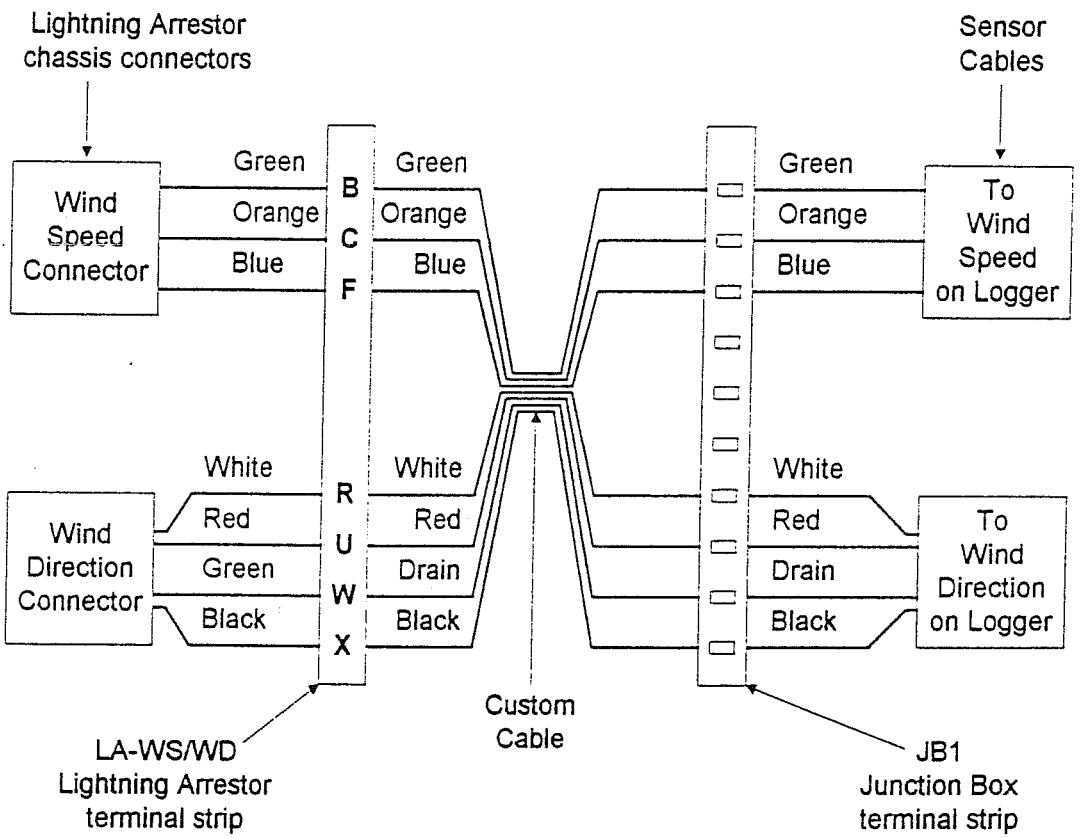


Figure 5-13

You may have an installation that uses AC power to run the equipment. In that case, it is not likely that a solar panel will be used. Skip this section and continue on to the section on the equipment enclosure.

The solar panel should be installed on the side of the tower that receives the most sunlight. Ideally, one face of a triangular tower should face due south (in the Northern Hemisphere) but if this is not the case, select the face that will maximize solar exposure to the panel or attach the panel to the south leg of the tower by using stainless steel hose clamps.

Set the panel as high on the tower as possible while still allowing the cable to reach down into the equipment enclosure with sufficient cable slack for a drip loop. If the site is surrounded by trees or buildings that produce unavoidable blocking of sunlight, observe the tower during the day and set the solar panel at a height that is shaded the least throughout the day.

Rectangular solar panels should be attached to the tower with the long axis aligned vertically. Attaching the solar panel directly to the face of the tower, without angling the panel upward, provides good support combined with good orientation for solar collection during the winter months. This vertical installation also prevents snow or frost buildup which could cover the solar panel and reduce or eliminate battery charging.

For tower installations, Forest Technology Systems provides the solar panel with a mounting system. This consists of the solar panel with the standard black anodized mounting brackets on the back at top and bottom. These mounting brackets come with large diameter hose clamps attached so that the solar panel can be mounted to a tower leg. If the solar panel is to be attached to the tower face, galvanized steel tower mounting rails are bolted to the mounting brackets. See Figure 5-14.

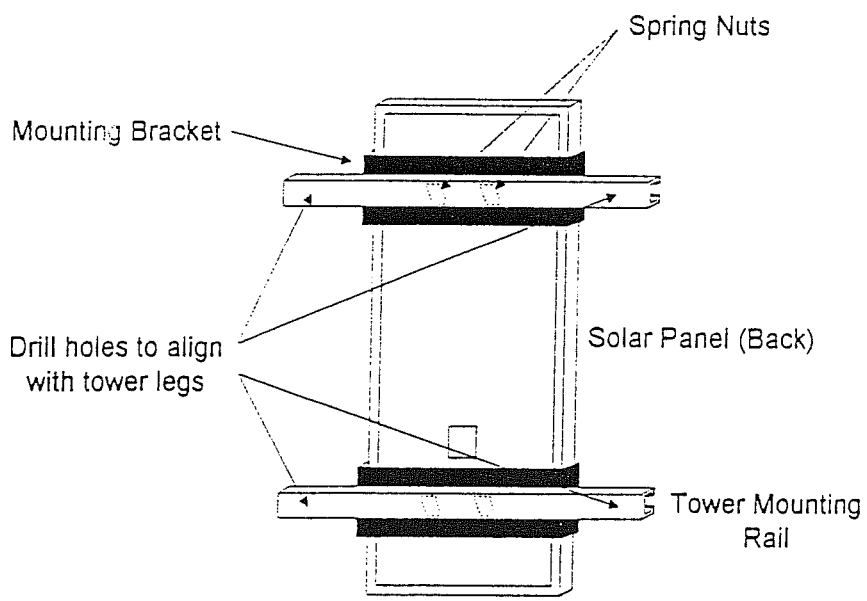


Figure 5-14

The optional tower mounting rails are attached to the mounting brackets by means of bolts and special spring nuts. The spring nuts snap into the tower mounting rails and allow side-to-side adjustment of the solar panel on the rails. Tighten the bolts threaded into the spring nuts to lock the panel in place. This tightening is important,

since wind can induce vibrations that may cause the bolts to loosen and produce conditions that may damage the solar panel.

To attach the solar panel assembly to the tower, you will have to drill matching holes in the tower mounting rails and the tower legs to accept bolts.

The cable should be taped or strapped to one leg of the tower down to the equipment enclosure where a drip loop should be allowed for. The solar panel is wired to the voltage regulator inside the equipment enclosure. Figure 5-15 shows the circuitry of a typical SPS-105-EXT solar charging system for use with a large deep-discharge battery. The section on the equipment enclosure also shows suggested physical placement of the voltage regulator and battery.

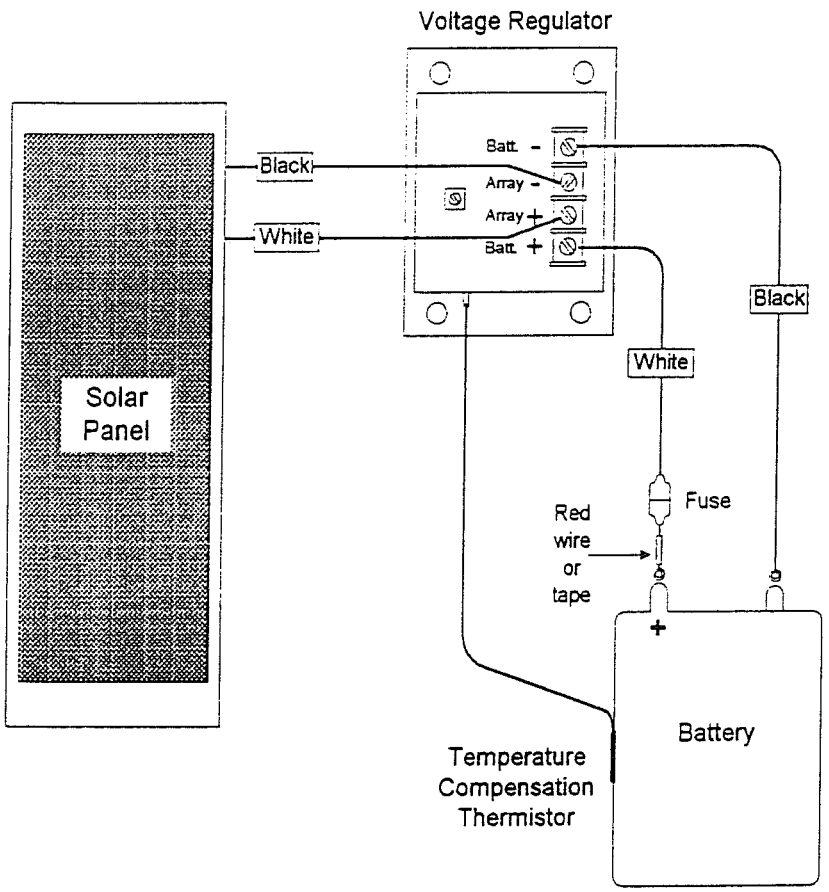


Figure 5-15

Note that in Figure 5-15, the wires are depicted as separate; this is only to provide clarity in the illustration. In an actual power system the black and white wires from the solar panel and the black and white wires from the regulator to the battery will be encased in individual cables.

The cable from the solar panel cannot be disconnected from the panel and is approximately 20 feet long. The cable to be connected from the regulator to the battery is about 3 feet long and has a fuse holder at the battery positive end. The battery end of this cable typically has color-coded wires that differ from the cable colors in that the positive wire is red rather than white.

There is also a wire that runs from one side of the voltage regulator and is terminated with a small, short piece of stiff black rod. This is a thermistor and its function is to help provide accurate charging current by monitoring the battery's temperature. This thermistor should be securely attached to the side of the battery with black electrician's tape, duct tape or putty. Whatever you use, be sure to periodically check that the thermistor is still in good contact with the battery. Try to avoid placing the thermistor in an area on the battery where it may receive incorrect readings, such as from contact with a freezing or sun-heated enclosure wall or door.

The fuse holder is opened by twisting it slightly and pulling it apart. The fuse is held by circular metal clips. The fuses used are 20 Amp and are identical in size and rating to the fuses in the fuse holder in RM4000 Radio Modem or TM telephone modem cables.

We suggest keeping a few spare fuses available, either in a tool kit that accompanies you to the site, or taped in an obvious location in the enclosure. The fuses are meant to break the power circuit in the event of an equipment short circuit, but they are also susceptible to eventual failure due to wide swings in temperature or exposure to shock. For instance, if the glass tube is cracked, the fuse will eventually fail.

If you replace a failed fuse and it fails again right away, do not replace it! It is time to perform some troubleshooting on the system to find out why it is drawing excessive current.

The equipment enclosure is a large rectangular aluminum box with a lockable door, rain shield over the door, and a back plate on which equipment can be mounted. There is large hole in the bottom for cables. This item can be purchased from FTS Forest Technology Systems, equipment enclosure manufacturers, or it can be custom built by the installer.

The enclosure provides protection from the elements. It is used when there is a need to keep data recording and/or communications equipment outdoors, such as on or near a tower. Equipment enclosures can be mounted in a variety of ways; suggested techniques include mounting on the tower, or on wooden or metal posts in a convenient location. Special mounting locations for the enclosure can be achieved by using custom cable lengths and junction boxes.

The equipment enclosure, ordered from FTS Forest Technology Systems as part of a complete site, arrives with adjustable mounting rails attached to the back. These rails consist of two pieces of metal channel attached vertically to the mounting lugs of the enclosure, and two pieces of the same channel material attached horizontally to the vertical pieces. See Figure 5-16.

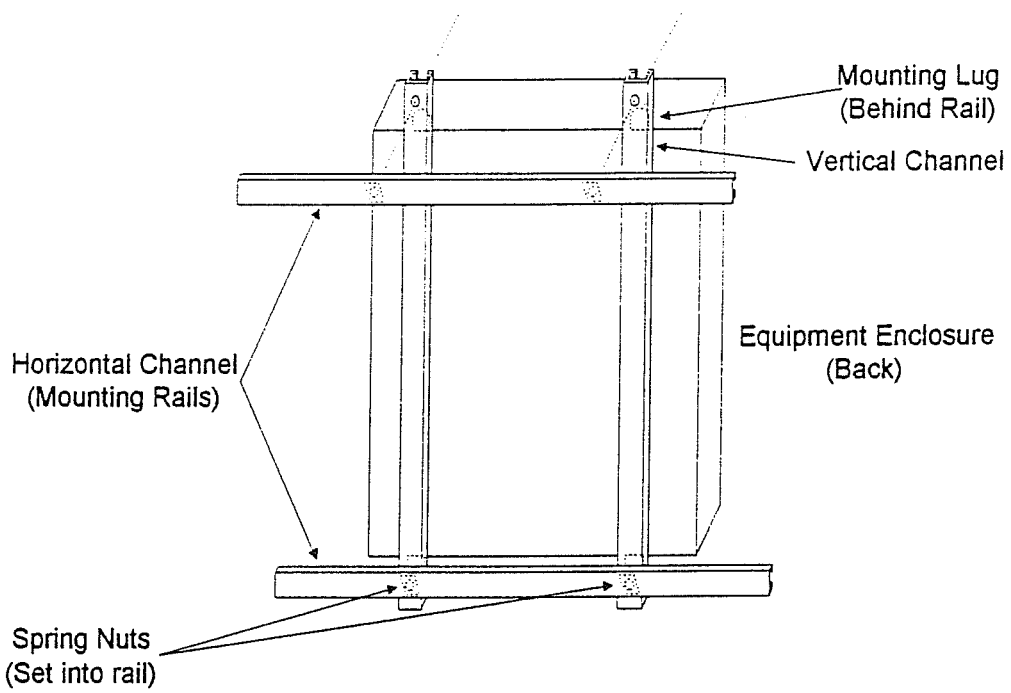


Figure 5-16

The horizontal channel pieces, or mounting rails, are intended to be drilled and bolted to the tower or post and are connected to the vertical channel rails with bolts and special spring nuts that allow side-to-side alignment of the enclosure. A detailed view of this mounting method and the spring nuts is shown in Figure 5-17.

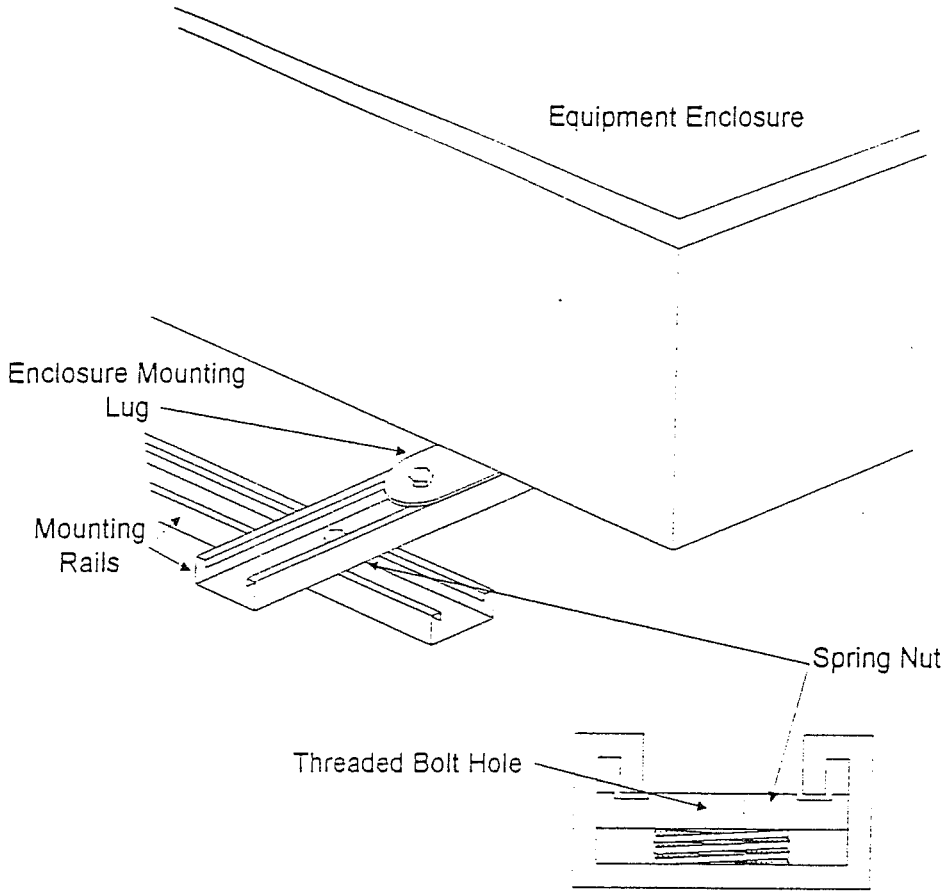


Figure 5-17

The spring nut is designed to fit into the channel loosely enough to slide without falling out. Its trapezoidal shape and the spring underneath it hold it in place sufficiently to allow movement. Tightening the bolt that is threaded through its center pulls it to the edge of the channel where it clamps firmly in place. Always tighten the bolts to the spring nuts securely so that vibrations induced by wind do not cause the bolts to loosen and allow damage to the equipment.

TOWER MOUNTING THE ENCLOSURE

1. Establish a convenient height for mounting the enclosure on the tower. Remember that there are considerations beside easy access to the interior.

It is often advantageous to attach the Temperature and Humidity sensor support arm to the top rail or back of the enclosure. The height and orientation of the T/H sensor is important to the accuracy of your readings and this will affect the height and location of an enclosure used as a platform. See the section in this chapter on T/H sensor mounting for specifics.

The solar panel and fuel stick are both mounted on the south side of a tower and may interfere with enclosure access. Thus another side of the tower should be selected for enclosure mounting.

2. Use a tape measure to ensure that the horizontal mounting rails on the enclosure are long enough to reach the tower legs at the desired enclosure height.
3. Use a carpenter's level or tape measure to mark a hole location on each tower leg for the **top** enclosure mounting rail. Drill a bolt hole in each tower leg.
4. Slide a bolt through each hole with the threaded end facing out. Use bolts that are no smaller than 1/4 inch diameter and long enough to go through the tower leg and the enclosure mounting rail, and to take two lock washers and two nuts.
5. Install a lock washer and a nut. Tighten the nut securely.
6. Measure the distance between the bolts on the tower legs and drill holes with this spacing in the top mounting rail of the equipment enclosure.
7. Hang the enclosure by sliding the top mounting rail onto the bolts protruding from the tower legs. Install lock washers and nuts.
8. The bolt holes for the bottom of the enclosure can be drilled through the mounting rail and the tower leg.
9. Install the bolts and sets of lock washers and nuts.
10. If the enclosure is not laterally positioned to your satisfaction, make sure the bolts holding the vertical rails to the horizontal mounting rails are slacked off enough to allow the spring nuts to slide back and forth. Position the enclosure - this may require a very energetic person - and tighten the bolts to lock the enclosure in place. Figure 5-18 shows enclosure tower mounting details.

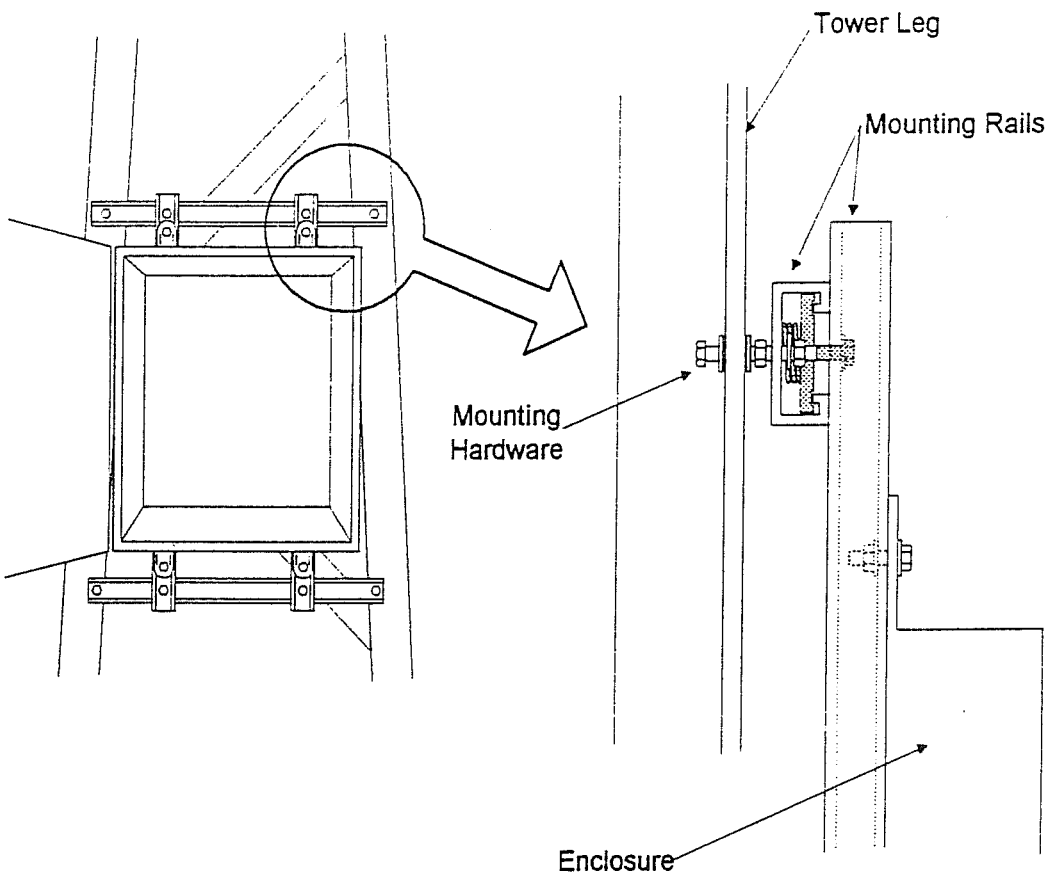


Figure 5-18

POST MOUNTING THE ENCLOSURE

It is sometimes desirable to mount the equipment enclosure some distance from the tower. The mounting is simple, but this method requires some pre-planning. Custom cable lengths will be needed for the sensors mounted on the tower as well as some junction boxes. A method such as buried conduit to protect the cables running between the tower and equipment enclosure will also be needed. See the section on the Lightning Arrestor junction box for ideas on interconnection methods.

You can use either a wooden or metal post. Wooden posts should not be smaller than 4 by 4 inches, with a 6 by 6 inch post preferred. Metal posts should be no less than 4 inches in diameter.

1. Post height above ground will be determined by the most comfortable height for access to the enclosure and whether the Temperature or Humidity sensor is to be attached to the enclosure or post at this location. For further information on T/H sensor height considerations, see the section on mounting the Temperature/ Humidity sensor in this chapter. Post depth below ground should ideally be 3 feet. Wooden posts should be painted with a wood preservative and be set on a few inches of gravel. Metal posts should be galvanized or painted.
2. Drill a hole at the centers of the top and bottom equipment enclosure mounting rails.
3. Measure the distance between the centers of the holes just drilled. This should be done at each installation due to minor variations in construction of each unit.
4. Wooden posts can be drilled through from the back with long bolts threaded through, but using lag bolts screwed in from the front is an easier method. On a metal post, holes must be drilled to match the measurement between the holes on the top and bottom mounting rails. Bolts must be threaded through from the other side of the post and kept in place with nuts and washers.
5. Wooden posts should have the top cut at an angle to encourage moisture to run off, metal posts should be capped or filled.

   Install and bury the *sealed* plastic or metal conduit used to protect sensor cables and any power or telephone cables, if used. The smallest pipe that can be conveniently used is 1.5 inch diameter material, depending on the number of cables to be run.

   Install "U" junctions at the ends so that the pipe points toward the ground. This keeps rain from filling the pipe .
6. Once the post has been prepared, place it in its hole. Use a carpenter's level to make sure the post vertical. Backfill the hole. Pouring concrete into the post hole is not absolutely necessary to provide support, but provides a more durable site.
7. Lag bolt the enclosure in place, or hang it on the bolts protruding through from the other side of the post and secure it with nuts and washers.

In Figure 5-19 there are examples of variations in post mounting methods. Don't forget that there may be useful posts already available, or other mounting locations such as building or shed walls that can be used if they are close to the desired position.

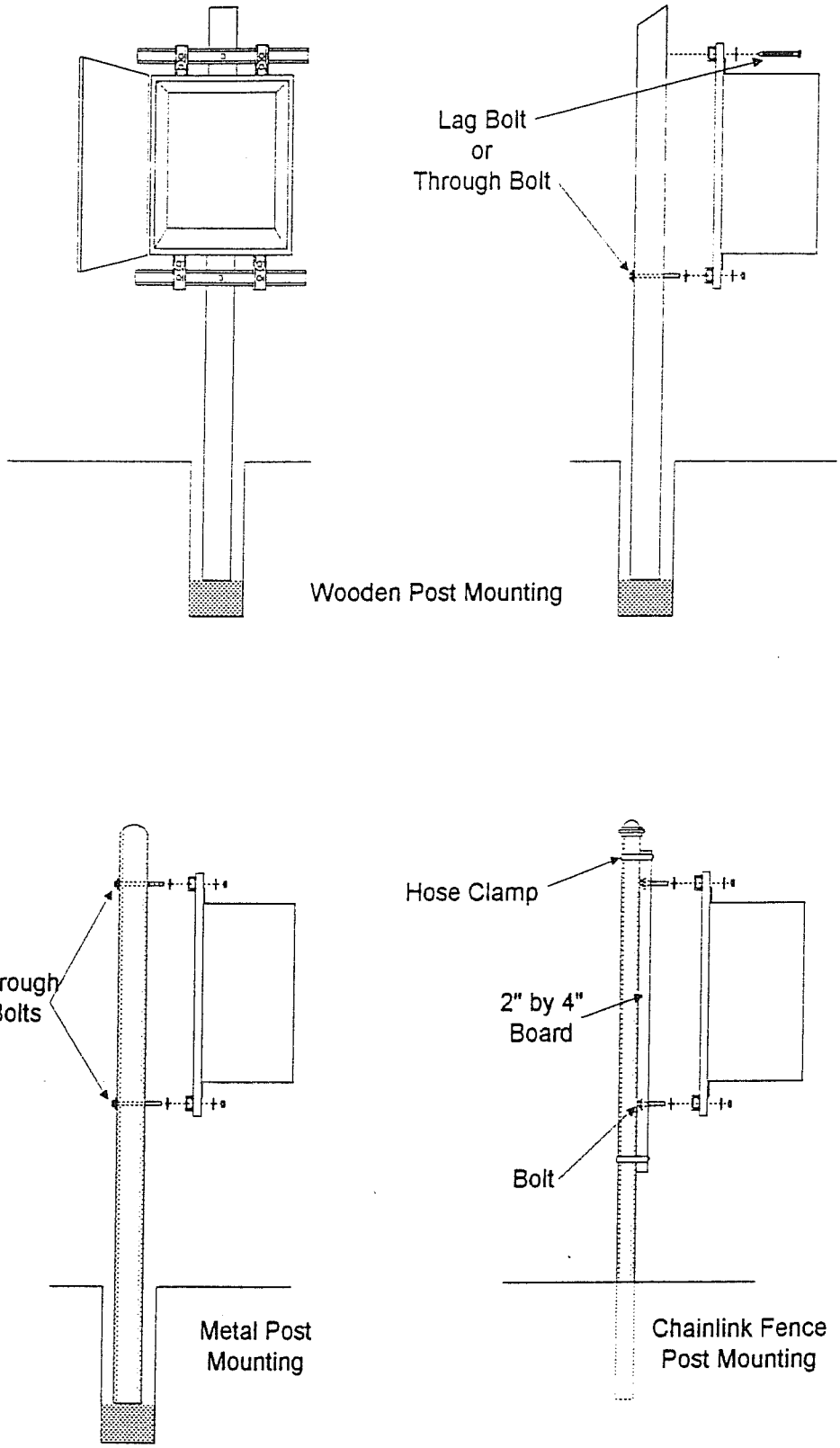

Lag Bolt
or
Through Bolt
Wooden Post Mounting
Through
Bolts
Metal Post
Mounting
Hose Clamp
2" by 4"
Board
Bolt
Chainlink Fence
Post Mounting

Figure 5-19

Inside the equipment enclosure, mounted to the back wall, is a sheet of aluminum. This backplate is attached to the enclosure by bolts in the corners and can be removed. The data recording and telemetry equipment is mounted on this backplate either by self-tapping machine screws or larger screws or bolts passed through from the back.

FTS Forest Technology Systems pre-drills the backplate to prepare it for most equipment variations. Figure 5-20 shows the generic layout with the locations for equipment and the pre-drilled mounting holes. You will not necessarily have - or need - all the equipment shown in the diagram or described below.

The specific mounting brackets for the data logger module and battery module will usually be already installed and the units need only be hung in place and the mounting screws tightened. The RM4000 Radio Modem is mounted with machine screws passing through mounting holes in each corner. These holes are accessible by removing the lid of the unit. The TM Telephone Modem has its own backplate which slides onto bolts installed from behind the equipment enclosure backplate. The Cellular Transceiver (if used) will come with a bracket that is mounted over the unit and held in place on the backplate with machine screws. Mounting the solar voltage regulator requires only that the machine screws are passed through the built in mounting flange and screwed into the backplate.

Note that the Radio Modem and Cellular Transceiver seem to occupy the same location. In fact, a site would usually require only one or the other.

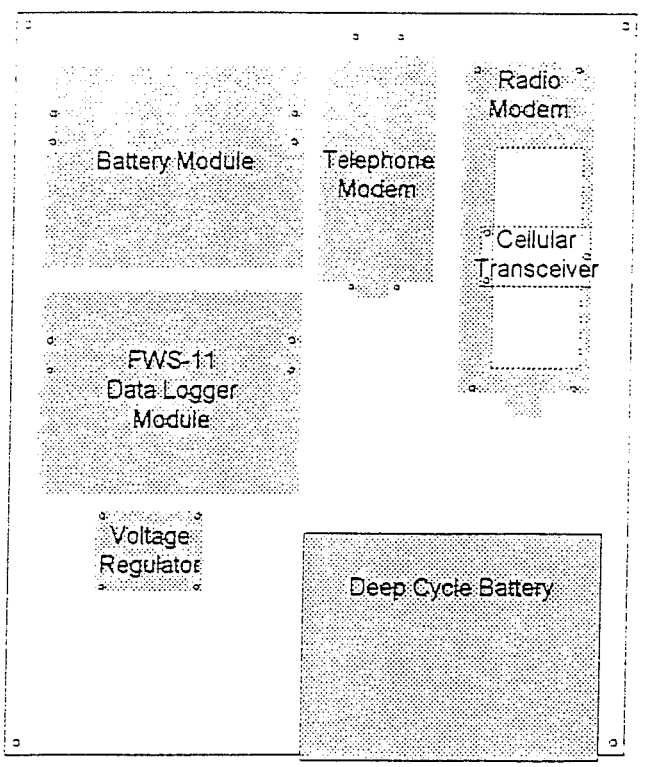


Figure 5-20

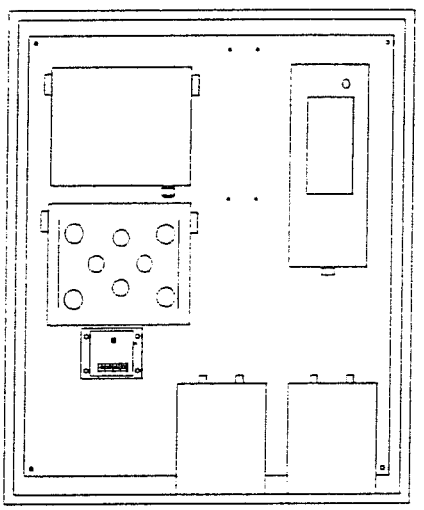
The deep cycle battery is included in Figure 5-20, but is not attached to the backplate. It is shown to demonstrate the relative size and positions of the equipment commonly stored inside the enclosure. The enclosure is deep enough for

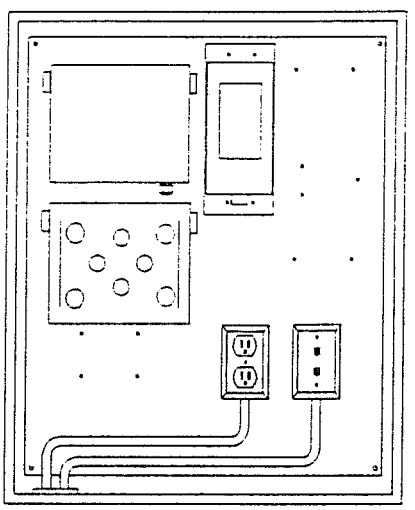
the battery to be turned 90 degrees and placed with its long axis from front to back. This provides room for two batteries if needed for extra capacity.

If the battery is not required, this location provides sufficient room to attach electrical boxes for AC power and a telephone jack to the enclosure backplate.

There can be wide variation in the equipment layout inside the enclosure. The layout and equipment requirements depend on the needs of each specific site. Rather than cover all possible options, Figure 5-21 shows three examples of equipment layout. Implicit in each example are different requirements for power or communications.

Remote weather site with solar power and dual batteries for frequent calls. Site accessed by RM 4000 radio telemetry.





Weather site with AC power and telephone line installed. Site accessed by TM telephone modem.

Weather site with AC power. Cellular transceiver with TM telephone modem for communications.
Note cellular antenna on top of enclosure.

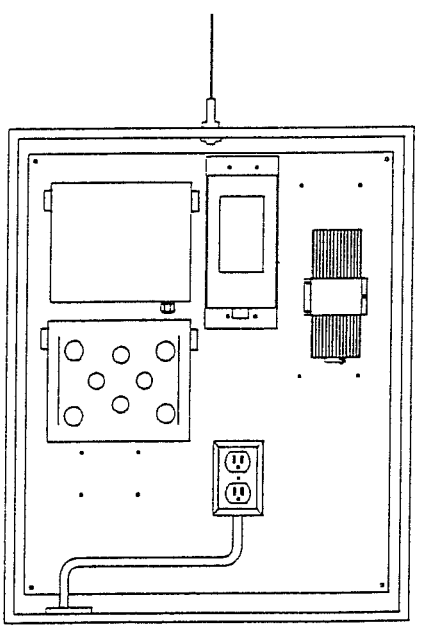


Figure 5-21

An ideal installation places the Temperature/Humidity sensor between 3 - 4 feet (1 to 1.3 M) off the ground in Canada, and between 6 to 8 feet off the ground in the United States. Both standards recommend installation on the south side of the tower, or the side that provides the best exposure to the prevailing winds at each site. Note that permanent installations in areas where the snowfall can exceed the normal installation height will require an alternative mounting method - such as higher on the mast - to prevent data loss during this period.

You must establish the correct placement height for the sensor according to your region's weather codes. This will determine the most feasible mounting method.

Here are some options. Note that the installed height of an equipment enclosure also influences the choice of mounting methods.

T/H - ENCLOSURE RAIL MOUNTING

In the United States the Temperature/Humidity sensor should be between 6 and 8 feet off the ground. If you install the equipment enclosure so that the top is 6 feet from the ground, the equipment inside is still easily accessible and at about eye-level. The T/H sensor arm will be attached to the top enclosure mounting rail.

In Canada, install the enclosure so the bottom of the enclosure is at just under 4 feet from the ground. The equipment inside should still be easily accessible and at about eye-level. The T/H sensor arm will be attached to the bottom enclosure mounting rail.

FTS Forest Technology Systems can provide a THS-1 support arm that is longer than the standard version and it can be used to place the sensor farther away from the tower. This long arm can be attached to the top or bottom mounting rail of the equipment enclosure with hose clamps or bolts. The sensor should be placed on the south side of the installation. See Figure 5-22.

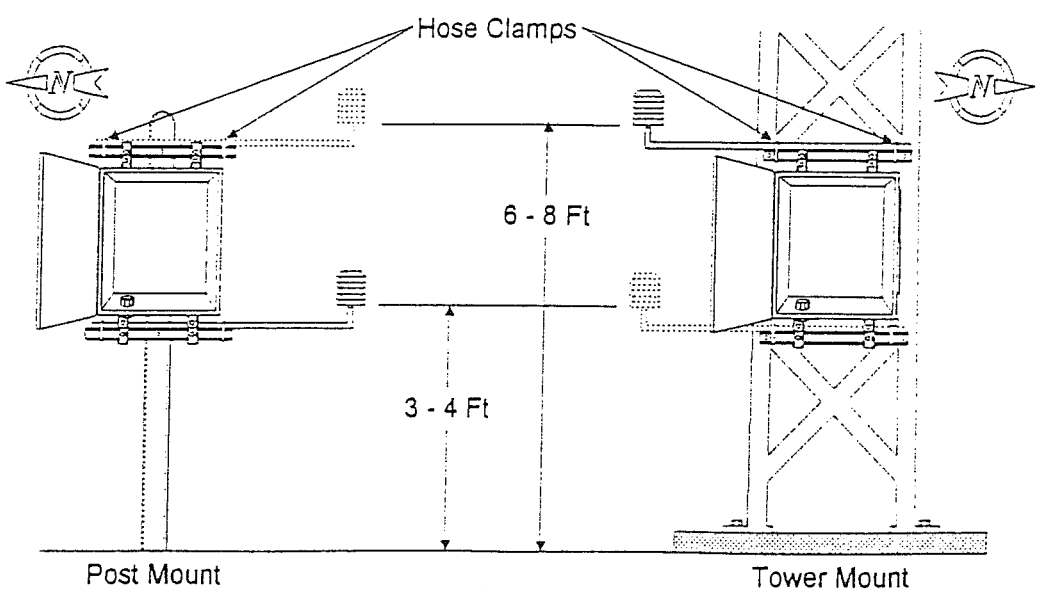


Figure 5-22

T/H - ENCLOSURE SIDE MOUNTING

For mounting of the sensor to the enclosure itself, the standard length support arm can be used. This option usually works best for T/H sensors mounted at the 3 - 4 foot height.

Holes are drilled through the equipment enclosure to match the bolt holes in the support arm. The arm is then bolted to the back or side of the enclosure.

On tower installations, the equipment enclosure should be slid along the mounting rails so that one side clears the tower leg. Mount the T/H sensor to this side of the enclosure so that the sensor arm is directed back, away from interfering with the enclosure door or latch. See Figure 5-23.

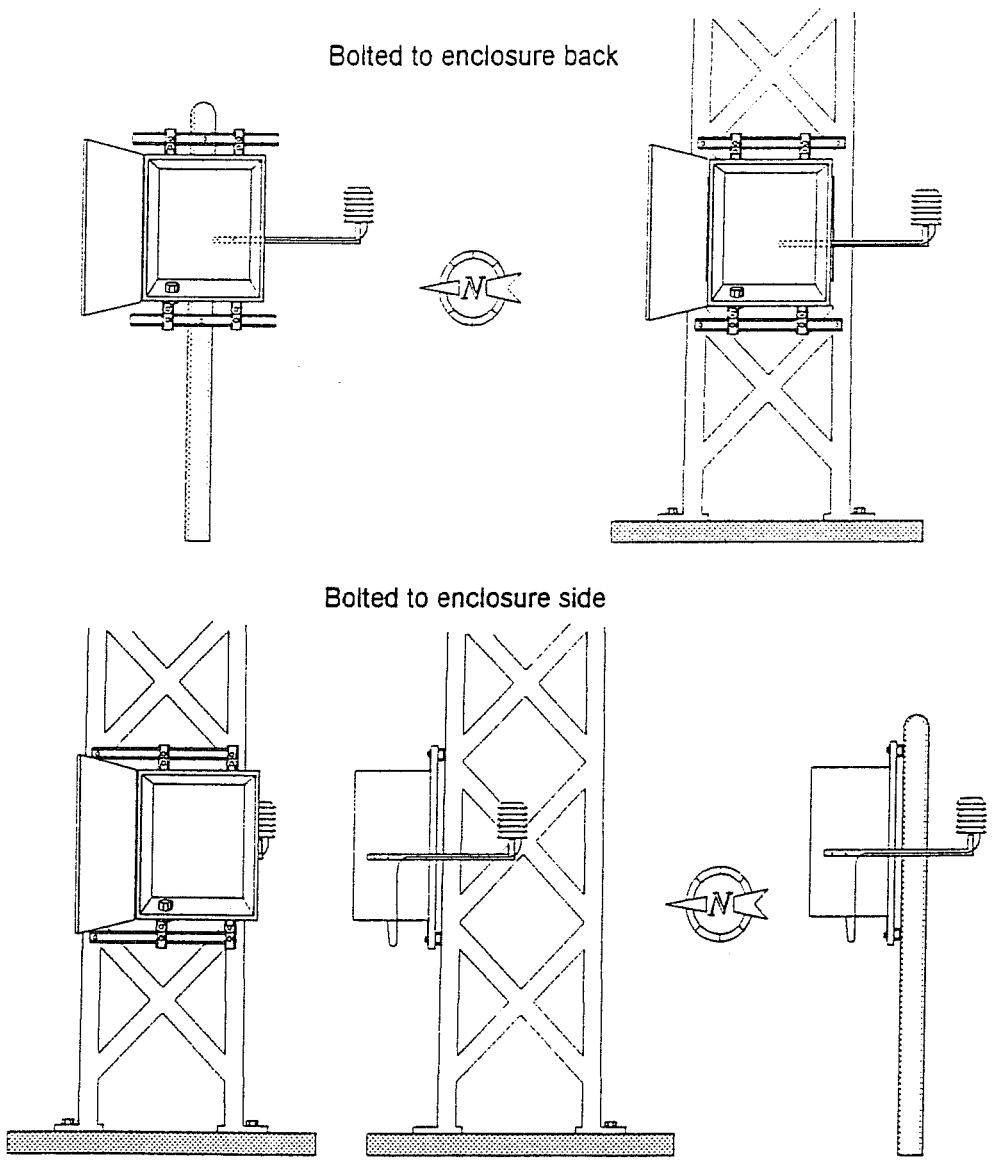


Figure 5-23

If the correct orientation of the sensor cannot be achieved by mounting it to the enclosure, it must be attached to the tower. Use the long version of the support arm and drill holes in the tower legs to match the mounting holes in the support arm. Make sure the arm is level. Attach the arm securely with bolts. See Figure 5-24. This method can be used to mount the sensor at any height required without depending on the enclosure placement.

This option can also be used when the sensor is mounted on the tower with other sensors and the data logger and other equipment are located in an enclosure mounted elsewhere. Junction boxes would be required with this method.

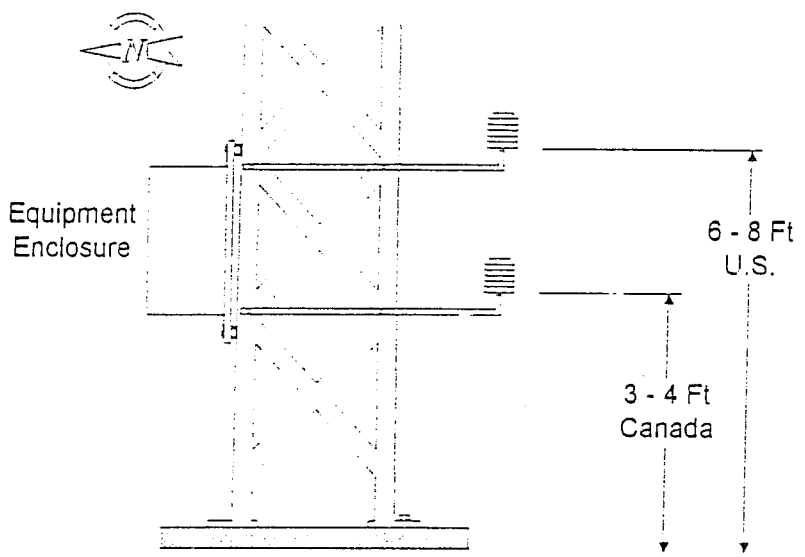


Figure 5-24

The Fuel Temperature/Fuel Moisture sensor is best situated on the south side of your mast or tower where it can take advantage of the effects of solar heating without obstruction. The sensor should be installed 10 - 12 inches (30 cm) above the fuel bed representative of local fuels.

If a natural fuel bed is to be used, care must be taken by the installers of the site so as not to destroy the local material. If representative fuel is not available nearby, then a fuel bed must be constructed and placed correctly as part of the site installation.

The Fuel Stick sensor is attached to a short support arm by means of a hose clamp. This support arm can be bolted to the leg of a tower by drilling holes through the leg to match the bolt holes in the support arm. See Figure 5-25.

Make sure that the sensor will be installed at the correct height for your application. A fuel bed can be placed under the sensor at the foot of the tower leg.

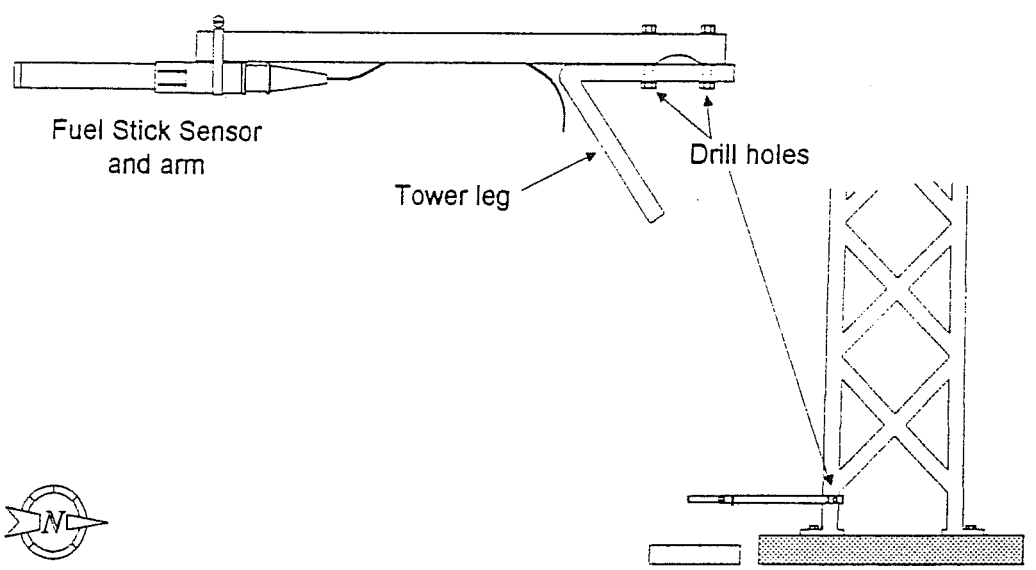


Figure 5-25

Another option is to mount the Fuel Stick sensor on a short length of pipe set vertically in the ground. This pipe should not have an outside diameter greater than 1.75 inches and should be long enough to be solidly embedded in the ground and allow the sensor to be 12 inches off the ground.

The pipe can be placed close to the base of the tower or near an equipment enclosure mounted on a post as long as the cable will reach the data logger. This method allows the sensor to read undisturbed fuel if it is close by. A tray of representative fuel can be placed beneath the sensor.

Clamp the Fuel Stick sensor support arm to this pipe with the U-Bolt supplied with the arm. Slide the support arm to the desired height and tighten the nuts.

Attach the sensor to the end of the support arm with the included hose clamp See Figure 5-26.

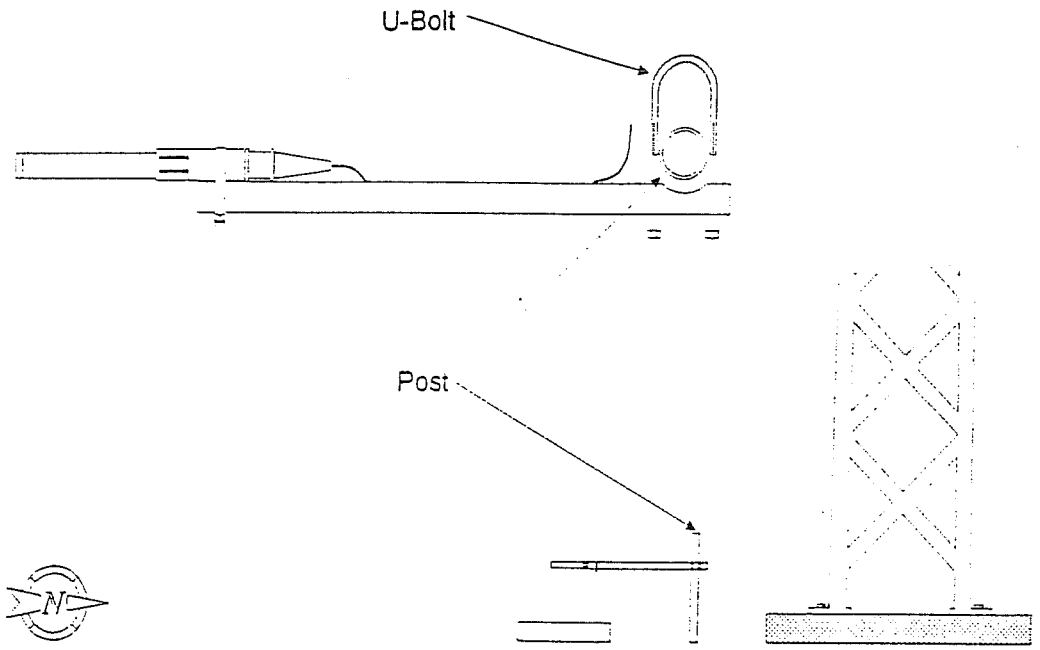


Figure 5-26

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6. CELLULAR TRANSCEIVER

OVERVIEW

The cellular transceiver or "Brick" is a simplified version of a cellular telephone. It is lacking the key pad and LCD readout, but is an otherwise complete cellular transmitter and receiver.

This device can be used in weather site installations where there is cellular coverage available, but providing a telephone wireline would be costly or inconvenient. Typically, these sites are solar powered since providing an AC power line also presents difficulties.

On the side of the transceiver is a telephone industry-standard RJ11 jack identical to the modular jack you would find on the wall at home. You can, for example, plug a telephone, FAX machine, or computer with a modem into the transceiver RJ11 jack and use this equipment as you normally would. At a weather site the TM telephone modem is plugged into the transceiver and operates as it would when connected to a regular wireline.

The circular connector at one end of the transceiver is an antenna coaxial lead connector. A standard cellular telephone trunk-mount antenna is installed in a convenient location, usually on the top of the equipment enclosure housing the transceiver. For weak signal fringe areas a directional antenna can be installed instead.

The DB25 "computer-style" connector is used as the power input connector in field installations. This is also the programming connector for use with the Motorola Programming Kit. Programming and keypad-style call dialing can also be achieved with an optional handset that plugs into an 8-pin connector covered with a rubber seal. This plug is next to the RJ11 jack. See Figure 6-1.

The cellular transceiver memory is programmed with its assigned telephone number and other essential information, either by the manufacturer's service center, FTS Forest Technology Systems, or by you if you have purchased a Programming Kit or handset. The programming of the transceiver is outside the scope of this manual since there are different models with different requirements available. Refer to the manual that arrived with the transceiver for detailed information on programming.

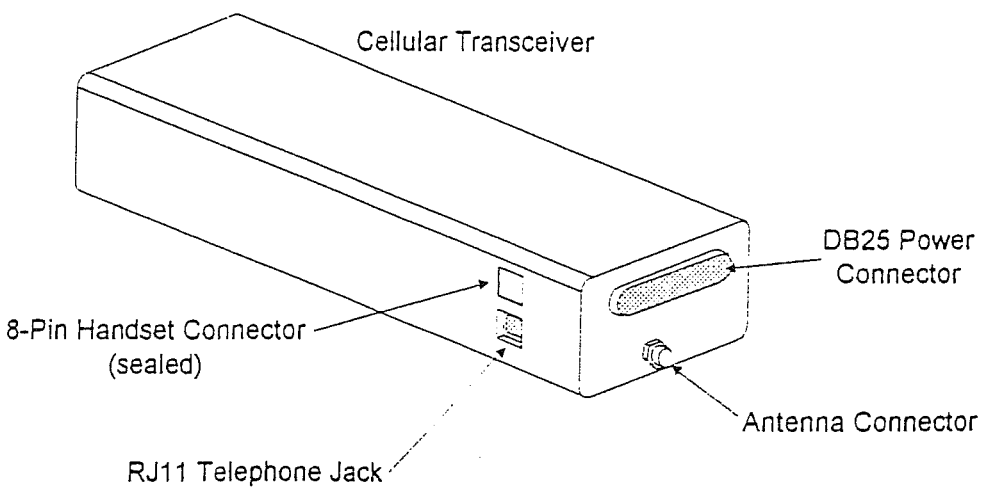

Figure 6-1

Usually the cellular transceiver's bracket will be installed in an equipment enclosure already. The transceiver is shipped in a padded box. Check the mounting procedure below. It varies slightly from the manufacturer's procedure.

There are pads and a rectangular mounting bracket included with the transceiver. The enclosure provided by FTS Forest Technology Systems has a backplate already drilled to take sheet metal screws in the correct alignment for this bracket.

1. Apply the pads to the inside of the mounting bracket where they will buffer the transceiver.
2. Start a sheet metal screw in the single hole on the right side of the mounting bracket, and one of the pair of screws on the left side. Leave them backed well out so that the bracket can be moved.
3. Slide the transceiver up under the bracket so that the transceiver case is being held approximately in the middle.
4. The transceiver should be oriented with the connectors facing downward to prevent any condensation from entering them. The RJ11 jack should be on the left, closest to the TM telephone modem. See Figure 6-2

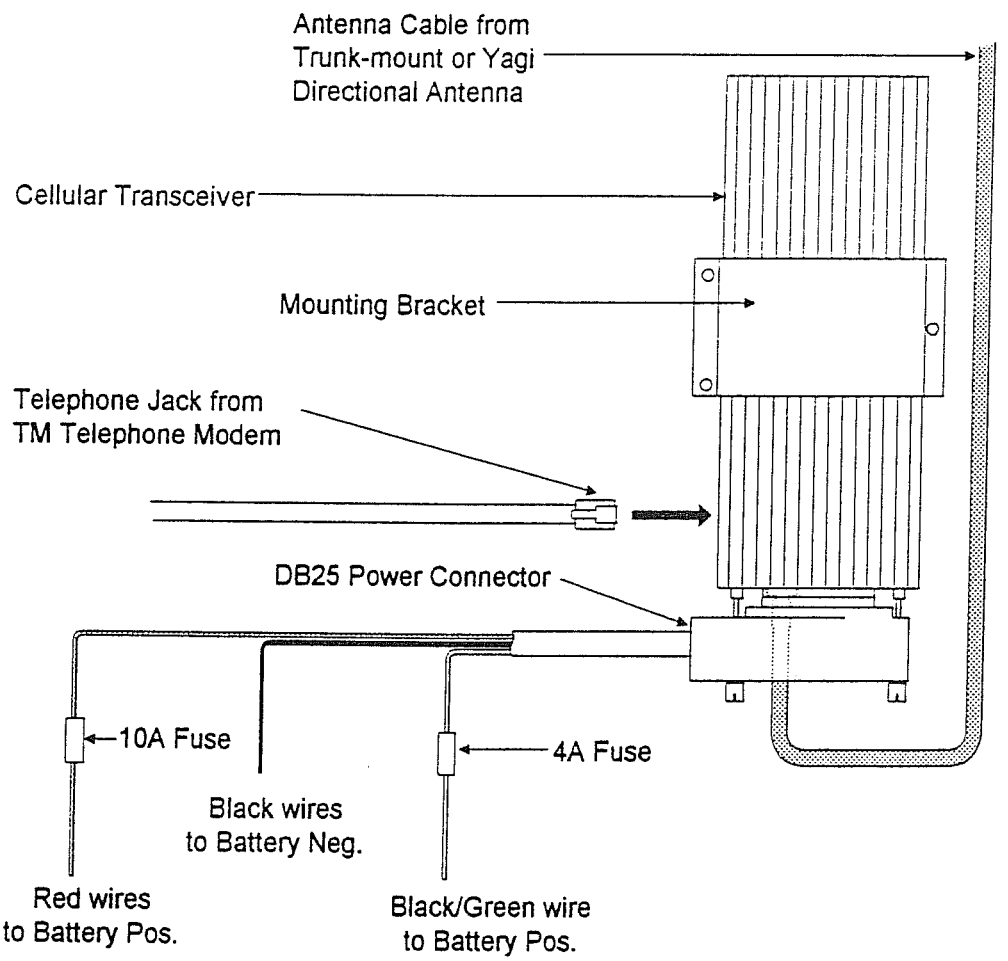

Figure 6- 2

NOTE: The transceiver manufacturer recommends that the side of the transceiver case closest to the antenna jack - the "hot" side - be left facing outward to help cool the unit, and that the rubber pads are applied to both sides to reduce vibration.

HOWEVER, since this is not an automotive installation, we recommend that no pads be used *under* the unit and that the "hot" side is placed in full contact with the enclosure backplate so that the backplate can function as a large heatsink.

5. Tighten the sheet metal screws until the transceiver is held firmly in place.
6. Attach the antenna cable and the telephone cable from the TM telephone modem to their proper connections.

   The RJ11 jack is recessed well into the transceiver case in order to prevent its accidental disconnection. This means that in order to remove this connector for any reason, you will have to use a small screwdriver or pencil tip to release the small tab on the connector before pulling the cable out.

Next to the RJ11 telephone jack is a small rubber plug. This covers an 8-pin connector used *only* for an optional handset. If you do not have this handset, do not remove the rubber plug. There are small voltages present on the pins and moisture intrusion can possibly cause malfunctions.

5. Connect the DB25 power cable. ALWAYS CONNECT THE POWER CABLE LAST!

MANUFACTURER'S PARTS

The cellular transceiver and some components described in this section are manufactured by Motorola. Included is a list of those parts and their Motorola part number.

- Cellular Transceiver #S3453A
- Mounting Bracket #SLN4103A
- DB25 Power Connector #SKN4302A
- 4 Amp Fuse and wire package #SKN4370A

CAUTIONS

Cellular telephones or transceivers are actually radio devices. Even a unit on standby will reply to a call with an acknowledgment. This acknowledgment is a short burst of radio frequency.

If there is any BLASTING or use of BLASTING CAPS in the area you must completely POWER DOWN THE TRANSCEIVER until the area is safe! Remove the wide black DB25 connector on the bottom of the transceiver to do so.

ALWAYS complete the antenna connections before connecting the power.

It should have previously been established that there is adequate and consistent cellular service to the area of the weather installation. This is fairly easy to determine by the use of a cellular telephone. Walk while you talk to make sure there are no dead spots that may indicate marginal service. If the location is marginal, certain weather conditions may prevent all communication with the site.

The transceiver itself must be programmed with information such as its assigned telephone number and system identification number. If this has not been done the transceiver may operate improperly or not at all.

If the above situations have been met and the site has previously been in operation, try the following sequence to help determine possible causes for failure.

CELL PHONE CALL

1. If possible, check the Cellular Service by making sure that a call can be made from the site with another cellular telephone. If you can, then continue to check the site.

POWER

1. Determine that the battery is fully charged. Low power at the site will cause the transceiver to fail. The use of a good multimeter is recommended.
2. If the battery is fine, check the fuses. There should be two fuses for the transceiver and it will not work if either are blown.

   Operating power is provided through the 10 amp fuse on the red wire.

   The 4 amp fuse on the green wire feeds a voltage to the transceiver's "ignition sense" line - used in automotive applications - that causes the unit to power up when the vehicle ignition is on. In this case there must always be power to the green wire.
3. Inspect all cables for defects or corrosion.

OPERATION CHECK

1. Use a standard touch-tone telephone and plug it into the RJ11 jack on the transceiver. You can now use this telephone as you normally would to make calls.
2. Check for a dial tone.

- Regular dial tone: The transceiver unit is operational. Try a call.
- No dial tone: The transceiver unit is off.
- Intermittent dial tone: The transceiver unit is not in good contact with the Service Area.
- High/low tone: The unit is locked. A lock code is needed to allow any calls to be made. A 3 digit lock code can be programmed into the transceiver. If this has not been done and the unit has been accidentally locked, you can unlock the unit by plugging in a telephone that uses tone dialing and dialing the number 123 . Refer to the manual included with the transceiver.

3. Check the condition of the antenna and antenna cable. Remove the antenna connector at the transceiver and check for corrosion or other signs of moisture intrusion.

7. OPERATING INSTRUCTIONS

USING THE LDS SOFTWARE

With the combination of the LDS software and a laptop or palmtop computer, it is possible to set the data logger time, look at the current weather conditions at the site, and view the data stored in the unit. Telemetry test functions and technical information are also available via the LDS display software and are useful for troubleshooting operations. Certain sensors, such as metal or plastic wind sensors, require that the correct model be selected in the Technical Menu in order for the sensor data to be accurate. Optional RD-05 display information is not included in this chapter since this item has been discontinued. However, the example screens depicted below are virtually identical to those seen on the RD-05.

Figure 7-1 shows a basic flow chart of display functions.

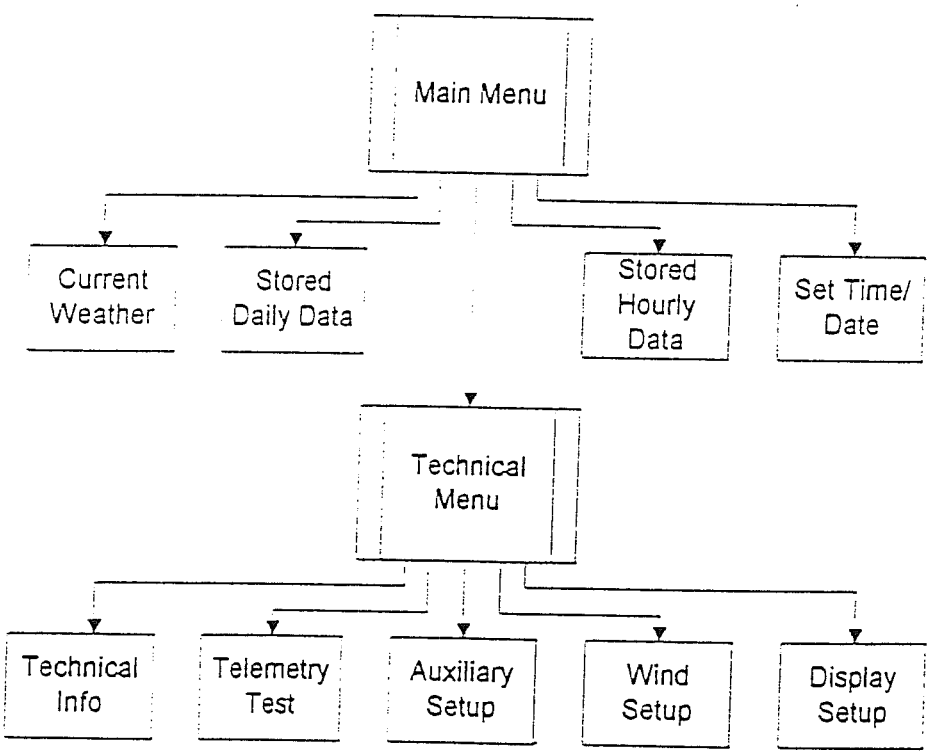

Figure 7-1

1. Your laptop or palmtop computer should already have the LDS software installed - usually in the default directory `C:\LDS`. Refer to the installation sheet you received with the LDS installation diskettes for instructions on how to do this.
2. You should also have a cable to connect your computer to the data logger unit. Plug the 9 pin computer connector into the serial Com port of your computer, and the orange color-coded military-style connector into the appropriate data logger connector marked "Display". At this point your data logger should also be plugged into a battery unit or some other source of power such as a solar battery pack.
3. Turn on the computer, invoke the LDS software, and adjust the computer screen for best viewing. The initial screen should appear with the designation "`Display Off`". See Figure 7-2 on the next page for an example of how this would appear.

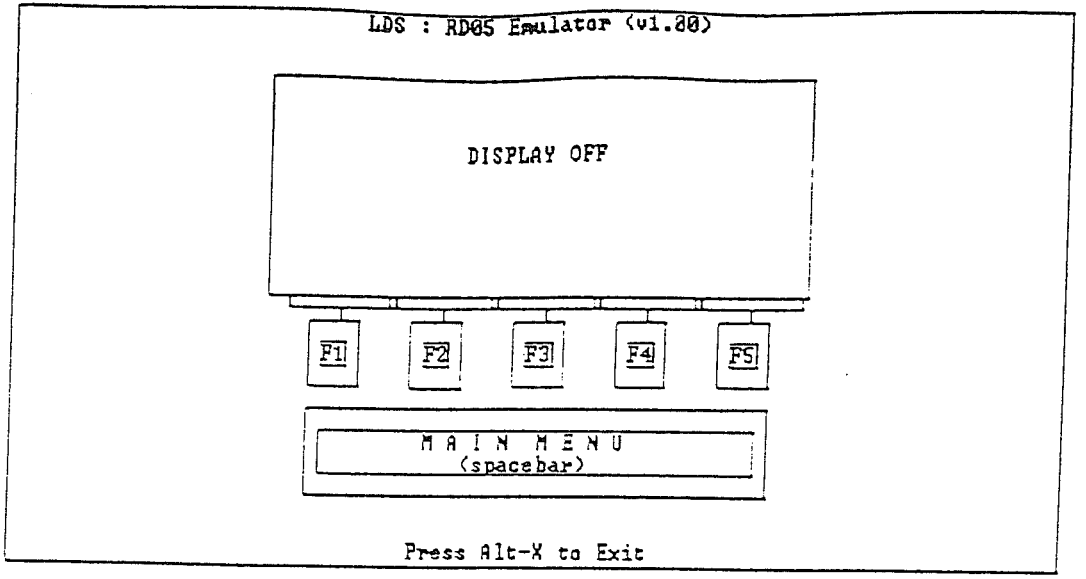

Figure 7-2

4. Press the computer's Spacebar to begin communication with the data logger and to bring up the Main Menu.

5. A list ("menu") of choices will appear as shown in Figure 7-3. Note that the row of Function key designations now has a letter above each key. For example, the key on the left (F1) has "A" above it. Pressing this key on your computer keyboard will give you the "A" option from the list, which is the current weather at the site.

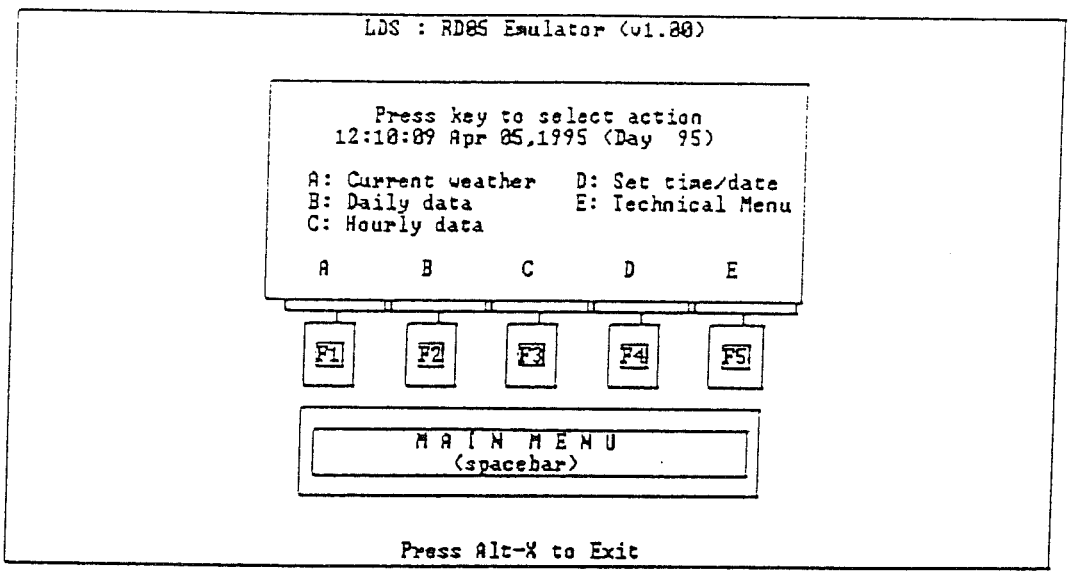

Figure 7-3

6. Press the F1 key. You will be presented with a summary of the weather conditions at the present time. An example can be seen in Figure 7-4 on the next page. Note that the bottom line of the display now says "Any key for new sample". This refers to all the Function keys on your keyboard. To get back to the Main Menu, just press the Spacebar again. Most of the screens are set up in this way, with instructions above each key as to your available options at that time. For example, the Hourly Data screen says "Ahead 1 Back 1 Ahead 24 Back 24 Exit" above the keys. What this means is that the F1 key will move you ahead one record (normally one hour if the data logger has

been running for a while). The second F2 key will move you back one record. The F3 will move you 24 records forward and so on. All of these Function keys will repeat within the LDS software when held down, so you can move through many days of data fairly rapidly. Each screen will be dealt with in more detail in later sections.

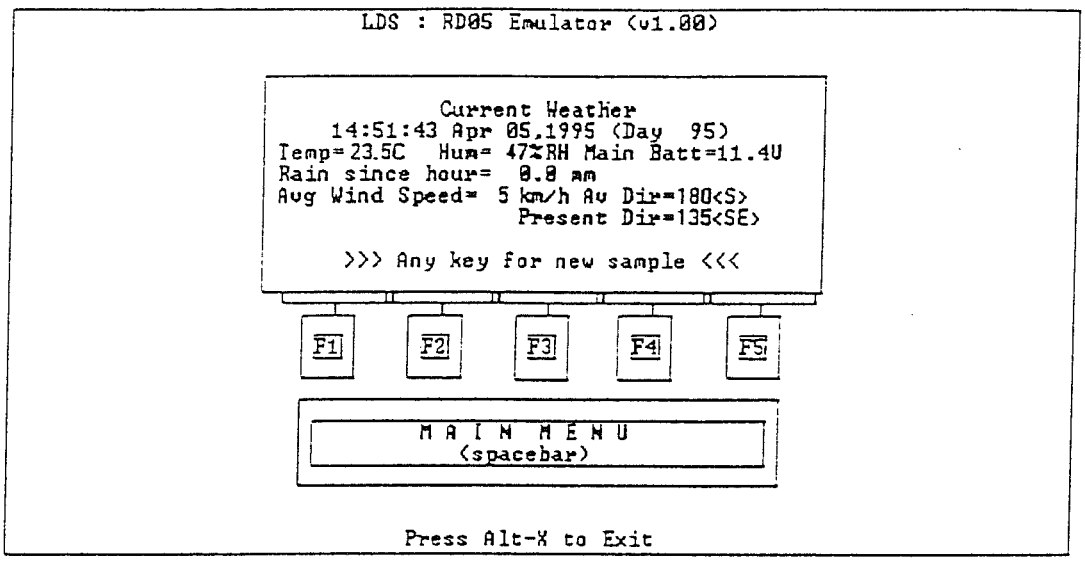

Figure 7-4

SETTING THE TIME

1. From the main menu (Figure 7-3), select option "D: Set Time" by pressing the F4 Function key on your keyboard.

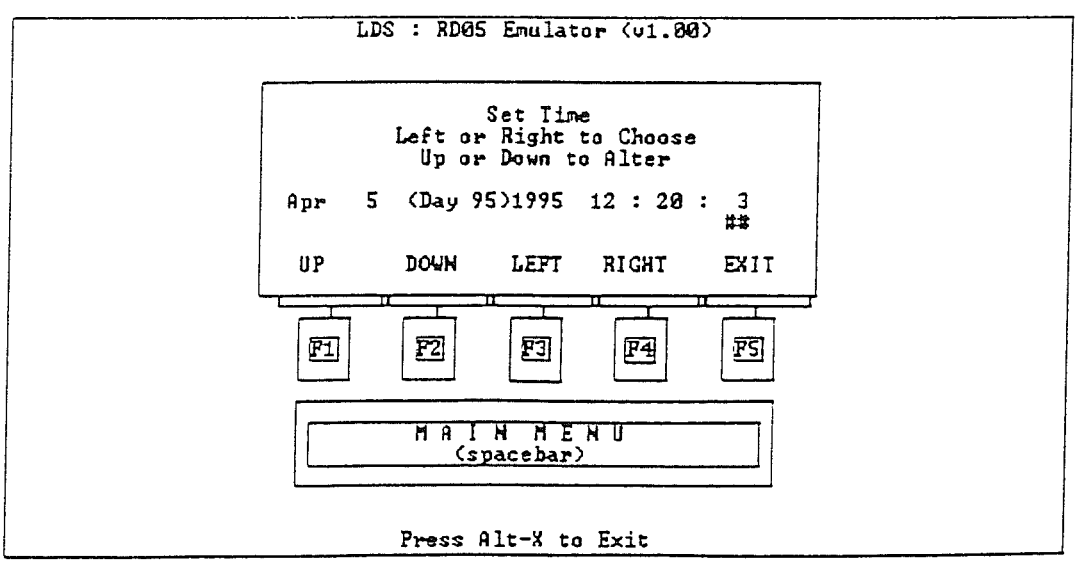

Figure 7-5

2. You will now have the complete station time in a spread-out format (Figure 7-5, above). Note the double crosshatch ("##") under the seconds. This is the

indicator that tells you which part of the time will be altered when you use the "up" or "down" selections. This can be moved left or right by using the "left" or "right" keys represented by Function keys F3 and F4. Moving the indicator left or right does not affect the time, it just tells you which part will be changed. Set the indicator under the part you want changed by using the F3 or F4 keys.

3. Change the time indicated by pressing the "up" or F1 key if you want to increase the value by one and "down" or F2 to decrease by one. Both keys will repeat if held down. Note that the time is no longer updated on the screen after you press either of these keys.
4. Set the time to a time that is slightly ahead of the present time.
5. When the present time matches the data logger time you have set, press either F5 to exit or the Spacebar for the Main Menu and you will be returned to the main menu with the time set to the new value.
6. Note that it is not possible to set the time manually to better than one or two seconds compared to the true time, so it is usually not worthwhile to continually correct small errors in time keeping.
7. If you have a telemetry system, it is possible to set the station time through the telemetry, thus saving a trip to the field. Instructions for how to do this are in the Manual for the WEATHER PLUS software.

READING THE CURRENT WEATHER

1. From the Main Menu, select option "A: Current Weather" by Pressing the F1 Function key on your keyboard. You will be presented with the current weather information (Figure 7-4, on previous page).

   This gives you the battery voltage, humidity, temperature, fuel stick moisture, fuel stick temperature and wind direction at the time of the keypress. The average wind speed and average wind direction are from the last complete ten minute average. The rain is the rain accumulated since the last hour. For the rain before this, refer to the stored hourly data or daily data, as required.
2. For a new sample of the readings, press any Function key on your keyboard key.
3. To return to the Main Menu, use the Spacebar on your keyboard.

READING THE STORED DAILY DATA

1. From the main menu, select "B: Daily Data" by pressing the F2 Function key on your keyboard. You will be presented with a summary of the data recorded at the 13:00 daily observation time (Figure 7-6). This gives you the temperature, humidity, fuel stick temperature, fuel stick moisture at 13:00 (if the sensor is installed), the maximum and minimum temperature and humidity since 13:00 of the previous day, the ten minute average of the wind speed and direction at 13:00 and the total amount and duration of rain since 13:00 of the previous day.

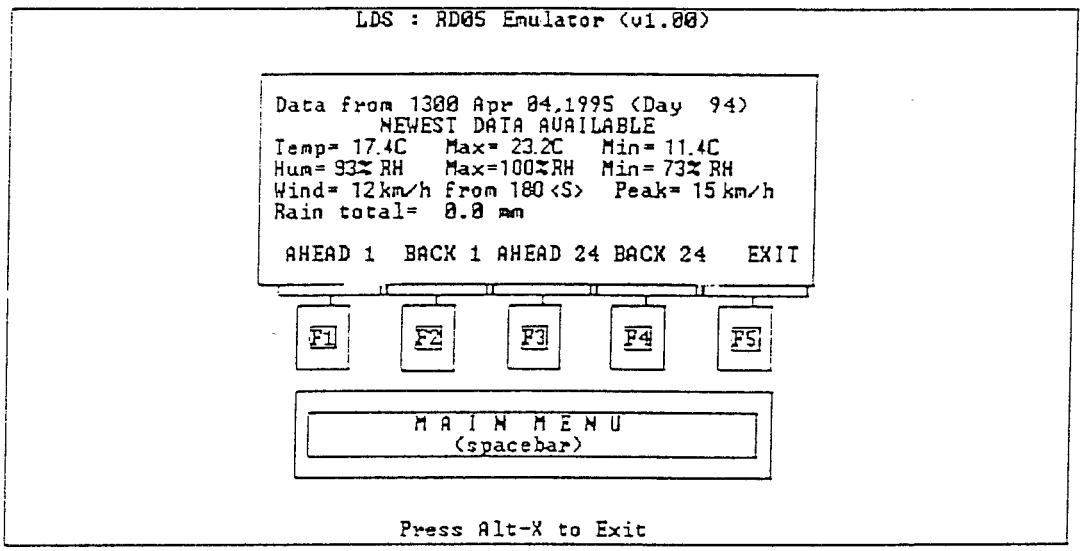

Figure 7-6

2. To move through the stored data, use the Function keys to move back (to earlier) records or ahead (to later) records by either one record or by several records. The messages "NEWEST DATA AVAILABLE" or "OLDEST DATA AVAILABLE" will appear if you reach the end of the stored data.

NOTE that the rain summaries are over two different times, as required by the NFDRS record system. The amount of rain each hour is from 13:00 of the previous day to 13:00 of the day of the record, as is shown by the times before each rainfall. The rainfall times run from midnight to midnight.

READING THE STORED HOURLY DATA

1. From the main menu, select "C: Hourly Data" by pressing the F3 Function key on your computer keyboard. You will be presented with the data from the most recently stored hour (Figure 7-7, next page). This gives you the temperature and humidity at the stated hour, the rainfall since the previous hour and the ten minute averages of the wind speed and direction. The wind readings are the average of the ten minutes before the hour, i.e., 15:50 to 16:00 for a 16:00 storage.

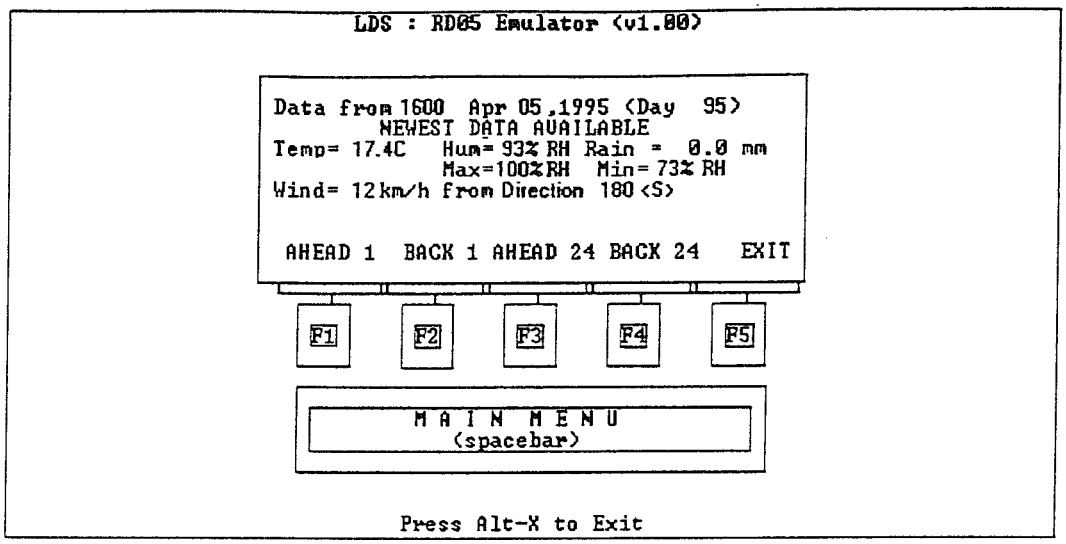

Figure 7-7

2. By using the Function keys, you can move backward (to earlier) readings and forward (to later) readings by either 1 record (usually one hour) or by 24 records at a time. The messages "OLDEST DATA AVAILABLE" or "NEWEST DATA AVAILABLE" will appear to tell you when you are at the ends of the available data.
3. To return to the main menu use either the F5 key or the Spacebar.

The Technical Menu provides access to various Setup functions in the data logger that would generally be performed once, and some troubleshooting utilities that can be used to determine where a malfunction in the telemetry system may lie.

The Setup functions include selection of the Auxiliary sensor, selection of the type of wind speed and wind direction sensors, selection of Imperial or Metric units for data recording and display, NFDRS or CFFDRS standards, and the daily observation time.

Troubleshooting utilities are run through the Telemetry Test selection and will perform a variety of tests.

1. From the Main Menu select option "E: Technical menu" by pressing the F5 Function key on your computer keyboard. See Figure 7-8

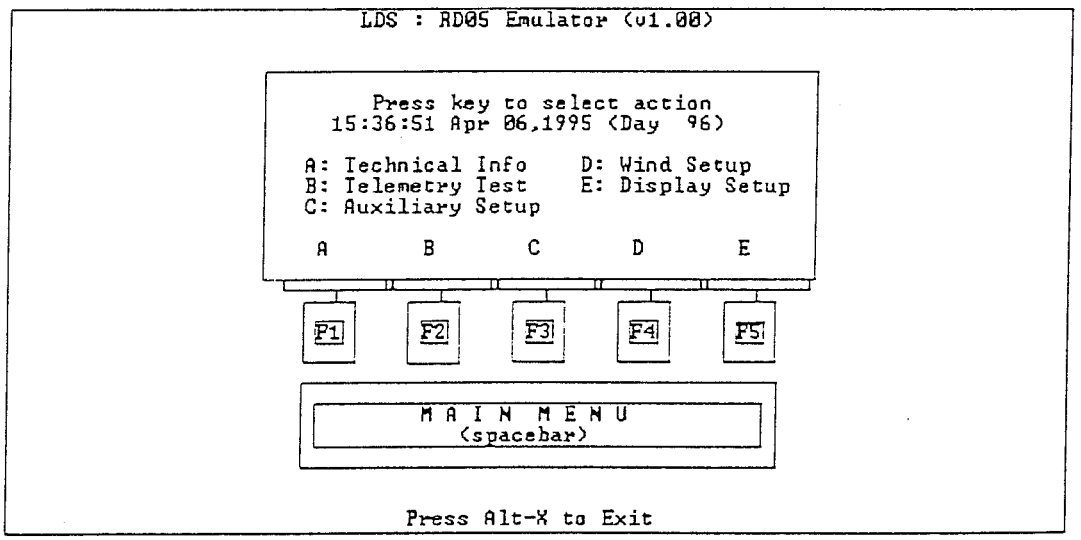

Figure 7-8

TECHNICAL INFO

The Technical Info data screen is used to check on the anemometer connections and provides our copyright notice, version and revision of the data logger software, and the voltage of the internal memory backup battery. There are also some data on the sensor readings for technicians.

1. From the Technical Menu select "Technical Info" with the F1 key. You will be presented with the screen shown in Figure 7-9. The main areas of interest in this screen are the battery voltages and the wind count.

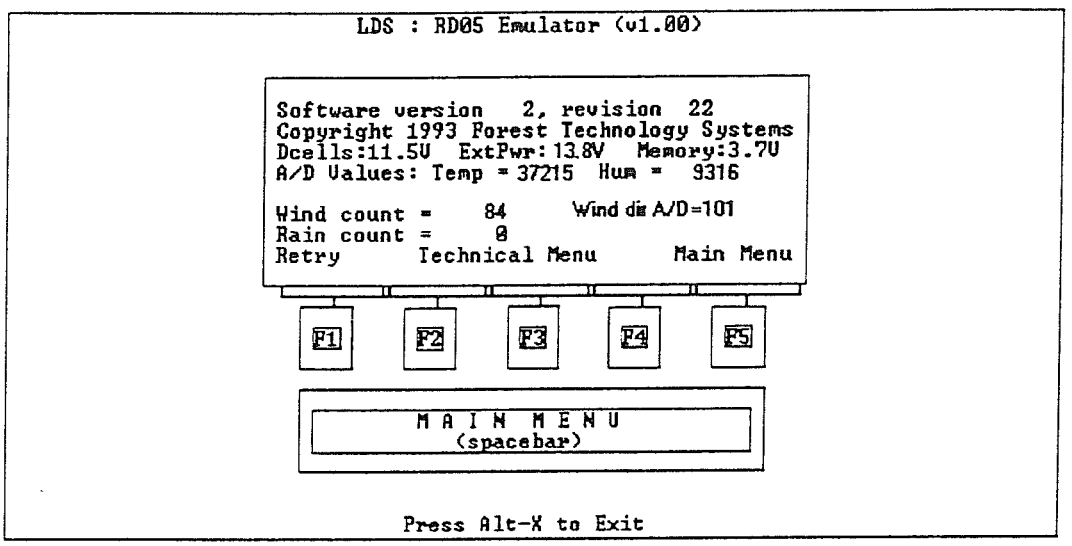

Figure 7-9

BATTERY VOLTAGES

The Voltages shown are:

D cells

The voltage of the batteries in the battery pack.

If these batteries are the only source of power to the data logger, they should be replaced when this voltage reading drops below about 10 volts. If left too long, data will not be stored at a voltage of less than 7.0V. If you are using external power from a radio modem, telephone modem, or direct computer connect, then this 10V limit could be relaxed to as low as 8.5V, as long as power failures are of short duration and infrequent. At 8.5V, the batteries will only have about 1-2 weeks of running capacity left.

ExtPwr

The voltage being supplied externally, usually by a solar panel and battery for the radio modem or an external AC adapter for the Telephone modem or a direct connect to a computer.

If this reads 0V, then the data logger is being run entirely from the D cell battery pack. If you have a solar panel connected, then this voltage should read about 13.8V at all times. If you are running from an AC adapter, this should read about 9-15V. Note that the data logger will run from the higher voltage source first! If you have an AC adapter that produces 10V at the data logger, the data logger will run from the D cells until they drop to 10V, and then start running from the AC adapter.

Memory

The voltage of a small lithium battery used to preserve the data in the data logger in case of power failure. The data logger can not run from this battery, it is installed just for data preservation.

If the voltage indicates 3V or lower, the data logger must be returned to FTS for replacement of this battery, or you risk the total loss of all data in the data logger on power failure. This battery is soldered in place in order to maintain reliable connections through transportation and years of field use, so it is not field replaceable. This battery is expected to last about 5 years from the time of manufacture.

WIND COUNT

This is an internal counter used to count the anemometer pulses. Since the 10 minute wind average does not give a quick method of checking the anemometer, this is what you must use for a quick test. When you select this screen, you will see a wind count. If the anemometer is rotated and a Function key pressed (to get another sample), the count should increase for each complete rotation of the cups. Note that the count will increase by ONE for plastic wind sensors, and by TWO for metal wind sensors. In the field, there is usually enough wind that the cups are rotating, so just do a couple of presses and note that the reading has changed. This count goes from 0 to 255 then starts at 0 again.

RAIN COUNT

This shows an internal counter for the rain tips. One count equals one tip of the bucket in the rain gauge. Remember to press a Function key between tips to display a new count.

SOFTWARE VERSION AND REVISION

This is the version and revision level of the program in the data logger. The main use of this is for information about upgrades or the program status of your data logger. Because Forest Technology Systems continually upgrades and improves the software in the recorders in response to customer feedback, this gives a way of knowing the software level of the data logger.

A/D READINGS

These are for FTS diagnostic and calibration purposes and are not needed by the field operator.

TELEMETRY TEST

This allows the user to verify the connections and operation of a telemetry unit that is connected to the weather data logger. This test returns various items of information about the telemetry and also about the other telemetry units that may be in radio range.

To choose this option, select the "Technical Menu" option from the main menu screen. Select the "Telemetry Test" option from the menu. The screen will clear and some of the messages shown will appear, one by one, as the test proceeds. The sequence of tests is as follows and the LDS display is shown in Figure 7-10.

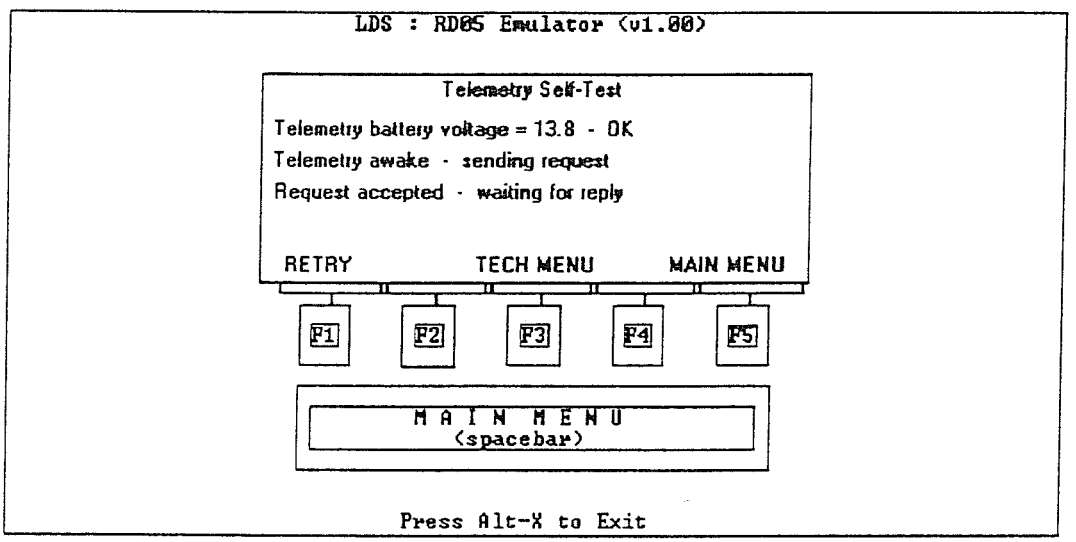

Figure 7-10

1. Determine the battery voltage of the supply in the telemetry and report it. It should have a nominal value of 13.8V, and the voltage will be marked as "OK" if above about 12.0V, or "LOW" if less than this. If low, you will get a message to check the cables and connections.
2. See if the telemetry will respond to a wakeup call. If not, an error message is shown and the test is ended.
3. Once awake, send a request for information to the telemetry and see if it replies within the allowed time. If it does not, an error message will be shown and the test ended.
4. The telemetry has accepted the message properly, and so there is now a delay while the telemetry unit does a radio call to find out what other telemetry units are within radio range. Once this information is gathered, the "Telemetry self test results" screen with the gathered information will be shown.

NOTE: The telemetry will now stay on the air for a while longer to allow a radio technician to perform other tests (see the telemetry manual). Do not attempt a retry of the self-test while the radio continues to transmit as the telemetry will not respond to the weather data logger correctly.

The information returned is as follows and the resulting LDS screen is shown in Figure 7-11.

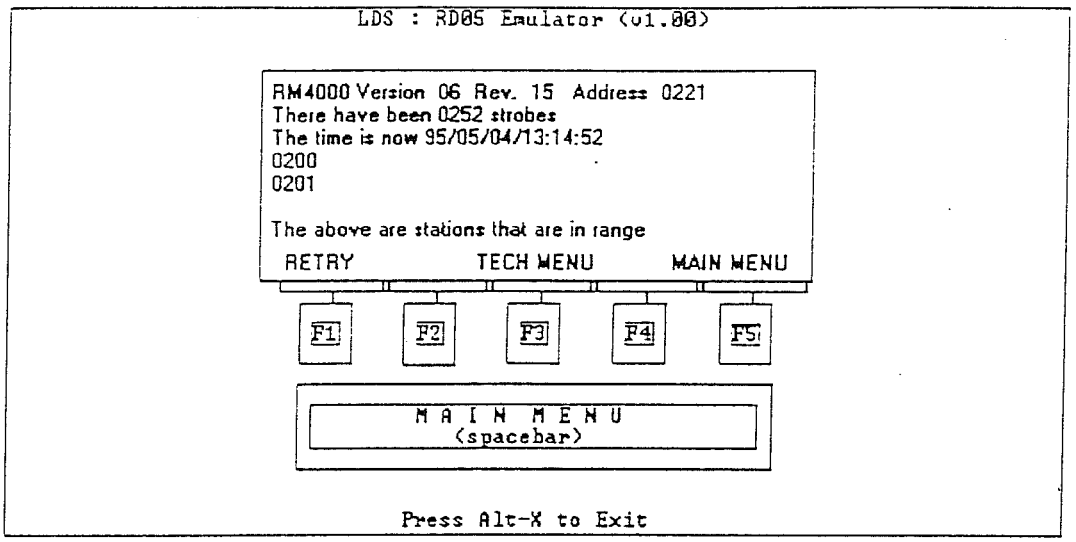

Figure 7-11

1. The model of the telemetry.
2. The telemetry software version and revision.
3. The serial number (address) of the telemetry attached to the data logger.
4. Number of strobes. This is the number of times the telemetry has done an air check since it was last turned on. This can be ignored under most circumstances, since it is used for very specific troubleshooting techniques by field staff.
5. The time in the telemetry unit. This can be ignored under most circumstances, as it is only used for certain special arrangements. It is arranged as year, month, day, hours, min. and seconds. Often, it is not set to the current date - this does not affect the operation of any of the equipment.
6. Stations in range. This is a partial list of the serial numbers of all the telemetry units that responded to the test call. This list does not necessarily include all stations that are actually in range, as two of them may have replied at the same time, causing either the loss of both or a false reply. If this is important, the test should be repeated several times to get a complete list. The chance of a simultaneous reply increases with the number of stations. Only the first eight stations to respond will be shown.

The FWS-11 data logger has an auxiliary sensor port that will accept several sensors not generally used for Fire Weather data collection. There are two useful auxiliary sensor selections already programmed into the data logger. These are the fuel moisture and temperature sensor, and the barometric pressure sensor, as well as a "No sensor" selection if no auxiliary sensor is used. The Auxiliary Setup screen is shown in Figure 7-12.

If you have either auxiliary sensor to install at your site, enter this screen and select the appropriate sensor (or none) by pressing the designated Function key on your computer keyboard.

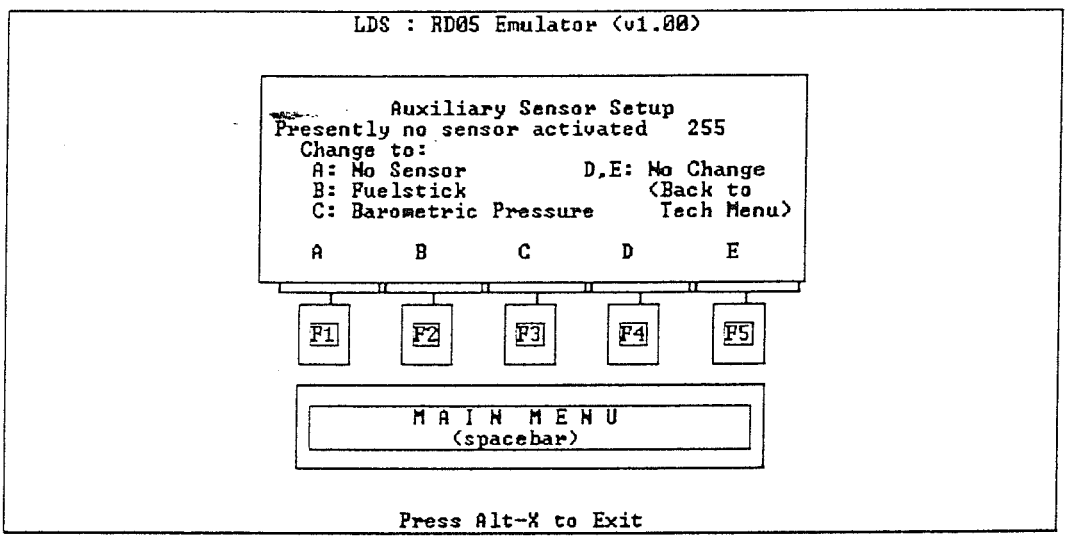

Figure 7-12

There are two types of wind direction and wind speed sensors available to FWS-11 data logger users.

One set is constructed of plastic for inexpensive, mild weather operation. The other available set is constructed of metal and is of higher cost and accuracy, but is also designed for harsh climates such as very high winds and icy rain. There is also a version of the metal units that will withstand 2 inches of ice buildup.

There is an internal difference between the plastic and metal sensors, so the data logger must be set up to accommodate the proper model's function. By selecting the "Wind Setup" menu (Figure 7-13), you will be able to configure the data logger for either plastic or metal sensors, or a *combination of the two*.

Press the Function key on your computer keyboard that corresponds to the letter for your sensor selection.

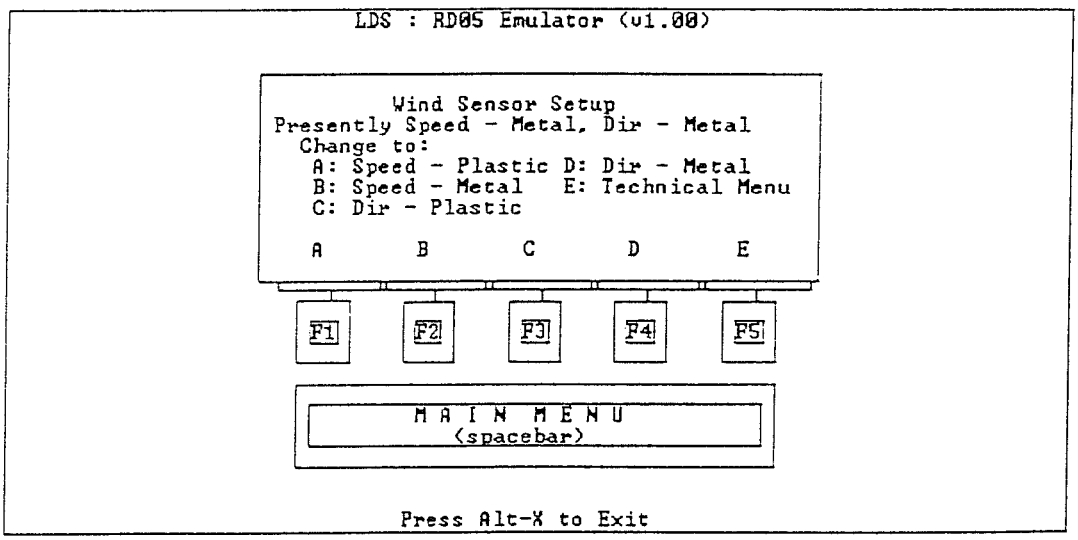

Figure 7-13

FTS WIND SENSOR SUMMARY

WS-11	Plastic Wind Speed
WD-11	Plastic Wind Direction
WSM-20	Metal Wind Speed
WSM-30	Metal Wind Speed
WS-013-20	Metal Wind Speed, Ice-rated
WS-013-30	Metal Wind Speed, Ice-rated
WDM-20	Metal Wind Direction
WDM-30	Metal Wind Direction
WD-023-20	Metal Wind Direction, Ice-rated
WD-023-30	Metal Wind Direction, Ice-rated

DISPLAY SETUP

The "Display Setup" screen (Figure 7-14) allows the selection of the following data collection formats:

1. Display units. Pressing the F1 Function key on your computer keyboard will toggle (that is, switch back-and-forth) the recorder's use of Metric or English (Imperial) units. In the example below, "Metric" is the selected choice. Pressing F1 will reverse the positions of the two types and re-program the data logger accordingly.
2. Rain display. Pressing the F2 Function key will toggle the method of rain information display between NFDRS and CFFDRS codes.
3. Daily observation time. Pressing the F3 Function key will increment the hour of the daily data records. Set this time for your specific needs or to the correct hour for such codes as NFDRS or Canadian FWI.

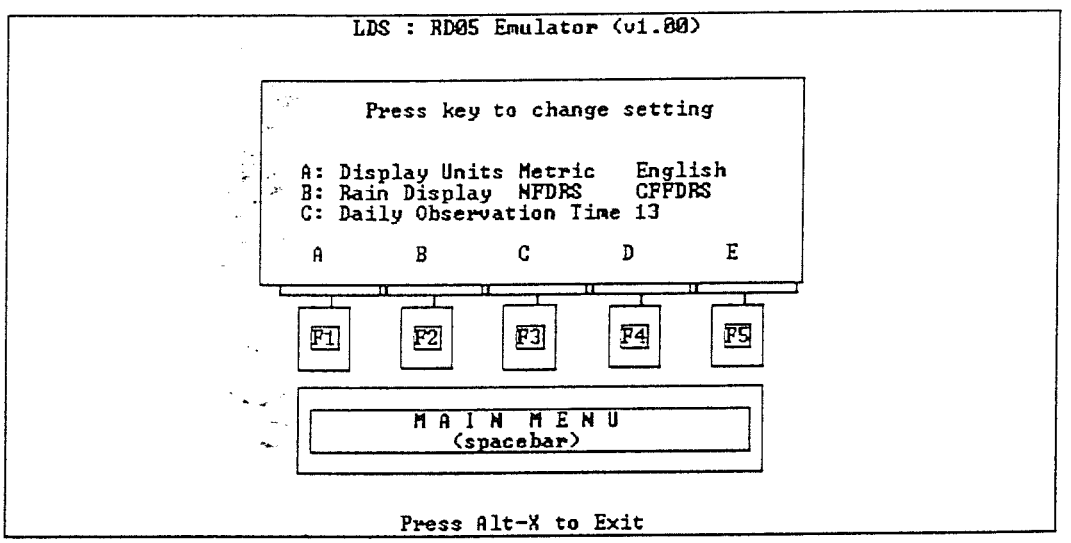

Figure 7-14

8. LIGHTNING PROTECTION

OVERVIEW

This chapter points out a number of lightning protection methods many of which are most easily done *during* the installation of a tower. If your equipment is being used on a tower already in place in an area where there are substantial numbers of lightning strikes, the tower may already be well protected. This chapter will provide you with the information to assess that condition. With some effort, a tower site can be modified to improve its lightning dissipation capabilities. The equipment protection methods can be installed along with your new equipment.

Telescoping mast grounding can be accomplished during set up. The permanence of the site will dictate how much effort goes into the grounding of these installations.

NOTE: The information in this chapter is intended to provide the user with a reasonably well protected site in areas with a moderate threat from lightning.

However, due to the complexity of the subject, there is no pretense that this information can replace a professionally designed and installed lightning protection system, or that it covers all possible site variations, or all materials available.

FTS Forest Technology Systems assumes no responsibility for injury or equipment damage resulting from the use of information provided here.

It is true that if you ground your tower or mast it is more likely to be struck by lightning. However, in certain parts of the country the tower *will* be struck several times each year in any case. The issue with lightning protection is not avoidance of strikes, but control over the damage done to your equipment. With a well-engineered tower and equipment grounding system in place, the energy of a lightning strike is dissipated quickly before it can cause damage to equipment. Poor connections will slow down the dissipation and allow the buildup of potentials that can cause damage.

Lightning is a static electric discharge caused by a potential electrical difference between clouds and the surface of the earth. A single lightning pulse can typically have a duration of 20 microseconds, a combination of frequencies from DC to 100 MHz, and a peak current of 18,000 amps. Every lightning strike may average three of these pulses. This electrical discharge ionizes the air and can have a temperature of $60{,}000^{0}$ F. The electrical current becomes a very large potential difference in voltage as it travels through any ground path that it can find in the equipment and tower, and this causes the damage. The best way to control and dissipate this energy is to provide a low impedance single point ground for all towers, coaxial cables, telephone protector, power lines, and attached equipment.

The tower grounding system should include ground rods forming a radial pattern from the base connected with bare buried copper wire or straps. Towers with guy lines must have the guy line anchor points as part of this radial grounding pattern. The equipment grounding system requires the use of a bulkhead plate where the telephone, AC power lines, and other cables enter the equipment enclosure or shed. Energy surges may enter through these lines and cables, but can be diverted by telephone and power line surge protectors using the bulkhead as the single ground point for all devices.

SYSTEM ELEMENTS

The grounding system must have an extremely low inductive/resistive path to the earth. This requires the correct combination of soil type, ground rods, tower footings, interconnection cables, interconnection points, and layout.

SOIL TYPE

For effective lightning protection the conductivity of the soil must be good in the immediate vicinity of the ground rods. Although water itself does not have sufficient ions present for good conductivity, most soils have natural salts that provide plenty of ions under damp conditions.

Soils made of sand, gravel, and rock are poor grounds because they do not retain water well. These soils can be treated using low resistance backfill such as Bentonite or Epsom salts around the ground rods. The amount required is typically four pounds of salt per linear foot of ground rod. The salt will last one to two years, depending on the rainfall of the area.

An alternative is to use chemically treated ground rods. These can be used alone or in conjunction with soil treatment. The rods contain EPA accepted metallic salts that condition the soil around the rod. One source of this type of ground rod, the Chem-Rod®, is Lightning Eliminators and Consultants Inc.

GROUND RODS

Ground rods come in diameters from one-half to one inch and lengths of 8 and 10 feet. Rods should be driven into the ground whenever possible, not placed in a hole that is then filled and tamped down. Better conductivity is achieved when the density of the soil is high. Driven rods always out perform rods that have been place in augured holes where the soil has not been tamped down to its original density.

Most ground rods are made of steel with a cladding of protective and conductive material. The coating may be of the chemical type for soil conditioning, copper, zinc galvanizing; or the rod may be all stainless steel. All of these coatings are more conductive than the soil they will be driven into.

The copper-clad types should not be used in acidic soils (areas with evergreen trees) since the copper will be attacked. The less expensive galvanized type used most often in house wiring applications are better in these locales.

Try to minimize the amount of cladding that is scraped off during installation. Unprotected areas will rust and become drastically less conductive.

Professional lightning protection installations often utilize ground rods that can be coupled together to provide grounding as deep as 40 feet - a recommended depth. The concept used here is to drive in single 10 foot rods, but provide an increased number of ground radials to compensate.

Make sure all ground rods used at a site are the same type, composition, and length.

CONCRETE FOOTINGS OR FOUNDATIONS

Steel re-enforced concrete is an excellent ground and tower footings poured for a new installation should be used as part of the grounding system. The steel rebar is a

good conductor and the concrete itself is conductive when wet due to the lime and other chemicals. The large surface area and volume of the foundation allows for good transfer of a strike's charge.

New concrete footings (including guy wire anchor footings) or tower foundations should take advantage of the Ufer grounding technique. This method requires that all rebar in the footing be tied together wherever there is a junction. Short copper "pigtails" are attached to the rebar and run out of the footing. One set is for connection to the radial grounding system, the other is attached to the tower. See Figure 8-1. Embedding the copper cable in the concrete provides a superior method of attaching the system to ground.

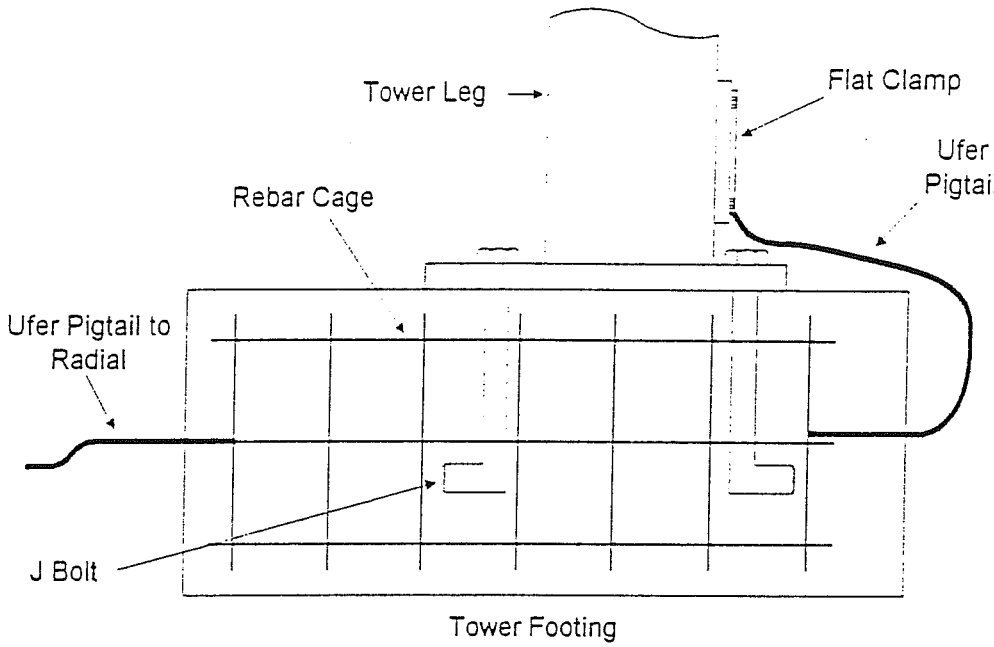

Figure 8-1

If a tower uses a foundation pad, the Ufer ground is also created here by tying all rebar tightly together. Short pigtails of copper wire are securely attached to the rebar and run out of the foundation. Large amounts of coiled copper - a standard Ufer technique - can cause corrosion of the rebar due to electrolysis caused by dissimilar metals in proximity. The short copper pigtails to the radials will not affect the rebar for the typical 30 year life of a tower.

INTERCONNECTION CABLES

The interconnecting cables for the radial grounding system can be #1 or #2 AWG bare copper wire, or 1.5 inch wide copper strap. The copper strap is more effective due to the larger surface area it presents to the soil, especially in low-conductivity soils. Lightning tends to travel on the "skin" of a conductor thereby making the surface area more important than the cross-sectional size. The horizontal interconnection cable or strap will also act as a grounding rod by dissipating the lightning energy into the soil.

Interconnecting cables should not have any sharp bends or coils since this condition will increase the inductance of the conductor and slow down dissipation of a strike's

energy. Very sharp bends can allow discharge at that point which can cause damage.

In poorly conducting soil such as sand and gravel, burying the interconnecting cable with Bentonite or salts to increase conductivity will help ensure proper functioning of the grounding system. Interconnection cables should be buried 2-3 feet below the ground surface in any case.

INTERCONNECTION POINTS

All interconnection points - locations where conductors are attached to towers or grounding rods - must be low resistance and low inductance connections. This is primarily achieved by making all connections cover a large surface area. Good examples of this technique are provided by clamps manufactured by PolyPhaser. Figure 8-2 shows a large (2/0 AWG to 4/0 AWG) copper cable connected to a 1.5 inch copper strap. The strap is then connected to a 5/8 inch grounding rod. A wide range of clamps are available.

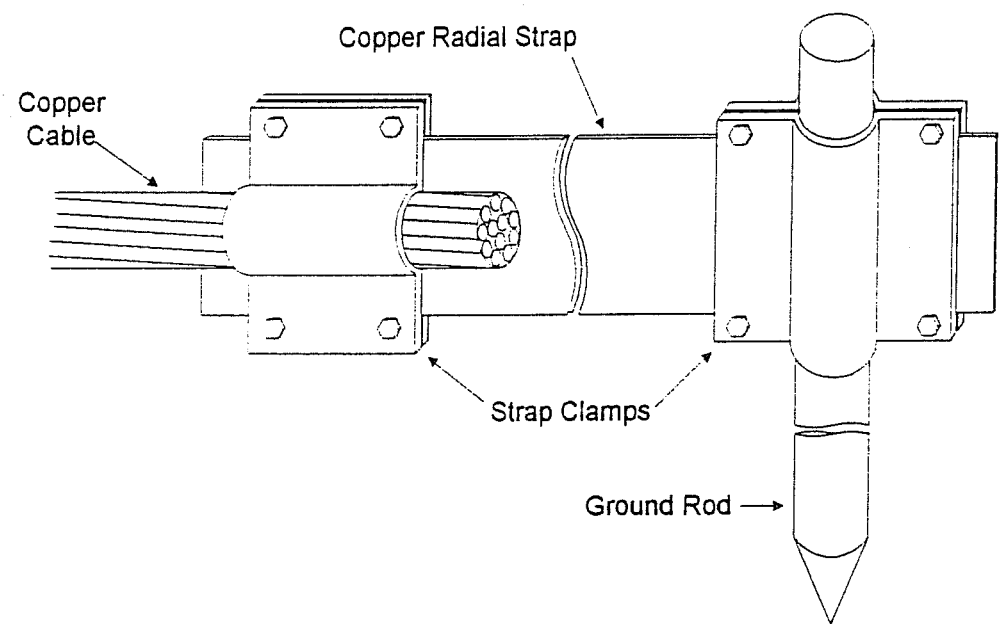

Figure 8-2

All interconnection points must be protected from corrosion caused by contact with dissimilar metals and environmental factors. There are several points to follow to achieve this.

- Whenever possible, make sure all grounding items are made from the same metal. This will avoid initiating an immediate process of corrosion which will ultimately destroy an efficient ground path. Tinned wire, tin, lead, zinc, and aluminum should not be used with copper ground rods in the soil. They will all rapidly disappear.
- Do not use copper rods and cables in highly acidic soils such as in evergreen forests. Soil acidity can be checked with the same package used for checking swimming pool pH.

- Where it is not feasible to match metal composition, then use a joint compound of either graphite or copper particles embedded in grease. This prevents moisture intrusion which promotes corrosion.
- Joining different metals can also be achieved using large surface area stainless steel clamps. Cover them with joint compound.
- Clean all points of contact. Remove oxidation and grease before making connections - especially with copper.

SYSTEM LAYOUT

All cables or straps used as conductors must be carefully installed to prevent kinking or sharp bends. The average for each bend should be no less than an 8 inch radius (Figure 8-3). Sharp bends cause areas of high inductance and slow down dissipation of current. Sharp points are also good areas for discharge that can cause damage to equipment or structures.

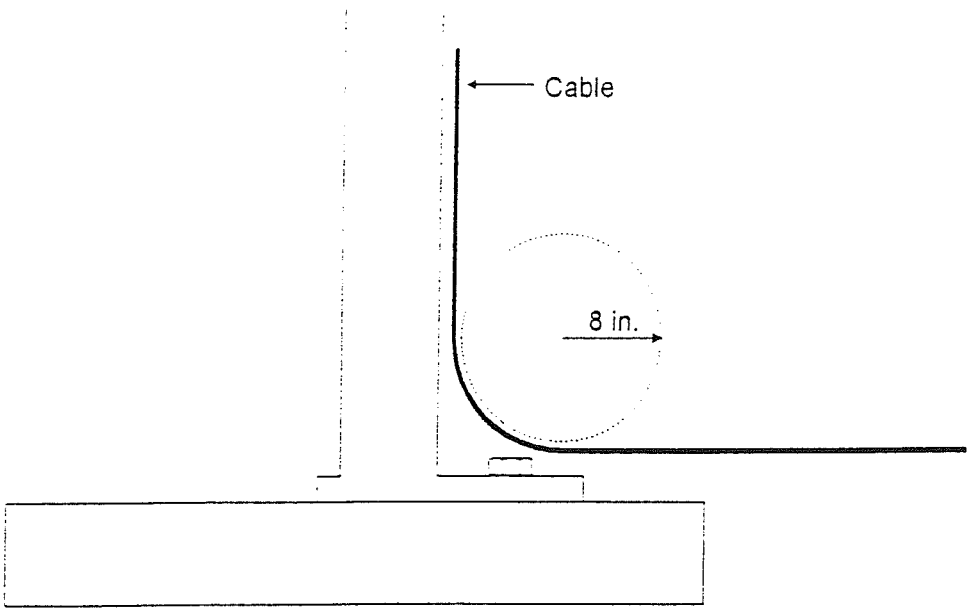

Figure 8-3

TOWER

Downconductor

Each corner of the tower should have a Downconductor. This copper strap or cable is attached to the tower at the top, before and after any tower section junctions, to the Ufer ground point, and to the first radial ground rod. See Figure 8-4.

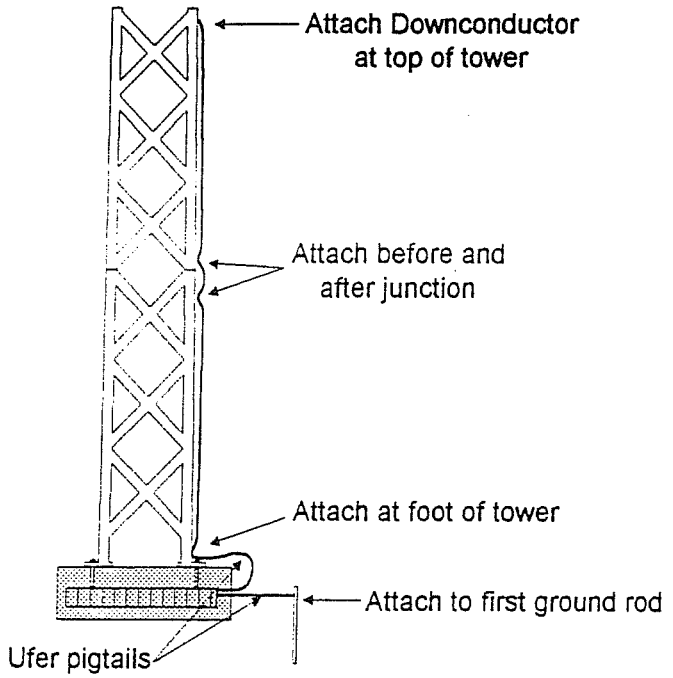

Figure 8-4

The Ufer ground point is the location where the Ufer pigtail from the footing attaches to the tower. This should be as low on the tower as possible. See Figure 8-5. Any lightning rods used to protect antennas, or lightning strike diverters used to protect solar panels should be connected to this Downconductor.

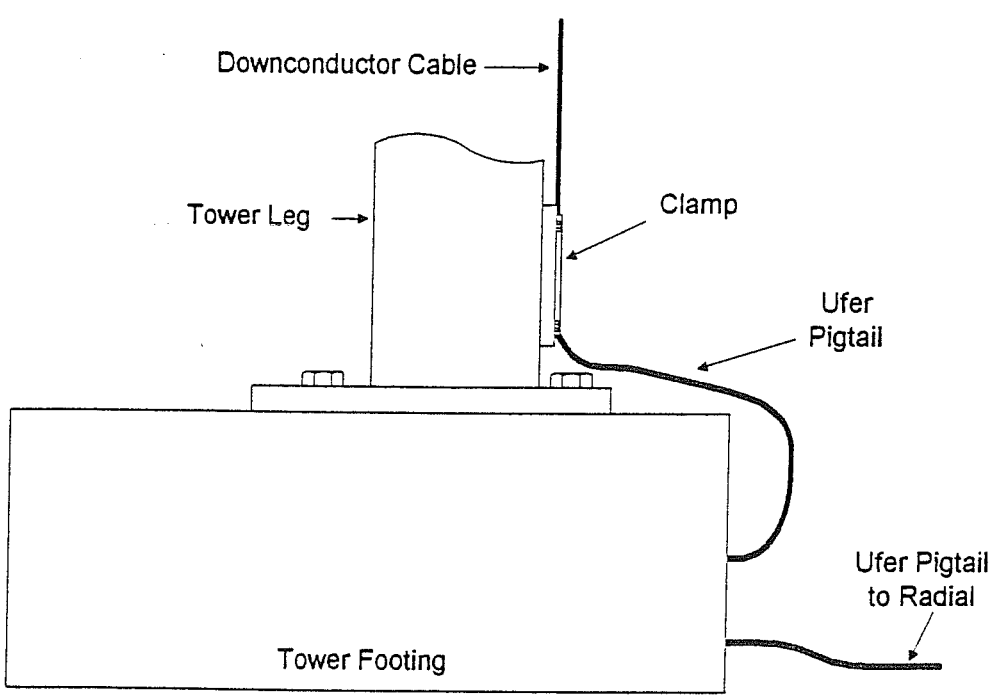

Figure 8-5

Ground radials for the tower should radiate from the tower corners to a distance of at least 20 feet, but no more than about 75 feet. More ground rods provide more protection, but it is most effective to add radials rather than make the radial too long. The Ufer pigtail(s) from the side of the tower footing should be connected to the ground rods with cable or straps. The first ground rod in a radial is placed 2 feet from the Ufer ground (tower corner). See Figure 8-6.

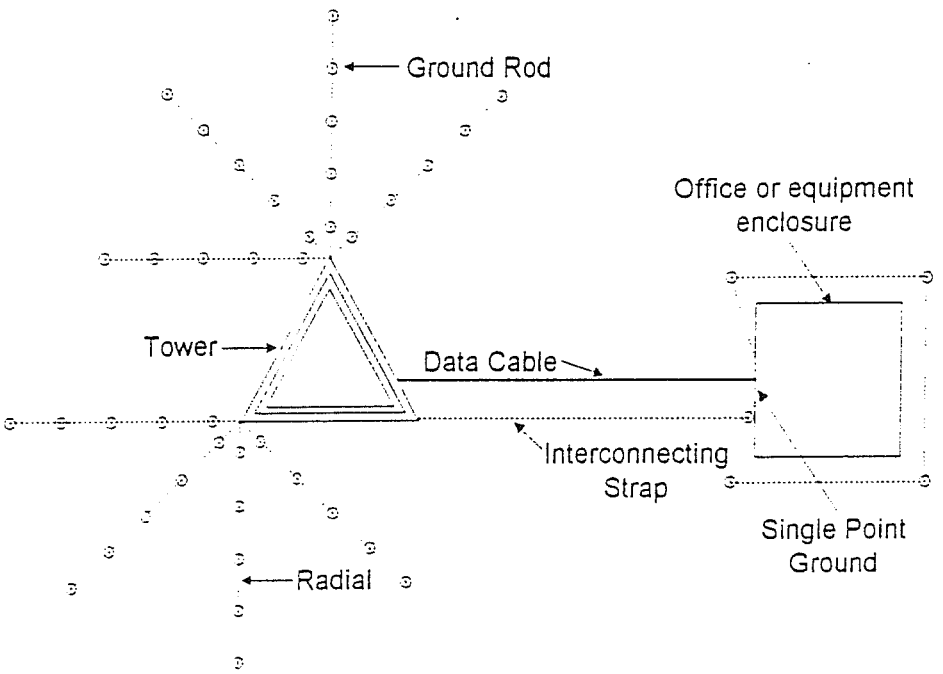

Figure 8-6

A ground rod's radius of influence (soil electron saturation) is about the same as its length. These areas of influence should not overlap or the energy dissipation will be slowed, thus the spacing between ground rods should be twice their length. See Figure 8-7. The connecting cable or strap that creates the radial must be attached and buried 2 to 3 feet below ground level. One reasonable way to install a radial ground system is to dig a trench, drive the ground rods in their correct locations within the trench, connect the radial, and backfill the trench with conductive soil or salts.

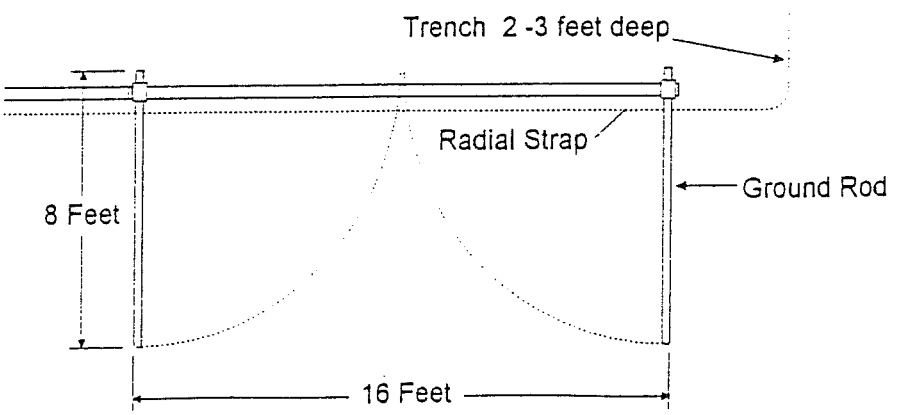

Figure 8-7

Guy Lines

Some towers require the use of sets of guy lines. These must also be grounded properly since a great deal of lightning surge current will travel down the guys. Figure 8-8 shows a good method of grounding guy lines and their anchor footings.

Guy lines are typically galvanized so do not use copper cable with them. The interaction of the metals will remove the zinc from the guy lines, allowing them to rust. It is best to use all galvanized materials.

Make the connections to the guy wires above the turnbuckles to help protect them from arcing. This cable should be bonded to a copper cable protruding just above the soil and above the snow or flooding level. The copper cable is connected to a ground rod 18 inches below the soil and then to a radial system similar to the tower radial system. Only 2 radials are necessary and these radials do not need to be longer than 20 feet.

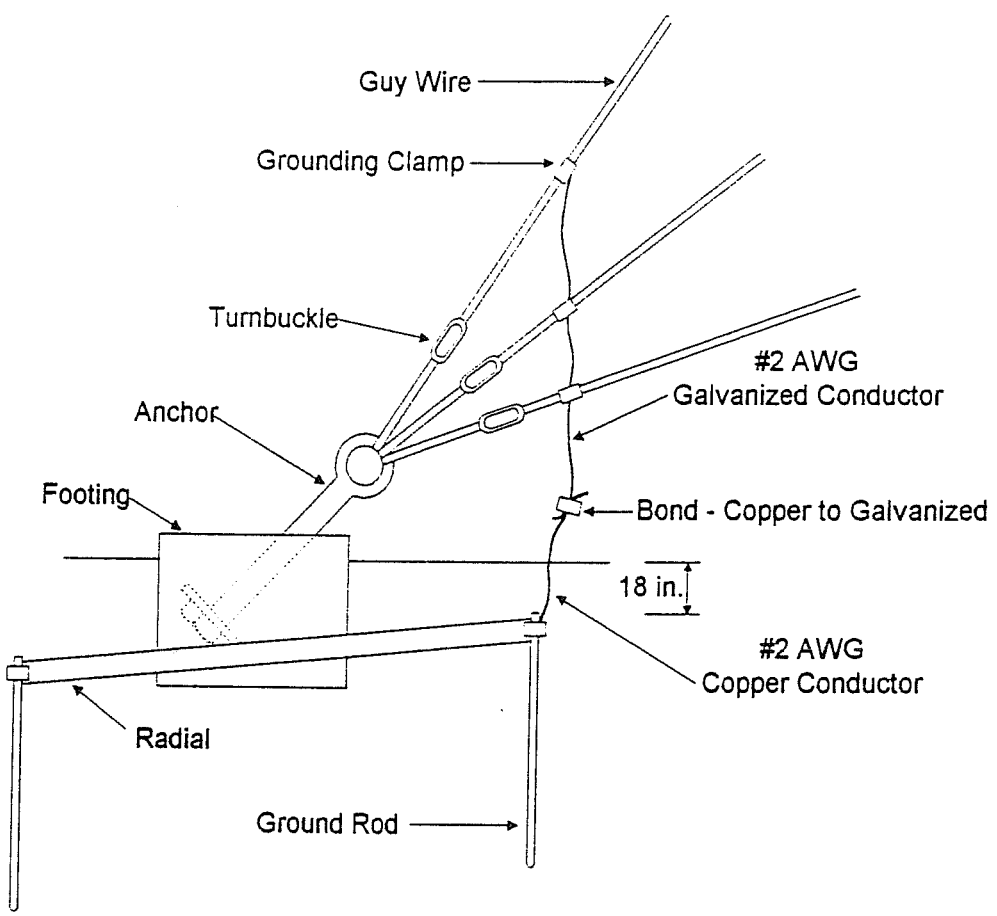

Figure 8-8

ANTENNA AND RADIO

One protection technique is to attract lightning away from the antenna. This can be achieved with lightning rods. These must be placed so that they extend at least one foot above the antenna. Lightning rods will interfere with the antenna's radiation pattern so their location must be carefully chosen.

The lightning rod is connected to the tower's Downconductor.

Even if the antenna does not take a direct hit, it may "ring" or carry a surge current containing a multitude of frequencies. This current can be bypassed to ground with protection device manufactured by Larsen under the model number QSD®. This device must be manufactured to the specific frequency used by your system's radio and is connected to the system ground at the bottom of the tower. PolyPhaser supplies coaxial grounding kits that allow the coaxial cable shielding to be grounded at the foot of the tower.

Another type of protector, the Coax Protector® is manufactured by PolyPhaser, and is used to protect the coaxial cable at its connection to the radio equipment. It is grounded to the single point ground at the equipment enclosure or bulkhead.

The FTS Forest Technology System's Radio Modem has internal lightning protection similar to that of the FWS-11 data logger. The only unprotected port is the antenna connection. Use of coaxial protectors and good grounding will preserve the radio equipment.

WIND SENSORS

If the metal wind sensors and support arm are attached to a tower taller than 20 feet, then a junction box is required. FTS Forest Technology Systems supplies a junction box and extension cable, specifically for the wind sensors, that contains lightning protection built in. The LA-WD/WS lightning arrestor is mounted to the tower within 20 feet of the wind sensors. This lightning arrestor junction box requires its own Downconductor that must be tied into the single point ground (Ufer connection) at the foot of the tower.

The extension cable from the LA-WD/WS may be run directly to the FWS-11 data logger, in which case it is shielded and grounded by its connection to the lightning arrestor chassis and the FWS-11 chassis by the military connectors on each end.

In some cases, an additional junction box is used at the bottom of the tower. If so, the bare "drain" wire from the extension cable must be tied into the single point ground at the tower foot.

The metal wind sensors contain limited static protection and are grounded to the tower through the mechanical connections of the support arm. Additional protection can be provided by the use of nearby lightning rods installed similarly to those used near the radio antenna.

The FTS Forest Technology Systems plastic type wind sensor do not have lightning protection and are considered disposable.

EQUIPMENT ENCLOSURE

The equipment enclosure may be mounted to the tower itself and will thereby be thoroughly grounded. In many cases the enclosure is mounted some distance from the tower, either on a post or in an equipment shed or office. In the either case, all

sensor cables routed from the tower to the data logger and radio equipment should exit the tower as low as possible and enter the equipment enclosure as low as possible.

The equipment enclosure on a post, or equipment backplate mounted in a shed must have a single point ground *strap* run out as close to the ground level as possible. A *cable* will be minimally effective in this situation. As wide a copper strap as possible must be used.

This backplate acts as the single point grounding bulkhead for equipment chassis grounds, coaxial cable protectors, and radial ground cables. At least 2 radials with a length of 20 feet will be required at the equipment location. Figure 8-9 shows a post-mounted equipment enclosure, but the technique is the same for a bulkhead mount on a shed wall.

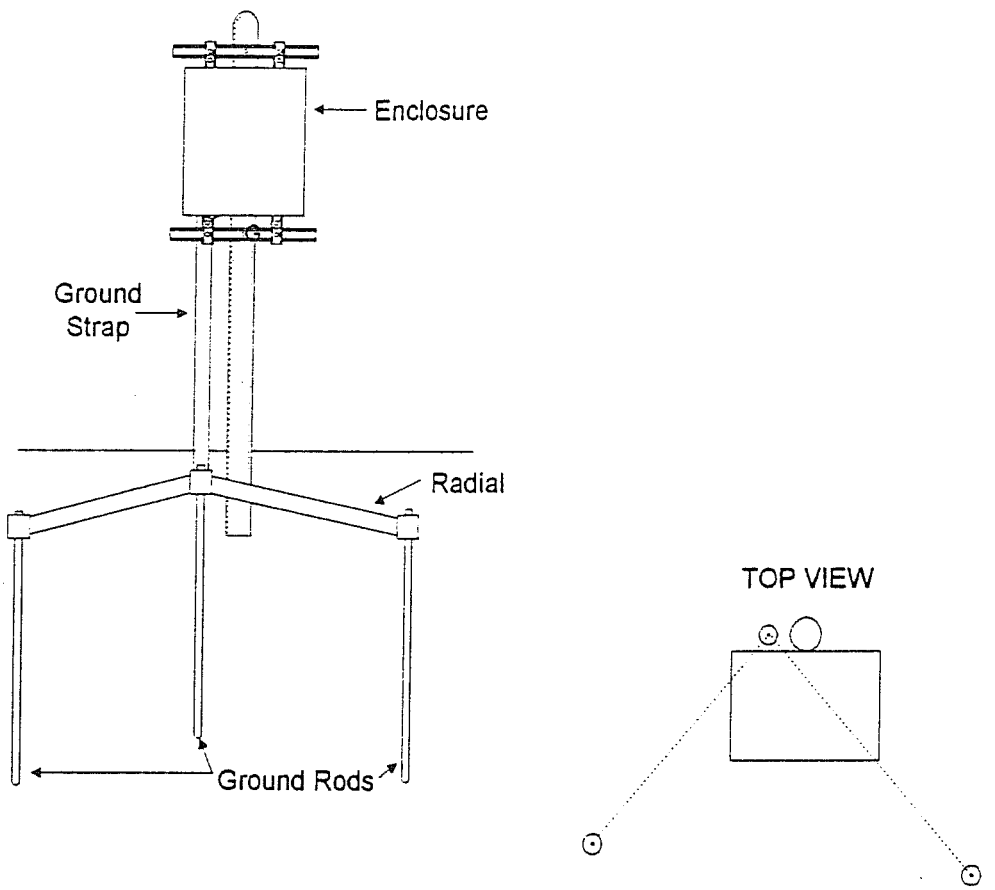

Figure 8-9

FWS-11 Grounding

The FWS-11 data logger has built-in lightning protection circuitry. This protection can be aided by the connection from the FWS-11 chassis to a single point ground. There is a ground lug on the FWS-11 that will accept #8 AWG copper cable that can be routed to a ground connection. This ground cable should always be run as low as possible, and without kinks or sharp bends, to the nearest Ufer ground point or Radial connection.

- On a tower mounted equipment enclosure this cable is connected to the enclosure backplate and then the nearest Ufer pigtail connected to a tower foot.
- On a post mounted equipment enclosure the cable is connected to the enclosure backplate which must be strapped to the nearest ground rod connection.
- In an equipment shed the cable is connected to the equipment backplate or bulkhead which must be strapped to the nearest ground rod.

All FTS Forest Technology Systems sensors used shielded cable and the "drain" wire of this cable is connected to the FWS-11 chassis through metal military-style connectors. If the FWS-11 chassis is well grounded, the sensor cables will be shielded as well.

Telephone Modem and Cables

The TM Telephone Modem and its cable harness are subjected to the additional danger of power surges from both the telephone and AC power line connections. The telephone or AC power lines could be struck by lightning many miles away from the weather site and cause damage as the surge travels along the overhead wires seeking a path to ground. This path may include your equipment attached to these lines.

The TM Telephone Modem has built-in protection on the telephone line input. This protection method is regulated by the DOC, FCC, and CCITT. The latter Australian standard ensures that the telephone line input can handle up to 5000 volts DC without damage. Without good grounding techniques a surge can go well beyond this level of protection and damage to the TM Telephone Modem can result.

The TM Telephone Modem's grounding information is contained in Chapter 2 - "Installation" - of the FTS Forest Technology Systems TM User Manual. The TM Telephone Modem chassis, FWS-11 chassis, and tower or mast must share a single point ground. The power utility and telephone company will have installed a ground rod where the services enter the equipment enclosure or shed. The TM Telephone Modem must be located as close to this grounding location as possible. The TM Telephone Modem chassis should be connected to the backplate or bulkhead, which in turn must be tied into the service ground and any other ground rods and radials.

Additional protection can be provided for the TM Telephone Modem and the AC to DC power adapter that is part of the CBL-FWS-TM-AC cable harness and is highly recommended. This takes the form of a device that designed to suppress surges on both telephone and power lines and is easily available in many areas. One such device that has undergone customer testing is the AC and Telephone Line Surge Protector manufactured by Data General, Model #119-1664®. This device shunts power surges from telephone and power lines into the AC power ground and away from the attached equipment.

MAST PACKAGE

The telescoping mast provided by FTS Forest Technology Systems is either 20 or 30 feet in height depending on the standards for wind measurement of the U.S. or Canada, respectively. This makes he mast package the tallest object in a cleared area and subject to lightning strikes. The metal mast base is held in place by four large spikes, but this is not an adequate ground. In areas exposed to lightning, the mast must be properly grounded. Here are two techniques for protection of a telescoping mast.

In locations of high lightning incidence:

- Drive a ground rod within 2 feet of the mast base. This is the single point ground.
- Install two to three radials by driving in ground rods and attaching them with cable or strapping. See Figure 8-10. Connect these radials to the single point ground rod also.
- Connect a Downconductor to the top of the mast and run it down to connect to the single point ground rod.
- Connect any other equipment grounds to the ground rod.

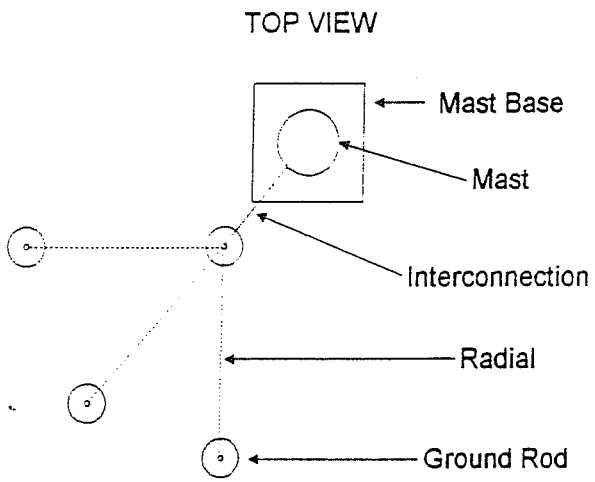

Figure 8-10

In areas where lightning incidence is lower a simpler method can be used:

- The areas where the telescoping mast sections slide together must be bonded with a copper strap. Use a joint compound between the copper and the galvanized material of the mast. See Figure 8-11. Special clamps for this application are made by PolyPhaser and should be used for long-term sites. These clamps are designated T.K. Series and are made to provide a good electrical connection without inducing corrosion.
- Drive a ground rod within 2 feet of the mast base. This is the single point ground.
- Connect this rod to the lowest possible point on the mast with #1 or #2 copper cable or wide strapping.
- Connect any other equipment grounds to the ground rod.

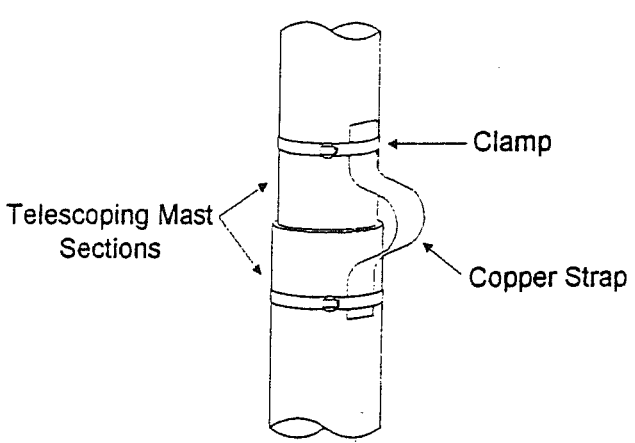

Figure 8-11

BIBLIOGRAPHY

Detailed information on lightning protection can be acquired from several sources. These articles and books cover the subject in much greater depth than is feasible here. You will find more information in the following journals:

- "The 'Grounds' for Lightning and EMP Protection", Second Edition, Roger R. Block, PolyPhaser® Corp.
- "Grounding Practices for Repeater Sites", Mobile Radio Technology. April 1992.
- "Lightning Protection for Radio Systems", Technology, February 1992.
- "Lightning Protection Theory", Mobile Radio Technology, April 1995.

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9. TROUBLESHOOTING

OBJECTIVE

Where possible, the simplest and quickest solution to a malfunction is to test the suspected unit against a known good unit or sensor. Where this is not possible, the following tests may help you isolate the problem unit. If you have any problems or questions, contact our service department.

DATA LOGGER

Other than actual component failures, which are rare, most data logger problems will be related to batteries or cables and connectors. The data logger carries extensive protection against damage caused by nearby lightning strikes inducing high voltages and currents in the sensor cables. If problems are observed after lightning occurs nearby, check the sensors and cables first. Also check cables for damage from rodents, careless handling, vandalism and so forth. Check all connectors for corrosion on the terminals. Any significant corrosion in a connector warrants replacement if the accuracy of the sensors is to be maintained.

UNIT GAINS OR LOSES TIME

A gain or loss of time in the field is normal, as long as it is less than about 4 or 5 seconds a day (1-2 minutes a month). The crystals used for time keeping change their frequency slightly with temperature, with the effect being worse at low and high temperatures. At room temperature, the time keeping should be within about 1 second a week. Note that this is better than most watches.

WIND SPEED

If there are no wind speed counts then the cable is open or shorted, or the data logger has failed. To test the data logger select the Technical screen. Connect another anemometer and rotate the cups one full turn. You can simulate anemometer turns by shorting pins A and B of the data logger's wind speed connector with a piece of wire.

Press a Function key for another sample. If the wind count has changed then the data logger is working.

Test the cable by removing it from the data logger and wind speed sensor and testing for continuity with an ohmmeter. Check from pin A at one end and pin A at the other end, then pin B at both ends. An open circuit (infinite reading) indicates a broken cable wire. Check between pin A and pin B at either end. A very low reading indicates a short circuit between the two wires. Either condition requires the repair or replacement of the cable.

To test the wind speed sensor, take an ohmmeter and measure between pins A and B of the cable connector. Rotate the anemometer slowly through a full circle. You should get a single point of low resistance value for plastic sensors, and two points of low resistance for metal sensors. The rest of the rotation should indicate an open circuit. If you get a continuous short or a continuous open circuit, repair or replace the unit. If the low resistance region is very small (less than 40 degrees) repair or replace.

MULTIPLE COUNTS PER REVOLUTION

The most likely cause is excessive bounce in the reed switch. If at all possible, check the data logger with another anemometer to eliminate a possible problem in the data logger. If it is not the data logger, repair or replace the anemometer.

LOW WIND SPEED

The most likely cause is bearing wearout or switch/magnet problems. If bearings seem stiff, replace unit. Otherwise check switch as outlined under "No wind speed counts". In particular, look for the small angle of closure.

WIND DIRECTION

The plastic wind direction sensor is a 1K ohm potentiometer while the metal sensor is a 10k ohm potentiometer. The main failure modes are broken or shorted cable, bearing wearout, pot wearout or pot damage from lightning induced currents.

OPEN SENSOR

When you get this message on the display, it indicates either a broken cable or a damaged resistance element in the pot. Replace.

OTHERS

Check for an end-to-end resistance (pins A to D) of 1k ohms ±5% for plastic wind speed sensors or 10k ohms ±5% for metal sensors. If readings are outside this range, replace the unit.

Check the resistance between pins B and D. As the vane is rotated, this should vary smoothly from about 3 ohms to the maximum measured in the first step. There will be a small open zone of about 2 degrees at the North point and a zone of constant resistance about 10 degrees wide at each end of the scale. There should be no other discontinuities or sharp changes. If any of these are suspect, replace the unit.

Check the bearings for smooth action.

TEMPERATURE

WARNING: DO NOT SMOKE IN THE SAME ROOM AS THE TEMPERATURE AND HUMIDITY SENSOR!

The humidity sensor is sensitive to this form of contamination, and may lose its calibration.

TEMPERATURE READS -60.0 C^0 OR -76.0 F^0

This usually indicates a broken wire in the cable. To make sure the data logger is working properly, connect a resistor of about 4.7k ohms between pins F and K of the data logger's temperature/humidity connector and take a reading. A value around 70 F^0 or 25 C^0 indicates that the data logger is working and that the fault is in the cable. Return for repair.

TEMPERATURE READS +60.0 C^0 OR +140.0 F^0

This usually indicates a short in the cable. Disconnect the cable and check the reading again. If the data logger reads -60.0 C^0 or -76.0 F^0, the fault is in the cable. Otherwise the fault is in the data logger and it must be returned for repair.

ERRONEOUS TEMPERATURES

How large are the errors? The sensor is quite accurate, and so small (less than 1 degree) errors may be due to inaccuracies in the instrument you are using for comparison. Also, note that even handling the sensor end may change the temperature by several tenths of a degree for a few minutes. We have not found the sensors to drift significantly with time, so the main thing to check is for corrosion on the cable or sensors. It is possible that the data logger has drifted, but it is not possible to field check this without precision (0.1%) resistors. If at all possible, check side by side with another sensor.

Another area that may be overlooked is the cleanliness of the sensor covering. If the solar shield gets dirty, it will absorb more sunlight and the interior temperatures will be higher than the air temperature.

We have also found users comparing temperatures between two units mounted outside a building where one unit was in the lee of the building and the other was catching the wind. It is guaranteed that you can get significant temperature differences in these conditions! You can only do comparisons if the two units are within a foot or so of each other. Also watch out for locations next to buildings where the exterior gets hot in full sun as this will create a warm plume of air running downwind from the building. The sensors must be well away from the exterior walls for meaningful measurements to be made. Parking lots and truck yards are not good places either for just the same reasons.

HUMIDITY

WARNING: DO NOT SMOKE IN THE SAME ROOM AS THE TEMPERATURE AND HUMIDITY SENSOR!

The humidity sensor is sensitive to this form of contamination, and may lose its calibration.

WARNING: THE HUMIDITY SENSOR IS AFFECTED BY DC VOLTAGES!

Do NOT use an ohmmeter to test the humidity sensor. This will cause a change in the calibration of the sensor.

HUMIDITY READS NEAR 100%

This is usually a short in the cable. Test the data logger by taking a reading with no probe attached. If you get a reading of about 10% or so, the data logger is working properly.

Check the connectors for corrosion on the pins and sockets. In particular look for corrosion paths between pins. If these are found, replace the whole cable assembly. If there is corrosion on the data logger, it must be sent in to have the connector replaced.

ERRONEOUS HUMIDITY READINGS

First check for corrosion as outlined above. Test the data logger with another sensor to verify data logger operation.

There are several items to be considered while checking humidity. The first is that if the ambient humidity is changing rapidly, the sensor will lag behind the change. The humidity must be stable to make good comparisons. In addition the sensor must be allowed to adapt to the present conditions if it's not already at the humidity of the test area. This may take an hour or so. Assuming that you are testing in a room, rather than outside, let the sensor stabilize (no reading change over about 10 minutes) and then compare the humidity to a good standard.

A motor driven wet and dry bulb psychrometer has about the minimum allowable accuracy in a comparison instrument. Do not try to use a sling psychrometer - these are not accurate in most hands to better than about 10%. You should have agreement within about 5%. If the comparison is worse, then replace the sensor. If you are testing outside, then a 10% discrepancy is acceptable because of the unavoidable changes in the air. Do not test when the humidity is changing rapidly as the lag of the sensor will introduce an apparent error.

NOTE: All the comments under TEMPERATURE about siting of the station also apply to humidity.

RAIN

The rain gauge unit uses a tipping bucket mechanism. A magnet attached to the bucket closes a reed switch as it passes during a tip. The most common problems relate to either cable flaws, reed switch failure, or magnet problems. The magnet problems are usually due to a shift in the bucket position caused by damage in transport because the bucket was not restrained during transportation.

LOW OR NO RAIN

The most straightforward test is to pour some water slowly through the gauge. As the tipper bucket tips, you will hear a "clunk" from the gauge and the rainfall should increment by 0.01" for each tip. If you get more than 1 count of 0.01" then remove the funnel and tip by hand. If you still get more than 1 count, send it in for service.

If you get no counts at all, there are several possibilities. Check the data logger by using another rain gauge or by taking a length of wire and shorting pins B and C of the rain connector on the data logger. If you get any counts, then the data logger is working.

Check the cable for damage. Use an ohmmeter to verify cable continuity (note that pin A is unconnected). If the cable is bad, send it in for replacement.

The remaining possibility is that the tipper bucket bearings have been shifted in transportation. To test this, gently push the bucket towards one support and check for counts when tipped. Then repeat after pushing towards the other support. If either of these positions does not count move the reed switch slightly closer to the bucket, or send the gauge in.

One flaw that is occasionally seen is that there will be a count when the bucket tips one way but no count when it tips the other. If this misalignment condition is found, send the gauge in for repairs.

FUEL MOISTURE AND TEMPERATURE

TEMPERATURE READS -60.0 C^0 OR -76.0 F^0

This usually indicates a broken wire in the cable. Return for repair.

TEMPERATURE READS +60.0 C^0 OR +140.0 F^0

This usually indicates a short in the cable. Disconnect the cable and check the reading again. If the data logger reads -60.0 C^0 or -76.0 F^0, the fault is in the cable. Otherwise the fault is in the data logger and it must be returned for repair.

ERRONEOUS TEMPERATURES

The sensor is quite accurate, and so small (less than 1 degree) errors may be due to inaccuracies in the instrument you are using for comparison. Also, note that even handling the sensor end may change the temperature by several tenths of a degree for a few minutes. We have not found the sensors to drift significantly with time, so the main thing to check is for corrosion on the cable or sensors. It is possible that the data logger has drifted, but it is not possible to field check this without precision (0.1%) resistors. If at all possible, check side by side with another sensor.

TELEMETRY

If telemetry is installed, refer to the telemetry manual for testing. The only test that can be done with the data logger is to activate the telemetry self-test through the LDS software. This will check the cable connections, but does not distinguish between cable failure and a telemetry problem. Further information on the self-test is in the telemetry manual, and under "Telemetry Test" in this manual.

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10. EQUIPMENT PREVENTATIVE MAINTENANCE

OVERVIEW

The following are the preventative field checks and procedures for the FWS-11 data logger family of equipment. These procedures are to be performed on site with the instruments and tools listed in the following section.

FWS-11 DATA LOGGER UNIT

Service interval: Once every five years, or if unit fails or if unit requires firmware upgrade. The fifth year depot tests include: internal power supplies checks, A/D adjustment, Lithium battery check, and CPU clock adjustment.

FWS-11 BATTERY UNIT

Service interval: Alkaline D cells should be changed every 3 months for stand alone sites. Solar or AC powered sites require yearly Alkaline D cell changes. Battery holder connections should be checked for corrosion during every battery swap. The desiccant should be changed when the indicator strip shows greater than 20% humidity.

THS-1 TEMPERATURE / HUMIDITY SENSOR

Service interval: A yearly calibration check of the humidity section should be done against a suitable standard. The standard must be set next to the sensor under test. It must also be accurate within ± 2% RH. If the calibration has drifted, the unit must be sent to the depot for "Hycal" sensor replacement.

A calibration check of the temperature section should also be done against a suitable standard. The standard must be shaded and set next to the sensor under test. It must also be accurate within 0.4°F or 0.2°C. If the calibration has drifted, the unit must be sent to the depot for "Yellowsprings Thermistor" sensor replacement.

The white solar screen elements should be kept clean. Dust, soil and moss should be removed as soon as visible. The screen can be removed and disassembled for a though cleaning. The plastic solar screen elements should be replaced if they have discolored or faded due to UV damage.

FS-11 FUEL STICK SENSOR

Service interval: A yearly calibration check of the fuel moisture section should be done against a suitable standard. The 10 hour fuel stick standard must be set next to the sensor under test and allowed to stabilize. If a 10 hour fuel stick standard is not available, the actual percentage humidity can be read on the technical menu of the Remote Display (RD-05) or the laptop or palmtop running the LDS Local Display Software. With the wooden dowel removed, this reading can be compared to the tested THS-1 relative humidity reading. It must be within ± 2% of the RH. If the calibration has drifted the unit must be sent to the depot for "Hycal" sensor replacement.

A calibration check of the temperature section should also be done against a suitable standard. The standard must be shaded and set next to the sensor under test, and it must also be accurate within 0.2 C^0 or 0.4 F^0. If the calibration has drifted, the unit must be sent to the depot for "Yellowsprings Thermistor" sensor replacement.

The Ponderosa Pine dowel should be kept clean. Dust, soil and moss should be removed as soon as visible. The wooden dowel should be replaced every season, or when the dowel shows excessive weathering. The dowel is a user serviceable part.

RG-T RAIN GAUGE SENSOR

Service interval: A yearly check of calibration and magnetic reed switch operation should be done. A syringe or 'Accupencer' can be used to check the tipping bucket trip points. The RG-T gauge's tipper bucket should tip when it contains 8.2 ml of water ± 2 drops. Each tip should register in the data logger as 0.01 inch or 0.254 mm; this confirms reed switch operation. Dripping 820 ml of water through the gauge should produce 1 inch or 2.45 cm of rain (or 100 tips). Depot re-calibration is recommended every 2 years.

The funnel and tipper bucket should be kept clean of soil and debris. The tipper bucket movement should be checked for smooth operation after every cleaning. If the bearings are binding, the unit must be sent in for repair. Bearing design life is 3 to 5 years, but will depend on local environmental severity.

WS-11-20 PLASTIC WIND SPEED SENSOR:

Service interval: Yearly checks of the magnetic reed switch and bearing operation are required. There should be one reed switch closure per rotation of wind cup section. The bearing operation should be smooth. The wind sensor head assembly should be changed outright every three years (there is a date code on the base of the sensor head).

WD-11-20 PLASTIC WIND DIRECTION SENSOR

Service interval: Yearly checks of the potentiometer are required. There should be eight trip points, 45° apart per rotation of wind vane section. The bearing operation should be smooth. The wind sensor head assembly should be changed outright every three years (there is a date code on the base of the sensor head).

WSM-20 METAL WIND SPEED SENSOR & WS-013-20 ICE RATED METAL WIND SPEED SENSOR

Service interval: Yearly checks of the magnetic reed switch and bearing operation are required. There should be two reed switch closures per rotation of wind cup section. Check the cups and head are securely mounted. The bearing operation should be smooth, with a starting threshold of 1.0 mph or 1.6 kph. The unit should be sent in for repair if either the bearing or reed switch are defective. Bearing design life is 1 to 5 years but will depend on local environmental severity.

WDM-20 METAL WIND DIRECTION SENSOR & WD-023-20 ICE RATED METAL WIND DIRECTION SENSOR

Service interval: Yearly checks of the potentiometer are required. There should be eight trip points, 45° apart per rotation of wind vane section. Check that the tail and pointer are securely mounted. The bearing operation should be smooth, with a starting threshold of 1.0 mph or 1.6 kph. The unit should be sent in for repair if either the bearing or potentiometer defective. Pot and bearing design life is 1 to 5 years but will depend on local environmental severity.

SPS-26P SOLAR POWER SUPPLY

Service interval: The battery should be charged and disconnected before storage. The battery should be charged and reconnected before deploying the unit for the season. Battery connections should be cleaned of corrosion yearly. Battery capacity can be checked at the depot to ensure peak performance. Battery design life is 2 to 5 years but will depend on local environmental severity.

The solar panel array collection surface should be kept clean for peak efficiency. A typical glass cleaner, such as Windex®, and paper towels should be taken to any site visit for this purpose.

TM TELEPHONE MODEM

Service interval: Once every five years; or if unit fails due to lightning damage or if unit requires firmware upgrade. The fifth year depot tests include: internal power supplies, modem operation, and CPU clock check.

RM4000 VHF & UHF RADIO MODEM

Service interval: Once every two years; or if unit fails or if unit requires firmware upgrade. The second year depot tests include: internal power supplies, data demodulator, CPU clock checks. Also included is a transceiver acceptance test including: receive sensitivity, transmit power, deviation and frequency error check. The radio is realigned if necessary.

CABLE HARNESSES (ALL SENSOR AND TELEMETRY TYPES)

Service interval: Yearly checks of all connectors for damage or corrosion. All cabling should be checked for weathering, rodent chewing or other physical damage. Any damaged cable should be sent to the depot for repairs as required.

ANTENNA

Service interval: Yearly checks of all connectors for damage or corrosion. All cabling should be checked for weathering, rodent chewing or other physical damage. Any damaged cable should be sent to the depot for repairs as required. The antenna elements should be secure and free of kinks and bends. The alignment of directional antennas should be checked with a compass.

Service interval: Yearly checks of all clamps, bolts and guy lines for tightness, damage, or corrosion. The alignment of the wind sensor support arm should be checked with a compass. It should be aligned to true north as per the label attached to the arm. Replacement parts may be ordered from FTS.

REPAIR DEPOT EQUIPMENT REQUIREMENTS

COMPLETE SET OF HAND TOOLS:

1. Screw driver set
2. Nut driver set
3. Allen (Hex) driver set
4. Combination wrench set
5. Assorted pliers and cutters

INSTRUMENTS:

1. DVM (multimeter)
2. Oscilloscope
3. Frequency counter
4. Communications monitor
5. VHF /UHF - FM
6. Transmitter Power, Frequency, and Deviation meter
7. Signal and Tone generator with SINAD and Sensitivity meter
8. Laptop or Palmtop with LDS or WEATHER PLUS software.
9. WS and WD test jigs
10. Temperature / Humidity test Chamber
11. 'Accupencer' water dispenser for RG-T calibration

CONSUMABLE ITEMS:

1. Zap straps (Quick ties) 5 to 10 inch
2. Electricians tape and Heat shrink tubing.
3. Spare nuts, bolts, and clamps.

The following are refurbishment and calibration procedures for the FWS-11 data logger family of equipment. These procedures are to be performed in a service shop environment with the instruments and tools listed on this page. The following checklists and instructions assume the service technician has taken an FTS Forest Technology Systems factory training course. The scope of this document does not cover circuit functionality or schematics drawings. It does however include cable diagrams for the fire weather sensors and attached telemetry devices. You may also make use of the Maintenance / Repair Sheets contained in Appendix B at the back of this manual.

FWS-11 DATA LOGGER UNIT:

Service interval: Once every five years, or if unit fails.

- Check firmware revision and application.
- Check internal power supplies levels.
- Check A/D adjustment.
- Check Lithium battery.
- Check CPU clock adjustment.
- Check power consumption at idle and during A/D cycle.
- Check all sensor input ports for correct operation.
- Check display and Telemetry port operation.
- Perform data dump to local computer and examine data for glitches.
- Clear memory to remove old data records.
- Check unit is configured for the correct wind sensor type and auxiliary sensor.
- Check chassis connectors for corrosion or damage. Replace or repair.

FWS-11 BATTERY UNIT:

Service interval: Alkaline D cells should be changed every 3 months for stand alone sites. Solar or AC powered sites require yearly Alkaline D cell changes.

- Check battery holder connections for corrosion.
- Replace desiccant if the indicator strip shows greater than 20% humidity.
- Install a fresh set of Alkaline D cells.
- Check cable connector for corrosion or damage. Replace or repair if necessary.

THS-1 TEMPERATURE / HUMIDITY SENSOR:

Service interval: A yearly calibration check of the humidity section should be done against a suitable standard.

- The standard must be set next to the sensor under test.

- The standard must be accurate within ± 2% RH.
- The sensor must read within ± 2% RH.
- If the calibration has drifted, the unit must have the "Hycal" sensor replaced. The board must be aligned to the new "Hycal" sensor's calibration points.
- The sensor should be checked for both room humidity and 100% levels. A humidifier can be used to raise the test chamber to 100% humidity.

The calibration check of the temperature section should also be done against a suitable standard.

- The standard must be shaded and set next to the sensor under test.
- It must also be accurate within 0.2 C^0 or 0.4 F^0.
- If the reading has drifted the unit must have the "Yellowsprings Thermistor" replaced.

The white solar screen elements should be kept clean. Dust, soil and moss must be removed.

- The screen louvers can be removed and disassembled for a thorough cleaning.
- Ensure any insect nests or webs are removed.
- The plastic solar screen elements should be replaced if they have discolored or faded due the UV damage.
- Check the cable connector for corrosion or damage. Replace or repair, if necessary.

FS-11 FUEL STICK SENSOR:

Service interval: A yearly calibration check of the fuel moisture section should be done against a suitable standard. The 10 hour fuel stick standard must be set next to the sensor under test and allowed to equalize. If a 10 hour fuel stick standard is not available, the actual percentage humidity can be read on the technical menu of the Remote Display (RD-05) or the Lap/Palmtop running the Local Display Software (LDS). With the wooden dowel removed this reading can be compared to the tested THS-1 relative humidity reading, it must be within ± 2% of the RH.

- If the calibration has drifted, the unit must have the "Hycal" sensor replaced. The board must be aligned to the new "Hycal" sensor's calibration points.
- The sensor should be checked for both room humidity and 100% RH (26% FSM) levels. A humidifier can be used to raise the test chamber to 100% relative humidity.

The calibration check of the temperature section should also be done against a suitable standard.

- The standard must be shaded and set next to the sensor under test.
- It must also be accurate within 0.2 C^0 or 0.4 F^0.
- If the reading has drifted the unit must have the "Yellowsprings Thermistor" replaced.
- The wooden dowel should be replaced every season or when the dowel shows excessive weathering. The dowel is a user serviceable part.
- Check cable connectors for corrosion or damage. Replace or repair, if necessary.

RG-T RAIN GAUGE SENSOR:

Service interval: A yearly check of calibration and reed switch operation.

- A syringe or 'Accupencer' can be used to check the tipping bucket trip points.
- Adjust the RG-T gauge's tipper bucket stops to achieve one tip with 8.2 ml of water ± 2 drops.
- Each tip will register in the data logger as 0.01 inch or 0.254 mm
- This data logger count confirms reed switch operation.
- Dripping 820 ml of water through the gauge should produce 1 inch or 2.45 cm of rain (or 100 tips).
- Check cable connector for corrosion or damage. Replace or repair if necessary.
- The funnel, screen, and tipper bucket should be cleaned of any soil and debris.
- The tipper bucket movement should be checked for smooth operation after every cleaning. If the spring loaded jewel bearings are binding, they must be replaced. (Bearing design life is 3 to 5 years, but will depend on local environmental severity).

WS-11-20 PLASTIC WIND SPEED SENSOR:

Service interval: Yearly checks of the reed switch and bearing operation are required.

- Check for one reed switch closure per rotation of wind cup section.
- Invert the sensor head and recheck for one reed switch closure per rotation.
- Check bearing operation is smooth
- Check cable connector for corrosion or damage. Replace or repair if necessary.
- The wind sensor head assembly should be changed outright every three years (there is a date code on the base of the sensor head).

WD-11-20 PLASTIC WIND DIRECTION SENSOR:

Service interval: Yearly checks of the potentiometer are required.

- Using the FWS-11 display, verify the eight trip points, 45° apart per rotation of wind vane section.
- The bearing operation should be smooth.
- Check cable connector for corrosion or damage. Replace or repair if necessary.
- The wind sensor head assembly should be changed outright every three years, (there is a date code on the base of the sensor head.)

WSM-20 METAL WIND SPEED SENSOR & WS-013-20 ICE RATED METAL WIND SPEED SENSOR:

Service interval: Yearly checks of the reed switch and bearing operation are required.

- Check for two reed switch closures per rotation of wind cup section.
- Check the cups and head are securely mounted.
- Check bearing operation is smooth, with a starting threshold of 1.0 mph or 1.6 kph.
- Bearing design life is 1 to 5 years but will depend on local environmental severity. Replace bearings and reed switch as required.
- Check cable connectors for corrosion or damage. Replace or repair if necessary.

WDM-20 METAL WIND DIRECTION SENSOR & WD-023-20 ICE RATED METAL WIND DIRECTION SENSOR:

Service interval: Yearly checks of the potentiometer are required.

- Using the FWS-11 display, verify eight trip points, 45° apart per rotation of wind vane section.
- Check the tail and pointer are securely mounted.
- The bearing operation should be smooth, with a starting threshold of 1.0 mph or 1.6 kph.
- Pot and bearing design life is 1 to 5 years but will depend on local environmental severity. Replace as required.
- Check cable connectors for corrosion or damage. Replace or repair if necessary.

SPS-26P SOLAR POWER SUPPLY

Service interval: Battery should be charged and disconnected before storage. Battery should be charged and reconnected before deploying unit for the season.

- Battery connections must be cleaned of corrosion yearly.
- The 26 Amp Hour battery capacity must be checked to ensure peak performance.
- Battery design life is 2 to 5 years but will depend on local environmental severity. Replace as required.
- The fuses should be checked.
- The solar input and regulator function must be checked for correct operation.
- Check solar panel cable connector for corrosion or damage. Check chassis connectors for corrosion or damage. Replace or repair if necessary.
- The solar panel array collection surface must be kept clean for peak efficiency. Use Windex® or similar glass cleaner and paper towels to remove any accumulations.

TM TELEPHONE MODEM

Service interval: Once every five years; or if unit fails due to lightning damage.

- Check firmware revision and application.
- Check internal power supplies levels.
- Check CPU clock.
- Check power consumption at idle and during answer cycle.
- Check Telemetry and data logger ports for correct operation.
- Check chassis connectors for corrosion or damage. Replace or repair if necessary.
- Check modem operation: unit answers and connects at 1200 baud.

RM4000 VHF & UHF RADIO MODEM

Service interval: Once every two years, or if unit fails.

- Check firmware revision and application.
- Check internal power supplies levels.
- Check data demodulator adjustment.
- Check CPU clock adjustment.
- Check power consumption at idle receive and transmit mode cycle.
- Check telemetry port for correct operation.
- Perform data retrieval to local computer and RM4000 base.
- Check chassis connectors for corrosion or damage. Replace or repair if necessary.
- Perform transceiver acceptance test: receive sensitivity, transmit power, deviation and frequency error check. Realign radio if required.

CABLE HARNESSES (ALL SENSOR AND TELEMETRY TYPES)

Service interval: Yearly checks of all connectors for damage or corrosion.

- All cabling should be checked for weathering, rodent chewing or other physical damage.
- Any damaged cable must be replaced as required.
- Check cable connectors for corrosion or damage. Replace or repair if necessary.
- Connect the unit to the appropriate hardware and perform a functional test.

ANTENNA

Service interval: Yearly field checks of all connectors for damage or corrosion.

- All cabling should be checked for weathering, rodent or other physical damage.
- Check the antenna elements are secure and free of kinks and bends.
- Perform an S.W.R. test on unit.
- Upon reinstallation, check the alignment of directional antennas with a compass.

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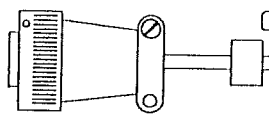
APPENDIX A CABLE DRAWINGS

TO FWS-II TEMP/HUM CONNECTOR
10 PIN MALE 520-1210P



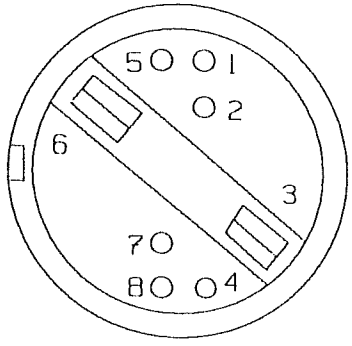
COLOR CODE RED

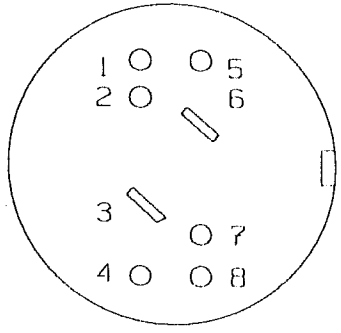
BELDEN #8723 LENGTH 10 FEET

FWS-II TEMP/HUM 520-1210P		
PIN A	N/C	A/D SUPPLY
PIN B	N/C	AUX 12V SUP
PIN C	DRAIN	CHASSIS GND
PIN D	WHITE	HUM SEN I/P
PIN E	N/C	AC EXCIT
PIN F	RED	TEMP SEN I/P
PIN G	N/C	CPU SUP O/P
PIN H	N/C	A/D SUPPLY
PIN J	GREEN	SIGNAL GND
PIN K	BLACK	SIGNAL GND

TOP VIEW	
PIN 1	N/C
PIN 2	N/C
PIN 3	HUM WAFER
PIN 4	5K THERMISTOR
PIN 5	N/C
PIN 6	HUM WAFER
PIN 7	HEAT SINK
PIN 8	5K THERMISTOR

BOTTOM VIEW	
PIN 1	N/C
PIN 2	N/C
PIN 3	WHITE
PIN 4	RED
PIN 5	N/C
PIN 6	GREEN
PIN 7	N/C
PIN 8	BLACK

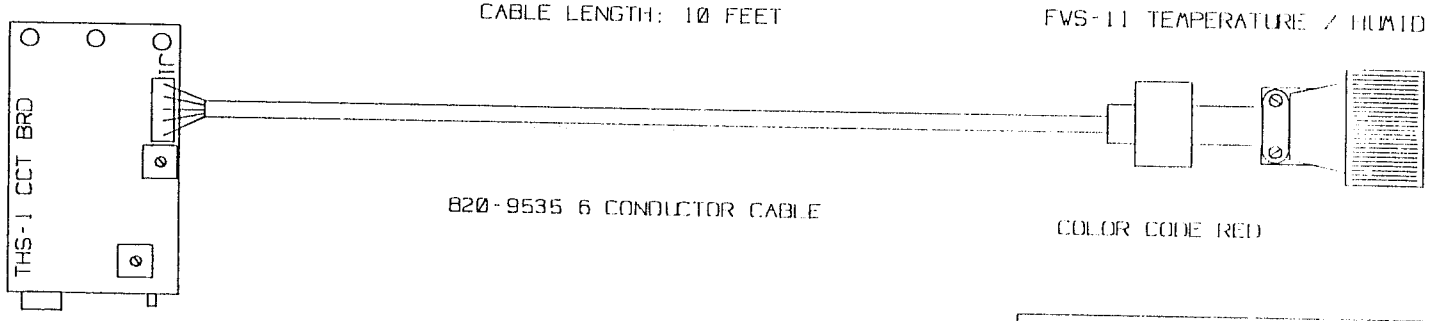




FOREST TECHNOLOGY SYSTEMS LTD

TH-11

JAN 1995 PHIL JONES

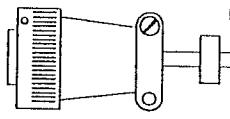


THS-1 CIRCUIT BOARD CONNECTIONS J1		
PIN #	COLOR	THS-1 FUNCTION
PIN #1	RED	POWER I/P
PIN #2	BLACK	CIRCUIT GND
PIN #3	WHITE	HUMIDITY O/P
PIN #4	BROWN	TEMPERATURE O/P
PIN #5	GREEN	TEMPERATURE GND
CUTOFF	DRAIN	CHASSIS GROUND

FWS-11 TEMP/ HUM CONNECTOR 520-1210P		
PIN #	COLOR	FWS FUNCTION
PIN #A	N/C	A/D SUPPLY
PIN #B	RED	AUX 12V SUPPLY
PIN #C	DRAIN	CHASSIS GND
PIN #D	WHITE	HUM SEN I/P
PIN #E	N/C	AC EXCIT
PIN #F	BROWN	TEMP SEN I/P
PIN #G	N/C	CPU SUP O/P
PIN #H	N/C	A/D SUPPLY
PIN #J	BLACK	SIGNAL GND
PIN #K	GREEN	SIGNAL GND

FOREST TECHNOLOGY SYSTEMS L	
TITLE: THS-1	
FILE: THS1.DWG	SHEET: 1 OF
DATE: 11-01-95	REV: 1.00
SCALE NOT TO SCALE	DWG. #:
DRAWN BY: PHIL JONES	

TO FWS WIND DIRECTION CONNECTOR
4 PIN MALE 520-84P



COLOR CODE YELLOW

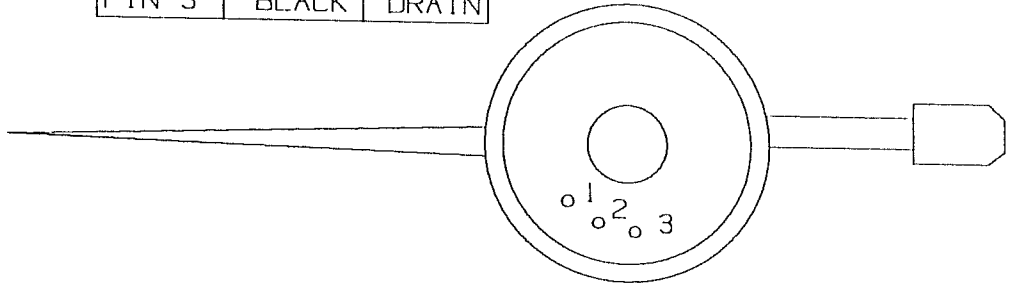
BELDEN #9533
WD-11 20FT
WD-11-30 30FT

TO WIND DIRECTION SENSOR
3 RING TONGUE CONNECTIONS

RED
BLACK
WHITE

FWS-11 WIND DIRECTION 520-84P			
PIN A	BLACK	N/C	SIGNAL GND
PIN B	WHITE	CLEAR	SIGNAL O/P
PIN C	DRAIN	DRAIN	CHASSIS GND
PIN D	RED	BLACK	SIGNAL I/P

SENSOR CONNECTIONS BOTTOM VIEW		
PIN 1	RED	BLACK
PIN 2	WHITE	CLEAR
PIN 3	BLACK	DRAIN



FOREST TECHNOLOGY SYSTEMS LTD

WD-11 WD-11-30

JAN 1995 PHIL JONES

TO FWS WIND SPEED JACK
3 PIN MALE 520-833P

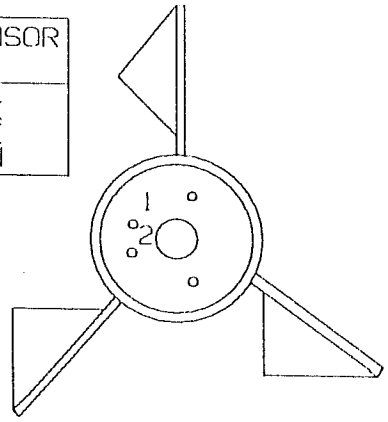
COLOR CODE RED

BELDEN #9533
WS-11 20FT
WS-11-30 30FT

FWS WIND SPEED 520-833P		
PIN A	WHITE	SIGNAL O/P
PIN B	BLACK	CHASSIS GND
PIN C	DRAIN	SIGNAL GND

TO WIND SPEED SENSOR
2 RING TONGUE CONNECTIONS

WIND SPEED SENSOR BOTTOM VIEW	
PIN 1	BLACK
PIN 2	WHITE
N/C	DRAIN



FOREST TECHNOLOGY SYSTEMS LTD.

WS-11 WS-11-30

JAN 1995 PHIL JONES

CABLE LENGTHS:

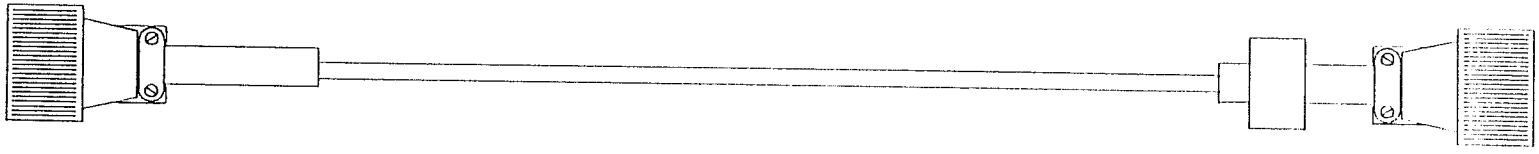
USA - 25 FEET
CAN - 35 FEET
MOF - 35 FEET

530-6S-SC (MS3106E14S-6S)

MET ONE WIND DIRECTION CONNECTOR

520-84P (85106JC 8-4P50)

FWS-II WIND DIRECTION CONNECTOR



820-9533 4 CONDUCTOR CABLE

COLOR CODE YELLOW

MET ONE WIND DIRECTION		FWS-II WIND DIRECTION
530-6S-SC PIN #	WIRE COLOR	520-84P PIN #
PIN # A 1.5K PIN # B 1.5K PIN # C PIN # D N/C PIN # E N/C PIN # F N/C	RED BLACK WHITE DRAIN	PIN # D PIN # A PIN # B PIN # C
NOTE: 1.5K OHM RESISTOR BETWEEN PIN A AND B OF THE 530-6S-SC SENSOR CONNECTOR.		

FOREST TECHNOLOGY SYSTEMS LT	
TITLE: 00-CBL-MET-WD	
FILE: CBLMTWD.DWG	SHEET: 2 OF
DATE: 05-09-94	REV: 1.02
SCALE NOT TO SCALE	DWG. #:
DRAWN BY: PHIL JONES	

CABLE LENGTHS:

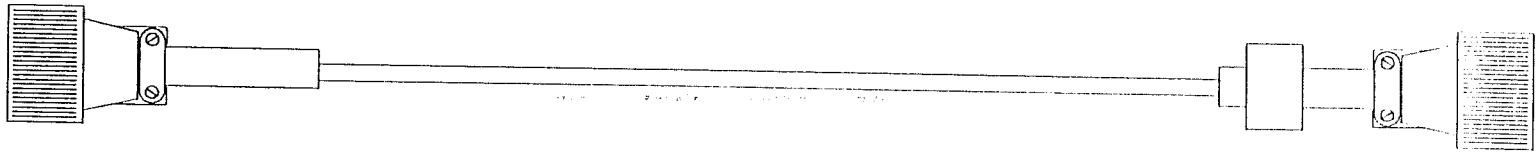
USA - 25 FEET
CAN - 35 FEET
MOF - 35 FEET

530-9S-SC (MS3106E14S-9S)

MET ONE WIND SPEED CONNECTOR

520-833P (85106 JC 8 33P50)

FWS-II WIND SPEED CONNECTOR



820-9533 4 CONDUCTOR CABLE

COLOR CODE RED

MET ONE WIND SPEED		FWS-II WIND SPEED
530-9S-SC PIN #	WIRE COLOR	520-833P PIN #
PIN # A PIN # B N/C	WHITE / RED BLACK / BLACK DRAIN / DRAIN PLAIN / ARMOUR	PIN # A PIN # B PIN # C

FOREST TECHNOLOGY SYSTEMS LT	
TITLE: 00-CBL-MET-WS	
FILE: CBLMTWS.DWG	SHEET: 2 OF
DATE: 05-09-94	REV: 1.02
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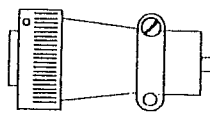
DRAWN BY: PHIL JONES	

FWS-II TELEMETRY CONNECTOR
8 PIN FEMALE 520-128S



COLOR CODE GREEN

BELDEN #9533 6 FEET OR
Length as required.

FWS-II TELEMETRY 520-128S		
PIN A	N/C	CTS I/P
PIN B	DRAIN	CHASSIS GND
PIN C	BLACK	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	N/C	CHASSIS GND
PIN G	N/C	EXT PWR I/P
PIN H	N/C	NO CONNECT

IBM COM PORT DB CONNECTOR			
PIN # DB25F	PIN # DB9F	COLOR	FUNCTION
PIN 1	PIN 5	DRAIN	SIGNAL GND
PIN 2	PIN 3	BLACK	TX DATA
PIN 3	PIN 2	WHITE	RX DATA
PIN 4	PIN 7	N/C	RTS O/P
PIN 5	PIN 8	JUMPER	CTS
PIN 6	PIN 6	JUMPER	DSR
PIN 7	-----	JUMPER	GND
PIN 20	PIN 4	N/C	DTR
PIN 8	PIN 1	JUMPER	DCD
JUMPER DB25 PIN (5&6&8) (1&7)			
JUMPER DB 9 PIN (1&6&8)			

IBM PC CONNECTOR
DB25F 562-25F OR 562-9F

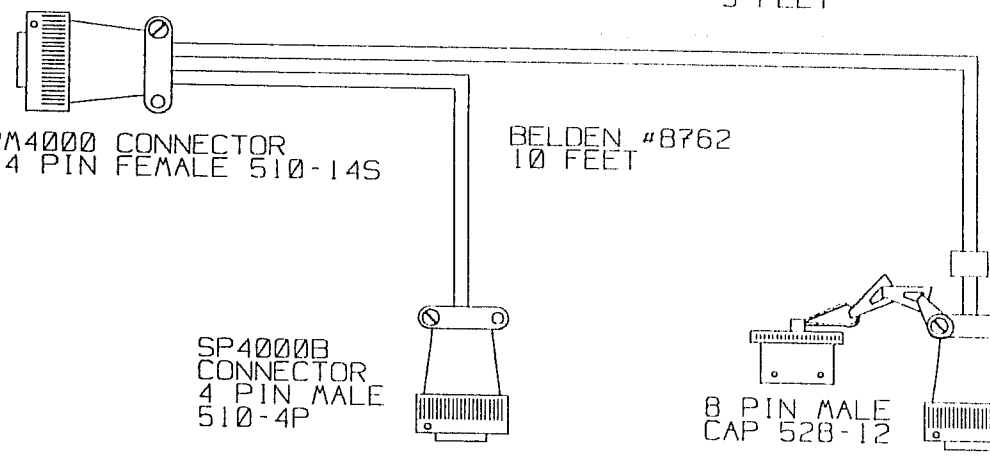
FOREST TECHNOLOGY SYSTEMS LTD

CBL-FWS-IBM

OCT 1991 PHIL JONES

RM-4000 CONNECTOR 510-14S			
PIN #	TO FWS-II	TO SPB	RM4000 FUNCTIONS
PIN A	N/C	N/C	RM AUDIO O/P
PIN B	N/C	N/C	RM AUDIO I/P
PIN C	N/C	N/C	RTS I/P
PIN D	GREEN	N/C	TX DATA O/P
PIN E	N/C	N/C	DSR O/P
PIN F	N/C	N/C	SELF TEST I/P
PIN G	N/C	N/C	PTT O/P
PIN H	JUMPER K	N/C	CTS I/P
PIN I	WHITE	N/C	DATA I/P
PIN J	N/C	N/C	CLOCK O/P
PIN K	RED	CLEAR	POWER I/P
PIN L	BLACK	BLACK	CHASSIS GND
PIN M	DRAIN	DRAIN	CHASSIS GND
PIN N	N/C	N/C	CHASSIS GND

INTERCONNECT TO IM4000 OR		
FWS-II TELEMETRY 520-128S		
PIN A	N/C	CTS I/P
PIN B	DRAIN	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	BLACK	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT



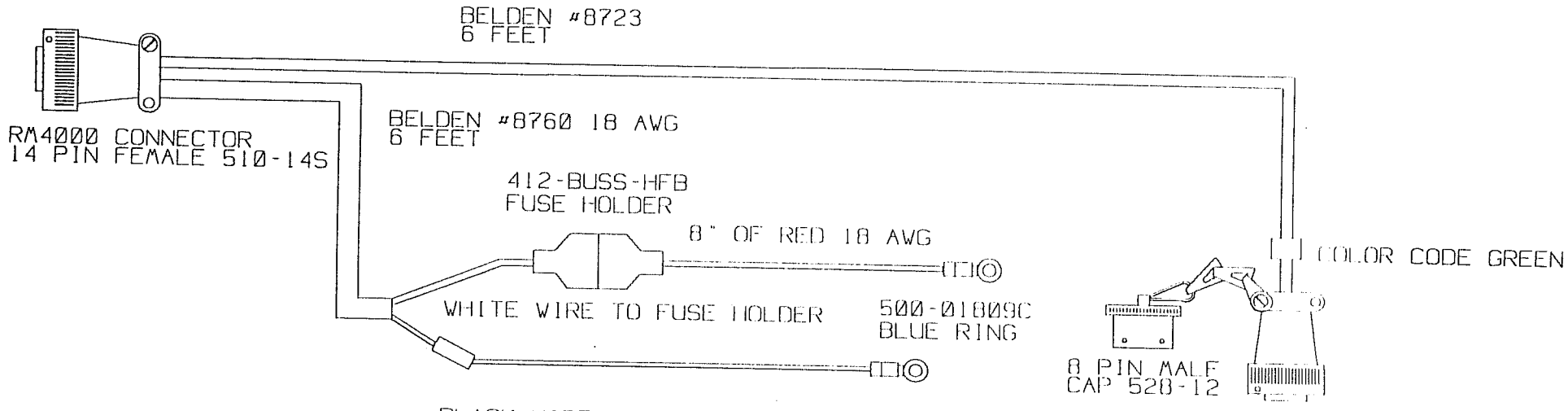
SP4000B OUTPUT 510-4P		
PIN A	CLEAR	13.8 VDC O/P
PIN B	BLACK	CHASSIS GND
PIN C	N/C	EXT CHARGE I/P
PIN D	DRAIN	CHASSIS GND

NOTE: IF CABLE IS USED FOR AN RM4000 STORE AND FORWARD SITE (CBL-SP-RM) BE SURE TO CAP THE FWS-II TELEMETRY CONNECTOR.

FOREST TECHNOLOGY SYSTEMS LTD

CBL-FWS-RM-F

JAN 1995 PHIL JONES



RM-4000 CONNECTOR 510-14S			
PIN #	TO FWS-II	TO BATT	RM4000 FUNCTIONS
PIN A	N/C	N/C	RM AUDIO O/P
PIN B	N/C	N/C	RM AUDIO I/P
PIN C	N/C	N/C	RTS I/P
PIN D	GREEN	N/C	TX DATA O/P
PIN E	N/C	N/C	DSR O/P
PIN F	N/C	N/C	SELF TEST I/P
PIN G	N/C	N/C	PTT O/P
PIN H	JUMPER K	N/C	CTS I/P
PIN I	WHITE	N/C	DATA I/P
PIN J	N/C	N/C	CLOCK O/P
PIN K	RED	RED	POWER I/P
PIN L	BLACK	BLACK	CHASSIS GND
PIN M	DRAIN	DRAIN	CHASSIS GND
PIN N	N/C	N/C	CHASSIS GND

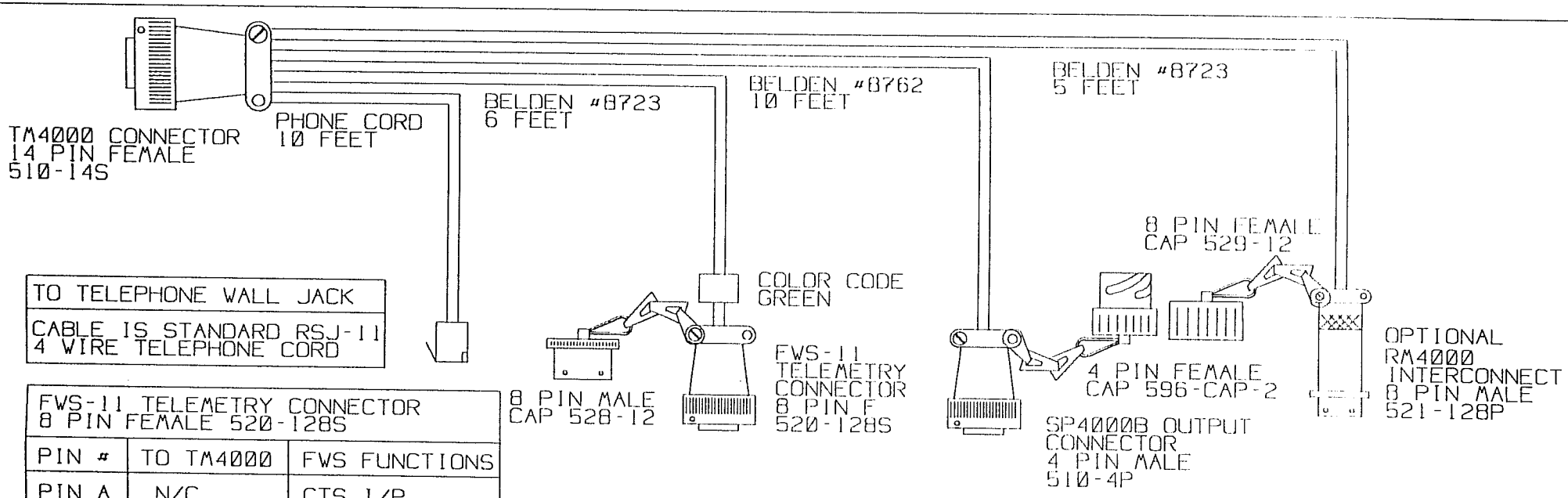
INTERCONNECT TO TM4000 OR FWS-II TELEMETRY 520-128S		
PIN A	N/C	CTS I/P
PIN B	DRAIN	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	BLACK	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT

NOTE: IF CABLE IS USED FOR AN RM4000 STORE AND FORWARD SITE (CBL-SP-RM) BE SURE TO CAP THE FWS-II TELEMETRY CONNECTOR.

FOREST TECHNOLOGY SYSTEMS LTD.

CBL-FWS-RM-BAT

OCT 1994 PHIL JONES



TO TELEPHONE WALL JACK
CABLE IS STANDARD RSJ-11 4 WIRE TELEPHONE CORD

FWS-II TELEMETRY CONNECTOR
8 PIN FEMALE 520-128S

PIN #	TO TM4000	FWS FUNCTIONS
PIN A	N/C	CTS I/P
PIN B	BLACK	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	DRAIN	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT

SP4000B OUTPUT 510-4P

PIN A	CLEAR	13.8 VDC O/P
PIN B	BLACK	CHASSIS GND
PIN C	N/C	EXT CHARGE I/P
PIN D	DRAIN	CHASSIS GND

NOTE: ANY UNUSED CONNECTORS MUST BE CAPPED TO PROTECT THEM FROM WATER DAMAGE. THIS CABLE CAN BE USED IN CONJUNCTION WITH THE CBL-SP-RM-FWS TO CREATE A CBL-SP-TM-RM-FWS.

TM4000 CONNECTOR 510-14S

PIN #	RM INTCON	TEL CORD	TO SPB	TO FWSII	TM4000 FUNCTIONS
PIN A	N/C	RED	N/C	N/C	TELPH RING
PIN B	N/C	GREEN	N/C	N/C	TELPH TIP
PIN C	RED	N/C	CLEAR	RED	PWR I/P
PIN D	N/C	N/C	N/C	GREEN	DATA O/P TO FWS
PIN E	WHITE	N/C	N/C	N/C	DATA I/P (OF RM)
PIN F	N/C	N/C	N/C	N/C	RTS I/P (TM)
PIN G	GREEN	N/C	N/C	N/C	DATA O/P (OF RM)
PIN H	N/C	N/C	N/C	WHITE	DATA I/P FROM FWS
PIN I	N/C	N/C	N/C	N/C	EXT CLOCK O/P
PIN J	N/C	N/C	N/C	N/C	RTS O/P (TTL)
PIN K	N/C	BLACK	N/C	N/C	TELPH BLACK
PIN L	N/C	N/C	N/C	N/C	DATA I/P (WR)
PIN M	N/C	YELLOW	N/C	N/C	TELPH YELLOW
PIN N	BLK&DRN	N/C	BLK&DRN	BLK&DRN	CHASSIS GND

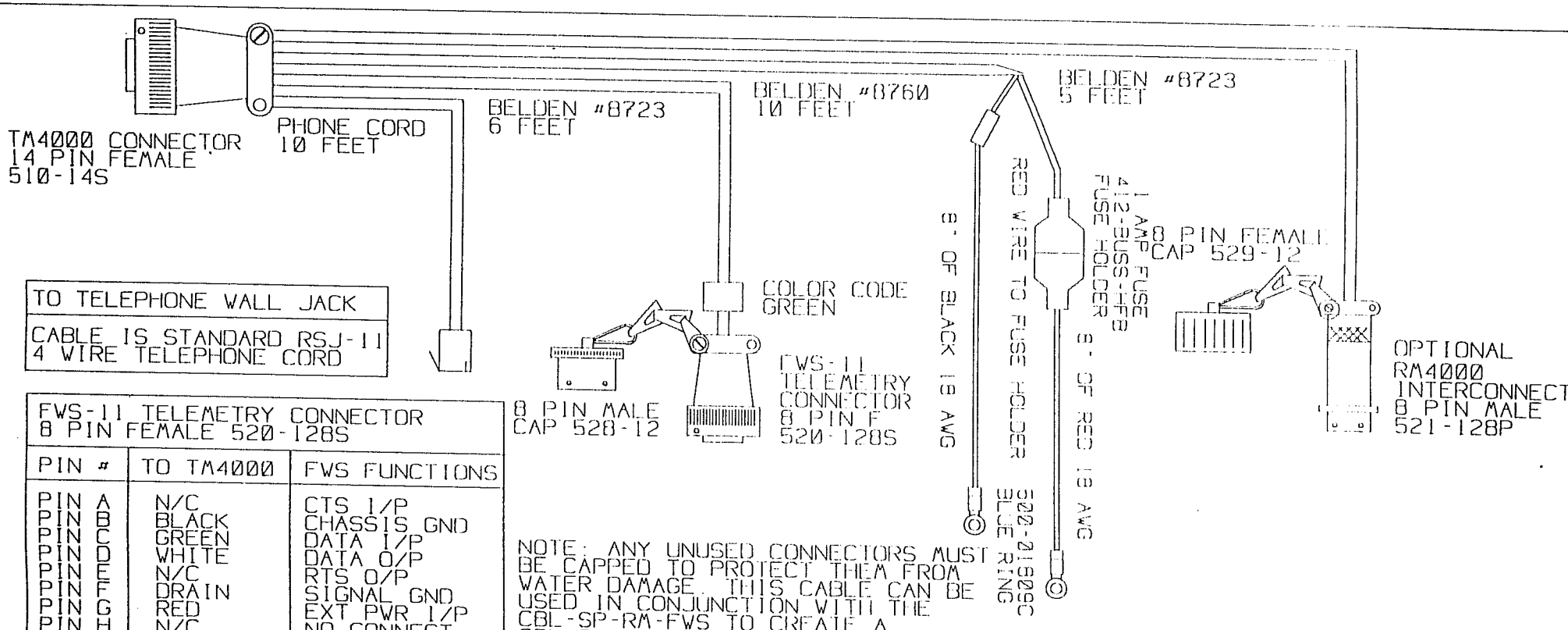
RM-4000 INTERCONNECT 521-128P

PIN #	TO TM4000	RM INTERCON FUNC
PIN A	N/C	NO CONNECT
PIN B	DRAIN	CHASSIS GND
PIN C	GREEN	RM DATA O/P
PIN D	WHITE	RM DATA I/P
PIN E	N/C	NO CONNECT
PIN F	BLACK	SIGNAL GND
PIN G	RED	EXT POWER I/P
PIN H	N/C	NO CONNECT

FOREST TECHNOLOGY SYSTEMS LTD

CBL-FWS-TM-F

JAN 1995 PHIL JONES



TO TELEPHONE WALL JACK
CABLE IS STANDARD RSJ-11 4 WIRE TELEPHONE CORD

FWS-II TELEMETRY CONNECTOR
8 PIN FEMALE 520-128S

PIN #	TO TM4000	FWS FUNCTIONS
PIN A	N/C	CTS I/P
PIN B	BLACK	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	DRAIN	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT

NOTE: ANY UNUSED CONNECTORS MUST BE CAPPED TO PROTECT THEM FROM WATER DAMAGE. THIS CABLE CAN BE USED IN CONJUNCTION WITH THE CBL-SP-RM-FWS TO CREATE A CBL-SP-TM-RM-FWS.

TM4000 CONNECTOR 510-14S

PIN #	RM INTCON	TEL CORD	TO SPB	TO FWSII	TM4000 FUNCTIONS
PIN A	N/C	RED	N/C	N/C	TELPH RING
PIN B	N/C	GREEN	N/C	N/C	TELPH TIP
PIN C	RED	N/C	CLEAR	RED	PWR I/P
PIN D	N/C	N/C	N/C	GREEN	DATA O/P TO FWS
PIN E	WHITE	N/C	N/C	N/C	DATA I/P (OF RM)
PIN F	N/C	N/C	N/C	N/C	RTS I/P (TM)
PIN G	GREEN	N/C	N/C	N/C	DATA O/P (OF RM)
PIN H	N/C	N/C	N/C	WHITE	DATA I/P FROM FWS
PIN I	N/C	N/C	N/C	N/C	EXT CLOCK O/P
PIN J	N/C	N/C	N/C	N/C	RTS O/P (TTL)
PIN K	N/C	BLACK	N/C	N/C	TELPH BLACK
PIN L	N/C	N/C	N/C	N/C	DATA I/P (WR)
PIN M	N/C	YELLOW	N/C	N/C	TELPH YELLOW
PIN N	BLK&DRN	N/C	BLK&DRN	BLK&DRN	CHASSIS GND

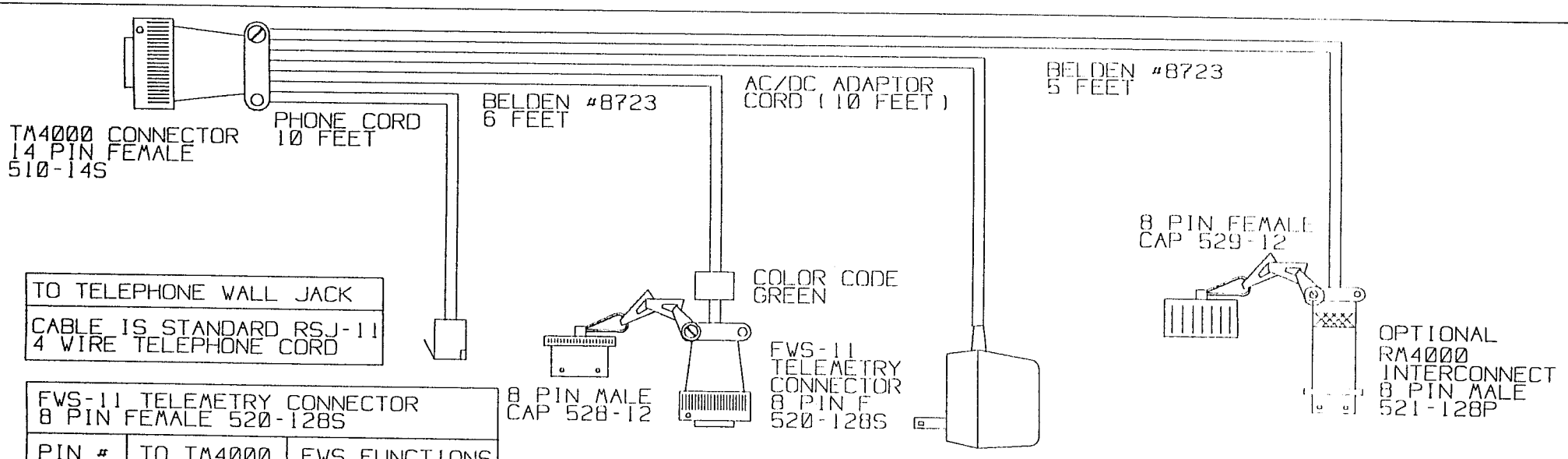
RM-4000 INTERCONNECT 521-128P

PIN #	TO TM4000	RM INTERCON FUNC
PIN A	N/C	NO CONNECT
PIN B	DRAIN	CHASSIS GND
PIN C	GREEN	RM DATA O/P
PIN D	WHITE	RM DATA I/P
PIN E	N/C	NO CONNECT
PIN F	BLACK	SIGNAL GND
PIN G	RED	EXT POWER I/P
PIN H	N/C	NO CONNECT

FOREST TECHNOLOGY SYSTEMS LT

CBL-FWS-TM-BAT

JUNE 1994 PHIL JONES



TO TELEPHONE WALL JACK
CABLE IS STANDARD RSJ-11 4 WIRE TELEPHONE CORD

NOTE: ANY UNUSED CONNECTORS MUST BE CAPPED TO PROTECT THEM FROM WATER DAMAGE. THIS CABLE CAN BE USED IN CONJUNCTION WITH THE CBL-SP-RM-FWS TO CREATE A CBL-SP-TM-RM-FWS.

FWS-11 TELEMETRY CONNECTOR
8 PIN FEMALE 520-128S

PIN #	TO TM4000	FWS FUNCTIONS
PIN A	N/C	CTS I/P
PIN B	BLACK	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	DRAIN	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT

TM4000 CONNECTOR 510-14S

PIN #	RM INTCON	TEL CORD	TO AC/DC	TO FWS11	TM4000 FUNCTIONS
PIN A	N/C	RED	N/C	N/C	TELPH RING
PIN B	N/C	GREEN	N/C	N/C	TELPH TIP
PIN C	RED	N/C	STRIPE +	RED	PWR I/P
PIN D	N/C	N/C	N/C	GREEN	DATA O/P TO FWS
PIN E	WHITE	N/C	N/C	N/C	DATA I/P (OF RM)
PIN F	N/C	N/C	N/C	N/C	RTS I/P (TM)
PIN G	GREEN	N/C	N/C	N/C	DATA O/P (OF RM)
PIN H	N/C	N/C	N/C	WHITE	DATA I/P FROM FWS
PIN I	N/C	N/C	N/C	N/C	EXT CLOCK O/P
PIN J	N/C	N/C	N/C	N/C	RTS O/P (TTL)
PIN K	N/C	BLACK	N/C	N/C	TELPH BLACK
PIN L	N/C	N/C	N/C	N/C	DATA I/P (WR)
PIN M	N/C	YELLOW	N/C	N/C	TELPH YELLOW
PIN N	BLK&DRN	N/C	BLACK -	BLK&DRN	CHASSIS GND

RM-4000 INTERCONNECT 521-128P

PIN #	TO TM4000	RM INTERCON FUNC
PIN A	N/C	NO CONNECT
PIN B	DRAIN	CHASSIS GND
PIN C	GREEN	RM DATA O/P
PIN D	WHITE	RM DATA I/P
PIN E	N/C	NO CONNECT
PIN F	BLACK	SIGNAL GND
PIN G	RED	EXT POWER I/P
PIN H	N/C	NO CONNECT

FOREST TECHNOLOGY SYSTEMS LTD

CBL-FWS-TM-AC

JAN 1995 PHIL JONES

COLOR CODE
GREEN

COLOR CODE
GREEN

FWS-11
TELEMETRY
CONNECTOR
8 PIN F
520-128S

RM4000
INTERCONNECT
8 PIN MALE
521-128P

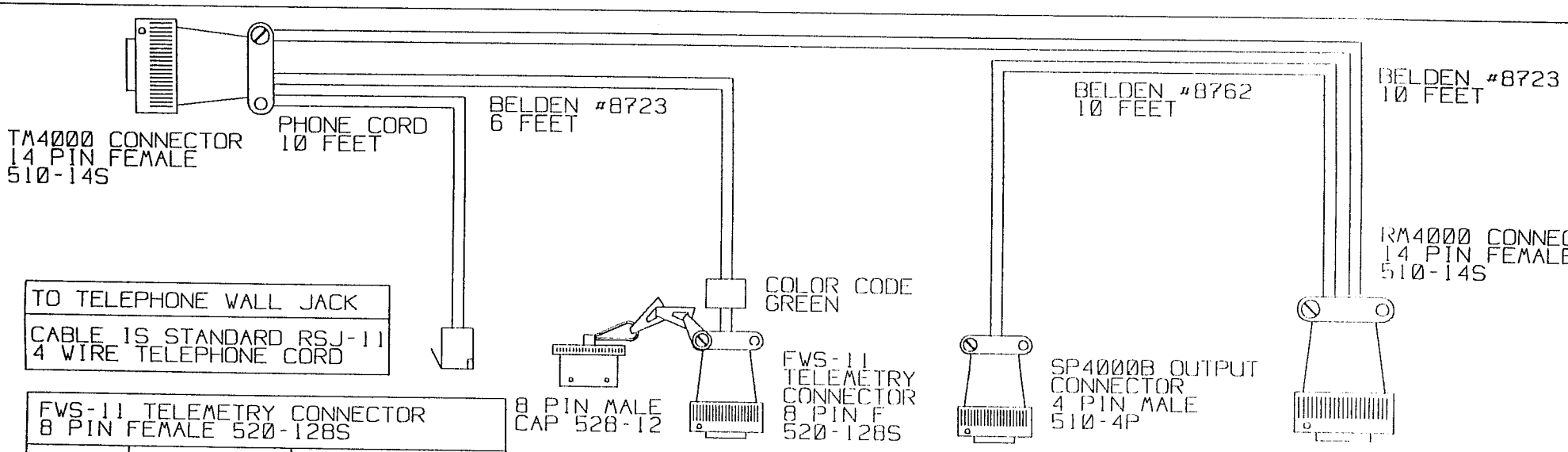
FWS-11 TELEMETRY CONNECTOR 8 PIN FEMALE 520-128S		
PIN #	TO INTER	FWS FUNCTIONS
PIN A	N/C	CTS I/P
PIN B	BLACK	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	DRAIN	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT

FWS-11 TELEMETRY INTERCONNECT 8 PIN MALE 521-128P		
PIN #	TO INTER	FWS FUNCTIONS
PIN A	N/C	CTS I/P
PIN B	BLACK	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	DRAIN	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT

FOREST TECHNOLOGY SYSTEMS LTD

CBL-FWS EXT-TM

JUNE 1992 PHIL JONES



TO TELEPHONE WALL JACK
CABLE IS STANDARD RSJ-11 4 WIRE TELEPHONE CORD

FWS-11 TELEMETRY CONNECTOR 8 PIN FEMALE 520-128S

PIN #	TO TM4000	FWS FUNCTIONS
PIN A	N/C	CTS I/P
PIN B	BLACK	CHASSIS GND
PIN C	GREEN	DATA I/P
PIN D	WHITE	DATA O/P
PIN E	N/C	RTS O/P
PIN F	DRAIN	SIGNAL GND
PIN G	RED	EXT PWR I/P
PIN H	N/C	NO CONNECT

SP4000B OUTPUT 510-4P

PIN A	CLEAR	13.8 VDC O/P
PIN B	BLACK	CHASSIS GND
PIN C	N/C	EXT CHARGE I/P
PIN D	DRAIN	CHASSIS GND

RM-4000 CONNECTOR 510-14S

PIN #	TO TM	TO SPB	RM4000 FUNCTIONS
PIN A	N/C	N/C	RM AUDIO O/P
PIN B	N/C	N/C	RM AUDIO I/P
PIN C	N/C	N/C	RTS I/P
PIN D	GREEN	N/C	TX DATA O/P
PIN E	N/C	N/C	DSR O/P
PIN F	N/C	N/C	SELF TEST I/P
PIN G	N/C	N/C	PTT O/P
PIN H	JUMPER K	N/C	CTS I/P
PIN I	WHITE	N/C	DATA I/P
PIN J	N/C	N/C	CLOCK O/P
PIN K	RED	CLEAR	POWER I/P
PIN L	BLACK	BLACK	CHASSIS GND
PIN M	DRAIN	DRAIN	CHASSIS GND
PIN N	N/C	N/C	CHASSIS GND

NOTE: ANY UNUSED CONNECTORS MUS
BE CAPPED TO PROTECT THEM FROM
WATER DAMAGE.

TM4000 CONNECTOR 510-14S

PIN #	TO RM4000	TEL CORD	TO FWS11	TM4000 FUNCTIONS
PIN A	N/C	RED	N/C	TELPH RING
PIN B	N/C	GREEN	N/C	TELPH TIP
PIN C	RED	N/C	RED	PWR I/P
PIN D	N/C	N/C	GREEN	DATA O/P TO FWS
PIN E	WHITE	N/C	N/C	DATA I/P (OF RM)
PIN F	N/C	N/C	N/C	RTS I/P (TM)
PIN G	GREEN	N/C	N/C	DATA O/P (OF RM)
PIN H	N/C	N/C	WHITE	DATA I/P FROM FWS
PIN I	N/C	N/C	N/C	EXT CLOCK O/P
PIN J	N/C	N/C	N/C	RTS O/P (TTL)
PIN K	N/C	BLACK	N/C	TELPH BLACK
PIN L	N/C	N/C	N/C	DATA I/P (WR)
PIN M	N/C	YELLOW	N/C	TELPH YELLOW
PIN N	BLK&DRN	N/C	BLK&DRN	CHASSIS GND

FOREST TECHNOLOGY SYSTEMS LTD

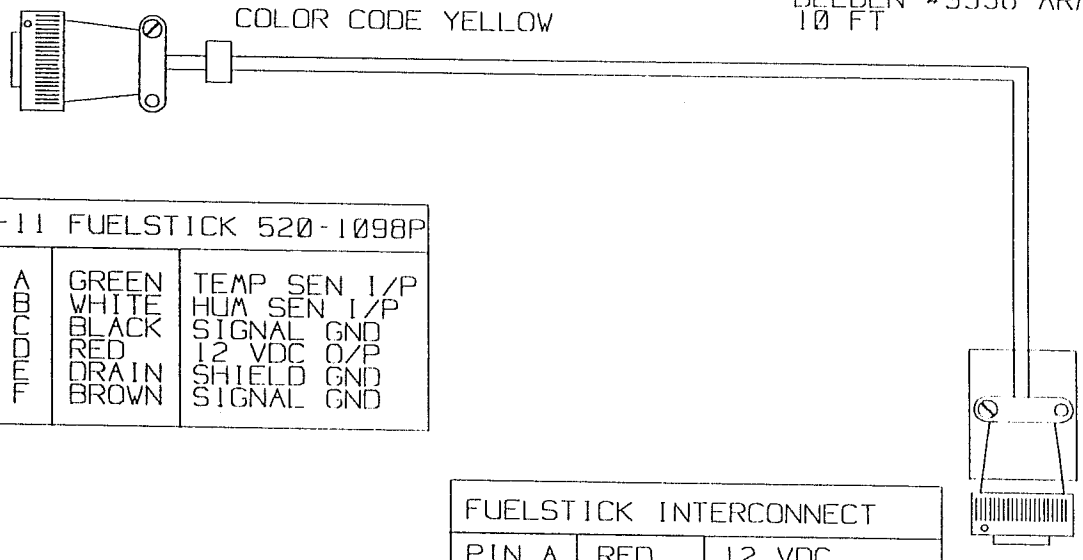
CBL-FWS-TM-RM

JAN 1995 PHIL JONES

TO FWS FUEL STICK CONNECTOR
6 PIN MALE 520-1098P

COLOR CODE YELLOW

BELDEN #9536 ARMOURED
10 FT



TO FUEL STICK CONNECTOR
6 PIN FEMALE 530 1812S
HEAT SHRINK BACKSHELL

FWS-11 FUELSTICK 520-1098P		
PIN A	GREEN	TEMP SEN I/P
PIN B	WHITE	HUM SEN I/P
PIN C	BLACK	SIGNAL GND
PIN D	RED	12 VDC O/P
PIN E	DRAIN	SHIELD GND
PIN F	BROWN	SIGNAL GND

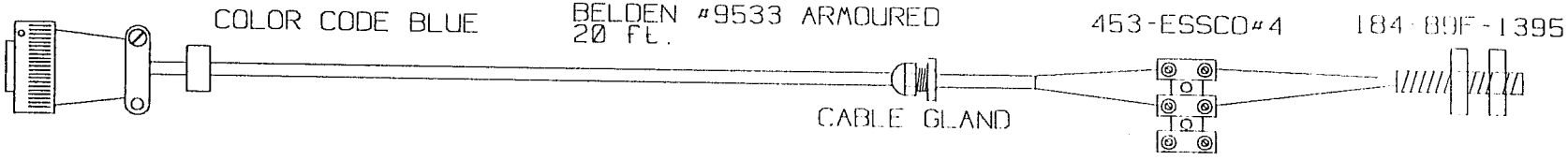
FUELSTICK INTERCONNECT		
PIN A	RED	12 VDC
PIN B	BLACK	SIGNAL GND
PIN C	WHITE	MOISTURE
PIN D	GREEN	TEMPERATURE
PIN E	BROWN	SIGNAL GND
PIN F	N/C	N/C

FOREST TECHNOLOGY SYSTEMS LTD

CBL-FS

JAN 1995 PHIL JONES

TO FWS-II RAIN CONNECTOR
3 PIN MALE 520-83AP

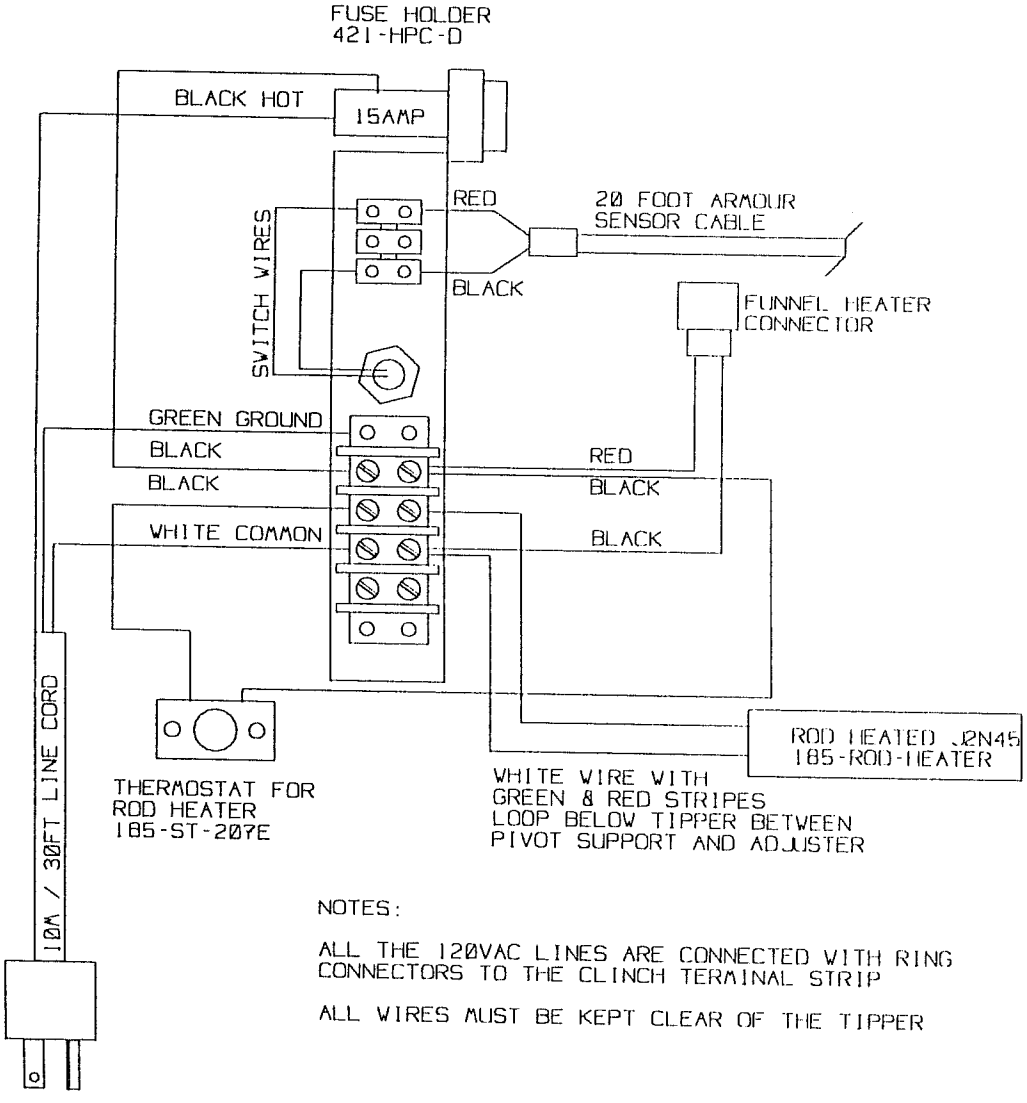


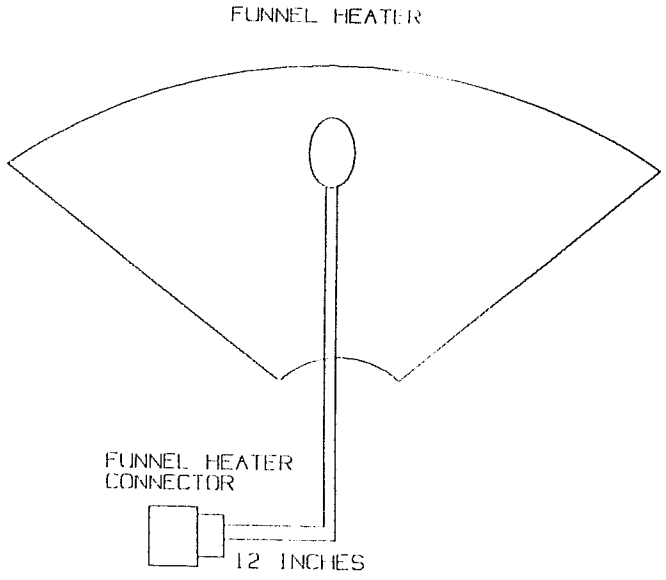
FWS-II RAIN 520-83AP		
PIN A	BLACK	SIGNAL GND
PIN B	WHITE	DATA O/P
PIN C	DRAIN	CHASSIS GND

FOREST TECHNOLOGY SYSTEMS LTD

00-RG-CBL-ARM

JAN 1995 PHIL JONES





NOTES:

ALL THE 120VAC LINES ARE CONNECTED WITH RING CONNECTORS TO THE CLINCH TERMINAL STRIP

ALL WIRES MUST BE KEPT CLEAR OF THE TIPPER

FOREST TECHNOLOGY SYSTEMS LTD	
TITLE: RG-E12-20/30	
FILE: RGHEAT.DWG	SHEET: 1 OF
DATE: 27-09-93	REV: 1.01
SCALE NOT TO SCALE	DWG. #:
DRAWN BY: PHIL JONES	

APPENDIX B MAINTENANCE SHEETS

FWS-11 Datalogger Maintenance/Repair Sheet

Date: / / RMA# 9☐-☐☐☐ __ of __

☐ Annual Maintenance - 1 Year ☐ Corrective maintenance - 90 Day Warranty ☐ Warranty Repair - No Charge

Customer Information

Company

Address

City Prov./State Zip Code

Equipment Information

Serial No. Firmware

Microprocessor type:

☐ A0 ☐ A1

Checks

Preliminary checks:
- ☐ Apply 12-14VDC to +TP#1, -TP#19, or TP18
- ☐ Check CPU voltage at TP15 within 4.8VDC to 5.2VDC
- ☐ Check CPU clock at TP9 3072.000KHz +/- 0.001KHz (adjust CV1 if required)
- ☐ Check A/D adjustment using tech menu - apply 1.000VDC to input (adjust R38 until 10000 is displayed if required)
- ☐ Connect all inputs to calibrator box cables

Sensor input checks
- ☐ Current consumption 4-6 mA/display off, 15-20 mA/display on, 25mA/A/D sampling

Rain:
- ☐ Use 'tech' menu to confirm rain counts

Wind Speed:
- ☐ Use 'tech' menu to confirm wind counts

Wind Direction:
- ☐ Select plastic or metal on calibration box
- ☐ Check 8 trip points with 'current weather' menu

Temp/hum or fuel stick:
- ☐ Select Temp or Fuel Stick on calibration box/check reading with 'current weather' menu
- ☐ Adjust variable supply to 1.000VDC/check reading with 'Tech Menu'/adjust to 0.450VDC
- ☐ Check telemetry port using FWP or FUTIL then clear station memory
- ☐ Note V2.21 requires A1 processor. Then configure to sensor type of customer.

Description of Fault/Repair

Technician: _____

Parts

Quant.	Part No.	Cost	Quant.	Part No.	Cost

FWS-11 Metal Sensor Set Maintenance / Repair Sheet

Date: / / RMA# 9☐-☐☐☐ __ of __

☐ Annual Maintenance - 1 Year ☐ Corrective maintenance - 90 Day Warranty ☐ Warranty Repair - No Charge

Customer Information

Company

Address

City Prov./State Zip Code

Equipment Information

All Serial Numbers Listed Below

Custom Cable Length

Configured for use with: FWS-11

THS-1 Temperature/Humidity Sensor - Hycal (Red)

FTS Serial # _____ Transducer Serial # _____

- ☐ With sol screen? (Y/N)
- ☐ Check connector
- ☐ Red color-coding tape
- ☐ Inspect base connections
- ☐ Circuit board free of corrosion
- ☐ Room humidity test ±2%
- ☐ 100% humidity test
- ☐ Temp. within 1°C of thermometer

If transducer replaced:

- ☐ Re-cal transducer levels, 5%____VDC, 75%____VDC

Description of Fault/Repair

Technician: _____

Parts

Quant.	Part No.

WSM-20 Wind Speed Sensor (Red)

FTS Serial No. _____

- ☐ Check connectors + cable
- ☐ Red color coding tape
- ☐ Inspect sensor head/date code
- ☐ Check operation - 2 closures per revolution
- ☐ Threshold friction test

Description of Fault/Repair

Technician: _____

Parts

Quant.	Part No.

WDM-20 Wind Direction Sensor (Yellow)

FTS Serial No. _____

- ☐ Check connectors + cable
- ☐ Yellow color coding tape
- ☐ Inspect sensor head
- ☐ Check operation of all 8 trip points
- ☐ Alignment of label correct

Description of Fault/Repair

Technician: _____

Parts

Quant.	Part No.

RG-T Rain Gauge (Blue)

FTS Serial No. _____

- ☐ Check connector
- ☐ Blue color-coding tape
- ☐ Clean funnel
- ☐ Check tipper free-play
- ☐ Check connectors for corrosion
- ☐ Calibrate unit - 8.2ml/tip (monitor 7.2ml/tip)
- ☐ Check operation

Description of Fault/Repair

_____

_____

_____

Technician: _____

Parts

Quant.	Part No.

FS-11 Fuel Stick Sensor (Yellow)

FTS Serial No. _____

- ☐ Check connector
- ☐ Test cable (if included)
- ☐ Yellow color coding tape
- ☐ Circuit board free of corrosion
- ☐ Temp. within 1°C of thermometer
- ☐ Room humidity test ±2%
- ☐ 100% humidity test (26%FSM)
- ☐ New fuel stick dowel replaced (00-FS-11)

If replacement required:

- ☐ Re-cal levels of new transducer 5% ___ VDC 75% ___ VDC

Transducer Serial No. _____

- ☐ Handar fuel stick? No warranty - calibration check only

Handar Serial No. _____

Description of Fault/Repair

_____

_____

_____

Technician: _____

Parts

Quant.	Part No.

FWS-11 Plastic Sensor Set Maintenance / Repair Sheet

Date: / / RMA# 9 ☐ – ☐☐☐ __ of __

☐ Annual Maintenance - 1 Year ☐ Corrective maintenance - 90 Day Warranty ☐ Warranty Repair - No Charge

Customer Information

Company

Address

City Prov./State Zip Code

Equipment Information

All Serial Numbers Listed Below

Custom Cable Length

Configured for use with: FWS-11

TH-11 Temperature/Humidity Sensor - Physchem (Red)

FTS Serial # _____ Transducer Serial # _____

- ☐ With stainless steel filter screen and sol screen? (Y/N)
- ☐ Add serial number label
- ☐ Check connector
- ☐ Red color-coding tape
- ☐ Inspect base connections
- ☐ Replace transducer - (991-humidity)
- ☐ Temperature within 1°C of thermometer
- ☐ Humidity ±5%
- ☐ Solar screen cleaned

Description of Fault/Repair

Technician: _____

Parts

Quant.	Part No.

WS-11 Wind Speed Sensor (Red)

FTS Serial No. _____

- ☐ Check connectors
- ☐ Red color coding tape
- ☐ Inspect sensor head/date code
- ☐ Check operation - reed
- ☐ Threshold friction test

Description of Fault/Repair

Technician: _____

Parts

Quant.	Part No.

WD-11 Wind Direction Sensor (Yellow)

FTS Serial No. _____

- ☐ Check connector
- ☐ Yellow color coding tape
- ☐ Inspect sensor head
- ☐ Check operation of all 8 trip points
- ☐ Alignment of label correct

Description of Fault/Repair

Technician: _____

Parts

Quant.	Part No.

RG-11 Rain Gauge - Monitor style (Blue)

FTS Serial No. _____

- ☐ Clean syphon at base of funnel
- ☐ Check connector
- ☐ Blue color-coding tape
- ☐ Check for tipper bucket free play
- ☐ Nylon tipper stops
- ☐ Check connections for corrosion
- ☐ Calibrate unit - 8.2ml/tip (monitor 7.2ml/tip)
- ☐ Check operation

Description of Fault/Repair

_____

_____

_____

Technician: _____

Parts

Quant.	Part No.

FS-11 Fuel Stick Sensor (Yellow)

FTS Serial No. _____

- ☐ Check connector
- ☐ Test cable (if included)
- ☐ Yellow color coding tape
- ☐ Circuit board free of corrosion
- ☐ Temp. within 1°C of thermometer
- ☐ Room humidity test ±2%
- ☐ 100% humidity test (26%FSM)
- ☐ New fuel dowel replaced (00-FS-11)

Description of Fault/Repair

_____

_____

_____

Technician: _____

Parts

Quant.	Part No.

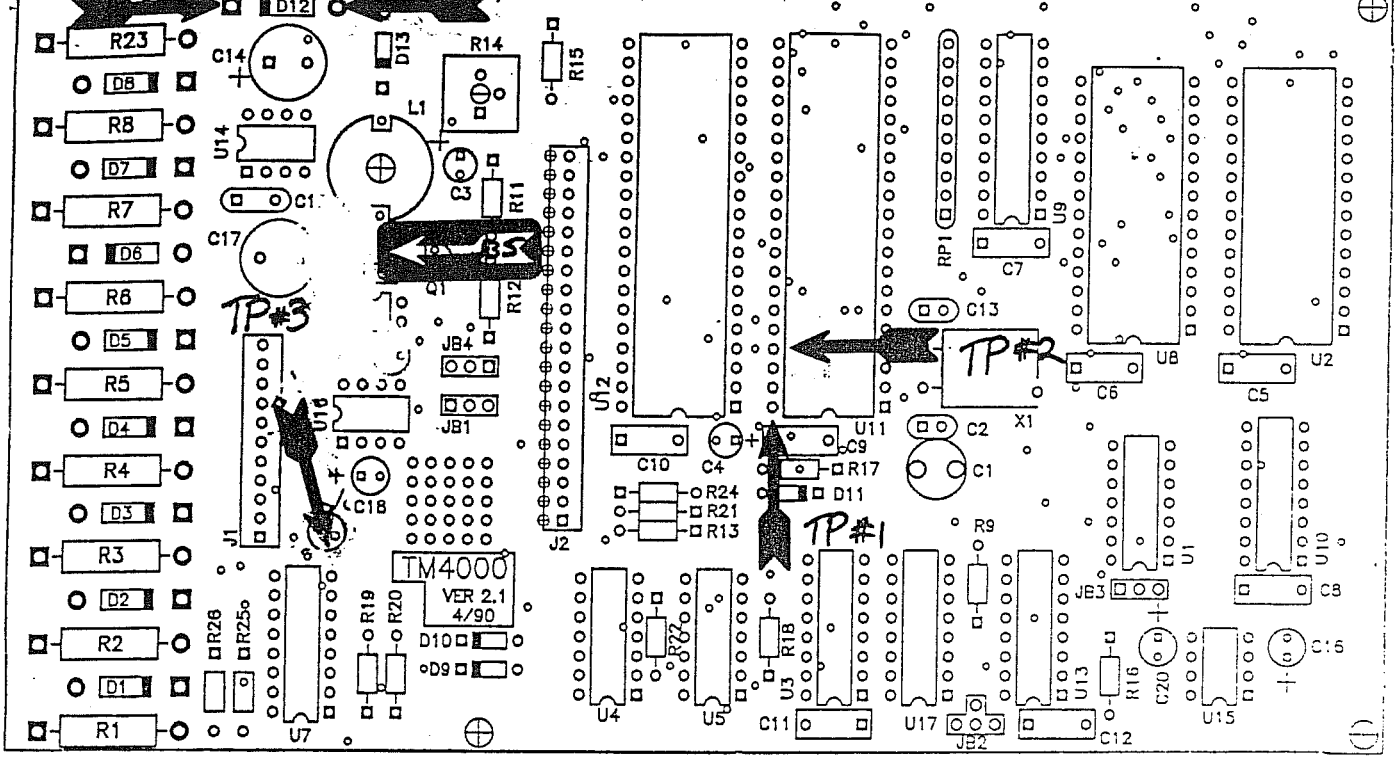
If replacement required:

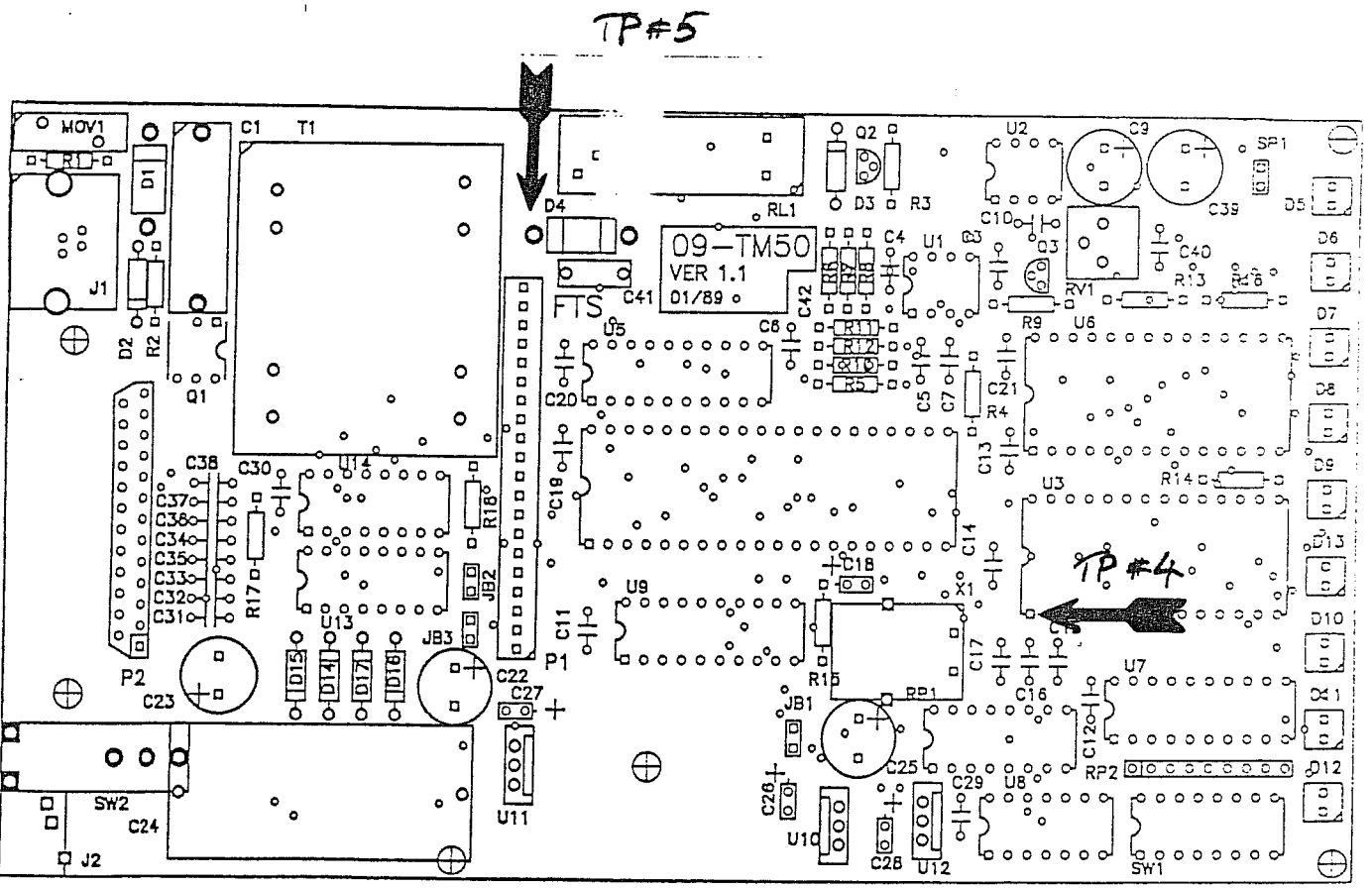
☐ Re-cal levels of new transducer 5% ___ VDC 75% ___ VDC

Transducer Serial No. _____

☐ Handar fuel stick? No warranty - calibration check only

Handar Serial No. _____


TP#3
TP#2
TP#1
TM4000
VER 2.1
4/90


TP#5
TP#4
09-TM50
VER 1.1
01/89
FTS

TM Maintenance / Repair Sheet

Biege Case (New Style)

Date: / / RMA# 9 ☐ - ☐☐☐ __ of __

☐ Annual Maintenance - 1 Year ☐ Corrective maintenance - 90 Day Warranty ☐ Warranty Repair - No Charge

Customer Information

Company

Address

City Prov./State Zip Code

Equipment Information

Serial No. Firmware

Configured For Use With:

☐ AWL/CD ☐ WR62 ☐ FWP
☐ NECOLS ☐ FWS-11 ☐ DCAMS

Checks

Preliminary checks:
- ☐ Answers call on the _____ ring
- ☐ Produces connect tones after answer
- ☐ Transmits weather data to hub
- ☐ Reports correct battery voltage (+/- 0.1V) (option not always used)
- ☐ Reports baud rate of 1200

CPU board checks:
- ☐ Power supplies: TP #1 +5V_____V +/- 0.25V TP #3 -5V_____V +/-0.25V
- ☐ CPU clock _____KHz (3072.000KHz +/- 0.010KHz)
- ☐ Firmware version 1.27 CD/AWL, 1.7 FWP, 2.7 CD/NECOLS

Modem board checks:
- ☐ Place JB5 (CPU) farthest from Q1. All dip switches off except #2.
- ☐ 2 Vpp scramble-tone at TP #5 D4
- ☐ Clock frequency TP #4 Pin #1 U3 _____MHz (11.0592 MHz)
- ☐ Reset jumpers and DIP switches for normal operation
- ☐ Active current _____mA (<20mA)
- ☐ Stand-by current _____mA (after 20 seconds <10mA) (except CD modems)

Final checks:
- ☐ Add dessicant

Call-up test:
- ☐ FWP call-up test to local FWS-11 or WR62 (BCDCAMS)
- ☐ FWP call-up test to local RM4000 or TS4000 (NECOLS)
- ☐ Leak test

Description of Fault/Repair

_____

_____

_____

_____

_____ Technician: _____

Parts

Quant.	Part No.	Cost

Quant.	Part No.	Cost

RM4000 Maintenance / Repair Sheet

(Serial No. 0161 - 02xx)

Date: / / RMA# 9☐-☐☐☐ __ of __

☐ Annual Maintenance - 1 Year ☐ Corrective maintenance - 90 Day Warranty ☐ Warranty Repair - No Charge

Customer Information

Company

Address

City Prov./State Zip Code

Equipment Information

Serial No. Radio Type

Firmware CTSS Tone

Tx Channel Rx Channel

Checks

Tranciever checks:
- ☐ Sensitivity: _____uV @12dB SINAD
- ☐ Transmit power: _____Watts @13.8VDC
- ☐ Transmit frequency error: _____Hz (<500Hz)
- ☐ Check specifications for other channels
- ☐ Squelch open

CPU board checks:
- ☐ Power supplies: +12.07V_____V +5V_____V -5V_____V
- ☐ CPU clock _____KHz (3072.000KHz +/- 0.010KHz)

Modem board checks:
- ☐ Power supplies: +5V:_____V
- ☐ Demod adjust (perform loop back test)
- ☐ Input level adjust
- ☐ Transmit deviation adjust _____KHz deviation (2.5KHz TYP)
- ☐ Receive test current _____mA
- ☐ RM wakes up, stable data signal at: _____uV (0.35uV)

Final checks:
- ☐ Add dessicant
- ☐ Self test
- ☐ Call-up test
- ☐ Leak test

Description of Fault/Repair

_____

_____

_____

_____

_____

_____

_____ **Technician:** _____

Parts

Quant.	Part No.	Cost

Quant.	Part No.	Cost