

**COOP C129 NOTE 1, MAINTENANCE**

Operations Division  
W/OPS12: JD/GLD

SUBJECT:	<b>Evaporation Pan Thermometer Replacement</b>
PURPOSE:	To provide the installation and setup instructions for logistics replacement of the Six's thermometer with a <i>ThermoWorks</i> 24" (TW-24) digital thermometer for evaporation pan water temperature measurements.
SITES AFFECTED:	All evaporation pan sites when replacement of the Six's thermometer is necessary.
AUTHORIZATION:	The authority for this note is by National Weather Service Headquarters direction.
VERIFICATION STATEMENT:	This procedure was tested and verified at Sterling Field Support Center (SFSC) in Sterling, VA; National Weather Service (NWS) Training Center in Kansas City, MO; and at Western Region sites associated with Weather Forecast Office (WFO) Spokane, WA.
ESTIMATED COMPLETION DATE:	As required when Six's thermometer fails.  Complete system-wide replacement of the Six's thermometer is not authorized. Only replace the Six's thermometer when they no longer function on a site-by-site basis.
TIME REQUIRED:	Approximately 1 hour.
ACCOMPLISHED BY:	NWS Representative or Electronics Systems Analysts/ Electronics Technicians for local Cooperative Observer Program (COOP) operations.
EQUIPMENT AFFECTED:	Agency Stock Number (ASN): C128-5 Six's Thermometer.
SPARES AFFECTED:	All ASN: C128 parts and subassemblies.
PARTS/MATERIALS REQUIRED:	<b>From National Logistics Support Center (NLSC):</b> <ul style="list-style-type: none"><li>• C129 Digital Thermometer (<i>ThermoWorks</i> 24" [TW-24])</li></ul> <b>Locally Sourced:</b> <ul style="list-style-type: none"><li>• A76 (LR44) Button Cell Battery, Alkaline.</li><li>• Assorted polyvinyl chloride (PVC) plastic pipe parts as required (see Attachment B ).</li><li>• Ohm meter.</li></ul>
SOURCE OF PARTS/MATERIALS:	C129 is available from NLSC. All other parts are locally purchased.
DISPOSITION OF REMOVED PARTS/MATERIALS:	The glass tube of the C128 contains mercury. Double bag this part and dispose according to NWS Hazmat instructions, <a href="#">NWSM 50-5116</a> .  All other parts of C128 may be locally disposed.

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TOOLS AND TEST EQUIPMENT REQUIRED:	Small Phillips screwdriver will be required if battery replacement is necessary.  Fabrication of a holder may require a hacksaw, drill, and other woodworking tools. See Attachment B for options and materials needed.
DOCUMENTS AFFECTED:	None
PROCEDURE:	See Attachment A for installation and operating instructions.  See Attachment B for TW-24 holder ideas.  See Attachment C for sample Cooperative Station Service Accountability (CSSA) entries.
TECHNICAL ASSISTANCE:	For questions or problems pertaining to this note, contact SFSC at (703) 661-1268.
REPORTING INSTRUCTIONS:	Report the completed modification using a CSSA site inspection report, and update the site metadata on the B-44 Station Information Report. Follow the reporting instructions in Attachment C for example forms and entries.

Deirdre R. Jones  
Director, Operations Division

Attachment A – Installation and Operating Instructions for TW-24 Evaporation Pan Thermometer  
Attachment B – Suggested Holders and Installation Instructions for the TW-24  
Attachment C – Sample Cooperative Station Service Accountability Report

## ATTACHMENT A Installation and Operating Instructions for the TW-24 Evaporation Pan Thermometer

### A.1 Preparation at Weather Forecast Office (WFO)

1. Unpack and examine the TW-24 (ASN: C129) received from National Logistics Support Center (NLSC). The probe should be straight with no kinks/nicks in it.
2. Obtain a new alkaline A76 (LR44) button cell battery (Figure A-1) and set aside for use in the next section (Section A.1.1).



Figure A-1: A76 Button Cell Battery

3. Press the right button (**ON/OFF**) on the TW-24 faceplate. See Figure A-2. The display should come on. If the display does not come on, replace the battery (see A.1.1 and following) before continuing with these steps.



Figure A-2: TW-24 Faceplate

4. Hold the very end of the probe in one hand. Observe thermometer display. The temperature should increase. Release the probe by setting it down on a sturdy surface.
5. Press the left button (**MAX/MIN**). The maximum temperature from holding the probe will display.
6. Press the left button again and the minimum temperature is shown, which should be the temperature displayed when the thermometer was first turned on.
7. Press the left button a third time. The current temperature is displayed again.
8. Press the right button and hold it for several seconds, to turn the TW-24 **OFF**. Maximum and minimum temperatures are reset when the TW-24 is turned off.

If Steps 3 - 8 in this section work as indicated, the TW-24 is operational. If the TW-24 fails any of these steps after testing with a working battery, then return the TW-24 to NLSC as "received defective."

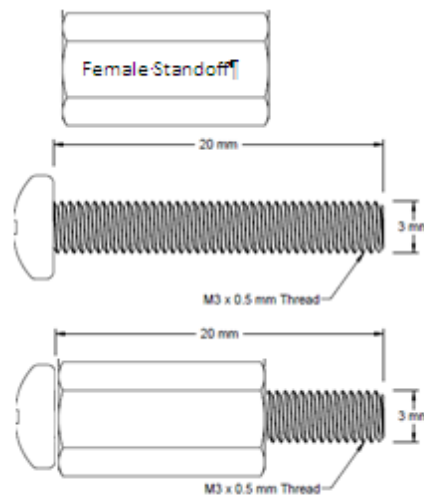
### A.1.1 Opening the TW-24

Accessing the battery requires separation of the upper and lower case halves with a Phillips screwdriver. Place the TW-24 face down on a protective surface and remove the two screws.

If screws need to be replaced, replace with stainless steel, metric pan head, Phillips, machine screw M3 size (with a 0.5mm thread pitch), 10mm long (M3x10) with a 5.3mm diameter head. It is very similar to McMaster-Carr part number 92000A120.

Because battery replacement is going to be an ongoing process, we recommend replacing the screws with a tool-less, finger-tight enabled screw assembly (see Figure A-3). To make a finger-tight enabled screw for the TW-24 thermometer, use a M3x20 machine screw (McMaster-Carr part number 92000A128) or a M3x20mm long wing-type thumb screw and thread it through a 4.5mm Hex M3 standoff 10mm long (92080A006).

Upon re-assembly, make sure the gasket is in place and fully seated in its groove before closing up the case.



**Figure A-3: Finger-tight Enabled Screw Assembly**

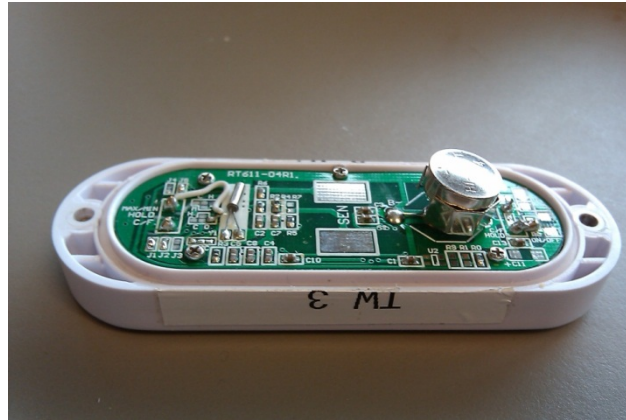
### A.1.2 Replacing the Battery

Always replace the battery at the start of the season and anytime a unit from NLSC is deployed. This unit uses an A76 (LR44) button cell battery, as shown in Figure A-1. Use an Alkaline battery, not a Silver Oxide and definitely not a Lithium-Air hearing-aid battery. The battery is a local purchase item and is not stocked at NLSC. The battery is available at Radio Shack and other stores, as well as in bulk on the Internet. Internet prices are lower, typically less than 80 cents each for bulk buys.

The battery has an expected life of ~5000 continuous operating hours. The battery life is less than one year, but longer than most evaporation pans are deployed in a year.

Perform the following to replace the TW-24's battery:

1. Use a small Phillips screwdriver to remove the screws under the head of the unit and pull the halves apart. See Figure A-4.



**Figure A-4: Battery Sitting on Clip**

2. Making sure to avoid touching the electronic circuitry, use fingernail or a non-conductive probe (dry wood) to work the battery up and out of the clip.
3. Insert the new battery with the + side up (the text side) and push it into the clip.
4. Ensure the O-ring seal is in position and reposition the probe-half over the faceplate-half.
5. Screw the screws in finger-tight.

### **A.1.3 Rechecking Operation after Battery Replacement**

Perform Steps 3 - 8 of Section A.1 to verify the unit works after replacing the battery, and then proceed with Section A.1.4.

### **A.1.4 Assemble Necessary Items**

Gather the following items to install the thermometer:

- A holder/cover, WFO made, (see Attachment B for options and materials needed)
- The TW-24 thermometer itself, ASN: C129, with a fresh battery installed

## **A.2 Installing the TW-24 and Fabricating a Holder**

The thermometer should be positioned in the pan with the end of the probe near the bottom/wall corner on the south side of the pan. The end of the probe should be in the shade of the south wall of the pan.

The TW-24 is advertised as waterproof but actually only carries an IP67 rating – splash resistant.

**CAUTION**

**Do not immerse the head of the TW-24.**

A holder is required to retain the TW-24 in place on the rim of the evaporation pan. The holder will fix the thermometer in position and provide a sun shield for the faceplate of the TW-24. There is no commercial item available for this function and one will have to be fabricated by the WFO. See Attachment B for suggested holders and installation instructions.

### A.3 Operating Instructions

The TW-24 measures maximum/minimum temperatures from when it was last turned ON. Therefore, at observation time, the observer will perform the following:

1. Remove the sun shield.
2. Lift the head **without** taking the end of the probe out of the water.
3. Note the current reading.
4. Press the left button and note the maximum reading.
5. Press the left button again and note the minimum reading.
6. Press the left button again to get back to the current reading.
7. Press and hold the right button to turn it off and reset the maximum/minimum.
8. Press the right button again to turn the TW-24 back ON.

**NOTE:** The TW-24 must be left **ON** to capture the maximum and minimum of a whole day.

9. Reposition the TW-24 in the holder, with the probe in the shade at the edge of the pan.
10. Reposition the sun shield over the head of the TW-24.
11. Emphasize to the Observer that the probe should not come out of the water while taking the readings or after the unit has been turned back on.

**NOTE:** Doing so will affect the MAX/MIN readings.

### A.4 Maintenance and Troubleshooting

The TW-24 requires no maintenance other than: inspecting it for operation and damage, keeping it clean, and replacing the battery as needed. Periodic calibration is not required.

The upper surface membrane switch cover is Ultraviolet (UV) resistant but it should not be exposed to constant sunlight. Keep it covered. Exposure to UV will harden the membrane and shorten its life. If the membrane is cracked and exposing the underlying switch, that TW-24 should be retired from field service.

Battery replacement is covered in previous Section A.1.1.

Operational checkout is covered in previous Section A.1.3.

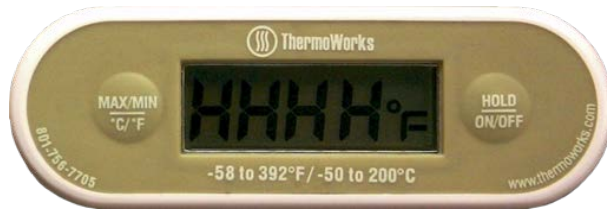
#### A.4.1 Suspect Readings or No Numbers on Display

The probe in the lower half of the case is connected to the upper case electronics with two spring contacts that must touch the square contact pads on the printed circuit board when assembled. Do not touch the square contact pads with your fingers, as the oil from fingers will oxidize over time and form an insulating layer preventing connection. Alcohol on a cotton swab may be used to clean both the square pads and the spring contacts.

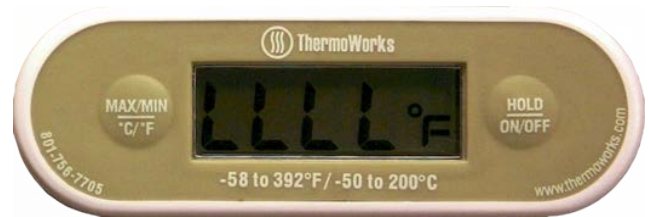
The display can be used for basic troubleshooting of the TW-24, but first the display must work. If pressing the ON/OFF button does not turn ON the display, replace the battery and try again. If it still won't turn on, replace the whole TW-24.

1. If the assembled unit shows HHHH (see Figure A-5), then the probe is shorted, or the probe is sensing a temperature greater than 392 °F. The thermistor resistance at 392 °F is about 120 Ohms. The thermistor can be checked to see if it has failed with an Ohm meter. Place the ohm

meter probes across the spring contacts of the lower case and if the Ohm meter indicates any resistance between 120 Ohms and 392 Kohms, the probe is probably good. If the probe is good, look to see what is shorting out the pads on the circuit board. If the short cannot be found and removed, replace the TW-24.



**Figure A-5: HHHH Display**



**Figure A-6: LLLL Display**

2. If the assembled unit shows LLLL on the display (see Figure A-6), this means one of three things: the spring contacts do not touch the pads (open circuited), the temperature is lower than -58F, or probe wiring and contacts have a resistance greater than approx. 392 Kohms. Perform the following to correct:
  - a. Use an ohm meter to check the probe resistance across the spring contacts and determine if it is open circuited, if so look for loose or broken wires or replace the whole TW-24.
  - b. If the probe resistance is less than 392 Kohms, look to see if the spring contacts actually touch the pads on the circuit board. Bending the springs up slightly may fix this. Be very careful to bend the springs straight up and not offset to one side or the other. There is nothing to prevent a miss-bent spring from contacting the other electrical traces on the printed circuit board beside the pads and short out the instrument.

#### **A.4.2 Maintenance Schedule**

The TW-24 should be inspected at each site visit, or at least coincident with the required COOP site visitation guidelines.



## ATTACHMENT B - Suggested Holders and Installation Instructions for the TW-24

### B.1 Requirement

The TW-24 should be installed so the tip of the probe is in the shade of the south wall of the evaporation pan. The head of the TW-24 contains a display and a membrane switch that should be shaded from sunlight to protect it from UV degradation. The head of the TW-24 should be restrained so it does not fall out of the pan or blow into the water. The TW-24 is advertised as waterproof, but it is not, and should only be treated as water-resistant. The TW-24 should be held in position on the pan so the preceding conditions are maintained, yet still be available for convenient use by the observer.

The WFO will construct a holder to position the TW-24 in place on the pan, and install one with each TW-24. The holder does not need to be elaborate, but must satisfy the preceding conditions.

### B.2 Holder Suggestions

During the test and evaluation phase of the TW-24 development, several holder designs evolved. They are illustrated here as examples. Look over each illustration, pick one that is feasible to fabricate and within the WFO's budget and install one with each TW-24. These ideas are just to get started. Feel free to improve them or create a new one. Share any design that is unique and useful with the SFSC so others can benefit from the ingenuity.

Figure B-1 shows several holders installed on a pan at SFSC during the testing program. All of these can be built for between \$1 and \$16.



Figure B-1: Holders Installed at SFSC



### B.2.1 Simple Holders

A simple holder can be made out of a short length of plastic pipe (see Figure B-2). To create a similar holder, perform the following:



Figure B-2: Simple Holder

1. Obtain a short length of plastic pipe.
2. Using a hacksaw, cut a slot in one end so that it fits tight on the pan's rim (see Figure B-3).

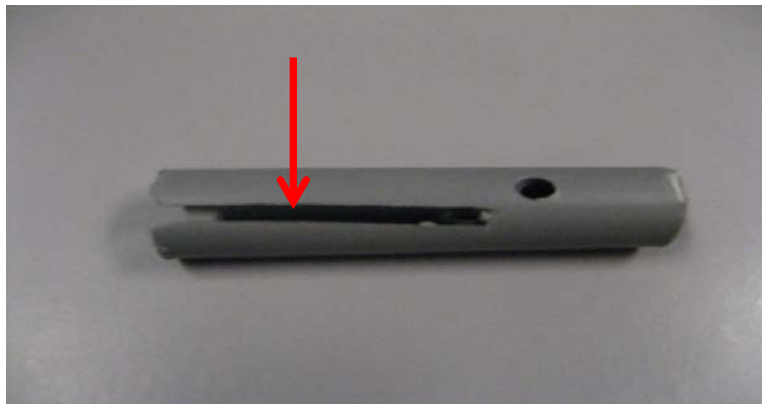
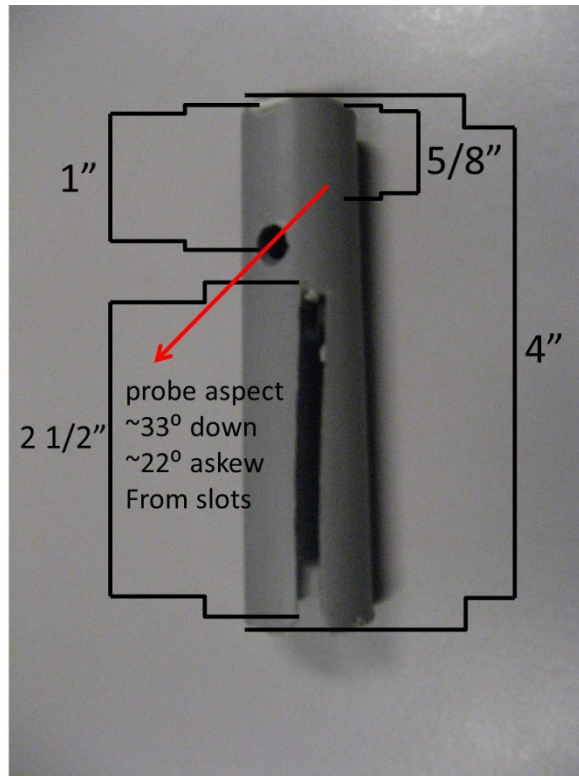


Figure B-3: Plastic Pipe with Slotted End

3. Drill a downward angled ¼-inch hole above the slot (see Figure B-3) to hold the TW-24 as shown Figure B-2.

**NOTE:** The dimensions (see Figure B-4) are not critical, but drilling the hole is best done at the pan to get the two angles to line up so the probe tip ends up in the corner of the pan.



**Figure B-4: Plastic Pipe Dimensions**

A UV cover will need to be included with this holder. A 3-inch PVD DWV Flexible Cap (see Figure B-5) will fit over the TW-24 thermometer and make a good UV cover. It is made of flexible black rubber, is a friction fit over the width of the TW-24 body, has withstood 40-knot gusts in field testing and is available at places like Home Depot (part number PQC-103, SKU 688088, \$4.21 each). The steel band clamp is not needed and may be removed.



**Figure B-5: Ultraviolet Cover**

### B.2.2 Better Holder Ideas

Holders with well-fitting covers can easily be made out of 4-inch PVC plastic pipe or pipefittings. The following are two ideas:

- 4-inch PVC plastic pipe holder that allows users to pick up the head for easy reading (see Figure B-6)



Figure B-6: PVC Plastic Pipe Holder

- Street-elbow pipe fitting holder that holds the head in one orientation (see Figure B-7):



Figure B-7: Street-Elbow Pipe Fitting Holder



Both holders include slots in the bottom to fit the pan edge, and a pipe cap to cover the unit. See Figure B-8 and Figure B-9.



**Figure B-8: Street-Elbow Pipe Fitting with Pipe Cap Cover**



**Figure B-9: PVC Plastic Pipe with Pipe Cap Cover**

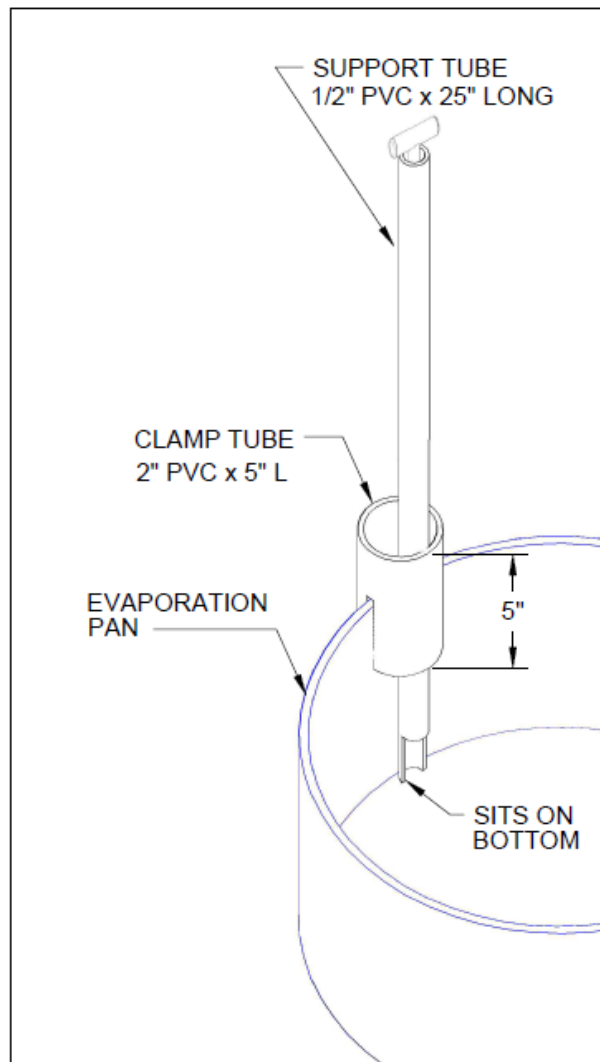
The 4-inch PVC plastic pipe holder in Figure B-6 has a  $\nabla$  cutout that allows easy replacement after reading. The street-elbow pipe fitting holder has a hole drilled at the right angle to position the head where it can be handled.

These holders will need ventilation holes drilled in the sides to reduce condensation buildup. The vent holes should be as high as possible, numerous, and large (i.e.,  $\frac{1}{4}$ -inch or larger).

### B.2.3 Stand Holder Ideas

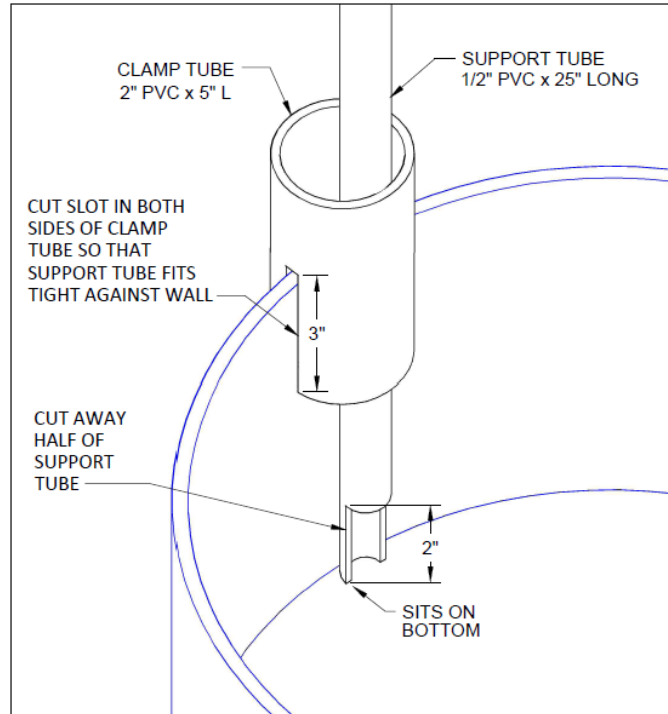
Older Observers may appreciate a holder that positions the TW-24 vertically so they do not have to bend over as far to take the readings. Here are two stand ideas:

A simple stand can be constructed from two pieces of plastic pipe as shown in Figure B-10.



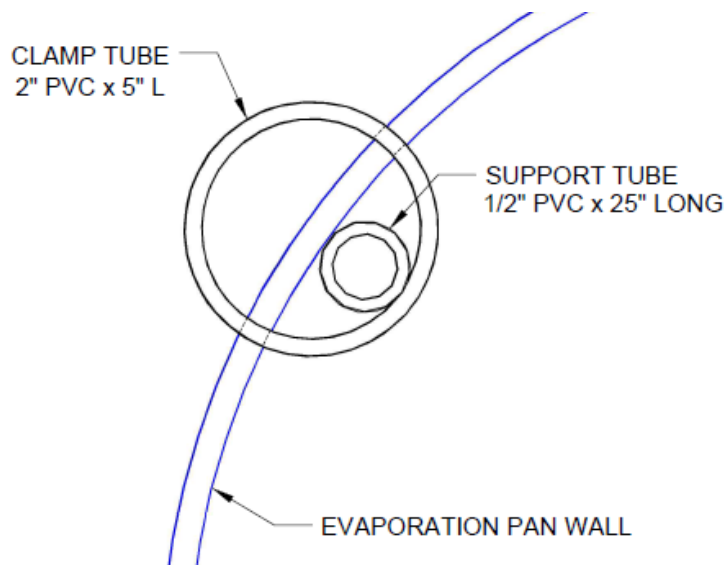
**Figure B-10: Two Tube Holder**

The tall support tube is cut just a little longer than the probe so the probe is not resting on the bottom of the pan. The lower end should be cut away to allow free water circulation to the probe. See Figure B-11



**Figure B-11: Clamp Tube Detail**

The clamp tube slots must be cut so the support tube is tight between the pan wall and the inside of the clamp tube. See Figure B-12.



**Figure B-12: Clamp Tube Position**

A sun shield should be included over the head of the TW-24. See the sun shield note in Section B.2.1.



A more rugged stand can be assembled from steel and plastic pipe and pipe fittings. This stand is screwed to the platform and may provide some support to the Observer while taking readings. See Figure B-13.



**Figure B-13: Rugged Stand**

The pipe and fittings are all standard off-the-shelf items at hardware stores. The length of the upper section of plastic pipe should be adjusted to keep the probe tip from hitting the bottom of the pan. The lower section of plastic pipe inside the pan does not need to extend all the way to the bottom.

Black iron pipe is much cheaper than galvanized pipe and both will need to be painted to last outside. Use rust resisting enamel paint. Brushing is better than spraying as it creates a thicker coat and can flow paint into the threads at each joint.

Again, a sun cover will need to be added over the head of the TW-24. See the note in Section B.2.1.





## ATTACHMENT C - Sample Cooperative Station Service Accountability (CSSA) Report

### C.1 Metadata Requirements on Evaporation Pan Digital Thermometer Implementation

#### C.1.1 Creating a CSSA Site Inspection Report

After completing the TW-24 installation and returning to the office, access the CSSA and call up the CSSA Station Name/CSSA Station Number to generate a new Site Inspection Report. Account for the total hours of work and total dollars of expense incurred to install the TW-24 system.

1. Access the CSSA system at:  
[https://cssamain.nws.noaa.gov/cssade/cssa\\_main.cssa\\_main\\_menu](https://cssamain.nws.noaa.gov/cssade/cssa_main.cssa_main_menu)
2. Select **Enter Inspection Data** from the *CSSA Main Menu*. See Figure C-1.

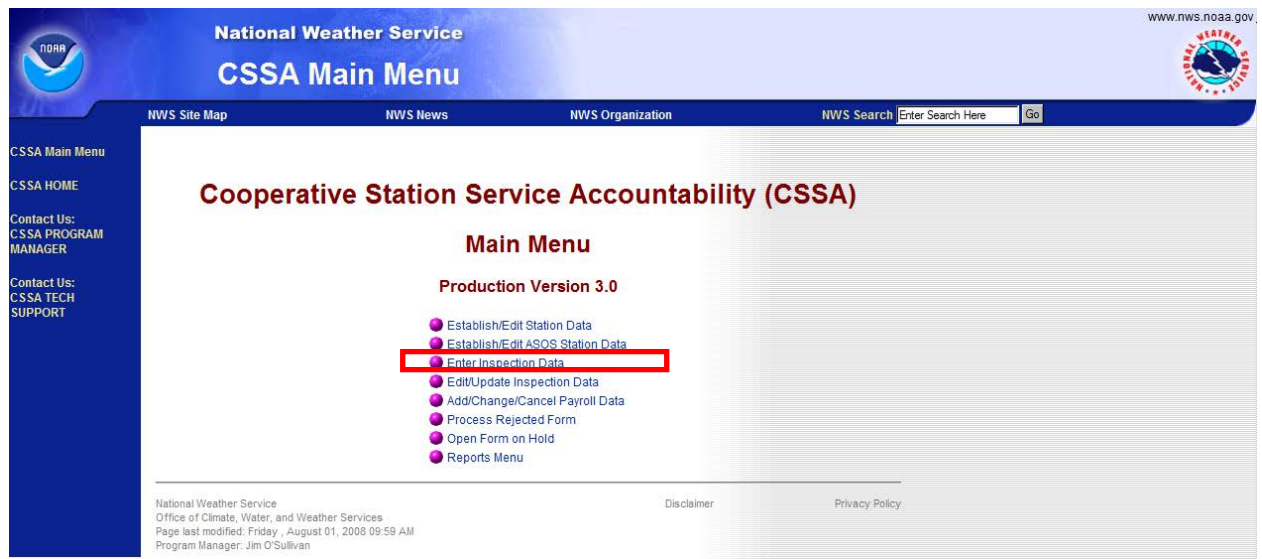


Figure C-1: Selecting Enter Inspection Data

3. Enter the station's COOP identification number (ID) in the User Prompt pop-up. See Figure C-2.



Figure C-2: User Prompt Pop-up

- Fill out the **INSPECTION DATA** section using the following attributes as required:

Account for the hours of work and total expense incurred to install the TW-24.

**Inspector:** select from pull-down menu as appropriate  
**Inspection Type:** select from pull-down menu as appropriate  
**Inspection Date:** mm/did/ivy  
**Staff Hours:** x  
**Miles Driven:** xxx  
**Per Diem:** select from pull-down menu as appropriate  
**Trip Number:** xxxxxxxxxxxx  
**Supplies Cost:** xx.xx  
**Trip Cost:** xxx.xx

- Fill out the **EQUIPMENT - Maintenance Performed** section as required. See Figure C-3.

EQUIPMENT	Maintenance Performed - More than one may be chosen				
<b>TOTAL</b>	<input type="checkbox"/> Not Serviced	<input type="checkbox"/> Painted	<input type="checkbox"/> Modified	<input type="checkbox"/> Replaced	<input type="checkbox"/> Moved/Relocated
	<input checked="" type="checkbox"/> Routine Maintenance	<input type="checkbox"/> Calibrated	<input type="checkbox"/> Repaired	<input type="checkbox"/> Installed	<input type="checkbox"/> Removed
<b>SRG</b>	<input type="checkbox"/> Not Serviced	<input type="checkbox"/> Painted	<input type="checkbox"/> Modified	<input type="checkbox"/> Replaced	<input type="checkbox"/> Moved/Relocated
	<input checked="" type="checkbox"/> Routine Maintenance	<input type="checkbox"/> Calibrated	<input type="checkbox"/> Repaired	<input type="checkbox"/> Installed	<input type="checkbox"/> Removed
<b>NIMBUS</b>	<input type="checkbox"/> Not Serviced	<input type="checkbox"/> Painted	<input type="checkbox"/> Modified	<input type="checkbox"/> Replaced	<input type="checkbox"/> Moved/Relocated
	<input checked="" type="checkbox"/> Routine Maintenance	<input type="checkbox"/> Calibrated	<input type="checkbox"/> Repaired	<input type="checkbox"/> Installed	<input type="checkbox"/> Removed
<b>MONEL (H)</b>	<input type="checkbox"/> Not Serviced	<input type="checkbox"/> Painted	<input type="checkbox"/> Modified	<input type="checkbox"/> Replaced	<input type="checkbox"/> Moved/Relocated
	<input checked="" type="checkbox"/> Routine Maintenance	<input type="checkbox"/> Calibrated	<input type="checkbox"/> Repaired	<input checked="" type="checkbox"/> Installed	<input type="checkbox"/> Removed
<b>SOLRX</b>	<input type="checkbox"/> Not Serviced	<input type="checkbox"/> Painted	<input type="checkbox"/> Modified	<input type="checkbox"/> Replaced	<input type="checkbox"/> Moved/Relocated
	<input checked="" type="checkbox"/> Routine Maintenance	<input type="checkbox"/> Calibrated	<input type="checkbox"/> Repaired	<input type="checkbox"/> Installed	<input type="checkbox"/> Removed

148 characters left

**Remarks**  
 INSTALLED NEW TW24 DIGITAL EVAPORATION THERMOMETER. PROVIDED OBSERVER TRAINING ON USE OF NEW THERMOMETER.

**Figure C-3: Maintenance Performed Section**

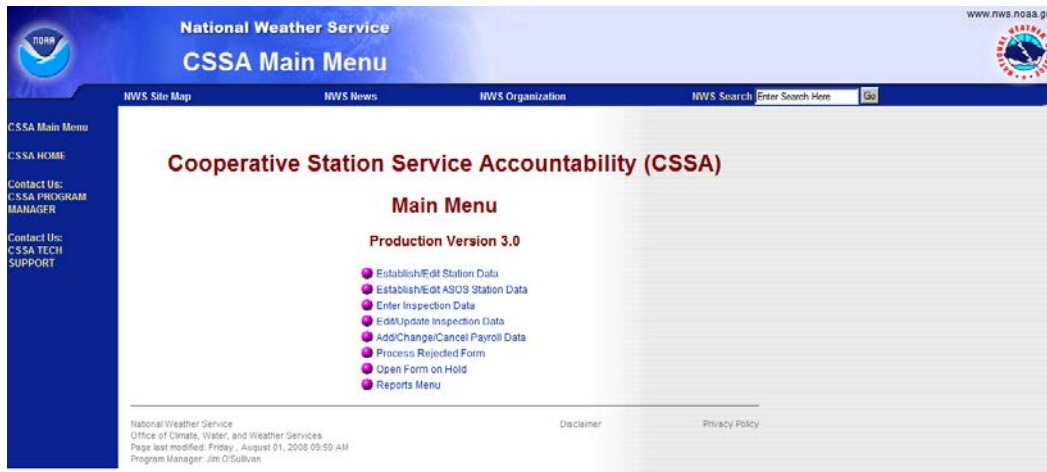
- Click the Equipment category **SIXES** under *Maintenance Performed*, and click in the checkbox, **Removed**. Then click on the next category **TW-24**, under *Maintenance Performed* and click the checkbox, **Installed**.
- At the bottom of the CSSA Site Inspection Report, in the free text field, insert the following information: **Replaced Six’s Mercurial with the TW-24, ThermoWorks long stem digital Max/Min Thermometer – ASN C129, June 15, 2012.**

**NOTE:** These values are for illustrative purposes only (e.g., **June 15, 2012**), and will differ for each evaporation pan site

### C.1.2 Updating the B-44 for the Observed Element - EVAPORATION

Instructions on editing the B-44 are located in the **Cooperative Station Service Accountability (CSSA) Manual** (NDS 10-1313), at: <http://www.nws.noaa.gov/directives/010/010.htm>. Turn to Appendix C, Section 2.4.4, Other Equipment Info, for instructions on adding secondary equipment (Table C-10), to add the selection TW-24 or, if necessary, to edit an existing entry from SIXES to TW-24.

1. Access the CSSA system at:  
[https://cssamain.nws.noaa.gov/cssade/cssa\\_main.cssa\\_main\\_menu](https://cssamain.nws.noaa.gov/cssade/cssa_main.cssa_main_menu)
2. Select **Establish/Edit Station Data** from the *CSSA Main Menu*. See Figure C-4.



**Figure C-4: Selecting Establish/Edit Station Data**

3. Enter the station's COOP ID number in the User Prompt popup. See Figure C-5.



**Figure C-5: User Prompt Station Number**

4. Select **Change/Edit/Correct Existing Surface Station Information and Metadata** from the Station Number Check pop-up window. See Figure C-6.

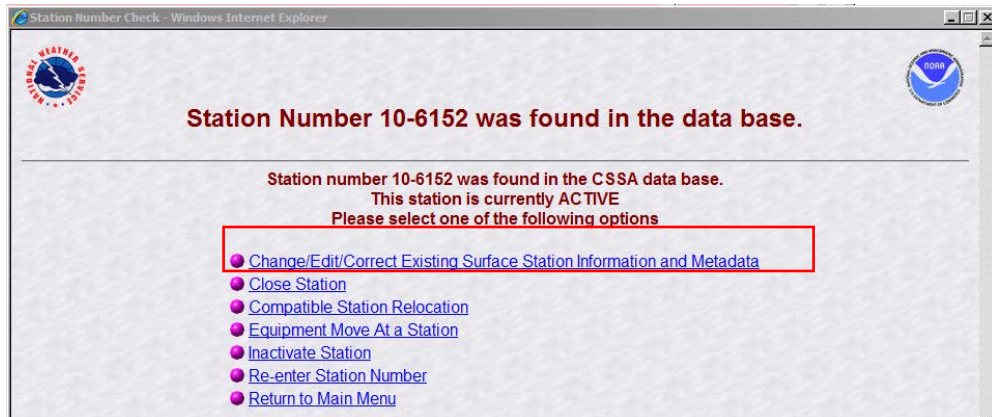


Figure C-6: Station Number Check Pop-up

5. On the *STN INFO* page (see Figure C-7), in the *Remarks* section, enter the following: **Updated EVAP thermometer, changed SIXES to TW-24. The TW-24 is a long-stem digital thermometer with an LCD display.**

Update the *STATION ADMIN* section as required.

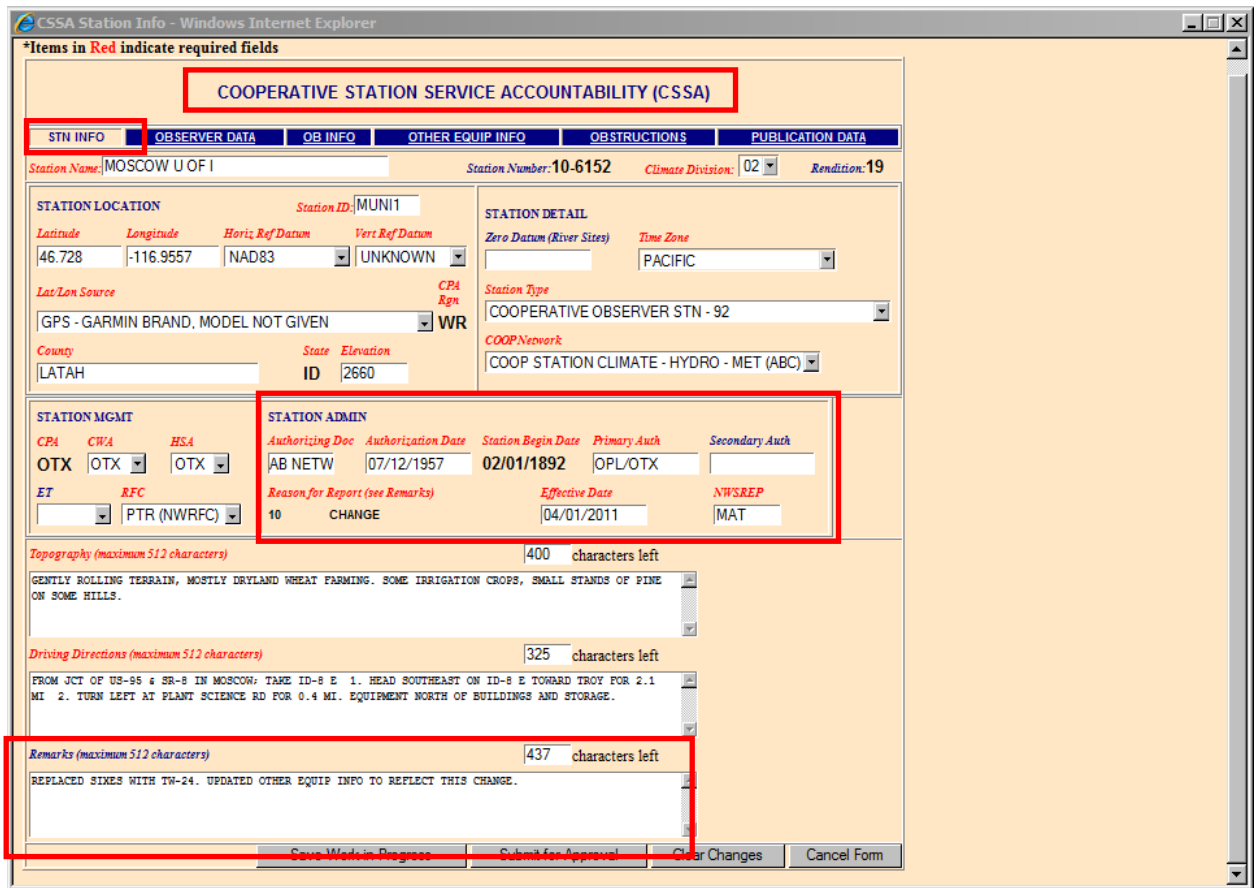


Figure C-7: STN INFO Page

6. Make the following changes in CSSA on the *Other Equipment Info* screen, to add new equipment to the Category that is titled, **EVAP**. See Figure C-8.

<i>Observed Element: EVAPORATION</i>								
EQUIPMENT								
<i>Equipment Code</i>	<i>Serial Number</i>	<i>Owner</i>	<i>Exp</i>	<i>Tel</i>	<i>Equipment Description</i>	<i>Azimuth</i>	<i>Distance</i>	
EVAP-C		NWS		N	GALVAN(F) TEMP: TW24, WIND: F106	185	18	

Figure C-8: Equipment/Evaporation Window

- **Equipment Category**, Select **EVAP**, from drop-down menu
- **Equipment**, Select **TW-24**, from drop-down menu (ASN C-129 thermometer, digital)
- **Serial Number**: Not applicable
- **Owner**: Select **NWS**
- **Exposure**: Not applicable
- **Telemetry**: Select **N** for Not
- **Azimuth**: Enter the compass bearing (i.e., 270) from the SRG
- **Distance**: Enter nearest whole feet (i.e., 7) from the SRG
- **Backup**: Select **N** for Not
- **Equipment Description**: enter **ThermoWorks long stem digital thermometer, TW-24, with LCD display**