PART 2B. MANUAL WEATHER STATIONS: INSTALLATION AND EXPOSURE OF EQUIPMENT

Certain standards were presented in Part 1, sections 2.5 and 3.2, concerning weather station location and instrument accuracy. The objective of these and other standards is to obtain reliable data that represent, as much as possible, the weather occurring in the station vicinity. The data should be comparable with past data at the same station and also with similar data collected at other stations in an observing network.

Part 2B presents both guidelines and details for station and equipment setup, with specific attention given to two standard types of manual stations—fire-weather stations and evaporation stations. The information will pertain to other manual station configurations, which, in their equipment, may be subsets or combinations of the stations described. For example, standard climatological substations in the National Weather Service network, reporting only daily precipitation and maximum and minimum temperatures, would be subsets operating on a year-round basis.

Standards covering station siting, instruments, and the installation and exposure of the instruments apply to all of these stations.

CHAPTER 15. STANDARD WEATHER STATIONS

15.1 Standard Fire-Weather Station

The term "standard fire-weather station" as used here refers primarily to a permanent, manually operated station. Such stations are part of a network maintained for purposes of routine fire-danger rating and fire-weather forecasting. Many of these stations also serve as National Weather Service climatological stations.

The standard or recommended fire-weather station equipment has been listed in section 6.1. Station checklists that summarize equipment installation and maintenance standards are presented in appendix 4.

LOCATION

The standard fire-weather station should be located in a large opening, away from obstructions and local sources of dust and surface moisture. The station should be on level ground with only low vegetative cover. The station should be exposed to full sunshine throughout the day, or as much as possible, during the fire season. If the station is located on a slope, a southerly or westerly exposure is required to meet fire-danger rating specifications (Deeming and others 1977). (See section 2.5 for detailed location and exposure guidelines.)

LAYOUT

Arrangement of Equipment—A recommended ground plan for a standard fire-weather station is shown in figure

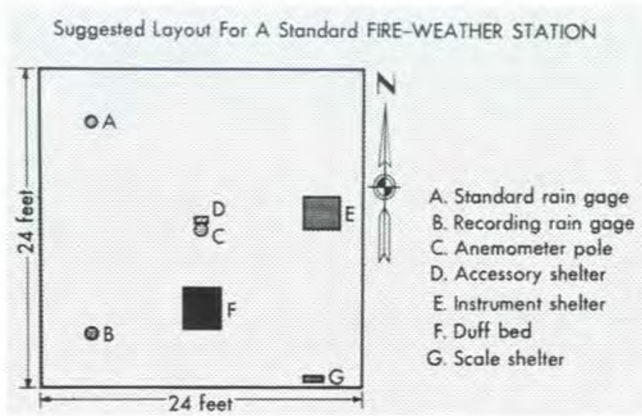


Figure 15.1—Ground plan for a standard manual fire-weather station.

15.1. This particular arrangement of equipment allows a free flow of air and full exposure to sunshine. Plot size should be based on the individual station requirements. Ideally, the size should be large enough to accommodate instruments that may be added in the future. Recommended dimensions (fig. 15.1) are 24 by 24 ft. Plots should be at least 15 by 15 ft for proper exposure of minimum instrumentation.

Grounds—The station grounds, and a surrounding 20-ft radius, should be free of tall vegetation. Brush and trees beyond this area should not interfere with exposure. A ground cover of native perennial grass is ideal, provided it is kept well clipped (to about 3 inches height) and is not irrigated. Graveled paths to the various instrument locations are desirable to avoid dust or mud problems.

Fence—A fence around the station plot is not essential unless there is danger that instruments will be upset or otherwise damaged by animals or human intruders. A fence, however, often improves the appearance of a station and discourages unauthorized entry.

A fence should be no higher than 4 ft and constructed of open material such as woven wire. Picket fences and other types that would restrict airflow across the plot are unacceptable.

15.2 Standard Evaporation Station

The standard or recommended evaporation station equipment has been listed in section 6.2.

LOCATION

Location requirements for a standard evaporation station largely follow those given in section 15.1. In general (U.S. Department of Commerce 1972), the site should be fairly level and free from obstructions that cast shadows over the evaporation pan during any part of the day, other than brief periods near sunrise and sunset. The site should be representative of the natural soils and ground cover common to the area. Locations with nearby sprinkling, or subject to flooding, should be avoided.

LAYOUT

A recommended ground plan for a standard evaporation station is shown in figure 15.2. The layout is designed to eliminate shadows over the evaporation pan from adjacent instruments or structures. The plot dimensions, 16 by 20 ft, and the indicated spacings within are the minimum for the equipment shown. To accommodate additional equipment or accessory equipment (such as a wind shield for the precipitation gauge), the plot should be 20 by 20 ft or larger.

The ground cover should be sod where its maintenance is permitted by the climate and soil conditions—without irrigation. Grass and weeds about the plot should be kept mowed below the evaporation pan level.

The plot should be enclosed by a fence to protect the equipment from possible interference by animals, who may drink water from the evaporation pan, and humans. A chain link fence, of 9 or 11 gauge steel and at least 4 ft high, is recommended, with access through a 3-ft-wide locking gate. Additional precautions such as low chicken mesh barriers may be needed to exclude rodents or other small animals.

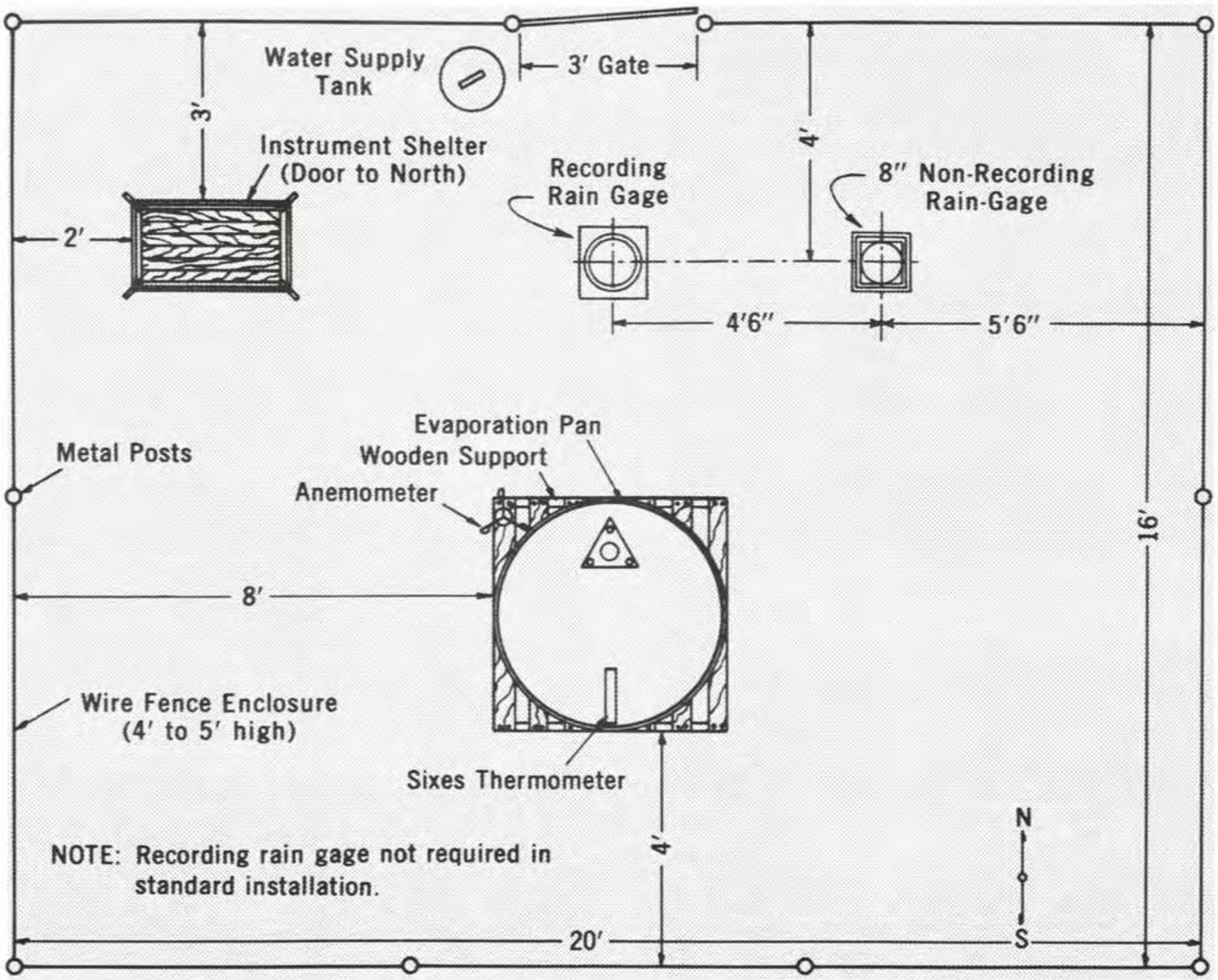


Figure 15.2—Ground plan for a standard evaporation station. (From U.S. Department of Commerce 1972.)

CHAPTER 16. TEMPERATURE AND HUMIDITY EQUIPMENT

16.1 Instrument Shelter

COTTON REGION SHELTER

A properly installed instrument shelter will meet the following requirements:

1. Shelter is open to the free movement of air.
2. Shelter is located over low vegetative cover, such as grass, or other ground surface representative of the surrounding area. It should be at least 100 ft from any extensive paved surfaces.
3. Door faces north, so that sun cannot shine on the thermometers when the door is opened for observations during the day.
4. Floor is level and 4 ft above ground, except higher in areas of heavy snowfall accumulation.
5. Shelter is firmly mounted on its support, and the support legs are firmly anchored to the ground. This is required to prevent blowdown by wind and also to minimize vibrations that could displace the index of liquid-in-glass minimum thermometers. Likewise, the door should close firmly to prevent possible wind vibration, but it should not rub against its frame during opening and closing.

At a permanent station, it is recommended that the shelter support legs are fastened to concrete footings; the legs are buried, however, only if they are constructed of metal. Wooden support legs may alternatively be fastened to metal or treated-wood stakes. Metal mounting pins of the type shown in figure 16.1 can aid in obtaining proper, level installation of the shelter (fig. 16.2).

In windy areas where shelter vibration causes erroneous minimum-thermometer readings, the maximum and minimum thermometers should be mounted on a separate post, which enters the shelter through a hole cut in the bottom.

The instrument shelter should be used only for the exposure of temperature and humidity instruments (fig. 16.3). Storage should be limited to related small items that do not block ventilation of the instruments.

Figure 16.1—Instrument shelter mounting pin. (See appendix 5 for details.)

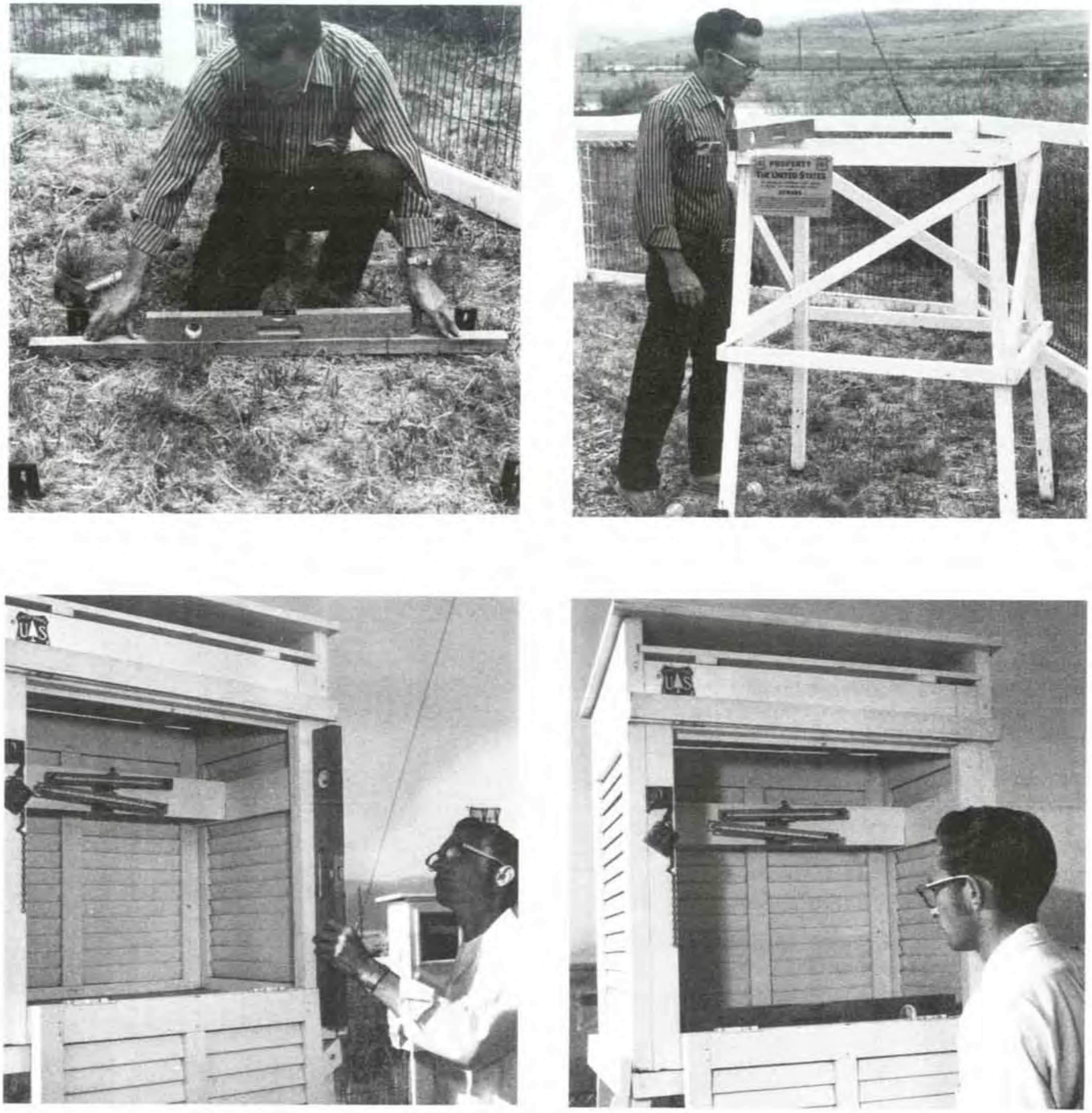


Figure 16.2—Installing and leveling instrument shelter using mounting pins.

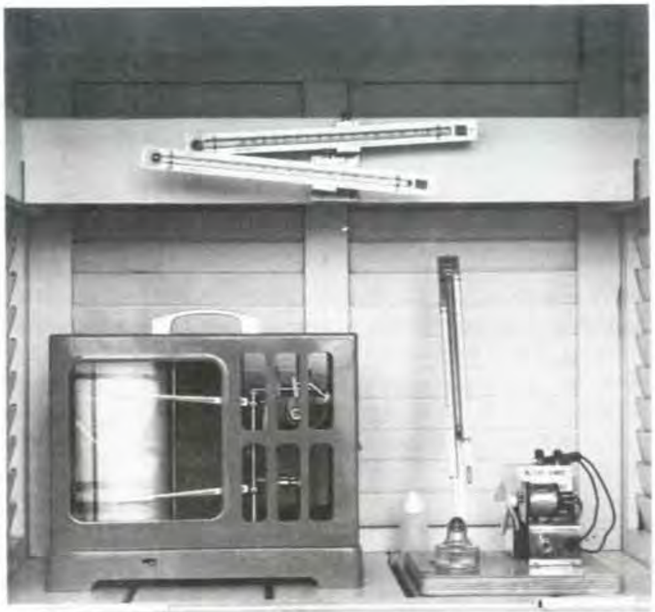


Figure 16.3—Suggested arrangement of instruments in a cotton region shelter. Only temperature and humidity instruments should be installed in this shelter.

16.2 Maximum and Minimum Thermometers

STANDARD LIQUID-IN-GLASS THERMOMETERS

The standard maximum and minimum thermometers with Townsend support are mounted in an instrument shelter, as follows:

Townsend Support—Attach the Townsend support with screws at the center of the instrument shelter crossboard. Be sure that the support is positioned with the spinning clamp (for the maximum thermometer) at the bottom (fig. 16.3).

Maximum Thermometer—With the clamp in locked ("set") position, mount the maximum thermometer, bulb end to the left, in the spinning (lower) clamp of the Townsend support. Mount at about two-thirds distance up the thermometer stem (near the 80° mark on a –20 to +120 °F-range thermometer). If the thermometer is mounted too near its midpoint, the mercury column is apt to separate during spinning, and part of it may become lodged at the top of the stem.

Tighten the thumbscrew on the bracket securely to prevent thermometer slippage during spinning. When properly mounted, the bulb end of the maximum thermometer is inclined about 5 degrees above the horizontal. This position facilitates the movement of mercury as the temperature rises and minimizes the chance of mercury retreating through the constriction as the temperature falls.

Minimum Thermometer—Mount the minimum thermometer, bulb end to the left, in the upper clamp, slightly beyond the middle of the stem (near the 60° mark on a –40 to +120 °F-range thermometer).

Tighten the thumbscrew on the clamp to hold the thermometer in place. Gently push the bulb end downward to its limiting position. When properly mounted, the bulb end is inclined about 5 degrees below the horizontal. This position facilitates the downward movement of the index when the temperature falls. It also tends to prevent accumulation of vaporized liquid above the alcohol column and resulting bubble formation (section 30.2). The minimum thermometer, however, must be protected against vibration that would slide the index downward (section 16.1).

OTHER MAXIMUM-MINIMUM THERMOMETERS

The Six's and dial types of maximum-minimum thermometer can also be mounted in an instrument shelter, using the crossboard or a vertical post. The Six's thermometer should be mounted rigidly in a vertical position. Its index rods ordinarily remain in place until reset by a magnet, but movement is possible from wind vibration. In mounting a dial-type thermometer, the end of the sensor stem should be near the standard thermometer height and position, at least several inches from the shelter louvers.

The sensor of a remote-reading digital maximum-minimum thermometer likewise can be mounted in an instrument shelter (particularly when this shelter is required for housing other temperature and humidity instruments). The digital thermometers employed by the National Weather Service have their sensors mounted in a small radiation shield (section 7.3).

16.3 Psychrometers

STANDARD ELECTRIC FAN PSYCHROMETER

Locate the psychrometer in the right front portion of the instrument shelter, fastening it to the floor board (fig. 16.3). Be sure that the position of the psychrometer does not interfere with the spinning of the maximum thermometer. To obtain the proper ventilation, observe the polarity of the battery wires when connecting the fan to the battery.

OTHER PSYCHROMETERS

The above instructions concerning location also apply to a hand fan psychrometer. A Mason hygrometer if used should be mounted in an instrument shelter, on a hook or screw near the right end of the crossboard, clear of the maximum and minimum thermometers.

16.4 Hygrothermograph

Set the hygrothermograph in the left front portion of the instrument shelter (fig. 16.3). It is ordinarily set on the floor, but it may be raised slightly on 2- by 4-inch wooden blocks (broad side up) at year-round stations where snow blows into the shelter and covers the floor. Be sure that the hygrothermograph is placed far enough forward to be clear of the spinning maximum thermometer.

CHAPTER 17. WIND EQUIPMENT

17.1 Anemometers

Anemometers should be exposed 20 ft above open, level ground (fig. 17.1). This standard height must be adjusted, however, to compensate for height of ground cover, uneven ground, and nearby obstructions. To obtain a suitable, representative exposure, the anemometer can, if necessary, be located one-quarter mile or farther away from the main weather station plot.

HEIGHT ADJUSTMENT

Uneven Ground—In rolling country or over rough ground characterized by depressions and ridges, mount the anemometer 20 ft above a representative high spot. If the anemometer is mounted over a low spot, increase the height by the average depth of the depression in relation to the surrounding higher ground.

Ground Cover—Adjustment of anemometer height will depend on the density and height of the ground cover. If the ground is densely covered with rocks, brush, or small trees, increase the height of the anemometer by the average height of the ground cover. If the ground cover is scattered, increase the height of the anemometer by one-half the average height of the ground cover. If the ground cover is sparse, increase the height of the anemometer by one-third the height of the ground cover.

Nearby Obstacles—No adjustment of anemometer height is necessary if the distance of an obstacle from the anemometer is more than seven times the height of the obstacle. If the distance is less than seven times the height of the obstacle (fig. 17.2), table 17.1 can be used to determine the adjusted anemometer height (USDA FS 1964b).

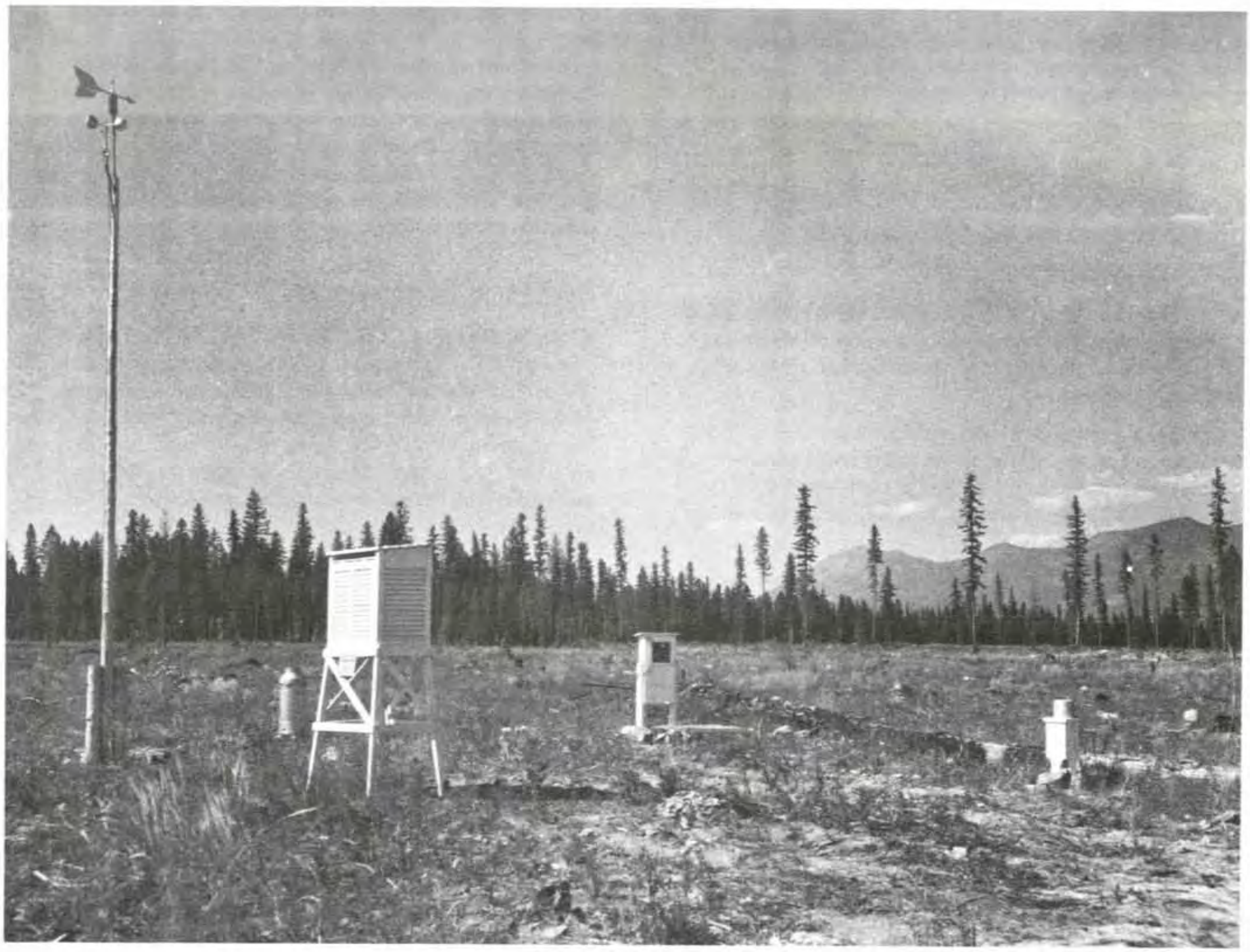


Figure 17.1—A standard anemometer installation 20 ft above open, level ground.

Table 17.1—Anemometer height (20-ft standard)[1] correction table

Distance to obstacle	Height of obstacle (feet)														
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Feet							*[2]Feet*								
10	27	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	25	34	—	—	—	—	—	—	—	—	—	—	—	—	—
30	24	32	41	—	—	—	—	—	—	—	—	—	—	—	—
40	22	30	39	48	—	—	—	—	—	—	—	—	—	—	—
50	21	29	37	46	55	—	—	—	—	—	—	—	—	—	—
60	21	27	35	44	53	62	—	—	—	—	—	—	—	—	—
70	20	26	34	42	51	60	69	—	—	—	—	—	—	—	—
80	20	24	32	40	49	58	67	76	—	—	—	—	—	—	—
90	20	23	31	38	47	56	65	74	83	—	—	—	—	—	—
100	20	22	29	37	45	54	63	72	81	90	—	—	—	—	—
120	20	21	26	34	42	50	59	68	77	86	95	104	—	—	—
140	20	20	24	31	39	47	55	64	73	82	92	100	109	118	—
160	20	20	23	28	36	44	52	60	69	78	87	96	105	114	123
180	20	20	22	26	33	41	49	57	65	74	83	92	101	110	119
200	20	20	20	24	30	38	46	54	62	70	79	88	97	106	115
220	20	20	20	23	28	35	43	51	59	67	75	84	93	103	112
240	20	20	20	22	26	32	40	48	56	64	72	80	89	98	107
260	20	20	20	21	25	30	37	45	53	61	69	77	85	94	103
280	20	20	20	20	24	28	34	42	50	58	66	74	82	90	99
300	20	20	20	20	23	26	32	39	47	55	63	71	79	87	95
350	20	20	20	20	20	23	27	33	39	48	55	64	71	80	88
400	20	20	20	20	20	21	25	28	34	40	48	56	64	72	80
450	20	20	20	20	20	20	22	26	29	35	41	48	56	65	73
500	20	20	20	20	20	20	20	23	27	30	36	42	49	56	65
600	20	20	20	20	20	20	20	20	21	25	28	32	38	44	50
700	20	20	20	20	20	20	20	20	20	20	23	27	31	34	40
800	20	20	20	20	20	20	20	20	20	20	20	22	26	29	33
900	20	20	20	20	20	20	20	20	20	20	20	20	20	24	28
1,000	20	20	20	20	20	20	20	20	20	20	20	20	20	20	22
1,100	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

[1]The computed anemometer heights do not include an adjustment for uneven ground or ground cover. These adjustments must be added to table values.

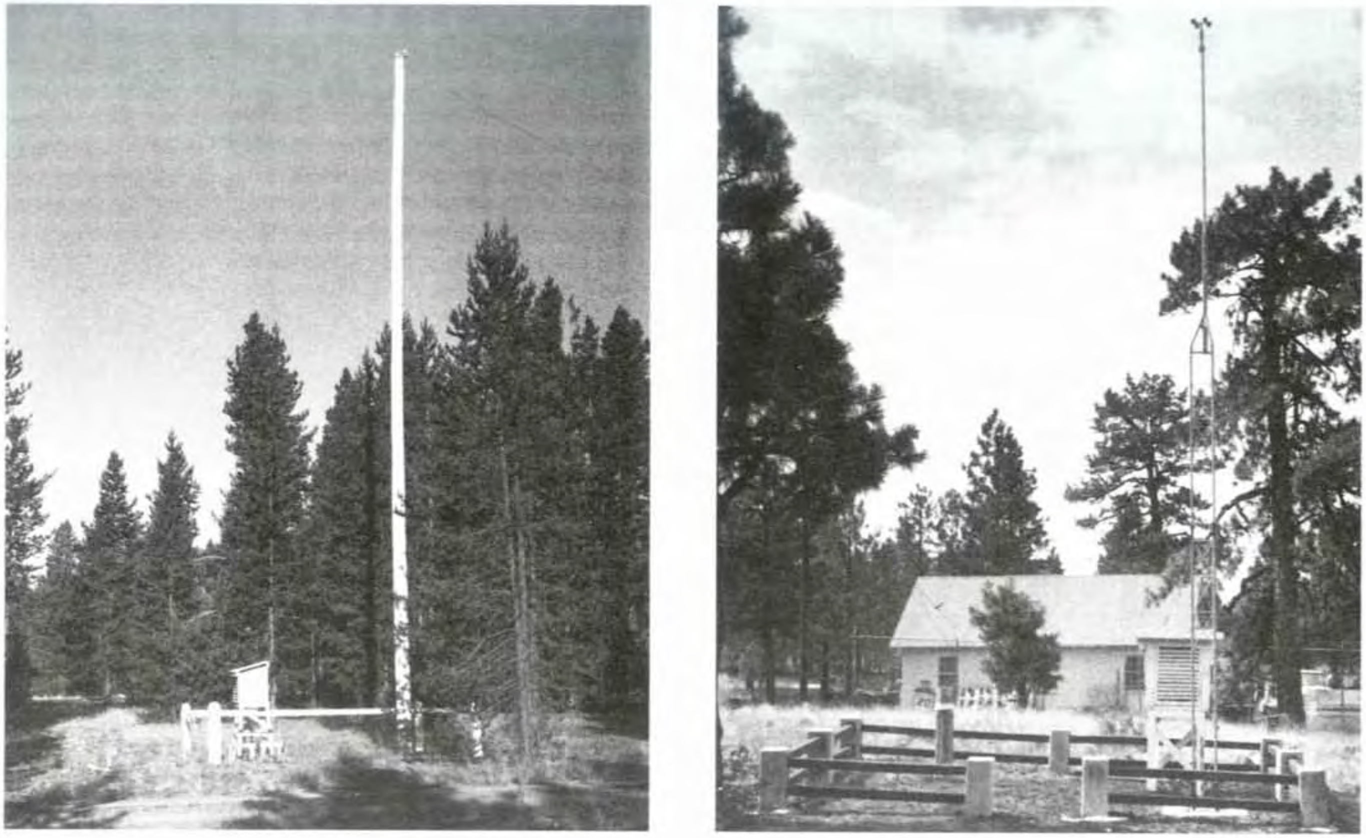
[2]For distances less than height of obstruction, place anemometer 20 ft above the obstruction.

INSTALLATION

Anemometers have been most commonly installed on wooden poles at fire-weather stations (figs. 8.1, 17.1, and 17.2A), but installations on metal poles and towers are also used (figs. 17.2B, 17.3, and 17.4).

Metal towers (fig. 17.2B) are especially favored where adjusted anemometer heights in excess of 25 to 30 ft are required; also, at temporary field stations, where equipment portability is a major consideration. The towers are available in a variety of forms: (1) one-piece towers of a specified height, (2) stacked 10-ft sections that are extended and bolted together, (3) telescoping sections that crank up and down, and (4) foldover models equipped with a hand winch for raising and lowering the upper half of the tower.

Regardless of the type used, and whether at temporary or permanent stations, anemometer installations should have the following features: (1) remain firm during windy conditions, (2) allow easy access to the anemometer, (3) accommodate a readout device, (4) provide for periodic adjustment of anemometer height, and (5) be compatible with any existing lightning protection system.



A B

Figure 17.2(A and B)—Anemometer installations with height adjusted upward because of nearby trees.

Figure 17.3—Anemometer installation employing metal pole fastened to wooden pole. This installation allows easy access to the anemometer and provides for periodic height adjustment. The wire to right of metal pole connects the anemometer to a wind counter located inside the fire dispatcher's office.

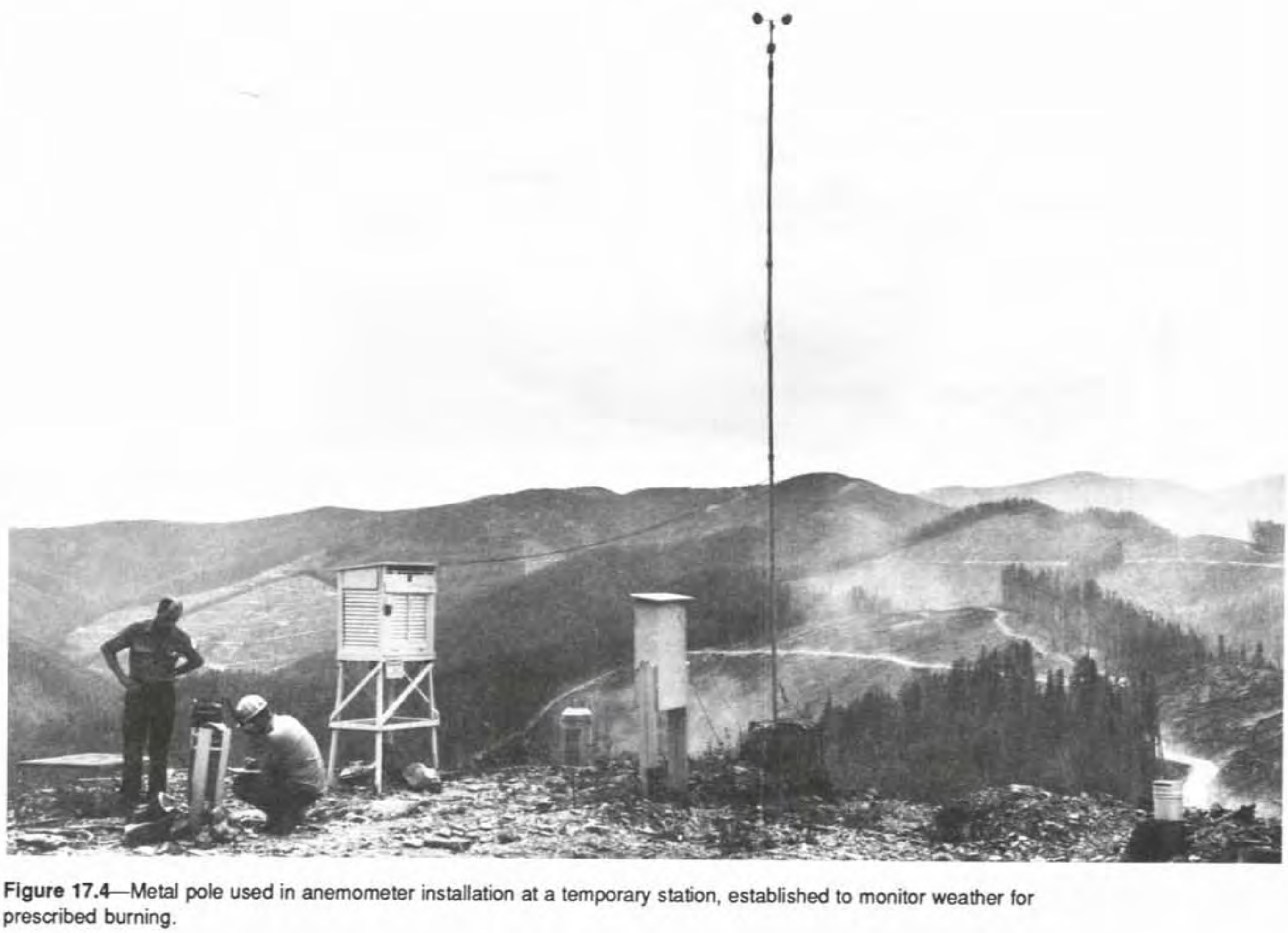


Figure 17.4—Metal pole used in anemometer installation at a temporary station, established to monitor weather for prescribed burning.

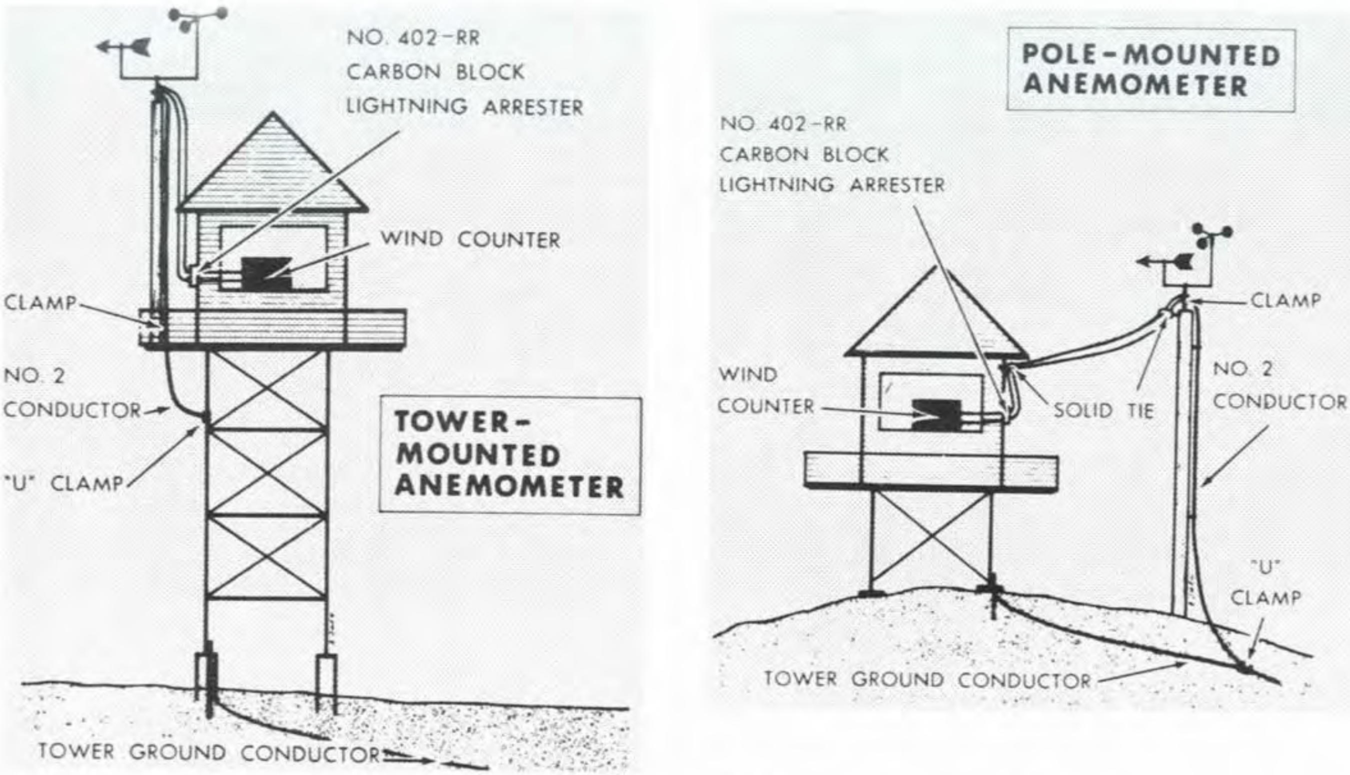


Figure 17.5—Suggested method for obtaining adequate lightning protection at lookout anemometer installations: left, anemometer pole on tower; right, anemometer pole on ground.

LIGHTNING PROTECTION

In many areas, good safety practice requires adequate lightning protection on both the anemometer and the wires leading to the indoors reading device.

Lookout Tower Installation—If the anemometer is mounted on a lookout tower (fig. 17.5), follow these procedures for lightning protection:

1. Clamp a length of #2 copper-wire conductor onto the anemometer pole (if metal) or the anemometer itself (if the pole is wooden).
2. Run the conductor underneath the catwalk of the lookout cab and clamp it to the existing lightning protection system.
3. Install a carbon block lightning arrester (#402-RR, or equivalent) on the tower leg. The wire connecting the anemometer to the readout device must pass through the arrester before it is run into the lookout cab. Be sure that this wire is tightly connected to both the anemometer pole and the tower.

Ground Installation—The following procedures apply if the anemometer is mounted on a pole set into the ground, either at a lookout station (fig. 17.5) or at a valley bottom station (fig. 17.6):

1. Clamp a length of #2 copper-wire conductor onto the pole (if metal) or to the anemometer itself (if the pole is wooden).
2. If a ground wire from an existing lightning protection system is available nearby, run the conductor down the pole and clamp onto the ground wire.
3. If an existing ground wire is not available, install a ground rod near the pole and run the conductor down to it.
4. Install a carbon block lightning arrester (#402-RR, or equivalent) on the tower leg or exterior of the building where the readout device is located. The wire connecting the anemometer to the readout device must pass through the arrester before it enters the building. Again, be sure that this wire is tightly connected to both the anemometer pole and the tower or building that it enters.

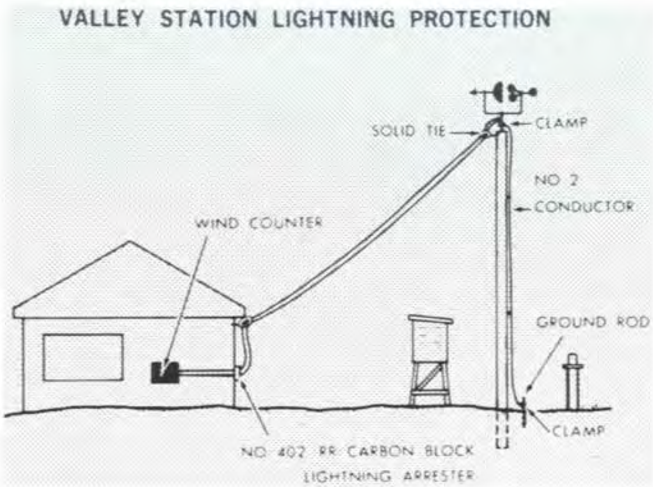


Figure 17.6—Suggested method for obtaining adequate lightning protection at valley-bottom anemometer installations.

17.2 Wind Counters

LOCATION

The location of a wind counter is largely a matter of observer convenience. An office installation (fig. 17.7) may be desirable if windspeed observations are required periodically throughout the day or if the observation duration is relatively long. When making an office readout installation, be sure that the appropriate lightning protection is also installed.

If the wind counter is located at the weather station plot, its position must not interfere with exposure requirements of other instruments. Recommended as a housing for the wind counter is a small, weatherproof cabinet, located about 4½ ft above the ground near the anemometer pole. Construction plans for this cabinet (fig. 17.8) are provided in appendix 5. The counter should not be placed in the station's instrument shelter, which should contain only temperature and humidity instruments.

INSTALLATION

Moistureproof insulated copper lead-in wire should be used to connect the wind counter to the anemometer. When connecting the battery to the counter, be sure to observe the polarity of the battery wires.

An important consideration when installing a wind counter is the relationship between length and diameter of wire, electrical resistance, and battery voltage. As the linear distance between anemometer and counter increases, the resistance increases; thus, additional voltage may be needed for very long distances. The diameter of the wire can be a modifying factor, since resistance decreases as the diameter of the wire increases. A final consideration is the fact that too much voltage can burn the anemometer contacts.

The wind counter can be located up to 1 mile away from the anemometer, without increased voltage, provided that #20 or #22 copperweld twin-conductor wire is used for the anemometer-battery connection (USDA FS 1969).

Because of the above factors, it is recommended that an electronics technician check the proposed installation before the actual work and operation proceed.

17.3 Indicator Dials and Chart Recorders

These readout devices, as used with generator-type anemometers, are typically installed inside an office near the weather station. Such devices should be installed by a qualified technician, following manufacturer's instructions. Proper lightning protection should be provided.

17.4 Wind Vanes

LOCATION

The wind vane can be mounted on the same pole as the anemometer. A connected wind-direction readout device is recommended at the standard fire-weather station.

The readout device can be located either in the the office (fig. 17.7)—with required lightning protection—or at the weather station plot, depending on available facilities and observer convenience. If located at the station plot, the readout device can be installed in the same cabinet as the wind counter (fig. 17.8).

Figure 17.7—Wind counter and wind direction indicator installed in an office.

Figure 17.8—Accessory cabinet for on-site installation of wind counter and wind direction readout device. The upper shelf can be used for tools and supplies.

INSTALLATION

Two matters requiring particular attention during installation of a wind direction system are:

1. Proper orientation of the wind vane in relation to true north.
2. Careful wiring of the readout device so that the indicated wind direction agrees with the direction shown by the vane.

Use insulated, moistureproof cable to connect the readout device with the wind vane. A 10-lead cable is required for the wind direction indicator in figure 17.9.

True North Orientation—The following procedure is useful for obtaining proper orientation of the Stewart and other makes of wind vanes:

1. Remove the front cover from the wind vane housing.
2. Rotate the wind vane arrow until the north contact is closed, causing the "north" indicator lamp to light.
3. Draw a chalk line on top of the wind vane housing directly under and parallel with the shaft of the arrow.
4. Replace the front cover and extend the chalk line down the face of the housing.
5. Paint the line, or install a strip of plastic tape, so that it is visible when the wind vane is on the pole (fig. 17.10).
6. With the wind vane in operating position, drive a stake so that it is directly under the center of the wind vane housing. Use a compass and sight a line from this stake (designated point A) to true north, correcting for magnetic declination.
7. Drive a second stake (designated point B) about 100 ft from point A along the sighted line to true north.
8. Backsight a line from point B to the painted line on the wind vane housing.
9. Adjust the position of the wind vane housing until the line backsighted in step 8 is along that obtained in step 6; corrected compass reading should be exactly south (180°).

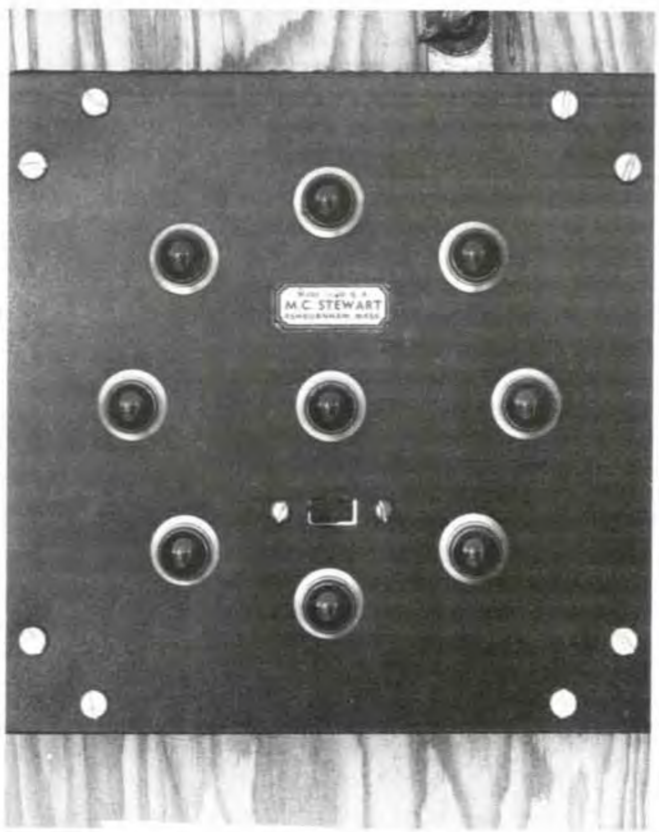


Figure 17.9—Wind direction indicator. Lighted lamps indicate the direction.

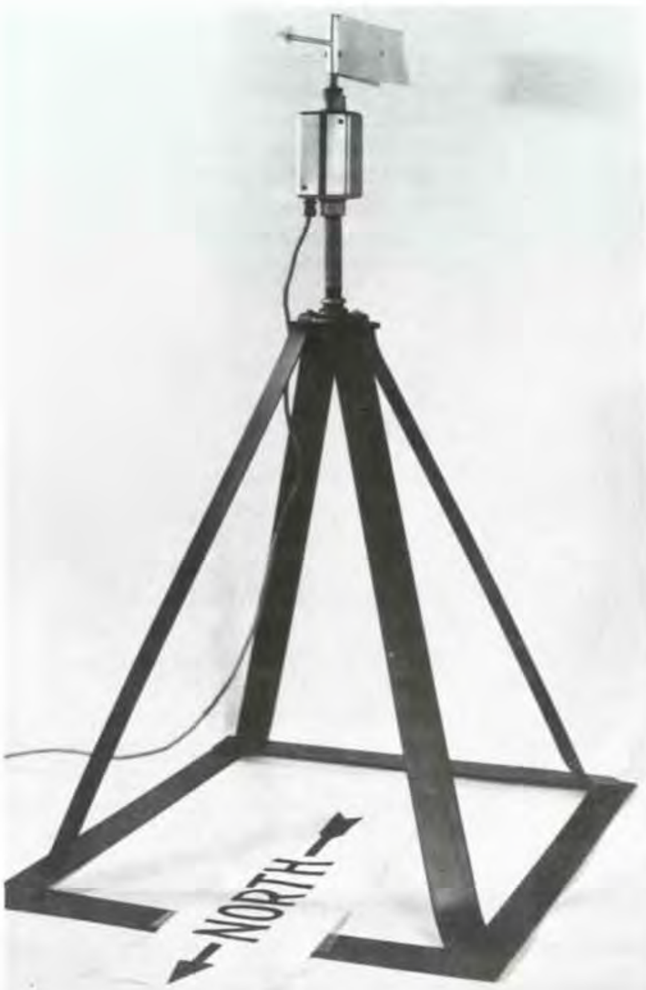


Figure 17.10—Wind vane with marking to assist in true north orientation.

CHAPTER 18. PRECIPITATION EQUIPMENT

18.1 Exposure Guidelines

Accuracy of precipitation measurements (the gauge catch) is affected by wind and also the presence and height of adjacent objects. Thus, although an exposure that is open to wind is recommended for a weather station in general (section 2.5), the action of wind on a precipitation gauge results in eddy currents (increasing with windspeed) that tend to carry away the precipitation and cause a deficient gauge catch. With a windspeed of 10 mi/h at gaugetop level, the catch deficiency may average about 15 percent for rain and 40 percent for snow (Linsley and others 1958). Unrepresentative windy sites should therefore be avoided; likewise, exposures on roofs or near corners of buildings.

Equipping gauges with wind shields (section 18.3) will improve the catch in open areas, but further improvement can be obtained by using suitable low objects, bushes, or trees as a windbreak. Gauge installations at lookouts or other mountaintop stations should take advantage of available sheltering terrain, away from the windy crest. In seeking wind protection, it may be advisable to locate the precipitation gauge some distance from the other weather instruments. The bushes, trees, and other objects should not be so close as to create additional eddy effects or block precipitation from the gauge. As a general rule (U.S. Department of Commerce 1972; World Meteorological Organization 1983), their distance from the gauge should not be closer than twice their height above the gauge orifice.

18.2 Precipitation Gauges

Installation instructions are given for only two specific, standard-type precipitation gauges. For other gauges, the same basic principles apply with respect to level mounting and proper exposure height. Consult the manufacturer's instruction manual for further details, particularly where mechanism assembly and electrical connections are required for recording gauges.

Additional installation procedures particularly helpful where gauges are operated in snowy, windswept areas are described by Winter and Sturges (1989).

STANDARD 8-INCH GAUGE

Wooden or metal stands for the large- and small-capacity 8-inch gauges must be firmly anchored to the ground; stakes may be used or the stands fastened to a wooden or concrete base set into the ground. During the procedure, set the gauge in the stand and use a spirit level in several positions across the gauge top (collector properly seated), to be sure that the installation is perfectly level (fig. 18.1). Ordinarily, the gauge top should be 3 ft above the ground. A greater height will be required if the gauge is to be used throughout the year in a heavy snowfall area.

UNIVERSAL WEIGHING GAUGE

Mount the gauge securely onto a heavy, raised wooden or concrete base set into the ground. Fasten with a metal anchor base, if this has been provided, and bolts through the three $^3/_8$-inch-diameter holes in the base of the gauge. The bottom of the gauge usually should be 1 to 2 ft above the ground surface, for observer convenience and to raise the gauge and inspection door above puddles or snow accumulation. As described for the standard 8-inch gauge installation, use a spirit level to ensure that the gauge top is perfectly level.

If the weighing gauge will be operated year-round in an area of deep snow accumulation, install it on a platform or tower (fig. 18.2). In such cases, a wind shield should be used, particularly in an open location, as windspeeds can increase steeply with height in the layer of air near the ground. The gauge height will depend on the expected maximum snow depth. Where possible, tower location should take advantage of windbreaks provided by trees (section 18.1). The recommended distance of these trees from the gauge is twice their height above the gauge orifice; the distance should at least equal this height where exceptions are made. A standard 8-inch nonrecording gauge, with its top 3 ft above ground, should also be employed—for comparison during the snow-free months or fire season. Depending on wind effects, it may be advisable to use this lower gauge for the official precipitation readings during the fire season. The weighing-gauge record will still be used to obtain the time and duration of precipitation.

18.3 Wind Shields

The Alter wind shield should be installed level and concentric with the precipitation gauge, with the top of the baffles (leaves) one-half inch above the gauge orifice. Toward leveling the shield, use a spirit level placed on a rigid straight edge spanning the 4-ft-diameter baffle ring. Adjust the position and height of the support pipes as necessary and imbed the ends into the ground or concrete. Where greater height of the shield is required (gauge orifice raised), the support pipes may be attached to wooden posts (Winter and Sturges 1989). On a tower or platform installation, attach the shield supports to the structure or to special horizontal wings. Angled supports are used to attach the wind shield directly onto a standpipe gauge (fig. 9.15).

Figure 18.1—The rain gauge installation should be level and plumb.

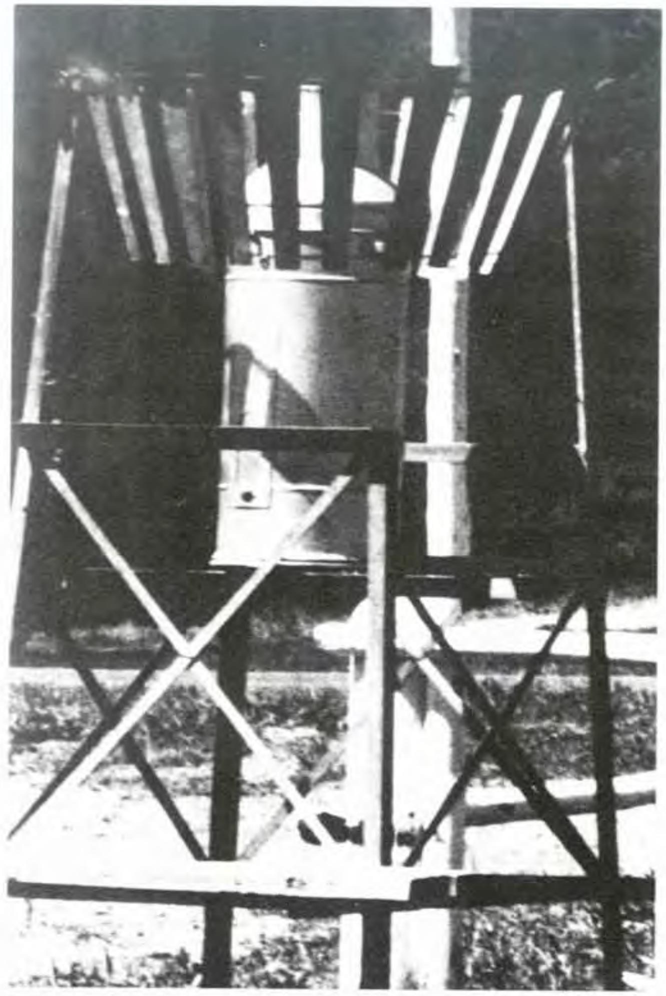


Figure 18.2—Recording precipitation gauge mounted, with wind shield, on tower in area with heavy snowfall.

18.4 Snow Stakes

Install a snow stake vertically with the zero line at the ground surface. Fasten the stake to a galvanized angle iron or wooden post set vertically and securely into the ground. Location should be representative (section 9.5), away from trees, buildings, and other influences affecting wind flow and snowmelt near the stake. The ground at the stake should be free of bushes and tall grass, but low leafless vegetation near the stake may help curtail drifting of snow.

CHAPTER 19. FUEL MOISTURE EQUIPMENT

19.1 Fuel Moisture Sticks

DUFF BED

Prepare a bed of conifer needles or hardwood leaves 2 inches deep over a 3-ft-square area of level ground. The underlying ground surface usually requires some form of treatment to eliminate herbaceous vegetation. Place the needles evenly on the level surface to assure proper runoff of water after rainfall occurs. The purpose of the duff bed is to provide a standard reflective surface and to prevent mud from splashing on the sticks during heavy rain. Burlap-sack material secured to the ground under the sticks provides a satisfactory alternative if litter is not readily available.

STICK EXPOSURE

Weathering (the effect of sun, rain, wind, and repeated wetting and drying) reduces the ovendry weight of fuel moisture sticks over a period of time. Therefore, install a new set of indicator sticks at the beginning of each season and, if necessary, periodically during the season. Install the sticks several days prior to the beginning of measurements to allow the sticks time to attain equilibrium with the surrounding air. Expose the sticks horizontally 10 inches above a fresh duff bed. Place two galvanized wire racks over the duff to support the sticks (fig. 19.1).

Screening—In the past, at many openly exposed fire-weather stations, fuel moisture sticks have been shaded. This was an attempt to simulate a forest canopy's effect on the moisture content of fuels on the forest floor. The shading, a practice now generally discontinued, is accomplished by use of screens.

In the Western United States, a double layer of 14-mesh screen has been used, held taut in a 3-ft-square frame located 13 inches above the ground. This installation produces shading about equal to that existing on an old-growth area from which three-fourths of the canopy has been removed.

Whether or not screening is used depends on the objective of the fuel stick measurements. For example, if the measurements are taken to help decide when to broadcast burn a clearcut area, screening should not be used—because there would be no tree canopy over the clearcut. *Current fire-danger rating procedures do not use screens.*

19.2 Fuel Moisture Scales

FORESTER SCALE

A Forester (or Appalachian) scale, mounted in an Appalachian scale shelter, is recommended for weighing fuel moisture sticks at a standard fire-weather station (figs. 10.2 and 19.2). Construction details of the Appalachian shelter are provided in appendix 5.

The scale shelter should be plumb and firmly secured to the ground. It should be located in a spot where it neither shades the fuel sticks nor interferes with the exposure of the instrument shelter or rain gauge.

Install the Forester scale on the mounting board or backplate of the shelter, and level it as shown in figure 19.2. The scale must be exactly plumb to yield accurate readings. After the scale is properly mounted, zero the scale by manipulating the three wing nuts located about the face of the scale.

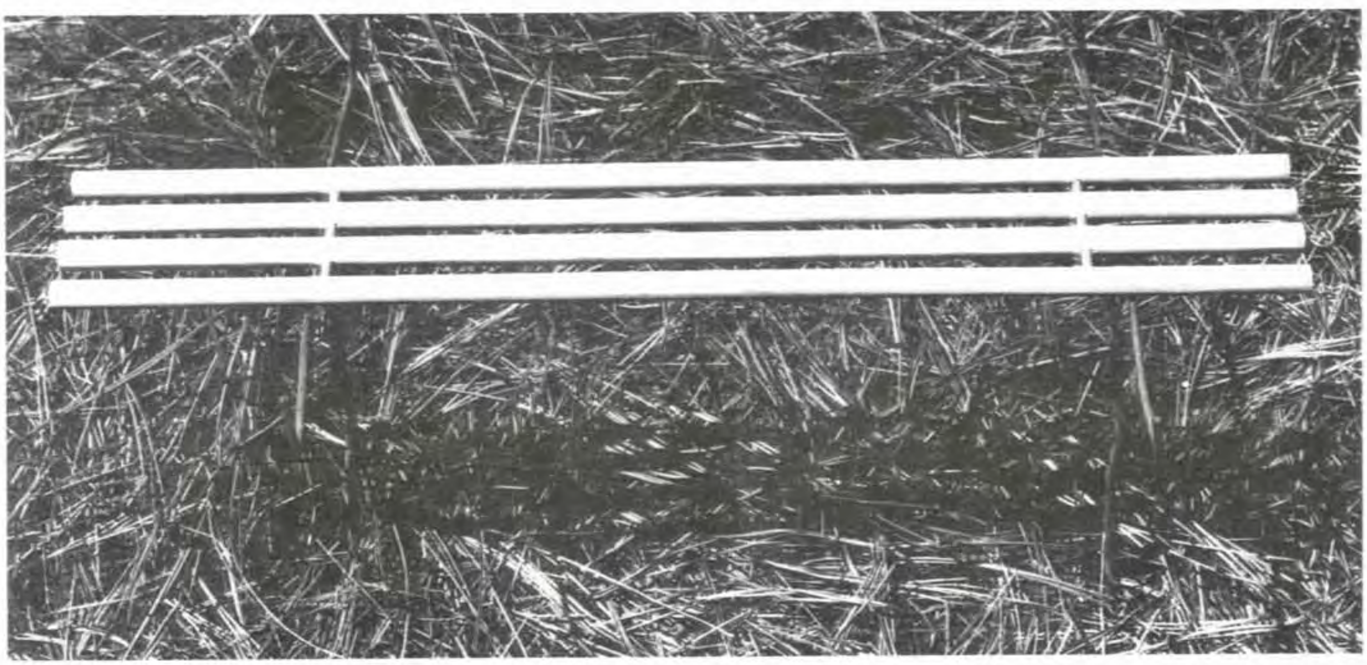
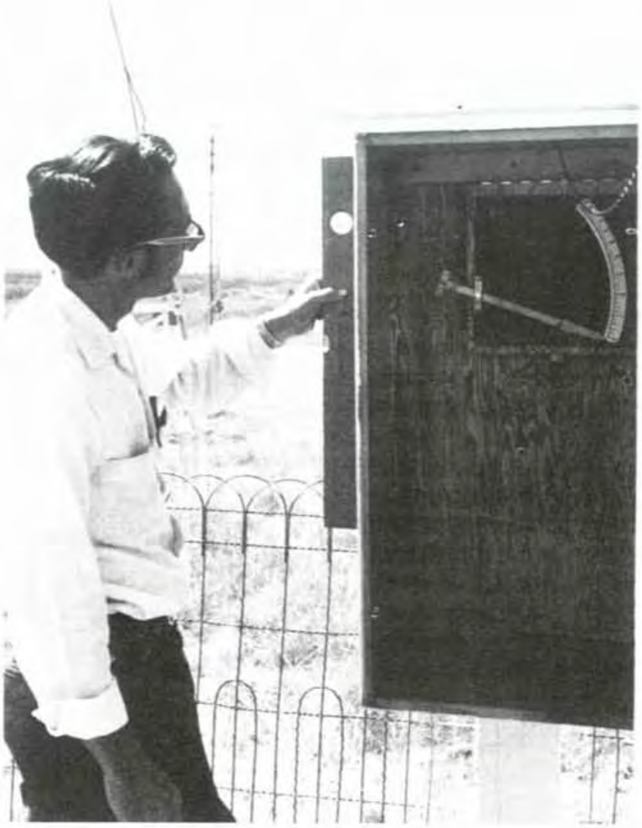


Figure 19.1—Fuel moisture stick installation over a bed of conifer needles.



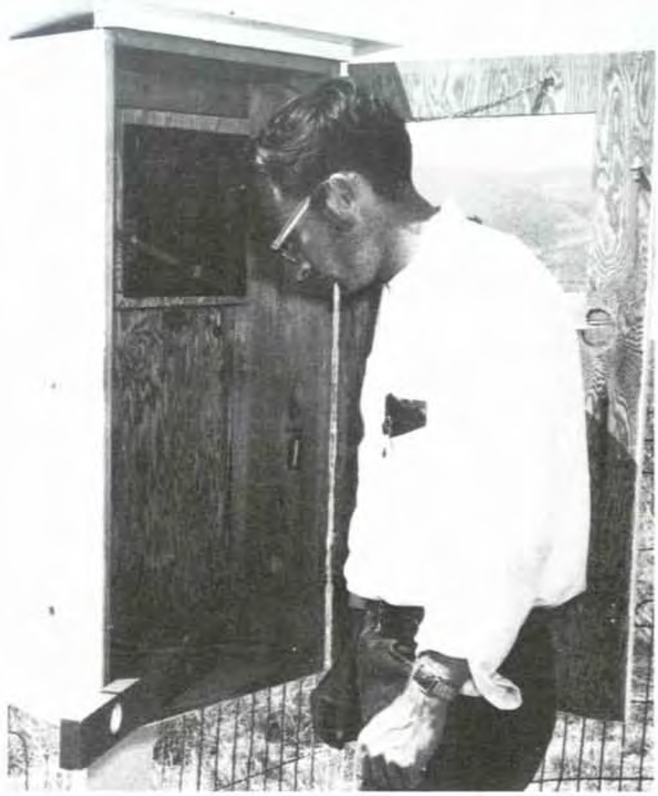


Figure 19.2—Checking the installation of Forester scale in an Appalachian shelter. Both the shelter and the scale should be level and plumb.

CHAPTER 20. PYRANOMETERS AND SUNSHINE RECORDERS

20.1 Exposure

Because a pyranometer measures global solar radiation (both direct beam and diffuse sky radiation), the exposure site ideally should be free from any obstructions above the horizontal plane of the sensing element; the site should also be readily accessible. Otherwise, as much as possible, the site should be free of obstructions (including terrain) extending more than 5 degrees above the horizontal plane—particularly within the azimuth range of sunrise and sunset during the year (World Meteorological Organization 1983). The pyranometer should not be exposed near light-colored walls or other objects that may reflect sunlight onto it. Where available, a flat roof usually provides a good location for mounting the pyranometer on its support. Alternatively, the pyranometer may be installed on a board fastened horizontally atop a post inside the station enclosure or atop the roof of the instrument shelter.

Correct exposure of a sunshine recorder is less stringent, requiring only an uninterrupted view of the sun at all times of the year. This applies to times of day when the sun's altitude is more than 3 degrees above the horizontal plane. The recorder can be installed on the roof of a building or on a board atop a post inside the station enclosure.

20.2 Installation

Detailed installation instructions for specific pyranometers and sunshine recorders can be obtained from manuals furnished by the manufacturers. The World Meteorological Organization (1983) presents some general instructions concerning pyranometers, together with calibration methods. The following paragraphs summarize the basic installation principles.

PYRANOMETERS

A pyranometer should be firmly mounted on its support and correctly leveled so that the receiving surface is truly horizontal. Avoid subjecting the instrument to jolts or vibration during installation. Connecting cables between the pyranometer and its recorder should be waterproof and firmly attached to the pyranometer mount to minimize breakage or disconnection in windy weather; observe the circuit polarity of the cables.

CAMPBELL-STOKES SUNSHINE RECORDER

Again, firm mounting and correct leveling are essential. The spherical segment should be adjusted according to instructions; latitude and meridian adjustments are necessary. When observing the sun's image at local noon, the image should fall on the noon mark of the spherical segment or card. If all adjustments have been carefully made, the burns should be parallel to the center lines of the cards.

CHAPTER 21. EVAPORATION STATION EQUIPMENT

21.1 Class A Evaporation Pan

Before placing the evaporation pan on its wooden support, first level and anchor the support to the ground, using earth fill underneath and around it. The fill should raise the support sufficiently to keep the bottom of the pan above the level of surface water in rainy weather. Tamp the fill firmly between the support boards to within one-half inch of the top, thus leaving an air space between the bottom of the pan and the fill surface. This space will facilitate inspection of the pan for leaks while it is in use.

Center the pan on the support and fill with water to within 2 inches of its rim. This will require about 62 gallons of water. The combined weight of the pan and water (about 550 lb) should hold the pan securely in place.

STILLING WELL

Place the stilling well, for either the hook gauge or fixed-point gauge, in the pan about 1 ft from the pan's north edge. Level the top rim of the well, using the leveling screws in its base and a spirit level. The well, weighing about 10 lb, should rest firmly on the bottom of the pan, which must be free from buckling.

21.2 Supplemental Instruments

PRECIPITATION GAUGE

Install the precipitation gauge or gauges, as described in section 18.2, on the north side of the evaporation pan (fig. 15.2). This will avoid casting of shadows on the pan.

TOTALIZING ANEMOMETER

Install the anemometer, mounted on a display stand, on the northwest corner of the pan support (figs. 12.1 and 15.2). The stand is fastened with wood screws through holes provided in its base. The center of the cups should be 6 to 8 inches above the rim of the pan. In their northwest position, the cups may cast a shadow on the pan only during late afternoon. Some anemometers have a knurled retaining screw for mounting and height adjustment on the stand; tighten the screw only by hand.

WATER TEMPERATURE THERMOMETER

Float-Mounted Six's Thermometer—Position the thermometer by attaching a flexible line from each of the two floats to an anchor. The lines should be at least 10 inches long, but short enough to keep the thermometer 1 ft from the edge of the pan and the stilling well. Thermometer should rest one-fourth inch below the water surface; if necessary, adjust screws holding the bulb end.

Submerged-Mount Six's Thermometer—Fasten handle to the bulb end of the thermometer mount and hook the handle ring over the edge of the pan (fig. 12.1). Locate the mount on the south-side bottom of the pan, to shade thermometer as much as possible from direct sunshine. Submerge the unit gently.

CHAPTER 22. SOIL TEMPERATURE AND MOISTURE INSTRUMENTS

22.1 Soil Thermometers

LOCATION OF SOIL PLOT

The location chosen for exposure of soil thermometers should have natural soil and ground cover conditions that are representative of its general area. Ordinarily, the soil plot should be closely level, well-drained, and open to full sunshine throughout most of the day; it should not be subject to irrigation. Additional criteria are given in section 22.2, for plots where both soil moisture and soil temperature will be measured. When snowfall occurs, the soil plot should have representative snow cover. The plot should be as free as possible from nearby obstructions that affect the wind and lead to either localized drifting or scouring of snow.

Ground cover may be sod, where the climate and soil normally permit this, or other natural cover that is common to the area. Alternatively, the cover may be removed, by use of a hoe or chemical treatment, to create a bare soil plot.

Because the site will usually be within or adjacent to the plot where other weather or climatological measurements are taken, the above considerations should enter into the overall selection of station location. Suitable fencing or other protection should be afforded to prevent trampling of the soil plot.

INSTALLATION OF THERMOMETERS

Soil thermometers or sensing elements should be located centrally in their observation plot, in close contact with undisturbed soil. The soil should be free of insulating air spaces and artificial channels through which water can enter. When temperatures are measured at more than one depth, mercury-in-glass thermometers are installed along a horizontal line. Mercury-in-steel thermometer and electrical thermometer sensing elements are installed in a vertical line.

Mercury-in-Steel Thermometers—The following installation steps are based on U.S. Department of Commerce (1972) instructions:

1. Dig a small trench or pit immediately adjacent to and north of the observation spot. Existing sod cover should be carefully removed and set aside on boards or tarpaulin for later replacement (except where a bare soil plot is desired). The soil should be removed in layers and also set aside, or put in boxes, to be later replaced as nearly as possible in its original condition and order. The pit should be slightly deeper than the lowest sensing depth, to allow sufficient working space and also permit slight looping of the flexible thermometer cables. This will help prevent a moisture channel to the sensing element.

2. Position each sensing element (fig. 13.1), which is 13 inches long and five-sixteenths inch in diameter, with a rod of similar diameter and 18 inches long. The rod is pressed into the soil face on the south end of the pit, at the proper depth, and driven nearly its full length horizontally into the soil. It can be withdrawn by grasping firmly with pliers and turning or twisting slightly while tapping outward on the pliers with a hammer.

3. Carefully press each sensing element, by hand, into the hole formed in step 2. If too much resistance is met, the element should be withdrawn and the hole cleared again with the rod.

4. Replace the soil in the pit, in correct order of layers, to conform as nearly as possible to the original condition. The soil will usually require firm packing as each layer is replaced; this can often be facilitated by soaking the replaced layer. The added moisture will usually not move far enough laterally, before its depletion, to affect the soil in contact with the sensing elements. Finally replace the sod (where a sod cover is desired); the added moisture will help in renewing its growth.

Electrical Thermometers—The same procedure as above is followed for installing sensors such as thermistors or thermocouples (U.S. Department of Commerce 1972). For these smaller sensors (and probes), however, the rod used in step 2 should have a correspondingly smaller diameter—equal to or only slightly larger than that of the probe.

THERMOMETER HEAD SHELTER

The shelter protecting the soil thermometer heads should be located over or alongside the pit, about 1 ft from the south face, when mercury-in-steel thermometers are used (fig. 22.1). If the shelter is located over the pit, its supports can be set in the floor of the pit before replacing the soil. The shelter may be located away from the pit in the case of electrical sensors and their connecting wires to recording dials.

The height of the shelter above ground surface should be sufficient to make reading convenient within the limitations of the cable length. The 5-ft mercury-in-steel thermometer cable will permit a shelter height of about 2 ft, with the lowest sensing element at a 20-inch depth, allowing for a slight loop in the cable at the floor of the soil pit.

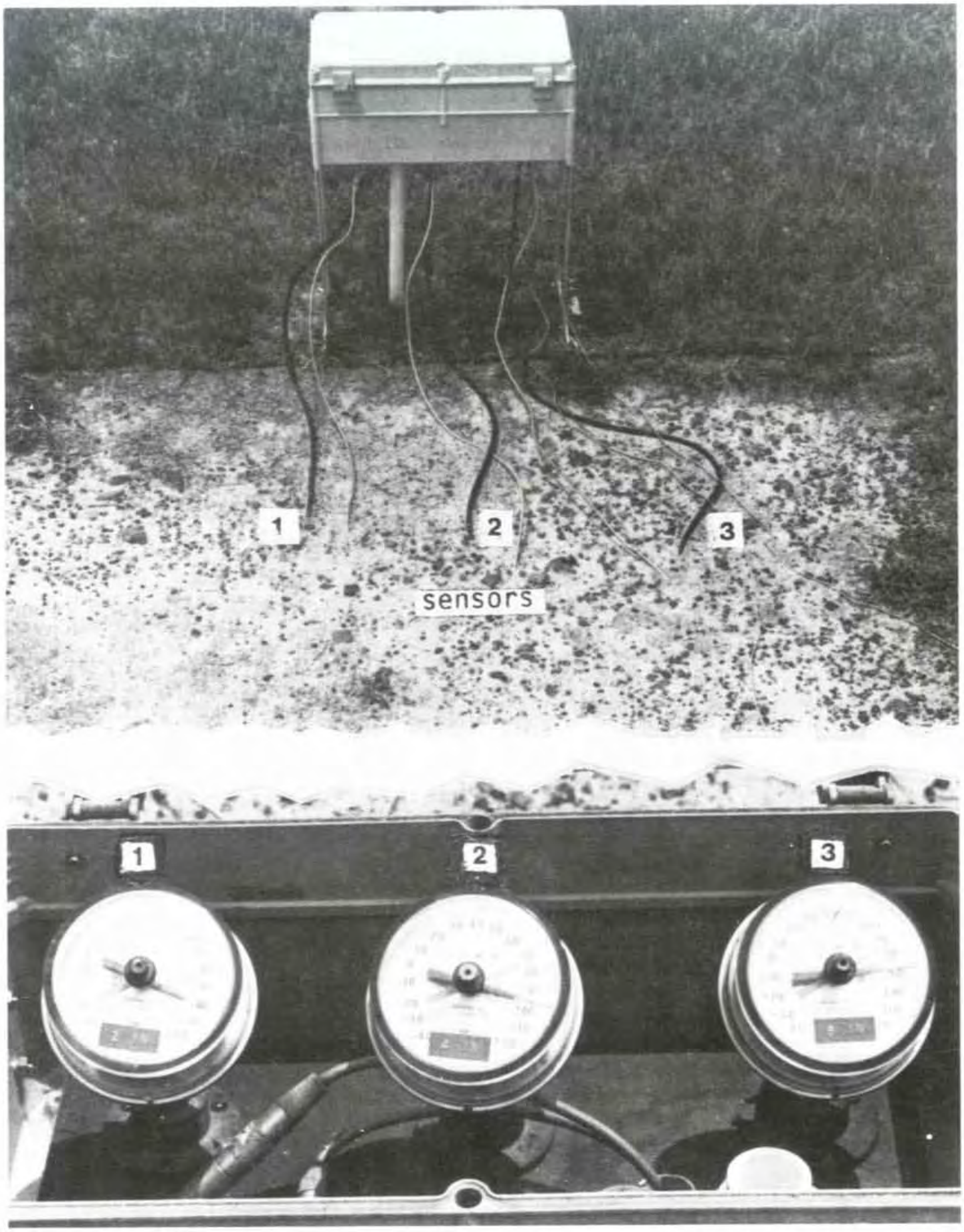


Figure 22.1—Top: a soil-thermometer installation in bare soil plot, with thermometer-head shelter alongside plot. Bottom: thermometer heads inside shelter. (Photo from National Weather Service.)

22.2 Soil Moisture Meters

SITE SELECTION

Because of large, local variations in soil moisture, observation sites must be carefully selected to be typical of their surroundings (World Meteorological Organization 1983). With respect to topography, a site is considered typical of surroundings if it is situated on level ground or on a slope of uniform aspect and inclination. Soil type, depth of water table, obstacles, and land-use practices must also be considered. When observations are for hydrological uses, the site should be typical of the watershed in slope, soil cover, and exposure for the elevation selected (USDA SCS 1972); steep slopes should be avoided. No standard measurement depths are specified, but depths as great as 3 to 6 ft may be required for hydrological and other purposes.

ELECTRICAL RESISTANCE METERS

Installation of electrical resistance blocks (or units) requires excavation of a pit, with soil carefully set aside and later replaced, in a manner largely similar to that described for soil thermometers (section 22.1). The depth will often be greater, however, and a post-hole digger will thus be helpful. After the pit is dug (USDA SCS 1972), the resistance units are placed in holes extending 2 to 6 inches into undisturbed soil in the uphill face, which must be vertical. The bottom unit is installed first, and each successively higher unit is installed after first refilling and packing the pit up to that unit's level.

The wires leading from the resistance units are run though a vertical pipe set in concrete. The pipe, 2 inches in diameter, should be placed about 3 ft from the units and 2 to 3 ft deep into the soil. The pipe should be long enough to protrude above maximum snow cover during the months of soil moisture measurement. One cubic foot of concrete around the pipe should be adequate, and wires must not be imbedded in the concrete. A 6-inch nipple and a cap are used at the top of the pipe to hold a terminal strip for the wires. Further details are given by the USDA Soil Conservation Service (1972).

NEUTRON PROBE

Use of a neutron probe requires installation of an access tube or pipe vertically into the soil. The pipe, usually made of steel or aluminum, has a diameter of about $1\frac{1}{2}$ to 2 inches, depending on the probe's outer diameter. The pipe should be watertight and the bottom sealed. It should fit tightly in the soil, without any cavity between the soil and pipe. The pipe extends a few inches above the ground and is capped.

To obtain a tight fit, the access pipe may be installed in a hole drilled with a soil auger having a slightly smaller diameter (World Meteorological Organization 1983). Where a larger hole is dug, the space around the pipe must be carefully refilled and packed, using soil corresponding to the layers that were removed. A depth of at least 3 ft is used by the USDA Soil Conservation Service (1972).