# 8" STANDARD RAIN GAUGE

## I. GENERAL DESCRIPTION:

The 8" standard rain gauge has three components: A large outer container called the overflow can, which is 8 inches in diameter and almost 24 inches tall; A brass or clear plastic measure tube, which is 2.5 inches in diameter and 20 inches deep; a copper or white plastic collector (funnel), which is 8 inches in diameter. A fourth article that completes the set is the measuring stick, which will measure up to two inches of liquid. Since there is a 10 to 1 ratio, the measure stick may be used to measure snow depth; one tenth inch on the stick is one inch of snow depth.

The collector rests atop the tube which is inside the overflow can. Rainfall is funneled into the tube which holds exactly 2 inches of water when full. If rainfall overfills the tube, the excess is caught in the outer overflow can. To measure rainfall that is less than 2 inches, simply place the measuring stick inside the tube slowly until it touches the bottom. Withdraw and read the top of the water mark on the stick, which is graduated in tenths and hundredths. For amounts greater than 2 inches, dump the first 2 inches from the full measure tube, pour the overflow from the outer can into the measure tube and then measure it. Remember to add the 2 inches from the full tube. In extremely heavy storms, it may be necessary to pour water into the tube several times. A good way to remember is to write it down each time.

Wind shields can be used in areas where snow constitutes 20 percent of the total catch. In areas where heavy snowfall occurs, gauges are mounted on supports at heights well above the average level to which snow accumulates. In some cases, they must be mounted on towers to avoid being completely covered with snow. The wind shield should be used in such cases.

## II. OPERATIONS:

Observations are NORMALLY taken 24 hours apart at the designated time. The preferred time for hydrological purposes is the early morning while the preferred time for temperature observations is in the evening. For climatological purposes, rainfall readings should be taken at the same time as temperature readings. Times

# 8" STANDARD RAIN GAUGE - CONTINUED

**II. OPERATIONS - CONTINUED:**

of temperature observations should not be changed except in rare cases. Most reporting rainfall stations have an observation time of 7AM. A reading taken within 30 minutes of the designated time of observation is considered as taken at the designated time.

In many case supplemental precipitation observations are taken as the result of heavy rains. If these supplemental readings are taken, these supplemental amounts must be added together to determine the 24 hour total. These supplemental observations are normally taken if the rainfall equals one quarter inch in the last 3 hours or a half inch in the last 6 hours. These amounts can change bases on the needs of the area.

Each day, at the designated time, the observer should check the gauge for precipitation. First, the observer should look into the funnel to see if water can be seen. If so, the tube is likely full and the funnel should be removed very carefully so they do not spill any water. If the tube is full, empty it and then pour from the overflow can until the can is empty or until the tube becomes full again. Add successive readings until a total is reached. Remember that a full tube is equal to 2" of rainfall.

If no water can be seen, looking into the funnel, slowly lower the measuring stick into the tube and let it rest on the bottom momentarily. Water will adhere to the stick at the level corresponding to amount in the tube.

In times of frozen or freezing temperatures, the collector and measure tube should be removed and stored for two good reasons:

1) To more accurately get a true catch of snow (or other forms of frozen precipitation)
2) To prevent damage to the tube if liquid precipitation were to freeze inside the tube.

If frozen or freezing precipitation is collected, the fastest way to thaw it so it can be measured is to measure an amount of hot water, pour it into the overflow can and melt the frozen precipitation. The total liquid is then measured and the amount of hot water is subtracted, giving the total liquid value. Another slower method is to bring the overflow can indoors and

**II. OPERATIONS - CONTINUED:**

place it by a heat source. After the frozen precipitation has melted, a reading can be taken using the measure stick. Most often there will only be one entry for precipitation on the B-91 or B-92 that is the amount of liquid precipitation that

fell. If frozen or freezing precipitation occurred, there will be at least two entries and likely three. The first column is for liquid precipitation reported in inches, tenths and hundredths; the second column is for frozen precipitation and this is reported in inches and tenths; and the next column is for total frozen precipitation on the ground at observation time and this value is reported in whole inches.

**III. INSTALLATION:**

The 8" standard rain gauge is installed in a metal support that is attached to three stakes driven in the ground. The support is mounted firmly and so the top of the gauge is level, and the base is 10 to 15 inches above the ground. Be sure to protect the collector (funnel)from dents or damage, as this will effect the catch. The support has a complete set of nuts, bolts and washers provided by the manufacturer which are made of aluminum. From experience it is noted that in time these components will corrode and often break. Avoid this problem by replacing the nuts, bolts and washers with components made of stainless steel.

A good installation also includes a good exposure. A wide open area is good except during high wind. Any appreciable wind has an effect on the catch, the greater the wind speed, the greater probability for error. An exposure that dampens the wind speed yet does not hinder the catch is a better exposure. Sites may be protected or open as defined in the "Observing Handbook No. 2". Since a perfect exposure is the exception rather than the rule and you must to use your own discretion. However, there are limits that one can accept. In brief, a rule to shoot for is:

> **For an Open Exposure the distance from the gauge to the obstruction should be at least twice the height for individual or small groups of objects. In a more protected area, the height of the obstruction should not exceed twice their distance from the gauge.**

# 8" STANDARD RAIN GAUGE - CONTINUED

**IV. MAINTENANCE:**

Tighten all nuts and bolts when needed. Check measuring tube and overflow can for leaks and clean as needed. Check the measure sticks and replace if necessary. Level the gauge as needed. A fresh coat of paint will improve the gage appearance but care should be if painting the collector. The collector's upper edge must remain "sharp" to get an accurate catch and excess paint may round this edge.

# 11 INCH PLASTIC RAIN GAUGE

## I. GENERAL DESCRIPTION:

The 11 inch plastic rain gauge has been used for many years to support the supplemental rainfall networks. This gauge has been determined to meet the accuracy standards of the National Weather Service and may be used to document official rainfall data.

The cost of these gauges is considerably less than the SRG and there is no need for a measuring stick. These all help to reduce the operating cost of a station. Major drawbacks to the plastic gauge are the deterioration of the gauge in only a few years, and the problems associated with measuring frozen precipitation with the smaller orifice and overflow tube. There is a continuing concern with the accuracy of this gage when rainfall rates are high because of the smaller orifice and the size of the overflow gap in the measure tube.

The gauge is made of an acrylic plastic and consists of three parts:

1. The measuring tube is marked in 1/100th of an inch with a total capacity of 1 inch. Any additional precipitation overflows into the overflow tube.
2. The funnel which reduces the size of the collection area by a factor of 10 to make reading the measuring tube easier.
3. The overflow tube which will catch any overflow from the measure tube and can be used alone to collect frozen precipitation.

## II. OPERATIONS:

Observations are NORMALLY taken 24 hours apart at the designated time. The preferred time for hydrological purposes is the early morning. Most reporting rainfall stations have an observation time of 7AM. A reading taken within 30 minutes of the designated time of observation is considered as taken at the designated time.

# 11 INCH PLASTIC RAIN GAUGE - CONTINUED

**II. OPERATIONS - CONTINUED:**

Each day, at the designated time, the observer should check the gauge for precipitation. The observer should look into the gage if water can be seen. If the measure tube is completely full it should be removed very carefully so they do not spill any water. Empty the measure tube and then pour from the overflow until the it is empty or until the tube becomes full again. The value of the rainfall is read through the plastic tube and is to the hundredth of an inch. Add successive readings until a total is reached. Remember that a full tube is equal to 1" of rainfall.

**III. INSTALLATION:**

The installation of the plastic gauge should follow the same guidelines as the standard rain gauge (SRG). The gauge is installed on a bracket that is provided with the gauge and is held in place with screws that are driven into a post or similar permanent mount. Exposure is an extremely important consideration. Be certain the top of the funnel is well above the top of the post or similar mount.

**IV. MAINTENANCE:**

Little maintenance of the plastic gauge is needed. Be certain that the measure tube and the overflow tube do not leak. The measure tube should be easy to read. If the plastic becomes 'clouded' from exposure, the gauge should be replaced.

In areas that receive frozen precipitation, be certain that the funnel and measure tube are removed from the gauge before a frozen precipitation event. It is often advisable to provide the observer an extra overflow tube if one is available. This allows the observer to exchange tubes at observation time instead of making additional trips to the gauge site.

# Maximum/Minimum Temperature System (MMTS)

**I. GENERAL DESCRIPTION:**

The Maximum/Minimum Temperature System (MMTS) measures temperature over the range of -55 to +125 degrees F. (-50 to +50 degrees C.) and compares it to maximum and minimum values stored in the memory of a microcomputer. If the current temperature exceeds the previous high or is less than the previous low, this value becomes the new maximum or minimum temperature.

**II. OPERATION :**

## C450-1 MMTS display

1. Current temperature is displayed if no buttons are pressed.
2. Depress "MAX" to display the maximum temperature that has occurred since the instrument was last reset. Depressing "MIN" will display the minimum temperature.
3. To reset the store maximum or minimum temperature reading, depress and hold the "RESET" while simultaneously pressing the "MAX" and "MIN" buttons. This resets the stored values to the current temperature.
4. If the "HELP" message appears in the display, depress the reset button to clear it. This indicates an interrupt in A.C. line voltage has occurred. The microcomputer enters a "power down" condition so the internal back-up battery will preserve the maximum and minimum values stored in memory. These values are stored for up to 2 hours however, no updating of new maximum and minimum values occurs during this “power down” period.
5. Blinking of the decimal digit on the display indicates that the internal back-up battery is charging. If this condition persists for more than 30 minutes the battery is probably defective.

## C450-7 MMTS display

1. Current temperature is displayed if no buttons are pressed.
2. Depress "MAX" to display the maximum temperature that has occurred since the instrument was last reset. Depressing "MIN" will display the minimum temperature.
3. To reset the store maximum or minimum temperature reading, depress and hold the "RESET" while simultaneously pressing the "MAX" and "MIN" buttons. This resets the stored values to the current temperature.

# Maximum/Minimum Temperature System - Continued

**II. OPERATION - CONTINUED :**

## C450-7 MMTS display - Continued

4. In the event of a power failure the display will go blank except for the decimal point. The system is using the battery to continue data collection but the display is disabled. When power is restored the display will again become active. The battery will continue to operate the system for up to 24 hours.
5. Blinking of the decimal digit on the display indicates that the internal battery is charging. If this condition persists for more than 30 minutes the battery is probably defective.

**III. INSTALLATION:**

The MMTS must be installed in accordance with the attached diagram. Each installation is different but must follow the NWS policies and procedures. The following is one example.

1. The cable from the sensor to the digital readout is a direct buried cable. The cable should be installed in a type of conduit. Thin wall EMT has been used and PVC is also acceptable. Use a form of cable protection that fits the needs of your area.

2. Dig a hole 18" deep at the location selected for the sensor. Dig a trench to the house or building where the digital readout will be installed. You must have already agreed with the observer where she/he wants the readout to be.

3. A 2" chain link fence corner post about six and one-half feet long makes a good post for the sensor. Drill a 3/8" hole about six inches from each end of the post and route the cable inside the post using the 3/8" holes to enter/exit. Pull up enough wire to extend up to the sensor. Using 1/4" grommets in the holes will help protect the cable.

**III. INSTALLATION - CONTINUED:**

4. Use a 2" PVC male adaptor on top of the post to mount the sensor. Secure the adaptor to the post with two or three metal screws by drilling small holes through the PVC into the metal post. Mount the sensor on the adaptor and attach the connector pins to the end of the cable, and install the plug. Connect cable plug to sensor plug. (See wiring instructions for details on cable connectors.)

5. Stand the post up in the previously dug hole. Roll off enough cable to go to the house, through the wall and to the location of the MMTS readout unit. Cut the cable only when you are sure you have enough. Try to avoid having to splice the cable, especially outside where the cable is buried. Fill the post hole with a cement and water mixture, alternating water (not too much) and cement. Make sure the post is plumb, using a level. It takes should take about three coffee cans of cement (#3 type can) to fill the post hole. Only fill the hole to within two inches of the top. Then leave it to set.

6. If you are using conduit (recommended), start at the post and run the cable through the conduit to the entry point for the house or building. When you get to the house, fasten the cable to the wall and drill a 1/4" hole through the wall. **(Be sure you have permission from the observer before drilling a hole through their wall!)** Install the MOV (gray) box near hole and connect wiring as shown in the diagram. Be certain the cable and all connections look neat. Connect the ground wire from the MOV box to the service ground of the home.

7. Set the digital readout where you and the observer previously agreed put it. Plug it into an electrical outlet using a surge protector, and turn it on. Connect the cable from the Line Clamping unit to the digital unit. Reset the digital unit, and you should have the current outside temperature displayed. Show the observer how to take the readings and reset the display. Emphasize that reported values are to the nearest whole degree.

**III. INSTALLATION - CONTINUED:**

8. Be sure to clean up any debris you may have left. Go back outside and fill the trench and the last two inches around the post. Be sure you get the trench properly filled. You may have to get additional dirt from some other place in the yard or from wherever the observer says you may. Be sure to leave the premises looking neat.

9. Pick up and put away all of your tools.

**IV. MAINTENANCE:**

The MMTS should be checked during each visit. If the tenths digit on the display is blinking, replace the unit. Take the unit back to your office and replace the internal battery. If anything else is wrong with the unit, send it to NLSC for repair.

At least once a year loosen the four bolts going down through the sensor until the nuts are at the end of the threads. Lift each louver so you can see through the housing, and check for any wasp or mud dauber nests. If you find any, clean them out. This can usually be done without taking the sensor apart. With a rag or paper towel, clean the outside of the sensor with a cleaning solution. If the sensor is very dirty or has faded from the sun, replace it and take it back to your office to take apart and clean thoroughly. Soaking the sensor unit in a soap & bleach solution helps remove the yellow color caused by the sun.

Clean the MMTS display unit with a damp cloth. Check inside and outside plugs for any damage. If the insulation around the black and white wires have cracked, strip the wires and install new metal inserts. Replace the plug if needed. Check the MOVs (blue disks) for indications of lightning damage (burns).

# Maximum/Minimum Temperature System - Continued

**V. CALIBRATION:**

The MMTS can not be calibrated but it can be tested for accuracy. The following will determine if the unit is reporting accurate temperatures.

1. MMTS display unit: Disconnect cable plug. Connect the MMTS calibration plug to the display unit. The display unit should read 77.1 degrees. (Plus or minus 0.1 degree accuracy). Replace display unit if not within tolerance.

2. MMTS sensor unit: If you think that the temperature is off, place a good glass thermometer under the top plate of the sensor. Make sure the thermometer bulb is not in the sunlight, and leave it for about 20 minutes. The display temperature and thermometer should agree within one degree. If there is a difference of more than one degrees, try another digital display unit. If there is still a difference, try another sensor. You should always carry a spare sensor and a couple of spare display units along with you.

## MMTS OBSERVER INSTRUCTIONS

To determine the maximum temperature - push "MAX" button.

To determine the minimum temperature - push "MIN" button.

The At Observation temperature is the current temperature displayed.

***Record temperatures in whole degrees only.***

For example, if the display shows a temperature of 76.5, record "77".
For a temperature of 76.4, record "76).

To reset temperatures, press and hold in the "RESET" button and push the "MAX" and then the "MIN" buttons. Only do this immediately after recording the daily temperatures.

If the word "HELP" is displayed, just push the "RESET" button.

# MMTS - TROUBLE SHOOTING CHART

These are some of the more common troubles associated with the MMTS but definitely not all. These PROBABLE CAUSES are based on the use of a C450-1 display. They may or may not apply to other MMTS display types.

| TROUBLE | PROBABLE CAUSE |
|---|---|
| Tenths digit blinking continuously. (More than an hour). | Change out the display unit or remove the NICAD battery and install a new one. (Soldering is required.) |
| Blank display. | Unit may be unplugged.<br>Blown fuse. Replace fuse and leave spare fuses with observer. |
| Displays all figures as strange figures or just partial figures and the figures won't reset. | Unit has suffered either a lightning strike or a very strong power surge. Replace with new unit and send defective unit to NRC for repair. |
| Temperatures jump around several degrees. | Cable insulation has been skinned, allowing the bare wire to touch each other or a ground. Check cable with test box. If the temperature tests bad, replace the cable and install a new cable. If the cable is OK, check the 2 white wires inside the sensor unit from the thermistor to the plug. They may be damaged. If so, replace the sensor. |
| Unit reads "HI" or "LO" | Check inside and outside connections & check cable for breaks or shorts. "HI" indicates a short and "LO" indicates an open circuit. |
| Unit reads "HELP" | A power interruption has occurred. Press the "RESET" button. |
| Suspicious temperatures. | Check system with test box. Disassemble the sensor unit and clean. It may contain wasp or mud dauber nests. |

# Cotton Region Shelter (CRS)

## I. GENERAL DESCRIPTION:

The Cotton Region Shelter (CRS) gets its name from the cotton belt of the southern United States. It is and has been the NWS standard shelter for many years. It consists of a 20 x 30 x 32 inch rot resistant wooden box mounted on a set of metal legs. In order to minimize any solar radiation, the shelter has a double roof with an air space between the two layers. It also has a slatted floor and louvers on all four sides designed so the natural flow of air is only slightly impeded. The CRS should kept painted with a semi-gloss exterior white paint at all times, not only for looks but also to reflect the suns rays.

This shelter is built to house two thermometers, maximum and minimum, mounted on a Townsend temperature support. There is room for other instruments when needed. At some locations a Palmer Soil Temperature gage, a thermograph or hygrothermograph may be needed. At other locations wet and dry bulb thermometers may be used, in which case there may also be an aspirator. One note of caution, do not place so many objects in the shelter that you cut off the air flow through the slated floor. This would certainly have an effect on the temperatures. Observers have a tendency to place objects in the shelter, and birds sometimes want to make a nest in them. These activities should be discouraged. At some F&P gauge stations the observers will keep oil or an antifreeze/oil in the shelter. As long as there is limited quantity in the shelter there is little problem however after a period of time there is likely to be oil seepage that soon penetrates the wood.

## II. INSTALLATION:

The CRS should be installed in an open and fairly level location where the thermometers are ventilated by the free flow of air. The CRS should be installed so the height of the Townsend support is approximately 5 feet above the ground. The ground beneath the shelter should be representative of the surrounding area and not effected by unnatural influences such as irrigation. When possible, the shelter should be no closer than four times the height of any obstruction and it should be no closer than 100 feet to any paved or concrete surface. The metal legs should be mounted securely in concrete or packed soil to prevent any

**II. INSTALLATION - CONTINUED:**

vibration. In windy areas it may be necessary to install a 4 x 4 post in the center of the CRS to help reduce vibration created by the wind. **The door must always face the North.** A door opening to the north prevents any solar radiation from reaching the thermometers and causing a bias in the temperatures.

**III. MAINTENANCE:**

Maintenance is minimal for the most part. The CRS should be kept clean with a good quality semigloss white painted surface. Be certain the inside is kept clean and free of insect nests. Always check to metal support to be certain all bolts and screws are tight.

# MAXIMUM & MINIMUM THERMOMETERS (MXMN)

## I. GENERAL DESCRIPTION:

The basic instruments in the Cotton Region Shelter (CRS) are the liquid-in-glass maximum and minimum thermometers. These are mounted on a temperature support, called a Townsend Support, that permits resetting of both thermometers without removing them from the shelter.

The Minimum thermometer is mounted in the Townsend Support and can be tilted to approximately ninety degrees. The Minimum thermometer includes a small weighted, dumb-bell shaped index which is installed in the bore of the thermometer. As the temperature decreases, the meniscus of the alcohol column forces the index down to the lowest temperature. As the alcohol rises, the index remains at the lowest point which is the minimum temperature for the period. At reset time, the bulb end is raised to a vertical position (bulb up), allowing the index to slide to the top of the alcohol column again. The bulb end is then lowered to back to the observation position.

The Maximum thermometer is constructed with a constriction just above the bulb end. As the temperature rises, liquid is forced through this tiny opening into the thermometer tube. When the temperature decreases the constriction prevents the liquid from being drawn back into the bulb. As a result the liquid will move up the column to indicate the highest temperature and will remain at this level until reset. The thermometer is reset by unlocking the Townsend Support and spinning the thermometer until the liquid returns to a position to indicate a temperature which is equal to the current temperature read from the Minimum thermometer.

## II. OPERATION:

To properly read the Maximum thermometer, unlock and carefully lower (bulb down) the thermometer. The maximum temperature is read at the top of the mercury column. Spin the thermometer until the reading agrees (within one degree) with current temperature indicated by the Minimum thermometer. When the two thermometers differ by more than one degree the thermometers need to be replaced with a set that are within standards.

**II. OPERATION - CONTINUED:**

The Minimum thermometer is read in it's "rest" position which is nearly horizontal - slightly bulb high. The At Observation temperature is determined by reading the value at the top of the liquid column. The minimum temperature is the value opposite the **TOP** of the index. To reset the thermometer invert the minimum thermometer (bulb up) until the index slides to the end of the alcohol column. Return thermometer to its nearly horizontal position.

**III. MAINTENANCE:**

The Townsend Support must be kept cleaned and lubricated in allow the spinning of the maximum thermometer which would force the liquid past the constriction, back into the bulb. Simply remove the thermometer from the mounting bracket and remove the spindle from the shaft. Clean the spindle and lubricate with either a light oil or an all temperature grease and then replace. If this is done each visit, the observer will have no problems resetting the maximum thermometer. A drop or two of oil on the bracket pivot of the minimum thermometer will aid in resetting the minimum as well.

The etching on the thermometers may fade with time. This can be corrected by applying either black china ink to the etchings or rubbing the etchings with a black grease pencil. Once either has been applies, clean the thermometer with a dry towel to remove any excess material.

The approved method for getting separations out of thermometers can be found in Observation Handbook #2 in paragraphs 3.4.6.

# FISCHER AND PORTER RAIN GAUGE

## INSPECTION AND MAINTENANCE

**I. Upon arrival at a Fischer Porter station** the inspection starts while walking to the gauge. A visual exterior inspection including appearance, solar panel orientation and the level of the intake.

A. Gauge has oil and grit on the outside of the hoods.

1. This condition usually happens if the funnel is not installed in the collector. A hard rain will hit the fluid in the collector, splash out and run down the sides and onto the lower hood. Always keep plenty of rags and a good cleaner with you for this purpose. If the funnel is not in the collector during the spring, summer and fall, install it. Leave it out during the winter because freezing precipitation will collect on the funnel. If the paint on the gauge is weathered paint the cases or make arrangements to replace them on the next visit.

**Helpful Hint**: Using a good quality automotive wax on the covers will help protect the paint and make cleaning much easier.

B. Check the exterior of the solar panel for damage.

1. Dogs (and other animals) may chew on the wires leading from the solar panel to the top of the pipe.

2. The mounting post for the solar panel should be tightened as needed.

C. Intake at the top of the hood should be level. If not, level it by adjusting the leveling bolts on the base of the gage.

D. Check the gauge support to be certain it is secure. If loose, dig around the support and pour concrete or equivalent around the support.

**II. Inspection of the interior of the gauge.**

A. Open the door, draw a line across the top of the punch block and check the gage time for accuracy. Complete the legend (Station name, number, Date and Time).

B. Remove the top hood, bucket and bottom hood. Inspect the interior.

1. Turn the gauge off using the on/off switch.

2. Disconnect the terminals from the battery and using the voltmeter, check the battery voltage with the battery “under load”. This loading can be accomplished by attaching a timer or a motor to the battery terminals during the voltage check. Voltage will vary according to the battery in use. A 6v battery should have a little more than 6 volts (under load conditions), etc. Check the output of the solar panel for proper voltage. Check the diode on the solar panel for proper current flow.

**Helpful Hint**: The F&P can operate with a good solar panel and a bad battery on a sunny day. Do not trust the battery is good simply because the gauge is

operating when you are there. Check the battery voltage to be certain. **II. Inspection of the interior of the gauge - CONTINUED.**

3. Check the lower drive cable. If frayed or broken, replace it.

4. Visually inspect the flexures. Replace any that are bent or broken.

5. Check the timer. Advance the display from 00 thru 14 to make sure every number is displayed. If there are numbers missing either reset or replace the timer. Be certain glass cover over numbers is secure

6. Check the terminal board and make sure all connections are tight. (Do not over tighten the screws, as the screws or the terminal board may break. If this happens, replace the terminal board.)

7. Turn gauge on and manually punch several times making sure the motor isn't dragging and the punches are clean. Thoroughly check around the punch block making sure it is clean and the punches are not binding in the block. Manual punch at 7.7, 17.7 and 18.8 inches to be certain all pins are in place.

8. Pull the tape roll back from the take-up spool and inspect several days of data looking for ragged punches, skips, over punching, etc. Be certain the punches are cut through the time lines. If not, adjust the feed pawl. Be certain the punches are also cutting through the vertical lines. If not, adjust the take-up reel.

9. Check the take-up spring for tightness. If too loose, replace it.

10. Check the base plate rubber gasket. If broken or worn, replace it.

11. Make sure timer is set to correct time.

12. Install lower cover, bucket and upper hood. Empty, clean and add oil or antifreeze/oil mixture to bucket as needed.

**Remember the HazMat Rules**!

13. Advance the tape at least 24 hours so it is at the correct time and draw a line across the top of the punch block. Complete the legend.

14. Close the door, install the latch cover and lock. The latches may be rusted, if so, replace them.

*****THROUGH ALL OF THE ABOVE STEPS, IF PROBLEMS ARISE, FIX THEM.*****

# FISCHER AND PORTER RAIN GAUGE - CONTINUED

## TROUBLE SHOOTING CHART

| TROUBLE | PROBABLE CAUSE |
|---|---|
| Gauge insensitive. | Bent flexures.<br>Hook interference.<br>Dash pot interference.<br>Gear or Locking Lever interference. |
| Excessive oscillation | Check dash pot oil level. |
| Gauge will not reach maximum limits. | Check shipping and limit screw.<br>Improper index of pulley to code disk. |
| Broken drive cable. | Install new cable. **Important**: read the instruction manual before replacing. |
| Gauge will not start. | Check battery voltage. If voltage is good, check the punch motor. If the punch motor is good, check the on/off switch. |
| Punch motor runs but camshaft does not turn. | Gear train stripped caused by:<br>A) nicked cam causing the cam follower to bind.<br>B) misadjusted force spring.(replace punch motor after correcting.) |
| Gauge will not stop running. | Micro switch defective or not aligned properly with camshaft. |
| Gauge stops in mid-cycle. | Punch motor may be running intermittently. |
| Punches are between time lines. | Adjust feed pawl. |
| Pointer to code disc does not reflect punched value. | Check zero position. |
| Tape stuck in punch block. | Check for bent or stuck punch pins. Cam follower misadjusted. |
| Bent punch pins. | Usually caused by human intervention. |
| Tape mis-punching (lacing or close punches). | Misaligned punch block shim. Improper paper take-up tension. Misaligned take-up spool. Binding of supply spool section. |
| Close punches. | Alignment or bad sprocket. |
| Close punches every 40 spaces. | Bad sprocket teeth. |
| Holes not punching through. | Punch pressure misadjusted. Worn punch pins. Bad punch block. |
| Manual punch button will not actuate punching cycle. | Check manual punch button. Check battery. |
| Tape comes off sprocket causing mis-punching. | Check supply bracket spring and sprocket. |

# CHANGING TAPE ON THE F&P RAIN GAUGE

1. After opening the door on the gauge, **draw a line across the top of the punch block**. Noting the time on your watch, **complete the legend** which consists of Station name, Station number, Date and Time.

   Example: Hulah Dam
   41-2343-03
   Feb 10, 2002
   8:05 AM CDT

2. **Make a couple of manual punches**. **Turn the gauge off** with the on/off switch. Loosen the tape by rolling back the take-up spool. With slack in the tape below the punch block release the tape guide pressure from the sprocket and **draw up about 18 inches of tape**. Pull the slack through the punch block and **tear off tape at the top of the punch block**. Roll up the remainder of tape on the take-up spool and slide it off for shipping.

3. **Empty the gauge** at this time if needed. **Please observe all HazMat rules**.

4. Again release the pressure of the tape guide on the sprocket and **pull through 18 to 24 inches of tape**, making sure there is at least 18 inches of tape above the starting time at the punch block and enough leader to start the take-up spool. The time at the punch block should be a little short of the actual time. **Turn the on/off switch to the "on" position and manually punch up to the correct time**. Check the timer for accuracy as the next punch will automatically be within 15 minutes.

5. After the time is accurately set, **draw a line across the top of the punch block and complete the legend**. The time on the tape should agree with the real time on the legend.

   Example: Hulah Dam
   41-2343-03
   Feb 10, 2002
   8:05 AM CDT

6. If the collector was emptied or maintenance was completed, make a notation on the tape at the start.

7. **Replace the chad tray and close the door**.

# FISCHER AND PORTER RAIN GAUGE - CONTINUED

## CALIBRATION OF F&P GAUGE

The Fischer and Porter rain gauge is aligned and calibrated at the factory. If properly cared for, the gauge seldom goes out of calibration. However, each gauge should be checked during each visit to assure nothing has caused it to get out of adjustment. **If the calibration is bad, be certain to check the flexures, the pulley cables, and the sensitivity of the gauge to determine what caused the equipment to go out of adjustment**. Once all problems have been repaired, the following adjustments should be made to return the gauge to calibration.

**1. Adjust the ZERO on the scale.**

A. Rotate the zero adjust knob located on top of the support until the code disk pointer is at the exact 0 position. Depress the manual punch button to get a punch cycle.

B. If the tape does not punch zero, rotate the zero adjust knob to compensate and punch again until zero is obtained.

C. When the tape does punch zero, initiate another manual punch and turn off the power during the cycle while the code disk is locked. Adjust the code disk pointer to the exact zero position.

D. Reapply the power and allow gauge to complete cycle. When the code disk is free the pointer should point to exact zero. If not, repeat step C.

**2. Adjust the span of the scale.**

A. Place 27.186 pounds of weight in the collector. This is equal to 15 inches of rain. This can be accomplished by using the three 5 inch weights designed for the Fischer & Porter gauge, 15 of the one inch weights designed for the Universal gauge, or a combination of the two methods.

B. The code disk should rotate one and one-half revolutions and indicate 5.0 inches on the code disk and 15.0 inches on the vertical indicator. Manually punch the tape to assure the correct pins perforate the tape. If not, adjust the span adjust screw, located under the lower support, to remove the error. A clockwise rotation of the span adjust screw will increase the code disk travel (increase reading).

C. After adjusting the span, remove the calibration weights and recheck the zero.

**It will be necessary to adjust the zero and the span adjustments several times before the gauge is calibrated.**

D. Place 19 inches of weights in the collector to assure that gage can move completely through the operational limits. If not, adjust the shipping screw to increase travel.

# PROCEDURES FOR CHANGING TAPE ROLL ON THE FISCHER & PORTER WEIGHING RAIN GAUGE

1. Opening the door on the gauge and **draw a line across the top of the punch block.** Noting the time on your watch, **complete the legend** which consists of station name, station number, date, and time.

   Example: Biggest Dam, TX
   41-9876-03
   Off: Nov. 3, 2000
   Time: 8:05 AM CDT

2. **Make a couple of manual punches. Turn the gauge "Off"** with the on/off switch. Loosen the tape by rolling back the take-up spool. With slack in the tape below the punch block, release the tape guide pressure from the sprocket, and **pull about 18 inches of tape.** Pull this slack tape through the punch block and **tear off tape at the top of the punch block.** Roll up the remainder of data tape on the take-up spool and slide it off for shipping.

3. Check the amount of fluid in the collection pan. If this is more than _____ inches please contact the National Weather Service Office and ask that someone come to your site.

4. Again release the pressure of the tape guide on the sprocket and **pull through 18 to 24 inches of tape** making sure there is at least 18 inches of tape above the starting time at the punch block and enough leader to start the take-up spool. The time at the punch block should be a little short of the actual time. **Turn the on/off switch to the "ON" position and manual punch up to the correct time.** Check the timer for accuracy, as the next punch will automatically be within 15 minutes.

5. After the tape is accurately set up, **draw a line across the top of the punch block and complete the legend.** The time on the tape should agree with the real time on the legend.

   Example: Biggest Dam, TX
   41-9876-03
   On: Nov. 3, 2000
   Time: 8:05 AM CDT

6. **Replace the chad tray and close the door.**

7. If there are **any problems, please call** your National Weather Service representative immediately at _____**.**

8. Don't forget to **mail your data** to the National Weather Service office no later that the 5th of the month.

# PALMER SOIL THERMOMETER

## I. GENERAL DESCRIPTION:

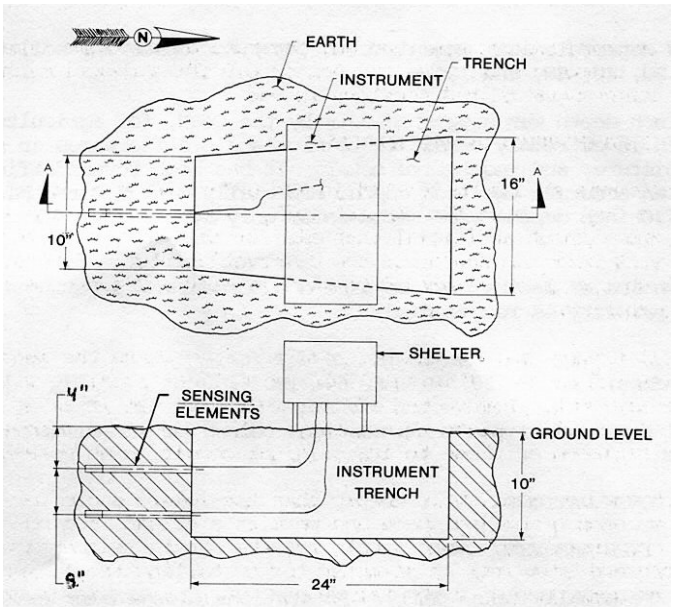
The Palmer Soil Temperature gauge is used to determine the Maximum, Minimum and observation soil temperatures at a determined depth. The probe, 13 inches in length, is buried at the determined depth - normally 4 inches. The probe is connect to the meter by a flexible metal cable that is approximately 4 feet in length.

The meter is inside a glass cover that protects it from the weather. The black pointer inside the cover will move as the temperature increases and decreases. This movement will cause the red and green pointers to move and thus indicate the maximum and minimum temperatures. This meter is normally housed inside a CRS or a special housing provided specifically for the Palmer unit.

## II. INSTALLATION:

The soil thermometer should have an exposure which is typical of the surrounding natural soil. The site should not be subject to irrigation or unusual ground-water conditions. Ideally the location will be open to full sunshine. A 4x4 foot area should be enclosed by a wooden frame made of 2x4 inch lumber. The probe will be buried in the area and the shelter will be located to the north side of the area. Before installation it must be determined if the soil temperatures measured are to reflect the values of bare ground (typical for agriculture needs) or sod covered ground.

Dig a trench just to the north of the spot where the sensor will be imbedded in the earth. This trench should be as small as possible without hindering the necessary work. It should be slightly deeper than the intended sensor depth. Remove the soil carefully and sit it aside on boards or a tarpaulin since it will be replaces later. The soil should be removed in layers so it can be replaced as close to it's original depth as possible.



# PALMER SOIL THERMOMETER - CONTINUED

**II. INSTALLATION - CONTINUED:**

Use a 5/16 diameter rod to make a horizontal hole approximately 15 inches in length for the sensor. This hole is to be at the depth for the observations - in most cases 4 inches. The earth around this hole should be disturbed as little as possible. Press the sensor into this hole until resistance is met. If the sensor is not fit completely in the hole, remove the sensor and use the rod to increase the size of the hole.

At the opposite end of the trench the meter is to be installed. This may be installed in a CRS or a specially designed shelter specifically designed for the meter. The shelter is to be to the north of the probe to minimize any shadow from the shelter effecting the temperatures.

When the probe has been installed and the meter is in place the soil should be returned to the trench. Every effort should be made to place the soil in the trench at the same depth as it was removed from. The soil should be compacted only enough to prevent erosion. If temperatures are to be taken beneath sod be certain to replace the grass to the top layer.

If the temperatures are to be taken beneath bare ground be certain to not replace any of the grass that was removed. The area should also be treated with a sterilant that will prevent vegetation growth. Extreme care must be taken to follow manufacturers instructions. See Observing Handbook No. 2 for recommended chemicals.

**III. OPERATION:**

After recording the max/min temperatures, carefully reset the green and red pointers. **Always reset the red pointer first** by bringing it into contact with the black "drive" pointer. After resetting the red pointer, gently rotate the green pointer to the opposite side of the black pointer. Do not press down on the green pointer knob as this will result in a loss of tension on the pressure washer and cause loose pointers. When resetting the max/min pointers always check the flex of the black pointer. The black pointer should flex less than 1 degree F. from either the red or green pointer. Movement of more than 1 degree F. indicates either loss of tension in the sensor system or too much drag on the max/min pointers. Lubrication will often relieve excessive tension. If lubrication does not correct the situation, the instrument must be replaced.

**IV. MAINTENANCE:**

The most common maintenance needs of the Palmer soil thermometer are loose pointers, frozen pointers, moisture in head, broken covers and calibration errors.

**Loose pointers:** This usually results from improper reset procedures by the observer. Proper instructions may prevent most of these problems. Loose pointers can be corrected by removing the bezel ring and glass cover. The red and green pointers are mounted in the glass cover. With the cover off,remove the allen set-screw embedded in the green knob. With the thumb on the bottom of the connecting shaft inside the glass cover, reset the green knob to the desired tension. You may find it necessary to replace the tension washer under the green knob. Following adjustments, replace the allen setscrew in the green knob and re-assemble.

**Frozen pointers:** Frozen pointers can often be corrected by cleaning and lubricating. A good silicone lubricant in a pressure spray applicator is recommended. In some cases, you may have to remove the bezel ring and glass cover to perform adequate cleaning and lubrication.

**Moisture in head:** This indicates need for a new gasket. Remove the bezel ring and glass cover. Replace the gasket in an area with as low a humidity as possible.

**Broken cover:** To remove the bezel ring, a file or hacksaw is required. Make a cut across the outside edge of the retaining ring. Use a screwdriver to press down and outward to snap off the retaining ring. The new cover will be sent with a new retaining ring complete with connecting screw to fasten it in place.

**Calibration errors:** Calibration of the thermometer should be performed at least twice a year. Calibration checks and offset correction is covered in the following section.

# PALMER SOIL THERMOMETER - CONTINUED

**V. CALIBRATION:**

**In-place calibration checks:** Erroneous data due to long-term calibration drifts can be eliminated with careful, routine periodic calibration checks. Three methods of in-place calibration checks are:

1. A bi-metal or similar type thermometer of known accuracy can be used for comparison. It is imperative that the sensor of the bi-metal be pushed to the same depth as the Palmer soil thermometer sensor bulb. The bi-metal must remain in place long enough to stabilize at the soil temperature (4 or 5 minutes).

2. A more desirable technique for the shallow depths is that of removing the soil to the level at the base of the Palmer sensor bulb. The comparison thermometer sensor should then be inserted along the sensor bulb some 2 or 3 inches from the base. As in step 1, the comparison thermometer must be allowed to stabilize at the soil temperature. This technique will also insure that the observational sensor is at the prescribed depth by revealing the amount of erosion that may have taken place.

3. In areas where the surface layers freeze, an ice-point comparison can be made. Check the temperatures recorded daily as the soil begins to freeze. As the soil freezes, the temperature will be maintained at the 32 degree F. ice-water equilibrium point for several days.

A calibration check of the Palmer Model 35B should be performed at least twice a year. When making the checks, remember that the Model 35B is an "area" sensor. Bi-metals and other "point" sensors may be more sensitive to heat penetration during diurnal heat cycles. For reliable calibration checks, methods 1 and 2 should not be made between 9:00 AM and 6:00 PM on bright, sunny days.

# PALMER SOIL THERMOMETER - CONTINUED

**V. CALIBRATION - CONTINUED:**

When comparing Palmer Model 35B readings with those of a check thermometer, remember two things:

A) tolerance of the Palmer (approx. 2 degrees F.) and the check thermometer (generally 1% of scale) may be additive.

B) a seemingly slight difference in exposure between the two may contribute to a variation in the readings. A spread of up to 4 degrees F. between the two readings can be considered satisfactory. If using method 3, a reading between 29 degrees F. and 35 degrees F. can be considered sufficiently accurate at the ice-point.

**Do not add any allowable difference as a correction to future observations!**

**Calibration setting:** If the check indicates a calibration offset, the calibration may be set as follows:

A. Place the probe in the shelter with the dial indicator. Place a known accuracy thermometer in the shelter and close the door. After 10 minutes, open the door and record the Palmer reading and the reference thermometer reading.

B. Immerse the entire probe of the Palmer in a slushy ice-bath for ten minutes. Similarly, immerse the reference thermometer.

C. If the difference in the readings of the two thermometers is approximately the same in both steps A and B, an offset is indicated. If the differences are not approximately the same, the Palmer must be considered inoperative and replaced.

D. If an offset is indicated, turn the "reset" screw on the back of the dial head for an indication of 32 degrees F. with the probe still in the ice bath. The adjustment on early models is limited to approximately two degrees. If greater adjustment is needed, the bezel ring must be removed. After removing the ring and glass cover, place a suitable size screwdriver in the center screw of the black pointer hand and loosen it. Rotate the black pointer hand gently to the desired setting. Retighten the center screw. If the instrument is equipped with a non-reusable bezel ring, the ring may be removed with a file. A replacement ring must then be obtained from NLSC.

# EVAPORATION PAN

## I. General description:

The standard is made of Monel stainless steel which is 47.5 inches in diameter and 10 inches deep. The pan can be either seamless or have a seam in the bottom. In either case, it should never be lifted with any significant amount of water in the pan. The pan should sit atop a 4 x 4 foot pallet, or similar surface, made of treated wood 2x4s and 2x6s or the equivalent.

## II. Installation:

The platform should be installed on a level plane above the level of any surface water. Earthen fill should be spread around the support to anchor it and be tamped firmly to within approximately one half (½) inch of the top of the support, thus leaving a space beneath the pan to allow inspection of the pan for leaks. Any obstructions must not be closer than four times their height. No shadows can be tolerated except near dawn or dusk. Avoid installing an evaporation site in areas that are irrigated or prone to flooding.

## III. Maintenance:

During visits the pan should be inspected for leaks and cleanliness. Care should be taken to keep foreign matter out of the pan. Never paint it, except for two red marks 2 to 3 inches from the top on the inside to indicate a proper water level for those observers that use hook gages. Observers at hook gage locations must be certain to keep the water level between these two red marks. During freezing weather the pan should be emptied and inverted on the base until the possibility of a freeze is past. Evaporation values are not valid when ice forms in the pan. If algae growth is a problem, a small amount of Copper Sulphate should be added to the water periodically. The NWSREP should provide this Algaecide to those observers that need it.

# TOTALIZING ANEMOMETER

## I. General description:

The totalizing anemometer is used to determine the total miles of wind that have passed during the observation period. The three cup, F-104 series are used almost exclusively. The three cup rotor turns a shaft and the associated worm gear turns a totalizer calibrated in miles and tenths. Readings are taken only to the nearest whole mile.

## II. Installation:

The anemometer should be mounted on the Northwest corner of the evaporation pan support. The cups should sit approximately 6 inches above the top lip of the evaporation pan.

## III. Maintenance:

The anemometer should be checked for stability, damage, and freedom of movement during each visit. At least once each year, and ideally during each visit, the anemometer should be serviced using the following procedures:

1. Loosen the set screw near the bottom end of the housing and lift the anemometer from its pintle.

2. Remove the nut on top of the spindle above the cups.

3. Loosen the screw on the hub side of the cups and remove the cups from the spindle.

4. Remove the spindle bearing and clean thoroughly. Lubricate lightly using an all temperature grease such as Dow Corning 33 then reinstall.

5. Open the gear housing by removing the screws.

6. Check the odometer to be certain is readable, working properly and ensure that the gasket does not leak.

7. Clean the gear assembly thoroughly and apply a light coat of grease (Dow Corning 33 or an equivalent is preferred).

8. Close the gear housing, using a new gasket if needed.

9. Replace anemometer on pintle and assure it is turning freely and the odometer is functioning properly.

# Hook Gauge

## I. General description:

There are two types of evaporation gauges in use by the NWS networks. These are the Hook Gauge and the Fixed Point Gauge. Both require a stilling well to dampen wind effects. The fixed point gauge has a fixed point is an integral part of the stilling well while the hook gauge and it's stilling well are separate components.

## II. Operation:

The hook gauge is designed so the "spider" or support arms sit on top of the stilling well with the hook at water level during observations. The hook is raised or lowered until the point just dimples the water surface. The reading is taken from the vernier on the gauge. The inch scale is located on the shaft and the hundredths scale is found on the adjustment knob. The gage should not be left in the stilling well between observations.

## III. Maintenance:

The manufacturer recommends applying a light viscosity oil twice a year. However, invariably this does result in oil on the water surface for a short time following maintenance which will retards evaporation. Use of a lubricant should be used only when absolutely necessary. Experience has shown it is best to unscrew the adjustment knob from the shaft, and use alcohol to clean each part. If further cleaning is needed, use a wire brush to thoroughly clean the threads and then complete the cleaning with alchol. Put the two parts back together and the gauge should function freely.

Be sure that the openings in the bases of the stilling well are open at all times so the water level in the well is representative of the pan.

# FIXED POINT

## I. General description:

This type of gauge is a stilling well with a fixed rod tapered to a point. The fixed point is below the top of the stilling well. An additional component needed to use this type of gage is a plastic fill cylinder. This cylinder is calibrated in hundredths of an inch and holds the equivalent of 0.15 inch of water with respect to the evaporation pan.

## II. Operation:

Each day, water is added to the pan to bring the level up to the top of the fixed point. The amount added to the pan from the cylinder is the amount of evaporation for the observation period. This has a decided advantage over the hook gauge, where the water level may vary by as much as 2 or 3 inches. When the water level goes over the top fixed point (due to precipitation) water is removed using the fill cylinder. The amount of water removed to bring the level down to the point is subtracted from the amount of precipitation to obtain the evaporation reading.

## III. Maintenance:

Be sure that the openings in the bases of the stilling well are open so the water level is representative of the pan.

# SIXES WATER THERMOMETER

## I. General description:

The Sixes water thermometer may be of two types, submerged and floating. The one most commonly used is the submerged type. There are four parts to the submerged type; a liquid-in-glass U-tube thermometer, a plastic backing with metal holder and a magnet used to reset the indices. The tube is mounted on the backing, which is attached to the handle or holder. The Sixes thermometer uses a Beechwood Creosote and alcohol mixture as the measuring liquid.

## II. Operation:

The thermometer is a "U-tube" type with metallic indices at each end of a column. As the temperature changes the indexes will move to higher and lower positions. These final positions will indicate the max/min water temperatures for the observation period. To reset the indices, a magnet is used to pull them back to the liquid column. The Sixes assembly must placed on the South side of the pan to eliminate any shadow effect. The assembly is raised and lowered from the water by the holder.

## III. Maintenance:

As a result of being kept constantly submerged, the graduations on the thermometer have a tendency to fade. They may be re-blackened in the same manner as other thermometers by using either black china ink or a black grease pencil. During freezing weather, the six's thermometer should be removed from the pan, to prevent breakage. Always check thermometer for separations which can cause the readings to be in error by several degrees. The best way to remove these separations is to remove the thermometer from the backer and tap it, "U" shape down, on a semi-soft object. This may take several minutes depending on the degree of separation. Never use heat to remove the separations.

# WIRE WEIGHT RIVER GAUGE

## I. GENERAL DESCRIPTION:

The wire weight river gauge is house in a cast metal enclosure that is mounted on a bridge, piling or other permanent structure that allows the gauge to overhang the river or lake. Inside the case is a weight and cable system mounted on a drum that is exactly one foot in circumference. One complete revolution of the crank raises or lowers the weight one foot. Mounted to the left is a counter that measures the number of turns in feet. A pointer indicates tenths and hundredths of feet from an index wheel mounted on the left side of the drum.

The wire weight gauge must be calibrated properly to be of any use. Levels known as Datums are determined from known elevations, which is usually a bench mark located near the bridge. The zero datum is established above mean sea level (MSL)and may or may not be an actual point at the site. In some cases it is an arbitrary elevation and in others it is the approximate bottom of the river at the gaging sight. A survey is run to determine the level of the check bar on the gauge. The resulting - the difference between the two points - is the check bar reading.

## II. OPERATION:

1. Unlock the case and gently open the cover. Grasp the crank handle, release the pawl, and raise the weight to slide the check bar to the rear position.
2. Lower the weight until it just touches the water surface. Average the peaks and troughs if the water surface is rough. It may be necessary to strum the cable or swing the weight in extremely difficult conditions to get an accurate reading.
3. Read the counter to determine feet. Read the index wheel, at the pointer, to determine tenths and hundredths.
4. Engage the pawl and raise the weight to its original position. Slide the check bar forward, under the weight, into the notch.
5. Be certain that the crank handle is in a rear position. This will allow the cover to close without touching the handle.
6. Close the cover and lock the gauge.

# WIRE WEIGHT RIVER GAUGE - CONTINUED

**III. CALIBRATION:**

Calibrations should only be done to gauges owned by the National Weather Service. If the gauge is owned by anyone else notify them that the gauge need adjustment - do not adjust it yourself.

The gauge is calibrated by placing the weight on the check bar and loosening the two retaining bolts on the left side of the drum. **Caution** - be sure to grip the drum firmly with the left hand before loosening the retaining bolts. If not, the drum will suddenly be released and the weight will end up in the river. After loosening the bolts, and while holding the drum firmly, place the weight on the check bar, turn the crank until the counter and index pointer are at the correct reading. Now tighten the two retaining bolts and release the drum.

Adjustments should never be allowed to get out more than 0.06 Ft. **Example:** Let's say a bench mark is located near a bridge. After running levels, the zero datum (the zero of the gauge) is determined to be 243.52 Ft. MSL. Then the height of the check bar is determined to be 264.54 Ft. MSL. The check bar reading would be the difference between the two readings, 21.02 feet. When the weight is lowered to the water, the correct stage reading is given on the gauge. It will be the height of the water above the zero datum of the gauge. Flood stage, bank full stage and other measurements are referenced to the zero datum.

**IV. MAINTENANCE:**

**NOTE:** Maintenance responsibility for NWS owned wire weight river gauges are assigned to the electronic technician.

Different agencies use each other's equipment. However, there is a rigidly observed rule that must be mentioned: ***Never make adjustments to equipment belonging to another agency.*** If the readings are out of tolerance, call the responsible person in that agency.

# WIRE WEIGHT RIVER GAUGE - CONTINUED

**IV. MAINTENANCE - CONTINUED:**

Wire weight gauges are kept locked, usually with a Master 2640 lock. Few people should have a key, and those that do should be trained to use the gauge. It is very easy to crimp or damage the cable and easier to lose the weight in the river.

A few wire weight river gauges are transistorized; that is, they are equipped with a battery and light system that allows the observer to take readings in the dark and from gauges mounted great distances above the water. When the weight touches the water, a circuit is completed thereby turning on the light. The maintenance on these gauges is the responsibility of the electronics technician. It is a simple thing for the NWSREP to change batteries on his routine visits, rather than have an ELTECH make a special trip for that purpose.

# THERMOGRAPH/HYGROTHERMOGRAPH

## I. GENERAL DESCRIPTION:

The thermograph is a single pen temperature recording device. The hygrothermograph is a dual pen recorder that records both the temperature and the relative humidity.

These instruments should be used only rarely with the cooperative program as a 'backup' for observers that are not able to take observation on a daily basis. **These instruments should be used only when no other way is available to collect the data needed.**

Both instruments are totally self contained and consist of a measuring system, a rotating drum with a clock, and a pen to record the data on a paper chart which is wrapped around the drum.

The thermograph uses either a liquid filled bourdon tube or a bimetallic strip to monitor the temperature. The bimetallic strip will bend as the temperature changes since the two metals do not react identically to the temperature changes. The bourdon tube will flex as the liquid inside the tube expands or contracts with the temperature changes. This bending or flexing is transferred to the pen which then records the movement onto the chart as a temperature change.

The hygrothermograph uses a similar temperature system and also includes strands of hair to monitor the humidity. As the humidity increases the hairs will stretch and as the humidity decreases the hairs will contract. This varying length of the hairs is transferred to a pen which records the movement on the chart as a humidity change.

## II. INSTALLATION:

The thermograph and the hygrothermograph are normally installed in the cotton region shelter (CRS). The unit must be placed in such a way to allow the free flow of air around the sensors on the unit. Care must also be exercised to be certain that the location of the unit does not interfere with the resetting of the Max/Min thermometers if they are installed.

**II. INSTALLATION - CONTINUED:**

The clock must have the appropriate gears to match the chart, and the pen nib must be clean. The pen must also contain enough ink to operate but not be overfilled since the excess ink will drip onto the case and damage the paint.

**III. OPERATION:**

The gauge is designed to operate for a period of time that is determined by the gears on the clock and the drum. The normal setting is for one week which would use 168 gears. Be certain that the rotation rate and the chart match each other. A one week rotation drum must have a chart that is graduated for a week.

Each time the chart is changed, the clock must be wound however care should be taken not to "over-wind" the clock. This will damage the mainspring and the clock will stop. A small amount of ink should also be added to the pen at each chart change. This is also a good time to compare the recorded temperature on the chart with a quality thermometer to be certain that they agree within 2 degrees. If the difference is more than two degrees, the knurled thumbnut should be adjusted to remove approximately half of the difference.

**IV. MAINTENANCE:**

Since there are no rapidly moving parts, no scheduled lubrication is required. The gauge should be tested to be certain that all parts move freely and the case is clean. The pen should be cleaned regularly and checked to be certain that a fine trace is being recorded. Also be certain that excess ink is not dripping onto the case. If the readings do not appear to be accurate, compare with a good quality thermometer and make adjustments with the knurled thumb nuts mounted on the element support brackets of the gauge.

**IV. MAINTENANCE -CONTINUED:**

If the bourdon tube leaks, do not attempt to patch it as it is filled with a flammable hydrocarbon. The tube must be replaced.

The humidity can be checked by comparing the humidity value calculated for a sling phsycrometer against the value on the chart. If the error is excessive, the humidity calibration can be checked by wetting the hairs with distilled water until they become saturated. This will cause the reading to be between 95 and 100 percent. If not, the span can be adjusted by sliding the link at the top of the hairs to adjust the span. Once the hairs have dried, adjust the thumbnut to adjust the reading to remove approximately half the error. Repeat this process until the data recorded on the chart is reasonably accurate. Since the humidity data is not used by the cooperative program, any adjustment to the humidity sensor and readings should be minimal.

# REMOTE OBSERVATION SYSTEM AUTOMATION - ROSA

## I. GENERAL DESCRIPTION:

The ROSA program was implemented in 1983 as a method to send cooperative weather observations to the National Weather Service in an automated fashion. A coded message consisting of date and time information plus the observed weather data is sent to a "host" National Weather Service computer. This computer converts the data into a SHEF format that is transfer to AWIPS for distribution. A computer program called "COMPU-ROSA" was later developed for use by any observers with personal computers. The original ROSA software, which used the RDOS operating software, was upgrade to operate on a personal computer in the mid 1990s and was renamed PC-ROSA at that time.

## II. INSTALLATION:

Quite often the National Weather Service will provide a touch tone telephone with display functions and memory to be used by the volunteer. If provided, the NWSREP should be able to program the telephone for use by the observer. The NWSREP does NOT do any wiring of the telephone system at the observers home or place of business.

The National Weather Service Representative is responsible for training the Cooperative Weather Observer to send coded data to the ROSA system. The coded message for each station is somewhat unique, depending on the amount and type of data collected. The general principals of the coded message are the need for two pound symbols (##) to indicate the start or end of the message and one pound symbol (#) to separate data groups. Each data group, other than station number and the date/time group at the beginning of the message, are identified by a code number.

**##211234#02070700#100.35#2296#2355#2158#3387.50##**

| station number | date/time group (8 digits) | precip. code (0.35) | max temp (96) | min temp (55) | obs temp (58) | river stage (87.50) |
|---|---|---|---|---|---|---|

Touch tone telephones are commonly used to send ROSA data to the host computer. In this case, the "*" button is used as a decimal point and a "**" is used to indicate a negative value.

**II. INSTALLATION - CONTINUED:**

Installation instructions for the "COMPU-ROSA" program are included with the software and use the PROCOMM software to transmit the data to the host computer. The software must be modified to make is "site specific" before it is issued to the observer.

**III. MAINTENANCE:**

Other than programming telephone numbers into the telephone memory, no maintenance is done at the field level. The telephones require a new set of batteries each year. Often this maintenance can be accomplished by the volunteer if batteries are provided.

## COMMONLY USED ROSA CODES

### Precipitation

10 24 hour total (inches, tenths and hundredths)
11 precipitation since last scheduled report (inches, tenth and hundredths)
12 flash flood criteria met (2 inches or more) (inches, tenths and hundredths)
68 total depth of snow, hail or sleet on ground (whole inches)
69 24 hour snowfall (inches and tenths)
71 water equivalent of snow (and ice) on the ground (inches, tenth and hundredths)

***To report a Trace, the code is "0.001"***

### Temperature

21 At observation temperature (F)
22 24 hour maximum temperature (F)
23 24 hour minimum temperature (F)

### River Stage

33 Stage at observation time (feet)

A complete list of data codes for use with the ROSA system is available from the RCPM for each region that uses these coding procedures.

# GLOBAL POSITION SYSTEM - G.P.S.

***Be certain to read the manual that is shipped with your current GPS before using. The DATUM should be set to NAD83 and all Latitude and Longitude readings must be in degrees, minutes, and seconds. Do not use of hundredths and thousandths of a minute.***

## I. GENERAL DESCRIPTION:

The Global Position System (G.P.S.)unit is used to determine the latitude and longitude of a location. A position is calculated by the G.P.S. using a triangulation formula based on the location of several geostationary satellites. The accuracy of the position is increased by the number of satellites that are accessed as part of the calculation.

The G.P.S. unit will indicate an elevation for the point that is being evaluated. This **ELEVATION SHOULD NOT BE USED**. Tests have shown that it is often a very inaccurate value. To determine elevation, consult a quality topographical map. Errors of more than 100 percent have been noted in the elevation provided by a GPS unit.

It is important that the unit be placed in a location that will allow a clear view of the sky and that the antenna is pointed vertical to the surface. This will allow the GPS unit to access the maximum number of satellites and thus improve accuracy.

## II. OPERATION:

Verify that the G.P.S. is set to the proper Datum. The National Weather Service standard is North American Datum 1983 - NAD83. Refer to the instruction manual for your G.P.S. unit to set this datum.

Place the G.P.S. unit near the location where the latitude and longitude readings are needed. This is normally the top of the SRG or F&P gauge. Be certain that the G.P.S. unit has a clear view of the sky and the antenna has been pointed upward. Turn the unit on and allow the unit to access as many satellites as it can - this can take several minutes. When the unit has accessed all possible satellites, it will calculate the latitude and longitude of the location and display it on the screen.

# GLOBAL POSITION SYSTEM - CONTINUED

**II. OPERATION - CONTINUED:**

The battery status of the unit should be checked before each use. If the batteries do not have sufficient power, an accurate reading may not be obtained.

Once the readings have been documented turn the unit off. The GPS units do use a great deal of power and will drain batteries rather quickly.

**III. MAINTENANCE:**

Minimal maintenance of the G.P.S. unit is needed. The unit must be kept clean and dry at all times. The battery status must be monitored and batteries replaced regularly.