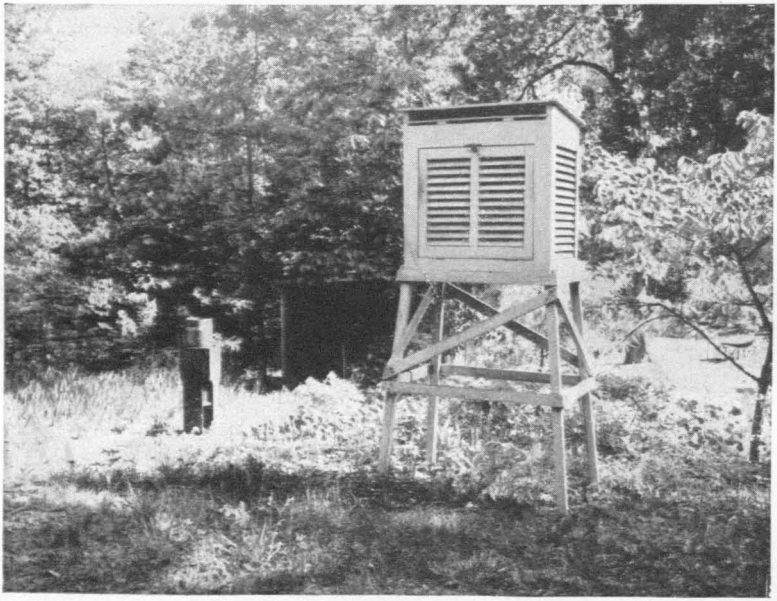
U. S. DEPARTMENT OF COMMERCE
WEATHER BUREAU :: :: Washington, D. C.

Instructions for Cooperative Observers

CIRCULARS B AND C, INSTRUMENT DIVISION :: *Ninth Edition (Revised 1941)*



Thermometer shelter and rain gage for cooperative observer.

W. B. No. 843

UNITED STATES DEPARTMENT OF COMMERCE

WEATHER BUREAU

INSTRUCTIONS

FOR

COOPERATIVE OBSERVERS

CIRCULARS B AND C, INSTRUMENT DIVISION

NINTH EDITION (REVISED 1941)

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Circular B & C, Instrument Division

(Ninth Edition)

INSTRUCTIONS FOR COOPERATIVE OBSERVERS OF THE WEATHER BUREAU

INTRODUCTION

The object of this pamphlet is to furnish cooperative observers with instructions for their guidance in taking and recording meteorological observations, more especially of temperature and rainfall, and for reporting earthquakes.

To render these observations of the greatest value and to facilitate their use in investigating questions relating to climate, a uniform system for the exposure of the instruments and the recording of the observations is in use.

There are at this writing about 5,500 cooperative observers in the United States. The records furnished by these observers are of great value in affording information upon which many of the important publications of the Weather Bureau are based, and it is a policy of the Bureau to foster and encourage the keeping of such records. The Meteorological Yearbook and the monthly and annual summaries of the several sections of the climatological service of the Bureau contain more or less complete summaries of the observations, and through their wide dissemination the public is furnished extensive and reliable data concerning the peculiarities of climate in every section of the country. Besides the records mentioned above, the observers furnish reports that form in part the basis of the Weekly Weather and Crop Bulletin, which gives prompt information as to weather and crop conditions during the principal growing season.

The cooperative observer who each day faithfully records the readings of his instrument and notes the meteorological conditions prevailing at his station is performing a valuable public service. The publications in which his records appear are widely consulted by persons seeking information regarding climate and weather.

Cooperative observers receive no money compensation for their services, but they regularly receive such of the publications of the Weather Bureau as can be furnished free of cost.

As the value of a meteorological record increases with its duration, continuity of record is of the utmost importance, and it is urgently recommended that those who undertake to conduct observations endeavor to provide, as far as practicable, for an uninterrupted

series. A member of the observer's family, or other competent person, should be fully instructed in the matter of taking and recording observations, so that no break in the record will result from the temporary absence of the observer or from his inability from any cause to make the necessary observations.

For the purpose of securing these observations, the Chief of the Weather Bureau is authorized by law to lend instruments to persons willing to take the observations, on certain conditions. These conditions, in the main, are the safe-keeping of the instruments, their return to the Weather Bureau if for any reason the station is discontinued, and the furnishing of copies of the observations to the section director of the climatological service of the Weather Bureau for the State where located, free of expense to the Government.

Cooperative observers are usually furnished with maximum and minimum thermometers, instrument shelters, and rain gages, but not with barometers or recording instruments; nor will instruments be supplied when the proposed station is considered too near others already established.

Cooperative observers who fail to comply with the conditions upon which Weather Bureau instruments have been issued will be called upon by the section director to return them.

Blank forms and franked envelopes are furnished free of expense to the observers for transmitting reports to the section centers.

Observers willing to furnish the local press with meteorological data for publication will be supplied with suitable postal-card forms, properly addressed, upon application to the section director.

The cooperative observer is requested to fill up and forward to the section center, as soon as the equipment is installed, a copy of Form No. 4029—Mis. (Description of cooperative observer's station and instruments), and when any change is made in the location of instruments to notify promptly the official in charge of the section center.

All correspondence relative to the work of a cooperative station and requests for instruments, supplies, repairs, etc., should be addressed to the official in charge of the section center, who will furnish such information as may be required and act promptly upon the requests.

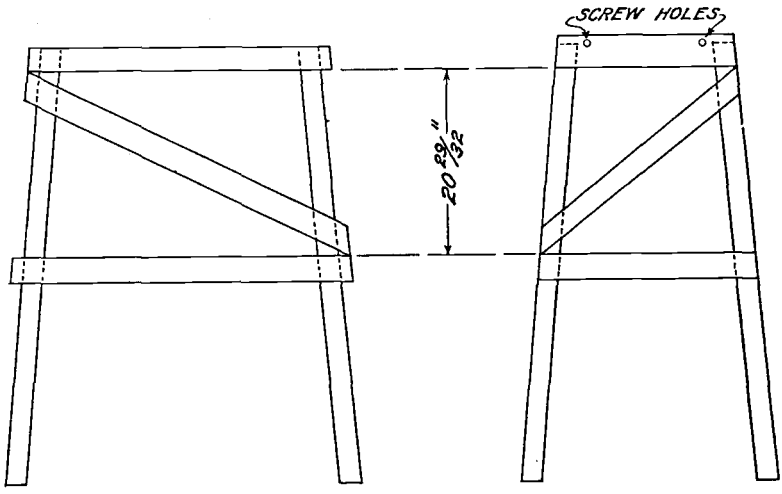
I. INSTRUCTIONS FOR THE ERECTION AND CARE OF INSTRUMENTS

THE OBJECT OF TEMPERATURE READINGS AND THE EXPOSURE OF THERMOMETERS

1. *Temperature of the air.*—The use of thermometers in meteorological observation is for the purpose of obtaining the *true temperature of the free air.*

The air near the surface of the earth is nearly always in motion and when not confined in a comparatively closed space the several portions are thoroughly mixed and have nearly or quite the same temperature. When any portion of the air is confined, however, so that it cannot intermingle freely with the general air masses, its temperature will be influenced to a marked extent by the local surroundings and will not be a free-air temperature.

2. These ideas show us at once that if we intend to make observations of the real air temperatures our thermometers must, if possible, be placed in an open space where the circulation of the air is quite unobstructed. It will not do, however, to place the thermometers simply in the open air, exposed freely to the sky and the direct rays



Front or rear section. End view showing ties and brace.

FIGURE 1.—Details of support for small instrument shelter.

of the sun. The sunshine would cause the thermometer to register too high, and even if not exposed directly to the sun it could not be depended upon to indicate the true air temperature either day or night.

3. *Thermometer shelter.*—To overcome these difficulties it is necessary to employ a thermometer shelter. This is nothing more than a wooden box painted white with louvred sides made in such a way that the air can move through it with the greatest possible freedom. This is an essential condition in thermometer exposure. The object of the box or shelter is simply to screen off the direct and reflected sunshine and the radiation to and from the sky and to keep the thermometers dry.

To obtain the true air temperature, therefore, all thermometers will be placed in a suitable shelter where the circulation of the air is as free as possible.

The standard shelter for cooperative work is shown with its support in the frontispiece. The maximum and minimum thermometers mounted on the Townsend support are illustrated in figures 2 and 6.

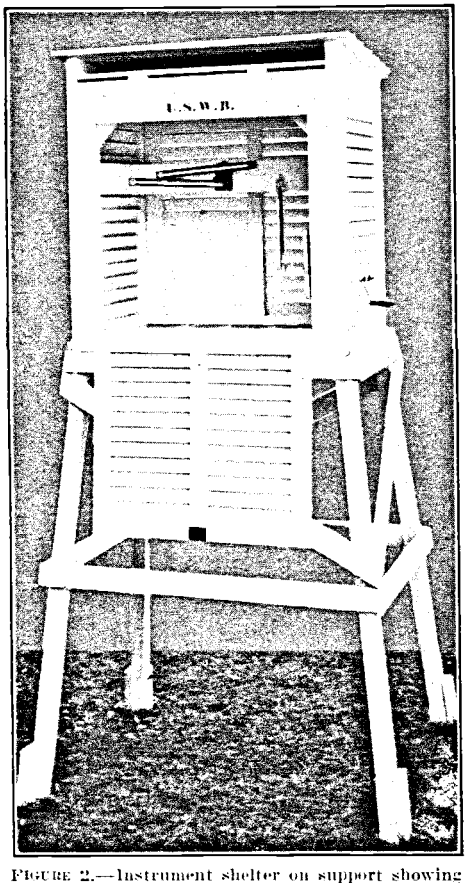


FIGURE 2.—Instrument shelter on support showing angle anchors buried in ground. (Psychrometer and fan not used by cooperative observers.)

The frontispiece shows also the rain gage, but in order to bring this into the picture it was placed nearer the shelter than it should be in actual use. The rain gage should be at least 15 or 20 feet from the shelter.

4. *Installation of shelter and support.*—Shelters sent to observers are assembled complete ready to be set up, and each shelter is usually accompanied by a support made up according to the details given in figure 1. The assembled support with the shelter mounted thereon is plainly shown in the frontispiece and in figure 2. It is occasionally better to arrange for a support to be constructed locally. Four substantial posts, of material known to last well in the ground and long enough to provide a good anchorage, may be employed.

The instrument shelter support comes shipped knocked down, and must be assembled as follows:

Make up each end section first as follows: Lay two legs on a floor or other flat surface. There will be found on each leg a pencil mark near the top and another near the middle on two adjacent sides of the legs. Place the legs so that these marks are on top and on the outside. A wide short girt, having two countersunk screw holes, should be nailed to the two legs, *the lower edge to the pencil line near the top of the legs.* It will be noticed that this girt extends 1 inch

beyond the top of the legs. This is to enable it when the support is completed, to clasp the shelter and be screwed thereto. The short lower girt will be nailed to the legs with *its upper edge on the lower pencil mark.* The ends of both girts should be flush with the outside of the legs. A short brace should then be nailed in position with the lower end to right and with the beveled ends flush with the outside faces of the legs. It is suggested that the parts be laid down before nailing, and that only one nail be driven at each joint until after the brace is in position.

The two long upper girts can then be nailed on, their ends coming out flush with the outside edges of the wide upper girts, and their lower edges to the pencil lines. In a similar manner nail the two long lower girts, their upper edges to the pencil lines and their ends flush with the outside faces of the lower girts of the end sections. Now nail the two long braces in position, left end lowermost, and if the end sections were braced properly it will be found that the ends of the long braces will meet and cover the ends of the short braces.

The eight crosspieces from the crate in which the instrument shelter support is shipped may be used to anchor it to the ground, but it is much better to provide suitable anchor posts locally of material known to last well in the ground.

5. *Steel shelter supports.*—To provide a more rigid and lasting support, steel supports have been procured locally on specifications which may be obtained from the Instrument Division, if desired. The corner posts of these supports may be footed in concrete or otherwise weighted to prevent the overturning of the shelter in high winds.

6. *Locks for instrument shelters.*—For many years all shelters issued to stations from the Central Office have been furnished with the same kind of lock and key (known as the No. 39). This is the standard lock, and new keys can always be procured promptly on application to the section center, where a small stock will be kept.

7. *Location or exposure of shelter.*—The location chosen should meet the following requirements so far as practicable, having as the objective the determination of the true maximum and minimum temperatures at the elevation above ground of the thermometers, nearly 4 feet 6 inches.

(*a*) Choose a level, open space or small clearing so that the thermometers are ventilated so far as possible by the natural wind. At the same time, consideration must be given to the convenience of the observer, which requires the shelter to be reasonably close to the observer's dwelling.

(*b*) The location should be, in general, typical of the near-by area and not be unduly influenced by local conditions. While the ground

beneath the shelter may be grass-covered, as a rule, being part of the observer's premises, the air reaching the thermometers should be representative of the surrounding area. This is of particular importance as regards the minimum temperature, which often occurs when there is little or no wind. The character and color of the ground surface influences the rate of loss of heat by radiation during clear nights, so that the ground near to, if not directly beneath the shelter, should be representative of the area in general; or, the grass-covered surface small enough not to seriously affect the temperature distribution. It should be borne in mind that during clear, calm nights the lowest temperature is at or very close to the ground, while it will often be considerably higher at the elevation of the thermometers in the shelter.

Roof installations are undesirable but, if unavoidable, the shelter should be located where heat from the building will influence the temperature readings the least, and an open-board platform placed beneath the shelter will usually be required to minimize the effect of heat reflected from the surface of the roof.

GENERAL DESCRIPTION OF THERMOMETERS

8. Before the observer attempts to set up the thermometers, let him first examine them and compare them with the description and familiarize himself with all the peculiarities of each, so that he may understand which is the maximum and which is the minimum.

9. *Maximum thermometer.*—The glass bulb and bore of a maximum thermometer is *always* filled with mercury, sometimes called quicksilver.

The most distinctive peculiarity of the maximum thermometer, however, is not so easily seen. If the observer will hold the thermometer vertically with the bulb down, he will notice that the mercurial column does not extend entirely into the bulb. A close examination of the thermometer at the point just above the bulb where the mercurial column stops will show that the glass tube seems to have been almost closed at that point. This is just what has been done, and the passageway for the mercury is so fine at that point that the mercury will go through only with some difficulty. The observer should next hold his warm fingers around the bulb. The mercury in the bulb, expanding as it becomes warm, will then be forced to pass the constricted portion of the tube, flowing through in little spurts. When the fingers are removed from the bulb the mercury below the constriction, contracting as it cools, withdraws toward the bulb, but none of the mercury above the constriction goes back, and the length of the column remains the same as it was when the bulb was warmest. In this way the maximum temperature is registered.

If the thermometer is held in a horizontal position and then alternately tilted—first with bulb higher than stem, then with bulb lower than stem—it will be noticed that the thread of mercury may be made to flow to either end of the tube as desired.

10. *Retreaters.*—Experience has shown that in spite of every care in the inspection and testing of maximum thermometers, they will, if exposed vertically, sometimes fail to record the maximum temperature; that is to say, the constriction in the bore of the tube is not so fine as required, and when the temperature falls after reaching the maximum point the mercury in the column of the thermometer withdraws into the bulb and the record of the maximum temperature is lost. Such thermometers are sometimes said "to retreat," and are called "retreaters."

A good maximum thermometer may be made a retreater by a too violent throw-down of the mercury, as explained in paragraph 24.

11. Since it is known that a maximum thermometer may become a retreater without that fact being noticed, the safest procedure is to mount it with the bulb a little higher than the stem, as shown in figure 7. The support is so made that the angle of elevation of the thermometer back is 5 degrees. In this position the column of mercury is not under pressure, and when the thermometer is lowered gently to reading position it will rarely fail to record the highest temperature reached.

When it is desired to make a reading, the thermometer must be slowly and carefully lowered to a position in which *the mercury rests on the constriction.* This reading position, or angle, is not the same for all maximum thermometers, but rather should be determined by tlhe observer watching the manner in which the mercury flows in the tube at different angles of elevation. Greater care must be used with high temperatures because of the greater weight of the long column of mercury.

After reading, the thermometer should be set by whirling as described in paragraph 24.

12. *Minimum thermometer.*—The bulb and bore of this thermometer are always filled with alcohol, sometimes colored to aid visibility. It is, therefore, at once distinguished from a mercurial thermometer. Besides the alcohol, the bore of the thermometer contains an elongated, dark-colored object, made of glass, having rounded heads on each end. This object is called the index.

13. Generally the index will slide freely up and down the thermometer tube when one end is raised or lowered. Sometimes, however, and especially after the thermometer has been shipped, the alcohol in the tube becomes broken up into short, detached columns and the index is frequently caught and held.

14. Of course the thermometer cannot be used until this is remedied, which in some cases proves to be a difficult operation. Observers are requested to use special care in learning and following the instructions given below and to notice carefully the several effects so that they may judge for themselves as to what must be done to unite detached columns and avoid the danger of breaking the instrument.

The fact that vapor of alcohol condenses in the upper end of a minimum thermometer is well known to those who handle a considerable number of such thermometers. Manufacturers seal off such thermometers under considerable air pressure in order to lessen the probability of separation; but it will be apparent upon reflection that when a marked fall of air temperature occurs, conditions favorable for condensation of the vapor of the alcohol coincide with lessening of internal pressure, due to increased space above the column.

Under such circumstances a good minimum thermometer is likely to be misjudged as defective, when all that is needed to correct the condition is to reunite the column, then hang it in a vertical position for an hour or more so that the alcohol adhering to the walls may drain down. The test for the success of the effort is simple—merely to set the thermometer, immersed up to the reading point in melting, shaved, pure ice, or snow. Within an hour or so it should read very close to 32°.

15. The many different ways in which the alcohol column becomes separated make it impossible to unite it by any single method, different methods being required not only for different conditions but also for different thermometers.

Frequently there are only a few short, detached portions near the top, and the index slides freely along the lower portion of the tube and drops into the bulb. Again, the detached columns are found all along the tube, and the index is caught and held at some point above the main column. In such a case it is advisable first to bring the index into the bulb as follows:

16. *First process.*—Hold the thermometer lightly between the thumb and fingers and strike the lower end of the metallic scale against the top of a table or other firm object, as shown in figure 3. first, however, interposing one or two thicknesses of cloth or several folds of paper, so as not to produce too severe a shock upon the thermometer. The taps of the thermometer should be made lightly at first and the index examined to see if it has moved along the tube even a little distance, as can be told by noticing the exact position of the index in reference to the graduations on the tube. If several taps fail to move the index, increase the force of the taps a little at a

time until the index starts, after which repeat the operation until the index gets within the continuous column. Here it will fall of its own weight into the bulb. Generally this will be all that is necessary to place the index in the bulb. Sometimes the detached column will also have been partly or wholly united. If the column is still broken in places, the observer should try a few more taps, and examine quickly in a very careful manner. Small portions of the alcohol will generally be seen slowly moving along the sides of the tube toward the main column, and a continuation of the taps will unite the columns. In some cases 15 or 20 minutes may be required to completely unite broken columns. If, however, the index cannot be made to move with quite hard taps, or the columns cannot be united, it is advisable to try some of the methods described next, being careful always to avoid carrying any process so far as to endanger breaking the thermometer.

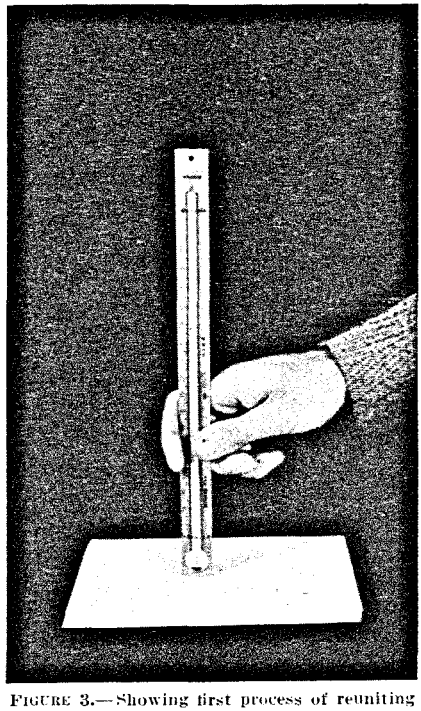


FIGURE 3.—Showing first process of reuniting alcohol column in minimum thermometer.

17. *Second process.* — This method will not loosen the index, but may unite the detached columns. Grasp the thermometer securely a little below the middle, with the bulb end down, and strike the edge of the metal back opposite the broken column sharply against the fleshy portion of the palm of the other hand, or, if necessary, against a small block of wood held in the hand. (See fig. 4.) A continued jarring in this way often causes the alcohol to run down, though in many cases a large number of taps are necessary. Observers should therefore not give up if the column does not unite at once, but should watch very closely for the movements of small portions of alcohol along the sides of the tube. Here, again, care must be used not to strike too hard and to hold the thermometer by the metal back in such a manner as not to squeeze or press against the stem of the thermometer itself. When the bore of the thermometer is large, the above process is almost

sure to unite the column. Good results are also obtained with thermometers of fine bore, though the latter, even in skilled hands, often require a half hour or more of time if the column is badly detached.

18. *Third process.*—This method can also be used in place of those above and is sometimes effective in forcing the index into the bulb. Grasp the thermometer a little above the middle, clasping the fingers

FIGURE 4.—Showing second process of reuniting alcohol column in minimum thermometer.

and hand firmly against the edges of the metallic back, but not so as to bring any pressure upon the glass tube, which should be turned toward you and with the bulb uppermost, as shown in figure 5. With the thermometer in this position and about as high as the head and the arm free from the body, quickly lower the arm and hand a foot or more, turning the wrist at the same time, so that the bulb of the thermometer describes a somewhat circular path downward through the air, stopping the motion with a sudden jerk just as the ther-

mometer is vertical. If the thermometer is grasped properly, a very violent motion can be given in this way without danger. It will sometimes be necessary to repeat the operation a considerable number of times to entirely unite the detached columns.

19. *Fourth process.*—A modification of the swinging process just described consists in whirling the thermometer rapidly on a short string. For this purpose a stout string is passed through the hole in the top of the metal back of the thermometer. This is left double and firmly grasped at a distance of 6 or 8 inches from the thermometer, which may then be given a very rapid whirling motion. Considerable care and practice are required to whirl the thermometer rapidly and stop it safely. This method will, however, often bring down the index and unite detached columns.

FIGURE 5.—Showing third process of reuniting alcohol column in minimum thermometer.

20. If observers are unsuccessful after carefully following the above instructions, the matter should be reported to the section center, giving full particulars as to what has been done.

21. *Testing minimum thermometer.*—Some one or more of these processes should in nearly all instances be sufficient to unite any detached column, and when all the bubbles have been removed the observer can then see how the instrument works. Hold the thermometer vertically and warm up the bulb by holding it in the hand; then turn the instrument upside down. Watch the index as it glides along the tube; when it strikes the top of the column it will at once stop. This operation of bringing the index to the top of the colmun is called "setting" the thermometer.

Next hold the thermometer horizontally. As the bulb cools off the index will be dragged backward toward the bulb, but always remains at the end of the column of alcohol. It is a good plan to hasten the cooling by placing a little wet cloth or piece of ice against

the bulb. When you have watched the index go down with the column, warm the bulb again with the hand. The column will go up immediately, but the alcohol will flow around the index and leave it at the lowest point; that is, the index remains so that its *top* end is at the lowest point reached by the alcohol column, and the minimum temperature is indicated in this way. The thermometer must be held horizontally throughout these operations.

When the thermometer is not in use for observation, it is a good plan to hang it up, as bubbles are less likely to form in the tube in this position.

The thermometer should also be maintained in a vertical position for several hours after a broken column has been united to permit any alcohol clinging to the sides of the bore to drain down.

INSTRUCTIONS FOR MOUNTING MAXIMUM AND MINIMUM THERMOMETERS

22. *The Townsend thermometer support.*—This support, with thermometers attached, shown in figures 6 and 8, should be firmly screwed to the cross board of the instrument shelter, approximately in the middle, and with the legend "U. S. W. B." right side up.

23. *Maximum thermometer.*—Mount the maximum thermometer on the carrier on the *long* projection stud, and clamp it just below the upper strap, and with the bulb at the left, so that it over-balances and tends to hang bulb end down.

24. *To whirl and set the maximum thermometer.*—Release the pawl fixed near the base of the maximum pin. This unlocks the carrier. Place the finger, or pencil, at one side of the thermometer scale and impart to it a rapid rotation, as suggested by the dotted line and arrow in figure 8. Allow the thermometer to whirl until it comes to rest itself. Do not try to stop it while whirling. Note carefully whether or not the space between the bulb and constriction is filled with mercury. Repeat the whirling, if necessary, until the column is whirled down as far as it can go.

The space in the bore of the tube not occupied by the mercury is a vacuum. Hence, the mercury should rest upon the constriction when whirling is started. Otherwise its violent throwdown may fracture the glass constriction. When such internal fracture has occurred it will be apparent as an irridescent patch in the neighborhood of the constriction when the thermometer is examined by reflected light.

Engage the pawl again and carefully elevate the bulb end of the thermometer until the pawl catches and holds the carrier. The thermometer is now "set" and ready to indicate the ensuing maximum temperature.

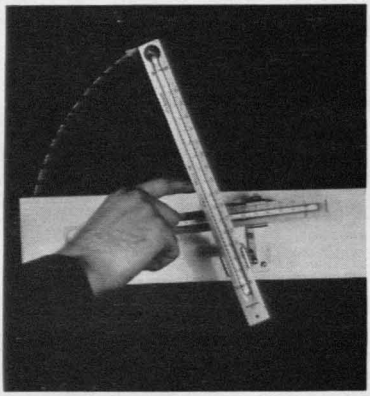


FIGURE 6.—Illustrating setting of maximum thermometer by whirling.

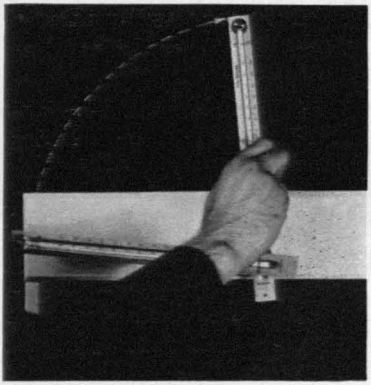


FIGURE 7.—Illustrating setting of minimum thermometer by turning it to an inverted position until the index falls to the end of the column.

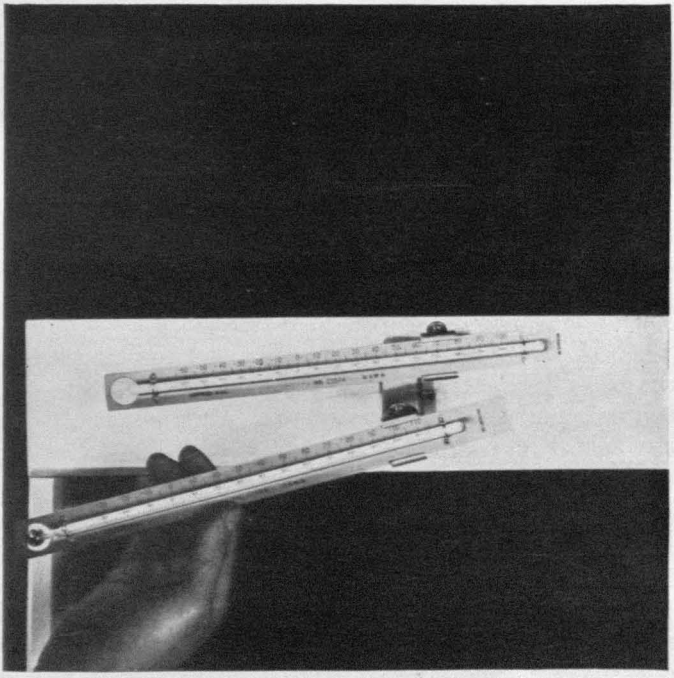


FIGURE 8.—The maximum thermometer should be gently lowered to a reading position.

326040°—41——3

25. The revolving carrier for the maximum thermometer must be oiled occasionally through the hole in the side provided for the purpose so that the carrier will revolve easily. A thin, nongumming oil should be used.

26. *To read the maximum thermometer.*—First carefully disengage the pawl that holds the maximum thermometer, then *slowly* lower it, as shown in Fig. 8, bulb end down, until the mercury rests on the constriction. The thermometer must not be lowered suddenly, especially in warm weather, as the weight of the long column of mercury is likely to force some portion through the constriction and cause an erroneous reading. *The maximum temperature is the scale reading at the top of the column of mercury.*

27. *Mounting minimum thermometer.*—The minimum thermometer must be mounted in the support on the *short* projecting stud. Clamp the thermometer as shown in the support at about two-thirds of the thermometer length as measured from the bulb end, *with the bulb end to the left.*

28. *To set the minimum thermometer.*—Turn the carrier and thermometer to a vertical position, bulb uppermost, and allow the index to fall to the end of the column. After setting do not fail to turn the minimum thermometer back to its nearly horizontal position, as shown in figure 8.

29. *To read the minimum thermometer.*—The minimum thermometer must always be read while it is still in its horizontal position as left after setting at the previous observation. To avoid possible displacement by vibrations, the minimum thermometer must be read before whirling and setting the maximum thermometer. The reading is obtained by noting the number of degrees on the scale *opposite the end of the index farthest from the bulb.* A reading taken at the end of the spirit column will give the current termperature.

30. If at any time the column is found to be broken and bubbles are observed in the tube the instrument should be taken off the supports and an effort made to unite the column by some of the methods already described.

THE RAIN GAGE

31. The *exposure of the rain gage* is a very important matter. The most serious disturbing effect in collecting rainfall is the wind. In blowing against the gage the eddies of wind formed about the mouth tend to carry the rain away, so that frequently too little is caught in the gage.

Weather Bureau officials will therefore take particular care in selecting a place for the location of the gage, as the value of the

records is sometimes greatly impaired by improper exposure. It is scarcely necessary to say that every precaution should be taken to protect gages from the interference of animals and unauthorized persons. Select, if possible, a position in some open lot, unobstructed by large trees, buildings, or fences. Low bushes and fences, or walls that break the force of the wind in the vicinity of the gage, are, however, beneficial, if at a distance at least twice as great as the height of the object. Such surroundings, in general, afford the best exposure. Gages should be exposed upon roofs of buildings only

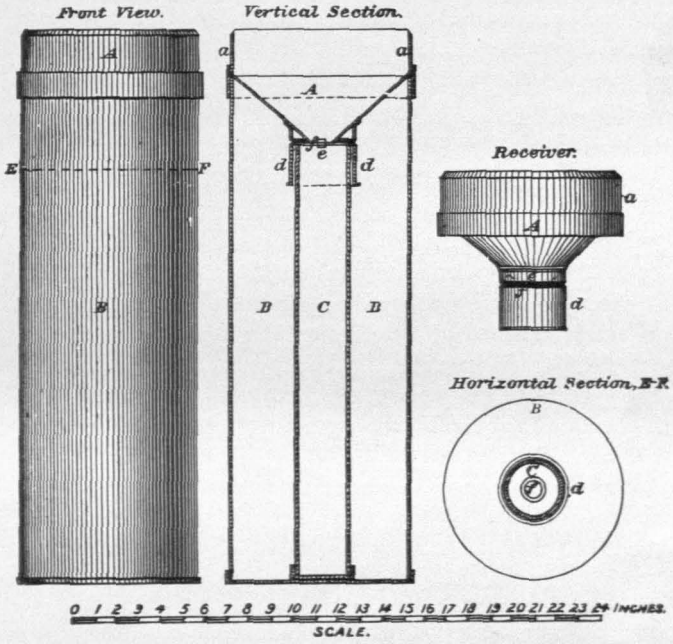


FIGURE 9.—Rain gage.

when ground exposures are impracticable, and then the roof should be flat, or nearly so, and the middle portion should be selected to get the best results.

32. Rain gages in slightly different positions, if badly exposed, catch very different amounts of rainfall. Within a few yards of each other two gages may show a difference of 20 percent in the fall in a heavy rainstorm. The stronger the wind the greater the difference will be. In a high location eddies of wind produced by walls of buildings divert rain that would otherwise fall in the gage. A gage near the edge of the roof, on the windward side of a building, shows less rainfall than one in the center of the roof. The

vertical, ascending current along the side of the wall extends slightly above the level of the roof, and part of the rain is carried away from the gage. In the center of a large, flat roof, at least 60 feet square, the rainfall collected by a gage does not differ materially from that collected at the level of the ground.

33. *Wind Shields.*—In windy locations, as before mentioned rain and snow gages give a more or less deficient catch, unless aided by fortuitous features of topography, and gage location, with respect to structures which shield the gage from the wind in varying degrees. Shields for precipitation gages made of metal or cloth have long been known to be effective in securing a reasonably normal catch, and are needed especially for snowfall.

Shields of various type have been used quite extensively in experiments carried out in the State of Utah and have been found to be distinctly beneficial ("Shielded Storage Precipitation Gages," by J. Cecil Alter, Monthly Weather Review, July 1937). They consist essentially of a circular metal frame from which are suspended wedged-shaped pieces of thin metal, free to be deflected inward by the wind about their suspension. The wind is thereby deflected downward at the windward side of the gage, resulting in a normal instead of an accelerated wind speed over the top of the gage in the absence of shields. When the wind speed over the gage is not accelerated the precipitation enters the receiver instead of being blown past the gage to the lee of the gage where an excess would be deposited.

34. *Description of rain gage.*—The rain gage consists of the following parts:

The receiver *A;*

The overflow attachment *B;*

The measuring tube *C.*

The top cylindrical portion of the receiver, marked *a* in figure 9, is exactly 8 inches in diameter, inside, and is provided with a funnel-shaped bottom, which conducts any precipitation caught in the receiver into the tall cylindrical measuring tube, *C*, the total height of which, inside, is exactly 20 inches. The diameter of this tube is much smaller than the large receiving tube, *a*, being only 2.53 inches. In consequence of this a small amount of rain falling into the receiver and flowing into *C* fills the latter to a depth greater than the actual rainfall in proportion as the area of the receiver is greater than the area of the measuring tube. In the standard gages of the Weather Bureau the depth of the rainfall, in accordance with this principle, is magnified just 10 times. The receiver, *A*, has a sleeve, *d*, figure 9, which slips over the tube, *C*, and very effectually prevents any loss of rainfall. Again, when the rainfall is very heavy, the tube, *C*, may

overflow. In this case, to prevent loss, a little opening, shown at *e*, figure 9, is made in the sleeve, *d*, just on a level with the top of the tube, *C*. The excess of rainfall escapes through this opening, and is retained in the large overflow attachment, *B*, and can be measured afterwards, as will be described later. The opening *e* is omitted in the latest forms of gages, as the water easily flows between the sleeve and the tube *C*, which fit each other loosely. The inside diameter of the overflow attachment is just 8 inches, and this portion of the instrument can be used as a snow gage, as will be explained hereafter.

35. *Rain-gage support.*—The box in which the gage is shipped to the observer is expressly designed as a stand for the instrument, and should be opened at the head, which is fastened by screws. Set the box as nearly vertical as possible at the place selected for exposure and secure it in this position by driving down four stakes alongside, in the manner indicated in figure 10. Care must be taken to have the gage held in a truly vertical position. Slip in the head and lower it to the level of the screw holes in the sides of the box about 10 inches from the bottom, where the head will be securely fastened with the screws taken out in opening the box. The gage can now be placed inside, and appears as shown in figure 10. Separate the botttom of the box support from the ground sufficiently to prevent rotting of the wood.

More durable supports have occasionally been substituted for the box support, but the wooden support protects the gage somewhat from the sun's rays and thereby mostly prevents the loss through evaporation of a small part of the rainfall which may have fallen.

HOW TO MEASURE RAINFALL AND SNOWFALL

36. *Rainfall.*—The measuring stick of the rain gage is graduated into inches and tenths. Remembering that the actual depth of the rainfall is magnified 10 times, as explained above, it is plain that if we find the water 10 inches deep in the measuring tube, then the actual rainfall must have been only 1 inch deep, or if the water in the tube is only one-tenth inch (or written as a decimal, 0.1 inch) deep, then the rainfall must have been only one-hundredth inch (or written as a decimal, 0.01 inch.)

37. The depth of the water is measured by inserting the measuring stick into the gage through the small hole in the funnel. When the stick reaches the bottom of the measuring tube it should be held for a moment and then quickly withdrawn and examined to see at what division of the graduation the top of the wet portion comes. The numbering of this division, *as stamped on the stick*, gives, as has just been explained, the actual depth of rainfall, and in making out records and reports observers should *always use the decimal expressions.*

38. After measuring and recording in this way the precipitation found in the gage, the top should be removed, the measuring tube emptied and drained, and the gage put in position again. Observers should be careful after emptying the gage to replace the measuring tube so that the bottom stands within the ring in the middle of the bottom of the overflow, and in putting on the receiver that it passes over the measuring tube and rests squarely down upon the overflow.

39. When the amount of rain that has fallen more than fills the measuring tube, some care is required to determine the total rainfall. First, carefully remove the receiver so as not to spill any of the water in the measuring tube, which should be exactly full. If some water has been slopped out and the measuring tube is not exactly full, the amount of water remaining must be accurately measured with the stick, as already described. The tube is then lifted out slowly and carefully, so as not to spill any of the water into the overflow, emptied, and allowed to drain a moment or so. The water remaining in the overflow is now poured into the measuring tube, care being taken not to lose any, and measured in the usual way. Suppose we find this to be 0.47 inch rainfall; then, remembering that the measuring tube is just 20 inches high, the total rainfall will be 2 inches+0.47 inch=2.47 inches. Or, in case some water was spilled from the measuring tube, the 0.47 inch should be simply added to the first measured amount to give the total rainfall.

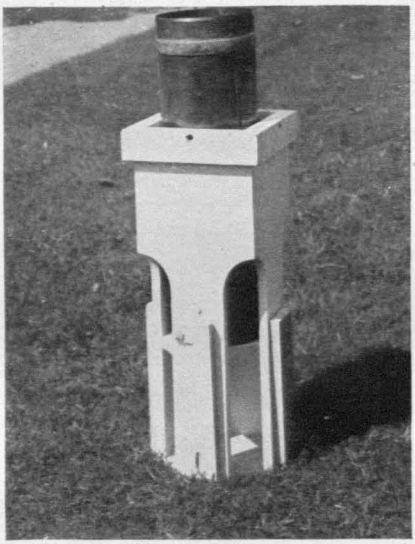


FIGURE 10.—Rain gage and box support.

40. *Snowfall.*—During the winter season, especially in those climates where the precipitation is nearly all in the form of snow, the overflow attachment only of the rain gage should be exposed in the support as a snow gage. Remove the receiver and measuring tube to the house, as these parts cannot be used for measuring snow, and even if rain should occur it is very apt to be frozen while in the measuring tube, generally bursting it and rendering it worthless or highly inaccurate.

41. *First method.*—The snowfall collected in the overflow attachment is measured after placing the vessel in a warm room until the

snow is melted. The water is then carefully poured into the measuring tube and measured just as though it were rainfall.

42. *Second method.*—The first method is objectionable, because it often requires considerable time, and is liable to be inaccurate, owing to the loss of the snow or water by evaporation. The following plan is much better, unless clumsily conducted so as to spill and waste the water: Take the overflow into the room and pour into it carefully *one measuring tube full to the brim* with water, preferably warm water. This, in general, will mostly melt, or at least reduce to a very fluid slush, a considerable snowfall. The measuring tube should be again carefully filled to the brim from the melted contents of the overflow and emptied; whereupon the remaining water in the overflow should be carefully measured in the measuring tube, thus giving quickly and easily the depth of melted snow.

43. The amount of snow collected in the overflow of the rain gage is likely to be greatly deficient when the wind blows during the snowfall. In such cases it will be much better if the observer will discard the snowfall in the overflow, empty it out and cut out a section of the snow in an open place where the depth truly represents the precipitation. This section is to be taken by plunging the empty overflow, mouth downward, in the snow so as to cut out a cylindrical portion the size of the overflow and the depth of the snow. By the use of a thin board or other means it will not be difficult to gather up the complete section of snow inside the overflow, after which it should be reduced to slush and measured as already explained.

GENERAL INSTRUCTIONS ABOUT INSTRUMENTS

44. *Shipment of thermometers.*—The boxes and packing material received with thermometers should be carefully preserved for use in returning instruments.

In packing thermometers for transportation each instrument must be carefully wrapped in sheet cotton; the whole surrounded with excelsior or similar packing material, and, to prevent shifting, no vacant spaces whatever should be left in the box.

45. *Care of thermometers, and support.*—When, from action of the weather and long exposure, the graduation marks, figures, or lettering on the glass tube, or metallic back of a thermometer are obliterated or illegible, they can easily be renewed by the application of a small quantity of artists' black pigment (ivory black). The best method of applying the substance is to put a drop on a small stick, such as a match, and rub it *across* the marks or lettering until the spaces are thoroughly filled. The superfluous pigments should then be wiped off with a piece of tissue or blotting paper in such manner as not to draw the pigment from the lines.

The thermometer support should be watched to see that the thermometers are securely held by the set screws and shims when used. This attention should prevent a considerable breakage of thermometers, especially the maximum.

46. *Care of gages, shelters, etc.*—The rain and snow gage should be critically inspected now and then to see that neither the measuring tube nor the overflow leak. Any such defect will be promptly reported to the section director, as will also the need for the repair, repainting, or replacement of the shelter and support, or the rain-gage support.

47. *Action to take when instruments are broken.*—When from any cause instruments are broken they should be promptly returned, with an explanation, to the section center.

Ordinary precautions are required in the use of instruments, and observers are requested to use every reasonable care to avoid accidents, breakage, and loss.

II. TO MAKE AND RECORD OBSERVATIONS

48. *Observations desired.*—It is requested that cooperative observers make and record, daily, observations of the maximum and minimum temperatures; precipitation (rainfall or snowfall); the state of the weather (that is, the general character of the day from sunrise to sunset), and such other miscellaneous phenomena as fog, frost, coronas, thunderstorms, hail, sleet, tornadoes, and auroras.

Form No. 1009, furnished by the section centers, is arranged to facilitate recording the data desired by the Weather Bureau.

49. *Time of making observations.*—But one observation in each 24 hours is necessary on the part of cooperative observers, since the average of the readings of the maximum and minimum thermometers gives an approximately correct mean temperature for the day.

Uniformity as to time of taking observations is desired. A definite hour should be determined upon and the observations made each day as near that hour as possible. About sunset is recommended as the most satisfactory time for making the record, as the thermometers will then, except under unusual conditions, register both maximum and minimum temperatures for the day. The time at which observations are taken should invariably be noted on Form No. 1009.

50. *Form No. 1009, meteorological monthly record.*—At the end of this pamphlet will be found a copy of the form used by cooperative observers for recording observations, with data properly filled in to show how observations should be recorded. The instructions on the cover of a book of WB Form 1009, similar to those here given, should also be carefully followed.

It is particularly important, in the interest of accuracy, that the observations be recorded as soon as made, and that the entries be made day by day as observed. Even if no rain has fallen the observer should bear in mind that his official record of that fact is as important as the record of rainfall.

Special care should be exercised in the preparation of reports; pencils should be kept sharp, and good carbon paper used to insure satisfactory duplicate copies. Three copies of the report should be made, one to be retained by the observer and two to be sent to the section center on the first of each month. To make three copies of the record requires two carbon sheets; these should be placed between the forms, carbon side facing the form on which the record is to be made, and an ordinary pencil—one not too soft—used in writing. If a mistake occurs in recording, attempt should not be made to write over the figures; draw a line through the incorrect entry and make new figures either to the right or left, or on the margin of the form.

When the carbon paper no longer makes clear duplicates, ask for a new supply. It is the wish of the Chief of the Weather Bureau to keep cooperative observers well supplied with all material pertaining to their official duties, and they are requested to make timely requisitions therefor on their respective section centers.

When the name of the station and its post office are not the same, both should always be entered on Form No. 1009, the name of the station at the top of the form, and any change in location or name of the station should be explained by note.

TEMPERATURE RECORDS

51. The readings of the maximum and minimum thermometers should be made as explained in paragraphs 26 and 29 and recorded in the appropriate columns of Form No. 1009.

Enter temperatures to the nearest whole degree. When the temperature is an even number of degrees with an additional half degree, e. g., 76½°, drop the half and enter 76°. When an odd number and a half degree, e. g. 73½°, enter 74°, the next higher whole number.

In recording maximum and minimum temperature the following should be borne in mind. The maximum temperature of any day *cannot be lower* than any of the following readings: (1) The minimum of the previous day; (2) the minimum of the same day; (3) the minimum of the following day; (4) the set maximum of the preceding day; (5) the set maximum of the same day.

The *minimum* temperature of any day *cannot be higher* than (6) the maximum of the preceding day, (7) the maximum of same day, (8) the maximum of the following day, (9) the set maximum of the day before, (10) the set maximum of the same day.

52. *Thermometers set.*—Immediately after the thermometers have been carefully read and the values noted on the form, they should be set; first noticing, however, that both thermometers are in their proper position and are securely fastened to their supports.

The maximum should be whirled and set first, and the minimum next. In no case should the thermometer be set, except *once each day*, just after making the observation.

53. *Test.*—After setting the thermometers, the readings of the top end of the index of the minimum thermometer and the top of the mercurial column of the maximum should give the same temperature generally within a fraction of a degree. If the difference is a degree or more, and it cannot be corrected by resetting, it is possibly due to bubbles in the minimum thermometer or slight displacements of the alcohol. Persistent discrepancies of this sort should be reported to the section center, and observers are requested to have this test in mind and apply it frequently in order to detect this source of inaccurate records.

54. *Plus and minus signs.*—Temperatures below zero are written with the minus sign prefixed, thus: −1, −2, −4, etc., all indicating that the temperature is below zero. If the temperature is exactly zero, it should be recorded 0. Temperatures above zero are recorded simply 2, 45, etc., as the case may be, it being understood by the absence of any sign that it is (+), or above zero.

In determining means when there are minus (below-zero) temperatures, the sum of the minus readings is deducted from the sum of the plus readings and the remainder divided by the number of days in the month, unless one or more days' records are missing, when, of course, those missing days are deducted from the divisor.

If the sum of the minus readings is greater than the sum of the plus readings, the latter is subtracted from the former and the remainder divided, as above. The resulting mean is a minus temperature.

The preceding remarks about the computation of monthly means is given only for information. Present practice requires the observer to enter sums only, the means being computed afterward at the section center.

55. *Shelter locked.*—The shelter should be carefully locked after taking each observation in order to prevent unauthorized persons from interfering with the instruments.

PRECIPITATION RECORDS

56. *Rainfall.*—Measurements of rainfall should be made at the time of regular observations, and the gage should be emptied of all

the water it may contain as soon as it has been measured and the parts replaced in readiness for the collection of the next rainfall. The amount of rainfall will be determined as explained in paragraphs 37, 38, and 39.

57. *Snowfall.*—Snowfall is measured both in terms of the depth of water equivalent and also by the thickness of the layer of snowfall on the ground. When the water equivalent can not be determined accurately by melting, as given in paragraphs 41–43, inclusive, as a last resort, take one-tenth the average measured depth of the snowfall on a level, open place as the water equivalent of the snowfall; for example, 10 inches of snow squals 1 inch of melted snow or water. Some estimate of the wetness or density of the snow should be made, for the relation between the depth of snow and depth of water equivalent varies widely in different storms, depending on the wetness of the snow. It is, therefore, always best if possible to reduce snow to a liquid condition for measurement, and the simplest way to do this is to add to it a known volume of water sufficient to change it to a state of slush, as explained in paragraph 42. For each entry in the column 7 of Form 1009, headed "Snowfall, inches and tenths," there must be an entry in the column 6, "Amount." For rainfall, only one entry is made; for snowfall, two, one of which is the depth of the snow, the other the depth of the water obtained by melting the snow.

58. In the winter season the overflow only of the gage should be exposed, as stated in paragraph 40, and the snow collected therein between observations (or, better, a section of snow cut out, as explained in paragraph 43) should be reduced to a state of slush and measured in the manner described above and in paragraph 42.

59. In addition to the entry of the 24-hour precipitation as the water equivalent of the snowfall, column 6 in WB Form 1009, the snowfall in inches and tenths, is itself entered in column 7, and also the total depth on the ground at time of observation, column 8. This latter measurement is made by taking the mean of the depths at three or more places least affected by drifting. Sometimes, in the absence of more accurate determinations, the average depth of the 24-hour snowfall is used to obtain the entry for columns 6 and 7, using $\frac{1}{10}$th of the snowfall depths as the water equivalent. This value must be set down in column 8 of the report in precisely the same manner as rainfall or snow melted in the gage. After having once made a measurement of the snowfall, it is not desired that the same snow be measured at each succeeding observation until it shall finally disappear, except to get the actual depth of the snow on ground for entry in the proper column. Any fresh snow, however, should be measured and recorded after it falls.

60. If no rain, snow, or hail has fallen since the last observation, make an entry 0.00 in the proper column. If the amount is too small to measure, make the entry "Trace" or "T."

MISCELLANEOUS PHENOMENA

61. *Frost.*—Occurrence of first and last frost of the growing season should be specially noted.

The terms descriptive of frost will be as follows:

Light, to indicate a frost that has no destructive effect, although tender plants and vines in exposed places may be injured. *Heavy*, to indicate a frost that in itself is severer than a light frost—that is, the deposit of frost is heavier and the temperature falls to a lower point, although the staple products of the locality may not have been generally destroyed. *Killing*, to indicate a frost that is generally destructive of vegetation and the staple products of the locality.

62. *Coronas.*—These must be distinguished from halos. Coronas are broad bands of light, very commonly seen around the moon, due to rays of light passing through a thin layer of cloud. Sometimes as many as three small concentric circles may be seen whose diameters are in the ratio 1:2:3. They are frequently colored, red being the outside color. These colors are not the pure colors of the spectrum, but rather those of the opal, and are caused by interference and not refraction. A solar corona is not often visible, on account of the dazzling brightness of the sun, but is may generally be seen by viewing the sun through colored glass, or noticing its reflection in water.

63. *Halos* are large rings of about 45° or 90° in diameter—that is, the diameter is equal to one-eighth or one-fourth the circumference of the horizon. The colors are very feeble; the red is the inside color. Halos arise from the presence in the atmosphere of minute prisms of ice, and are due to refraction of light. Sometimes the halo is intensified into two bright spots, one on each side of the central luminary. These are called "parhelia" or "paraselenæ" (mock suns or mock moons), sometimes sun dogs. Still more complicated optical phenomena are sometimes seen, though rarely, except in high latitudes.

64. *Thunderstorms.*—Thunderstorms 6 hours apart may be considered as separate storms.

Upon the occurrence of thunder, give as nearly as possible the times of first and loudest thunder and its duration, being careful to note if a. m. or p. m.

Give the direction from which the storm appears to be coming, as shown by threatening sky, lightning flashes, or thunder peals. Also the direction toward which it goes.

65. *Tornadoes.*—All the meteorological circumstances attending these should be minutely noted, viz, the form and color of the clouds; the direction and intensity of the wind, direction of movement and width of path, the frequency, intensity, and form of the lighting; the occurrence of hail, destructive effects, etc.

66. *Auroras.*—The date, hour, and minute of the beginning and ending of auroras should be carefully noted, as well as the azimuth of the base and the altitude of the extremity, and of the crown of any arch of light.

When the observer is familiar with the names of the principal fixed stars, he may locate the arch or crown by reference to them, but it is preferable that he should observe directly the altitude and azimuth.

Observers should be particular as to the date of the aurora; and when it begins in the evening of one day and continues into the early morning of the next day, it will be entered as occurring on the *first* day, but its details will be given in the record as occurring between the hours of its actual beginning and ending. Thus, an aurora that began on the evening of the 12th of January and continued until the early morning of the 13th would be entered as the aurora of the 12th, but its details would be recorded as occurring, for instance, between the hours of 10 p. m. of January 12 and 2 a. m. of January 13.

67. *General phenomena of climate.*—Information of a general character relating to the growth of plants will be of value in determining the climatology of a district.

68. *Character of the day.*—The general character of the day from sunrise to sunset should be recorded as "clear," when the sky averages three-tenths or less obscured; "partly cloudy," when from four-tenths to seven-tenths obscured, and "cloudy," when more than seven-tenths obscured. The average cloudiness from sunrise to sunset may be estimated with considerable accuracy by noting the degree of cloudiness, on the scale given, as near sunrise as possible, between noon and 1 p. m., and near sunset; add these and divide this sum by 3; the quotient will be considered the average cloudiness.

When light fog, light haze, or light smoke has prevailed during the greater part of the day, with three-tenths or less of clouds, its character should be recorded as "clear," but when dense fog, dense haze or dense smoke has prevailed the character of the day should be recorded as "foggy," "hazy," or "smoky," as the case may be. When the last-named conditions prevail, it is recommended that observers note in the column headed "Miscellaneous phenomena" the duration of same, e. g., "dense fog from early morning till 3 p. m.," etc.

DEFINITIONS

69. Several meteorological terms are often used by the public in a sense somewhat different from that in which they are used by meteorologists; this is particularly true of the words "cyclone" and "tornado." It is desirable to adhere to the following usage:

70. By "tornado," the Weather Bureau means the violent "twister" of the prairies—a destructive, whirling column of air, from 50 feet to half a mile in diameter, usually, though it may be greater, accompanied by a dark funnel-shaped cloud that extends in a sinuous line down to the earth. The whirl originates at the cloud level, and bores downward.

71. The Weather Bureau uses the word "cyclone" to mean, in general, an atmospheric formation in temperate latitudes that is characterized by relatively low barometric pressure over an extensive area, usually several hundred miles across, with which is associated a system of gentle to moderate, occasionally strong, winds that (in the Northern Hemisphere) circulate spirally inward in a counterclockwise direction about the center; it is commonly accompanied by more or less widespread cloudiness and precipitation, and constitutes the ordinary, familiar general rain- or snowstorm of temperate latitudes. A number of such formations usually move across the United States each month, traveling from westerly toward easterly directions, and requiring a day or more to pass over a given place.

72. The severe storms of the tropics, such as the West Indian hurricanes, are known as *tropical* cyclones, to distinguish them from the ordinary cyclones of the temperate regions; they are smaller in diameter, and usually more violent than the extra-tropical cyclones.

73. Popularly, the tornado, or, indeed, any violent and destructive wind, is often called a cyclone; but this usage is not accepted among meteorologists, and is not practiced by the Weather Bureau.

74. An *anticyclone* is characterized by relatively high barometric pressure over an extensive area, with winds that in the Northern Hemisphere circulate spirally outward in a clockwise direction about the center. It is commonly, though not always, accompanied by fair and settled weather; the winds may be very strong over a narrow belt around the outer part, but throughout most of the anticyclone they are gentle.

75. The terms "high" and "low" refer to areas in which barometric pressure is above or below that of the surrounding country, without reference to any normal values and without implying any specific peculiarity as to winds or weather.

III. EARTHQUAKES AND INSTRUCTIONS FOR THEIR NONINSTRUMENTAL OBSERVATION

IMPORTANCE OF EARTHQUAKE DATA

76. While really destructive earthquakes are unusual, only a few occurring during the course of a year in any part of the world, tremors strong enough to produce slight damage occur somewhere every few days. Indeed, if we count all disturbances from the most destructive to the feeblest, it would appear that the earth is seldom, if ever, wholly at rest.

77. Some portions of the earth's surface are, as is well known, far more frequently visited by earthquakes, both great and small, than are certain others, but no place is entirely free from at least an occasional shock. Hence, seismology, or the science of earthquakes and their phenomena, is of some importance to everyone and of great importance to many. Thus, to be specific and to confine attention strictly to the obviously and eminently practical, we should know the exact locations of those numerous breaks and weak vertical seams in the earth's crust along which abrupt slipping and sliding (the cause of nearly all earthquakes) most frequently occur, so that as far as possible we may avoid them in the location of such permanent structures as dams, irrigation channels, aqueducts, bridges, and even ordinary houses.

WHY THE WEATHER BUREAU SHOULD COLLECT EARTHQUAKE DATA

78. In spite of the good it clearly would serve, there is, however, no map of any country that gives at all fully the locations of earthquake breaks or faults, nor is the collection of the data essential to the construction of such a map of any extensive section possible, except through the long and constant cooperation of a large number of observers widely scattered over the area in question.

79. If then the people of the United States are to be supplied with such practical maps as would enable them to reduce to a minimum their fears of and losses from earthquake disasters, the necessary data obviously may most easily be collected by the Weather Bureau, since it alone, of the various Federal scientific institutions, already has the adequate personnel and necessary organization.

REQUESTS FOR COOPERATIVE OBSERVERS

80. Although each of the Weather Bureau's regular first-order stations, approximately 300, will report all earthquakes felt, yet the territory covered is so great that its seismic disturbances cannot adequately be recorded without the aid of a large number of voluntary assistants. Hence it is earnestly hoped that, so far as possible, all the

Bureau's numerous cooperative observers will assist also in the collection of seismological data, by reporting, on forms (No. 5000) that will be furnished for that purpose, the date, etc., of each earthquake that they may experience. To each observer the labor will be exceedingly light, and the time consumed only a few minutes in a whole year, but the collected results will be permanent and extremely valuable—absolutely essential to the construction of the maps in question and exceedingly helpful in the explanation of many obscure earthquake phenomena. The data thus secured is finally analyzed by the United States Coast and Geodetic Survey.

INSTRUCTIONS FOR THE COLLECTION OF EARTHQUAKE DATA

81. The particular earthquake data desired are indicated on the forms that will be supplied to all who take part in this work, but the method of collecting and forwarding this information to the Central Office for classification and study is explained by the following instructions:

(1) Regular Weather Bureau stations will be communicated with directly from the Central Office; cooperative stations entirely by, or when necessary, through section centers.

(2) All routine communications on seismology directed to the Central Office will be enclosed in penalty envelopes marked "Earthquake Reports."

(3) Each regular Weather Bureau station and each cooperative station that agrees to assist in this work will be furnished with a supply of forms.

(4) Each station, regular and assisting cooperative, will promptly fill out and forward in a penalty envelope one form for each earthquake felt.

(5) The regular stations at Boston, Atlanta, St. Louis, Denver, and San Francisco will also send to the Central Office such newspaper clippings in regard to earthquakes in the United States as may come to their notice.

(6) Each section center may supply forms to other reliable persons in addition to the cooperative observers. This is especially desirable in those portions of the country which are either subject to earthquake shocks or sparsely inhabited.

(7) An earthquake that produces any appreciable damage will be made the subject of a special investigation determined upon at the time.

(8) All forms collected by section centers recording the occurrence of an earthquake will be promptly forwarded to the Central Office.

INDEX

W B FORM 1009

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

COOPERATIVE OBSERVERS' METEOROLOGICAL RECORD:

STATION *Graceville*, COUNTY *Willoughby*, STATE *N.Y.* HOUR OF OBSERVATION TEMP. *Sunset*
LATITUDE *44°23'N.* LONGITUDE *74°27'W* ELEVATION ____ PRECIP. *Sunset*
MONTH *Nov.*, *1934*. MERIDIAN OF TIME *Eastern*.

DATE	TEMPERATURE: MAXIMUM (1)	TEMPERATURE: MINIMUM (2)	TEMPERATURE: SET MAX [2] (3)	PRECIPITATION: TIME OF BEGINNING (4)	PRECIPITATION: TIME OF ENDING (5)	PRECIPITATION: AMOUNT [3] INCHES & HUNDREDTHS (6)	PRECIPITATION: SNOWFALL INCHES & TENTHS (7)	PRECIPITATION: SNOW ON GROUND AT OBSERVATION (8)	PREVAILING WIND DIRECTION FOR THE DAY (9)	CHARACTER OF DAY SUNRISE TO SUNSET: CLEAR (0-3) (10)	CHARACTER OF DAY: PCLDY (4-7) (10)	CHARACTER OF DAY: CLOUDY (8-10) (10)	MISCELLANEOUS PHENOMENA INCLUDING CHARACTER OF PRECIPITATION, AS RAIN, DRIZZLE, SNOW, SLEET, HAIL, THUNDERSTORMS, ETC. (11)
1	52	26	28			0			E		✓		
2	38	27	32			0			NW			✓	Killing frost
3	46	26	30			0			SW	✓			
4	37	29	31			0			NW			✓	
5	43	26	30			0			E		✓		
6	34	27	28	3:12 p.m.	6 p.m.	T	T	T	NW			✓	
7	28	24	28	During Night a.m.	During Night a.m.	T	T	T	NW			✓	
8	29	16	22	During Night a.m.	4:45 p.m.	T	T	T	NW			✓	
9	41	19	30	During Night a.m.	During Night a.m.	0.11	1.2	1.2	SE			✓	
10	31	21	21	During Night a.m.	2:45 p.m.	0.62	6.1	7.0	NE			✓	Sleet changing to snow, early a.m.
11	22	2	21			0		5.5	NW	✓			Light fog
12	26	3	16			0		4.2	NW	✓			
13	31	3	28	During Night p.m.		0		3.0	NE		✓		Dense fog
14	52	2	47		During Night a.m.	T		1.5	NE		✓		
15	55	20	35	During Night p.m.	During Night p.m.	T					✓		
16	70	25	31			0			S		✓		Solar halo
17	32	21	22	2:45 p.m.		T			N			✓	
18	22	16	18			0			NW			✓	High NW winds
19	18	10	16			0			NE			✓	
20	25	10	21	8:20 p.m.		0			NE			✓	
21	21	12	20			T	T		NW		✓		
22	36	6	30			0			S		✓		
23	35	10	21			0			SW		✓		
24	34	15	24	11 a.m.		0.06			E			✓	
25	34	15	20	12:15 p.m.		0.46			N			✓	
26	23	10	12		6:30 p.m.	0.12	1.4		NW			✓	Lunar halo
27	12	2	3	4 p.m.	6:20 p.m.	T	T		NW		✓		Solar halo, 10 a.m.
28	4	-5	2			T			NW	✓			Aurora, 8 to 4 p.m.
29	3	-5	2			0			NW	✓			
30	11	-9	3			0			N	✓			
31													
1st [1]													
SUM													

SEE COVER FOR INSTRUCTIONS

1 ENTER TEMP. AND PRECIP. FOR 1ST DAY OF FOLLOWING MO. WHERE OBS. IN MORNING ONLY.
2 READING OF MAX. THERMOMETER IMMEDIATELY AFTER SETTING.
3 INCLUDING RAIN, HAIL, SLEET AND MELTED SNOW ON DAY OF MEASUREMENT.
(IN TRIPLICATE)

John Roe
(COOPERATIVE OBSERVER)
Graceville, New York
(P.O. ADDRESS)

MONTHLY SUMMARY
(TO BE FILLED IN BY OBSERVER)

DATES OF —
HIGH WINDS, *18th.*
GLAZE, (FREEZING RAIN) ____
SLEET, (SMALL ICE PELLETS) *10th.*
HAIL, ____
KILLING FROST, *2nd.*
THUNDERSTORMS, ____
FOG, LIGHT (VIS. 5/16 MI. OR MORE) *11th.*
DENSE (VIS. LESS THAN 5/16 MI.) *13th.*
DEPTH OF FROZEN GROUND AT END OF MO ____ INS.

(NOT TO BE FILLED IN BY OBSERVER)

TEMPERATURE

MEAN MAXIMUM, ____
MEAN MINIMUM, ____
MEAN MONTHLY, ____ DEPARTURE, ____
MAXIMUM, ____ ; DATE, ____
MINIMUM, ____ ; DATE, ____

PRECIPITATION

TOTAL, ____ INS. DEPARTURE, ____

GREATEST AMOUNT

IN ANY OBSERVATIONAL DAY: AMOUNT	IN ANY OBSERVATIONAL DAY: DATE	COMPUTED FOR 24-HOUR PERIOD: AMOUNT	COMPUTED FOR 24-HOUR PERIOD: DATE

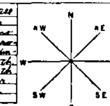
SNOW

TOTAL SNOWFALL, ____ INCHES
GREATEST IN ANY OBSERVATIONAL DAY ____
DATE ____

NUMBER OF DAYS

MAX. TEMP. 90° OR ABOVE, ____
MAX. TEMP. 32° OR BELOW, ____
MIN. TEMP. 32° OR BELOW, ____
MIN. TEMP. 0° OR BELOW, ____
WITH 0.01 INCH OR MORE PRECIP., ____
0.25 INCH OR MORE, ____; 1.00 INCH OR MORE, ____
CLEAR, ____ PARTLY CLOUDY, ____ CLOUDY, ____

REMARKS BY OBSERVER. *All crops having been secured the killing frost of 3d caused no injury. Winter wheat was protected by a covering of snow during extreme cold of 28th–30th. Minimum temperature of 30th lowest of record for November since station established.*



STATION ____
MONTH ____, 19 ____