

NATIONAL WEATHER SERVICE INSTRUCTION 10-1302

June 21, 2010

Operations and Services

Surface Observing Program (Land), NDSPD 10-13

REQUIREMENTS AND STANDARDS FOR NWS CLIMATE OBSERVATIONS

NOTICE: This publication is available at: <http://www.nws.noaa.gov/directives/>.

OPR: W/OS7 (T. Trunk)

Certified by: W/OS7 (K.Schrab)

Type of Issuance: Routine

SUMMARY OF REVISIONS: This directive supersedes NWSI 10-1302 “*Instrument Requirements and Standards for the NWS Surface Observing Programs (Land)*” dated October 4, 2005. Parts of that directive, Section 2.1, 2.2, 3.1, and 4, and Appendices A, B, and F, were moved to NWSI 10-1301, ‘*Aviation and Synoptic Observations.*’ The remaining sections addressed instrument standards for the Supplementary Observation Program and the Climate Observing Program. Instrument requirements and standards for the Supplementary Observation Program adhere to the Aviation Observing Program’s criteria and are excluded from this instruction. The title was then changed to ‘*Requirements and Standards for NWS Climate Observations,*’ because the temperature and precipitation observations from the Cooperative Observer Program substantially support the NWS climate program.

Sections were added to describe minimum standards for: data generation, product formation, and documentation of metadata. This version eliminates duplication of instrument requirements and standards where climate observations are taken from Synoptic Observing Program and the Aviation Observing Program.

Signed
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June 7, 2010
Date

Requirements and Standards for NWS Climate Observations

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1. Introduction. This instruction describes the requirements and standards for National Weather Service (NWS) meteorological climate observations. The standards are for instrument siting, exposure, performance, and output data for temperature and precipitation. If standards can not be met by equipment in place, the standards should be achieved as stations are changed, equipment is installed, programs are modified, or new stations are established.

The standards for instrument performance, exposure, and data output in this instruction will support the recommendations of the World Meteorological Organization (WMO) for a climate observing program. As new instruments are introduced, studies to determine adjustment factors to account for differences between old and new instruments, gauges, and shelters are made. For further information see procedure NWS 10-21, *Intercomparison of Hydrometeorological Instruments and Algorithms*. The goal is to preserve the temporal continuity of station databases and make the change as seamless as possible in terms of the official climate record. The initiator of the change will be responsible for managing the studies. The results of the study will be documented and changes included in the station history file.

2. Cooperative Observing Program Observations. This section outlines the types of instruments in use by the Cooperative Observing Program (COOP). The NWS COOP station equipment can be the property of the NWS, the observer, a company, or any other government agency. All equipment meets the site exposure requirements defined in NWSI 10-1302 and NWSI 10-1315. Photos and descriptions of the observing equipment are found in NWSI 10-1315, *Cooperative Observations*.

Climate observing programs may meet their data requirements with these or other instruments.

- a. Maximum / Minimum Air Temperature Instruments
- b. Standard Rain Gauges (Non-recording)
- c. Recording Rain Gauges
- d. Snow Sticks, Snow Boards, and Snow Stakes
- e. Soil Temperature Maximum / Minimum Instruments
- f. Pan Evaporation Gauges
- g. Wind Run Anemometers
- h. Water Temperature Maximum / Minimum Instruments

For some COOP sites, data collection platforms (DCP) integrate and disseminate observations data. Any data provided by DCPs meet the most stringent standards set for all observing programs the system supports (i.e., Aviation Observing Program, Synoptic Observing Program, Climate Observing Program, and Supplementary Observing Program).

The minimum standards for producing the required observations in the Aviation Observing Program and the Synoptic Observing Program are described in the NWS Instructions (NWSI) 10-1301, *Aviation and Synoptic Observations*. The procedures for NWS forecast offices and contractors to provide supplemental observations in support of the climate observing program are detailed in the NWSI 10-1311, *Supplementary Observations and Complementary Data Sources and Networks*.

3. Site and Exposure Standards. This section provides instrument siting and exposure standards for the Climate Observing Program. Policies for how to establish cooperative sites, collection and distribution of observations, site visitation and management, are outlined in NWSI 10-1307, *Cooperative Program Management and Operations*.

Standards in this document will be followed as closely as possible to ensure uniformity of observations to meet national and international climatic observation requirements. Site and exposure standards define and establish specifications and guidelines. The implementation of these should be flexible to achieve a balance between meteorological representativeness, space availability, and cost effectiveness. Site and exposure standards differ between the aviation and climate programs. The Office of Federal Coordinator for Meteorology (OFCM) details the site and exposure standards as they apply to federal and non-federal observers. See FCM-S4-1994, Washington DC, 1994), accessible on: <http://www.ofcm.gov/siting/text/a-cover.htm> .

Instruments are **not** sited on rooftops. Relocation of existing rooftop instruments will be accomplished as funds permit and after coordination with the Regional Headquarters.

3.1. Air Temperature Measurement. Install the temperature instrument according to the following standards:

- a. over level terrain (earth or sod) typical of the area around the station, and;
- b. at least 100 feet from any extensive concrete or paved surface.
- c. all attempts will be made to avoid:
 - (1) areas where rough terrain or air drainage are proven to result in non-representative temperature data,
 - (2) areas where water tends to collect, and
 - (3) areas where drifting snow collects.
- d. If the instrument is within a shelter, position the shelter so it opens to the north (to protect the instruments from direct sun exposure) with the floor 4 to 6 feet above the surface. Shelters should be located no closer to an obstruction than four times the height of the obstruction.

- e. In the case of remote instruments not enclosed in shelters, the instrument (and display, if configured) will be mounted 4 to 6 feet above the surface and shielded by an integral thermoscreen. Remote instruments should be located no closer to an obstruction than four times the height of the obstruction.
- f. An object will be considered an obstruction if the object is greater than ten degrees in horizontal width as measured from the instrument and within 200 feet of the instrument. The instrument should be no closer than four times the estimated height of any nearby building, tree, fence, or similar obstruction.

3.2. Precipitation Gauges. The exposure of the precipitation gauge is of primary importance in the accuracy of precipitation measurements, especially snowfall measurements. An ideal exposure would eliminate all turbulence and eddy currents, near the gauge, that tend to carry away the precipitation. The loss of precipitation in this manner tends to increase with wind speed and orifice height.

- a. The orifice of the gauge will be horizontal and 3 to 5 feet above the surface. Exceptions are granted by the Regional Headquarters in writing and described in the station information documentation.
- b. The gauge site should have protection in all directions by objects of uniform height. Where the heights of the objects are uniform and the height of these objects and the distance from the gauge is generally uniform, their height above the gauge orifice should not exceed twice their distance from the gauge.
- c. In open areas, the heights of obstructions above the orifice should not exceed twice their distance from the gauge.

4. Air Temperature. Air temperature is temperature of the free air conditions surrounding the station at height between 4 feet to 6 feet above ground level. The air should be freely exposed to sunshine and wind and not close to, or shielded by trees, buildings, or other obstructions.

4.1 Air Temperature Measurement Performance. The following temperature instruments are currently being used in the cooperative observing program:

- a. Maximum / Minimum Temperature System (i.e., Nimbus)
- b. Liquid-in-glass maximum and minimum thermometers

Temperature instruments will be shielded from the following elements:

- a. Precipitation,
- b. Direct and reflected sunshine,

c. Direct and reflected thermal energy (i.e., Infrared),

All thermometers should be shielded with a thermoscreen or radiation shelter just large enough to protect against the elements stated, and slotted sufficiently to allow air to convect naturally into and out of the thermoscreen during calm air conditions. Powered aspirators are not required for these instruments.

All temperature measuring instruments should be issued with a certificate confirming compliance with the appropriate performance specification and accuracy; or be issued with a calibration certificate which gives the corrections that are applied to meet the required accuracy. This initial testing should be performed by an accredited calibration laboratory or a national testing institution.

Air Temperature Measurement Performance Standards				
Observed Element	Range - Fahrenheit	Reference Temperature	Time Constant	Accuracy At Reference (F)
Air Temperature, Current Reading	-80° to -20°	- 40°	25 sec	± 2.0° 90% confidence
	-20° to +115°	+ 50°	25 sec	± 1.0° 95% confidence
	+115° to +140°	+ 120°	25 sec	± 2.0° 90% confidence
Air Temperature, Maximum	-40° to +32°	- 20°	25 sec	± 2.0° 90% confidence
	+32° to +140°	+ 120°	25 sec	± 1.0° 95% confidence
Air Temperature, Minimum	-80° to -20°	- 40°	25 sec	± 2.0° 90% confidence
	-20° to +110°	+ 20°	25 sec	± 1.0° 95% confidence

Table 4.1 Air-Temperature Measurement Performance Standards.

Test and Evaluation: The National Weather Service, Office of Operational Systems requires traceability of the performance of these instruments by a two pressure-two temperature reference generator (i.e., Thunder Scientific model 4500) in accordance with the National Institute of Standards and Technology (NIST) guidelines. Uncertainty in the evaluation temperature is estimated in accordance with the National Conference of Standards Laboratory Report RISP-5, to be ±0.1° C at 95% confidence level, k=2. This implies the difference of generated and measured evaluation temperature values is less than ±0.1°C in the range, -60° C to +20° C.

Time Constant: This is the time required by the thermometer to register 63% of a step change in air temperature. Instruments possess time constant values that produce a step change of 1.0° F

and afford valid measurement of air temperature with 1.0 minute temporal resolution. The WMO *Guide to Meteorological Instruments and Methods of Observation*, advises the time constant be between 30 and 60 seconds with winds of 10 miles per hour.

General Instruments: The WMO suggests ordinary thermometers be able to measure with high certainty in the range -20° F to 115° F, with maximum error less than 0.4° F. In practice it may not be economical to provide thermometers that meet this performance goal. Less expensive thermometers, calibrated against a laboratory standard, may be used with correction applied as necessary. Such thermometers are then considered ‘calibrated.’

Hardened Instruments: General purpose, current day technology, thermometers may not have the ability to directly measure the temperature extremes identified in Table 4.1. In addition to the general climate instruments, an additional set of instruments to measure extreme air temperature is required for sites where air temperature falls below -20° F, or rises above 115° F at least one day per year in the 30-year climate record. A separate instrument is used, or a separate calibration factor is applied to the same instrument, for any observing site that meets this definition of a site that requires hardened instruments.

4.2 Air Temperature Data. These are the minimum requirements for the calculation, storage, and display of air temperature data for instruments with ability to log data. This instruction requires manual retrieval of the observed elements from the instrument display (outdoors) or system console (indoors).

Air Temperature Data Requirements					
Observed Element	Data Output Resolution	Data Average	Calculation Update	Time Stamped	Memory Recall
Air Temperature - Maximum Daily	0.1 deg F	15 seconds	1 minute	Yes	33 days
				No*	1 day
Air Temperature - Minimum Daily	0.1 deg F	15 seconds	1 minute	Yes	33 days
				No*	1 day
Air Temperature - Current Reading	0.1 deg F	15 seconds	1 minute	No	1 minute

* Thermometers without an internal clock that provide data for one time period, or require manual reset of the data for a single time period, are not required to time segregate or time stamp their Max/Min values.

Table 4.2. Air Temperature Data Requirements.

The observer notes the instrument readings and enters the observed values to an NWS reporting system according to instructions given him by the NWS Representative. This may include the

WxCoderIII web site, the IV-ROCS voice recognition system, or a paper form.

The observer will round the displayed data to whole units Fahrenheit by rounding all positively signed values up (i.e., +3.5°F to 4°F), and all negatively signed values rounded toward zero (i.e., - 3.5°F to - 3°F).

Less than 25 percent of all air temperature observation sites use liquid in glass thermometers. For these sites, on a daily basis, the observer walks out to the shelter (i.e., cotton region shelter), opens the shelter and visually inspects the liquid in glass thermometers to observe the readings of daily maximum temperature, daily minimum temperature, and current temperature. The observer notes the instrument readings and enters the observed values to an NWS reporting system according to instructions given him by the NWS Representative. This may include the WxCoderIII web site, the IV-ROCS voice recognition system, or the paper form.

4.3 WFO Generated Products. Temperature observations from COOP observers that are received daily by the WFO are run through a minimum level of quality assurance before they are transmitted as text products such as the Max/Min Temperature and Precipitation Table (RTP), State Weather Roundup (RWR), and Public Information Statement (PNS). Some offices also produce the agricultural summary (AGO) product, which includes air temperature.

The reporting forms, reporting methods, reporting frequency by which cooperative data is received into the WFO, are identified in Table 4.3. Some observers still use a reporting method of United States Postal Service only, and for these sites the WFO does not generate any of the products identified in Table 4.3.

Air Temperature - WFO Products				
Observed Element	Observation Form	Reporting Time	Reporting Method	Generated Products
Air Temperature - Maximum Daily	WS B-91	Daily to WFO	WxCoderIII; IV-ROCS (phone)	RTP, RWR, PNS, AGO
Air Temperature - Minimum Daily	WS B-91	Daily to WFO	WxCoderIII; IV-ROCS (phone)	RTP, RWR, PNS, AGO
Air Temperature - Current Reading	WS B-91	Daily to WFO	WxCoderIII; IV-ROCS (phone)	RTP, RWR, PNS, AGO

Table 4.3 Air Temperature - WFO Products

4.4 NOAA Published Data. The COOP observers send their temperature observations to the WFO either by paper form, or via an electronic means. The NCDC will access the data reported electronically by a web based collections data base (i.e., WxCoderIII). The NCDC flags data as

missing or questionable when it runs its quality control program and then reports either original or edited values. Summary results are issued in a monthly bulletin, Health of Network. A subset of COOP sites report ASOS temperatures for the climate program. Those are automated observations that report in the *Local Climatological Data* (LCD) and *Climatological Data* (CD).

Air Temperature - NOAA Publications				
Observed Element	NWS Source	Reporting Date	Agency / Users Who Publish	Name of the Publication
Air Temperature - Maximum Daily	WxCoder, and Printed Form	Monthly to NCDC	National Climatic Data Center	<i>Climatological Data (CD)</i>
Air Temperature - Minimum Daily	WxCoder, and Printed Form	Monthly to NCDC	National Climatic Data Center	<i>Climatological Data (CD)</i>
Air Temperature - Current Daily	WxCoder, and Printed Form	Monthly to NCDC	National Climatic Data Center	<i>Climatological Data (CD)</i>

Table 4.4. Air Temperature - NOAA Publications

5. Precipitation. Precipitation data is collected from two principal types of rain gauges. The first is a daily observation taken by the observers with a manual rain gauge. These observers will report their daily measurements to the NWS forecast office either daily, or by precipitation event, or once per month. The second is a recorded measurement of accumulated precipitation that is reported to the NWS forecast office in coded format. These are the primary equipment for the precipitation observation:

- a. Manual Rain Gauge (i.e., Standard Rain Gauge [SRG])
- b. Recording Rain Gauge (i.e., Fischer-Porter (F&P) recording gauge)

5.1 Daily Precipitation Observation. Nearly all cooperative observation sites are equipped with the Standard Rain Gauge (SRG). These are non-mechanical gauges with a 2.53 inch diameter tube surmounted by an eight inch diameter funnel aperture. The tube holds up to two inches of precipitation for measurement in hundredths of an inch. The SRG measures up to 20 inches of rain from the overflow can. Observers follow the procedures for taking a daily precipitation measurement as described in the NWSM 10-1315, *Cooperative Observations*, see <http://www.nws.noaa.gov/directives/sym/pd01013015curr.pdf>,

Manual Daily Precipitation – Gauge Standard					
Parameter	Requires	Seasonal	Range	Resolution	Measurement Accuracy
Precipitation, Rain	Collection Vessel	Funnel (warm season)	0 to 20 inches	0.01 inches	±0.02 inches
Precipitation, Frozen (liquid equivalent)	Collection Vessel	Open Aperture (snow season)	0 to 20 inches	0.01 inches	±0.04 inches

Table 5.1. Manual Daily Precipitation – Gauge Standard.

5.1.1 Data and Reporting Standard.

Manual Daily Precipitation - Data Standard					
Observed Element	Observation Method	Observation Period	Observation Time	Data Resolution	Null Precipitation
Precipitation, Rain	Rain stick, into tube	24-Hours	Daily at Set Time (i.e., 7am)	0.01 inch	‘0’ for dry. ‘T’ trace is < 0.01 inch
Precipitation, Accumulated Frozen	Indoor melt, then rain stick into tube	24-Hours	Daily at Set Time (i.e., 7am)	0.01 inch	‘0’ for dry. ‘T’ trace is < 0.01 inch

Table 5.2. Daily Precipitation - Data Standard.

5.1.2 Snow Measurement. Cooperative observers and contract observers for the term of their contract agreement are given NWS owned equipment to take snow depth measurements. There are two snow measuring sticks, one to measure up to 20 inches, the other up to 40 inches, and there is a snow stake to measure snow depths up to 60 inches. A snow board is used to measure the snow depth and it is cleared of all snow and frozen precipitation once per day, immediately after the observation is taken.

Snow Depth - Equipment Standard

Parameter	Equipment	Range	Resolution	Accuracy
Snow Depth: 0.1 inch to 20 inches	Snow stick (20") and Snow board	0 to 20 inches	0.1 inch	±0.1 inch
Snow Depth: 0 to 40 inches	Snow stick (40") and Snow board	0 to 40 inches	0.1 inch	±0.1 inch
Snow Depth: 0 to 60 inches	Snow stake (60")	0 to 60 inches	1 inch	± 1 inch

Table 5.3. Snow Depth - Equipment Standard.

5.1.3. Snow Depth Observation. Cooperative observers who are required to report snow depth, report snow depth at a minimum once per day on the established hour and enters the observed values into an NWS reporting system. The NWS reporting systems includes electronic systems as well as paper forms, Form B-91 or Form B-92) according to the instructions given him by the NWS Representative. Supplementary Climatological Observers are required to observe and report on the 6-hour synoptic times according to the instructions in NWSI 10-1311, *Supplementary Observations and Complementary Data Sources and Networks.*

Snow Depth - Data Standard				
Parameter	Observation Period	Observation Time	Reported Depth	Observation Form
Snow Depth: 0.0 inch to 40 inches	24-Hours	Daily at Set Hour (i.e., 7am)	0.5 inches ±0.1 inch	WS B-91, WS B-92
Snow Depth: (snow stake) 0 to 60 inches	24-Hours	Daily at Set Hour (i.e., 7am)	Whole inches ± 1 inch	WS B-91, WS B-92

Table 5.4. Snow Depth - Data Standard.

5.2 Hourly Precipitation Data Observation. Approximately 2,300 cooperative observation sites are equipped with the Fischer-Porter recording precipitation gauge (F&P). The mechanical gauges are in the process of being retrofitted with electronic equipment. The following data standards apply to both the mechanical and the electronic recording gauges.

Recorded Precipitation – Data Requirements

Parameter	Requires	Range	Resolution	System Accuracy
Precipitation, Rain (Hourly)	Oil and funnel in warm season	0 to 20 inches	0.1 inches	±0.1 inches, from 0 to 20 inches
Precipitation, Frozen (Hourly) Liquid Equivalent	Antifreeze and oil, and open aperture – snow season	0 to 20 inches	0.1 inches	±0.1 inches, from 0 to 20 inches

Table 5.5 Recorded Precipitation – Data Requirements.

5.2.1 Data and Reporting Standard. These are the minimum requirements for the production of precipitation data. The recording gauge produces 15-minute data elements that corresponds to the clock hour such that the first element contains precipitation data measured at HH:15 local time.

5.2.2 Electronic Logging Gauges. The gauge is able to produce a record of the stored data elements on a portable memory device for monthly reporting to the forecast office. These data elements are time stamped and stored in the gauge for a minimum of ninety days, and best if 365 days. The forecast office does not edit the data elements. Metadata on the maintenance and gauge configuration that might affect quality of data is reported separately into CSSA until further instruction is given in the course of the modernization program.

Recorded Precipitation - Data Requirements (Electronic)					
Observed Element	Calculation Update	Data Store Rate	Memory, Minimum	Data Retrieval	Data Quality Control
Precipitation, Accumulated Rain	5 minute	15 minutes	90 days	Monthly	None
Precipitation, Accumulated Frozen	5 minute	15 minutes	90 days	Monthly	None

Table 5.6. Recorded Precipitation - Data Requirements.

5.3 WFO Generated Products. Manually reported precipitation and snow depth observations are received by the WFO daily. During floods and special weather events observers report data in near real time and may use observations taken from the recording rain gauges. For this reason all recording gauges have a display/readout to indicate the amount of precipitation in the gauge, from which the observer can calculate the daily precipitation amount.

Precipitation - WFO Products				
Observed Element	Observation Form	Reporting Time	Reporting Method	Generated Products
Manual Daily Precipitation	WS B-91	Daily to WFO	WxCoderIII; IV-ROCS (phone)	RTP, RWR, PNS, AGO
Recorded Precipitation	WS B-18 (paper tape), or CSV file (electronic)	Monthly to WFO	Mail to NCDC, or FTP to NCDC web	None
Snow Depth	WS B-91	Daily to WFO	WxCoderIII; IV-ROCS	RTP, RWR, PNS, AGO

Table 5.7 Precipitation – WFO Products

Precipitation observations from COOP observers are run through a minimum level of quality assurance before they are transmitted as text products as identified in Table 5.7. The observer uses an observation form and a specific reporting method to deliver precipitation observations to the WFO.

Precipitation - NOAA Publications				
Observed Element	NWS Source	Reporting Date	Agency / Users Who Publish	Name of the Publication
Standard Rain Gauge (SRG)	B-91 Form (printed and WxCoder3)	Monthly to NCDC	National Climatic Data Center	<i>Climatological Data (CD)</i>
F&P Recording Gauge (Paper Tape)	B-18 Printed Form	Monthly to NCDC	National Climatic Data Center	<i>Hourly Precipitation Data (HPD)</i>
F&P Recording Gauge (Electronic)	File Transfer Protocol (CSV files)	Monthly to NCDC	National Climatic Data Center	<i>Hourly Precipitation Data (HPD)</i>
Snow Depth	B-91 Form (printed and WxCoder3)	Monthly to NCDC	National Climatic Data Center	<i>Climatological Data(CD)</i>

Table 5.8. Precipitation – NOAA Publications

5.4 NOAA Published Data. The NWS submits detailed observation records, either in print or in electronic form, to NCDC. The NCDC quality control process may delete precipitation data that are spatially inconsistent, exceed climatological limits, or are inconsistent with prevailing weather patterns. Table 5.8 identifies the NWS source of the precipitation data reported in the publications.

6. Soil Temperature. The observation site should not be subject to irrigation, overflow, or unusual ground water conditions. The site should be open to full sunshine and represent the seasonal sun and shade patterns for the growing season. Snow cover should remain natural and undisturbed. For the detailed instruction on how to install the soil thermometer refer to NWSM 10-1315, Appendix E.

6.1 Measurement Performance. Soil temperature observations should be taken at the same time of day. Generally, this will be between 7am and 8am or between 5pm and 8pm. This instruction does not require soil temperatures to be recorded on electronic thermometer. If automated recording instruments are used, the instruments should be checked daily to assure they are operating. Instrument performance meets the principles described in Section 4.1.

Soil Temperature – Measurement Standard				
Observed Element	Range – Fahrenheit	Reference Temperature	Time Constant	Accuracy At Reference (F)
Soil Temperature, Current	-10° to +120°	+50° F	60 sec	± 2.0° 90% confidence
Soil Temperature, Maximum	0° to +120°	+100° F	60 sec	± 2.0° 90% confidence
Soil Temperature, Minimum	-10° to +50°	+20° F	60 sec	± 2.0° 90% confidence

Table 6.1 Soil Temperature - Measurement Standard

Soil thermometer heads or recorders are mounted 4 to 6 feet above the ground and shielded from precipitation and direct sunlight by a shield that may be fully enclosed. A wooden post may serve as the mount. Electronic thermometers (i.e., Frontier) that measure soil temperatures will have their display read-out mounted in an enclosed shelter.

6.2 Data Requirement. Soil temperatures are essential to the agricultural industry and should

represent the temperature of the natural agricultural soils of the area. Soil thermometers should be located in and under undisturbed soil in close contact with the ambient soil, with no insulating air spaces, or pockets. Soil temperatures should be taken at depths of 4 inches and 20 inches. If required for special needs, depths of 8 inches, 60 inches, and 120 inches can be reported if they meet the measurement standards described in Table 6.1.

Regardless of the type of soil temperature instrument, the observer makes a visual reading of the measurement and notes the values to WS Form B-83A, Supplementary Record of Climatological Observations. The form can be updated and transmitted daily to the local WFO via WeatherCoderIII. Otherwise the Form B-83A is completed for all days of the month, and mailed to the WFO after the end of the month.

The minimum requirements for data retrieval and reporting are described in Table 6.2.

Soil Temperature - Data Requirement				
Observed Element	Observation Period	Observation Time	Observation Method	Data Resolution
Soil Temperature - Maximum Daily	24-Hours	Daily at Set Hour (i.e., 7am)	Examine dial / readout	Whole Degree Fahrenheit
Soil Temperature - Minimum Daily	24-Hours	Daily at Set Hour (i.e., 7am)	Examine dial / readout	Whole Degree Fahrenheit
Soil Temperature - Current Reading	Current	Daily at Set Hour (i.e., 7am)	Examine dial / readout	Whole Degree Fahrenheit

Table 6.2. Soil Temperature - Data Requirement.

The observer is required to report the maximum, minimum, and current soil temperature at two depths: 4 inches and 20 inches. The shallow soil depth experiences the greatest diurnal range in temperature and soil temperatures in the summer can exceed the air temperature. Seasonal changes are observed at 20 inches. If the observer also reports air temperature, he should take the air temperature observation at the same hour of the day as the soil temperature.

6.3 WFO Generated Products. Soil temperatures are reported in the Agricultural Weather Summary product (AGO) on a daily basis. The AGO is a text product distributed by some offices daily through the year on AWIPS. Other offices transmit the AGO during growing season, only.

Soil temperature observations from COOP observers are run through a minimum level of quality assurance before they are transmitted as text products as identified in Table 6.3. The observer

uses an observation form and a specific reporting method to deliver soil observations to the WFO.

Soil Temperature - WFO Products				
Observed Element	Observer Reports	Observation Form	Reporting Method	WFO Generated Products
Soil Temperature - Current Reading	Daily to WFO	WS B-83A	WxCoderIII; IV-ROCS (phone)	AGO
Soil Temperature - Maximum Daily	Daily to WFO	WS B-83A	WxCoderIII; IV-ROCS; ROSA (phone)	AGO
Soil Temperature - Minimum Daily	Daily to WFO	WS B-83A	WxCoderIII; IV-ROCS; and ROSA (phone)	AGO

Table 6.3 Soil Temperature - WFO Products

6.4 NOAA Published Data. Many stations who measure soil temperature transmit their readings daily via communications circuits in the beginning and middle portions of the growing season. Nationwide weekly average soil temperatures are published during the growing season in the *Weekly Weather and Crop Bulletin*. Daily readings from one or more sub-soil depths are published by NCDC in their monthly publication, *Climatological Data*.

Soil Temperature - NOAA Publication				
Observed Element	NWS Source	Reporting Date	Agency / Users Who Publish	Name of the Publication
Soil Temperature Max/Min, Daily (Multiple Depths)	WS Form B-83A	Monthly to NCDC	National Climatic Data Center	<i>Climatological Data (CD)</i>
Soil Temperature Max/Min, Weekly (4-Inch Only)	WS Form B-83A	Monthly to NCDC	Dept of Agriculture	<i>Weekly Weather and Crop Bulletin (WWCB)</i>

Table 6.4. Soil Temperature – NOAA Publication

7. Pan Evaporation. During the growing season, when air temperatures are above freezing, Cooperative Sites may take observations of the daily evaporation to the nearest hundredth of an inch. The daily observations are useful for agricultural programs and are published monthly in the *Climatological Data*.

When the pan evaporation observation is taken, additional observations are made of water temperature, air temperature, precipitation, and air movement. The detailed instructions for conducting an evaporation observation are located in NWSM, 10-1315, *Cooperative Observations*, Appendix D.

7.1 Evaporation Pan Standards. The pan is constructed of monel or stainless steel and is 47.5 inches in diameter and 10 inches deep and is mounted on a wooden pallet so the pan sits approximately six inches above ground surface and is level as measured with a leveling beam.

The pan should be sited in an open field if possible, in full sunlight, and enclosed by a chain link fence. Empty the pan during months when freezing temperatures are expected. Either store the pan indoors, or secure it outdoors, inverted.

Observers use a fixed point gauge and calibrated refill cylinder to measure decreases in the volume of water. The fixed point gauge equipment is described in NWSM 10-1315, Appendix D.

Pan Evaporation – Observation Requirements				
Parameter	Frequency	Range	Resolution	Accuracy
Evaporation	Daily, or as Specified	0 to 10 inches	0.01 inches	±0.02 inch

Table 7.1. Pan Evaporation Observation.

7.2 Required Observations. Pan evaporation is an empirical observation with additional observations made on site, within 50 feet of the evaporation pan, and reported to the WFO as useful for agricultural interests.

- a. Maximum and Minimum Water Temperature in the last 24 hours are recorded to WS Form B-92 at time of observation. The instrument should be held in a bracket, shielded from sunlight, and submerged in the evaporation pan. The bracket may be mounted to the south wall of pan or set on the bottom of the pan, depending on type.
- b. Maximum and Minimum Air Temperature in the last 24 hours are recorded to WS Form B-92 at time of observation. The air temperature observations comply with

standards described in section 4 of this instruction.

- c. Precipitation Accumulation in the last 24-hours is recorded to hundredth of an inch. This is recorded to B-92 at time of observation. Precipitation observations comply with standards described in section 5 of this instruction.

- d. Air Movement as measured by a totalizing anemometer or by an anemometer with logger with ability to produce a 24-hour average wind speed. The anemometer should be mounted to the pan support with the cups positioned between 6 to 8 inches above the lip of the pan. Air movement observations should be accurate plus or minus one mile of wind that has passed over the pan since the last scheduled observation. The measurement of one mile of wind should represent one ‘count’ unit as appears on the totalizing anemometer’s display. If a recording anemometer is used, then multiply the average 24-hour wind speed by 24 to calculate the miles of wind. Air movement is recorded to Form B-92 at time of observation.

The WS Form B-92 mentions dew point temperature and wet bulb temperature, however these observations are not required for the pan evaporation observation.

Water Temperature Measurement Performance Standards				
Observed Element	Range - Fahrenheit	Reference Temperature	Time Constant	Accuracy At Reference (F)
Water Temperature, Current Reading	32° to 120°	50° F	25 sec	± 2.0° 90% confidence
Water Temperature, Maximum	33° to 120°	80° F	25 sec	± 2.0° 90% confidence
Water Temperature, Minimum	32° to 110°	50° F	25 sec	± 2.0° 90% confidence

Table 7.2 Water-Temperature Measurement Performance Standards.

7.3 WFO Generated Products. Pan evaporation observations are reported in the Agricultural Weather Summary product (AGO) during the warm season. The COOP observer uses an observation form and a specific reporting method to deliver pan evaporation observations to the WFO. The daily evaporation gets reported in the AGO together with the same site’s daily precipitation, air movement, and max/min air temperature observations.

WFO Products - Pan Evaporation Reporting Requirements				
Observed Element	Observation Form	Reporting Time	Reporting Method	Generated Products
Evaporation, Daily	WS B-92	Daily to WFO	WxCoderIII; IV-ROCS (phone)	AGO
Precipitation	WS B-92	Daily to WFO	WxCoderIII; IV-ROCS (phone)	AGO
Water Temperature Max/Min, Daily	WS B-92	Daily to WFO	WxCoderIII; IV-ROCS (phone)	None
Air Movement, Daily	WS B-92	Daily to WFO	WxCoderIII; IV-ROCS (phone)	AGO
Air Temperature Max/Min, Daily	WS B-92	Daily to WFO	WxCoderIII; IV-ROCS (phone)	AGO

Table 7.3 Pan Evaporation - WFO Products

7.4 NOAA Published Data. Pan evaporation observations are published during the warm season in the NCDC monthly publication, *Climatological Data*.

NOAA Publications – Pan Evaporation				
Observed Element	NWS Source	Reporting Date	Agency / Users Who Publish	Name of the Publication
Evaporation, Daily	WS Form B-92	Monthly to NCDC	NCDC	<i>Climatological Data (CD)</i>
Water Temperature Maximum, Daily	WS Form B-92	Monthly to NCDC	NCDC	<i>Climatological Data (CD)</i>
Water Temperature Minimum, Daily	WS Form B-92	Monthly to NCDC	NCDC	<i>Climatological Data (CD)</i>
Air Motion, Daily	WS Form B-92	Monthly to NCDC	NCDC	<i>Climatological Data (CD)</i>

Table 7.4. Pan Evaporation – NOAA Publications

8. Sunshine Duration. The sunshine duration parameter measures direct insolation and should exclude the effects of diffuse radiation. Locate the sensor where there are no stationary obstructions reflecting or casting a shadow on the sensor. The percent of possible sunshine is published monthly by the NCDC for a number of sites in, *Local Climate Data*.

Sunshine Sensor Performance Standard			
Parameter	Accuracy	Resolution	Solar Flux Density Threshold
Sunshine Duration	±10%	1 minute	120 Watts/m ²

Table 8.1. Sunshine Sensor Performance Standard.

9. Metadata for Cooperative Observations. Observations made for the NWS Climate Program have a minimum corresponding set of metadata to describe the observing instruments, the observation character, the data entry form necessary to record the observation, method of reporting, name of product generated by forecast office, and name of publication in which the observation is published.

The metadata are recorded to the NWS Cooperative Station Service Accountability (CSSA) system for real time access and archive access. The required metadata and instructions for recording this information into the CSSA are found in NWSM 10-1313, *Cooperative Station Service Accountability* (Appendix C, The Data Entry).

<http://www.nws.noaa.gov/directives/sym/pd01013013curr.pdf>