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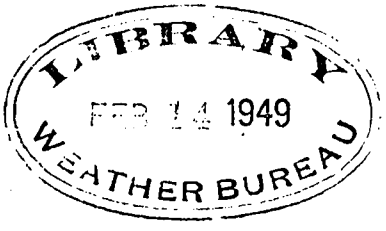
UNITED STATES DEPARTMENT OF COMMERCE • Charles Sawyer, Secretary
U.S. WEATHER BUREAU • F. W. Reichelderfer, Chief

WBAN MANUAL OF
SURFACE OBSERVATIONS

CIRCULAR N
Sixth Edition



JANUARY 1949

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RECORD OF CHANGES

Amendment number	Date effective	Pages affected	Initials	Date
Amendments bound separately		MO.1-U587C	-N-1949-	Suppl. W.B.
Errata	1-4-49	Follows T.p.		1/49
Interpretations	Ser. 1 +	AT end of Text		1/49
Change	No 1	Follows T.p.		1/50

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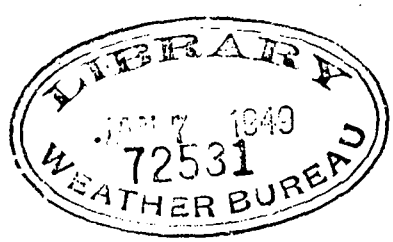

January 4, 1949

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
WBAN MANUAL OF SURFACE OBSERVATIONS

Circular N, 6th Edition, January 1949
Errata

Circular N, 6th Edition, will be corrected as follows and a notation of action taken will be entered in the Record of Changes.

WBAN Chapters

1. Page 18, opposite Shallow fog, change reference page number to 22.

2. Page 19, paragraph 3231, line 4, read ..."30 miles an hour."

3. Page 90, paragraph 11105, Table 25, Fractional increments column, change "1/10" to read "1/16."

4. Page 91, paragraph 11106.1, line 5. Delete comma after "Tornados."

5. Page 96, paragraph 11419, line 3, read ..."dry-bulb temperature."

6. Page 101, paragraph 11454.3, Table 35, opposite code number 9, read ..."H_sH_s."

7. Page 104, paragraph 11483, line 3, read "in column 88 for the day preceding midnight, and in column 87 ....."

8. Page 112, opposite "Date," read "June 8-11, 1949."

9. Page 113, (a) Summary of Criteria for Taking Special Observations, Item 9a, read ..."miles per hour."
(b) Summary of Criteria for Taking Local Extra Observations, Item 1a, read ..."highest airline minimum."

10. Page 115, opposite "Ceiling determination: frequency," read "9320-32, 9370."

11. Page 116, for "Hydrometers," read "Hydrometeors."

12. Prefix chapter numbers to corresponding titles on index tabs. Cover the tabs with clear scotch tape.

Weather Bureau Addendum

13. Page A5, Adjustment of Gain Controls, line 2, read ..."detector gain."

14. Page A18, paragraph A5544, Table A2, center column heading, read ..."wet-bulb 33°F. or lower."

15. Page A18, paragraph A5545, (a) line 2, read "29.5 inches or more;" (b) line 3, read "less than 29.5 inches."

16. Page A19, Example, Computation, first line, read "Enter diagram 1-A."

17. Page A25, paragraph A9120.02, last line, read "(see paragraph A11004)."

18. Page A31, paragraph A11002, (a) line 3, read "First-order stations will forward the original...." (b) last line, add "Routing procedures for other than first-order stations will be established by the Regional Offices."

19. Page A41, paragraph A12114, line 12, for "A11485-.7," read "A11485-.9."

20. Page A44, paragraph A12302, line 3, read ..."sums to whole degrees and averages..."

21. Page A48, paragraph A12361, read "Enter the sum of (a) one-half the sum ..... of Form 1130B, and (b) the correction to adjust to 24-hour mean."

22. Page A51, paragraph 13410, line 7, read ..."Form 1017 or 1017B."

23. Page A54, paragraph A13610, change first sentence to read "Forms will be changed on thermographs at 0800 local standard time or as soon thereafter as practicable."

CHAPTER 2. VISIBILITY

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CHAPTER 2. VISIBILITY

2000. GENERAL

2010. Visibility is a term that denotes the greatest distance an object of specified characteristics can be seen and identified. This term may express the visibility in a single direction or the prevailing visibility based on all directions. Binoculars, theodolites, etc., will not be used in taking visibility observations.

2100. GUIDES IN DETERMINING VISIBILITY

2110. CHART OF VISIBILITY MARKERS. Each station will have on display a chart of prominent objects and their distances from the observation point. This chart should include objects suitable for determining the visibility at night as well as by day.

2120. VISIBILITY MARKERS AT NIGHT. The most suitable objects for determining visibility at night are unfocused lights of moderate intensity at known distances, and the silhouettes of mountains or hills, etc., against the sky. The brilliance of stars near the horizon may also be a useful indication. Because of their intensity, airway beacons may not be used as visibility markers, but their degree of brilliance may be used as an aid to indicate whether visibility is greater or less than the distance of the beacon. "Course lights" (red or green) of beacons may be used as definite visibility markers. These and all other lights normally used as visibility markers should be used with caution after storms, for their intensity may be reduced by snow or freezing precipitation.

2130. VISIBILITY MARKERS DURING DAYLIGHT. For accurate determinations during daylight hours, confine the choice of markers to black, or nearly black, objects against the horizon sky rather than to light-colored markers and those appearing against terrestrial backgrounds.

2140. SIZE OF VISIBILITY MARKERS. In order that visibility values may be representative, they must apply to objects of specified minimum size or larger. An object that subtends an angle of less than 0.5 degree at the eye becomes invisible at a shorter distance than larger objects under the same conditions. Therefore, objects whose angular size is 0.5 degree or greater should be selected as visibility markers whenever possible. A hole 0.3 inch (or $\frac{5}{16}''$) in diameter punched in a card that is held at arm's length subtends an angle of approximately 0.5° at the eye. If the portion of any object above the horizon completely fills the hole when the card is held as explained above, the object is of suitable size for a marker.

2150. DAY AND NIGHT VISIBILITY. The change from darkness to daylight, and vice versa, does not as such affect the visibility. Therefore, abrupt changes in visibility values as between night and day should be based on definite changes in atmospheric conditions; e. g., frequently the visibility decreases sharply at dawn, owing to the photochemical effect of sunlight on smoke.

2160. ESTIMATIONS OF VISIBILITY. In estimating the visibility when the farthest object is at a comparatively short distance, note the sharpness with which the object stands out. Sharp outlines in relief, with little or no blurring of color, indicate that the visibility is much greater than the distance of the reference object. On the other hand, blurred or indistinct objects indicate the presence of haze or other phenomena that has reduced the visibility to not less than the distance of the objects.

2200. VISIBILITY IN A DEFINITE DIRECTION

2210. Visibility in a definite direction is the greatest horizontal distance at which the outlines of visibility markers can be distinguished against the horizon sky under the conditions existing at the time of observation.

2300. PREVAILING VISIBILITY

2310. DEFINITION. Prevailing visibility is the maximum visibility common to sectors comprising ½ or more of the horizon circle. Under nonuniform conditions the sectors may be distributed in any order. Under uniform conditions the prevailing visibility is the same as the visibility in any direction. The term variable visibility describes a condition in which the prevailing visibility rapidly increases and decreases. The average of the extremes is used as the prevailing visibility.

2320. DETERMINATION. To determine prevailing visibility under nonuniform conditions, regard the horizon circle as divided into several sectors of equal size in each of which the visibility is substantially uniform. Select the highest value that is equal to or less than the visibility of sectors that cover at least one-half of the horizon circle. For example, if the horizon circle were divided into 6 sectors and the respective visibility values were 1/16, ⅛, ¼, ½, ¾, and 1 mile, the prevailing visibility would be ½ mile. This is evident from the fact that ½ mile is the highest value equal to or less than the visibility values of ½ or more of the horizon circle. This is illustrated in Figure 2.

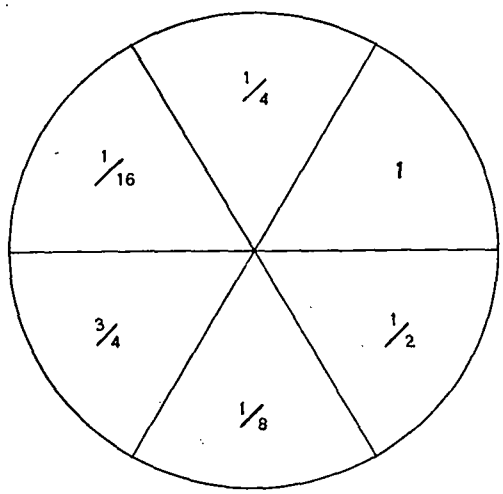

FIGURE 2.—Visibility in sectors of horizon circle.

Atmospheric Phenomena

CHAPTER 3. ATMOSPHERIC PHENOMENA

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CHAPTER 3. ATMOSPHERIC PHENOMENA

3000. GENERAL

3010. Atmospheric phenomena observed as weather elements of an observation comprise tornadoes, waterspouts, thunderstorms, squalls, and precipitation in any form. Hydrometeors other than precipitation, and lithometeors, are termed obstructions to vision. Igneous and luminous meteors, such as lightning, rainbows, halos, coronas, and auroras, are also observed. Observations of these phenomena, except freezing rain and the determination of intensity of precipitation, are taken without the use of instruments. Terms in parentheses indicate equivalents as used in synoptic reports, e. g., Light (Slight).

3100. TORNADOES AND WATERSPOUTS

3110. DESCRIPTION. These storms occur when meteorological conditions are favorable for intense thunderstorm activity. The distinguishing feature is the funnel-shaped appendage that hangs from the base of the cloud. The storm is described as a tornado when it occurs over land and as a waterspout when it occurs over water.

3120. OBSERVATION. Note the direction from the station, and the direction toward which it is going. The direction of motion is the same as that of the cloud with which the phenomenon is associated; however, it should be remembered that the direction of motion of a cloud is observed as the direction from which the cloud is moving. Intensity values are not ascribed to tornadoes or waterspouts. See Table 29, Item 16, for public reports of tornadoes.

3200. THUNDERSTORMS

3210. DEFINITION. A thunderstorm is regarded as occurring at the station when thunder is heard.

3220. OBSERVATION. Note the following:

(1) Occurrence of thunder.
(2) Location of storm center with respect to the station.
(3) Direction toward which the storm is moving, when this can be determined with reasonable accuracy.
(4) Whether lightning is occurring from cloud to cloud, cloud to ground, or within clouds.
(5) Intensity of the storm.

3230. DETERMINATION OF INTENSITY. Classification of a thunderstorm as light (slight),[1] moderate or heavy is based upon the appearance of the storm from the point of observation. The thunderstorm may be classified as light throughout its history as viewed from this point, or it may be classified during its passage by the station as light, moderate, heavy; and, as it recedes, moderate, and light. Description of intensity will be based on the following general guides:

3231. LIGHT (SLIGHT) THUNDERSTORM. Lightning occurs within the cloud and rainfall accompanying it is light or moderate. Small hail may also be observed. The thunder is not loud, and lightning occurs at intervals of a minute or more. The surface wind speed at the beginning of or during the storm does not exceed 30 miles and hour (26 knots), and any sudden increase in speed is of short duration. The classification also applies to occasional peals of thunder during a general rain storm.

[1] The classification "light (slight)" is used only in synoptic observations.

3232. MODERATE THUNDERSTORM. Loud peals of thunder occur at brief intervals and frequent flashes of lightning occur from cloud to ground, as well as from cloud to cloud; rain is moderate or heavy, and small hail is light or moderate. An onrush of wind may precede the storm, with a speed as high as 40 miles an hour (35 knots). Extensive masses of dark clouds showing visible indications of turbulent motion and rapid horizontal translation are usually observable.

3233. HEAVY THUNDERSTORM. Sharp and pronounced thunder and lightning occur almost continuously. Heavy rain occurs, sometimes accompanied by hail. The wind preceding and accompanying the storm may reach a speed in excess of 40 miles an hour. A rapid drop in temperature occurs, sometimes as much as 20° F. in 5 minutes.

3300. SQUALLS

3310. A squall is a strong wind that increases suddenly in speed, maintains a peak speed over a period of minutes, and decreases in speed; similar fluctuations will occur at succeeding intervals. The occurrence of squalls is indicative of turbulence near the surface. Although squalls are classified as an atmospheric phenomenon, instructions for observing them will be found in paragraph 8320, because their observational criteria are exclusively wind.

3400. HYDROMETEORS—PRECIPITATION

3410. GENERAL. The term hydrometeors includes all atmospheric phenomena composed of liquid or solid forms of water. Clouds are not described here since they are considered separately in Chapter 1. The term precipitation includes all forms of moisture that fall to the earth's surface—rain, snow, hail, etc. Dew, frost, and rime, although classified as precipitation, are discussed in this chapter as miscellaneous hydrometeors.

3420. CHARACTER OF PRECIPITATION. Determine character of precipitation in accordance with the following criteria:

3421. CONTINUOUS. Intensity increases or decreases gradually.

3422. INTERMITTENT. Intensity increases or decreases gradually and precipitation stops and recommences at least once within 1 hour preceding the time of observation.

3423. SHOWERY. Precipitation associated with cumuliform clouds, especially swelling cumulus and cumulonimbus. Intensity varies rapidly. Showers begin and end abruptly.

3424. COMBINATIONS. Showers and continuous or intermittent rain may occur in combination, when the precipitation does not always cease between showers. Under these conditions, showery precipitation is marked by a sudden increase and decrease in intensity as the showers abruptly begin and end.

3430. INTENSITY OF PRECIPITATION. Intensities of precipitation are determined by one of two methods:

(1) Rate of accumulation (vertical depth of water per unit time, or depth on ground in solid form per unit time).
(2) Degree to which the precipitation affects visibility.

3431. Intensities of all forms of precipitation except snow are determined by (1) above. Intensities of all forms of snow, when they occur alone, are determined by (2) above. When any form of snow occurs in combination with one or more hydrometeors or lithometeors, the intensity of the precipitation will be on the basis of the rate of accumulation (1) above.

3432. The rate of accumulation, measured by the vertical depth of water, can be accurately and quickly determined with a recording rain gage at stations equipped with one. Criteria for intensities will be found in Table 5.

TABLE 5.—*Criteria for determining intensity of rain*

Light (Slight)	Trace to 0.10 inch per hour; maximum 0.01 inch in 6 minutes.
Moderate	0.11 inch to 0.30 inch per hour; more than 0.01 inch to 0.03 inch in 6 minutes.
Heavy	More than 0.30 inch per hour; more than 0.03 inch in 6 minutes.

3433. For approximate determination of the rate of accumulation for liquid forms, the guides indicated in Table 6 will be used.

TABLE 6.—*Guides for approximating intensity of rain*

Light (Slight)	Individual drops are easily identifiable; spray observable over pavements, roofs, etc., is slight; puddles form very slowly; over two minutes may be required to wet pavements and similarly dry surfaces; sound on roofs ranges from slow pattering to gentle swishing; steady small streams may flow in gutters and downspouts.
Moderate	Individual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces, puddles form rapidly; downspouts on buildings run ¼ to ½ full; sound on roofs ranges from swishing to gentle roar.
Heavy	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observable over hard surfaces; downspouts run more than ½ full; visibility is greatly reduced; sound on roofs resembles roll of drums or distinct roar.

3434. Determine the rate of accumulation of sleet and all forms of hail by estimating the accumulating amount on the ground. This applies also to forms of snow when occurring in combination with hydrometeors and lithometeors. Drizzle will be estimated in accordance with the intensities indicated in Table 7.

TABLE 7.—*Intensity of drizzle on rate-of-fall basis*

Light (Slight)	Trace to 0.01 inch per hour.
Moderate	More than 0.01 inch to 0.02 inch per hour.
Heavy	More than 0.02 inch per hour.

NOTE.—When precipitation equals or exceeds 0.04 inch per hour, there is a strong presumption that the precipitation is rain.

3435. The intensity to be ascribed to snow occurring alone will be determined from Table 8.

TABLE 8.—*Intensity of snow with visibility as criteria*

Light (Slight)	Visibility 1,100 yards or more.
Moderate	Visibility less than 1,100 yards but not less than 550 yards.
Heavy	Visibility less than 550 yards.

3440. TYPES OF PRECIPITATION. For purposes of these instructions, precipitation is divided into liquid, freezing, and frozen types. These types are discussed in paragraphs 3441 to 3443.7. A combination of types or of forms of one type will be individually observed and reported regardless of existing meteorological conditions that might appear to be inconsistent with them.

3441. LIQUID PRECIPITATION. Liquid precipitation is classified as rain or drizzle in accordance with the criteria below.

3441.1 RAIN. The falling from clouds of drops of water (in the liquid state) in which most drops are larger—or if not larger, sparser—than the drops in drizzle. Rain, as used in this manual, excludes drizzle and freezing rain.

3441.2. DRIZZLE. Very small and uniformly dispersed droplets that appear to float in the air and to follow very slight air currents. Drizzle usually falls from low stratus clouds and is frequently accompanied by low visibility and fog.

3442. FREEZING PRECIPITATION. Freezing precipitation is classified as freezing rain or freezing drizzle, in accordance with criteria below.

3442.1 FREEZING RAIN. Rain that falls in liquid form but freezes to the exposed surface of the ground, or to unheated objects on the ground. If the fall is so rapid that run-off occurs, the formation of ice will usually appear as glaze.

3442.2 FREEZING DRIZZLE. Drizzle that freezes similarly to rain (see paragraph 3442.1) is classified as freezing drizzle.

3443. FROZEN PRECIPITATION. Solid precipitation is classified in accordance with the criteria in paragraphs 3443.1 to 3443.7.

3443.1. SLEET (ICE PELLETS). Transparent, more or less globular, hard grains of ice about the size of raindrops, that rebound when striking hard surfaces. Its fall may be continuous, intermittent, or showery.

3443.2. HAIL. Ice balls or stones, ranging in diameter from that of medium-size raindrops to an inch or more. They may fall detached or frozen together into irregular, lumpy masses. They are composed either of clear ice or of alternating clear and opaque snowflake layers. Hail often accompanies thunderstorm activity. Surface temperatures are usually above freezing when hail occurs. Determination of size will be based on the diameter, in inches, of normally shaped hailstones.

3443.3 SMALL HAIL. Semitransparent, round or conical, grains of frozen water. Each grain generally consists of a smaller grain of soft hail as a nucleus, surrounded by a very thin ice layer, which gives it a glazed appearance. The grains are wet when they fall at temperatures above freezing. They are not crisp or easily compressible, and do not generally rebound or burst even when they strike hard ground.

3443.4. SNOW. White or translucent ice crystals chiefly in complex branched hexagonal form (six-pointed "stars"), often mixed with simple crystals. It occurs under meteorological conditions similar, with the exception of the accompanying temperatures, to those with which corresponding forms of rain are associated.

3443.5. SNOW PELLETS (SOFT HAIL). White, opaque, round or occasionally conical, kernels of snow-like consistency, 1/16 to 1/4 inch in diameter. They are crisp and easily compressible, and may rebound or burst when striking hard surfaces. They occur almost exclusively in showers.

3443.6. SNOW GRAINS (GRANULAR SNOW). The solid equivalent of drizzle. They take the form of minute, branched, star-like snowflakes, or of very fine simple crystals. At times they have the appearance of rime. They occur under meteorological conditions similar to those of drizzle, except that the termperature is lower.

3443.7. ICE CRYSTALS. Small, unbranched crystals in the form of rods or plates that have a descending motion and that may be observed when the sky is clear. Ice crystals are associated with halo phenomena and with temperatures near or below 0° F.

3500. HYDROMETEORS—MISCELLANEOUS

3501. FOG. Minute droplets suspended in the atmosphere. These droplets have no visible downward motion. Fog differs from clouds in that the base of fog is at the surface and the base of clouds is above the surface. It is easily distinguished from haze by its dampness and grey color. It is unusual for fog to form when the difference between the air temperature and the temperature of the dew point is greater than 4.0° F.

3502. GROUND FOG. Same as fog except that the top is not contiguous with the base of clouds that may be above it and obscures less than 0.6 of the sky, i. e., the sky condition above an angle of 36° (see Table 2, Chapter 1) is observable.

3503. SHALLOW FOG. Low-lying fog that does not obstruct horizontal visibility at a level 6 feet or more above the surface.

3504. ICE FOG. Suspended particles in the form of ice crystals. It occurs at low temperatures, and usually in clear, calm weather in high latitudes. The sun is usually visible, and may cause halo phenomena.

3505. DEW. Liquid water that condenses upon objects at or near the surface of the earth at temperatures above freezing. Condensation results when a shallow layer of air immediately above these objects is cooled by conduction until the dew point of the air is reached. Dew occurs on calm, clear nights.

3506. FROST AND FREEZE. Frost and freeze are defined as follows.

3506.1. FROST (HOARFROST). Thin ice crystals in the form of scales, needles, feathers, or fans, deposited under conditions similar to dew, except that temperatures of the surfaces on which frost forms are 32° F. or lower. Air temperatures several degrees above freezing may occur a few feet above the surface upon which frost appears. Determine the intensity in accordance with paragraphs 3506.11 and 3506.12.

3506.11. LIGHT. Surface objects, vegetation, etc., covered with a thin deposit of frost which may be more or less patchy.

3506.12. HEAVY. Surface objects, vegetation, etc., covered with a copious deposit of frost.

3506.2. FREEZE. The condition of the lower atmosphere when the temperature of surface objects is 32° F. or lower. Air temperatures several degrees above the freezing point may occur a few feet above the region where a freeze occurs. A freeze may or may not be accompanied by an actual deposit of frost. When vegetation is injured by relatively low temperature without the occurrence of frost, the condition is termed a freeze. Classification follows.

3506.21. LIGHT. A freezing condition having little destructive effect on vegetation except on tender plants and vines, often accompanied by temperatures of 32° F. or higher at the 5′ observation level.

3506.22. KILLING. A freezing condition capable of having widely destructive effects on staple vegetation usually accompanied by temperatures below 32° F. at the 5′ observation level.

3506.23. HARD. A freezing condition capable of completely destructive effects on staple vegetation which freezes the ground surface solid under foot and causes heavy ice formation on small water surfaces such as puddles and water containers.

3507. RIME. Rime is classified as soft or hard.

3507.1. Soft rime consists of white layers of ice crystals deposited chiefly on vertical surfaces—especially on points and edges of objects—generally in supercooled fog or light fog. On the windward side soft rime may grow to very thick layers, or long feathery cones, or needles pointing into the wind and having a structure similar to that of frost.

3507.2. Hard rime is opaque, granular masses of ice deposited chiefly on vertical surfaces in wet fog at temperatures below 32° F. It is more compact and amorphous than soft rime, and may build out into the wind as glazed cones or feathers.

3508. DRIFTING SNOW. Snow raised from the surface by the wind to a height less than 6 feet above the surface. Drifting snow is not regarded as an obstruction to vision (see Table 29, Item 20 (d)) since it does not restrict visibility at 6 feet or more above the surface. When snow is raised 6 feet or more above the surface, it is classified as blowing snow.

3509. BLOWING SNOW. Snow lifted from the surface by wind to a height 6 feet or more above the surface and blown about in such quantities that the horizontal visibility is restricted at and above that height.

3510. GLAZE. Glaze is composed of homogeneous, transparent ice layers that are built up on exposed surfaces either by supercooled rain or drizzle, or by rain or drizzle that freezes upon contact with surfaces whose temperature is 32° F. or lower. The use of ice-accretion indicators, at stations equipped with them, is required in determining whether or not rain or drizzle is freezing at the time of observation.

3600. LITHOMETEORS

3610. GENERAL. Lithometeors comprise a class of atmospheric phenomena, among which dry haze and smoke are the most common examples. In contrast to a hydrometeor, which consists largely of water, a lithometeor is composed of solid dust or sand particles, or the ashy products of combustion.

3620. HAZE. Dust or salt particles so small that they cannot be felt, or individually seen by the unaided eye; however, they reduce visibility and lend a characteristic opalescent appearance to the air. Haze resembles a uniform veil over the landscape that subdues its colors. This veil has a bluish tinge when viewed against a dark background, such as a mountain; but it has a dirty yellow or orange tinge against a bright background, such as the sun, clouds at the horizon, or snow-capped mountain peaks. When the sun is well up, its light may have a peculiar silvery tinge owing to haze. These color effects distinguish haze from light fog, whose thickness it may sometimes attain. NOTE:—Irregular differences in air temperature may cause a shimmering veil over the landscape; this is called "optical haze."

3630. SMOKE. An ashy product of combustion consisting of fine particles suspended in the atmosphere. When smoke is present the disk of the sun at sunrise and sunset appears very red and during the daytime has a reddish tinge. Smoke at a distance, such as from forest fires, usually has a light grayish or bluish color and is evenly distributed in the upper air.

3640. DUST. Finely divided earthy matter, uniformly distributed in the air. It imparts a tannish or grayish hue to distant objects. The sun's disk is pale and colorless or has a yellow tinge at all periods of the day.

3650. DUST DEVIL. Small, vigorous whirlwind, usually of short duration, made visible by dust picked up from the surface.

3660. BLOWING DUST. Dust picked up locally from the surface by the wind and blown about in clouds or sheets. Blowing dust may completely obscure the sky.

3670. DUSTSTORM. Blowing dust that reduces the visibility to less than 1,100 yards, but not less than 550 yards.

3671. HEAVY (SEVERE) DUSTSTORM. Blowing dust that reduces the visibility to less than 550 yards.

3680. BLOWING SAND. Sand picked up from the surface by the wind and blown about in clouds or sheets.

3690. SANDSTORM. Sand blown through the air by a very strong wind or gale. Visibility is reduced to less than 1,100 yards but not less than 550 yards. The sand particles are not carried to appreciable distances from their source.

3691. HEAVY (SEVERE) SANDSTORM. Blowing sand that reduces visibility to less than 550 yards.

3700. IGNEOUS METEORS

3710. LIGHTNING. A visible electrical discharge occurring in the atmosphere. Lightning is the only common igneous meteor of importance in meteorology. It occurs as a discharge within a cloud; from cloud to cloud; or from cloud to ground. Distant lightning is any lightning that occurs so far from the observer that the resulting thunder cannot be heard. It may be observed as streaks or sheets.

3800. LUMINOUS METEORS

3810. GENERAL. Optical phenomena, with the exception of aurora, are caused by reflection, refraction, or diffraction of the light from the sun or moon as it passes through clouds or other hydrometeors.

3820. HALO, SOLAR OR LUNAR. A luminous ring, commonly of 22° radius around the sun or moon. It usually appears whitish, but it may show the spectral colors with the red on the inside. The sky is darker inside the ring than outside. Halos are formed by refraction of the light as it passes through ice crystals. NOTE.—This description applies only to the 22° halo. Other phenomena are the 46° ring, parhelia, tangent arc, etc.

3830. CORONA, SOLAR OR LUNAR. A luminous ring surrounding the sun or moon and formed by diffraction of light by water droplets. It may vary greatly in size, but is usually smaller than a halo. All the spectral colors may be visible, with the red on the outside, but frequently the inner colors are not visible. Sometimes the spectral colors or portions of them are repeated several times and are somewhat irregularly distributed; this is called iridescence.

3840. RAINBOW. A semicircular arc seen opposite the sun, usually exhibiting all the primary colors, with red on the outside. It is caused by diffraction, refraction and reflection of light within rain drops, which often produces a secondary bow outside the primary one. In this case the colors are reversed.

3850. FOG BOW. A whitish, semicircular arc, seen opposite the sun in fog. Its outer margin has a reddish and its inner a bluish tinge. The middle of the band is white. An additional bow, with the colors reversed, sometimes appears inside the first.

3860. AURORA. A luminescence, frequently called Northern Lights. It is usually seen in the northern skies in lower latitudes, and overhead, or even to the southward of the zenith, in higher latitudes. It may appear in such forms as arcs, rays, curtains, coronas, etc. It is usually of a whitish color but may have various other colors. The lower edges of the arcs and curtains of the aurora are usually fairly well defined, while the upper edges are ill-defined.

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CHAPTER 4. MEASUREMENT OF PRECIPITATION

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CHAPTER 4. MEASUREMENT OF PRECIPITATION

4000. METHOD OF DETERMINING VERTICAL DEPTH OF WATER AND WATER EQUIVALENT

4010. GENERAL. Measurements of all forms of precipitation are expressed in terms of vertical depth of water (or water equivalent, in the case of solid forms) accumulated within a specified time on a horizontal surface. It is assumed that no loss from evaporation occurs. Solid forms of precipitation are also measured on the basis of actual depth of accumulations.

4020. UNIT OF MEASUREMENT. The inch is the unit of measurement of precipitation. The vertical depth of water or water equivalent is expressed to the nearest 0.01 inch; 0.005 inch or less is called a trace. The actual depth of solid forms is expressed to the nearest 0.1 inch, and 0.05 inch or less is called a trace.

4030. TYPES OF GAGES. Precipitation measurements are made from samples caught in gages, or from samples taken from representative areas when the catch of solid forms in the gage is not representative. When more than one type of gage is in use, the official measurement will be taken from the gage appearing highest on the following list:

(1) Shielded gage of any type.
(2) Stick measurement of tipping-bucket gage.
(3) 8-inch gage.
(4) 4-inch gage.
(5) Weighing gage.

All other measurements will be corrected to agree with the official measurement.

4040. MEASUREMENT OF RAIN. If a tipping-bucket gage is used, drain the catch into the measuring tube. If an 8-inch gage is used, it is not necessary to remove the tube to make a measurement. Insert a dry measuring stick into the measuring tube. Permit the stick to rest on the bottom of the tube for two or three seconds. Withdraw the stick and read the depth of precipitation at the upper limit of the wet portion of the stick. Precipitation collected in the 4-inch gage is measured by lining up the top of the catch with the measuring scale on the transparent wall of the receiver.

4041. If the measuring tube of the 8-inch gage is full (this equals two inches of precipitation), carefully remove it from the overflow container and empty it. Pour the overflow into the measuring tube, measure it, and add the value to the two inches emptied from the tube. If in removing the full measuring tube some water is spilled into the overflow container, measure the amount remaining in the tube before measuring the amount of the overflow. The total precipitation is the sum of the individual measurements. When measurement is completed, empty the measuring tube and reassemble the gage.

4050. MEASUREMENT OF SNOW, SLEET, HAIL, FREEZING RAIN. Pour a measured quantity of warm water into the overflow container of the 8-inch gage to melt the collected snow or ice. Pour the entire contents into the measuring tube. Measure the water as outlined in paragraph 4040. To obtain the water equivalent of the precipitation, subtract the amount of water used to melt the solid forms from the total measurement.

4051. When moderate or strong winds occur during a snowfall, the amount of snow collected in the overflow container will not be representative of the actual snowfall, and the catch should be discarded. To obtain a representative amount invert the overflow container of the 8-inch rain gage and use it to cut a cylindrical sample from the snow to be measured at a location where the fall seems least affected by drifting. Melt the sample and measure it in accordance with instructions in paragraph 4050. If the snow is deeper than the inside vertical height of the container, any cylinder with an 8-inch diameter may be used.

4052. When the procedure described in paragraph 4051 is used, the snow sample must not include snow resulting from a previous storm. When the ground has once been covered with snow, greater accuracy in taking future snow samples will be secured if pieces of thin wood or its equivalent at least 2 feet square are placed on top of the first fall at various locations, all of which are not likely to be subject to drifting from a single storm. An observation for the next succeeding storm could then be based on a sample taken from the top of the snow to the wooden square, after which the square would be moved to the top of the snow to serve as a reference point for future observation. When taking a sample, estimate the depth of snow as a check on the vertical thickness of the sample, to insure that a hard crust is not mistaken for the ground or for the reference board.

4053. When an observation is taken of the water equivalent of snow on the ground, the sample of snow will be secured in the same manner as that described in paragraph 4051 except that the sample will extend from the top of the snow to the ground.

4100. ESTIMATION OF WATER EQUIVALENT OF SNOW

4110. When the water equivalent of snow cannot be accurately measured by melting, use one-tenth of the average snow depth as the water equivalent. For example, 10 inches of snow correspond to 1 inch of melted snow.

4200. DEPTH MEASUREMENT OF SOLID FORMS

4210. GENERAL. For purposes of depth measurements, the term snow also includes sleet, glaze, hail, any combination of these, and sheet ice formed directly or indirectly from precipitation. Therefore, if snow falls, melts, and refreezes, the depth of ice formed will be included in depth measurements of snow.

4220. MEASUREMENT OF TOTAL DEPTH. Measurement of total depth will be made in accordance with the following instructions:

4221. UNDRIFTED SNOW. Thrust the measuring stick vertically into the snow so that the end rests on the ground surface. Read the depth to the nearest 0.1 inch. Repeat at several spots and take the average of the readings as the snow depth. If the ground is covered with ice, cut through the ice with some suitable implement, and measure the thickness. Add the thickness of the ice to the depth of snow above the ice.

4222. DRIFTED SNOW. When the snow is drifted, a reasonably accurate depth measurement may be made by taking the average of several measurements over representative areas. These should include the greatest and least depths. For example, if spots with no snow are visible, one of the values should be zero.

4230. SNOWFALL WITHIN SPECIFIED PERIODS. These measurements are most conveniently made on a surface that has been cleared of previous snowfall. If such a spot is not available, measure the total depth of snow and subtract the depth previously measured. If the previous snowfall has crusted, the new fall may be measured by permitting the end of the measuring stick to rest on the crust. If different falls of snow are mixed by drifting, measure the total depth of snow and subtract the previously measured depth. The remainder is the approximate depth of the new fall, which will be adjusted if necessary to correct for evaporation and run-off.

Temperature

CHAPTER 5. TEMPERATURE

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CHAPTER 5. TEMPERATURE

5000. GENERAL

5010. SCALE: With certain specified exceptions, Fahrenheit thermometers are used to measure temperature. It will therefore be assumed, lacking a statement to the contrary, that temperatures as used in these instructions refer to the Fahrenheit scale.

5020. TYPES OF THERMOMETERS. The Fahrenheit thermometers in general use include the following nonrecording and recording types:

5020.1. Nonrecording mercurial or spirit-filled thermometers.
(1) Dry-bulb (exposed).
(2) Wet-bulb (with muslin-covered bulb).
(3) Psychrometer (dry- and wet-bulb mounted on a common back).
(4) Maximum.
(5) Minimum.

5020.2. Nonrecording electrical resistance thermometers.
(1) Telethermoscope.

5020.3. Recording thermometers.
(1) Thermograph (including hygro-thermograph).
(2) Telepsychrometer.

5100. TEMPERATURE READINGS FROM NONRECORDING THERMOMETERS

5110. READING THE THERMOMETER. Determine the temperatures indicated by any mercurial or spirit thermometer as follows:
(1) Stand as far from the thermometer as is consistent with accurate reading, to prevent body heat from affecting the instrument.
(2) Insure that the line of sight from the eye to the top of the liquid column makes an angle of 90° with the thermometer tube. This will avoid an error of parallax.
(3) Read the thermometer to the nearest 0.1°. A degree interval begins at the middle of the degree markings etched on the tube.

5120. DRY-BULB TEMPERATURE. The dry-bulb temperature is the temperature of the free air taken at a specified location under conditions designed to eliminate as completely as possible the effects of extraneous sources of heat and the effects of radiation on the measuring apparatus.

5120.1. With driving rain or snow, the dry-bulb thermometer may become wet. When this occurs, dry the bulb and shield it from the precipitation for a few seconds, or longer if necessary, to permit dissipation of extraneous heat before reading it again. Use this reading for psychrometric purposes rather than the reading made when lowest wet-bulb reading was taken.

5130. WET-BULB TEMPERATURE. The wet-bulb temperature is the lowest temperature to be secured by evaporating water from the muslin-covered bulb of a thermometer at a specified rate of ventilation. It differs from the dry-bulb temperature in an amount dependent on the temperature and relative humidity of the air. At temperatures below −35° F. the wet-bulb thermometer will not be read.

5131. MOISTENING THE WET-BULB. The procedure used in moistening the wet-bulb varies according as the temperature is above or below freezing and as the relative humidity is high or low.

5131.1. Moisten the wet-bulb just prior to ventilating the psychrometer. If, however, the temperature is high and the relative humidity is low, or it is expected that the final temperature of the wet-bulb will be 32° or less, moisten the wet-bulb thoroughly several minutes before taking a reading so that a drop of water will have formed on the end of the bulb. This will reduce the temperature of the wet-bulb without prolonged ventilation and the consequent danger of the muslin's drying out before the temperature of the wet-bulb will have reached its lowest point.

5131.2. In areas where the temperature is high and the humidity low, it may be necessary to use pre-cooled water for moistening the wet-bulb to avert premature drying of the muslin. Water can be precooled for this purpose by storing it in a porous jug in the shelter. Sufficient water will seep through the jug to cool it by evaporation. If this method should not be effective, the muslin may be extended from the wet-bulb to an open container of water. Between observations, the end of the muslin should remain immersed in the water. Continuous evaporation will maintain the thermometer close to the wet-bulb temperature. When the psychrometer is ventilated, the muslin must be removed from the water until the wet-bulb thermometer has been read. Regardless of the method used, the psychrometer must always be ventilated in accordance with paragraph 5150 before determining the wet-bulb temperature.

5131.3. At temperatures of 37° F. or below, use water that has been kept at room temperature in order to melt completely any accumulation of ice on the wet-bulb. Moisten the bulb thoroughly 10 to 15 minutes before ventilating the psychrometer. This time interval will permit the latent heat, released if the water freezes, to be dissipated before ventilation is begun. Do not allow excess water to remain on the wet-bulb, since a thin, thoroughly cooled coating is necessary for accurate data.

5140. CORRECTIONS. Instrumental calibration corrections are listed on a correction card. When supplied with each thermometer, corrections will be applied to all thermometer readings under conditions (1) and (2). An additional correction factor will be applied to all wet-bulb thermometer readings under condition (3).

(1) Whenever the temperature indicated by the thermometer is above 42° F., and the instrumental correction is ±0.3° F. or more in the case of mercurial thermometers, or ±0.5° F. or more in the case of spirit-filled thermometers.
(2) Whenever the temperature indicated by the thermometer is 42° F. or less.
(3) Whenever the wet-bulb thermometer has an indicated reading higher than that of the dry-bulb thermometer. If the reading of the wet-bulb thermometer, after the correction has been applied, remains higher than the dry-bulb reading, disregard it and use the dry-bulb value for both temperatures.

5141. Corrections are furnished for intervals not greater than 20°. Add the appropriate correction algebraically to the reading of the thermometer.

EXAMPLES:	°F.
Reading of the thermometer	62.1
Correction to be applied	−0.5
Corrected reading	61.6
Reading of the thermometer	−8.2
Correction to be applied	−1.2
Corrected reading	−9.4
Reading of the thermometer	+0.4
Correction to be applied	−1.2
Corrected reading	−0.8

5142. For an observed reading between the temperatures for which corrections are given, an interpolated value of the correction will be used whenever necessary. Tables for the purpose may be prepared locally.

5150. PSYCHROMETER. Psychrometers are designed to secure ventilation by means of a fan, a whirling apparatus, or a sling apparatus. The psychrometer should be so ventilated that the minimum speed of air passing over the thermometer bulbs is at least 15 feet per second. This

INTRODUCTION

It will be helpful in using this manual to keep in mind that the material in it has been organized under (1) taking observations, and (2) recording and reporting observations. The first portion of the manual comprises chapters 1 to 9, and describes standard procedures for evaluating the elements of surface observations. The second portion comprises chapters 10 and 11, and describes standard procedures for entries on forms and coding for transmission.

It follows from the nature of this organization that each observational element will be treated twice in the manual: first, from the point of view of observing and evaluating the element without reference to its ultimate use; and second, from the point of view of making a permanent record of it and preparing it for dissemination. To find instructions applicable to a given topic, it is necessary to determine whether the problem is one of observations, which would be found in the first portion of the manual, or of coding, etc., which would be found in the second portion.

To facilitate use of the manual, a complete index has been included, which should be consulted whenever there is any doubt as to whether material sought is in the first or second portion. Items are listed in the index from the general to the particular, e.g., reporting visibility by quadrants would be listed as "Visibility, reporting by quadrants." In some cases, where a given topic might equally well be given two listings, cross listings have been included.

Taking observations is the primary duty of the observer. Nothing except the most pressing demands upon the observer's attention should be given precedence to this fundamental duty. Since life, property, and the convenience of travelers, as well as accurate forecasts, may depend upon his observations, the observer should make every effort to take the observations as accurately and completely as possible, and to file them in sufficient time for scheduled transmission. Every observation must be accurate in all its parts, and it must convey a complete picture of the meteorological situation existing at the station.

Observations of clouds, visibility, and atmospheric phenomena will be taken from as many points at the station as are necessary to view the entire horizon.

* When computations require the disposal of decimals, the following procedure will be observed:

(1) If the decimal to be disposed of is five or greater, the preceding digit will be increased by one.

(2) If the decimal to be disposed of is less than five, the preceding digit will remain unchanged.

Algebraic signs will be disregarded - e.g., 1.5 = 2; -1.5 = -2.

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FOREWORD

This manual was prepared by Weather Bureau personnel, with the collaboration of representatives of the Air Force and Navy, to secure uniformity in taking and recording surface observations.

The manual is supplemented by an addendum issued separately by the Weather Bureau, Air Force, and Navy. The instructions in the manual will be followed by all personnel taking surface observations; the instructions in the addendum will be followed only by personnel of the organization issuing the addendum. Amendments to this manual will be issued as revised pages for insertion in the manual in accordance with instructions accompanying them. Station copies of the manual will be corrected promptly upon receipt of each amendment. The effective date and number of each amendment and the pages or paragraphs affected will be entered on the page entitled "Record of Changes." The entries will be initialed by personnel who make them.

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INTRODUCTION

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Observations of clouds, visibility, and atmospheric phenomena will be taken from as many points at the station as are necessary to view the entire horizon.

When computations require the disposal of decimals, the following procedure will be observed:

(1) If the decimal to be disposed of is greater than 5, or is 5 with a remainder, the preceding digit will be increased by 1.

(2) If the decimal to be disposed of is 5 exactly, the preceding digit will be increased by 1 when odd, and will remain unchanged when even; the result will always be an even number.

(3) If the decimal to be disposed of is less than 5, the preceding digit will remain unchanged.

CHAPTER 1. CLOUDS AND OBSCURING PHENOMENA

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CHAPTER 1. CLOUDS AND OBSCURING PHENOMENA

1000. GENERAL

1010. Code numbers for cloud forms and states of the sky are described in detail in Weather Bureau Circular S and the International Cloud Atlas. Instructions in this chapter are confined to those necessary for observing clouds and obscuring phenomena with respect to their amount, stratification, direction of movement, height of bases, and the effect of obscuring phenomena on vertical visibility.

1100. DETERMINATION OF SKY COVER

1110. DEFINITION OF SKY COVER. Sky cover is a term used to denote one of the following conditions:

(1) Amount of sky covered by clouds,
(2) Amount of sky rendered unobservable by the presence of obscuring phenomena, or
(3) A combination of (1) and (2).

The tenths of sky cover plus the tenths of sky visible will always equal 1.0 (10/10). All sky cover observations may be taken without the use of instruments, although at night it will frequently be necessary to observe the clouds and obscuring phenomena passing through the beam from a ceiling light or ceilometer projector over a period of several minutes in order to obtain a more nearly representative picture of the amount and extent of layers of clouds and obscuring phenomena. Determine the amount of sky cover in accordance with paragraphs 1120 through 1123.

1120. WITH ADVANCING CLOUD LAYER. To estimate the amount of cloudiness in an advancing (or receding) cloud layer, determine the angular elevation above the horizon of the forward or rear edge of the layer as seen against the sky. This may be done with a theodolite or clinometer until experience is gained in estimating vertical angles. Convert the angle to tenths of sky cover by use of Table 1.

1120.1. When the cloud layer does not extend to the horizon, determine the angular elevation of the forward and rear edges and the tenths of sky cover corresponding to each elevation. The difference would be the required sky cover. For example: Forward edge 78°=0.4 sky cover. Rear edge 53°=0.2 sky cover. Total sky cover is the difference between the two, or 0.2 sky cover.

TABLE 1.—*Sky cover with advancing or receding cloud layers*

Angles subtended by sky cover	Tenths of sky cover	Angles subtended by sky cover	Tenths of sky cover
Less than 37°	0.0	102°—113°	0.6
37°—52°	0.1	114°—126°	0.7
53°—65°	0.2	127°—143°	0.8
66°—77°	0.3	144°—179°	0.9
78°—89°	0.4	180°	1.0
90°—101°	0.5		

1121. WITH CONTINUOUS LAYER SURROUNDING STATION. To estimate the amount of cloudiness present when a continuous layer of clouds surrounds the station and extends to the horizon, determine the angular elevation of cloud edges, and convert to tenths of sky cover by use of Table 2.

TABLE 2.—*Sky cover with cloud layer surrounding station*

Angular elevation	Tenths of sky cover	Angular elevation	Tenths of sky cover
Less than 6°	0. 0	37°—43°	0. 6
6°—11°	0. 1	44°—52°	0. 7
12°—16°	0. 2	53°—63°	0. 8
17°—23°	0. 3	64°—89°	0. 9
24°—29°	0. 4	90°	1. 0
30°—36°	0. 5		

1122. WITH UNEVEN DISTRIBUTION. When the clouds are unevenly distributed over the sky, imagine the sky to be divided into quarters and then estimate the amount covered by the clouds in each quarter. The sum of the estimated amounts will be the total sky cover.

1123. WITH OBSCURING PHENOMENA. Whenever the sky cover cannot be evaluated in terms of cloud cover, because of the presence of fog, lithometeors, or precipitation, determine the amount of sky rendered unobservable by these phenomena similarly to cloud cover. (See pars. 1120–1122.)

1200. DETERMINATION OF STRATIFICATION

1210. DEFINITION OF LAYER. When clouds or obscuring phenomena whose bases are at approximately the same level cover at least 0.1 of the sky, they are regarded as a layer. The layer may be continuous or composed of detached elements. The use of the term layer does not imply that a clear space exists between the layers or that the clouds or obscuring phenomena composing them are of the same type. (See par. 1230.) Clouds are termed thin if the outline of the sun, moon, or stars is visible through them. Clouds unusually dark or threatening in appearance are termed dark. Obscuring phenomena, thin enough to reveal the sky, clouds or other obscuring phenomena directly above the observer, or phenomena, not overhead but thin enough to reveal the sky through them, are termed thin.

1220. EVALUATION OF MULTIPLE LAYERS. Frequent observation is necessary to evaluate stratification. A series of observations will often show the existence of upper layers above a lower layer. Through thin lower layers it may be possible to observe higher layers. Differences in the directions of cloud movements are often a valuable aid in observing and differentiating cloud stratification, particularly when haze, smoke, etc., render depth perception difficult.

1230. INTERCONNECTION OF LAYERS. Cumulo-type clouds developing below other clouds may reach or penetrate them. Also, by horizontal extension, swelling cumulus or cumulonimbus may form stratocumulus, altocumulus, or dense cirrus.

1300. DETERMINATION OF DIRECTION

1310. CLOUD DIRECTION. Cloud direction is the direction from which the cloud bases are moving. This direction will be determined visually by one of the methods indicated in paragraphs 1310.1–1310.3.

1310.1. Observe the movement of clouds past a structure that forms a right angle in either a horizontal or a vertical plane. When the orientation of the structure is known, the direction is indicated by equal or unequal movement of clouds along both sides of the angle, or by movement of clouds parallel to either side.

1310.2. Sight a distinctive point of the cloud over a projection. Move about to keep this point in the same position with respect to the projection. The direction toward which the observer moves is the cloud direction; that is, the direction from which the cloud is moving.

1310.3. When clouds are moving slowly, their direction can be determined with reasonable accuracy by taking several observations a few minutes apart, and noting the relative positions of the clouds.

1320. DIRECTION OF OBSCURING PHENOMENA. Determine direction of movement of obscuring phenomena aloft similarly to clouds. When the base of the obscuring phenomena is at the surface, the direction will be that of the surface wind.

1400. CEILING AND CLOUD HEIGHT

1410. CEILING DEFINITION. When 0.6 or more of the sky is covered with clouds, obscuring phenomena, or both, the ceiling is defined, and is expressed in numerical terms, as:

(1) The height of the lowest layer of clouds that, in summation with all lower layers of clouds and obscuring phenomena, covers 0.6 or more of the sky.
(2) The vertical visibility into obscuring phenomena not classified as thin that, in summation with all lower layers, cover 0.6 or more of the sky.
(3) The height of clouds visible through obscuring phenomena when the combination covers 0.6 or more of the sky.

The ceiling is termed "unlimited" and is not expressed as a numerical value when the conditions listed above are not satisfied. At all other times, the ceiling is expressed as a numerical value in feet above the surface. (See par. 1412.)

1411. VERTICAL VISIBILITY. Vertical visibility is a ceiling value used when obscuring phenomena make it impossible to express ceiling in terms of cloud height above the surface. (See par. 1441.2.)

1412. SURFACE. "Surface" as used here is a horizontal plane, whose elevation above sea level equals the field elevation. At stations where the field elevation has not been established, "surface" will refer to the ground elevation at the point of observation.

1420. VARIABLE CEILING. The term "variable ceiling" describes a condition in which the ceiling rapidly increases and decreases. The average of all values secured will be used as the ceiling. (See par. 1441.1.)

1430. CEILING CLASSIFICATION. When the ceiling is expressed as a numerical value, it will be classified in accordance with the following:

1431. MEASURED CEILING. A ceiling is classified as measured:

(1) Whenever obtained by means of a ceiling light or ceilometer, provided penetration of the beam is not in excess of that normally experienced for the cloud height.
(2) Whenever a raob balloon is observed to disappear abruptly into a cloud base whose height is computed from the recorder record.
(3) Whenever determined from the known heights of unobscured portions of objects, other than natural landmarks, within 1½ miles of the point of observation.

1432. AIRCRAFT CEILING. A ceiling is classified as an aircraft ceiling when it is determined by a pilot while in flight over, or within 1½ miles of the boundary of, the airport.

1433. BALLOON CEILING. A ceiling is classified as a balloon ceiling when its height is ascertained by means of a ceiling balloon or a pilot balloon, provided that (a) the clouds cover more than 0.9 of the sky in a single layer, and (b) the balloon disappears abruptly into them (i. e., 10 seconds or less elapse from the time of first obscuration to complete disappearance). The height at which obscuration begins will be regarded as the height of the cloud base.

1434. INDEFINITE CEILING. A ceiling is classified as indefinite:

(1) Whenever a ceiling projector or ceilometer beam penetrates the cloud to an extent greater than that normally experienced for the cloud height. The height corresponding to the lower end of the most clearly defined portion of the spot or first maximum reaction of the ceilometer will be regarded as the height of the cloud base.
(2) Whenever a balloon disappears slowly (i. e., more than 10 seconds elapse from the time of first obscuration to complete disappearance) into a tenuous or an irregular overcast comprising one layer only. The height at which obscuration begins will be regarded as the height of the cloud base.
(3) Whenever hydrometeors, other than precipitation, or lithometeors obscure the cloud base and prevent a determination of its height. Under these circumstances, the height corresponding to the upper limit of a ceilometer reaction, the top of a ceiling light projector beam, or the height at which a balloon completely disappears will be used as a guide in determining the value of an indefinite ceiling. If none of these guides are available, the ceiling will be determined on the basis of experience.

Ceiling values discussed in this paragraph are based on estimations. The values nevertheless are classified as "indefinite," which should not be confused with the classification "estimated."

1435. PRECIPITATION CEILING. A ceiling is classified as a precipitation ceiling when precipitation obscures the cloud base and prevents a determination of its height. The value ascribed to a precipitation ceiling is an estimation that may be based on experience; or, when equipment is available, the limit of penetration of a projector beam or the upper limit of a ceilometer reaction may be used as a guide in determining the value of a precipitation ceiling. Although this value is an estimation, it is classified as a precipitation ceiling, which should not be confused with the classification "estimated."

1436. ESTIMATED CEILING. A ceiling is classified as estimated:

(1) Whenever determined by means of the "Convective Cloud Base Height Diagram" under conditions appropriate to and in accordance with instructions for its use. (See par. 1447.)
(2) Whenever a ceiling balloon or pilot ballon is observed to enter a base of clouds covering 0.9 or less of the sky, or the base of an overcast comprising more than one layer.
(3) Whenever determined from the known heights of unobscured portions of natural landmarks, or of objects more than 1½ miles from the point of observation.
(4) Whenever determined on the basis of experience provided that the sky is not obscured by hydrometeors or lithometeors, and other guides are lacking.

1440. METHODS OF DETERMINING CEILING AND CLOUD HEIGHTS. The methods indicated in paragraphs 1441 to 1447.2 will be used in determining ceiling and cloud heights.

1441. CEILING LIGHT (OR CEILOMETER PROJECTOR). The ceiling light will be used in determining cloud heights as follows:

(1) Turn on the ceiling light.
(2) Sight through the clinometer, and center the intersection of the cross hairs upon the lower part of the most clearly defined portion of the spot.
(3) When the pendant has come to rest, clamp it in position, without moving the clinometer.
(4) Turn off the ceiling light.
(5) Read the angle to the nearest whole degree.
(6) Obtain the height from prepared tables appropriate to the baseline. (See Table 3 for heights computed for baselines of 500, 1,000, and 1,500 feet.)
(7) Add algebraically to the tabular value the difference between the height of the observation point and the official field elevation; if an official field elevation has not been established, add the height of the observation point above the ground.

1441.1 INDICATIONS OF VARIABLE CEILING. Rapid fluctuation of the light spot will indicate an irregular cloud base whose height will be regarded as measured but variable. (See par. 1420.)

1441.2 INDICATIONS OF VERTICAL VISIBILITY. Precipitation and obstructions to vision may prevent use of the ceilometer or the ceiling light to determine cloud heights. However, if the horizontal visibility is equal to or greater than the length of the baseline, the upper limit of penetration of the beam can be used as a guide in evaluating vertical visibility. (Under these circumstances the ceiling would be classified as indefinite or precipitation.) (See par 1411.)

1441.3. OBSERVATIONS ON REDUCED BASELINE. When the horizontal visibility is less than the length of the baseline, pace the distance towards the projector to a point from which a spot can be observed. Use this shorter baseline to compute the height. For any given angle, the height will be proportional to the lengths of the baseline in accordance with the following equation:

$$h = \frac{b}{B} \times H \text{ or } \frac{h}{H} = \frac{b}{B}$$

where

B=normal baseline
H=height from tables at observed angle with normal baseline
b=normal baseline minus distance paced
h=height determined from short baseline and table for H.

1441.4. CORRELATION WITH VISUAL OBSERVATION. Data taken from the ceilometer or ceiling light must be supported by visual observations to insure that the data are representative of the cloud base to which they are ascribed. For example, under conditions of multiple cloud layers, a cloud height value must not be reported as a ceiling when actually it is the height of a cloud layer above or below the layer constituting the ceiling.

TABLE 3.—*Height of cloud base, feet, light projected vertically*

Angle \ Base Line	500′	1,000′	1,500′	Angle \ Base Line	500′	1,000′	1,500′
5	44	87	131	46	518	1,036	1,554
6	52	105	157	47	536	1,072	1,608
7	62	123	185	48	556	1,111	1,667
8	70	141	211	49	575	1,150	1,725
9	79	158	237	50	596	1,192	1,788
10	88	176	264	51	618	1,235	1,853
11	97	194	291	52	640	1,280	1,920
12	106	213	319	53	664	1,327	1,991
13	116	231	347	54	688	1,376	2,064
14	124	249	373	55	714	1,428	2,142
15	134	268	402	56	742	1,483	2,225
16	144	287	430	57	770	1,540	2,310
17	153	306	459	58	800	1,600	2,400
18	162	325	487	59	832	1,664	2,496
19	172	344	516	60	866	1,732	2,598
20	182	364	546	61	902	1,804	2,706
21	192	384	576	62	940	1,881	2,821
22	202	404	606	63	982	1,963	2,945
23	212	424	636	64	1,025	2,050	3,075
24	222	445	667	65	1,072	2,144	3,216
25	233	466	699	66	1,123	2,246	3,369
26	244	488	732	67	1,178	2,356	3,534
27	255	510	765	68	1,238	2,475	3,713
28	266	532	798	69	1,302	2,605	3,907
29	277	554	831	70	1,374	2,748	4,122
30	288	577	865	71	1,452	2,904	4,356
31	300	601	901	72	1,539	3,078	4,617
32	312	625	937	73	1,636	3,271	4,907
33	324	649	973	74	1,744	3,487	5,231
34	338	675	1,013	75	1,866	3,732	5,598
35	350	700	1,050	76	2,006	4,011	6,017
36	364	727	1,091	77	2,166	4,332	6,498
37	377	754	1,131	78	2,352	4,705	7,057
38	390	781	1,171	79	2,572	5,145	7,717
39	405	810	1,215	80	2,836	5,671	8,507
40	420	839	1,259	81	3,157	6,314	9,471
41	434	869	1,303	82	3,558	7,115	10,673
42	450	900	1,350	83	4,072	8,144	12,276
43	466	933	1,399	84	4,757	9,514	14,211
44	483	966	1,449	85	5,715	11,430	17,175
45	500	1,000	1,500	86	7,150	14,301	21,441

1442. PILOT AND CEILING BALLOONS. Heights of cloud bases and vertical visibility into obscuring phenomena may be determined from the elapsed time of flight and the ascensional rate appropriate to the balloon used. Observe the following procedure in determining the heights of clouds or vertical visibility into obscuring phenomena:

(1) Choose the appropriate color of balloon; red balloons are usually preferable with thin clouds and blue or black balloons under other conditions.

(2) Watch the balloon continuously, determining with a stop watch (or any watch having a second hand) the length of time that elapses between release of the balloon and entry of it into the cloud base or disappearance into the obscuring phenomenon.

(3) Determine the height by means of the table appropriate to the balloon used. (See Table 4 for ascensional rate of ceiling balloons.) Interpolate if necessary.

(4) Add algebraically to the tabular value the difference between the height of the observation point and the official field elevation; if an official field elevation has not been established, add the height of the observation point above ground.

1442.1. LIMITATIONS. Ceiling and pilot balloons may be used when drizzle of any intensity, or any other form of precipitation of light intensity, is occurring, since significant changes in the ascensional rate are not caused by these phenomena. However, owing to other factors that may affect the ascensional rate, cloud heights determined by their use will be classified as "balloon" only when the clouds form an overcast comprising one layer. This does not preclude the use of ceiling balloons to estimate the height of overcasts comprising more than one layer or of clouds covering 0.9 or less of the sky.

TABLE 4.—*Height, in feet, determined by ceiling balloon*

Time (minutes) / Type of balloon	10-Gram Spherical		Time (minutes) / Type of Balloon	10-Gram Spherical	
	For Weather Bureau use (45 grams free lift)[1]	For Air Force and Navy use (40 grams free lift)[2]		For Weather Bureau use (45 grams free lift)[1]	For Air Force and Navy use (40 grams free lift)[2]
½	250	250	5½	2, 510	2, 110
1	500	480	6	2, 720	2, 290
1½	730	670	6½	2, 930	2, 470
2	960	850	7	3, 140	2, 650
2½	1, 190	1, 030	7½	3, 350	2, 830
3	1, 420	1, 210	8	3, 560	3, 010
3½	1, 650	1, 390	8½	3, 770	3, 190
4	1, 880	1, 570	9	3, 980	3, 370
4½	2, 090	1, 750	9½	4, 190	3, 550
5	2, 300	1, 930	10	4, 400	3, 730

[1] Add 210 feet for each additional ½ minute after the tenth minute.
[2] Add 180 feet for each additional ½ minute after the tenth minute.

1443. RADIOSONDE. The height may be computed whenever a radiosonde balloon is observed to enter a cloud base, or disappears into obscuring phenomena and the entry is marked on the recorder record. (See pars. 1431 (2); 1434 (2); and 1434 (3).)

1444. PILOT OBSERVATIONS. Heights of clouds and obscuring phenomena reported by pilots will be used in accordance with paragraph 9211. These heights will ordinarily be expressed by the pilot in terms of feet above mean sea level, and will be converted to feet above field elevation if necessary. It must be determined, in any case, whether the report refers to field elevation or sea level. If the report of ceiling height is obtained within 1½ miles of the airport, the ceiling is classified as aircraft; if more than 1½ miles, the report will be used as basis for an estimation.

1445. BUILDINGS, ETC. Determination of cloud heights may be based on interception by clouds of objects (buildings, etc.) other than natural landmarks whose heights are known. Allow, so far as possible, for any appreciable slope in the cloud base from the point of observation to the point of interception of the object. When the objects, etc., are within 1½ miles of the boundaries of the airport, the cloud height may be regarded as measured. When they are more than 1½ miles from airport boundaries, heights are regarded as estimated.

1446. NATURAL LANDMARKS. Cloud heights based on the unobstructed portion of hills or mountains surrounding the station, when their height above the elevation of the station is known, will be classified as estimated. Orographic lifting may cause these clouds to differ in height from those immediately above the station. Estimates of cloud heights based on mountains more than 50 miles away will not be regarded as applicable to those overhead.

1447. CONVECTIVE CLOUD HEIGHT DIAGRAM. This diagram eliminates the computations necessary in determining height of convective-type clouds by use of a dew point formula. It is not suitable for use at stations situated in mountainous or hilly terrain and will, therefore, not be used at these stations. Heights determined in this manner will be classified as estimated. (See Fig. 1.)

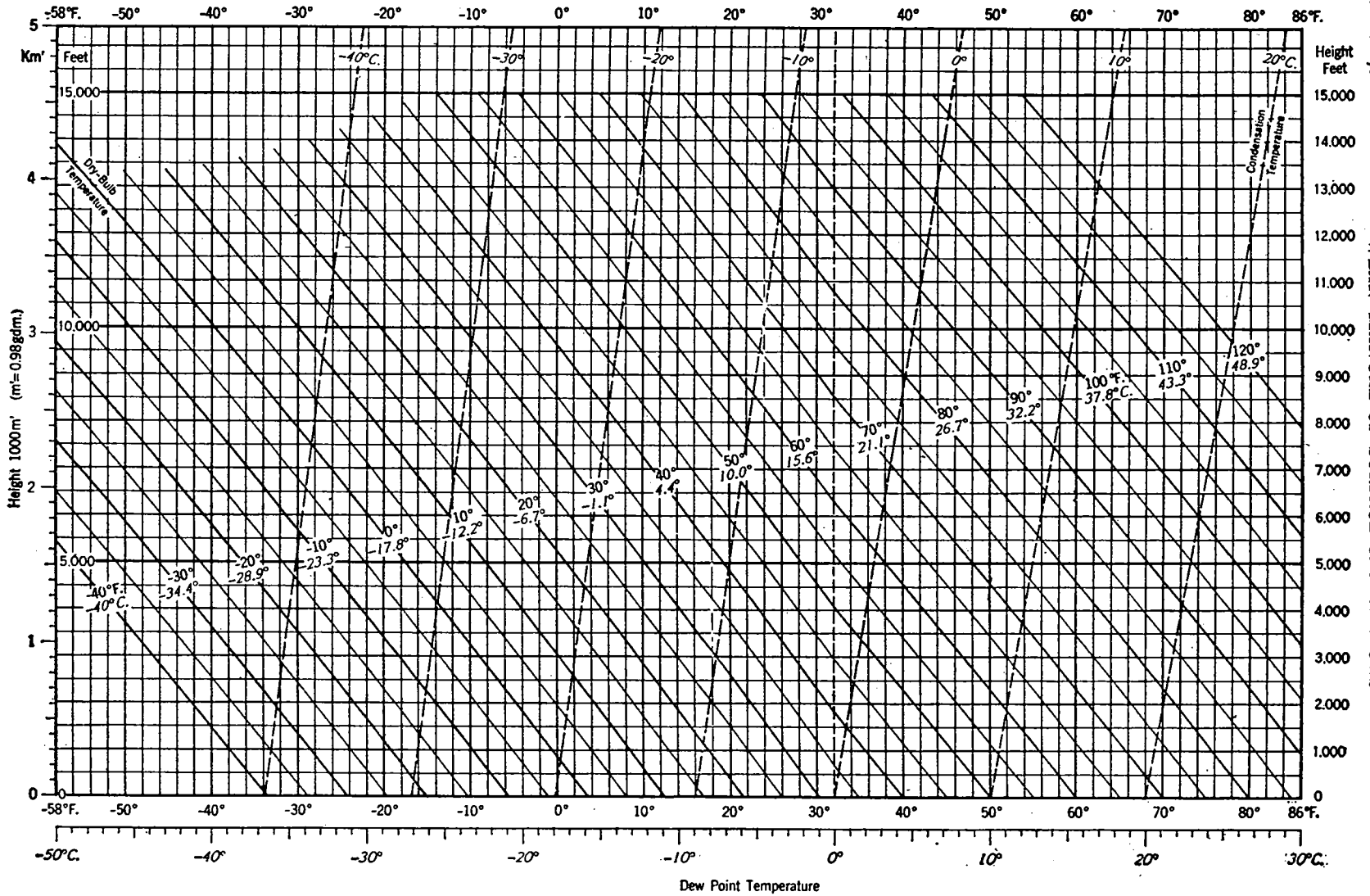

FIGURE 1.—Diagram for determining height of convective-type clouds.

1447.1 The diagram will be used only when the clouds present are formed by active surface convection near the point of observation. The diagram is usually most accurate when used to compute the height of cloud bases 5,000 feet or below; but at land stations in coastal regions, sea breezes frequently render it inapplicable to clouds formed over land before the onset of the sea breeze.

1447.2. Obtain the estimated height of a cloud base above the point of observation as follows:

(1) Locate the point of intersection of the vertical line (abscissa) corresponding to the observed dew point temperature, and the curve (sloping upward to left) corresponding to the observed dry-bulb temperature.

(2) Find the height of the convective cloud base above the ground at the scale value (printed along the right side of the chart) corresponding to the point found in (1).

is approximately equal to one r. p. s. (revolution per second) of the geared (2 to 1 ratio) whirling psychrometer crank, 2 r. p. s. of the sling psychrometer, and 3½ r. p. s. of the psychrometer fan or rotor (direct drive) whirling psychrometer. Psychrometric tables and slide rules are based upon this rate of ventilation, which must be maintained to obtain accurate humidity measurements.

5150.1 The sling psychrometer should be used as follows:

(1) Select a shady spot with no obstructions within radius of the whirling sling.

(2) Face into the wind.

(3) Whirl the psychrometer as far in front of the body as possible.

5151. PSYCHROMETRIC READINGS. Obtain readings from the dry- and wet-bulb thermometers in accordance with paragraph 5110 and the following instructions.

5151.1 Saturate the muslin of the wet-bulb thermometer with clean water.

5151.2. After ventilating the psychrometer for about 10 seconds, quickly read both thermometers, the wet-bulb first. Repeat until two successive readings of the wet-bulb are the same, indicating that the wet-bulb has reached its lowest temperature. If the temperature of the wet-bulb should rise between two successive readings, the muslin will have dried and must be moistened again, and the process of ventilation repeated. Before commencing for a second time, permit the wet-bulb to assume as low a temperature as possible.

5151.3. It is especially important that thermometers should be read accurately at low temperatures, for as temperatures (especially below freezing) become lower, a given difference between the dry- and wet-bulb readings has a progressively greater effect upon the accuracy of humidity values computed from them.

5151.4. Read the dry- and wet-bulb temperatures at the time of the lowest wet-bulb reading. (See paragraph 5120.1.)

5151.5. Apply corrections, if necessary, in accordance with paragraph 5140.

5160. MAXIMUM READINGS. The maximum thermometer is a mercurial thermometer made with a constriction in the bore near the bulb to prevent the mercury from withdrawing into the bulb when the temperature falls.

5161. To read the maximum thermometer, release the catch on the support and lower the bulb end slowly until the thermometer is vertical or approximately so, and the mercury column is resting on the constriction at the base. Read similarly to the dry-bulb thermometer.

5162. Before setting the maximum thermometer, be sure that the mercury column is resting on the constriction at the base. Otherwise, the glass forming the constriction may be broken when the thermometer is spun. To set it, spin the thermometer until its reading is the same as that of the dry-bulb temperature. Lock the thermometer in place on the support.

5163. If the maximum thermometer reading is known to be in error, obtain the maximum temperature to the nearest whole degree from a thermogram, if one is available; otherwise, use the highest corrected temperature observed within the observation period.

5170. MINIMUM READINGS. Alcohol is used in the minimum thermometer. A freely moving dark-colored glass index is placed in the bore. As the temperature falls, the retreating upper end of the alcohol column retracts the index, which remains at the position of the lowest temperature until reset.

5171. The minimum temperature is read at the end of the colored glass index farther from the bulb. Read the thermometer without disturbing it and while it is in its correct position for exposure. It will be read before reading the maximum thermometer. Set the minimum thermometer after the maximum thermometer has been set, by turning it to a vertical position and holding it bulb end up until the index reaches the end of the column. Return the thermometer to its correct position.

5172. Minimum thermometers are subject to errors caused by separation of the spirit column. Sometimes the spirit vapor condenses in the upper end of the bore to form one or two short segments above the rest of the column. At other times, bubbles that form in the column may trap the index. Erroneous readings will result in both cases, and therefore the thermometer should be examined at each observation for separation of the column. Errors also result from recession of the index owing, chiefly, to the shelter's being jarred or subjected to vibration by the wind.

5173. If the minimum thermometer reading is known to be erroneous, obtain the minimum temperature to the nearest whole degree from the thermogram, if one is available, or use the lowest corrected temperature observed within the observation period.

NOTE.—The maximum and minimum temperatures for any observation period must be at least as high and low, respectively, as any temperature observed within the period, including those observed at the beginning and end of the period.

5180. TELETHERMOSCOPE READINGS. The telethermoscope is used to obtain air temperatures at a location remote from the observer. It is an electrical resistance thermometer, the resistance of which changes with the temperature. The instruments are calibrated to read directly in degrees Fahrenheit.

5200. RECORDING THERMOMETERS

5210. THERMOGRAPH. The thermograph consists of a temperature-sensitive element whose movements are communicated by suitable linkage to a pen bearing upon a chart that is mounted on a clock-driven drum. A continuous record of temperature is traced upon the chart, which is called a thermogram. The temperature-sensitive element is either a bimetallic thermometer or a Bourdon-tube assembly. When the thermograph is combined with a humidity measuring instrument it is called a hygrothermograph.

5211. The temperature is read on a thermogram by first finding the point at which the appropriate printed time curve intersects the temperature trace. This point is evaluated in terms of temperature by referring it to the closest of the horizontal printed lines of the thermogram. These lines correspond to the engraved degree marks on a thermometer tube, and are labeled accordingly. Interpolation may be necessary for values of temperature and time intermediate between those corresponding to the printed lines of the thermogram.

5212. At specified times, make a time-check mark on the trace by depressing the pen the width of two temperature intervals printed on the chart. (See paragraph 9381.)

5300. SNOW SURFACE TEMPERATURE OBSERVATIONS

5310. GENERAL. Snow surface temperature observations will be taken at specified raob stations north of the 40th parallel under the conditions stated below. They will be taken not later than 10 minutes after the release of the nighttime radiosonde and preferably as soon after release as possible.

(1) 5/10 of the ground is covered with snow not less than 2 inches in average depth.
(2) A snow-covered area is available that is remote from buildings and that will permit exposure of the thermometer, in accordance with paragraph 5320, within 200 feet of the instrument shelter.
(3) Snow between shelter and point of exposure is relatively level.
(4) Precipitation is not occurring and fog is not present.
(5) Height of the dry-bulb thermometer above the snow-surface thermometer can be determined with reasonable accuracy.

5320. EXPOSURE OF THE THERMOMETER. The thermometer will be exposed as follows:

(1) At least 50 feet from the edge of the snow-covered area, whenever complete snow coverage is not present.
(2) As close to the instrument shelter as possible and preferably under it.
(3) If the snow is too light to support the weight of the thermometer, place it on a piece of

metal light enough to be supported by the snow, with the bulb extending beyond the metal support.

(4) Cover the bulb with ⅛ to ½ inch of snow.

(5) Expose the thermometer for at least ten minutes prior to reading it.

5330. READING THE THERMOMETER. Read the thermometer to the nearest whole degree before removing it from the snow and while it is in a horizontal position. At the same time note the depth of snow under the thermometer.

5340. HEIGHT OF DRY-BULB ABOVE SNOW SURFACE. Favorable exposure sites within 200 feet of the instrument shelter should be sketched on a map to assist in selecting a suitable site for exposing the snow surface thermometer under various conditions. When there is no snow on the ground, compute the differences in elevation between these exposure sites and the dry-bulb thermometer. The height of the dry-bulb above the snow surface at each observation thereafter will be determined by subtracting algebraically the depth of snow under the exposed thermometer from the difference in elevation between the exposure site and the dry-bulb thermometer.

5400. WATER TEMPERATURE OBSERVATIONS

5410. Read the temperature of the water surface (sea or lake) to the nearest 0.1° F. at designated stations.

CHAPTER 6. HUMIDITY MEASUREMENT

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CHAPTER 6. HUMIDITY MEASUREMENT

6000. DEFINITIONS

6010. GENERAL. These instructions are concerned with the expression of humidity in terms of relative humidity and dew point. These data are calculated with psychrometric tables or slide rules, based on atmospheric pressures of 23, 25, 27, 28, 29, and 30 inches of mercury. At Weather Bureau stations if a psychrometric slide rule is available, it will be used in preference to the tables.

6010.1. Relative humidity and dew point data can be expressed with respect to ice or water. For purposes of this manual, it is required that these data be expressed at all temperatures with respect to water. The circular slide rule satisfies this requirement. Psychrometric tables numbered WB 235 express values of relative humidity with respect to ice when the dry-bulb is less than 32°, and of dew points, with respect to ice when the dew point is less than 32°. These values must be converted to their water equivalent, and Tables 9 and 10 are provided for this purpose.

6020. DEW POINT. The dew point is the temperature to which a sample of air must be cooled, while the mixing ratio [1] and barometric pressure remain constant, in order to attain saturation [2] with respect to water. The dew point is expressed to the nearest whole degree Fahrenheit.

6030. RELATIVE HUMIDITY. Relative humidity is the percentage of (a) the mixing ratio of a sample of air to (b) the mixing ratio of air saturated with respect to water at the same temperature and pressure as those of the sample.

6100. PSYCHROMETRIC COMPUTATIONS

6110. DEPRESSION OF THE WET-BULB. The depression of the wet-bulb is the algebraic difference between the dry- and wet-bulb temperatures. It is used with the slide rule and psychrometric tables to make dew point and relative humidity computations.

EXAMPLES:

(1)	Dry-bulb temperature	40.6
	Wet-bulb temperature	32.1
	Depression	8.5
(2)	Dry-bulb temperature	1.2
	Wet-bulb temperature	−0.7
	Depression	1.9
(3)	Dry-bulb temperature	−3.4
	Wet-bulb temperature	−4.7
	Depression	1.3

6110.1. When the wet-bulb is covered with water and a depression cannot be obtained, the relative humidity will be regarded as 100%, and the temperature of the dew point as the same as that of the wet-bulb. If the wet-bulb is covered with ice, the relative humidity and the dew point will be converted to their water equivalents. (See pars. 6131.1—6131.2.)

[1] MIXING RATIO. The mixing ratio of moist air is the ratio of the mass of water vapor to the mass of dry air with which the water vapor is associated.

[2] SATURATION. Saturation as used here denotes a state in which the mixing ratio of a sample of air is equal to that of air immediately over a flat surface of pure water, where equality exists between the rates of evaporation from and condensation of water vapor on the surface, provided that the temperature and barometric pressure of the sample are the same as those of the surface and the superjacent air.

6120. PSYCHROMETRIC SLIDE RULE. Use the slide rule based on the barometric pressure nearest the normal station pressure. (See par. 6010.) Instructions for use of the rule are printed on it. Note that different scales of the rule will be used according as the wet-bulb is covered with ice or water at the time of observation.

6130. PSYCHROMETRIC TABLES. Use the tables based on the barometric pressure nearest the normal station pressure. (See par. 6010.) The arguments are (a) the dry-bulb temperature as given in the vertical column at the left of the table, and (b) the depression of the wet-bulb printed across the top of the table. Dew point and relative humidity data are given as tabular values on correspondingly captioned pages.

6131. The dew point and relative humidity are found from the tables as follows:

(1) When the temperature of the dry-bulb and the depression of the wet-bulb coincide with those given in the tables, the dew point or relative humidity is the tabular value at the intersection of the vertical column corresponding to the wet-bulb depression and the horizontal row corresponding to the air temperature.
(2) When either the air temperature or the depression of the wet-bulb is between the values given in the tables, find, by single interpolation, the proportional part to be used in determining the dew point or relative humidity from the tabular values.
(3) When both the air temperature and the depression of the wet-bulb are between the values given in the tables, double interpolation is required to determine the proportional parts to be used in the calculation of the dew point from the tabular values.

6131.1. When the dew point is less than 32°, dew points derived from the tables are expressed with respect to ice. (See par. 6010.1.) Before these data are used for any purpose, they must be converted to their water equivalent. Using Table 9, find on the upper scale the value with respect to ice derived from the psychrometric tables. Read this point in terms of the lower scale to find the corresponding value with respect to water.

6131.2. When the temperature of the dry-bulb is less than 32°, relative humidity data derived from the tables are with respect to ice and must be converted to their water equivalent. Using Table 10, find the tabular value at the intersection of (1) the vertical column corresponding to the value derived from the psychrometric tables, and (2) the horizontal row corresponding to the dry-bulb temperature in whole degrees. Interpolation will be made for values of relative humidity between those printed at the top of the table.

EXAMPLE: A small portion of the psychrometric tables is reproduced below.

Temperature of dew point in degrees Fahrenheit

(Pressure=29.0 inches)

Air temperature	Depression of wet-bulb thermometer ($t-t'$)				
	0.2	0.4	0.6	0.8	1.0
−10	−12	−14	−17	−19	−23
−9	−11	−13	−15	−18	−21
−8	−10	−12	−14	−16	−19
	0.5	1.0	1.5	2.0	2.5
40	39	38	37	35	34
41	40	39	38	37	35
42	41	40	39	38	36

Relative humidity, percent—Fahrenheit temperatures

(Pressure=29.0 inches)

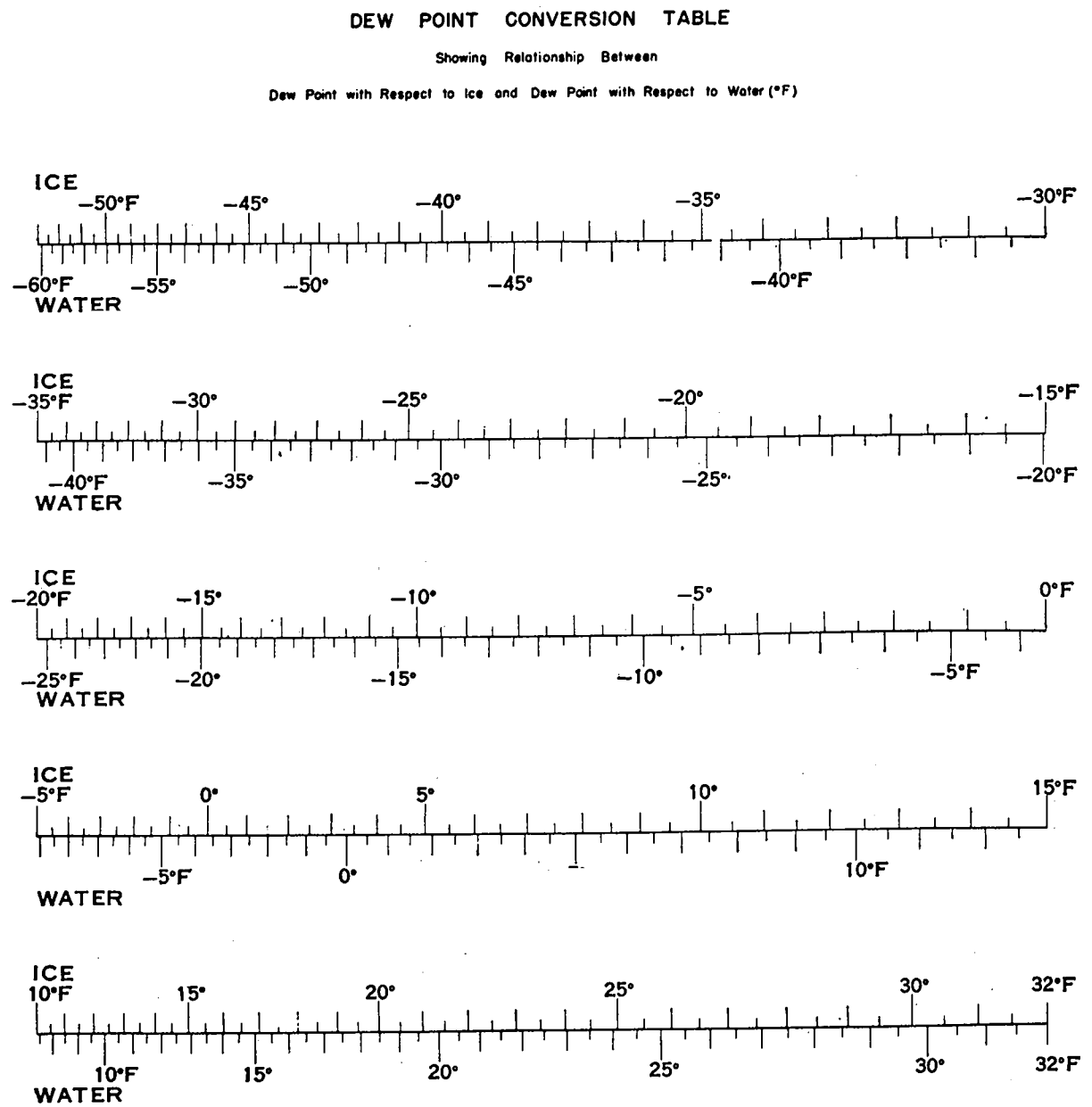
Air temperature	Depression of wet-bulb thermometer (t−t′)				
	0.2	0.4	0.6	0.8	1.0
−10	90	79	69	58	48
−9	90	80	70	60	51
−8	91	81	72	62	53
	0. 5	1. 0	1. 5	2. 0	2. 5
40	96	92	88	84	80
41	96	92	88	84	80
42	96	92	88	85	81

COMPUTATIONS

Dry-bulb reading	−9. 6°	−8. 4°	41. 3°	−10. 0°
Wet-bulb reading	−10. 2°	−9. 3°	39. 9°	−10. 7°
Depression of wet-bulb	0. 6°	0. 9°	1. 4°	0. 7°
Dew point temperature (ice)	−16°	−18°		−18°
Dew point temperature (water) (See Table 9)	−21°	−23°	38°	−23°
Relative humidity (ice)	69	57		64
Relative humidity (water) (See Table 10)	55	46	89	51

(Note that the relative humidity and dew point for temperatures below freezing in this example are with respect to ice and must be converted to their water equivalents.)

TABLE 9.—*Dew point conversion table, showing relationship between dew point with respect to ice and dew point with respect to water (° F.).*



[NOTE.—Saturation vapor pressures over ice and water, used in computing this table, are based on formulas by J. A. Goff and S. Gratch, *Trans. Amer. Soc. Heat. and Vent. Eng.*, vol. 52, p. 95, 1946. Formula for saturation vapor pressure over water assumed to apply from −60° F. to 140° F.]

TABLE 10A—*Relative humidity conversion table*

[Tabular values are relative humidities with respect to water (RH_w) corresponding to relative humidities with respect to ice (RH_i) given at heads of the columns]

Dry bulb temp. (°F.)	Relative humidity with respect to ice (RH_i)										Dry bulb temp. (° F.)	Relative humidity ratio RH_w/RH_i
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
	%	%	%	%	%	%	%	%	%	%		
−11	7.9	15.8	23.8	31.7	39.6	47.5	55.5	63.4	71.3	79.2	−11	0.7922
−10	8.0	15.9	23.9	31.9	39.8	47.8	55.7	63.7	71.7	79.6	−10	.7963
−9	8.0	16.0	24.0	32.0	40.0	48.0	56.0	64.1	72.1	80.1	−9	.8007
−8	8.1	16.1	24.2	32.2	40.3	48.3	56.4	64.4	72.5	80.5	−8	.8051
−7	8.1	16.2	24.3	32.4	40.5	48.6	56.7	64.8	72.9	80.9	−7	.8095
−6	8.1	16.3	24.4	32.6	40.7	48.8	57.0	65.1	73.2	81.4	−6	.8139
−5	8.2	16.4	24.6	32.7	40.9	49.1	57.3	65.5	73.7	81.8	−5	.8184
−4	8.2	16.5	24.7	32.9	41.1	49.4	57.6	65.8	74.1	82.3	−4	.8230
−3	8.3	16.5	24.8	33.1	41.4	49.6	57.9	66.2	74.4	82.7	−3	.8271
−2	8.3	16.6	24.9	33.3	41.6	49.9	58.2	66.5	74.8	83.2	−2	.8315
−1	8.4	16.7	25.1	33.4	41.8	50.2	58.5	66.9	75.2	83.6	−1	.8360
0	8.4	16.8	25.2	33.6	42.1	50.5	58.9	67.3	75.7	84.1	0	.8410
+1	8.5	16.9	25.4	33.8	42.3	50.7	59.2	67.6	76.1	84.5	+1	.8454
2	8.5	17.0	25.5	34.0	42.5	51.0	59.5	68.0	76.5	85.0	2	.8501
3	8.5	17.1	25.6	34.2	42.7	51.3	59.8	68.4	76.9	85.5	3	.8546
4	8.6	17.2	25.8	34.4	43.0	51.6	60.2	68.7	77.3	85.9	4	.8593
5	8.6	17.3	25.9	34.6	43.2	51.8	60.5	69.1	77.8	86.4	5	.8641
6	8.7	17.4	26.1	34.7	43.4	52.1	60.8	69.5	78.2	86.8	6	.8685
7	8.7	17.5	26.2	34.9	43.7	52.4	61.1	69.9	78.6	87.3	7	.8733
8	8.8	17.6	26.3	35.1	43.9	52.7	61.5	70.2	79.0	87.8	8	.8780
9	8.8	17.7	26.5	35.3	44.1	53.0	61.8	70.6	79.5	88.3	9	.8829
10	8.9	17.8	26.6	35.5	44.4	53.3	62.1	71.0	79.9	88.8	10	.8876
11	8.9	17.9	26.8	35.7	44.6	53.6	62.5	71.4	80.3	89.3	11	.8927
12	9.0	17.9	26.9	35.9	44.9	53.8	62.8	71.8	80.8	89.7	12	.8974
13	9.0	18.0	27.1	36.1	45.1	54.1	63.2	72.2	81.2	90.2	13	.9024
14	9.1	18.1	27.2	36.3	45.4	54.4	63.5	72.6	81.6	90.7	14	.9072
15	9.1	18.2	27.4	36.5	45.6	54.7	63.8	73.0	82.1	91.2	15	.9121
16	9.2	18.3	27.5	36.7	45.9	55.0	64.2	73.4	82.5	91.7	16	.9171
17	9.2	18.4	27.7	36.9	46.1	55.3	64.5	73.8	83.0	92.2	17	.9220
18	9.3	18.5	27.8	37.1	46.4	55.6	64.9	74.2	83.4	92.7	18	.9270
19	9.3	18.6	28.0	37.3	46.6	55.9	65.3	74.6	83.9	93.2	19	.9322
20	9.4	18.7	28.1	37.5	46.9	56.2	65.6	75.0	84.3	93.7	20	.9371
21	9.4	18.8	28.3	37.7	47.1	56.5	65.9	75.4	84.8	94.2	21	.9421
22	9.5	18.9	28.4	37.9	47.4	56.8	66.3	75.8	85.3	94.7	22	.9473
23	9.5	19.1	28.6	38.1	47.6	57.2	66.7	76.2	85.7	95.3	23	.9526
24	9.6	19.2	28.7	38.3	47.9	57.5	67.0	76.6	86.2	95.8	24	.9576
25	9.6	19.3	28.9	38.5	48.1	57.8	67.4	77.0	86.7	96.3	25	.9629
26	9.7	19.4	29.0	38.7	48.4	58.1	67.8	77.4	87.1	96.8	26	.9680
27	9.7	19.5	29.2	38.9	48.7	58.4	68.1	77.9	87.6	97.3	27	.9733
28	9.8	19.6	29.4	39.1	48.9	58.7	68.5	78.3	88.1	97.9	28	.9786
29	9.8	19.7	29.5	39.4	49.2	59.0	68.9	78.7	88.5	98.4	29	.9838
30	9.9	19.8	29.7	39.6	49.5	59.4	69.2	79.1	89.0	98.9	30	.9892
31	9.9	19.9	29.8	39.8	49.7	59.7	69.6	79.6	89.5	99.4	31	.9944
32	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	32	.9999

NOTE: Saturation vapor pressures over ice and water, used in computing this table, are based on formulas by J. A. Goff and S. Gratch, *Trans. Amer. Soc. Heat. and Vent. Eng.*, vol. 52, p. 95 (1946). Formula for saturation vapor pressure over water assumed to apply from −60° F. to 140° F.

TABLE 10B—*Relative humidity conversion table*

Tabular values are relative humidities with respect to water (RH_w) corresponding to relative humidities with respect to ice (RH_i) given at heads of the columns]

Dry-bulb temp. (°F)	Relative humidity with respect to ice (RH_i)										Dry bulb temp. (°F)	Relative humidity ratio RH_w/RH_i
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%		
	%	%	%	%	%	%	%	%	%	%		
−60	6.1	12.3	18.4	24.5	30.7	36.8	42.9	49.0	55.2	61.3	−60	0.6130
−59	6.2	12.3	18.5	24.6	30.8	37.0	43.1	49.3	55.4	61.6	−59	.6160
−58	6.2	12.4	18.6	24.8	31.0	37.1	43.3	49.5	55.7	61.9	−58	.6191
−57	6.2	12.4	18.7	24.9	31.1	37.3	43.5	49.8	56.0	62.2	−57	.6220
−56	6.3	12.5	18.8	25.0	31.3	37.5	43.8	50.0	56.3	62.5	−56	.6252
−55	6.3	12.6	18.9	25.1	31.4	37.7	44.0	50.3	56.6	62.8	−55	.6284
−54	6.3	12.6	18.9	25.3	31.6	37.9	44.2	50.5	56.8	63.1	−54	.6315
−53	6.3	12.7	19.0	25.4	31.7	38.1	44.4	50.8	57.1	63.5	−53	.6347
−52	6.4	12.8	19.1	25.5	31.9	38.3	44.7	51.0	57.4	63.8	−52	.6379
−51	6.4	12.8	19.2	25.6	32.1	38.5	44.9	51.3	57.7	64.1	−51	.6412
−50	6.4	12.9	19.3	25.8	32.2	38.7	45.1	51.5	58.0	64.4	−50	.6444
−49	6.5	13.0	19.4	25.9	32.4	38.9	45.4	51.8	58.3	64.8	−49	.6479
−48	6.5	13.0	19.5	26.0	32.5	39.0	45.6	52.1	58.6	65.1	−48	.6507
−47	6.5	13.1	19.6	26.2	32.7	39.2	45.8	52.3	58.9	65.4	−47	.6541
−46	6.6	13.2	19.7	26.3	32.9	39.5	46.0	52.6	59.2	65.8	−46	.6576
−45	6.6	13.2	19.8	26.4	33.1	39.7	46.3	52.9	59.5	66.1	−45	.6611
−44	6.6	13.3	19.9	26.6	33.2	39.9	46.5	53.2	59.8	66.5	−44	.6646
−43	6.7	13.4	20.0	26.7	33.4	40.1	46.7	53.4	60.1	66.8	−43	.6677
−42	6.7	13.4	20.1	26.9	33.6	40.3	47.0	53.7	60.4	67.2	−42	.6716
−41	6.8	13.5	20.3	27.0	33.8	40.5	47.3	54.0	60.8	67.5	−41	.6751
−40	6.8	13.6	20.4	27.1	33.9	40.7	47.5	54.3	61.1	67.8	−40	.6785
−39	6.8	13.6	20.5	27.3	34.1	40.9	47.7	54.6	61.4	68.2	−39	.6820
−38	6.9	13.7	20.6	27.4	34.3	41.1	48.0	54.8	61.7	68.6	−38	.6855
−37	6.9	13.8	20.7	27.6	34.5	41.4	48.3	55.2	62.1	69.0	−37	.6895
−36	6.9	13.9	20.8	27.7	34.6	41.6	48.5	55.4	62.3	69.3	−36	.6928
−35	7.0	13.9	20.9	27.9	34.8	41.8	48.8	55.7	62.7	69.6	−35	.6965
−34	7.0	14.0	21.0	28.0	35.0	42.0	49.0	56.0	63.0	70.0	−34	.7002
−33	7.0	14.1	21.1	28.2	35.2	42.2	49.3	56.3	63.4	70.4	−33	.7039
−32	7.1	14.2	21.2	28.3	35.4	42.5	49.5	56.6	63.7	70.8	−32	.7077
−31	7.1	14.2	21.3	28.5	35.6	42.7	49.8	56.9	64.0	71.1	−31	.7114
−30	7.2	14.3	21.5	28.6	35.8	42.9	50.1	57.2	64.4	71.5	−30	.7152
−29	7.2	14.4	21.6	28.8	36.0	43.2	50.3	57.5	64.7	71.9	−29	.7192
−28	7.2	14.5	21.7	28.9	36.1	43.4	50.6	57.8	65.1	72.3	−28	.7229
−27	7.3	14.5	21.8	29.1	36.3	43.6	50.9	58.1	65.4	72.7	−27	.7267
−26	7.3	14.6	21.9	29.2	36.5	43.8	51.2	58.5	65.8	73.1	−26	.7308
−25	7.3	14.7	22.0	29.4	36.7	44.1	51.4	58.8	66.1	73.4	−25	.7344
−24	7.4	14.8	22.2	29.5	36.9	44.3	51.7	59.1	66.5	73.9	−24	.7386
−23	7.4	14.8	22.3	29.7	37.1	44.5	52.0	59.4	66.8	74.2	−23	.7425
−22	7.5	14.9	22.4	29.9	37.3	44.8	52.3	59.7	67.2	74.6	−22	.7465
−21	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	−21	.7504
−20	7.5	15.1	22.6	30.2	37.7	45.3	52.8	60.4	67.9	75.5	−20	.7546
−19	7.6	15.2	22.8	30.3	37.9	45.5	53.1	60.7	68.3	75.9	−19	.7586
−18	7.6	15.3	22.9	30.5	38.1	45.8	53.4	61.0	68.6	76.3	−18	.7627
−17	7.7	15.3	23.0	30.7	38.3	46.0	53.7	61.3	69.0	76.7	−17	.7668
−16	7.7	15.4	23.1	30.8	38.5	46.3	54.0	61.7	69.4	77.1	−16	.7709
−15	7.8	15.5	23.3	31.0	38.8	46.5	54.3	62.0	69.8	77.5	−15	.7751
−14	7.8	15.6	23.4	31.2	39.0	46.8	54.6	62.4	70.1	77.9	−14	.7794
−13	7.8	15.7	23.5	31.3	39.2	47.0	54.8	62.7	70.5	78.4	−13	.7835
−12	7.9	15.8	23.6	31.5	39.4	47.3	55.1	63.0	70.9	78.8	−12	.7878
−11	7.9	15.8	23.8	31.7	39.6	47.5	55.5	63.4	71.3	79.2	−11	.7922

NOTE: Saturation vapor pressures over ice and water, used in computing this table, are based on formulas by J. A. Goff and S. Gratch, *Trans. Amer. Soc. Heat. and Vent. Eng.*, vol. 52, p. 95 (1946). Formula for saturation vapor pressure over water assumed to apply from −60° F. to 140°F.

6200. HYGROGRAPH

6210. GENERAL. The hygrograph provides a continuous record of relative humidity. To read the relative humidity from the hygrograph, follow the same procedure as that for the thermograph, described in paragraph 5211. The scale is based on relative humidity values from 0 to 100 percent. When the hygrograph is adjusted to correspond with a psychrometric reading made at dry-bulb temperatures below freezing, the psychrometric value of relative humidity with respect to water will be used.

6220. TIME-CHECK LINES ON HYGROGRAM. A time-check line will be made on the hygrogram at any convenient time by depressing the pen about the width of two divisions of the graph.

Pressure

CHAPTER 7. PRESSURE

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7000. GENERAL

7010. Atmospheric pressure is the pressure exerted by the weight of a column of air, of unit area, extending vertically from the reference surface to the top of the atmosphere. Atmospheric pressure is measured by means of a barometer, four types of which are in general use:

(1) Mercurial barometers (adjustable and fixed-cistern).
(2) Aneroid barometers.
(3) Aneroid barographs.
(4) Altimeter setting indicators.

Pressure is not determined from types (2), (3), and (4) above unless an approved mercurial barometer is available for periodically checking them.

7100. READING MERCURIAL BAROMETERS

7110. ADJUSTABLE-CISTERN BAROMETERS. The construction of adjustable-cistern barometers requires that the mercury surface in the cistern be adjusted to the tip of an ivory point projecting downward into the cistern. The tip corresponds to the zero line of a scale calibrated in inches and hundredths.

7111. Prior to reading the barometer scale perform the following operations in the order given below:

(1) Read to the nearest 0.5° F. the thermometer attached to the barrel.
(2) Turn the thumb-screw at the bottom of the barometer until the surface of the mercury in the cistern touches the tip of the ivory point. The tip of the ivory point should be coincident with its image in the mercury. If a dimple forms on the surface, the cistern has been raised too far. Contact of the mercury with the ivory point is seen more easily against a white background.
(3) Tap the barrel near the top of the column of mercury.
(4) Set the vernier (movable scale) so that the base just cuts off light at the highest point of the meniscus. The meniscus is the curved upper surface of the mercury column. The front and rear sighting edges of the base of the vernier coincide when they are on a level with the eye. A white background is helpful when making this adjustment of the vernier.
(5) Lower the mercury about ¼ inch from the ivory point; do not change the vernier setting.

7112. Verniers on adjustable-cistern barometers are constructed in two ratios: 10 to 9, and 25 to 24. (See Figure 3.) The scale with which the 10 to 9 vernier is used is graduated at intervals of 0.100 inch. The length of the graduated portion of the vernier, 0.900 inch, is divided into 10 spaces, each 0.090 inch in length. Therefore, each vernier interval is 0.010 inch shorter than scale intervals. With these verniers the scale may be read without interpolation to the nearest 0.010 inch. The length of the 25 to 24 vernier, 1.200 inches, is divided into 25 intervals, each 0.048 inch in length. As the scale is graduated at intervals of 0.050 inch, each space on the vernier is 0.002 inch shorter than the spaces on the scale. With these verniers the scale may be read without interpolation to the nearest 0.002 inch.

7113. Obtain the barometer reading to the nearest 0.001 inch as follows:

(1) When both the zero and the top graduation lines of the vernier coincide with scale lines, read the scale at its coincidence with the zero line of the vernier; no further reading is necessary. If the zero line of the vernier lies between two lines on the fixed scale, read on the scale the value of the lower line, and proceed as outlined in (2) and (3) below.
(2) Select on the vernier the line that lies exactly opposite, or the shortest distance above, a line on the scale. For the 10 to 9 vernier multiply the number of this line by 0.010 and add the product to the reading obtained in step (1). For the 25 to 24 vernier multiply the number of the line by 0.002 and add the product to the reading obtained in step (1).
(3) Estimate the final thousandths, if any, from the proportional parts, and add to the sum obtained in step (2).

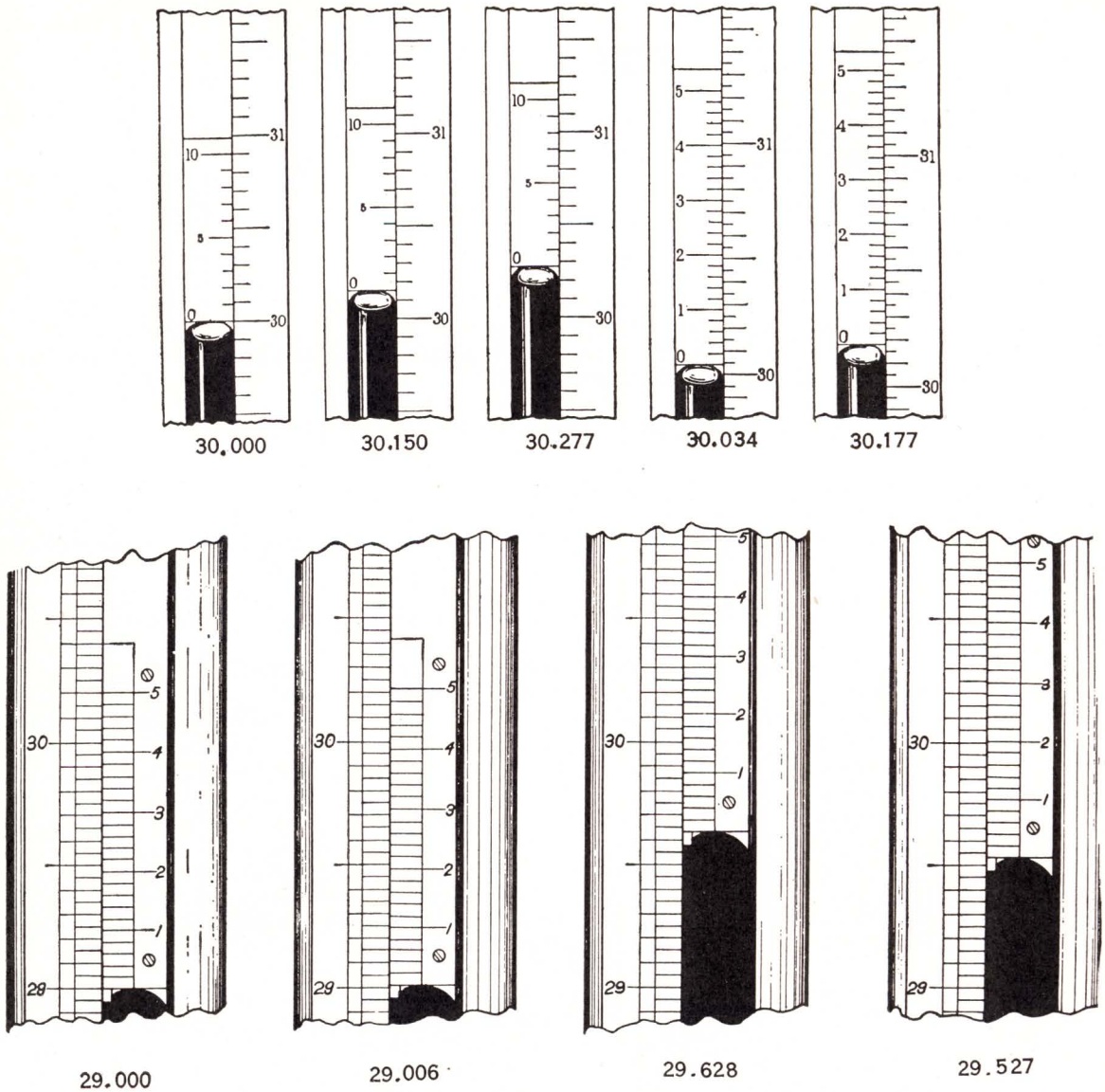

FIGURE 3.—Barometer verniers.

7120. FIXED-CISTERN BAROMETERS. The Bowen fixed-cistern barometer is calibrated to give pressure readings in millibars; the attached thermometer is in the centigrade scale.

7121. Before reading the Bowen barometer:
(1) Read the attached thermometer to the nearest 0.5°C.
(2) Tap the barrel near the meniscus.
(3) Set the vernier as for the adjustable-cistern type.

7122. The vernier on this barometer is so made that 10 spaces on the vernier are equal in length to 19 millibar spaces on the scale. That is, the length of 1 division on the vernier is equivalent to 1.90 millibars.

7123. Read the barometer to the nearest 0.01 millibar as follows:
(1) If the zero line of the vernier is exactly opposite a line on the scale, read the scale directly to whole millibars at that line. If the zero line of the vernier falls between two lines on the scale, read the value of the lower line, and continue as indicated in (2) and (3) below.

(2) Select the line on the vernier that lies exactly opposite, or the shortest distance above, a line on the scale. Multiply the number of this vernier line by 0.10, and add the product to the reading obtained in step (1).
(3) Estimate the hundredths of millibars, and add the value to the result obtained in step (2).

7200. DETERMINATION OF STATION PRESSURE

7210. GENERAL. Station pressure is determined at fixed intervals by means of corrected mercurial barometer readings, and at intermediate times by means of aneroid barometers or barographs periodically corrected to mercurial readings. Station pressure from mercurial barometer readings is the pressure value obtained after all required corrections have been applied to the observed mercurial reading. Station pressure from aneroid barometers and barographs is the value obtained after the correction established from the mercurial barometer reading has been applied.

7220. STATION ELEVATION. Station pressure is related to an assigned station elevation (H_b) above mean sea level. This assigned elevation remains constant even should the station be moved to a different elevation. If it should be moved, a "removal correction" is applied to readings taken at the new location. The corrected reading is then very close to what it would have been if it had been taken at the original location.

7230. CORRECTIONS TO BAROMETER READINGS—GENERAL. Atmospheric pressure from the observed barometer readings must be corrected for temperature, local gravity, and instrumental error. In addition, to make the pressure value comparable with previous pressure values at the same station, the application of a removal correction may be required (see paragraph 7220). Corrections to be applied to the different types of mercurial barometers are described as follows.

7231. CORRECTIONS TO ADJUSTABLE-CISTERN BAROMETERS. Corrections applied to readings of adjustable-cistern barometers comprise a temperature correction, a scale error and capillarity (instrumental) correction, local gravity correction, and sometimes a correction to assigned station elevation. The temperature correction is determined from the publication "Correction of Mercurial Barometer for Temperature, English Measures." Corrections for scale error and capillarity, local gravity, and removal are collectively referred to as the "sum of corrections." They are listed on the barometer correction card furnished with each barometer. The correction to station elevation may be constant. If the correction varies with temperature, owing to the amount of difference between assigned station elevation and the elevation of the barometer, the "sum of corrections" will be found on the back of the card. It will facilitate computation if the "sum of corrections" and the temperature corrections are incorporated into a single table. The algebraic sum of the temperature correction and the "sum of corrections," as defined above, in such a table is referred to as the total correction. To obtain the total correction from this table use as arguments the attached thermometer reading to the nearest 0.5° Fahrenheit or centigrade and the observed barometer reading in inches and thousandths or millibars and tenths.

7232. CORRECTIONS TO BOWEN FIXED-CISTERN BAROMETER. Corrections applied to the Bowen barometer comprise temperature, volume, gravity, residual, and removal (if required). These corrections are incorporated into a table furnished to the stations requiring it. To obtain the total corrections from this table, use as arguments the attached thermometer reading to the nearest 0.5° C. and the observed reading in millibars and hundredths.

7240. ANEROID BAROGRAPH. A continuous record of station pressure is recorded on a chart by the aneroid barograph. The barograph consists of an aneroid pressure unit with pen linkage, and a clock-driven drum upon which the chart is fastened. The scale of the 2½ to 1 open-scale microbarograph is magnified, or opened, so that a pressure difference of 1 inch of mercury is represented on the chart by a linear distance of 2½ inches. The distance between adjacent pressure ordinates printed on the chart is equivalent to 0.020 inch of mercury. On the 1 to 1 scale, a pressure difference of 1 inch of mercury is represented on the chart by a linear distance of 1 inch. The distance between adjacent pressure ordinates is equivalent to 0.050 inch of mercury.

7241. To determine station pressure from the barograph:
(1) Tap the instrument lightly, on the top of the case.

(2) Read to the nearest 0.005 inch the pressure value indicated by the position of the pen on the chart, estimating for values lying between the printed ordinates.
(3) Apply the correction established for the barograph in accordance with instructions in paragraph 7242.

7242. A barograph will not be used for original determination of pressure unless a correction is established every 6 hours by comparison with the station pressure determined from the mercurial or precision aneroid barometer or altimeter setting indicator. Determine to the nearest 0.01 inch the correction necessary to make the barograph reading agree with the station pressure computed from the barometer reading. If this correction exceeds .05 inch, the barograph should be reset at the time the barometer reading is made. If the barometer is calibrated in millibars, the barograph correction will be determined by converting station pressure from millibars and tenths to inches and hundredths. Apply this correction to all barograph readings until another correction is established at the next succeeding 6-hourly comparison. Post the correction so that it will be available to all personnel taking pressure readings from the barograph.

7243. Make a time-check line on the barograph sheet after the barograph correction is determined. This line should be about equal in length to the width of two divisions on the chart and should be made carefully to avoid injury to the delicate mechanism of the barograph. If the instrument is so exposed that the dash-pot liquid becomes cold, which prevents the pen from returning to position, do not make a time-check line.

7244. Whenever a reading is taken, ascertain that the clock is running and that the ink is flowing properly. When it appears that the pen will pass off the printed divisions of the chart, set the pen up or down, equivalent to one full inch of pressure, by means of the adjusting screw, renumber the lines accordingly, and indicate on the chart the time of the adjustment.

7250. ANEROID BAROMETER. Pressure is indicated on an aneroid barometer by the position of a hand on a graduated dial. Aneroids have dials graduated at intervals equivalent to inches and hundredths of mercury or millibars and tenths. Rapid changes of temperature, or exposure to direct heat or sunlight, may cause erratic performance in an aneroid barometer, and jars or shocks may dislocate elements of the linkage system. If an aneroid barometer is observed to have a correction that tends to be erratic (for example, +0.01 inch at one mercurial barometer comparison, +0.04 inch at the next, and a −0.02 inch at a third) the matter will be reported immediately. An unusually high wind will cause an aneroid barometer to indicate a pressure differing from one obtained from a mercurial barometer. This difference is especially apparent when the exposures of the two instruments are dissimilar. Differences noted at the time of high winds need not be reported unless they persist after the disappearance of the atmospheric conditions first associated with them.

7251. To determine station pressure from the aneroid barometer:
(1) Tap the face of the instrument lightly with the finger or the eraser-end of a pencil to bring the hand to its true position.
(2) Read to the nearest 0.005 inch or 0.1 millibar estimating for values between the scale graduations.
(3) Apply any necessary correction established in accordance with paragraph 7252.

7252. Corrections to be applied to precision-type aneroid barometers will be determined in accordance with instructions issued to the stations requiring them. Other types of aneroid barometers will not be used for original determination of pressure unless a correction is established at 6-hourly intervals by comparison with the station pressure determined from the mercurial or precision-aneroid barometer; or altimeter setting indicator. This correction is the difference between the station pressure computed from the mercurial barometer reading and the pressure indicated at the same time by the aneroid barometer. Apply the correction to all aneroid readings until another is established at the next succeeding 6-hourly observation. Post the correction so that it will be available to all personnel taking pressure readings from the aneroid barometer.

7260. STATION PRESSURE FROM ALTIMETER SETTING INDICATORS. Station pressure will be determined from altimeter setting indicators in accordance with the following instructions, provided that the indicators are periodically compared with mercurial barometers as required by instructions issued to stations having both instruments.

(1) Determine the corrected altimeter setting to the nearest 0.01 inch from the altimeter setting indicator.
(2) Find in the altimeter setting tables the tabular value corresponding to the altimeter setting determined in (1).
(3) Read at the side and top of the table the corresponding station pressure to the nearest 0.01 inch.

NOTE.—If the exact value of the altimeter setting determined in (1) does not appear in the altimeter setting tables, interpolate to obtain the station pressure and dispose of the thousandths digit in accordance with instructions in the Introduction.

7300. SEA-LEVEL PRESSURE

7310. GENERAL. Sea-level pressure represents the atmospheric pressure at sea level under prevailing meteorological conditions of temperature and station pressure. When the station is not at sea level, the station pressure is said to be reduced to sea level. The reduction is accomplished by the use of tables supplied each station. The tables are based on the elevation of the individual station at which they are to be used, and upon certain assumptions implicit in the hypsometric equation employed in their computation. The reduction table may be expressed in inches of mercury, or expressed directly in millibars, according as the original pressure readings are in inches or millibars. The arguments used in the tables are station pressure and temperature. Mean temperature intervals in the reduction tables vary with the station elevation as follows:

Station elevation	Mean temperature intervals
0— 50 feet	None (constant correction)
51— 500 feet	10°
501—1000 feet	5°
1001 feet or more	2°

7320. REDUCTION OF STATION PRESSURE TO SEA-LEVEL PRESSURE. In reducing station pressure to sea-level pressure, use as arguments:
(1) The station pressure rounded to the nearest 0.01 inch or 0.1 millibar in accordance with instructions contained in the Introduction.
(2) The 12-hour mean temperature, to tenths, obtained from the current air temperature, and the air temperature 12 hours previously. If a temperature observation was not made 12 hours previously, determine from the thermograph, to whole degrees, the temperature 12 hours previously.

7321. Determine the sea-level pressure from reduction tables as follows:
(1) When observed values of mean temperature and station pressure correspond exactly with tabular arguments, find the sea-level pressure as a tabular value at the intersection of the respective columns.
(2) In all other instances, interpolate for pressure or temperature or both, by use of proportional parts tables, or by means of arithmetical interpolation.

7322. Four tables of proportional parts, which are described below, are available to facilitate the interpolation referred to in (2) above:
Table 1—Temperature increments of 0.1° from 0.0° to 2.0°. Pressure increments of 0.01 inch from 0.01 to 0.04 inch. This table is for use with sea-level reduction tables having temperature arguments of 2° increments.
Table 2—Temperature increments of 0.1° from 0.0° to 1.0° and increments of whole degrees from 1.0° to 5.0°. Pressure increments of 0.01 inch from 0.01 inch to 0.04 inch. This table is for use with sea-level reduction tables having temperature arguments of 5° increments.
Table 3—Temperature increments of 0.1° from 0.0° to 1.0° and increments of whole degrees from 1.0° to 10.0°. Pressure increments of 0.01 inch from 0.01 to 0.04 inch. This table is for use with sea-level reduction tables having temperature arguments of 10° increments.
Table 4—Pressure increments of 0.01 inch from 0.00 to 0.10 inch for horizontal tabular differences (as found in sea-level reduction tables) in increments of 0.01 inch from 0.10 to 0.15 inch.

7323. The station pressure will be reduced to sea-level by use of a sea-level reduction table and tables of proportional parts in accordance with the following instructions. Each step in the instructions is illustrated by an example based upon a given station pressure and a given 12-hour mean temperature. Portions of the sea-level reduction and proportional parts tables necessary to evaluate the example are reproduced following par. 7324.

Given: Station pressure=24.17
12-hour mean temperature=58.7°

(1) Find the station pressure argument in the table next lower to the actual station pressure. In the example, 24.10 would be selected as next lower to 24.17.

(2) Find the temperature argument in the sea-level table next higher to the 12-hour mean temperature. In the example, 60 would be selected as next higher to 58.7.

(3) Find the tabular value at the intersection of the columns selected in accordance with (1) and (2) above. In the example, this tabular value would be 30.71.

(4) Find the vertical pressure difference between the tabular value selected in accordance with (3) above and the next higher tabular value. In the example this would be 0.01 (difference between 30.71 and the next higher value, 30.72).

(5) Find the horizontal pressure difference between the value found in accordance with (3) above and the next higher tabular value. In the example, the difference would be 0.12 (difference between 30.71 and the next higher horizontal value, 30.83).

(6) Find the temperature difference to tenths between the actual 12-hour mean temperature and the value selected in accordance with (2) above. In the example this would be 1.3 (the difference between 58.7 and 60.0).

(7) Find the pressure difference between the actual station pressure and the value selected in accordance with (1) above. In the example, this would be 0.07 (the difference between 24.17 and 24.10).

(8) To summarize, the following values have been found:
(a) Vertical pressure difference (this equals 0.01 in the example).
(b) Horizontal pressure difference (this equals 0.12 in the example).
(c) Temperature difference (this equals 1.3 in the example).
(d) Pressure difference (this equals 0.07 in the example).

(9) Select the vertical pressure versus temperature table of proportional parts appropriate to the station sea-level table in accordance with paragraph 7322. In the example, the difference between successive temperature arguments is 2°; therefore, proportional parts Table 1 is used.

(10) Using the table selected in accordance with (9), find the vertical pressure argument corresponding to the value found in (4) and the temperature argument corresponding to the value found in (6). Find the tabular value at the intersection of the respective columns. In the example this would be 0.006.

(11) Using proportional parts Table 4, find the horizontal pressure argument corresponding to the value found in (5), and the pressure difference found in (7). Find the tabular value at the intersection of the respective columns. In the example, this would be 0.084.

(12) Add the values found in (3), (10), and (11). The sum is the sea-level pressure. In the example this would be 30.800, which is obtained as follows:
(a) From (3), a tabular value of sea-level pressure=30.71.
(b) From (10), an interpolated value of pressure using Table 1=0.006.
(c) From (11), an interpolated value of pressure using Table 4=0.084.
(d) From (12) a sum that equals the sea-level pressure=30.800.
The thousandths digit is disposed of in accordance with instructions contained in the Introduction.

7324. Sea-level reductions in terms of millibars will be made similarly to the foregoing by use of proportional parts Tables 5–8. In all operations, values as they appear in the tables will be carried forward to the final computation before disposing of the final digit.

PORTIONS OF SEA-LEVEL REDUCTION AND PROPORTIONAL PARTS TABLES

Mean temperature (° F.)	Station pressure (inches)			
	24. 00	24. 10	24. 20	24. 30
56	30. 61	30. 74	30. 87	30. 99
58	30. 60	30. 72	30. 85	30. 98
60	30. 58	30. 71	30. 83	30. 96
62	30. 57	30. 69	30. 82	30. 95

FROM PROPORTIONAL PARTS TABLE 1

Temperature increments (° F.)	Vertical tabular differences (inch)	
	0. 01	0. 02
1. 2	0. 006	0. 012
1. 3	. 006	. 013
1. 4	. 007	. 014

FROM PROPORTIONAL PARTS TABLE 4

Pressure increments (inch)	Horizontal tabular differences (inch)	
	0. 12	0. 13
0.06	0. 072	0. 078
0.07	. 084	. 091
0.08	. 096	. 104

7400. COMPUTATION OF HEIGHT OF THE 850-MILLIBAR SURFACE ABOVE SEA LEVEL

7410. DESCRIPTION OF DIAGRAMS. The height of the 850-millibar surface (25.10 inches) is computed by means of one of the hypsometric diagrams listed below. The diagrams used for the computation must have ranges of pressure and temperature that include the current values of station pressure and mean virtual temperature.

Form number	Temperature Range, ° F	Pressure range, inches of mercury
1154C	10 to 90	28.80 to 25.10
1154D	10 to 90	27.70 to 22.75
1154E	10 to 90	25.10 to 20.60
1154F	−50 to 30	28.80 to 25.10
1154G	−50 to 30	28.00 to 22.50
1154H	−50 to 30	25.10 to 20.60

Forms 1154D and G are for intermediate values of pressure that overlap pressure ranges of other diagrams. Two linear scales, one in g. ft. and one in kilometers, are printed at the left of the diagram. To the right of the diagram is a millibar-inch pressure conversion scale for use at stations supplied with barometers calibrated in millibars.

7420. DESCRIPTION OF SCALE. A g.-ft. scale which is available as a separate form, is used in computing the height of the 850-millibar surface. It is furnished in a height range from 2,350 to 9,500 feet for use with all diagrams listed in paragraph 7410. A kilometer scale is printed on the right in a range equivalent to the range of the g.-ft. scale. The station elevation in g.-ft. should be indicated on the scale with a fine, thin penciled arrow that extends across the width of the scale. The position of this arrow on the scale should be verified for accuracy by another of the station personnel, after which the arrow should be retraced with permanent ink. The head of the arrow should terminate about $\frac{1}{16}$" from the edge of the scale. Trim the scale so that the line in the center becomes the right edge, and the graduations and legends remain on the left side. The scale is subject to contraction and expansion with changes in humidity and temperature. Precautions should therefore be taken to avoid subjecting the diagrams and the scales to extremes of either humidity or temperature.

7430. COMPUTATION OF MEAN VIRTUAL TEMPERATURE. Enter the following temperature data on the form provided for computation of the mean virtual temperature:

(1) Current temperature.
(2) Current temperature.
(3) Temperature 6- hours previously.
(4) Sum of (1), (2), (3).
(5) One-third of (4) (whole degrees).
(6) Correction from table entitled "Correction for Lapse Rate and Humidity," using as arguments the values closest to the current station pressure and the temperature computed in (5).
(7) Algebraic sum of (5) and (6).

7440. SELECTION OF DIAGRAM. Select a diagram whose range of pressure, printed along the side, includes the station pressure, and whose range of temperature, printed along the top, includes the mean virtual temperature computed in accordance with paragraph 7430 above. The slanting lines of the hypsometric diagrams represent values of pressure in increments of five-hundredths of an inch corresponding to station pressure; the vertical lines represent temperature in whole degrees Fahrenheit corresponding to values of mean virtual temperatures.

7450. USE OF SCALE. (Form 1154J). Place the g.-ft. scale on the hypsometric diagram so that height in g.-ft. increases with decrease in pressure. Place the edge of the scale parallel with and immediately adjacent to the vertical line corresponding to the mean virtual temperature, to the nearest whole degree Fahrenheit. Slide the scale vertically until the tip of the arrow coincides with the value of station pressure to the nearest 0.01 inch. The height of the 850-millibar surface above sea level will be read on the g.-ft. scale at its intersection with the 25.10 line, which is a dashed horizontal line with arrow heads at its extreme tips.

EXAMPLE

Given:

Station elevation g.-ft	5, 290
Station pressure	24. 645
Current temperature (t)	29. 3° F
Temperature 6 hours previously (t_6)	33. 6° F

(1) To determine temperature argument:

t	29. 3°
t	29. 3°
t_6	33. 6°
Sum	92. 2°
Mean	30. 7°
t'' (to nearest whole ° F)	31°.
c= Correction from lapse rate and humidity correction table (at intersection of 24.60 pressure line (closest to 24.64) and 30° F temperature column (closest to 31°)	+2
t_{m_v}= Mean virtual temperature argument, nearest whole ° F	33°

(2) Pressure argument (station pressure to nearest 0.01 inch) ..... 24. 64 inches

(3) To determine the height of the 850-millibar surface above sea level:
Using 24.64 as the pressure argument place the edge of the scale along the 33° temperature line with the arrow marking the station elevation, 5,290, at the 24.64 inch pressure value. At the intersection of the scale with the 25.10 inch pressure line (equivalent to 850-millibar) read the height of the 850-millibar surface above sea level (to nearest 10 g.-ft.). Height equals 4,810 g.-ft.

7500. ALTIMETER SETTING

7510. GENERAL. The altimeter setting is a pressure, in inches, used for setting a pressure-scale type sensitive altimeter in an airplane so that upon landing of the airplane the instrument will indicate an altitude reading equal or very close to that of the field elevation above sea level. The altimeter setting is sometimes called the standard atmosphere sea-level pressure, since it is based on the standard atmosphere. Computation of the altimeter setting is independent of temperature. Altimeter settings are determined only at stations equipped with an approved mercurial barometer with whose readings those of any pressure instrument used in determining the altimeter setting are periodically compared.

7520. DETERMINATION OF ALTIMETER SETTING FROM STATION PRESSURE. Altimeter setting tables, containing station pressure arguments for obtaining altimeter settings, are furnished to stations requiring them. The station pressures pertain only to the elevation of the station at which the table is designed to be used. Therefore, each table may be used only at a station whose elevation corresponds with that of the one used in computing the table. The station pressure arguments are given at the side of the table to tenths of an inch and at the top of the table to hundredths of an inch.

7521. To determine the altimeter setting, read the station pressure to the nearest 0.01 inch and find in the body of the table the value corresponding to the station pressure. No interpolation is necessary.

EXAMPLES

A portion of the altimeter setting table for Kansas City, Mo., follows:

ALTIMETER SETTINGS, KANSAS CITY, MO., FIELD ELEVATION 742 FEET

Station pressure (inches)	.01	.02	.03	.04
28.80	29. 60	29. 61	29. 62	29. 63
28.90	29. 70	29. 71	29. 72	29. 73

Station elevation, H_b=750.0 feet. Actual elevation barometer H_a=760.328 feet.

(1) Given:
Station Pressure 28.825, rounded to the nearest 0.01 inch 28. 82
Value from table found in column headed .02 ..... 29. 61

(2) Given:
Station Pressure 28.927, rounded to the nearest 0.01 inch 28. 93
Value from table found in column headed .03 ..... 29. 72

7530. ALTIMETER SETTING INDICATORS. The altimeter setting indicator is a special form of aneroid barometer so designed that after installation and proper adjustment, the altimeter setting may be read directly from the scale. Corrections for this instrument will be determined in accordance with instructions issued to stations requiring them.

7600. DETERMINATION OF CHARACTERISTIC AND AMOUNT OF BAROMETRIC TENDENCY

7610. The barometric tendency comprises three elements: (1) the net change in barometric pressure within a specified time before an observation, (2) indication as to whether the barometric pressure is higher or lower at the end of a period than at the beginning of the period, and (3) the characteristic of the change during the period.

7620. Pressure tendencies will be determined only at stations equipped with a barograph. The characteristic and amount of barometric tendency will be determined directly from the barogram. Determine the characteristic from the trace for the full 3-hour period preceding the actual time of observation, or, at specified stations, for the full 3-hour period ending three hours before the time of observation. Observe whether the pressure is the same as, or higher or lower than, at the time of the beginning of the period, and whether the trace shows a falling, rising, steady,

or unsteady tendency, or a combination of these. If the characteristic is so variable over the period that it cannot be identified, determine it for the period immediately preceding the observation, or for whatever interval will permit of a reasonably accurate determination of a characteristic.

7630. To find the amount of change, determine to the nearest 0.005 inch the net change over the interval. The net change is the difference in pressure values indicated by the trace between the beginning and the end of the period. No correction is to be applied to the value of the trace at these points.

7640. When the barogram indicates a rapid fall in pressure followed by an abrupt rise of 0.06 inch or more, the lowest pressure in the "V" will be noted and converted to sea-level pressure at airway stations for reporting in accordance with instructions in Table 29, item 21. The mean temperature used in the reduction will be determined in accordance with the following:

(1) When a thermograph is available, select the temperatures corresponding to the time of the lowest pressure and to the time 12 hours previously.

(2) When a thermograph is not available, select the temperatures at the preceding observation and at a time 12 hours previously.

Wind

CHAPTER 8. WIND

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CHAPTER 8. WIND

8000. GENERAL

8010. Wind is measured in terms of velocity, a vector that includes direction and speed. The absence of apparent motion in the air is termed "calm." Wind direction, speed, character, and shifts are determined instrumentally, or by estimation when instrumental determination is not possible.

8100. DETERMINATION OF DIRECTION

8110. GENERAL. Wind direction is defined as the direction from which the wind is blowing. Wind direction is determined with reference to true north, and is expressed to 16 points of the compass or nearest 10 degrees. (See Table 11.)

TABLE 11.—*Wind direction in degrees, to 16 compass points*

Direction	Compass point	Degrees	Direction	Compass point	Degrees
North	N	349°–11°	South	S	169°–191°
North-northeast	NNE	12 –33	South-southwest	SSW	192 –213
Northeast	NE	34 –56	Southwest	SW	214 –236
East-northeast	ENE	57 –78	West-southwest	WSW	237 –258
East	E	79 –101	West	W	259 –281
East-southeast	ESE	102 –123	West-northwest	WNW	282 –303
Southeast	SE	124 –146	Northwest	NW	304 –326
South-southeast	SSE	147 –168	North-northwest	NNW	327 –348

8120. NONINSTRUMENTAL. When the station is not equipped with wind-indicating equipment or the equipment is unserviceable, the direction will be determined by observing the wind cone or tee at an airport, or the drift of smoke, or the movement of twigs, leaves, and similar flexible objects elsewhere. True direction can be estimated quite accurately by facing into the wind in unsheltered areas.

8130. INSTRUMENTAL. Wind direction is taken from 4- and 9-light (4- and 8-point) wind-direction indicators, recorders, or from direct-reading dials, by observing the indicator for a 1-minute interval in accordance with the following instructions for the type of indicator in use.

8131. The lamps of a 4-point indicator are assigned the cardinal directions, North, East, South, and West. When one lamp of a 4-light (4-point) indicator burns steadily, or one lamp burns steadily with flashes occasionally from a lamp on either side of it, the lamp burning steadily indicates the wind direction. When one lamp burns steadily with occasional flashes of a lamp on one side only, the wind direction is between the cardinal and intermediate directions, e. g., north-northeast. When two adjacent lamps burn steadily or intermittently, the direction is the intermediate one between them, e. g., northeast.

8132. The lamps of an 8-point indicator are assigned the cardinal and intermediate directions, North, Northeast, East, Southeast, South, Southwest, West, and Northwest. When one lamp, for a cardinal or intermediate direction, of a 9-light (8-point) indicator burns steadily, with or without occasional flashes of either or both adjacent lamps, the direction is the cardinal or intermediate one indicated by the lamp burning steadily. When one lamp burns steadily with an adjacent lamp burning more than 50 percent of the time, or when both lamps burn intermittently, the direction is between the intermediate and cardinal directions represented by the lamps.

8133. Directions from a direct-reading dial will be indicated by the average position of the pointer during a 1-minute interval.

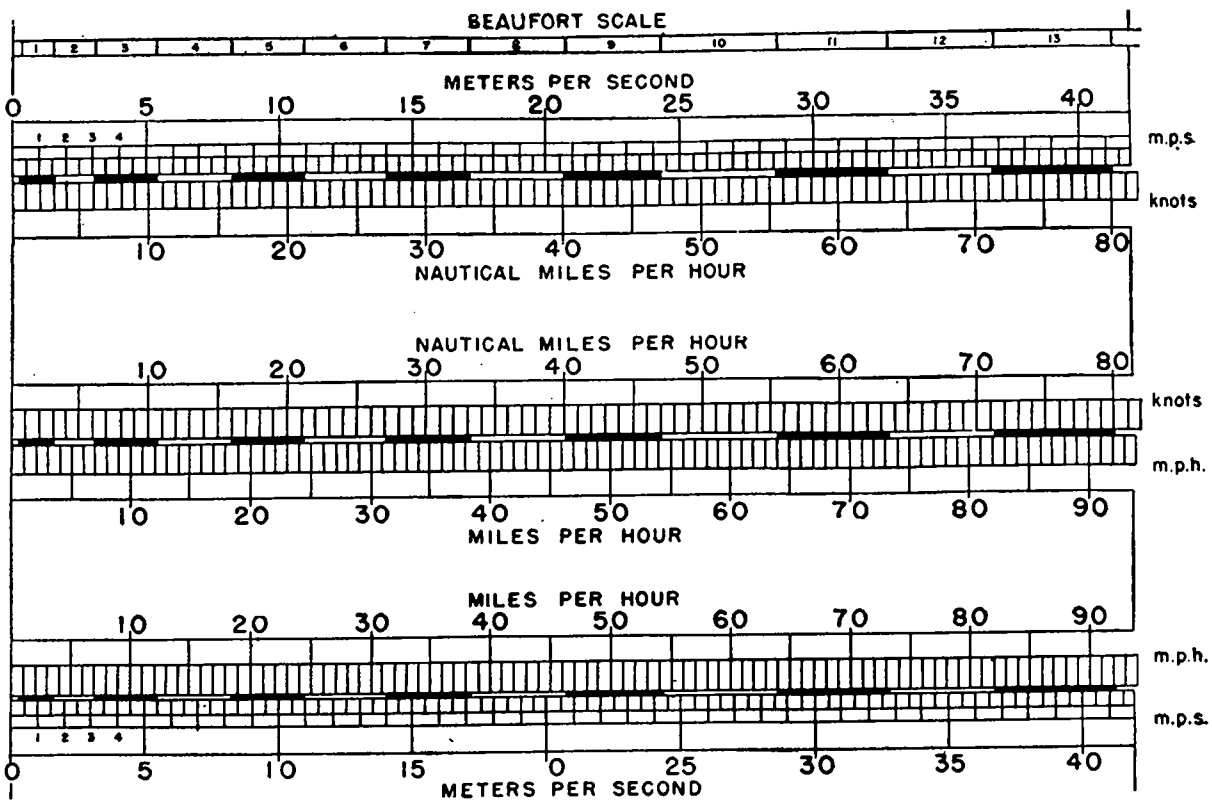
8134. Wind velocity recorders of the continuous registering type may be used for determining the direction, which will be that of the last full minute of record preceding the observation.

8135. Direction from a single or multiple register will be obtained by averaging the indications over a 5-minute period.

8200. DETERMINATION OF SPEED

8210. GENERAL. Speed of the surface wind will be determined to the nearest statute mile per hour or knot, depending on the anemometer used. Conversion will be made as required by means of Table 12. In general, observed wind speeds are a 1-minute mean, but may also be a 5-minute mean, or the fastest mile, when the speed is determined from recording equipment. So far as possible, mean wind speed observations will not be taken during periods of extreme wind speeds—either high or low.

TABLE 12.—*Wind speed conversion.*



8220. NONINSTRUMENTAL. If equipment for observing wind speed is not available, the speed may be estimated by means of Table 13 (usually known as the Beaufort scale of wind speeds).

TABLE 13.—*Wind equivalents—Beaufort scale*

Beaufort number	M. P. H.	Knots	International description	Specifications
0	Less than 1	Less than 1	Calm	Calm; smoke rises vertically.
1	1–3	1–3	Light air	Direction of wind shown by smoke drift; but not by wind vanes.
2	4–7	4–6	Light breeze	Wind felt on face; leaves rustle; ordinary vane moved by wind.
3	8–12	7–10	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	13–18	11–16	Moderate breeze	Raises dust, loose paper; small branches are moved.
5	19–24	17–21	Fresh breeze	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25–31	22–27	Strong breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32–38	28–33	Moderate gale	Whole trees in motion; inconvenience felt walking against wind.
8	39–46	34–40	Fresh gale	Breaks twigs off trees; generally impedes progress.
9	47–54	41–47	Strong gale	Slight structural damage occurs; (chimney pots, slates, removed).
10	55–63	48–55	Whole gale	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64–72	56–63	Storm	Very rarely experienced; accompanied by widespread damage.
12	73–82	64–71	Hurricane	
13	83–92	72–80		
14	93–103	81–89		
15	104–114	90–99		
16	115–125	100–108		
17	126–136	109–118		

8230. INSTRUMENTAL. Instrumental measurement of a 1-minute mean speed will be made by one of the following methods:

8231. Using the $\frac{1}{10}$ mile indicator (statute or nautical), count the number of times the center lamp lights or the buzzer sounds during an exact 60-second interval. Apply the correction, from Table 14, appropriate to the type of anemometer in use.

TABLE 14.—*Corrections to indicated wind speeds*

(¼o- or one-mile anemometers)

Speed Indicated				
By 3-cup "S" type anemometer, m. p. h.	By 4-cup anemometer, m. p. h.	By 4-cup anemometer with beaded cups, m. p. h.	By small airway "SA" type anemometer, m. p. h.	Corrections in whole miles per hour
0* to 16	0* to 8	0* to 5	0* to 35	+1
17 to 26	9 to 12	6 to 13	35 to 57	0
27 to 35	13 to 16	14 to 20	(Corrections for higher velocities not determined; use zero.)	−1
36 to 44	17 to 20	21 to 27		−2
45 to 52	21 to 24	28 to 34		−3
53 to 61	25 to 28	35 to 41		−4
62 to 70	29 to 32	42 to 48		−5
71 to 79	33 to 36	49 to 55		−6
80 to 87	37 to 39	56 to 62		−7
88 to 96	40 to 43	63 to 69		−8
97 to 105	44 to 47	70 to 75		−9
106 to 114	48 to 51	76 to 82		−10
115 to 122	52 to 54	83 to 89		−11
123 to 132	55 to 58	90 to 96		−12
133 to 139	59 to 62	97 to 103		−13
140 to 149	63 to 65	104 to 110		−14
150 to 157	66 to 69	111 to 117		−15
158 to 166	70 to 73	118 to 124		−16
167 to 174	74 to 77	125 to 131		−17
175 to 184	78 to 80	132 to 138		−18
185 to 192	81 to 84	139 to 145		−19
193 to 200	85 to 88	146 to 152		−20
	89 to 91	153 to 158		−21
	92 to 95	159 to 165		−22
	96 to 99	166 to 171		−23
	100 to 103	172 to 178		−24
	104 to 106	179 to 185		−25
	107 to 110	186 to 192		−26
	111 to 114	193 to 200		−27
	115 to 117			−28
	118 to 121			−29
	122 to 125			−30
	126 to 128			−31
	129 to 132			−32
	133 to 136			−33
	137 to 140			−34
	141 to 143			−35

*Movement of anemometer cups observed.

8232. Condenser discharge indicators give an uncorrected mean value at the highest point reached on the scale during a single pulse or oscillation. Observe the face of the indicator over a period of one minute and take the mean of the corrected highest points reached by the meter needle during successive pulses or oscillations. Apply the correction indicated in Table 15.

TABLE 15.—*Corrections to indicated wind speeds*

(Condenser-discharge type anemometers)

A. Type "S" anemometer		B. Type "SA" anemometer	
Uncorrected speed (m. p. h.)	Correction (whole m.p.h.)	Uncorrected speed (m. p. h.)	Correction (whole m. p. h.)
0–59	0	0–87	0
60–69	−1	88–94	+1
70–79	−2	95–100	+2
80–100	−3		

8233. Direct-reading indicators and recorders usually indicate almost instantaneous values. (Note that the condenser-discharge indicator is not considered direct-reading since an instantaneous wind speed cannot be taken directly from the indicator.) Observe the indicator or recorder trace for a 1-minute period and take the mean of the high and low values of successive fluctuations. Apply to the mean value the correction furnished for the particular instrument. If no correction table has been furnished, the correction will be assumed zero.

8234. If it is impossible to obtain a wind speed from any indicator described above, the wind speed may be taken from a single or multiple register record. Determine the average speed over the 5-minute interval immediately preceding the observation and apply the appropriate correction from Table 14.

8235. When the anemometer cups are moving so slowly that a speed is not registered on the indicator, the speed will be regarded as one m. p. h. or one knot. When the anemometer cups are not moving, the wind speed is regarded as calm.

8300. CHARACTER OF WIND

8310. GUSTINESS. Gustiness is characterized by sudden, intermittent increases in speed, with at least 10 miles per hour or 9 knots variation (corrected) between peaks and lulls. The peak speed must reach at least 19 m. p. h. or 17 knots before the wind is characterized as gusty. Gustiness is termed "fresh" or "strong" depending upon the peak speed, as shown in Table 16.

TABLE 16.—*Gustiness*

Description	Peak speed	
	M. P. H.	Knots
Fresh	19–24	17–21.
Strong	More than 24	More than 21.

8311. Gustiness will be estimated from ⅒ mile (buzzer or light) indicators by noting the variations in the time interval between buzzes or flashes, and will be determined from direct-reading indicators by observing the pointer. Gustiness cannot be determined directly with the condenser-discharge type indicator, but an estimate can be made after successive fluctuations of the pointer have been noted.

8312. At stations equipped with gust recorders, the character of the wind may be taken from recorders.

8320. SQUALLS. (See par. 3310 for definition.) The intensity to be ascribed to squalls will be determined from the peak speed of the gusts, in accordance with Table 17.

TABLE 17.—*Intensity criteria for squalls*

Description	Speed of gusts	
	M. P. H.	Knots
Light	Not to exceed 24	Not to exceed 21.
Moderate	25–39	22–34.
Heavy	More than 39	More than 34.

8330. WIND SHIFTS. Wind shifts, as defined and used in this manual, are associated with the following phenomena, characteristic of a cold-front passage. These phenomena are:

(1) Gusty winds shifting in a clockwise manner in the Northern Hemisphere, i. e., south shifting to west, or southwest shifting to northwest (shifting counterclock-wise in the Southern Hemisphere).
(2) Rapid drop in the dew point.
(3) Rapid drop in temperature.
(4) Rise in pressure.
(5) In summer; lighting, thunder, heavy rain, and possibly hail.
(6) In winter; frequent rain or snow squalls with cloud heights changing rapidly—either to higher or lower heights than existed prior to the wind shift.

8332. In the Northern Hemisphere, whenever the wind shifts suddenly to a westerly or northerly quadrant, be alert for the characteristic changes accompanying a shift. If some of the changes accompanying a shift are noted before the wind changes direction or speed, watch for a clockwise shift of wind direction, an increase in speed, or a change in direction of low clouds.

8333. In flat regions, wind shifts without precipitation, but accompanied by strong winds, sometimes occur. The visibility may be greatly restricted by blowing dust over extensive areas.

8335. Use the criteria indicated in Table 18 in classifying wind shifts.

TABLE 18.—*Intensity criteria for wind shifts*

Accompanying phenomena	Intensity		
	Light	Moderate	Heavy
Both precipitation and a decrease in cloud heights.	Does not exceed 24 m. p. h., 21 knots.	Exceeds 24 m. p. h. but not 39 m. p. h., 21–34 knots.	Exceeds 39 m. p. h., 34 knots.
No precipitation nor decrease in cloud heights.	Does not exceed 34 m. p. h., 30 knots.	Exceeds 34 m. p. h. but not 49 m. p. h., 30–42 knots.	Exceeds 49 m. p. h., 42 knots.

CHAPTER 9. AIRWAY AND SUPPLEMENTARY OBSERVATIONS

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CHAPTER 9. AIRWAY AND SUPPLEMENTARY OBSERVATIONS

9000. GENERAL

9010. An observation is an evaluation of the meteorological situation at the point where the observation is taken. The component parts of an observation, when referred to in a general sense, are termed elements. The evaluation of the state of the various elements consists in observing them. Meteorological elements observed at or from the surface are usually limited to clouds, visibility, atmospheric phenomena, wet- and dry-bulb temperatures, precipitation, pressure, wind, and duration of sunshine.

9011. The terms "airway observation" and "synoptic observation" connote the assemblage of specified observational elements in a manner designed to satisfy meteorological and operational requirements. The instructions in this chapter are concerned principally with the various types of airway observations. Pilots' reports of meteorological phenomena encountered in flight are used to supplement airway observations.

9012. The observation of elements will be taken in the order given below, unless the sites of instrumental equipment require deviation:

(1) Sky
(2) Visibility
(3) Atmospheric phenomena
(4) Temperature
(5) Precipitation measurement
(6) Humidity
(7) Pressure
(8) Wind

Observation of the elements listed above will be taken in accordance with applicable instructions elsewhere in this manual. At designated stations visibility observations will be taken at the control tower or the approximate level of the control tower, as well as at the usual point of observation, whenever the visibility at the usual point of observation is less than three miles. Under these circumstances, visibility observations taken at the control tower will be used for all purposes, such as record, coding and summary that require visibility data (paragraph 11105.3). The observer will inform himself of the nature of the visibility-restricting phenomena at the control tower level.

9013. All scheduled observations will be started just sufficiently in advance of the time of transmission to permit accurate evaluation of all the elements.

9100. AIRWAY OBSERVATIONS

9110. GENERAL. Airway observations are primarily intended to provide (a) immediate weather information for aviation interests, and (b) data for climatologists. The observations are classified as record, special, record-special, local extra, and check. The time and conditions under which the observations are taken, and the elements observed, are specified in the following paragraphs. When two or more types of observations coincide, all the elements observed for each type will be included in the observation, with the exception specified in paragraph 9142.

9120. RECORD OBSERVATIONS. A record observation is taken at scheduled hourly intervals and will be prepared for teletype transmission at least two minutes prior to the time of entrance into the sequence in which it first appears. An observation at an off-teletype station will be telephoned or telegraphed to a relay station at a time to be specified in separate instructions.

9121. The elements listed below will be observed insofar as the instrumental equipment of the station permits:

(1) Ceiling
(2) Sky
(3) Visibility
(4) Weather
(5) Obstruction to vision
(6) Sea-level pressure
(7) Temperature
(8) Dew Point
(9) Wind direction, speed, character, and shifts
(10) Altimeter setting

9130. SPECIAL OBSERVATIONS. A special observation is taken to provide information on significant developments in meteorological conditions occurring at other than scheduled periods.

9131. The number of elements included in a special observation depends on the conditions being reported. The special observation may consist of only one element (e. g., tornado) or of most of those included in a record observation. Each of the elements that may be included in a special observation is listed in paragraph 9134.01 to 9134.10. Following each element is listed the magnitude or nature of the change in it that would require a special observation. Any element listed in paragraph 9132 may be reported alone as a special observation. When a change in one or more of the elements listed in paragraph 9133 requires a special observation, the additional elements listed beside them must also be included in the observation. When changes in two or more elements individually satisfy the criteria for a special observation, the elements will be included in a single special observation. In all cases, remarks will be added as required.

9132. When a change in one of the following elements satisfies the criteria for a special observation, it may be reported alone as a special observation.

(1) Tornado or waterspout
(2) Dust-storm and sand-storm
(3) Altimeter setting
(4) Wind shift and increases in wind speed

9133. When a change in one or more of the following elements satisfies the criteria for a special observation, the observation will include all the elements listed to the right of them:

Elements, a specified change in any one of which requires a special observation.	All elements below to be reported with any element in opposite column.
(1) Ceiling	Ceiling
(2) Sky	Sky
(3) Visibility	Visibility
(4) Weather	Weather
(5) Obstructions to vision	Obstructions to vision
	Wind

9134. CRITERIA FOR TAKING SPECIAL OBSERVATIONS. A special observation will be taken whenever one or more of the elements listed below have changed in the amount specified. The amount of change is with reference to the preceding record or special observation.

9134.01. CEILING.

(1) The ceiling after decreasing by 50% or more is 5,000 feet or less.
(2) A ceiling of 5,000 feet or less increases by 100% or more.
(3) The ceiling decreases to less than 1,500 feet or increases to 1,500 feet or more.
(4) The ceiling decreases to less than 1,000 feet, or increases to 1,000 feet or more.
(5) The ceiling decreases to less than 500 feet, or increases to 500 feet or more.
(6) The ceiling increases from zero to 100 feet or more.
(7) The ceiling decreases to a value equal to or lower than the highest airline operating minimum for the airport.
(8) The ceiling increases to a value equal to or higher than the highest airline operating minimum for the airport.

9134.02. SKY CONDITION.*

(1) A change in total sky cover from clear to broken or overcast, and vice versa; or from scattered to overcast, and vice versa.
(2) A change in sky cover from clear to scattered
    a. below 1,000 feet or
    b. at or below the highest airline operating minimum for the airport.

9134.03. VISIBILITY.

(1) The visibility after decreasing by 50% or more is 5 miles or less.

*Note that in some instances a special observation not required because of a change in sky condition might nevertheless be required because of an associated change in ceiling. For example, a change in total cloudiness from scattered to broken would not require a special observation in accordance with paragraph 9134.02 but if the clouds were 5,000 feet or less, a special observation would be required in accordance with paragraph 9134.01.

(2) The visibility having been five miles or less, increases by 100% or more.
(3) The visibility decreases to less than:
  (a) 3 miles
  (b) 1 mile
  (c) ¾ mile
  (d) ½ mile } C. A. A. ILS stations only
  (e) ¼ mile
(4) The visibility increases to equal or exceed:
  (a) 3 miles
  (b) 1 mile
  (c) ¾ mile
  (d) ½ mile } C. A. A. ILS stations only
  (e) ¼ mile
  (f) 1/16 mile

9134.04. TORNADO.
(1) Is observed
(2) Disappears from sight
(3) Is reported by the public to have occurred within preceding six hours.

9134.05. THUNDERSTORM.
(1) Begins
(2) Increases in intensity
(3) Ends. (Special observation 15 minutes after thunder is last heard at station.)

9134.06. PRECIPITATION.
(1) Hail begins or ends.
(2) Liquid precipitation begins or ends. An observation will be required 15 minutes after ending of rain showers and intermittent rain. Special observation not required to report the beginnings and endings of showers occurring simultaneously with continuous rain, or to report changes of showers to continuous rain and vice versa.
(3) Freezing precipitation begins or ends.
(4) Sleet begins or ends.
(5) Snow begins or ends. An observation will be required 15 minutes after ending of snow showers and intermittent snow. Special observation not required to report the beginnings and endings of snow showers occurring simultaneously with continuous snow, or to report changes of snow showers to continuous snow and vice versa.

9134.07. FOG.
(1) Beginning and ending of fog, ground fog, or ice fog, or a change from one type of fog to another.

9134.08. SAND-STORM, DUST-STORM.
(1) Is observed within 6 miles of station.
(2) Disappears from sight.

9134.09. WIND AND WIND SHIFTS.
(1) Sudden doubling of speed (over a one-minute interval) to more than 30 miles per hour (26 knots).
(2) Wind-shift.

9134.10. ALTIMETER SETTING. A change in altimeter setting, as shown by a change in station pressure, at the rate of 0.08 inch (2.7 mb.) or more per hour. Special observations owing exclusively to rapid changes in pressure as specified above will be taken at 15-minute intervals as long as this rate of change persists.

9134.11. The foregoing will be regarded as the minimum requirements for taking a special observation. In addition, any meteorological situation that, in the opinion of the observer, is of importance to the safety or efficiency of aircraft operations will be reported in a special observation.

9140. LOCAL EXTRA OBSERVATIONS. Local extra observations are taken, at designated stations, for local distribution only. The changes requiring a local extra observation are within

narrower limits than changes requiring a special observation. When a local extra observation reveals a change in conditions that requires a special observation, the local extra observation will be classified as a special observation and treated accordingly.

9141. At designated stations, local extra observations will be taken at intervals not exceeding 15 minutes, beginning whenever:

(1) Ceiling or visibility decreases to a value equal to or less than the highest airline minimum applying to the airport.
(2) The ceiling decreases to 500 feet or less.
(3) The visibility decreases to one mile or less.

9141.1. Local extra observations will be discontinued when values above these minimums have been reported. Record or special observations coming within the 15-minute interval will also serve as the local extra observation. The 15-minute interval will begin at the time of the record or special observation.

9141.2. Except when taken in accordance with paragraph 9142 and 9143 the observation will include the following elements:

(1) Ceiling
(2) Sky
(3) Visibility
(4) Weather
(5) Obstructions to vision

Remarks will be added as required.

9142. Local extra observations of one or more elements requested for aircraft arrivals or departures will be taken and recorded at designated stations, in the usual manner, even though weather conditions do not warrant taking a special observation.* In this case the name of the agency requesting the local extra observation will be noted under "Remarks."

9143. Local extra observations will be taken whenever ceiling or visibility changes to a value above, equal to, or below

a. the minimum prescribed for the airport, or
b. any air carrier minimum applicable to the local airport.

This requirement is applicable only when takeoffs and landings impend. Suitable arrangements will be made at each station to keep informed of scheduled arrivals and departures as well as of operations involving delayed schedules.

9144. An observation of all elements ordinarily included in a record observation will be taken immediately following any aircraft accident in the vicinity of an airport at which a weather-observing station is situated. (See Fig. 8.)

9150. CHECK OBSERVATIONS. Check observations will be taken at specified stations where scheduled broadcasts of local weather are made. The local schedule of broadcasting will determine the time of taking them. The check observation will be taken within 20 minutes of the scheduled time of local broadcast, preferably as near to the time of the broadcast as practicable. The 20-minute requirement is waived when a pilot balloon observation is being taken. (See paragraph 10220.) If the broadcast equipment is inoperative, check observations will not be taken. A notation indicating the period of and reason for the suspension of check observations will be entered on WBAN 10.

9151. The check observations will include the following elements:

(1) Ceiling
(2) Sky
(3) Visibility
(4) Weather
(5) Obstructions to vision
(6) Wind
(7) Altimeter setting

9160. CORRECTED REPORTS. A corrected observation will be coded and disseminated in accordance with instructions in paragraph 10080.

*If a special observation is also required, a local extra observation of the one or more elements requested will be filed, after which the other elements required for the special observation will be evaluated, and the special filed.

9200. PILOT REPORTS

9210. GENERAL. Pilot reports of meteorological phenomena encountered in flight are variously termed PIREPS, AFREPS, NYREPS, POREPS, RMREPS, ALREPS. Pireps will be used as a basic term for convenience of discussion. These reports of weather are an extremely valuable source of information that often is not otherwise available. Observers will cooperate to the fullest extent possible with pilots and with ground personnel of commercial airlines to secure all available pilots' reports promptly after each observation is taken by the pilot.

9211. All pilots' reports, except those pertaining to ceiling within 1½ miles of the airport boundaries, will be disseminated by Navy and Weather Bureau stations immediately as a pireps; Air Force stations will handle these reports in accordance with policies established by Wing and Group Commanders. When a pilot's report pertains to ceiling within 1½ miles of the airport boundaries, and the report differs from the ceiling value of the current weather observation in an amount that would require the filing of a special or local extra observation, personnel of all three services will proceed as follows:

1. If the current ceiling value is classified as measured,
   a. redetermine the ceiling value immediately;
   b. If the redetermined ceiling value is not classified as measured, disseminate the pilot's report of ceiling in the form of a local extra or special observation with the ceiling classified as aircraft;
   c. If the redetermined ceiling value is classified as measured, enter the pilot's report in parentheses on WBAN 10, for record purposes only.
2. If the current ceiling value is not classified as measured,
   a. Disseminate the pilot's report immediately as a pireps and then as a special or local extra observation with the ceiling classified as aircraft;
   b. Redetermine the ceiling value immediately;
   c. If the redetermined ceiling value is classified as measured, file a special or local extra observation reporting the value;
   d. If the redetermined ceiling value is not classified as measured, enter the redetermined ceiling value on WBAN 10 in parentheses, for record purposes only.

9212. When a ceiling value classified as measured cannot be obtained, a pilot's report of ceiling will be used in subsequent airway observations taken within the succeeding 15 minutes, provided the ceiling has not changed to a degree that makes the pilot's report of ceiling inapplicable.

9213. Pireps of the following elements will be given the same dissemination as a special observation:

(1) Local ceiling (observed within 1½ miles of airport boundaries)
(2) Tops of cloud layers
(3) Icing
(4) Winds aloft exceeding 60 m. p. h., or 52 knots
(5) Turbulence
(6) Hail
(7) Electric discharge
(8) Any other elements of meteorological or operational importance (e. g., reports of ceiling, visibility, precipitation, and the presence or absence of fog or clouds (a) through mountain passes, (b) over mountainous regions and (c) over coastal channels, bays, or sounds.)

9214. Pilot reports will be coded in accordance with instructions in section 10300.

9215. All pireps prepared for transmission will be distributed by interphone or equivalent means to local operations similarly to special observations as described in paragraph 10230.

9300. SUPPLEMENTARY OBSERVATIONS AND EVALUATION OF ELEMENTS

9310. REQUIREMENTS. The weather will be observed and the various elements evaluated between record observations as often as is consistent with the condition of the weather and the station workload deriving from other duties. Changing weather situations that might require a special or local extra observation will be watched most closely to insure that an observation will

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be filed promptly after the change necessitating it occurs. In the following paragraphs certain requirements are stated with respect to the frequency of observation and the evaluation of specified elements. These are minimum requirements that must be met unless specific exceptions for special purposes are made elsewhere.

9320. CEILING MEASUREMENTS. Whenever available, ceiling measuring instruments (ceiling light or ceilometer) will be used as frequently as observations are taken, provided clouds are present at the observation and it appears likely that a cloud-height measurement can be secured within a reasonable time.

9330. CEILING BALLOONS. Stations equipped with ceiling balloons but not with ceilometers will use the balloons during daylight hours, provided the intensity of any precipitation present (other than drizzle) is light. (See paragraph 1442.1.)

9331. At airway weather-observing stations where hourly observations for scheduled transmission are taken, balloons will be used as follows to determine the ceiling value reported in observations prepared for transmission:

(1) At the discretion of the observer when clouds are at an estimated height of 2,000 feet or more.
(2) At hourly intervals or more frequently when the clouds are between 1,000 and 2,000 feet unless the highest ceiling minimum for the commercial air carriers at the airport where the station is situated is above 1,000 feet.
(3) At half-hour intervals or more frequently, when the clouds are at or below 1,000 feet or when the clouds are at or below the highest ceiling minimum for commercial air carriers where the station is situated.

9332. At stations not taking hourly airway observations ceiling balloons will be used whenever the clouds are estimated to be less than 3,000 feet.

9340. PRESSURE. Station and sea-level pressure data will be derived from readings of the mercurial barometer, precision aneroid, or altimeter setting indicator every 6 hours at the time of the 6-hourly synoptic observations. If less than four synoptic observations are taken daily, the pressure data will be derived from one of these instruments whenever the synoptic observations are taken.

9341. For observations other than synoptic, station pressures will be taken from an aneroid barometer, barograph, or altimeter setting indicator, for which corrections have been established by comparison with a mercurial barometer.

9350. ALTIMETER SETTING. A new determination of the altimeter setting will be made whenever the information is requested and the latest determination was made 30 minutes or more before the request.

9360. MISCELLANEOUS PHENOMENA. Miscellaneous phenomena will be included in observations whenever the phenomena are considered to be of importance to forecasters or to aircraft operations. They will be coded in accordance with instructions in Chapter 11.

9370. RECENCY. All elements reported in an airway observation prepared for transmission will have been observed within the 15 minutes preceding the time of entry on WBAN 10A. This has particular reference to ceiling classification. For instance, a ceiling classified as "measured" more than 15 minutes before an observation, must be differently classified at the time of observation, if a measured ceiling could not be determined within the preceding 15 minutes.

9380. SYNOPTIC OBSERVATIONS. Data to be included in synoptic observations are those specified in current synoptic codes. The required data will be observed and evaluated in accordance with instructions in this manual.

9381. At the time of taking each 6-hourly synoptic observation, observe the following procedure:

(1) Make a time check mark on all recording instrument charts in accordance with paragraphs 5212, and 7243.

(2) Set the maximum and minimum thermometers in accordance with paragraphs 5162 and 5171.
(3) Measure the precipitation, if any, and empty all but the weighing type gages.
(4) Observe the state of the ground with respect to the form and amount of precipitation, if any, accumulated upon it, and observe whether the ground appears to be frozen hard. If dew alone is on the ground, the state of the ground will not be regarded as "wet."

9390. MIDNIGHT OBSERVATION. At midnight, local standard time, an observation of maximum and minimum temperatures and of precipitation, will be taken at all stations having personnel in duty status at that time. This observation must be considered when determining the maximum and minimum temperatures, and the total amount of precipitation, for the 6-hour period ending at the time of the first 6-hourly observation taken after midnight.

9391. The maximum and minimum thermometers will be reset after reading them, and the readings entered on WBAN 10. After the precipitation is measured, the gages, except the weighing type, will be emptied. The measurement will be entered on WBAN 10.

CHAPTER 10. DISSEMINATION AND TRANSMISSION OF AIRWAY AND PILOT REPORTS

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CHAPTER 10. DISSEMINATION AND TRANSMISSION OF AIRWAY AND PILOT REPORTS

10000. ELEMENTS IN THE AIRWAY CODE

10010. GENERAL. Airway observations are disseminated in a code that consists of symbols and numerals arranged in groups with relatively fixed positions. Word and phrase contractions or complete words are used in a specified manner to supplement the coded data.

10020. GROUPING OF ELEMENTS. The elements of the observation are placed in groups as specified below. Spaces separate Groups I to V; and oblique lines (slants), used as mechanical devices, separate numerical data that might otherwise be misinterpreted. Further instructions on use of slants are to be found in paragraphs 10030, and 11002. Reference to specific instructions for coding are listed beside each item below.

Group number	Element number	Element	Instructions paragraph number
I	1	Station identification	10120
II	2	Type of report	10130, 11101
III	3	Time of report	10140, 11102
IV	4	Ceiling and cloud height	11103
	5	Sky condition	11104
	6	Visibility	11105
	7	Weather	11106
	8	Obstructions to vision	11106. 2
V	9	Sea-level pressure	11107
	10	Temperature	11108
	11	Dew point	11109
	12	Wind	
	a.	Direction	11110
	b.	Speed	11111
	c.	Character	11112
	d.	Shifts	11112
	13	Altimeter setting	11113
VI	14	Remarks	11114

10021. The letter symbol "M" is used to indicate missing data, or data entered in parentheses (see par. 11020), pertaining to an element normally included in a report. Elements regularly omitted are indicative of data not observed at a particular station.

10030. HOURLY REPORTS. Data pertaining to record observations are coded in Groups I, IV, V, and VI. Slants rather than spaces are used to separate Group V from VI. Slants are also used within Group V between sea-level pressure and temperature, temperature and dew point, wind data and altimeter setting, altimeter setting and remarks. Additive data are separated by a slant and a space from the last element of the record observation with which they are transmitted.

EXAMPLE: DCA E38◍12 271/74/58←↙8/032/CIG VRBL 36 TO 40/ 2002

10040. SPECIAL REPORTS. Special reports invariably include Groups I through III, and remarks, if required. In addition they contain either one element only (Group IV- 7, V- 12 or V- 13), or Group IV plus V- 12, according as the instructions for special observations (Chapter 9) apply. When a significant change, as defined in Chapter 9, occurs in altimeter setting, Group V-13 is included in the special report. When a check report coincides with a special report, all the

elements of a check report, as stated in paragraph 10050 below, are included in the special report. When any combination of elements V- 12, V- 13 and Group VI appears in a special report they are separated from each other by slant symbols.

10050. CHECK REPORTS. Check reports are composed of Groups I, II, III, IV, V- 12, V- 13, and VI.

10060. LOCAL EXTRA REPORTS. Local extra reports are composed of Groups I, II, III, IV, and VI.

10070. Group VI will contain pertinent general remarks, RAFRZ, RAICG, and 700-mb. data and PIREPS as required. These data will be transmitted with hourly (not 3- or 6-hourly) airway reports, with the exception of general remarks and pireps, which may be transmitted at any time.

10080. CORRECTED REPORTS. A report correcting a previously transmitted report will be identified by the letters "CQN" immediately preceding the station identification. The report will include Groups I and III; if the observation to be corrected is a special, record-special, or local extra report, the correcting report will also include Group II. If an error in a record, or record-special observation is discovered within the hour after the observation has been transmitted on the teletype, a complete corrected observation will be filed immediately, regardless of special observations that might have been transmitted in the meantime. If an error is discovered in a special or local extra observation before the next succeeding observation is given teletype or local distribution, a corrected observation will be filed. If an error is discovered in a check observation, a corrected observation will be given to the broadcaster. When more than an hour has elapsed before an error in a transmitted observation has been discovered at the originating station, a corrected report will not be transmitted.

10100. CODING FOR TELETYPE TRANSMISSION

10110. GENERAL. Instructions in Chapter 11 will be observed in coding individual elements of observations for teletype and radio distribution. Instructions for the coding of station identification, type of report, and time ascribed to observation follow.

10120. STATION IDENTIFICATION. The station identification is a three letter symbol assigned to the station for use in teletype transmissions. These symbols are listed in Federal Airways Manuals of Operations of the Civil Aeronautics Administration.

10130. TYPE. Record-type reports prepared at hourly intervals for scheduled sequence teletype transmission are not identified by any symbol in teletype transmission. Special and record-special reports are identified by the letter "S" followed by a serial number. Serial numbers are assigned consecutively for each day. Number 1 is the first special or record-special report filed for transmission on or after 0000, local standard time, of a given day. Local extra reports transmitted on local teletype circuits are identified by the contraction "LCL."

10140. TIME. The time of record and record-special observations is not included in the report, since the time of the sequence in which the reports are included appears at the heading of the sequence collection. The time of the sequence collection may therefore be used as a reference time. However, a corrected report of a record observation will include the sequence time of the record observation immediately following the station identification. The time of special and local extra reports is the local standard time of making the last entry on WBAN 10. In special and local extra reports, when coded for teletype transmission, the time, in four figures, is followed by the correct time zone indicator selected from Table 19, except that AF stations and other designated stations will use Greenwich mean time and the indicator "Z."

TABLE 19.—*Standard time zones and indicators*

Time zone	Indicator	Time zone	Indicator
Eastern	E	Alaskan	A
Central	C	Bering	B
Mountain	M	Yukon	Y
Pacific	P		

10200. FILING FOR DISSEMINATION

10210. GENERAL. Record and special airway observations will be transmitted by teletype or radio where suitable facilities are available. These transmissions will be made in accordance with communication manuals specified by the individual services.

10220. SCHEDULED BROADCASTS. At stations having broadcast facilities, observations filed for use in scheduled broadcasts will be the most recent and, if practicable, they will have been taken just prior to the broadcast, but at least within 20 minutes of the scheduled time of the broadcast. However, the 20-minute requirements may be disregarded when a pilot balloon is being observed. Under these circumstances the assumption will be that, in the absence of a special observation, there have been no significant changes in weather.

10230. LOCAL DISTRIBUTION. All observations of a change in weather will be distributed locally by interphone, telautograph, telephone, etc., to military agencies, local airline offices, Civil Aeronautics Administration facilities requiring them, and other agencies requesting them. When observations are communicated, acknowledgment should be received from recipients, if possible, and noted on WBAN 10.

10231. Altimeter settings based on mercurial barometer, precision aneroid, or altimeter setting indicator readings at the time of the 6-hourly synoptic observations will be interphoned to local operations immediately after their determination. These readings are required for purposes of comparison and are in addition to those normally transmitted in observations to local operations.

10300. CODING OF PILOT REPORTS

10310. GENERAL. When pilot reports are received by weather-observing personnel they will be coded in accordance with the following instructions. All reference to heights of phenomena encountered in flight will be expressed in hundreds of feet to the nearest hundred above mean sea level, indicated by the letters "MSL".[1] Authorized weather symbols, international cloud abbreviations, word and phrase contractions will be used or, if they are lacking, complete words.

10311. All phenomena having an authorized symbol (see Tables 26 and 27) will be reported in symbol form followed, if required, by the appropriate intensity indicator. "U" will be used for "intensity unknown." If the phenomenon has been reported in general terms by the pilot ("precipitation" without indication of rain or snow, etc.) the phenomenon and its intensity will be reported in an authorized phrase contraction, or lacking that, in one or more complete words.

10320. CODING OF ELEMENTS. In general, the order of coding will be:
(1) Station identification.
(2) Time of entering pilot report on WBAN 10.
(3) The term PIREPS, or authorized equivalent (AFREPS, etc.)
(4) Location or extent of phenomena with respect to a well-known point.
(5) Time of pilot's observation, whenever known.
(6) Phenomena reported.
(7) Altitude.
(8) Type of aircraft, whenever known.

10321. ICING. Code pilot reports of airfoil icing conditions as follows:
(1) Use the contraction "ICG" with indication of intensity and type, if known. For example:

ICG TRACE=Trace of ice.
LGT RIME ICG=Light rime icing condition.
MDT ICG=Moderate icing condition.
HVY ICG=Heavy icing condition.

(2) Code the height of the base and top of the icing area whenever known. Use slants to indicate that the base or top of the icing area is unknown.

[1] NOTE.—Pilot reports of cloud heights used as a ceiling in an airway observation will be converted to feet above the surface by the observer and coded in the intervals given in Table 21.

EXAMPLES:

The pilot of a Stinson, flying between Seattle and Oakland, reports to Medford that at 0700 PST he encountered light icing conditions 5 to 20 miles north of Eugene, Oreg., at 2,000 feet MSL; the top of the icing was not reported:

MFR 0715P PIREPS 5-20 N EUG 0700P LGT ICG 20—// MSL STSN

The pilot of an F-38 flying between Oakland and Burbank reports that he encountered heavy icing conditions at 0925 PST over mountains north of Burbank, with the top of the icing at 11,500 MSL, base unknown (note that AF stations use GCT.):

SRF 1731Z AFREPS MTNS N BUR 1725Z HVY ICG //—115 MSL F38

10322. ELECTRICAL DISCHARGE OR LIGHTNING STROKE. Use the word "DISCHARGE."

EXAMPLES:

A pilot flying a PBY between Richmond, Va., and Washington, D. C., reports to Washington that at 1620 EST his aircraft experienced an electrical discharge 20 miles south of Washington at an altitude of 5,000 feet MSL:

DCA 1629E NYREPS 20 S DCA 1620E DISCHARGE 50 MSL PBY

The pilot of a Flying Fortress enroute from St. Louis, Mo., to Chicago, Ill., reports to Chicago that at 1515 CST his plane experienced an electrical discharge over the Kankakee River at an altitude of 2,500 feet MSL:

CHI 1535C RMREPS 15 S JOT 1515C DISCHARGE 25 MSL B17

10323. TURBULENCE. Use the contraction "TURBC" followed by an indication of intensity as illustrated in the following list:

LGT TURBC=Light turbulence.
MDT TURBC=Moderate turbulence.
HVY TURBC=Heavy turbulence.

EXAMPLES:

A pilot reports to Kansas City, Missouri, that his C-54 encountered heavy turbulence at 2330 CST, 10 miles northeast of Knoxville, Tenn., at 6,000 feet MSL:

MKC 2335C AFREPS 10 NE TYS 2330C HVY TURBC 60 MSL C54

The pilot of a DC-3 flying at 10,000 feet MSL through Donner Summit Pass, Calif., reports to Reno, Nev., that light turbulence is being experienced 1050 PST.

RNO 1055P ALREPS OVR DOS 1050P LGT TURBC 100 MSL DC3.

10324. HAIL. Use the authorized teletype symbol for hail and indicate the intensity in the same manner as in weather reports of hail. Use the symbol "U" to indicate unknown intensity.

NOTE: It is quite possible that a pilot report of hail will be added to a report of turbulence and electrical discharge. All these phenomena may be included in the same "Pireps".

EXAMPLES:

The pilot of a DC-4 reports to Omaha, Nebr., at 1617 CST that he is flying through moderate hail 10 miles south at an altitude of 3,500 feet MSL:

OMA 1619C PIREPS 10 S OMA 1617C A 35 MSL DC4.

At 1628 CST the same pilot reports that he is flying in light hail and heavy rain, with heavy turbulence at 3,000 feet MSL, 15 miles southwest of Omaha, and that at 5,000 feet MSL his plane had experienced a discharge:

OMA 1635C PIREPS 15 SW OMA 1628C HVY TURBC R+A— 30 MSL DISCHARGE 50 MSL DC4.

10325. WINDS ALOFT EXCEEDING 60 MILES PER HOUR OR 52 KNOTS. Code winds aloft reported to exceed 60 mph or 52 knots as follows:

(1) Use the contraction "WND".

(2) Code true direction from which the wind is blowing in 3 figures representing the degrees of the compass, to the nearest 10 degrees.
(3) Use figures to code the wind speed in miles per hour or knots.

EXAMPLES:

At 0845 CST the pilot of an F–80 reports to Bismarck, N. Dak., that he is encountering an 82-knot wind west of Bismarck at 6,000 feet MSL, wind direction 80 degrees:

BIS 0850C AFREPS W BIS 0845C WND 080 82 KNOTS 60 MSL F80

At 1215 CST the pilot of a PBY reports to Madison, Wis., that he is encountering a 72-knot wind from 240 degrees, 20 miles southeast of the station, at 8,500 feet MSL.

MSN 1225C NYREPS 20 SE MSN 1215C WND 240 72 KNOTS 85 MSL PBY

10326. TOPS OF OVERCAST. Use the contraction "TOVC".

NOTE:—Intervals used in reporting ceiling heights are not applicable to pilot reports of tops of overcast.

EXAMPLES:

The pilot of a B–24 flying over Navasota, Tex., at 0613 CST reports to Houston that the top of the overcast is at 8,500 feet MSL:

HOU 0618C AFREPS OVR AVS 0613C TOVC 85 MSL B24

If the plane had been 15 miles southeast of Navasota when the pilot determined the height of the top of the overcast, the coded report would read:

HOU 0618C AFREPS 15 SE AVS 0613C TOVC 85 MSL B24

10327. CEILING HEIGHTS. Use the contraction "CIG".

EXAMPLES:

The pilot of a DC–3 flying over Washington, D. C. reports at 1110 EST to Washington that the ceiling is 1,500 feet MSL:

DCA 1118E PIREPS OVR DCA 1110E CIG 15 MSL DC3

A pilot flying between Casper and Sheridan, Wyo., reports to Sheridan that the ceiling over Kaycee is 14,000 feet MSL. The type of aircraft was not reported, nor the time of the observation.

SHR 1850M PIREPS 65 S SHR CIG 140 MSL

Entries on WBAN 10

CHAPTER 11. ENTRIES ON FORM WBAN 10 (REVISED)

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CHAPTER 11. ENTRIES ON FORM WBAN 10 (REVISED)

11000. GENERAL

11001. Form WBAN 10 revised, consisting of parts A, B, and D, will constitute the basic original record of surface observations at all stations at which the form is prepared. A new WBAN 10A–B will be started for recording each day's observations, beginning with the first observation at or following 0000 local standard time, as defined below. One page of WBAN 10B and as many pages of WBAN 10A as are needed will be used for each day. WBAN 10D will be prepared monthly in accordance with instructions on the form.

11002. Enter observations as legibly as possible in chronological order, restricting data, so far as possible, to the columns appropriate to them as indicated by the column headings. Ditto marks will not be used. At stations where the form is used by the communications operator directly, slants to separate data in the airway code may be used as specified in Chapter 10.

11003. The name of the station and date will be entered in the spaces provided.

11010. MISSING DATA. The symbol "M" will be entered only for missing data normally recorded. Appropriate notes explaining the missing data will be entered in column 90.

11020. STATISTICAL DATA. Data entered in parentheses are for statistical purposes only (see pars. 11109 and 11419) and are not to be transmitted as an element of an airway observation. (See paragraph 10021.)

11030. CORRECTION OF ENTRIES. When incorrect data have been entered, corrections will be made as follows:

11031. If the error is discovered before the report is transmitted, the erroneous entry will be erased and correct entry made.

11032. If an error is discovered in an observation after the report is transmitted, a red line will be drawn through the erroneous entry only and the correction entered in red immediately above it. If a correction is transmitted, enter the phrase "CQN (Time)" in red in column 14 of the erroneous observation. Carbon copies, if prepared, need not be corrected in red.

11040. TIME. For the purpose of securing a uniform understanding of time for use in Form WBAN 10, certain definitions are established as follows:

11041. GREENWICH CIVIL TIME. Greenwich Civil Time (G. C. T.) is sometimes called "universal time" because time used in most other parts of the world is derived from G. C. T. Greenwich Civil Time is the local civil time, standard time, and zone time within the time zone of Greenwich (0° longitude).

11042. LOCAL STANDARD TIME. In the United States, standard time zones have been established by law, and the time within these zones is the mean solar time at the meridians in Table 20. The time based upon any of the standard time meridians can be converted to G. C. T. by adding one hour for each 15° of longitude west from Greenwich. A conversion table follows:

TABLE 20.—*Meridians of standard time zones and conversion to G. C. T.*

Standard Time Zone	Meridian	To convert to G. C. T., add—
Atlantic Standard Time	60°	4 hours.
Eastern Standard Time (EST)	75°	5 hours.
Central Standard Time (CST)	90°	6 hours.
Mountain Standard Time (MST)	105°	7 hours.
Pacific Standard Time (PST)	120°	8 hours.
Yukon Standard Time (YST)	135°	9 hours.
Alaskan Standard Time (AST)	150°	10 hours.
Bering Standard Time (BST)	165°	11 hours.

11100. WBAN 10A

11101. TYPE. (Col. 1.) The type of report will be indicated by one of the following designations:

(1) *R* Record observation.
(2) *S* (followed by serial number) Special observation. Serial numbers are assigned consecutively for each day. Number 1 is the first special (or record-special) filed for transmission on or after 0000, LST, of a given day.
(3) *RS* (followed by serial number) Record-special observation.
(4) *L* Local extra observation.
(5) ✓ Check observation. (If a check observation requires local extra procedure, enter "L.")
(6) 6*H* Six-hourly (not applicable to AF stations).

11102. TIME ENTRIES. (Col. 2.) The time ascribed to an observation is that of the last entry on Form WBAN 10. Entries will be in local standard time to the nearest minute in terms of the 24-hour clock. The first two figures will indicate the hour, and the last two the minutes. For example, 0000 indicates the beginning of the day; 0235 indicates 2:35 A. M.; 1346 indicates 1:46 p. m.; 2359 indicates the end of the day.

11103. CEILING. (Col. 3.) Enter the ceiling as required by Table 21. When a value is half-way between two reportable values, the lower value will be selected, e. g., 50 feet will be entered as "0." Prefix an appropriate classification symbol selected from Table 22 to each ceiling value. All heights pertaining to symbols for sky condition (see par. 11104) are with reference to height above surface, not above sea level, except heights that may be recorded in Column 14 as a part of a pireps.

TABLE 21.—*Reportable ceiling values*

0 to 5,050 feet	To nearest 100 feet, in hundreds of feet.
5,051 to 9,750 feet	To nearest 500 feet, in hundreds of feet.
Above 9,750 feet	To nearest 1,000 feet in hundreds of feet.

TABLE 22.—*Ceiling classification symbols*

A	Ceiling reported from aircraft
B	Balloon ceiling
E	Estimated ceiling
M	Measured ceiling
P	Precipitation ceiling
W	Indefinite ceiling

11103.1. Whenever the ceiling is observed as variable, the range of variability will be recorded in column 14 (see Table 29, items 1–2). If the variable ceiling is less than 2,000 feet, the letter V will be entered immediately after the ceiling value.

11103.2. An entry is required in column 3 when 0.6 or more of the sky is covered by obscuring phenomena not classified as thin and by clouds. Note that the height ascribed to obscuring phenomena for entry in column 3 is the vertical visibility into the phenomena and not the base of the phenomena.

11103.3. If a thin obscuration is present, an entry will be made in column 3 only if
(1) Clouds are visible above the thin obscuration, or
(2) Clouds cover more than 0.6 of the sky below the thin obscuration. (See Table 24.)

NOTE.—See Table 24 for illustrations of entries in column 3; see Table 29, items 3–6, 10–12, for instructions for recording in column 14 heights of cloud layers not recorded in column 3, and bases of obscuring phenomena above the surface.

11104. SKY. (Col. 4) Record state of the sky in terms of the standard teletype symbols, or combinations* of them, listed in Table 23. See Table 24 for illustration of entries in column 4

*The symbol for clear will not be used in combination with any other sky condition symbol.

under various sky conditions. See Table 29 for instructions on reporting in column 14 cloud layers not reported in column 4.

11104.1. The symbols ⦶, ◍, and ⊕ may be modified by the prefixes plus (+) and minus (−) for dark and thin clouds respectively. The symbol X may be modified by the prefix minus (−) for thin obscuration.

TABLE 23.—*Sky-condition symbols*

Symbol and meaning	Explanation
X Obscuration	0.6 or more of the sky obscured by precipitation or obstructions to vision either alone or in combination with lower clouds, and irrespective of higher clouds.
○ Clear	Less than 0.1 total sky cover, or less than 0.6 obscuring phenomena with clouds not visible.
⦶ Scattered Clouds	0.1 to less than 0.6 sky cover.
◍ Broken Clouds	0.6 to 0.9 sky cover.
⊕ Overcast	More than 0.9 sky cover.

11104.2. HEIGHT OF SCATTERED CLOUDS. The height of scattered clouds immediately precedes the sky condition symbol to which it applies whenever (1) the symbol appears alone, e. g., 20⦶, or (2) the symbol is the second in a combination of sky condition symbols, e. g., ⦶20⦶. In all other cases the height of scattered clouds is reported in column 14. (See Table 29.)

TABLE 24.—*Examples of entries in columns 3, 4, and 14 under various sky conditions*

NOTE:—This table illustrates conditions requiring not more than two sky-condition symbols. (See Table 29 for instructions on reporting additional symbols in column 14.)

Conditions observed	Col. 3	Col. 4	Col. 14
CLOUDS ALONE VISIBLE			
1. Less than 0.1 of sky covered		○	
2. 0.1–0.5 of sky covered by one layer		240⦶	
3. 0.1–0.5 of sky covered by two layers		⦶18⦶	130⦶
4. 0.6–0.9 of sky covered by one layer	M65	◍	
5. 0.6–0.9 of sky covered by two layers:			
a. Lower layer covering less than 0.6 of sky	M25	◍10⦶	
b. Lower layer covering 0.6–0.9 of sky	A27	◍◍	E50◍
6. More than 0.9 of sky covered by one layer	M26	⊕	
7. More than 0.9 of sky covered by two layers:			
a. Lower layer covering less than 0.6 of sky	M140	⊕35⦶	
b. Lower layer covering 0.6–0.9	M35	⊕◍	M75⊕
OBSCURING PHENOMENA ALONE VISIBLE			
8. Less than 0.6 of sky obscured		○	BASE K LYR W E20
9. 0.6 or more of sky obscured by one layer:			
a. Sky overhead visible		−X	BASE K LYR E5
b. Sky overhead not visible	P2	X	
COMBINATIONS OF CLOUDS AND OBSCURING PHENOMENA VISIBLE			
10. Obscuration beneath clouds:			
a. 0.9 or less of sky covered by combination:			
(1) Sky or clouds overhead not visible through obscuration but visible at horizon	W8	◍X	E50◍
(2) Sky or clouds overhead visible through obscuration	M45	◍−X	
b. More than 0.9 of sky covered by combination:			
(1) Sky or clouds overhead not visible through obscuration but visible at horizon	W8	⊕X	E30⊕
(2) Sky or clouds overhead visible through obscuration	M50	⊕−X	

TABLE 24.—*Examples of entries in columns 3, 4, and 14 under various sky conditions*—Continued

Conditions observed	Col. 3	Col. 4	Col. 14
COMBINATIONS OF CLOUDS AND OBSCURING PHENOMENA VISIBLE—continued			
11. Obscuration above clouds:			
a. Less than 0.6 clouds:			
(1) Obscuration not thin	W25	X10◑	BASE K LYR E23
(2) Thin obscuration		−X10◑	BASE H LYR E50
b. 0.6 or more clouds:			
(1) Obscuration not thin	E25	X◍	BASE H LYR E48
(2) Thin obscuration	M18	−X◍	BASE H LYR E50
12. Obscuring phenomena at the same level as, or beneath, clouds with obscuring phenomena alone covering less than 0.6 of sky:			
a. Total sky cover less than 0.6		45◑	LWR K LYR W
b. Total sky cover 0.6–0.9	M48	◍	K LYR N
c. Total sky cover more than 0.9	E180	⊕	K LYR S
13. Obscuring phenomena above clouds with 0.1–0.5 total sky cover		25◑	K LYR E80

Note that if summation of obscuring phenomena and lower clouds is 0.6 or more, an obscuration exists, and item 11 applies.

11105. VISIBILITY. (Col. 5.) Enter the prevailing visibility, selecting the closest corresponding value from Table 25. When the prevailing visibility is exactly half-way between two of the values, select the lower value.

TABLE 25.—*Table of values for recording visibility in columns 5 and 14*

Fractional increments	1-mile increments when visibility is 3 to 15 miles, inclusive. 5-mile increments when visibility is more than 15.
0	1
1/16, 1/8	1¼
1/8	1½
3/16	1¾
¼	2
5/16	2¼
⅜	2½
½	
5/8	
¾	

11105.1 VARIABLE VISIBILITY. Whenever the visibility is variable, the range of variability will be recorded in column 14 (See Table 29, item 13). If the prevailing visibility is less than 2 miles, the letter "V" will be entered immediately after the visibility value.

11105.2. A plus sign (+) will be entered following the figure 15 when the visibility is estimated to be more than 15 miles and the most distant visibility marker is 15 miles or less.

11105.3. CONTROL TOWER VISIBILITY. When the visibility at the usual level of observation is less than 3 miles, the visibility at the control tower level will be recorded in column 5 at Weather Bureau stations participating in the control tower visibility program. The visibility at the usual point of observation, when it differs from that at control tower level, and the height of the restricting phenomena, when known, will be recorded in column 14. (See Table 29, item 15.)

11105.4. See Table 29, item 14, for recording visibility differing in various quadrants in column 14.

11106. WEATHER AND OBSTRUCTIONS TO VISION. (Col. 6.) Entries of weather

and obstructions to vision will be made in accordance with Tables 26 and 27. Two or more entries for a single observation will be made in the following order:

(1) Tornado (or waterspout).
(2) Thunderstorm.
(3) Liquid precipitation, in the order of decreasing intensity.
(4) Freezing precipitation, in the order of decreasing intensity.
(5) Frozen precipitation, in the order of decreasing intensity.
(6) Obstructions to vision in the order of decreasing predominance, if discernible.

Note that an entry is required in column 6 whenever the visibility is less than 7 miles.

11106.1. WEATHER AND INTENSITY. Enter the character of hydrometeors and other phenomena occurring at the time of observation in printed letter symbols in accordance with Table 26.* Use a plus sign after symbols for precipitation and squalls to indicate a heavy degree of intensity and a minus sign to indicate a light degree; the absence of any sign indicates moderate intensity. (See also paragraphs below captioned Thunderstorms and Tornados, and Waterspouts.)

TABLE 26.—*Symbols for weather*

TORNADO or WATERSPOUT (always written out in full)			
T+	Heavy Thunderstorm	S	Snow
T	Thunderstorm	SW	Snow Showers
R	Rain	SP	Snow Pellets
RW	Rain Showers	SG	Snow Grains
L	Drizzle	IC	Ice Crystals
ZR	Freezing Rain	A	Hail
ZL	Freezing Drizzle	AP	Small Hail
E	Sleet	Q	Squall

11106.11. PRECIPITATION. Precipitation of a showery or intermittent character not occurring at the time of observation will be reported in remarks (Table 29, item 19) for a period not exceeding 15 minutes after cessation of active precipitation.

11106.12. SQUALLS. A squall observed within 15 minutes of the observation will be reported in the symbol Q. When precipitation occurs at the time of observation and squalls occur at the same time or within 15 minutes prior to it, the precipitation will be coded in the symbols appropriate to its character and form (R—, RW, etc.) and prefixed to the squall symbol, e. g., RWQ, S—Q, etc.

11106.13. THUNDERSTORMS. Thunderstorms will be reported if 15 minutes or less have elapsed since thunder was last heard. Thunderstorms are reported as either heavy or moderate; that is, all thunderstorms not classified as heavy are reported as moderate.

11106.14. TORNADOS AND WATERSPOUTS. The direction of a tornado or waterspout from the station will immediately follow the term TORNADO or WATERSPOUT. (See Table 29, item 16, for entries in column 14.) Tornados and waterspouts will be reported without indication of intensity.

NOTE.—See Table 29, items 16–19, for additional information concerning weather to be reported in column 14.

11106.2. OBSTRUCTIONS TO VISION. Enter obstructions to vision in printed letter symbols in accordance with Table 27.

TABLE 27.—*Symbols for obstructions to vision*

F	Fog	IF	Ice Fog
GF	Ground Fog	H	Haze
BS	Blowing Snow	K	Smoke
BD	Blowing Dust	D	Dust
BN	Blowing Sand		

NOTE.—See Table 29, items 15 and 20, for additional information concerning obstructions to vision to be reported in column 14.

*See Table 29 for instructions for reporting intermittent and showery precipitations occurring within 15 minutes prior to the observation.

11107. SEA-LEVEL PRESSURE. (Col. 7) The initial "9" or "10" of the sea-level pressure will be omitted and the pressure will be entered as three figures (without a decimal point) representing tens, units, and tenths of millibars; e. g., 1013.2 would be entered as 132.

NOTE.—See Table 29, items 21 and 22, for reporting pressure data in column 14.

11108. TEMPERATURE. (Col. 8) Enter the dry-bulb temperature to the nearest whole degree Fahrenheit. Prefix a minus sign to temperatures below zero.

11109. DEW POINT. (Col. 9) Enter the dew point temperature to the nearest whole degree Fahrenheit. Prefix a minus sign to dew point temperatures below zero. Whenever the air temperature is below −35° F., the wet-bulb temperature will be regarded as the same as the dry-bulb temperature. Determine the corresponding dew point, with respect to water (see par. 6010.1), and enter this value in col. 9 in parentheses. (See par. 11020.)

11110. WIND DIRECTION. (Col. 10) Enter the wind direction to sixteen points of the compass by means of one or two short arrows, as shown in Table 28. When the wind is calm, make no entry in this column.

TABLE 28.—*Wind direction symbols*

↓ North	↑ South
↓↙ North-northeast	↑↗ South-southwest
↙ Northeast	↗ Southwest
←↙ East-northeast	→↗ West-southwest
← East	→ West
←↖ East-southeast	→↘ West-northwest
↖ Southeast	↘ Northwest
↑↖ South-southeast	↓↘ North-northwest

11111. WIND SPEED. (Col. 11) Enter the wind speed in units specified by the individual Services. If the wind speed is estimated, enter the letter E immediately following the speed. Enter C for calm.

11112. WIND CHARACTER AND SHIFTS. (Col. 12) Entries will be made without spaces to separate the data. The data will be entered in the following order.

11112.1. CHARACTER. When gustiness is present, enter in column 12 a minus sign to indicate fresh gusts, and a plus sign to indicate strong gusts (Table 16). When gustiness and a wind shift occur together, record the wind shift immediately following the intensity of the gustiness, without a space.

11112.2. WIND SHIFTS. Enter the direction of the wind before the shift to sixteen points of the compass with short arrows followed by the local standard time of the shift (24-hour clock) and a letter denoting the local standard time zone. Indicate the intensity of the shift after the time-zone indicator by a plus sign for a heavy shift, a minus sign for a light shift; the absence of a sign indicates moderate intensity. For example, if a heavy wind shift occurred from southeast to northwest in the Central time zone at 1614, the entry in the column would be "↖1614C+." Since the space provided in column 12 is not sufficient for wind shift data, distribute all wind data evenly among columns 10, 11, and 12.

NOTE.—See Table 29, item 23, for instructions on reporting peak speed of gusts in column 14.

11113. ALTIMETER SETTING. (Col. 13) Entries will be made in this column only at stations equipped with a mercurial barometer that is used to establish corrections for an altimeter setting indicator, barograph, or precision aneroid. Record the altimeter setting as three figures without a decimal point to represent units, tenths, and hundredths of inches. For example: 29.92 would be entered as 992.

11113.1. When the altimeter setting is the only element reported in a special observation, it will be preceded by the authorized contraction "ALSTG."

11114. REMARKS. (Col. 14) Certain conditions require the addition of explanatory remarks to the report. Instructions concerning conditions that require further explanation, or exclusive reporting, in column 14, together with examples of their use, have been condensed in

Table 29. The examples are not exhaustive, and when conditions other than those illustrated occur, the observer will amplify the report with such remarks as he judges to be pertinent to the meteorological situation and useful to the users of the data.

11114.1. When intensity of phenomena remote from the station cannot be determined, the symbol "U" will be placed after the symbol for the phenomena to indicate intensity unknown.

TABLE 29.—REMARKS: *Instructions and illustrations*

Conditions observed	Instructions for entry in column 14	Illustrations	
		Cols. 3–7 or 12	Col. 14
CEILING, CLOUD HEIGHTS, SKY			
1. Variable ceiling below 2000 feet.	Enter range of variability	M4V	CIG VRBL 2 TO 6
2. Variable ceiling 2000 feet or more.	Enter range of variability	M27	CIG VRBL 25 TO 30
3. Two broken, or overcast and broken, layers.	Enter classification, height, and symbol for upper layer.	M17◐◐ M28⊕◐	E31◐ E220⊕
4. Two scattered layers	Enter height and symbol for upper layer.	◐27◐	120◐
5. Intermediate broken layers between broken, or broken and overcast, layers.	Enter classification, height, and symbol for intermediate layers following entry for highest layer. See also item (3).	M47⊕◐	E140⊕E70◐E60◐
6. Several scattered layers below broken (or overcast) layer.	Enter height and symbol for scattered layers below the two highest layers.	E75◐55◐	35◐20◐
7. Variable sky condition	Enter corresponding sky condition symbols, separated by letter V.	33◐	◐V◐
8. Breaks in overcast	Enter contraction BINOVC, followed, if possible, by location of breaks.	M25⊕	BINOVC W
9. Special cloud types:			
(a) Towering cumulus	Enter appropriate abbreviations, as illustrated, followed by location of clouds, if practicable.	30◐	TWRG CU S
(b) Cumulonimbus		46◐	CB NW
(c) Cumulomammatus		M55⊕	CM OVHD
(d) Altocumulus castellatus		120◐	ACC SW
10. Less than 0.6 of the sky obscured and clouds not visible.	Enter nature and location of obscuring phenomenon.	○	K LYR E
11. 0.6 or more of sky obscured, base of obscuring phenomenon above surface.	Enter base and nature of obscuring phenomenon. (Note that if the obscuring phenomenon is at the surface the height of the base will not be entered in column 14.)	W7X	BASE K LYR E5
12. More than one layer of obscuring phenomena.	Enter character and elevation of additional layers.	−X	BASE K LYR E5 UPPER H LYR E80
VISIBILITY			
13. Variable prevailing visibility:			
(a) Less than 2 miles	Enter range of variability	1V	VSBY VRBL ½ to 1¾
(b) 2 miles or more		2	VSBY VRBL 1¼ to 3
14. Visibility differing in different quadrants:			
(a) Prevailing visibility less than 3 miles.	Enter visibility in each quadrant beginning with N or NE.	2½	VSBY N2E2½ S1¼W2½
(b) Prevailing visibility 3 miles or more.	Enter visibility in quadrants in which visibility differs by ½ or more or 100% or more from prevailing visibility.	4 5	VSBY S1½W10 VSBY E2
15. At designated stations—visibility differing at level of control tower from that at level of usual observation point; prevailing visibility less than 3 miles from latter point.	Enter visibility at level of usual observation point and height of visibility restricting phenomenon.	5	SFC VSBY 2 GFDEP 40

TABLE 29.—REMARKS: *Instructions and illustrations*—Continued

Conditions observed	Instructions for entry in column 14	Illustrations	
		Cols. 3–7 or 12	Col. 14
WEATHER			
16. Tornado and waterspout:			
(a) Observed from station	Enter direction toward which tornado or waterspout is moving. Entire report as a special observation appears as a remark.	TORNADO W	MOVG NEWD
(b) Reported by public	Enter (1) location with respect to weather-reporting station or a city or town, (2) direction toward which tornado is moving, (3) time tornado was observed.	----------	UNCONFIRMED TORNADO 15 MIS W DCA MOVG N 1600E
17. Thunderstorm	Enter direction, if observable: (1) with respect to station (2) direction toward which storm is moving.	T T+	T NW MOVG EWD T+ OVHD MOVG EWD
18. Lightning, with or without audible thunder.	Enter, if observed: (1) Frequency (2) Type (cloud to cloud, etc.)	----------	OCNL LTNG CLD TO CLD; LTNG CLD TO CLD AND TO GND; FQT LTNG CLD TO GND NW; OCNL LTNG N
19. Precipitation:			
(a) Hail	Enter diameter in inches of largest hailstones.	A+	HLSTO 1¼ INCHES
(b) Intermittent	Enter intermittent character of precipitation: (1) not occurring at time of observation (2) occurring at time of observation.	---------- R–	INTMT R– R–INTMT
(c) Sparse	Enter appropriate abbreviation describing rain or snow showers, or steady precipitation, when precipitation is very light.	RW– ---------- SW– R–S–	OCNL SPKL OCNL SPKL OCNL SNW FLRY PCPN VERY LGT
(d) Fine	Enter appropriate abbreviation describing precipitation in small drops (as opposed to sparseness).	R	R VERY FINE
(e) Variation of intensity	Enter abbreviation describing rapidly variable intensity.	R–	R– OCNLY R+
(f) Precipitation at a distance but not at station.	Enter form of precipitation if known and direction with respect to station.	----------	PCPN W INTSTY UNK RU OVR RIDGE N
20. Obstructions to vision:			
(a) Fog dissipating (or increasing).	Enter appropriate abbreviations	F F	F DSIPTG F INCRG
(b) Smoke drifting over field	Enter appropriate abbreviations	K	K DRFTG OVR FLD
(c) Shallow fog (height less than 6 ft.)	Enter abbreviations for phenomena excluded from coding as obstructions to vision since they do not restrict visibility to 6 miles or less at 6 ft. or more above ground.	----------	SHLW F 2 FT DEEP
(d) Snow drifting but not obscuring vision at 6 ft. or more above ground.		----------	DRFTG SNW
(e) Dust devils	Enter description of phenomenon, and direction, if possible.	----------	DUST DEVILS NW

TABLE 29.—REMARKS: *Instructions and illustrations*—Continued

Conditions observed	Instructions for entry in column 14	Illustrations	
		Cols. 3–7 or 12	Col. 14
PRESSURE			
21. A sudden marked fall, then rapid rise of 0.06 inch or more in pressure, shown on barogram as a "V".	Enter in the next record observation lowest sea-level pressure in tens, units and tenths of millibars, time of its occurrence in local standard time, with amount of rise in millibars since lowest pressure.	665	LOWEST PRES 631 1745C RSG 3 MB
22. Rapidly falling (or rising) pressure.	Enter abbreviation: PRESFR (or PRESRR).	821	PRESFR
WIND			
23. Peak gusts	Enter peak wind speed of strong gusts if station is equipped with direct-reading wind equipment.	↘45+	G75

11114.2. Whenever possible, enter remarks in symbols or authorized contractions. Otherwise, use plain English.

11114.3. If necessary, use additional lines for column 14 to record phenomena. It is not intended that the physical limitations of the column shall limit in any way the information to be reported.

11114.4. Raob stations will enter RAFRZ, RAICG, and 700-mb. data in column 14.

11114.5. Additive data groups, transmitted by designated stations with record observations at 3- and 6-hourly periods, will be entered after "Remarks."

11114.6. (Cols. 14A and 14B) Dry- and wet-bulb temperature readings taken for specialized purposes will be entered in these columns.

11115. OBSERVER'S INITIALS. (Col. 15) The observer taking the observation will enter his initials in this column.

11200. ENTRY OF DATA AT 6-HOURLY SYNOPTIC PERIODS

11201. Data pertaining to 6-hourly observations will be entered on both WBAN 10A and 10B, similarly to the airway hourly observations to the extent that 6-hourly and hourly observations contain the same data. Since the 6-hourly observation and the next succeeding record observation very nearly coincide in point of time, a single set of entries will suffice for both observations unless a change is observed in reportable values of ceiling, sky, visibility, weather, or obstructions to vision. If a single set of entries represents both a 6-hourly and a record observation, R will be entered in column 1 and the time of the record observation in columns 2 and 16.

11202. If a change is observed in reportable values of ceiling, sky, visibility, weather, or obstructions to vision, 6H will be entered in column 1 and the time of the 6-hourly in column 2. A separate record observation will be entered on the next lower line of WBAN 10A. On WBAN 10B, the values pertaining to the 6-hourly observation and entered in columns 21 through 35, will be changed to agree with the corresponding entries in columns 2 to 5 pertaining to the record observation. The changed values will be entered in parentheses above the entries for the 6-hourly observation, and the time of the record observation entered in column 16 in accordance with paragraph 11416. (See Fig. 5.)

11300. ENTRY OF PILOT REPORTS ON WBAN 10A

11301. Pilot reports of weather within 1½ miles of the boundaries of the field will be entered on WBAN 10A in accordance with the following instructions:

(1) Column 2. Record the time of entry of the pilot report on the form, unless the pireps is added to an observation. In the latter case, record the time of entry of the complete observation.

(2) Column 14. Enter the term "pireps," or authorized equivalent, followed by the report coded in accordance with instructions in Chapter 10.

11310. All pireps pertaining to weather more than 1½ miles from the boundary of the field and filed with observing units, and all pireps filed with FAWS, will be entered on a supplementary WBAN 10A distinct from that used for official observations. This supplementary form will be treated in all respects as part of the observational record. When a pireps of weather more than 1½ miles from the boundary of the field is transmitted in the remarks portion of an observation, an appropriate note will be entered in parentheses following the pireps on the supplementary form to identify the observation with hich the pireps is transmitted (e. g., "sent with 1028 obs.").

11311. The supplementary WBAN 10A for pireps will be started the first of each month, and pireps for as many days as possible entered on each page. The period covered by each page will be indicated in the space provided for the date. Pireps for consecutive days will be separated by a line space and the date pertaining to the succeeding entries will be entered in this space near the center of the form. Dates will not be entered for days on which pireps are not received.

11311.1. Entry of pireps on the supplementary form will not be confined to column 14, but may extend across the entire form.

11400. WBAN 10B

11416. TIME. (Col. 16) Entries in this column will be in chronological order, to the nearest minute. The times will be the same as times of corresponding record observations. (See par. 11102.) Note that the first two figures of the time group are printed on the form.

11417. STATION PRESSURE. (Col. 17) Enter station pressure from mercurial or precision aneroid barometers to the nearest 0.001 inch, and from altimeter setting indicators to the nearest 0.01 inch (see par. 7260 for instructions for determining station pressure from altimeter setting indicators). The station pressure for other than 6-hourly observations may be taken from a barograph at stations equipped with one, provided a correction applicable to the barograph has been established within the preceding 6 hours, by comparison with the reading of a precision aneroid, a mercurial barometer, or altimeter setting indicator. Enter values taken from a barograph to the nearest 0.005 inch. At stations not equipped with a mercurial barometer, all entries will be omitted from this column.

11418. DRY-BULB. (Col. 18) Enter the temperature of the dry-bulb to the nearest degree and tenth, Fahrenheit, supplying minus signs as required.

11418.1. At stations equipped with telepsychrometers, when the dry-bulb is above 20° F., but the wet-bulb is 33° or less, the dry-bulb temperature obtained from the telepsychrometer will be entered in column 18; the wet- and dry-bulb temperatures obtained from mercurial thermometers and used in computing the dew point will not be recorded.

11419. WET-BULB. (Col. 19) Enter the temperature of the wet-bulb to the nearest degree and tenth, Fahrenheit, supplying minus signs as required. At air temperatures below −35° F., the dry-bulb temperature from col. 18 will be entered in parentheses in col. 19. (See par. 11020.)

11419.1. At stations equipped with telepsychrometers, when the wet-bulb is 33° F. or less and the dry-bulb is above 20° F., enter in column 19 the wet-bulb temperature as computed on the psychrometric diagram,* using (1) the dry-bulb temperature obtained from the telepsychrometer, and (2) the dew point obtained from mercurial thermometers.

*Relating dew point, dry- and wet-bulb temperatures.

11420. RELATIVE HUMIDITY. (Col. 20) Enter relative humidity for each record observation unless the air temperature is below −35° F. (See par. 11010.)

11420.1. At stations equipped with telepsychrometers, when the wet-bulb is 33° F. or less and the dry-bulb is above 20° F., enter in column 20 the relative humidity as computed on the psychrometric slide rule, using 1) the dry-bulb temperature obtained from the telepsychrometer, and 2) the dew-point temperature obtained from the mercurial thermometers.

11421. TOTAL SKY COVER. (Col. 21) At each record hourly and each 6-hourly synoptic observation, enter total tenths of sky covered by clouds or obscured. Enter zero if neither clouds nor obscuring phenomena are present. Enter 1— if less than 0.1 clouds and obscuring phenomena are present. Enter 9+ if breaks in an overcast are present; enter 10 if the sky is completely overcast or obscured. Note that visible sky plus "total sky cover" equals ten-tenths.

11422. CLOUDS AND OBSCURING PHENOMENA. (Cols. 22–35) Entries will be made in columns 22–35 for each 3- and 6-hourly synoptic observation to provide information of clouds and obscuring phenomena. Data will be entered in appropriate columns for clouds and obscuring phenomena in ascending order of height with respect to their distribution in space. When they are present at more than four levels, data for levels above the 4th will not be entered here, but the presence of these levels will be indicated by the entry for total sky cover (column 21). Additional information concerning these levels will be recorded in column 90.

11422.1. AMOUNT AND SUMMATION TOTAL. (Cols. 22, 25, 28, 29, 32, 33) Enter to the nearest tenth the amount of clouds and obscuring phenomena observed at each level. Amounts of obscuring phenomena will comprise the amount of clouds or sky actually obscured by the phenomena and will not include that portion of the phenomena through which sky or clouds are visible. (Note that the amount of thin obscuring phenomena therefore cannot exceed 9+.) Enter less than 0.1 of clouds or obscuring phenomena as 1—; more than 0.9 but less than 1.0 as 9+. Since a series of frequent observations or pilot reports often indicates the extent or existence of cloud layers above a layer of broken or overcast clouds, the sum of the number of tenths entered in columns 22, 25, 29 and 33 may exceed ten-tenths. However, the entries in columns 28 and 32 will be a summation of the amount of sky covered by clouds or obscured at and below the elevations reported in columns 27 and 31 respectively, and will not exceed 1.0. For example: If 0.4 clouds are visible at 1000 feet and a pilot reports 1.0 clouds at 3000 feet, the summation total entered in column 28 would nevertheless be only ten-tenths.

11422.11. When an observation of higher layers is impossible because lower cloud layers or obscuring phenomena cover more than 0.9 of the sky, a "U" will be entered in the amount columns and entries will be omitted in the type, height, and summation columns pertaining to higher layers unless a pilot report of a higher layer is available.

11422.12. When (1) clouds or obscuring phenomena are not present at any level, or (2) higher layers are not visible and 0.1 or more of the sky is visible, enter zeros in the appropriate amount columns and omit any entry in type and height columns.

11422.13. Entries will be made as follows in columns 28 and 32:

Columns 25 and 29	Columns 28 and 32
a. "U" entered in columns 25 and 29.	No entries in columns 28 and 32.
b. Numerical entry in column 25; "U" in column 29.	Numerical entry in column 28; no entry in column 32.
c. Numerical entries (including zero) in columns 25 and 29.	Numerical entries in columns 28 and 32.

11422.14. When two or more types of clouds or obscuring phenomena occur at the same level, their combined amounts will be entered in the appropriate column captioned "Amount" (par. 11422.21).

11422.2. TYPE. (Cols. 23, 26, 30, and 34.) Enter the appropriate abbreviation selected from Table 30 for clouds or obscuring phenomena observed. A minus sign (−) denoting thin will be prefixed to the abbreviation for any obscuring phenomena thin enough to reveal the sky directly above the observer.

11422.21. When two or more types of clouds or obscuring phenomena are observed at the same level, the predominating type will be recorded.

TABLE 30.—*Cloud types and obscuring phenomena*

Cloud type and obscuring phenomena	Abbreviations
CLOUDS	
Altocumulus	Ac
Altocumulus castellatus	Acc
Altostratus	As
Cirrocumulus	Cc
Cirrostratus	Cs
Cirrus	Ci
Cumulonimbus	Cb
Cumulonimbus mammatus (Mammato-cumulus)	Cm
Cumulus	Cu
Fractocumulus	Fc
Fractostratus	Fs
Nimbostratus	Ns
Stratocumulus	Sc
Stratus	St
OBSCURING PHENOMENA	
Precipitation	
Drizzle (any form and intensity including ZL)	L
OBSCURING PHENOMENA—continued	
Precipitation—Continued	
Hail (any form and intensity including AP)	A
Ice crystals	IC
Rain (any form and intensity including RW and ZR)	R
Sleet	E
Snow (any form and intensity including SW, SP, and SG)	S
Hydrometeors other than precipitation	
Blowing snow	BS
Fog (any form, including GF and IF)	F
Lithometeors	
Dust	D
Haze	H
Sand	N
Smoke	K

11422.3. DIRECTION. (Cols. 23, 26, 30, and 34) Enter the direction from which the clouds and obscuring phenomena are moving. When the direction is unknown, omit the entry. When motion is not discernible, enter "C" for calm; otherwise, enter an arrow denoting the motion to eight points of the compass immediately above the abbreviation as follows:

TABLE 31.—*Cloud direction*

↓	from north	↑	from south
↙	from northeast	↗	from southwest
←	from east	→	from west
↖	from southeast	↘	from northwest

11422.4. HEIGHT. (Cols. 24, 27, 31, 35) Enter height of clouds and the vertical visibility ascribed to obscuring phenomena not classified as thin in columns captioned "height." Enter the height of the base of obscuring phenomena classified as thin. Make all entries in hundreds of feet. Enter heights to the nearest 100 feet from the surface to 5,000 feet; to the nearest 500 feet between 5,000 and 10,000 feet; and to the nearest 1,000 feet above 10,000. Prefix an appropriate classification letter selected from Table 22 to the height entries.

11436. PRESSURE TENDENCY. (Col. 36) This entry will be made for 3- and 6-hourly synoptic observations at stations equipped with a barograph or microbarograph. Enter a single code figure, taken from Table 32 for pressure tendency during the 3-hour period ending at the time of observation.

11437. NET THREE-HOUR PRESSURE-CHANGE. (Col. 37) Entries will be made in this column at stations where pressure tendencies are entered in accordance with instructions for column 36 above. At the time of the 3- and 6-hourly observations, the net change in station pressure for the preceding three hours will be entered to the nearest 0.005 inch or 0.2 millibar, depending upon whether the barograph sheet is graduated in inches or millibars.

TABLE 32.—*Pressure tendencies*

Code figure	Description	
0	Rising, then falling.	Barometer now higher than, or the same as, 3 hours ago.
1	Rising, then steady; or rising, then rising more slowly.	
2	Unsteady or rising unsteadily.	
3	Steady or rising steadily.	
4	Falling or steady, then rising; or rising, then rising more quickly.	
5	Falling, then rising.	Barometer now lower than 3 hours ago.
6	Falling, then steady; or falling, then falling more slowly.	
7	Unsteady or falling unsteadily.	
8	Falling steadily.	
9	Steady or rising, then falling; or falling, then falling more quickly.	

11440. SYNOPTIC OBSERVATIONS. (Cols. 41–65) Entries for synoptic observations will be made in columns 41–65, in accordance with instructions in paragraphs 11441 through 11465. Entries in columns 44–56 will pertain to the synoptic periods and portions of synoptic periods indicated by entries in column 42. Entries on the first and sixth lines of these columns will be made at the time of the first synoptic observation after midnight and at midnight, LST, respectively.

11441. TIME. (Cols. 41 and 42) Entries in column 41 will be omitted unless otherwise instructed. In column 42 in the block captioned "Midnight to . . .," enter the time of the beginning of the first 6-hourly observation after 0000 LST. In the next four blocks below, enter the time of the beginning of the 6-hourly synoptic observation. The entries will be to the nearest minute in terms of the 24-hour clock.

11444. PRECIPITATION. (Col. 44) Entries in the 6-hourly spaces will comprise the total precipitation occurring during the six hours ending with the observation. On the line captioned "Midnight" enter the amount measured at midnight, i. e., the amount that has occurred between midnight and the preceding 6-hourly observation. On the line captioned "Midnight to . . . ," enter the amount of precipitation that has occurred between midnight and the succeeding 6-hourly observation. At stations where personnel are not on duty at midnight, this entry and the one opposite "Midnight" will be omitted. Entries will be in inches and hundredths, thus, 0.06. When precipitation has occurred in amounts of 0.005 inch or less, enter "T" denoting trace. When precipitation has not occurred, enter 0.00.

11445. SNOWFALL. (Col. 45) Enter the depth of snowfall, sleet, and hail (unmelted) to inches and tenths for the 6 hours ending with the observation. (Entries for hail will be followed by an asterisk and "*Hail" will be recorded in column 90.) When snow, sleet, or hail has fallen in amounts of 0.05 inch or less, enter "T" denoting trace. When none has occurred, enter 0.0. When snow, sleet, or hail melted as it fell, enter "T" with a note "Melted as it fell" under "Remarks, Notes, and Miscellaneous Phenomena." On the line captioned "Midnight" enter the amount occurring between midnight and the preceding 6-hourly observation. On the line captioned "Midnight to . . . ," enter the amount that has occurred between midnight and the succeeding 6-hourly observation. At stations where personnel are not on duty at midnight, this entry and the one opposite "Midnight" will be omitted.

11446. SNOW DEPTH. (Col. 46) Enter the depth of snow, sleet, hail, and ice on the ground at each 6-hourly observation to the nearest inch. (Entries for hail will be followed by an asterisk and "*Hail" will be recorded in column 90.) When snow, sleet, hail, or ice is on the ground and the depth amounts to 0.5 inch or less, enter "T" denoting trace. When none of these are on the ground, enter 0. In the column captioned "Midnight" enter the amount on the ground at midnight.

11447. MAXIMUM AND MINIMUM TEMPERATURES. (Cols. 47 and 48). These data will be entered only at stations equipped with maximum and minimum thermometers, telepsychrometers, or thermographs. Enter the maximum and minimum temperatures to degrees and tenths Fahrenheit for the six hours ending with the observation. Take the data from telepsychrometer or maximum and minimum thermometers, if available; if not, from the thermograph. Note that these temperatures must be as high and low respectively as any temperature recorded in the preceding 6 hours, including the current temperature. On the line captioned "Midnight" enter the maximum and minimum temperatures occurring between midnight and the preceding 6-hourly observation. On the line captioned "Midnight to . . .," enter the maximum and minimum temperatures occurring between midnight and the succeeding 6-hourly observation. Note that these are not necessarily the maximum and minimum temperatures for the 6-hourly observation. At stations where an observer is not on duty at midnight, the data will be taken from the thermograph, if available; otherwise, the entry will be omitted.

11449. HEIGHT OF 850-MILLIBAR SURFACE. (Col. 49) At stations designated to compute this datum, the height of the 850-millibar surface above sea level will be entered in feet to the nearest ten g-feet.

11450. STATE OF GROUND. (Col. 50) Entries for the state of ground will be made in accordance with Table 33.

TABLE 33.—*State of ground*

Code figures	Description
0	Surface of ground dry (no appreciable amount of dust or loose sand).
1	Surface of ground moist.
2	Surface of ground wet (standing water in small or large pools on surface).
3	Surface of ground bare and frozen.
4	Glaze on ground but no ice, slush, or snow.
5	Ice, slush, or snow covering less than one-half of ground.
6	Ice, slush, or firm or settled snow covering more than one-half of ground (but not completely).
7	Ice, slush, or firm or settled snow covering ground completely.
*8	Loose dry snow covering more than one-half of surface (but not completely).
*9	Loose dry snow covering surface completely.

* Figures 8 and 9 may be used to indicate dust or loose sand on the surface of the ground in the proportions indicated. Under these conditions, when the temperature is below 32° F., enter the words "State of ground—dust" or "State of ground—loose sand" in column 90.

NOTE.—Numbers 0 to 4 apply to representative bare ground and numbers 5 to 9 to an open representative area.

11451. SEA, STATE AND DIRECTION.[1] (Col. 51) State and direction of the sea refer only to the condition of the sea surface resulting from the action of winds prevailing in the immediate local area. It should be noted that it is possible for a "flat, oily" sea to co-exist with a "light," "moderate," or even "heavy" swell.

11451.1. The state of the sea will be recorded as a code figure in accordance with Table 34.

11451.2. The direction of the sea is the direction, to eight points of the compass, from which the sea is coming. It is recorded as an arrow.

EXAMPLE: A rough sea (waves 5–8 feet) from the southwest would be recorded as "5↗."

[1] The instructions in paragraphs 11451 to 11454.5 will apply to designated stations only.

TABLE 34.—*State of sea*

Code figures	Description	Approximate average wave height, feet
0	Flat, oily	0
1	Calm rippled	0
2	Smooth (wavelets)	1
3	Slight	1–3
4	Moderate	3–5
5	Rough	5–8
6	Very Rough	8–12
7	High	12–20
8	Very high	20–40
9	Mountainous	More than 40

11452. SWELL, HEIGHT AND DIRECTION. (Col. 52) The term "swell" is restricted in usage to the wave motion that underlies the "sea" raised and driven by the local wind. Swell usually has traveled over a considerable distance from the point where it was generated by the wind, and its direction and height may often differ widely from those of the local wind-driven waves ("sea").

11452.1. Height of swell is recorded as the estimated average height of swell in the open sea, measured in whole feet from crest to trough.

11452.2. Direction of swell is the direction, to eight points of the compass, from which the swell is coming. It is recorded as an arrow.

EXAMPLE: A three-foot swell from the west would be recorded as "3→."

11453. SWELL PERIOD. (Col. 53) Swell period is the average time between successive crests, measured to the nearest second. The swell period usually can be observed best by watching the rise and fall in the swell of a patch of foam or other floating object. When the elapsed time, measured by a stop watch, of ten successive rises of such an object has been obtained, a good average period may be recorded by taking one-tenth of the value.

11454. SURF. (Col. 54) A five-figure code comprises the "Primary Data Group" of the combined Surf Code (SURFCO). Enter it every 6 hours at stations (and ships when appropriate) with means of observing surf condition.

11454.1. PRIMARY SURF DATA GROUP. A five-figure code group, symbol form $H_sH_sM_sP_sD_s$.

11454.2. SYMBOL H_sH_s. Average height of waves in feet. 99 indicates average height impossible to estimate. Two figures to be entered for whole feet.

EXAMPLE: 01 for 1 foot, 12 for 12 feet, etc.

11454.3. SYMBOL M_s. Difference between height of maximum waves and average waves in a 5-minute interval. Third figure in group to be entered in accordance with code Table 35.

TABLE 35.—*Surf* (M_s)

Code No.	Difference between height of maximum waves and average waves	Code No.	Difference between height of maximum waves and average waves
0	0.	7	7 feet.
1	1 foot.	8	8 feet.
2	2 feet.	9	Greater than 8 feet except when H_sH_s is reported as 99, in which case this figure means that an estimate is impossible.
3	3 feet.		
4	4 feet.		
5	5 feet.		
6	6 feet.		

11454.4. SYMBOL P_s. Period, i. e., time between passage of successive breakers at a fixed point. Fourth figure of group to be entered in accordance with code Table 36.

TABLE 36.—*Surf* (P_s)

Code No.	Time between successive breakers	Code No.	Time between successive breakers
0	No surf.	5	11 or 12 seconds.
1	Less than 5 seconds.	6	13 to 15 seconds.
2	5 or 6 seconds.	7	16 to 18 seconds.
3	7 or 8 seconds.	8	Greater than 18 seconds.
4	9 or 10 seconds.	9	Time impossible to estimate.

11454.5. SYMBOL D_s. Angle of breakers with the beach and direction of wave travel (referred to observer on beach facing the sea.) Enter fifth figure of group in accordance with Table 37.

TABLE 37.—*Surf* (D_s)

Code No.	Angle of breakers with the beach	Code No.	Angle of breakers with the beach
0	Calm.	5	0° up to 10°
1	0° up to 10°	6	10° up to 20° from the right.
2	10° up to 20° from the left.	7	More than 20°
3	More than 20°	8	Confused, but predominantly from the right.
4	Confused, but predominantly from the left.	9	Not known.

11455. WATER TEMPERATURE. (Col. 55) Enter the water temperature to degrees and tenths Fahrenheit, on ships and at designated land stations only.

11456. SOIL TEMPERATURE. (Col. 56) Enter soil temperature to degrees and tenths Fahrenheit at designated stations only.

11458. STATION PRESSURE COMPUTATIONS. Station pressure computations for the 6-hourly synoptic observations will be entered in accordance with the following instructions:

11459. TIME. (Line 59) Enter the time of reading the barometer. (Note that this time will usually differ from that ascribed to the observation in columns 2 and 16.)

11460. ATTACHED THERMOMETER. (Line 60) Enter the temperature of the thermometer attached to the mercurial barometer to the nearest 0.5° Fahrenheit or centigrade. Entries will be omitted when the pressure readings are taken from precision aneroid barometers.

11461. OBSERVED BAROMETER. (Line 61) Enter the uncorrected observed reading of the mercurial or precision aneroid barometer to the nearest 0.001 inch or 0.05 millibar.

11462. TOTAL CORRECTION. (Line 62) Enter the sum of all corrections required to reduce the observed reading to station pressure.

11463. STATION PRESSURE. (Line 63) Enter to the nearest 0.001 inch or 0.05 millibar for mercurial barometer readings, and to the nearest 0.001 inch or 0.1 millibar for precision aneroid readings.

11464. BAROGRAPH READING. (Line 64) Enter to the nearest 0.005 inch or 0.2 millibar. When the barogram is changed at the time of the 6-hourly observation, take the barograph reading from the new barogram.

11465. BAROGRAPH CORRECTION. (Line 65) Enter to the nearest 0.01 inch or 0.2 millibar with proper sign the difference between the station pressure read on the barograph and

that determined with a mercurial or precision aneroid barometer. When the barogram is changed at the time of the 6-hourly observation the barograph correction is based on the indicated station pressure after the new barogram has been installed. If for any reason the barogram is changed after the time of the 6-hourly observation, enter the new barograph correction in column 90 and an asterisk in column 65 preceding the correction established at the time of the 6-hourly observation.

11466. SUMMARY OF DAY. (Cols. 66–81) Midnight to midnight refers to the interval 0000 to 2359 local standard time.

11467. MAXIMUM AND MINIMUM TEMPERATURES. (Cols. 66–67) Enter these data in whole degrees Fahrenheit. Note that the maximum and minimum temperatures must be at least as high and low, respectively, as any temperature recorded through the day.

11468. TWENTY-FOUR-HOUR PRECIPITATION. (Col. 68) Enter the total amount of precipitation (water equivalent of solid types) to the nearest 0.01 inch. If precipitation has occurred in amounts of 0.005 inch or less, enter "T" denoting trace. If precipitation has not occurred, enter 0.00. The sum of any number of "T" observations will be regarded as a trace unless recording equipment indicates the total is greater than 0.005 inch (liquid).

11469. TWENTY-FOUR-HOUR SNOWFALL. (Col. 69) Twenty-four-hour snowfall is the total amount, to tenths of an inch, of unmelted snow, sleet, or hail that falls during a 24-hour period. (Entries for hail will be followed by an asterisk, and "*Hail" recorded in column 90.) If there are separate snowfalls, each of which melts before the following occurs, the total for the day will be the sum of the maximum depth of each fall. Record the amount of snowfall (unmelted) in inches and tenths. When snow, sleet, or hail melts as it falls, enter "T" with a note "Melted as it fell" under "Remarks, Notes, and Miscellaneous Phenomena." If snow, sleet, or hail has fallen in amounts of 0.05 inch or less, enter "T" denoting trace. If none has fallen, enter 0.0.

11470. SNOW DEPTH. (Col. 70) This entry will be taken from the 0030 GCT snow depth entry, column 46.

11471. PEAK GUST. (Cols. 71–73) This datum will be entered only at stations supplied with gust-recording equipment. The peak gust is the highest velocity of wind recorded during the 24 hours. Enter (1) the direction to 16 points, if suitable recording equipment is available; otherwise to eight points; (2) the speed to nearest mile; and (3) time to nearest minute.

11474. THICKNESS OF ICE ON WATER. (Col. 74) This datum will be entered only at designated stations, to the nearest 0.1 inch.

11475. FROZEN GROUND LAYER. (Cols. 75–76) This datum will be entered only at designated stations, to the nearest whole inch.

11477. RIVER GAGE. (Col. 77) The river gage reading will be entered to the nearest 0.1 foot at stations where a river gage is read.

11480. (Cols. 82–90) Authorized teletype symbols and contractions, and plain English only, will be used in making entries in columns 82, 86, and 90. Since there will always be a time lapse between the occurrence or cessation of phenomena and their reporting, it will not be necessary to reconcile this difference in time with the time entries pertaining to the observations reporting their occurrence or cessation.

11482. PRECIPITATION AND THUNDERSTORMS. (Cols. 82–85) Enter times of beginnings and endings, to the nearest minute, of thunderstorms, precipitation, changes in forms and character of precipitation (e. g., rain to rain shower) and changes in intensity of thunderstorms and precipitation. Intervals of 15 minutes or less between the time of ending and recommencement need not be recorded unless occurring within one hour previous to the beginning of a 6-hourly observation, when all beginnings and endings will be recorded. This also applies to changes in intensity that do not last more than 15 minutes. When any of these phenomena is occurring at midnight, enter "cont." in column 84 for the day preceding midnight, and in column 83 for the day following midnight.

11483. OBSTRUCTIONS TO VISION. (Cols. 86–89) Enter the times of beginnings and endings of each obstruction to vision. When any of these phenomena is occurring at midnight, enter "cont." in column 84 for the day preceding midnight, and in column 83 for the day following midnight.

11484. DURATION. (Cols. 85 and 89) Unless otherwise designated, make no entries in these columns.

11485. REMARKS, NOTES, AND MISCELLANEOUS PHENOMENA. (Col. 90) All pertinent information will be entered concerning severe storms, floods, and miscellaneous hydrometeors, etc., and, when required, snow surface temperature data.

11485.1. HAILSTORMS. Enter all available information, including the diameters of the largest and average sized hailstones, damage caused, etc.

11485.2. TORNADO OR WATERSPOUT. Enter as complete information as possible on time, path, size of storm, its appearance, direction of movement, damage, etc., and source of information.

11485.3. LIGHTNING. Enter notes on approximate duration, distance, direction, frequency, etc., of lightning observed when a thunderstorm is not in progress at the station; i. e., when thunder is not heard.

11485.4. AURORA. Enter appropriate notes on extent, color, duration, etc.

11485.5. HARBOR ICE. Enter appropriate data on quantity, thickness, character, breaks, size of floes, persistence, conditions of aircraft landing area, conditions affecting the transfer of passengers from craft of all types, and any other conditions worthy of note.

11485.6. SNOW SURFACE TEMPERATURE. Snow surface temperature and related data will be entered at designated station. Example: "SNW SFC TMP —20° C., 0410 GCT, 4.6 FT. DIF."

11485.7. MISCELLANEOUS. Phenomena sent in synoptic messages as special phenomena groups, such as frost, glaze, etc., will be entered also.

11485.8. SUNRISE AND SUNSET. Character of sunrise and sunset will be entered in the spaces provided, as clear, cloudy, foggy, hazy, dusty, or smoky, at stations equipped with triple registers.

NOTE: Correct Figures 5, 8, and 10 as follows:
Figure 5, second line, column 23: Correct "GF" to read "F"
Figure 5, second line, column 24: Correct "0" to read "M0"
Figure 5, eleventh line, column 26: Correct "Cs" to read "$\overrightarrow{Cs}$"
Figure 8, tenth line, column 14: Delete "FILED"
Figure 8, 29th line, column 14: Correct "set" to read "sent"
Figure 10, third line, column 10: Correct "080MPH" to read "80MPH"
Figure 10, third line, column 14: Correct "P38" to read "F38"

W.B. FORM 1130 A Revised 7-1-48 — U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU — WBAN 10 A

SURFACE WEATHER OBSERVATIONS

STATION WBAS SAN BRUNO, CALIF. DATE JAN 12, 1949

	TYPE (1)	TIME (LST) (2)	CEILING (Hundreds of Feet) (3)	SKY (4)	VISIBILITY (Miles) (5)	WEATHER and OBSTRUCTIONS TO VISION (6)	SEA LEVEL PRESS. (mbs.) (7)	TEMP. (°F) (8)	DEW PT. (°F) (9)	WIND DIRECTION (10)	WIND SPEED (m.p.h.) (11)	WIND CHARACTER AND SHIFTS (12)	ALTIMETER SET. (ins.) (13)	REMARKS AND SUPPLEMENTAL CODED DATA (14) (14A) (14B)	OBSERVERS INITIALS (15)
	✓	0002		0	7					→↘	8		989	ST BNK NW	ALY
	R	0028		0	7		125	52	51	→↘	7		989	VSBY NW 2GF	ALY
	SI	0045		0	4	GF				→↘	8			VSBY N2W½	ALY
	✓	0100		0	3	GF				→↘	8		990	VSBY N1W½	ALY
	R	0126		0	3	GF	129	51	51	→↘	8		990	103	ALY
	✓	0200		0	5	GF				→↘	9		990	VSBY N2½	ALY
	R	0227		0	5	GF	129	51	49	→↘	8		990		ALY
	✓	0300		0	4	GF				↘	10		990	VSBY N¾E2	ALY
	R	0328		0	4	GF	129	51	50	→↘	11		990	VSBY N¾W¾	ALY
	S2	0345	W2	X	½	F				→↘	10				ALY
(1)	S3	0400	W2	X	3/8	F				→↘	10		990		ALY
	L	0415	W2	X	3/8	F									ALY
	R	0428	W2	X	3/8	F	129	51	51	→↘	11		990	0000	ALY
	L	0445	W2	X	3/8	F									ALY
	S4	0501		0	3/4	GF				→↘	10		990	VSBY N½E½S¾W1	ALY
	L	0515		0	3/4	GF									ALY
	RS5	0527		0	1/4	GF	129	51	51	→↘	10		990		ALY
	L	0545		0	1/4	GF									ALY
(2)	S6	0600	W2	X	3/16Y	F				→↘	10		990	VSBY VRBL 0 TO 3/8	ALY
	S7	0615	W2	X	1/4	F				→↘	9				ALY
	R	0626	W2	X	1/4	F	132	51	51	→↘	10		991		ALY
(3)	—	0635												ALREPS OVR SFO 0630P FLD CLRLY	
	—													VSB THRU F 25MSL DE4	ALY
(4)	S8	0645		-X	1/2	F				↘	10			VSBY N¼E½S½W3 CNDS	
	—													RPDLY CHGBL	ALY
	S9	0658	M7	⊘	3	F				↘	10		991	VSBY N1E¾	ALY
	R	0728	M7V	⊘	3	F	135	53	53	↘	10		992	VSBY N1 C16 VRBL 5 TO 8 4PY 6006	ALY
	✓	0800	E6	⊘	3	F				↘	12		993		THR
(5)	-	0810												PIREPS OVR SFO 0810P C16 4MMD DE3	THR
(6)	L	0811	A4												THR
(7)	S10	0814	A4	⊘	3	F				↘	12				THR
(8)	RS11	0828	M5	⊘	3	F	146	56	54	↘	14		995		THR
	S12	0846		6⊘	4	H				↘	18				THR
(9)	✓	0901		6-⊘	4	H				↘	22	+	995	G30	THR
	RS13	0928		2000⊘	5	H	146	61	54	↘	24	+	995	G31 BD ON FLD SE	THR
	✓	1001		2000⊘	6	H				↘	23	+	995	G34 BD ON FLD SE	THR
	6H	1015		2000⊘	6	H	146	63	53	↘	20	+	995	G26	THR
(10)	RS14	1028	E200	-⊕	6	H	146	63	53	↘	18	—	995	5076/2	THR
	✓	1101	E200	-⊕	6	H				↘	17		995		THR
	R	1128	E200	-⊕	7		146	67	55	↘	16		995		THR

(1) VISIBILITY DECREASES TO LESS THAN ½ MILE
(2) VISIBILITY DECREASES TO LESS THAN ¼ MILE
(3) PILOT REPORT OF FIELD CONDITION VIEWED FROM ALOFT
(4) THIN OBSCURATION — SKY DISCERNIBLE
(5) PILOT REPORT OF CEILING OVER FIELD — CURRENTLY REPORTED VALUE NOT MEASURED 9211
(6) LOCAL EXTRA OF ONE ELEMENT ONLY 9142, 9211
(7) SPECIAL FOR CEILING DECREASE TO LESS THAN 500 FT 9134.01
(8) SPECIAL FOR CEILING INCREASE TO 600 FT (MEASURED) 9211, 9134.01
(9) THIN LOWER CLOUDS
(10) RECORD-SPECIAL OBSERVATION DIFFERING FROM PRECEDING SYNOPTIC 11202

REFERENCE: 9134.03, 9134.03, 9213 (8)

CAS 47037-1

FIGURE 4.—Consecutive entries on WBAN 10A.

W. B. FORM 1130 B Revised 7-1-48 U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU WBAN 10 B

SURFACE WEATHER OBSERVATIONS

STATION WBAS, San Bruno, Calif. DATE Jan. 12, 1949

TIME (LST) 16	STATION PRESSURE (ins) 17	DRY BULB (°F) 18	WET BULB (°F) 19	REL. HUMIDITY (%) 20	TOTAL SKY COVER 21	CLOUDS AND OBSCURING PHENOMENA: LOWEST LAYER AMT. 22	LOWEST LAYER TYPE & DIR. 23	LOWEST LAYER HEIGHT 24	SECOND LAYER AMT. 25	SECOND LAYER TYPE & DIR. 26	SECOND LAYER HEIGHT 27	SUMMATION TOTAL 28	THIRD LAYER AMT. 29	THIRD LAYER TYPE & DIR. 30	THIRD LAYER HEIGHT 31	SUMMATION TOTAL 32	FOURTH LAYER AMT. 33	FOURTH LAYER TYPE & DIR. 34	FOURTH LAYER HEIGHT 35	PRESSURE TENDENCY 36	NET 3-HR CHANGE 37	38	39	40
00 28	29.880	52.5	51.9	96	1-																			
01 26	29.885	51.1	50.8	98	1-	1-	GF	0	0			1-	0			1-	0			1	020			
02 27	29.885	50.9	50.0	94	0																			
03 28	29.885	50.8	50.3	96	2																			
04 28	29.888	51.0	50.8	99	10	10	F	W2	U				U				U			4	005			
05 27	29.890	50.8	50.8	100	4																			
06 26	29.900	51.3	51.3	100	10																			
07 28	29.910	53.4	53.2	99	9	9	SF	M7	0			9	0			9	0			4	.025			
08 28	29.915	55.8	54.8	95	9																			
09 28	29.915	61.4	57.0	77	3																			
10 28	29.913	63.2	56.9	68	(1y) 4	1-	St	E3	(1y) 4	Cs	E200	(1y) 4	0			(1y) 4	0			1	.035			
11 28	29.910	66.9	59.8	66	10																			
12																								
13																								
14						(Note: Entries on this form																			
15						correspond to those on Fig. 4)																			
16																								
17																								
18																								
19																								
20																								
21																								
22																								
23																								

SYNOPTIC OBSERVATIONS

TIME (G.C.T.) 41	TIME (LST) 42	NO. 43	PRECIP. (ins) 44	SNOW FALL (ins) 45	SNOW DEPTH (ins) 46	MAX TEMP (°F) 47	MIN. TEMP (°F) 48	HGT. 850 MB. SURFACE 49	STATE OF GRND 50	SEA STATE & DIR. 51	SWELL HGT. & DIR. 52	SWELL PERIOD 53	SURF H_w H_{w_a} P_w D_w 54	WATER TEMP. 55	SOIL TEMP. 56	57	58
	MID TO 0405	X	0.00	0.0	X	53.2	50.2	X	X	X	X	X	X	X	X		
	0405	1	0.00	0.0	0	54.3	50.2										
	1005	2	0.00	0.0	0	63.9	49.0										
		3															
		4															
	MID	X						X	X	X	X	X	X	X	X		

STATION PRESSURE COMPUTATIONS

TIME (LST) 59	0408	1007
ATT THERM 60	77.0	75.0
OBSVD BAR 61	30.040	30.090
TOTAL CORR 62	-.152	-.147
STA PRESS 63	29.888	29.943
BAROGRAPH 64	29.890	29.943
BAR CORR 65	0	0

SUMMARY OF DAY (MIDNIGHT TO MIDNIGHT)

24-HR MAX TEMP (°F) 66	24-HR MIN TEMP (°F) 67	24-HR PRECIP. (WATER EQUIV (ins) 68	24-HR SNOWFALL UNMLTD. (ins) 69	SNOW DEPTH (ins) 70	PEAK GUST SPEED (m.p.h.) 71	PEAK GUST DIRECTION 72	PEAK GUST TIME (LST) 73	THICKNESS OF ICE ON WATER (ins) 74	FROZEN GRND LAYER (ins) TOP 75	FROZEN GRND LAYER (ins) BASE 76	RIVER GAGE 77	78	79	80	81

PRECIP & THDRSTM 82	BEGAN 83	ENDED 84	DUR. 85 hrs	DUR. 85 mins

OBSTR TO VIS 86	BEGAN 87	ENDED 88	DUR. 89 hrs	DUR. 89 mins
GF	0040	0340		
F	0340	0454		
GF	0454	0555		
F	0555	0840		
H	0840	1120		

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA 90

SUNRISE Foggy... SUNSET.....

FIGURE 5.—Consecutive entries on WBAN 10B.

W B FORM 1130 A Revised 7-1-48

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

WBAN 10 A

SURFACE WEATHER OBSERVATIONS

STATION_____ DATE_____

	TYPE 1	TIME (LST) 2	CEILING (Hundreds of Feet) 3	SKY 4	VISIBILITY (Miles) 5	WEATHER and OBSTRUCTIONS TO VISION 6	SEA LEVEL PRESS. (mbs.) 7	TEMP (°F) 8	DEW PT. (°F) 9	WIND DIRECTION 10	WIND SPEED (mph) 11	WIND CHARACTER AND SHIFTS 12	ALTIMETER SET (ins.) 13	REMARKS AND SUPPLEMENTAL CODED DATA 14	14A	14B	OBSERVERS INITIALS 16
(1)	R	1328		O	8		122	84	31	↑↖	8		010	K LYR NW BASE E15			CAR
(2)	RS4	1828	W8	X	8		200	53	38	↑	7		024	BASE K LYR E5			LAT
(3)	RS10	1127	P25	X	2	TRWA	146	74	62	→	19		016	T W MOVG EWD FRT LTNG CLD TO ERT GND H LSTO 1/2 INCH			ERT
(4)	R	0925	P10	X	2	S-	119	62	53	→↘	14		007				HAN
(5)	R	2228	W0	X	0	L-F	176	57	56		C		020				YUT
(6)	R	1927		100 ⊕	7		112	71	23	↗	6		009	BASE K LYR E7			HIN
(7)	R	1828	E200	⊕40⊕	8		135	90	52	↑↗	5		013	BASE H LYR E55			KIT
(8)	R	0916	W5	⊕X	4	F	186	58	56	↖	2		022	BASE K LYR E3 E25⊕			LBD
(9)	R	0426	W20	X10⊕	7		166	52	29	↖	10		020	BASE K LYR E15 4⊕			CTL
(10)	R	0624		-X15⊕	8		129	89	30	↘	6		013	BASE K LYR E30			LMR
(11)	R	0327	E15	⊕-X	5	H	081	75	61	↑	4		993				RTK
(12)	R	0918	M21	-X⊕	7		105	70	29	↙	7		001	BASE K LYR E50			KLB

OBSCURING PHENOMENA ONLY VISIBLE:
(1) COVERING LESS THAN 0.6 OF SKY; BASE ALOFT
(2) COVERING 0.6 OR MORE OF SKY; BASE ALOFT
(3) COVERING 0.6 OR MORE OF SKY; BASE AT SURFACE
(4) }
(5) }

CLOUDS AND OBSCURING PHENOMENA VISIBLE:
(6) CLOUDS ABOVE OBSCURING PHENOMENA
(7) CLOUDS ABOVE AND BELOW OBSCURING PHENOMENA
(8) CLOUDS ABOVE OBSCURATION
(9) CLOUDS BELOW OBSCURATION
(10) CLOUDS BELOW THIN OBSCURATION
(11) CLOUDS ABOVE THIN OBSCURATION
(12) CLOUDS BELOW THIN OBSCURATION

FIGURE 6.—Entries of obscuring phenomena on WBAN 10A.

W B FORM 1130 B Revised 7-1-48

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

WBAN 10 B

SURFACE WEATHER OBSERVATIONS

STATION_____ DATE_____

	TIME (LST) 16	STATION PRESSURE (ins.) 17	DRY BULB (°F) 18	WET BULB (°F) 19	REL HUMIDITY (%) 20	TOTAL SKY COVER 21	CLOUDS AND OBSCURING PHENOMENA: LOWEST LAYER AMT 22	LOWEST LAYER TYPE & DIR 23	LOWEST LAYER HEIGHT 24	SECOND LAYER AMT 25	SECOND LAYER TYPE & DIR 26	SECOND LAYER HEIGHT 27	SUMMATION TOTAL 28	THIRD LAYER AMT 29	THIRD LAYER TYPE & DIR 30	THIRD LAYER HEIGHT 31	SUMMATION TOTAL 32	FOURTH LAYER AMT 33	FOURTH LAYER TYPE & DIR 34	FOURTH LAYER HEIGHT 35	PRESSURE TENDENCY 36	NET 3-HR CHANGE 37	38	39	40
	00				(1)	4	4	-K	E15	0			4	0			4	0							
	01				(2)	9	9	K	W8	0			9	0			9	0							
	02				(3)	10	10	K	P25	U				U				U							
	03				(4)	10	10	S	P10	U				U				U							
	04				(5)	10	10	F	W0	U				U				U							
	05				(6)	5	4	K	W10	2	AC	E100	5	0			5	0							
	06				(7)	10	2	CU	E40	3	H	W60	5	5	CI	E200	10	U							
	07				(8)	10	6	K	W5	6	SC	E25	10	U				U							
	08				(9)	10	2	SC	W4	1	SC	E10	3	7	K	W20	10	U							
	09				(10)	8	2	CU	E15	6	-K	E30	8	0			8	0							
	10				(11)	8	6	-H	M0	3	SC	E15	8	0			8	0							
	11				(12)	9+	6	SC	M21	9+	-H	E50	9+	U				U							
	12																								
	13																								
	14						(NOTE: ENTRIES ON THIS FORM CORRESPOND																			
	15						TO THOSE ON FIG 6.)																			
	16																								

FIGURE 7.—Entries of obscuring phenomena on WBAN 10B.

W B FORM 1130 A Revised 7-1-48

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

WBAN 10 A

SURFACE WEATHER OBSERVATIONS

STATION_____ DATE_____

	TYPE (1)	TIME (LST) (2)	CEILING (Hundreds of Feet) (3)	SKY (4)	VISIBILITY (Miles) (5)	WEATHER and OBSTRUCTIONS TO VISION (6)	SEA LEVEL PRESS. (mbs.) (7)	TEMP (°F) (8)	DEW PT. (°F) (9)	WIND DIRECTION (10)	WIND SPEED (m.p.h.) (11)	WIND CHARACTER AND SHIFTS (12)	ALTIMETER SET (ins) (13)	REMARKS AND SUPPLEMENTAL CODED DATA (14) (14A) (14B)	OBSERVERS INITIALS (15)	
(1)	R	1628		O	15		129	72	60	↘	8		991		ART	(1)
(2)	R	1728	M90	⊕⊕	12		091	72	31	↗	9		994	E200⊕A120⊕40①25① 973723	RJB	(2)
(3)	R	1627	M100	⊕	10		098	57	28	→	4		995		ORC	(3)
(4)	RS7	1828		4①	8		132	57	24	→↗	5		011		HCA	(4)
(5)	R	2227	M37	⊕	10		125	76	24	↖	7		009	HIR LYR VSB.THRU BRKS	BAB	(5)
(6)	R	1228		①25①	4	GF	142	67	66	↘	15		014	SFC VSBY 2½ 120①	DAC	(6)
(7)	RS1⊕	1927	W25	+⊕	3	RW-Q	115	82	70	↘28↑	920E		007	G35	DRC	(7)
(8)	S4	1618												UNCONFIRMED TORNADO 20 MLS S MOVG NEND 1530C		(8)
(9)	R	2226	M24	⊕①	2½	ZL-S-	200	32	92	↙	14		*005 ~~007~~	E70⊕C *(COR FILED 2240)	~~WDB~~	(9)
(10)	R	0628	E250	-①	12		173	60	M	→↘	20		021		DK.	(10)
(11)	R	1427		40①	15+			76	27	↑↖	12				RTH	(11)
(12)	S2	0244									AL	STG	995		MJC	(12)
(13)	L	2135	M5											(FOR AAL)	GTH	(13)
(14)	L	2150		O	15+		186	84	68	↑↗	15	F	009	(ACFT ACCIDENT)	CLB.	(14)

(1) No clouds or obscuring phenemena
(2) More than four layers of clouds
(3) 1.0 sky cover at one level
(4) Special required by scattered clouds
(5) Upper layer of clouds visible through breaks in lower overcast
(6) (a). Scattered clouds at two levels
(b) Tower visibility at Weather Bureau station participating in control tower visibility program
(7) (a) Wind shift
(b) Dark clouds
(c) Squall
(8) Public report of tornado
(9) Erroneous observation transmitted - correction set (* These data entered in red.)
(10) Data missing that would ordinarily be transmitted by station
(11) Data missing that would not ordinarily be transmitted by station
(12) Altimeter setting — sent as single element special
(13) Local extra requested by airline
(14) (a) Local extra for aircraft accident
(b) Estimated wind

FIGURE 8.—Miscellaneous entries on WBAN 10A.

/W.B. FORM 1130 B Revised 7-1-48 U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU WBAN 10 B

SURFACE WEATHER OBSERVATIONS

STATION _____ DATE _____

TIME (LST) 16	STATION PRESSURE (ins.) 17	DRY BULB (°F) 18	WET BULB (°F) 19	REL. HUMIDITY (%) 20	TOTAL SKY COVER 21	CLOUDS AND OBSCURING PHENOMENA: LOWEST LAYER AMT. 22	LOWEST LAYER TYPE & DIR 23	LOWEST LAYER HEIGHT 24	SECOND LAYER AMT. 25	SECOND LAYER TYPE & DIR 26	SECOND LAYER HEIGHT 27	SUMMATION TOTAL 28	THIRD LAYER AMT. 29	THIRD LAYER TYPE & DIR 30	THIRD LAYER HEIGHT 31	SUMMATION TOTAL 32	FOURTH LAYER AMT 33	FOURTH LAYER TYPE & DIR 34	FOURTH LAYER HEIGHT 35	PRESSURE TENDENCY 36	NET 3-HR CHANGE 37	38	39	40
00				(1)	0	0			0			0	0			0	0							
01				(2)	10	2	Fc	E25	2	Cb	M40	3	5	Ac	M90	7	2	As	A120					
02				(3)	10	10	Ac	M100	U				U				U							
03				(4)	2	2	St	E4	0			2	0			2	0							
04				(5)	10	9+	Sc	M37	10	Cs	E250	10	U				U							
05				(6)	5	2	Cb	E25	3	Ac	E120	5	0			5	0							
06				(7)	7	10	Cb	W25	U				U				U							
07				(8)																				
08				(9)	10	7	St	M24	7	Ac	E70	10	U				U							
09				(10)	8	8	Ci	E250	0			8	0			8	0							
10				(11)	4	4	Cu	M40	0			4	0			4	0							
11																								
12																								
13																								
14				Note: Entries on this form correspond with																				
15				those on Fig. 8																				
16																								
17																								
18																								
19																								
20																								
21																								
22																								
23																								

SYNOPTIC OBSERVATIONS

TIME (G.C.T.) 41	TIME (LST) 42	NO. 43	PRECIP (ins.) 44	SNOW FALL (ins.) 45	SNOW DEPTH (ins.) 46	MAX TEMP (°F) 47	MIN TEMP (°F) 48	HOR. BSO MB. SURFACE 49	STATE OF GRND 50	SEA STATE & DIR. 51	SWELL HGT. & DIR. 52	SWELL PERIOD 53	SURF H_S H_M M_S R_C S_S 54	WATER TEMP 55	SOIL TEMP 56	57	58
	MID. TO	X			X			X	X	X	X	X	X	X	X		
		1															
		2															
		3															
		4															
	MID	X			X			X	X	X	X	X	X	X	X		

STATION PRESSURE COMPUTATIONS

TIME (LST) 59				
ATT THERM 60				
OBSRVD BAR 61				
TOTAL CORR 62				
STA PRESS 63				
BAROGRAPH 64				
BAR CORR 65				

SUMMARY OF DAY (MIDNIGHT TO MIDNIGHT)

24-HR MAX TEMP (°F) 66	24-HR MIN TEMP (°F) 67	24-HR PRECIP. (WATER EQUIV ins) 68	24-HR SNOWFALL UNMLTD. (ins.) 69	SNOW DEPTH (ins.) 70	PEAK GUST SPEED (m.p.h.) 71	PEAK GUST DIRECTION 72	PEAK GUST TIME (LST) 73	THICKNESS OF ICE ON WATER (ins.) 74	FROZEN GRND LAYER (ins.) TOP 75	FROZEN GRND LAYER (ins.) BASE 76	RIVER GAGE 77	78	79	80	81

PRECIP & THDRSTM 82	BEGAN 83	ENDED 84	DUR. 85 hrs	DUR. 85 mins	OBSTR. TO VIS. 86	BEGAN 87	ENDED 88	DUR. 89 hrs	DUR. 89 mins

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA 90

SUNRISE _____ SUNSET _____

(2) 3Ci E200 (1728 Obs)

U. S. GOVERNMENT PRINTING OFFICE: 1948 O - 786833

FIGURE 9.—Miscellaneous entries on WBAN 10B.

W B FORM 1130 A Revised 7-1-48 U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU WBAN 10 A

SURFACE WEATHER OBSERVATIONS

STATION WBAS Los Angeles, Calif. DATE June 8-11, 1949

TYPE 1	TIME (LST) 2	CEILING (Hundreds of Feet) 3	SKY 4	VISIBILITY (Miles) 5	WEATHER and OBSTRUCTIONS TO VISION 6	SEA LEVEL PRESS. (mbs.) 7	TEMP (°F) 8	DEW PT (°F) 9	WIND DIRECTION 10	WIND SPEED (mph) 11	WIND CHARACTER AND SHIFTS 12	ALTIMETER SET (ins.) 13	REMARKS AND SUPPLEMENTAL CODED DATA 14 14A 14B	OBSERVERS INITIALS 15
					June	8								
		ALREPS	40-60 S OAK		0315	P			LGT		ICG	115-130 MSL	DC6 (sent with 0828 OBS)	AJO
		AFREPS	20 E BUR		0605	P			WND	270	080 MPH	100 MSL	P38 (SENT WITH 0626 OBS)	
		ALREPS	45 NW LAS		0745	P			LGT	TURBC	90 MSL	DC4	(SENT WITH 0828 OBS)	
					June	9								
		PIREPS	50 NW SFO		1714	P			DISCHARGE		50 MSL		LGT TURBC 35 MSL BCFT	
													(SENT WITH 1730 OBS)	
	2115	NYREPS	75 S LAS		2104	P			TOVC	55 MSL		PBY		
		AFREPS	85 E SFO		2312	P			LGT	ICG	11-140	MSL	B17 (SENT WITH 2330 OBS)	
					June	11								
	0910	PIREPS	0YR BFL		0904	P			CIG	28	MSL	ERCP		
		AFREPS	10 S LAS		1010	P			CIG	60	MSL	TOVC 85 MSL	B24 (Sent with 1026 OBS)	
	1138	PIREPS	15 SW BUR		1130	P			SKY	CLR		STSN		

FIGURE 10.—Entries of pilot reports on WBAN 10A.

Condensed Table of Critical Values

SUMMARY OF CRITERIA FOR TAKING SPECIAL OBSERVATIONS

1. CEILING:
   - a. The ceiling after decreasing by 50% or more is 5,000 feet or less.
   - b. A ceiling of 5,000 feet or less increases by 100% or more.
   - c. The ceiling decreases to less than 1,500 feet or increases to 1,500 feet or more.
   - d. The ceiling decreases to less than 1,000 feet, or increases to 1,000 feet or more.
   - e. The ceiling decreases to less than 500 feet, or increases to 500 feet or more.
   - f. The ceiling increases from zero to 100 feet or more.
   - g. The ceiling decreases to a value equal to or lower than the highest air-line operating minimum for the airport.
   - h. The ceiling increases to a value equal to or higher than the highest air-line operating minimum for the airport.
2. SKY CONDITION:
   - a. A change in total sky cover from clear to broken or overcast, and vice versa; or from scattered to overcast, and vice versa.
   - b. A change in sky cover from clear to scattered
     - (1) below 1,000 feet, or
     - (2) at or below the highest air-line operating minimum for the airport.
3. VISIBILITY:
   - a. The visibility after decreasing by 50% or more is 5 miles or less.
   - b. The visibility having been 5 miles or less, increases by 100% or more.
   - c. The visibility decreases to less than:
     - (1) 3 miles
     - (2) 1 mile
     - (3) ¾ mile
     - (4) ½ mile
     - (5) ¼ mile

     } C. A. A. ILS station only.
   - d. The visibility increases to equal or exceed:
     - (1) 3 miles
     - (2) 1 mile
     - (3) ¾ mile
     - (4) ½ mile
     - (5) ¼ mile

     } C. A. A. ILS station only.
     - (6) 1/16 mile
4. TORNADO:
   - a. Is observed.
   - b. Disappears from sight.
   - c. Is reported by the public to have occurred within preceding six hours.
5. THUNDERSTORM:
   - a. Begins.
   - b. Increases in intensity.
   - c. Ends. (Special observation 15 minutes after thunder is last heard at station.)
6. PRECIPITATION:
   - a. Hail begins or ends.
   - b. Liquid precipitation begins or ends.
   - c. Freezing precipitation begins or ends.
   - d. Sleet begins or ends.
   - e. Snow begins or ends.
7. FOG:
   - a. Beginning and ending of fog, ground fog, or ice fog; or a change from one type of fog to another.
8. SANDSTORM, DUSTSTORM:
   - a. Is observed within 6 miles of station.
   - b. Disappears from sight.
9. WIND AND WIND SHIFTS:
   - a. Sudden doubling of speed to more than 30 miles (26 knots).
   - b. Wind-shift.
10. ALTIMETER SETTING:
    - a. A change in altimeter setting, as shown by a change in station pressure, at the rate of 0.08 inch or more per hour. (Special observations taken at 15-minute intervals as long as this rate of change persists.)
11. In addition, any meteorological situation of importance to the safety or efficiency of aircraft operations.

SUMMARY OF CRITERIA FOR TAKING LOCAL EXTRA OBSERVATIONS

1. At designated stations at intervals not exceeding 15 minutes, beginning whenever
   - a. ceiling or visibility decreases to a value equal to or less than the highest aircraft minimum applying to the airport.
   - b. ceiling decreases to 500 feet or less.
   - c. visibility decreases to one mile or less.

   Local extra observations discontinued when values above these minimums have been reported. Record or special observations coming within 15-minute interval also serve as the local extra observation.
2. Upon request for one or more elements for aircraft arrivals or departures at any station, even though weather conditions do not warrant a special observation.
3. At any station immediately following any aircraft accident in the vicinity of an airport at which a weather-observing station is situated.
4. Ceiling or visibility changes to a value above, equal to, or below
   - a. the minimum prescribed for the airport, or
   - b. any air carrier minimum applicable to the local airport.

   This requirement is applicable only when takeoffs and landings impend.

INTENSITY CRITERIA FOR THUNDERSTORMS

Heavy Thunderstorm: Nearly incessant thunder and lightning; heavy rain, and possibly moderate to heavy hail; high winds, exceeding 40 mph (35 knots) at peak of gusts; rapid drop in temperature.

Thunderstorm: Intensity less than heavy.

INTENSITY CRITERIA FOR PRECIPITATION

Rate of Fall (hundredths of inch)

Intensity	Rainfall		Drizzle
	Per 6-minute interval	Per hour	Per hour
Light	0.01 or less	0.10 or less	Trace to 0.01.
Moderate	More than 0.01–0.03.	0.11–0.30	More than 0.01–0.02.
Heavy	More than 0.03	More than 0.30	More than 0.02.

Visibility—Snow Occurring Alone*

Intensity	Visibility
Heavy	Less than 550 yards.
Moderate	Less than 1100 yards but not less than 550 yards.
Light	1100 yards or more.

*Rate of accumulation is intensity criterion for snow occurring in combination with lithometeors and other hydrometeors.

INTENSITY CRITERIA FOR WIND SHIFTS

Maximum speed of gusts of wind

Accompanying phenomena	Intensity		
	Light	Moderate	Heavy
Both precipitation and a decrease in cloud heights.	Does not exceed 24 m. p. h., 21 knots.	Exceeds 24 m. p. h. but not 39 m. p. h., 21–34 knots.	Exceeds 39 m. p. h., 34 knots.
No precipitation nor decrease in cloud heights.	Does not exceed 34 m. p. h. 30 knots.	Exceeds 34 m. p. h., but not 49 mp. h., 30–42 knots.	Exceeds 49 m. p. h., 42 knots.

INTENSITY CRITERIA FOR SQUALLS

Maximum speed of gusts of wind

Description	Speed of gusts	
	M. P. H.	Knots
Light	Not to exceed 24	Not to exceed 21.
Moderate	25–39	22–34.
Heavy	More than 39	More than 34.

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U. S. Department of Commerce
Weather Bureau

ADDENDUM TO CIRCULAR N

(WBAN Manual of Surface Observations)

6th Edition

(This page may be discarded)

January 1, 1951

CHAPTER A16. SOLAR RADIATION

A16000. OBTAINING THE RECORD

A16010. General.—Solar radiation is recorded as a continuous trace and, in some installations, is also integrated on a watt-hour meter. Two types of recorders are in general use: The roll-chart type (see Fig. A16-1), whose records are described in par. A16120; and the circular-chart type (see Fig. A16-2), whose records are described in par. A16130. Recorders will be left in continuous operation, except that the chart-drive switch on the strip-chart recorder may be turned off during the interval beginning one hour after sunset and ending one hour before sunrise during seasons when an appreciable saving in paper would be effected. Do not turn off the chart-drive switch during a standardization cycle (see par. A16421).

A16020. Time Standard.—All time and date entries on solar radiation records and summary forms are in terms of True Solar Time (T.S.T.). To convert standard zone time to true solar time:

(1) Determine the number of degrees and minutes of longitude that the station is east or west of its standard meridian; i.e., the 75th, 90th, 105th meridian, etc.

(2) Convert minutes of longitude to quarters of degrees with Table A16-1.

TABLE A16-1 CONVERSION FROM MINUTES TO DEGREES

Minutes	Degrees
0' - 7'	0°
8' - 22'	1/4°
23' - 37'	1/2°
38' - 52'	3/4°
53' - 59'	1°

(3) Using the appropriate date and the value of longitude to degrees and quarters as determined in (1) and (2), find the corresponding tabular value in minutes from Table A16-2. Interpolate for the fractional degree.

(4) Add algebraically the value determined in (3) to the standard time to obtain the corresponding true solar time.

Example

Given: Station Longitude, 77°35'W.
Time, 5:00 a.m., 75th meridian time.
Date, January 1.

Determination of true solar time for the station:

(a) 77° 35' minus 75° 00' equals 2° 35' W.

(b) 2° 35' corresponds to 2-1/2° (Table A16-1).

(c) The correction for January 1 at 2-1/2° W from Table A16-2 is -14 minutes.

(d) 5:00 L.S.T. minus 14 minutes is 4:46 T.S.T.

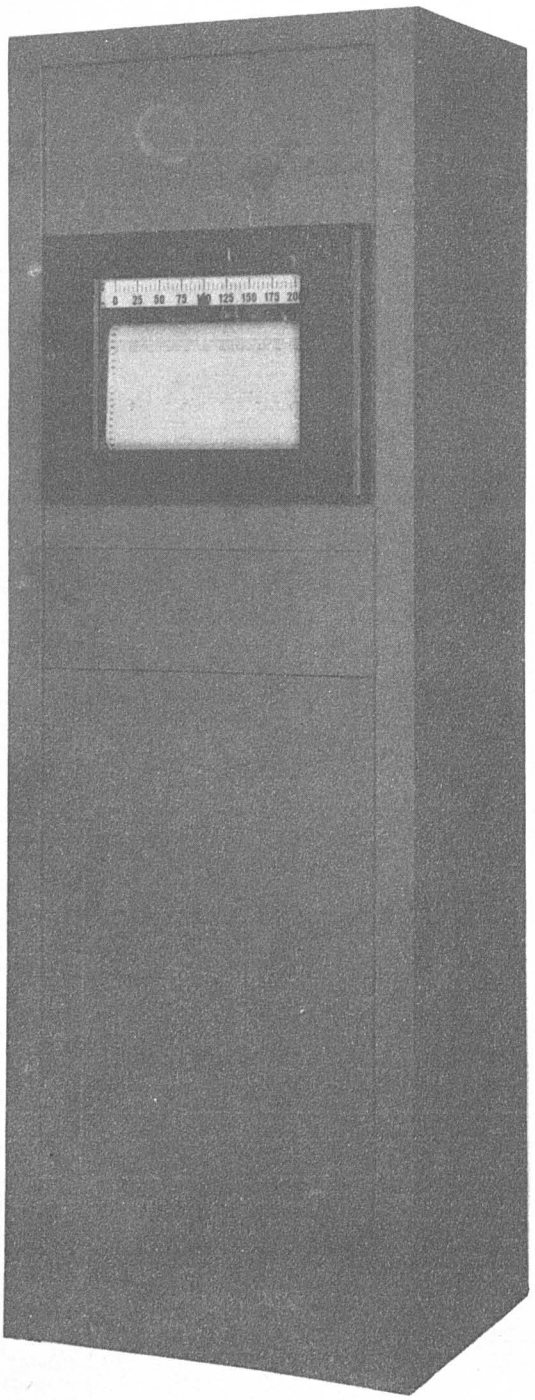


Fig. A16-1. Roll-chart recorder (full length)

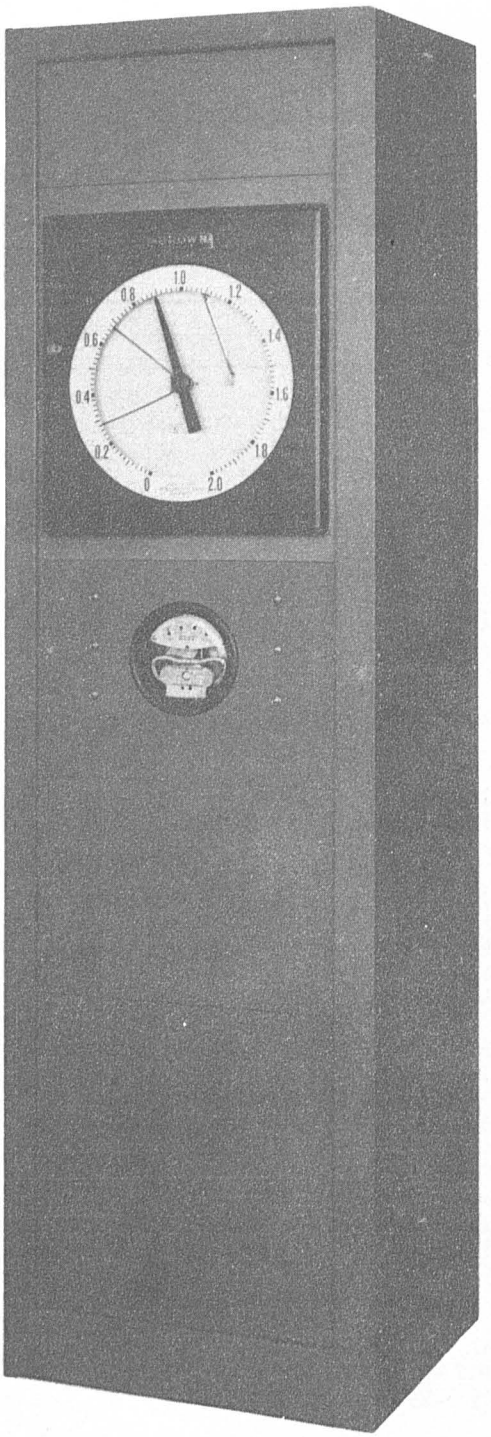


Fig. A16-2. Circular-chart recorder (full length)

Table A16-2. Number of minutes to be added algebraically to local standard time to obtain true solar time.

Equation of time values (Apparent-Mean) based on figures taken from the 1942 American Ephemeris and Nautical Almanac (for Washington Apparent Noon).

	Number of Degrees WEST of Meridian.									Number of Degrees EAST of Meridian.								
Date	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	Date
Jan.																		Jan.
1-3	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	1-3
4-5	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	4-5
6-7	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	6-7
8-9	-39	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	8-9
10-12	-40	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	10-12
13-15	-41	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	13-15
16-18	-42	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	16-18
19-21	-43	-39	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	19-21
22-25	-44	-40	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	22-25
26-30	-45	-41	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	26-30
31	-46	-42	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	31
Feb.																		Feb.
1-23	-46	-42	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	1-23
24-28	-45	-41	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	24-28
Mar.																		Mar.
1-5	-44	-40	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	1-5
6-9	-43	-39	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	6-9
10-13	-42	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	10-13
14-17	-41	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	14-17
18-20	-40	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	18-20
21-23	-39	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	21-23
24-27	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	24-27
28-30	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	28-30
31	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	31
Apr.																		Apr.
1-2	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	1-2
3-6	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	3-6
7-9	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	7-9
10-13	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	10-13
14-17	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	14-17
18-22	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	18-22
23-27	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	23-27
28-30	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	28-30

Table A16-2 - continued. Number of minutes to be added algebraically to local standard time to obtain true solar time.

Equation of time values (Apparent-Mean) based on figures taken from the 1942 American Ephemeris and Nautical Almanac (for Washington Apparent Noon).

	Number of Degrees WEST of Meridian.									Number of Degrees EAST of Meridian.								
Date	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	Date
May																		May
1-6	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	1-6
7-21	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	7-21
22-31	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	22-31
June																		June
1-6	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	1-6
7-11	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	7-11
12-16	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	12-16
17-20	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	17-20
21-25	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	21-25
26-30	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	26-30
July																		July
1-5	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	1-5
6-12	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	6-12
13-31	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	13-31
Aug.																		Aug.
1-8	-38	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	1-8
9-14	-37	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	9-14
15-19	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	15-19
20-23	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	20-23
24-27	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	24-27
28-30	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	28-30
31	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	31
Sept.																		Sept.
1-2	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	1-2
3-5	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	3-5
6-8	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	6-8
9-11	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	9-11
12-14	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	12-14
15-17	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	37	15-17
18-20	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	38	18-20
21-22	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	39	21-22
23-25	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	40	23-25
26-28	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	37	41	26-28
29-30	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	38	42	29-30

Table A16-2 - continued. Number of minutes to be added algebraically to local standard time to obtain true solar time.

Equation of time values (Apparent-Mean) based on figures taken from the 1942 American Ephemeris and Nautical Almanac (for Washington Apparent Noon).

	Number of Degrees WEST of Meridian.									Number of Degrees EAST of Meridian.								
Date	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	Date
Oct.																		Oct.
1	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	38	42	1
2-5	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	39	43	2-5
6-8	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	40	44	6-8
9-12	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	37	41	45	9-12
13-16	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	38	42	46	13-16
17-22	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	39	43	47	17-22
23-31	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	40	44	48	23-31
Nov.																		Nov.
1-14	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	40	44	48	1-14
15-19	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	39	43	47	15-19
20-23	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	38	42	46	20-23
24-26	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	37	41	45	24-26
27-29	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	40	44	27-29
30	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	39	43	30
Dec.																		Dec.
1-2	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	39	43	1-2
3-4	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	38	42	3-4
5-7	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	37	41	5-7
8-9	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	40	8-9
10-11	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	39	10-11
12-13	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	38	12-13
14-15	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	37	14-15
16-17	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	16-17
18-19	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	35	18-19
20-21	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	34	20-21
22-23	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	33	22-23
24-25	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	24-25
26-27	-33	-29	-25	-21	-17	-13	-9	-5	-1	3	7	11	15	19	23	27	31	26-27
28-30	-34	-30	-26	-22	-18	-14	-10	-6	-2	2	6	10	14	18	22	26	30	28-30
31	-35	-31	-27	-23	-19	-15	-11	-7	-3	1	5	9	13	17	21	25	29	31

A16030. Adjustments for Time.—Check and adjust the chart for time between sunrise and sunset as frequently as necessary to maintain the position of the pen within ± two minutes of the true solar time (see par. A16020). Time lines on roll charts are printed on the chart at ten-minute intervals. The wider of these lines are spaced thirty minutes apart. Adjust this type of chart so that the beginning of an hour corresponds to one of the wider time lines. Adjust circular charts so that the time of the records corresponds to the appropriately-labeled, radial time line. At each point of adjustment, and at sunrise, or as soon as practicable thereafter at stations where personnel are not on duty at that time, enter a short time check "✓" and the true solar time. When an adjustment of more than two minutes is made after the beginning of record each day, enter the amount and sign of the correction in parentheses.

A16040. Functioning of Equipment.—Inspect the record daily, and more often if necessary, to determine whether the trace is satisfactory. Test for malfunctioning of the equipment or a change in the condition of exposure of the pyrheliometer whenever the pattern described by the trace departs widely from patterns made previously under similar meteorological conditions. (See Sections A16300 and A16400.)

A16100. EVALUATING THE RECORD

A16110. General.—Observations of total solar and sky radiation received on a horizontal surface are evaluated in terms of langleys (gram-calories per square centimeter). Estimations of data for periods of missing or erroneous record are made in accordance with instructions for the type of recorder in use. When data cannot be estimated for periods of missing or erroneous record, entries for these periods will be omitted from the summary prepared on Form 1091A. Note that an entry may be required later in accordance with par. A16215.1.

A16111. Erroneous Records.—The following conditions are indicative of erroneous records:

(1) A stationary pen as evidenced by a record of unvarying intensity.

(2) Time lag in the response of the pen to cloud changes that normally cause an abrupt change in the pen position.

(3) An abrupt increase in the indicated amount of radiation following the removal of ice or other foreign matter.

When slight accumulations of frost, ice, etc. on the bulb make it impracticable to determine whether an increase in radiation results from cleaning the bulb, enter the nature of the conditions and the time of their beginning and ending adjacent to the questionable record.

A16120. Roll Charts.—When a portion of the record is unsatisfactory (missing or appears erroneous, see par. A16111), estimate the trace corresponding to the time interval of the unsatisfactory record provided (1) the sky condition during the interval was substantially the same as it was immediately preceding and following the interval, and (2) the interval is of two hours duration or less. Sketch the estimated trace on the chart as a smoothly interpolated curve connecting the ends of the satisfactory record. When the period of unsatisfactory record includes the beginning or end of measurable radiation for the day, estimate the normal time of the beginning or end of radiation from inspection of representative records on preceding and following days. At this estimated time on the zero reference line on the chart, plot one end of the estimated trace.

A16121. Hourly Radiation.—Hourly radiation data will be computed following the evaluation of the radiation for each twenty minutes of record. The record will be evaluated with a transparent evaluator graduated from 0 to 40 in increments of one langley per twenty minutes. The evaluator may be used directly with records from 10-junction pyrheliometers. When the evaluator is used with records from 50-junction pyrheliometers, the readings from the evaluator must be multiplied by a factor obtained as specified in 6(b) to provide radiation values in terms of langleys per twenty minutes. Hourly radiation values in langleys will be computed for each hour of record (including hours in which all or part of the record is estimated) as follows:

(1) Lay one side of the evaluator lengthwise along a time line corresponding to the beginning of a 20-minute period. Note that the width of this scale is such that when one side coincides with the time line at the beginning of a 20-minute period, the other side coincides with the time line at the end of the period.

(2) Move the evaluator parallel to the two time lines until, on each side of the 0.0 line of the scale, equal areas are bounded by the trace, the respective time lines, and the 0.0 line of the scale. (See Fig. A16-3).

(3) Draw a line across the entire 20-minute period, coincident with the 0.0 line, after adjustment (2) has been made.

(4) With the evaluator in the position described in (2), read the scale to the nearest tenth of a division at the intersection of the scale with the zero-radiation line on the chart

(5) When a 10-junction pyrheliometer is used, the hourly radiation is the sum of the three scalar readings for the hour.

(6) When a 50-junction pyrheliometer is used, (a) compute the sum of the scalar readings in each hour, (b) divide the calibration constant for the 10-junction pyrheliometer by the constant for the 50-junction pyrheliometer, and (c) multiply the quotient obtained in (b) by the sum obtained in (a). The result is the radiation for the hour in langleys. The calibration constants are entered on the standardization sheet furnished with each instrument.

Example

Given: Sum of the 3 scalar readings during a solar hour; 112.7
Calibration constant for 10-junction pyrheliometer of 2.16
Calibration constant for 50-junction pyrheliometer of 6.52

Computation: $\frac{2.16}{6.52} \times 112.7 = 37.3$ langleys

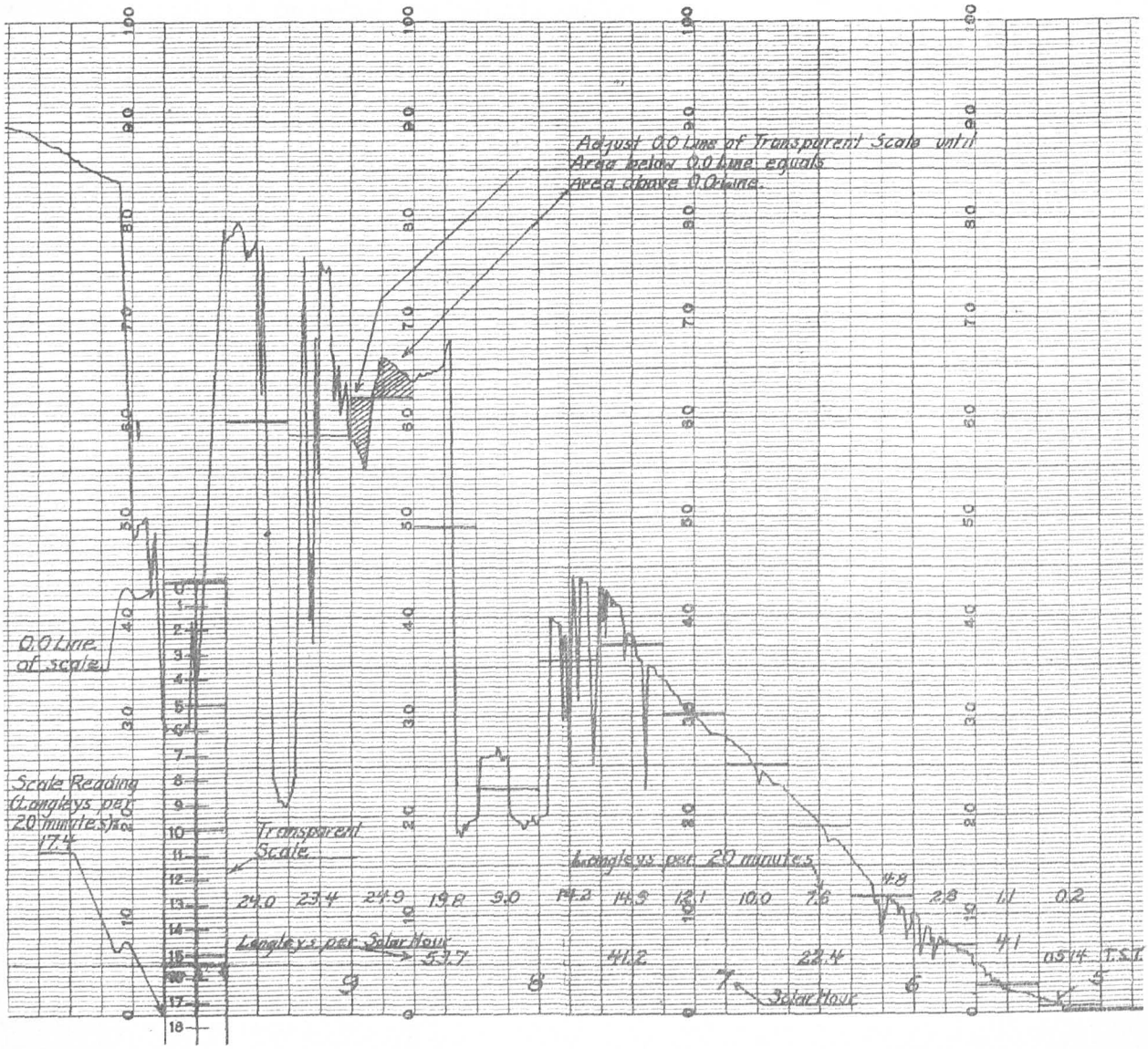


Fig. A16-3. Roll-chart record (section - with evaluator)

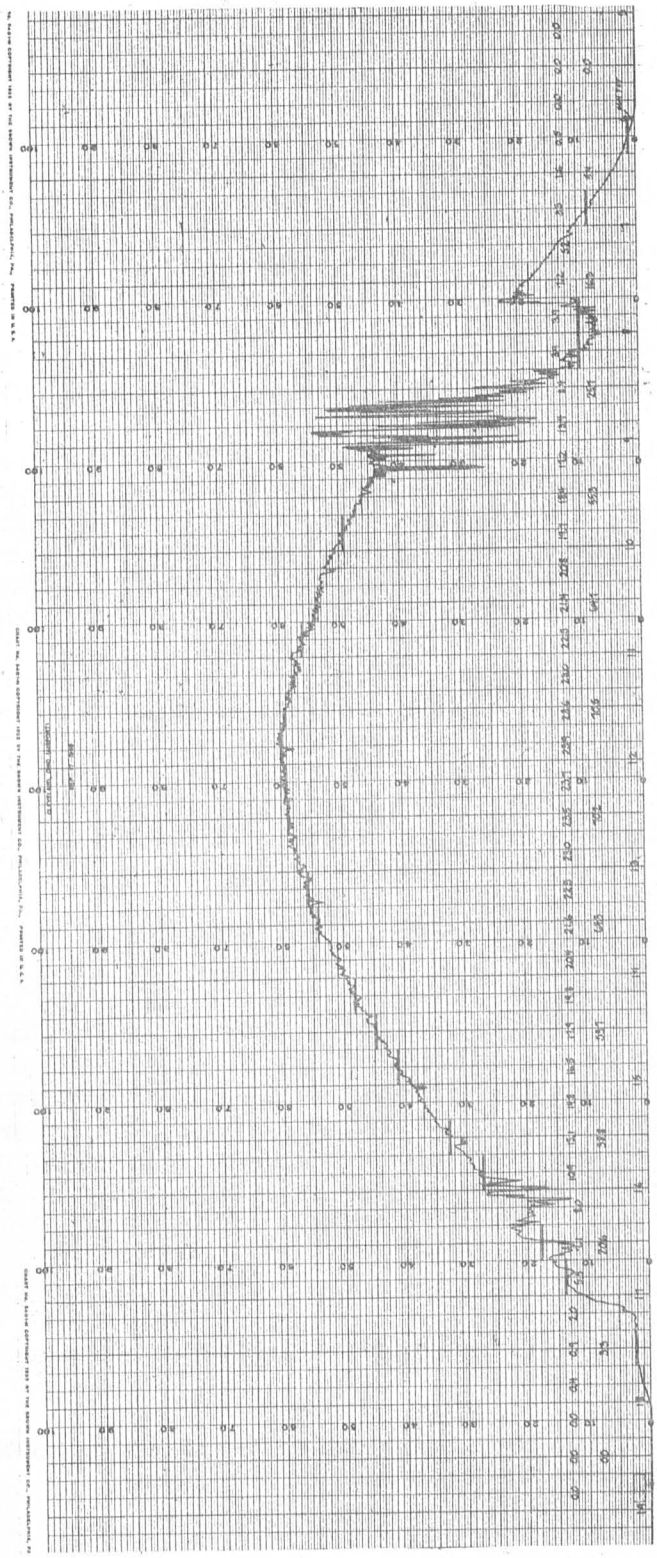


Fig. A16-4. Roll-chart record

A16122. Chart Entries (See Fig. A16-4).--Entries are made as follows:

(1) Between the 0-line and 5-line, enter the true solar hour on the corresponding time line.

(2) Parallel to, and between the 90- and 100-lines, and near each noon-line, enter the station name and date.

(3) Between the 10- and 20-lines and near the midpoint of each 20-minute interval, enter the appropriate scalar readings. Enter readings obtained entirely or in part from an estimated record in parentheses. Make no entry for periods for which radiation has not been computed in accordance with par. A16121.

(4) Between the 5- and 10-lines, and near the midpoint of each solar hour interval, enter the corresponding value of hourly radiation. Enter, in parentheses, values that include any estimated data. When the entry of radiation for one or more of the 20-minute periods of a given hour has been omitted as in (3), omit the entry of radiation data for the corresponding hour.

A16130. Circular Charts.--When malfunctioning of the equipment is indicated, data for the days affected will be regarded as missing. The daily total read from the watt-hour meter will be regarded as "missing" only if it appears reasonably certain from the characteristics of the trace that the indicator reading is incorrect (see par. A16111). When the faulty record results only from mechanical failure of the pen, such as depletion of the ink supply, the reading of the meter will be assumed correct.

A16131. Reading the Indicator.--Read the indicator to tenths, nightly, between sunset and sunrise. The indicator consists of four circular dials (see Fig. A16-5). From left to right, the four dials indicate thousands, hundreds, tens, and units, respectively. Tenths are estimated from the fourth dial. Note that the indexes of the first and third dials rotate counterclockwise, whereas the indexes of the second and fourth dials rotate clockwise. When an index is between two numbers, the lower value is taken as pertaining to the dial reading. A complete revolution of the index on one dial will advance the index on the left adjacent dial by one division. When reading the meter, reconcile readings of adjacent dials, e.g., if the index on one dial were close to six and the index on the next dial on the right close to eight, the reading of the former would be five and not six.

A16131.1 To avoid errors in reading the indicator meters, observe the following precautions:

(1) If practicable, have the reading verified by another observer; if not, recheck the reading.

(2) Compare the data for consistency with data on preceding days when cloud conditions were similar. When an inconsistency is noted, examine the recorder record to ascertain whether the inconsistency was actually caused by variations in radiation, or by an erroneous reading.

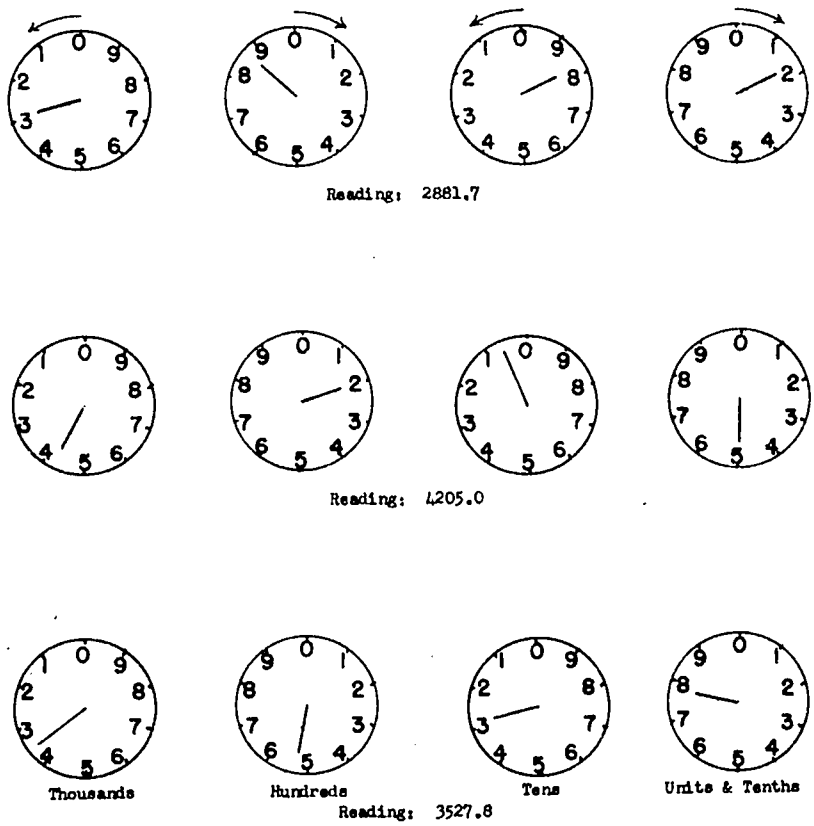


Fig. A16-5. Watt-hour meter

A16132. Chart Entries (See Fig. A16-6).—Entries are made adjacent to the midnight time lines as follows:

(1) Concentric with and below the 50-line enter:
  (a) The integrating-indicator reading for the day.
  (b) The difference between the indicator reading recorded in (a) and the indicator reading for the preceding day.
  (c) The total solar radiation for the day to tenths of langleys (see par. A16133 and A16134).

(2) Concentric with and between reference lines 70 and 90, enter the station name and date.

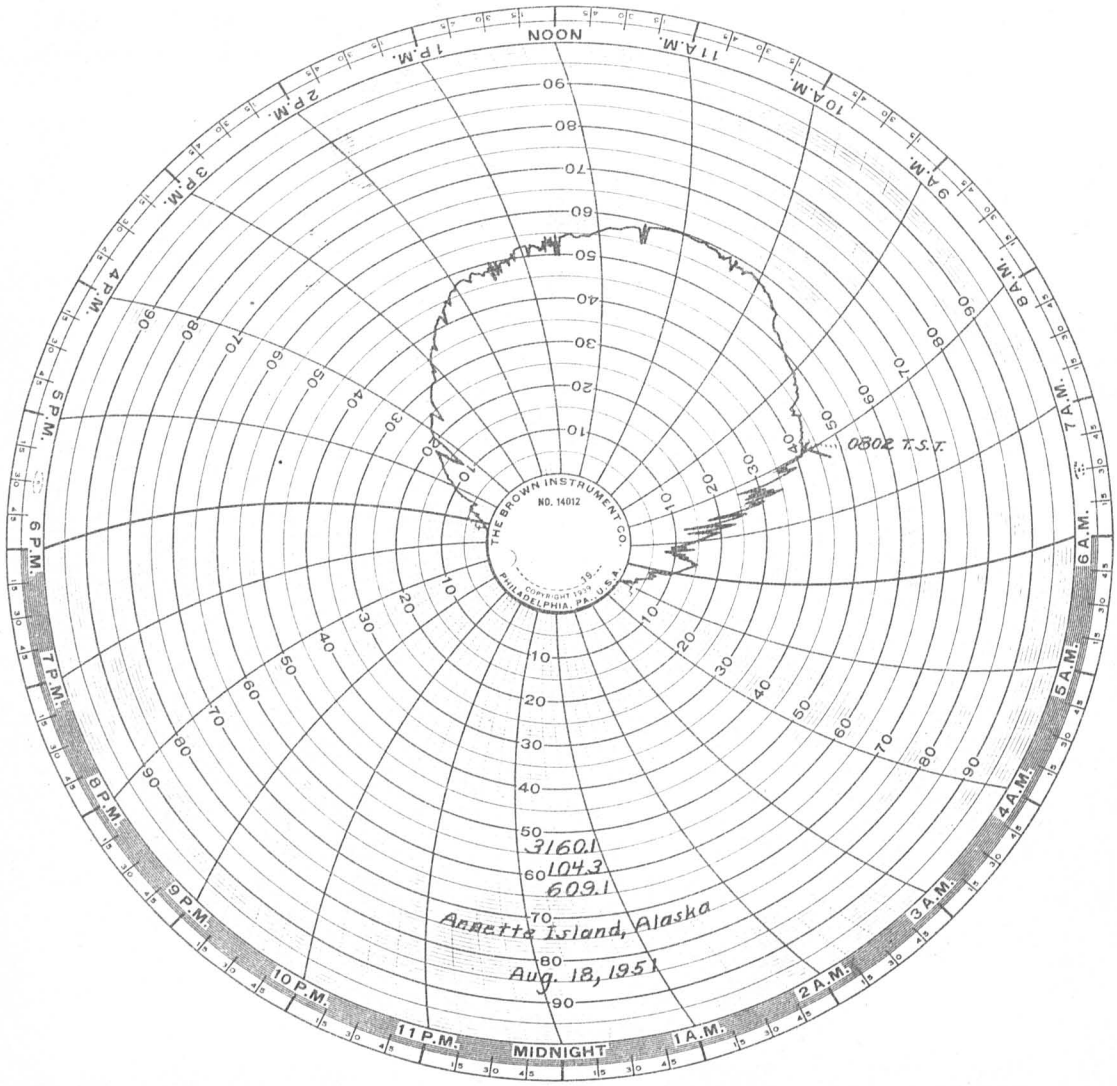


Fig. A16-6. Circular-chart record

A16133. Computation of Total Solar Radiation - 10-Junction Pyrheliometers.— When a 10-junction pyrheliometer is in use, obtain the total solar radiation in langleys by multiplying the difference referred to in par. A16132 (1(b)) by the conversion factor usually stamped on a plate beneath the dials of the meter.

Example

Given: Daily reading of 9291.3
Readings on preceding day of 9274.7
Conversion factor 6.787

Computation: 9291.3 minus 9274.7 = 16.6
16.6 multiplied by 6.787 = 112.7 langleys

Chart Entries: 9291.3
16.6
112.7

A16134. Computation of Total Solar Radiation - 50-Junction Pyrheliometers.--When a 50-junction pyrheliometer is in use, obtain the total solar radiation in langleys as follows:

(1) Multiply the difference referred to in par. A16132 (1(b)) by the conversion factor specified in par. A16133.

(2) Multiply the product obtained in (1) by the calibration constant of the 10-junction pyrheliometer.

(3) Divide the result obtained in (2) by the calibration constant of the 50-junction pyrheliometer. The quotient is the total solar radiation in langleys.

Note: The calibration constant is entered on the standardization sheet furnished with each pyrheliometer.

Example

Given: Daily reading of 7647.2
Reading on preceding day of 7546.2
Conversion factor of 6.243
Calibration constant for 10-junction pyrheliometer of 2.16
Calibration constant for 50-junction pyrheliometer of 6.52

Computations: 7647.2 minus 7546.2 = 101.0
101.0 multiplied by 6.243 = 630.5

$\frac{2.16}{6.52}$ multiplied by 630.5 = 208.9 langleys

Chart Entries: 7647.2
101.0
208.9

A16200. SUMMARY DATA

A16210. General.—Solar radiation data will be entered on Form 1091A, Solar and Sky Radiation Measurements. Entries will be made with a 3H drawing pencil or equivalent and the form will be prepared in triplicate. The entries are grouped into periods of seven days, except that the summary for December and, during leap year, for June, will comprise data for three seven-day periods and one eight-day period.

A16210.1. Mean Data.—When the computation of the mean value of a group of entries is required, compute the sum of the entries in the group and divide the sum by the number of entries in the group. Include entries of estimated data in the computation of mean values. Mean values that include estimated data will be entered in parentheses. Mean values of hourly radiation that are also entered as estimated hourly radiation for hours of unsatisfactory record in accordance with par. A16215.1 will not be entered in parentheses when entered as mean values. When means cannot be computed because of missing data, enter an "M" in lieu of a numerical entry.

A16210.2. Eight-Day Periods.—Entries for the eighth day of an eight-day period will be entered on the line labeled "Means". Enter the date in the space labeled "Means" and delete "Means". Label the next lower line "Means" and enter the mean data for the period on that line.

A16210.3. Verification of Computations.—At stations equipped with roll chart recorders, verify each computation of the mean value of total-daily-radiation entries by computing the sum of the corresponding entries of mean hourly radiation.

A16211. Station Name and Date.—Enter the station name and the dates of the first and last entries in the spaces provided at the top of the form.

A16212. Dates of Entries.—The periods covered by the summaries accord as nearly as possible with calendar months. The date of the first entry on each summary form will be determined from Table A16-3.

Table A16-3 - Starting Dates of Summaries

Month	Date of First Entry (Common Years)	Date of First Entry (Leap Years)
Jan.	Jan. 1	Jan. 1
Feb.	Jan. 29	Jan. 29
Mar.	Feb. 26	Feb. 26
Apr.	Apr. 2	Apr. 1
May	Apr. 30	Apr. 29
June	June 4	June 3
July	July 2	July 2
Aug.	July 30	July 30
Sept.	Sept. 3	Sept. 3
Oct.	Oct. 1	Oct. 1
Nov.	Oct. 29	Oct. 29
Dec.	Dec. 3	Dec. 3

A16213. Hourly Radiation.—Hourly radiation entries are made at stations equipped with roll-chart recorders. In the spaces provided, enter the date and, to tenths of a langley, the corresponding hourly radiation values from the evaluated record charts (see par. A16122) for the hour ending at the time indicated at the top of each column. Enter estimated data in parentheses. Omit entries for hours for which data are missing except as specified in par. A16215.1. If the data for an entire day are missing, enter the reason for the missing data in lieu of the data.

A16214. Daily Total Radiation.—At stations equipped with roll-chart recorders, enter, to tenths, under the caption "Daily Total", the sum of all the hourly data (recorded and estimated) for each day. If the sum for any day contains more than three percent estimated data (i.e., hourly data entered in parentheses) enter the sum in parentheses. When hourly radiation entries for any portion of a day are omitted in accordance with par. A16213, enter an "M" in lieu of a daily total.

A16214.1. At stations equipped with a circular-chart recorder and an integrating indicator, enter daily-total-radiation values, to the nearest tenth of a langley, in chronological order under the caption "Daily Total"; and enter the corresponding dates similarly under the caption "Dates". If the daily total is missing, enter an "M" (see par. A16130) and the reason for omission of the total.

A16215. Means of Hourly Radiation.—Means of hourly radiation will be computed only for such periods as satisfy the following conditions:

(1) Form 1091A must include numerical entries of daily total radiation for four or more days of the period.

(2) Total daily radiation pertaining to each of at least four days must not include more than three percent of estimated hourly data (as entered in parentheses) for any single day.

A16215.1. If sufficient data are available for the computation of means, but hourly radiation values for a portion of one or more days are missing, and cannot be estimated in accordance with par. A16120, enter, in lieu of an hourly radiation value, the mean for that hour, and enclose the value in parentheses to indicate that it is estimated.

A16216. Means of Daily Totals.—Compute the mean of all the daily totals for each period in which each of four or more daily totals contain not more than three percent of estimated data (i.e., hourly values entered in parentheses). Enter the mean on the line titled "Means" and under the caption "Daily Total".

A16217. Computers and Verifiers Initials.—To the right of the "Daily Total" entries, enter the initials of the computer, aslant, and the initials of the verifier of the daily entries and of the means.

WB Form 1091 A

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

(WB-1-20-49-10M) 80

Solar and Sky Radiation measured at Jonesville, Texas from July 30, 1949 to September 2, 1949

Radiation in gr-cal per cm² of horizontal surface during hour ending (apparent time)

Date	A.M. 1	2	3	4	5	6	7	8	9	10	11	Noon	P.M. 1	2	3	4	5	6	7	8	9	10	11	Mid't	Daily Total
July 30						0.5	12.7	36.4	55.1	72.8	83.3	87.8	87.0	80.6	76.2	53.1	39.2	17.4	2.3						711.4 EB/RY
31						1.1	14.8	36.2	56.8	73.5	71.7	79.0	63.6	80.2	73.3	56.3	38.9	16.3	1.8						663.6 EB/RY
Aug. 1						1.3	18.0	36.7	57.0	72.1	84.7	73.1	75.5	77.0	78.4	44.9	24.9	14.6	0.9						644.1 EB/RY
2						1.5	15.6	32.7	52.2	74.3	84.6	93.9	73.5	67.7	76.4	58.1	38.2	16.6	1.7						696.5 EB/RY
3						1.5	15.9	37.6	53.1	81.8	76.4	82.2	87.2	84.1	73.7	56.4	37.1	11.6	0.5						706.6 EB/RY
4						1.3	15.9	26.2	54.4	74.4	77.9	92.8	90.4	85.6	65.1	35.1	15.5	3.0	0.9						633.8 EB/RY
5						1.6	14.4	26.9	55.0	46.4	18.7	16.8	35.0	19.7	27.5	26.1	16.3	8.5	1.2						397.4 EB/RY
Means						1.3	14.8	33.1	54.7	70.5	70.3	76.3	74.7	70.7	66.2	47.7	30.0	12.6	1.3						633.7 EB/RY
6						0.4	16.1	27.8	50.4	27.4	44.2	62.2	53.6	57.6	44.5	37.8	24.5	10.9	6.3						404.8 WB/EG
7						2.9	15.4	36.2	60.1	68.0	84.2	83.5	76.2	83.3	74.5	62.9	32.3	14.5	1.5						672.7 WB/EG
8						0.8	16.1	30.9	57.2	67.2	83.9	83.0	83.6	84.8	71.8	54.8	32.5	11.9	0.7						687.2 WB/EG
9						2.4	17.0	40.0	52.3	60.8	87.1	91.6	96.9	88.8	82.8	43.1	40.6	16.6	1.2						696.8 WB/EG
10						1.2	11.3	28.1	46.8	54.5	66.8	86.5	94.1	86.2	76.6	57.6	32.0	16.9	1.8						662.4 WB/EG
11						2.0	17.3	30.4	65.4	60.3	63.3	86.2	93.4	84.9	73.6	55.9	36.4	14.5	1.3						693.9 WB/EG
12						1.4	15.2	37.1	58.2	77.0	86.9	96.5	99.9	84.5	73.1	55.0	35.5	14.2	1.3						726.8 WB/EG
Means						1.5	15.3	32.8	55.8	59.6	74.5	84.8	85.5	82.1	66.6	52.4	34.0	14.2	1.3						658.5 WB/EG
13						1.2	13.4	38.1	57.4	72.2	83.1	88.5	82.3	88.9	78.9	54.4	36.4	15.8	1.4						710.5 EB/RY
14						1.7	14.3	28.6	61.8	74.5	82.7	90.1	82.0	79.1	64.4	42.4	(35.0)	(13.0)	(1.0)						(681.4) EB/RY
15						1.6	10.9	35.9	58.0	72.9	86.2														M EB/RY
16						0.9	8.1	23.8	39.8	49.3	51.8	68.5	76.8	90.0	82.4	56.8	36.3	14.8	1.5						603.8 EB/RY
17										Relocation			of	Station											M EB/RY
18										Relocation			of	Station											M EB/RY
19										Relocation			of	Station											M EB/RY
Means						M	M	M	M	M	M	M	M	M	M	M	M	M	M						M EB/RY
20						0.8	12.4	35.2	52.4	71.4	85.1	86.6	79.3	86.6	76.0	56.4	36.4	14.2	1.3						704.3 EB/RY
21						1.3	11.6	34.6	56.6	61.9	80.6	79.8	66.0	80.5	75.6	55.7	36.9	13.0	1.0						653.9 EB/RY
22						(0.8)	(10.2)	(31.6)	(46.2)	46.1	80.2	90.8	38.0	77.8	71.6	53.5	22.3	10.8	0.9						(591.6) EB/RY
23						0.9	13.8	34.1	54.5	66.2	48.2	58.8	63.0	78.5	72.3	42.8	25.9	10.4	0.8						582.7 EB/RY
24						0.7	12.2	33.4	49.5	67.0	81.6	86.2	68.2	28.7	71.1	50.8	30.2	11.3	0.9						571.8 EB/RY
25						0.7	11.3	34.1	30.8	55.6	78.4	38.9	45.3	6.5	28.6	26.2	10.1	9.1	0.7						383.3 EB/RY
26						0.3	3.3	17.6	28.5	13.0	11.8	72.6	74.0	83.4	71.3	46.5	5.8	2.8	0.5						404.4 EB/RY
Means						0.8	10.7	31.6	46.2	54.5	65.9	74.0	61.8	63.1	65.8	48.3	25.4	10.2	0.9						[illegible] EB/RY
27						0.4	2.4	5.7	40.8	48.9	84.4	88.0	86.4	78.5	66.0	48.1	16.9	2.7	0.2						578.4 WB/EG
28						0.2	12.2	33.7	52.7	55.2	46.7	40.0	24.0	53.5	62.0	51.8	31.2	9.9	0.8						511.7 WB/EG
29						0.6	11.9	34.0	50.4	65.9	77.3	87.5	76.8	68.9	61.1	48.8	33.0	7.3	0.3						626.8 WB/EG
30						0.6	12.1	35.0	46.4	60.6	57.0	60.8	73.2	83.5	71.4	46.2	13.6	2.6	0.3						553.8 WB/EG
31						0.3	11.0	30.9	51.0	36.4	31.7	12.0	40.4	80.4	70.2	52.8	32.7	11.0	0.6						464.5 WB/EG
Sept. 1						0.6	11.0	31.8	47.2	12.4	21.8	88.5	82.9	61.2	32.5	28.2	14.9	4.9	0.4						443.3 WB/EG
2						0.5	11.2	22.6	50.9	63.9	79.9	88.5	86.7	76.3	63.0	43.3	13.6	5.0	0.3						613.9 WB/EG
Means						0.5	11.3	27.1	48.2	49.5	57.7	65.3	75.3	71.2	59.5	44.9	22.4	6.5	0.3						541.6 WB/EG

WB Form 1091 A

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

(WB-1-20-49-10M) 80

Solar and Sky Radiation measured at Annette Island, Alaska from June 3, 1952 to July 1, 1952

Radiation in gr-cal per cm² of horizontal surface during hour ending (apparent time)

Date	A.M. 1	2	3	4	5	6	7	8	9	10	11	Noon	P.M. 1	2	3	4	5	6	7	8	9	10	11	Mid't	Daily Total
June 3																									78.2 AL/FK
4																									70.6 AL/FK
5																									282.7 AL/FK
6																									288.7 AL/FK
7																									258.1 AL/FK
8																									128.8 AL/FK
9																									482.6 AL/FK
Means																									217.8 AL/FK
10																									342.3 KEM/FK
11																									339.9 KEM/FK
12																									266.4 KEM/FK
13																									161.9 KEM/FK
14																									444.5 KEM/FK
15																									444.4 KEM/FK
16																									413.5 KEM/FK
Means																									339.8 KEM/FK
17																									225.5 RH/FK
18																									488.1 RH/FK
19																									286.9 RH/FK
20																									411.7 RH/FK
21																									412.9 RH/FK
22																									609.1 RH/FK
23																									522.4 RH/FK
Means																									392.2 RH/FK
24																									502.8 AL/FK
25																									523.9 AL/FK
26																									333.4 AL/FK
27																									333.6 AL/FK
28																									404.1 AL/FK
29																									408.5 AL/FK
30																									403.3 AL/FK
July 1																									382.0 KEM/FK
Means																									410.3 KEM/FK
Means																									

Fig. A16-7. WB Form 1091A

A16220. Distribution of Forms.--Assemble recorder records for the period of record of each summary in chronological order with the earliest date on top and forward to the Central Office, attention C&HS Record Section. Roll-charts for each day will be separated before submission, and will cover the period from one hour before sunrise to one hour after sunset. The separated portion may be folded for mailing.

A16221. The original copy of Form 1091A will be mailed not later than the tenth of the following month to:

Weather Bureau Office
Solar Radiation Field Testing Unit
Boston 9, Massachusetts

One carbon copy will be forwarded to the Central Office, attention Scientific Services Division, while the second carbon copy will be retained at the station. Stations outside continental United States will airmail their copies to the Boston Office.

A16300. PYRHELIOMETER

A16310. General.--Solar radiation installations for the measurement of total solar and sky radiation consist of a pyrheliometer installed in a suitably exposed position and a recorder usually installed in the office. Any abnormal functioning of the equipment that cannot be corrected in accordance with the following instructions will be reported promptly to the Regional Office.

A16320. Types.--Thermoelectric 180° pyrheliometers are used in measuring total solar and sky radiation. Two types are in use: a "10-junction" type in general use (Fig. A16-8), and a more sensitive "50-junction" type used at selected northern stations (above approximately 55°N. latitude) during months when solar radiation is less intense (see par. A16324).

A16321. Exposure.--The ideal exposure site for the pyrheliometer is one that is free from any obstructions above the horizontal plane of the sensing element, and that is readily accessible for maintenance of the instrument. If it is impossible to obtain such an exposure, the site must be as free from obstructions as possible, especially in the northern hemisphere, from east-northeast through south to west-northwest; or in the southern hemisphere, from east-southeast through north to west-southwest. If practicable, the pyrheliometer should be so located that (1) a shadow will not be cast on it at any time, (2) it is not in proximity to light-colored walls or other objects likely to reflect sunlight directly on the sensing element of the pyrheliometer, and (3) it is not subject to radiation from other sources.

A16322. Installation.--The pyrheliometer is mounted on a pedestal, the top of which is horizontal. Orient the pedestal so that the pyrheliometer

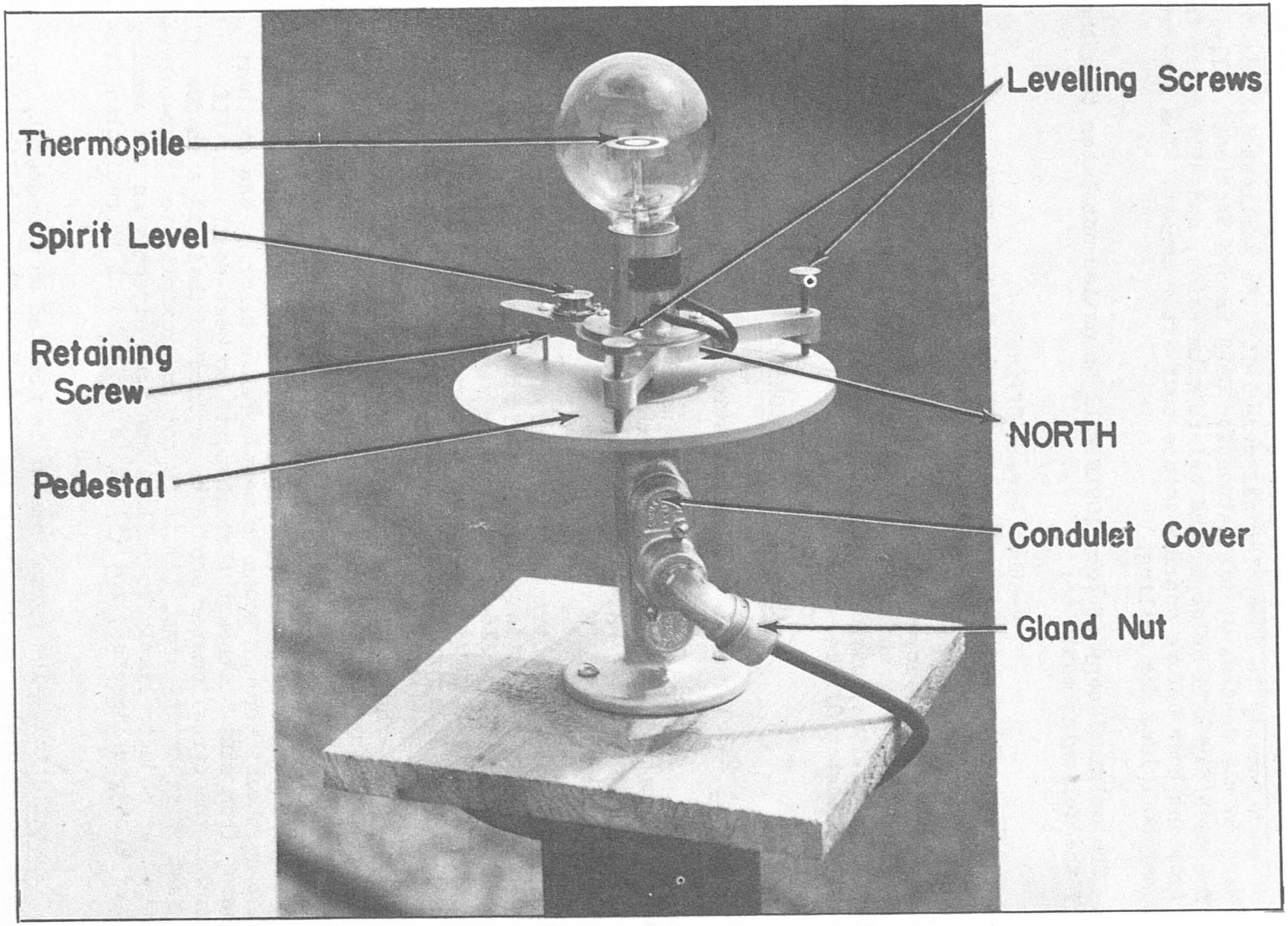


Fig. A16-8. Pyrheliometer - 10-junction

retaining screw is located directly south of the center of the pedestal. Center the pyrheliometer on the pedestal, and secure the instrument lightly with the retaining screw. Level the instrument with the leveling screws and with the spirit level that is mounted on the south leg of the instrument. Tighten the retaining screw, but not sufficiently to change the level setting of the instrument. When properly exposed, the sensing element is horizontal and the leads emerge from the north side of the instrument. At northern stations where the 50-junction pyrheliometer is used in winter to replace the 10-junction instrument (see par. A16324), care must be exercised to obtain a permanent copper-to-copper junction between the short leads from the pyrheliometer and the cable to the recorder; i.e., a junction that will not introduce thermal effects resulting either from temperature differences between the two connections or from gradual growth of an oxide film between the spliced wires. When disconnecting the pyrheliometer, melt the solder and remove as much of it as possible by striking the hot joint sharply against a firm object. Carefully straighten and separate the stranded leads, repeating the heating and striking process as necessary to separate the strands and to remove all but a thin film of solder. When connecting the pyrheliometer, scrape the strands to be twisted and soldered until a clean copper-to copper union is possible. Solder each splice with a minimum of free-running solder. Tape each splice, first with rubber tape and then with friction tape, and then tape the two together with friction tape. Replace the pedestal condulet cover, being careful not to pinch the splices, and tighten the gland nut on the squeeze connector.

A16323. Obstructions Above Free Horizon.—WB Form 1092, "Obstructions to Pyrheliometer or Illumination Cell" will be prepared (1) when the pyrheliometer is installed, (2) whenever the location of the instrument is changed, or (3) if a significant change occurs in the surrounding obstructions; i.e., obstructions likely to cast a shadow or reflected light on the pyrheliometer for even a brief period of the day. The form will be prepared in triplicate in accordance with the following instructions and in the manner illustrated in Fig. A16-9:

(1) Enter the elevation of the instrument to the nearest whole meter, msl.

(2) Plot the angular elevation above the pyrheliometer and the angular range in azimuth of all obstructions throughout the full 360° around the pyrheliometer. Obtain the elevation and range data by means of a theodolite set up as closely as possible to the pyrheliometer.

(3) On the same form, plot the path of the sun across the sky at the winter and summer solstice. The path of the sun is interpolated from a plot of the elevation and azimuth angles of the sun at (a) sunrise, (b) sunset, and (c) at hourly intervals between sunrise and sunset measured in whole hours from true solar noon. The time interval between the true solar noon and the time corresponding to a particular position of the sun is termed the "hour

angle" of the sun. During a.m. hours, the azimuth angle is said to be east and is obtained directly from Table A16-4. During p.m. hours, the azimuth angle is said to be west and is obtained by subtracting the east azimuth angle for the corresponding hour angle from 360 degrees. In table A16-4, only angles in azimuth are given for sunrise and sunset, since the altitude angle is zero regardless of the latitude. For hour angles between zero (true solar noon) and either sunrise or sunset, tabular values are given in pairs. The upper value is the solar altitude and the lower value is the east azimuth angle for any given set of arguments. The horizontal arguments are the hour angles to the nearest whole hour; the vertical arguments are values of latitude to the nearest five degrees. Tabular values are given to the nearest whole degree. Use as arguments latitude to the nearest whole degree and hour angle to the nearest whole hour. Interpolate as necessary to obtain values of solar altitude and azimuth to the nearest whole degree.

A16323.1. Values for 0° to 4° south latitude are identical with those for corresponding northern latitudes, except that azimuth values are computed from south instead of north and, in the case of the solstices, the seasons are reversed. For instance, in determining the solar altitudes and solar azimuths for the hour angles on the day of the southern winter solstice, consult the table for the corresponding hour angles for the day of the northern summer solstice.

A16323.2. The following example of the determination of the elevation and azimuth angles at a given hour angle at a northern latitude station is taken from the data shown in Fig. A16-9:

Example: Station latitude - 38°56'N (39°). Time - 1500 T.S.T. (hour angle three, west azimuth) at the time of the northern summer solstice.

(1) From Table A16-4, the altitude and east azimuth angles corresponding to a latitude of 39°N and an hour angle of three are 49°; and 99°, respectively.

(2) The west azimuth angle is obtained by subtracting 99 from 360; i.e., 261 degrees.

A16323.3. The hour angles and corresponding altitudes, and the east and west azimuth angles, are entered in the appropriate space on Form 1092. For each hour angle, plot the position of the sun on the chart and complete the path of the sun between sunrise and sunset by interpolation. On the chart, solar altitudes are represented by concentric ordinates, and east and west azimuth

angles (measured clockwise from zero) are represented by radial ordinates.

A16323.4. As soon as the form is completed, mail the original copy to:

Weather Bureau Office
Solar Radiation Field Testing Unit
Boston 9, Massachusetts

Forward one carbon copy to the Central Office, attention Scientific Services Division and retain the other copy. Airmail copies from stations outside the continental United States.

Table A16-4. Solar Altitudes and Azimuths at the Time of the SUMMER Solstice
(Expressed to the nearest whole degree)

Latitude	Hour Angle													Sunrise or Sunset	
	0	1	2	3	4	5	6	7	8	9	10	11	12	Hour Angle (h. m.)	Azimuth Angle (degrees)
0	67	62	53	40	27	14	0							6:00	67
	0	31	49	58	63	66	67								
5	72	67	56	43	29	16	2							6:09	66
	0	37	55	62	66	67	67								
10	77	70	58	45	31	18	4							6:17	66
	0	45	61	67	69	68	67								
15	82	74	61	47	33	19	6							6:26	66
	0	57	69	72	72	70	67								
20	87	76	62	48	35	21	8							6:37	65
	0	73	77	77	75	72	68								
21	88	76	62	48	35	21	8							6:39	65
	0	77	79	78	75	72	68								
22	89	76	62	49	35	22	9							6:40	65
	0	81	81	79	76	72	68								
23	90	76	62	49	35	22	9							6:43	64
	Z	85	83	80	77	73	68								
24	89	76	63	49	36	22	9							6:45	64
	180	89	85	81	78	73	68								
25	88	76	63	49	36	23	10							6:47	64
	180	93	87	82	78	74	69								
30	83	75	63	50	37	24	11							6:58	63
	180	113	97	88	82	76	69								
35	78	73	62	49	37	25	13	2						7:10	61
	180	127	106	94	86	78	70	62							
40	73	69	60	49	37	26	15	4						7:25	59
	180	138	114	100	89	80	72	63							
45	68	65	57	48	37	27	16	7						7:43	56
	180	145	122	105	93	83	73	63							
50	63	61	55	46	37	27	18	9	1					8:05	52
	180	151	128	110	97	85	74	64	53						
55	58	57	51	44	36	28	19	11	4					8:33	46
	180	155	133	115	101	88	76	65	53						
60	53	52	48	42	35	28	20	13	7	1				9:14	37
	180	157	137	119	104	90	78	65	53	40					
65	48	47	44	39	34	27	21	15	10	5	1	0		10:42	20
	180	160	140	123	107	93	80	67	54	41	27	0			
70	43	43	40	37	32	27	22	17	13	9	6	4	3	- -	-
	180	161	143	126	110	96	82	68	55	41	28	14	0		
75	38	38	36	34	30	26	23	19	15	13	10	9	8	- -	-
	180	163	145	129	113	98	84	69	56	42	28	14	0		
80	33	33	32	30	28	26	23	21	18	16	15	14	13	- -	-
	180	164	147	131	116	101	86	71	57	43	28	14	0		

Interpolate for values of solar altitude and azimuth corresponding to the nearest whole degree of latitude. The upper value of each pair of tabular values is the solar altitude and the lower value is the east azimuth angle. To find a west azimuth for a given hour angle, subtract the corresponding east azimuth angle from 360 degrees. Azimuths are east in the morning and west in the afternoon. North = 0°; Z = zenith.

Table A16-4 (continued). Solar Altitudes and Azimuths at the Time of the WINTER Solstice (Expressed to the nearest whole degree)

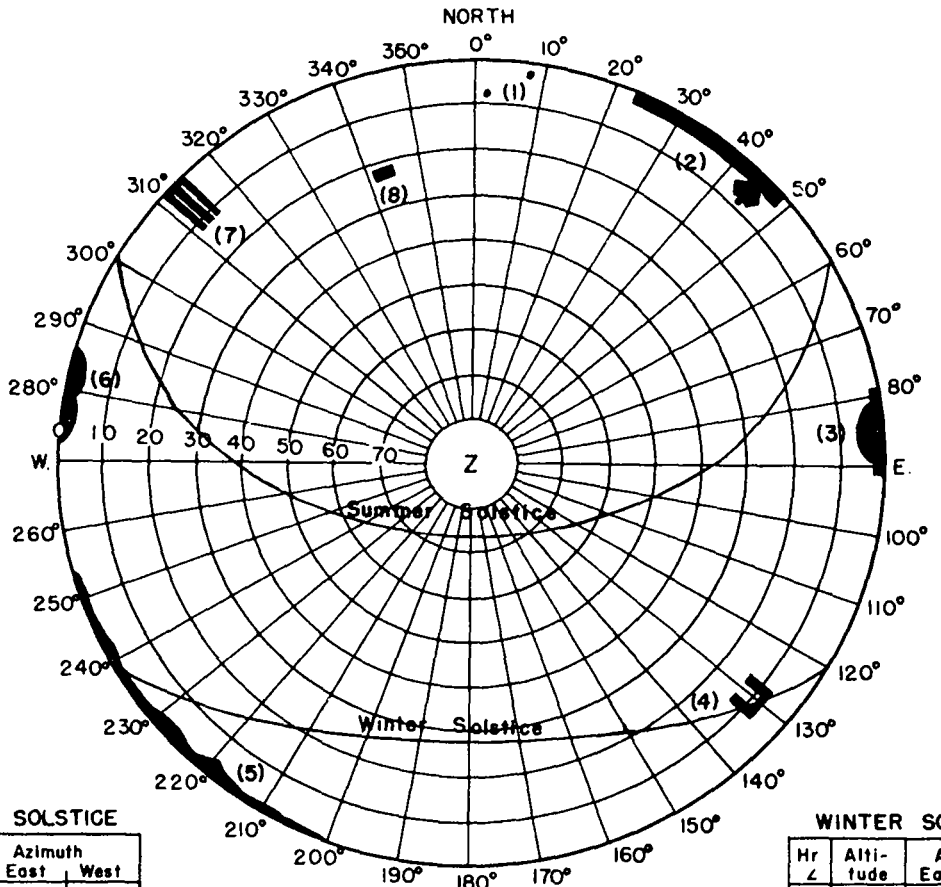
Latitude	Hour Angle						Sunrise or Sunset	
	0	1	2	3	4	5	Hour Angle (h. m.)	Azimuth Angle (degrees)
0	67 180	62 149	53 131	40 122	27 117	14 114	6:00	113
5	62 180	58 153	49 135	38 125	25 119	12 115	5:51	114
10	57 180	53 157	46 139	35 128	23 121	9 116	5:43	114
15	52 180	49 159	42 142	32 130	20 122	7 117	5:34	114
20	47 180	44 161	38 145	28 133	17 124	5 117	5:23	115
25	42 180	39 162	33 147	25 134	14 125	3 118	5:13	116
30	37 180	35 163	29 148	21 136	11 126	0 118	5:02	117
35	32 180	30 164	25 150	18 137	8 127		4:50	119
40	27 180	25 165	21 151	14 138	5 127		4:35	121
45	22 180	20 165	16 152	10 139	2 127		4:17	124
50	17 180	15 166	12 152	6 139			3:55	128
55	12 180	11 166	7 153	3 140			3:27	134
60	7 180	6 166	3 153				2:45	142
65	2 180	1 166					1:26	160

Interpolate for values of solar altitude and azimuth corresponding to the nearest whole degree of latitude. The upper value of each pair of tabular values is the solar altitude and the lower value is the east azimuth angle. To find a west azimuth for a given hour angle, subtract the corresponding east azimuth angle from 360 degrees. Azimuths are east in the morning and west in the afternoon. North = 0°.

W.B. FORM 1092 U.S. DEPARTMENT OF COMMERCE, WEATHER BUREAU

OBSTRUCTIONS TO PYRHELIOMETER OR ILLUMINATION CELL.

STATION Nameville, State LATITUDE 38 ° 56 'NORTH
DATE February 15, 1950 LONGITUDE 77 ° 05 'WEST
ELEVATION OF INSTRUMENT 10 METERS, MSL.



SUMMER SOLSTICE

Hr ∠	Alti-tude	Azimuth East	Azimuth West
0	74	180	180
1	70	136	224
2	60	112	248
3	49	99	261
4	37	88	272
5	26	80	280
6	15	72	288
7	4	63	297
SR	0	59	—
SS	0	—	301

LIST OF OBSTRUCTIONS

1.	ANTENNA POLES
2.	ADMINISTRATION BUILDING
3.	HANGAR
4.	APARTMENTS
5.	HILLS
6.	TREES
7.	STEEL MILLS
8.	COAL CHUTE
9.	
10.	
Prepared by	CDE

WINTER SOLSTICE

Hr ∠	Alti-tude	Azimuth East	Azimuth West
0	28	180	180
1	26	165	195
2	22	151	209
3	15	138	222
4	6	127	233
SR	0	121	—
SS	0	—	239

Fig. A16-9. WB Form 1092

A16324. Changing Pyrheliometers.--At northern stations supplied with both 50-junction and 10-junction pyrheliometers, the 50-junction pyrheliometer will be used during the fall, winter and spring. In the fall, after the sun has reached a low solar altitude such that the maximum deflection (amplitude) of the recorder pen at noon on a clear day is small, remove the 10-junction pyrheliometer and install the 50-junction instrument. The exchange should be made when the maximum deflection has decreased to a scalar reading of less than the ratio of the calibration constant for the 10-junction instrument to the constant for the 50-junction instrument multiplied by a factor of 100, e.g., if the constant for the 10-junction instrument is 2.5 and the constant for the 50-junction instrument is 7.5, the 50-junction instrument would be installed after the maximum amplitude of the trace on a clear day has decreased to less than $\frac{(100 \times 2.5)}{7.5}$, or 33.3 units as read on the graduated chart. In the spring, the 10-junction instrument will be installed after the maximum amplitude of the 50-junction trace reaches 90 to 95 units on a clear day. Enter the date and the true solar time of each exchange as a note on the record. Regardless of whether the 10- or 50-junction instrument is in use, the calibration dial on the recorder will not be changed from the calibration value in millivolts appropriate to the 10-junction instrument (see par. A16411).

A16325. Maintenance.--Clean the bulb daily or more frequently if pollution is excessive or frost or ice accumulates on the bulb. Use a soft, clean cloth and water if necessary. Remove frost or ice-coatings with warmed cloths or any other device that will not scratch the glass. Wipe the glass dry immediately following the removal of the ice.

A16325.1. Stations in areas where sandstorms occur are furnished with covers to protect the bulb of the pyrheliometer from sandblasting. The covers are equipped with drawstrings, which enable the cover to be tightly fitted to the bulb. Place the cover over the bulb at the beginning of each storm. During the season when storms are likely to occur at night, the cover will be left on all night and removed before sunrise.

A16400. RECORDERS

A16410. General.--Two types of Brown recorders are in general use: (1) a roll-chart type and (2) a circular-chart type which is used with a four-dial watt-hour meter as an integrating indicator. An L&N (Leeds and Northrop) recorder is also used at a few stations. All recorders are of the modified, commercial, self-balancing potentiometer type. Each recorder is calibrated by a technician to record over a range of 0 to 2.0 gm. cal./sq. cm./min. corresponding to the range of the individual 10-junction instrument to be used with it. The recorder is not recalibrated when a 50-junction is substituted for a 10-junction instrument (see par. A16324).

A16411. The circular calibration dial inside the recorder will be set by the technician to the value in millivolts indicated by the calibration sheet accompanying the station 10-junction pyrheliometer. Once set, the dial will be adjusted only by technicians during subsequent calibrations.

A16412. The location of the recorder should conform with the requirements stated in the manufacturer's manual of instructions that is supplied with each instrument. Any unavoidable changes that tend to make the location unsatisfactory, e.g., excessive dustiness, ambient temperatures above 110°F. or below 32°F. will be reported to the Regional Office.

A16413. Each observer should become familiar with the characteristics of the trace normally obtained under various meteorological conditions. The trace will vary constantly in amplitude between sunrise and sunset. The changes may be smooth or abrupt, but periods of record of 10 to 15 minutes or more without any change in amplitude, or a series of step-like changes in amplitude (brief periods of no change followed by abrupt increases or decreases), generally indicate malfunctioning of equipment. The slight curvature of the trace obtained near noon on a clear day should not be mistaken for a trace in which there is no change of amplitude. If faulty operation of a Brown recorder is suspected because of abnormalities in the trace or for other reasons, substitute spare tubes, one at a time, for the two 7F7 and the two 7N7 tubes in the recorder amplifier. One set of spare tubes should be kept available for replacement purposes, and used tubes should be retained for disposition by a technician.

A16420. Operation of Roll-Chart Type Recorder (Brown ElectroniK Recorder - See Fig. A16-10).—

(1) To start the recorder:

(a) Swing the chassis out of the case and turn on the power switch on the back of the chassis.

(b) After the amplifier tubes have warmed up for two minutes or more, turn on the chart-drive switch.

(c) Standardize the dry cell manually (see manufacturer's manual of instructions).

(d) Check the legibility of the trace.

(2) To stop the recorder:

(a) Turn off the chart-drive switch. CAUTION: If the recorder is in a standardization cycle, do not turn off the switch until the cycle is completed.

(b) If use of the recorder is being discontinued for servicing, or for more than 24 hours, turn off the power switch located on the back of the chassis.

A16421. Standardization.—When the recorder is in operation it initiates a standardization cycle automatically every thirty minutes. The cycle lasts for about thirty seconds. To avoid turning off the recorder chart-drive during a standardization cycle, standardize the instrument manually in accordance with the manufacturer's instructions until the audible and visual indications that accompany each cycle become familiar. A characteristic sound occurs during the cycle and another at the end of the cycle. Frequently, instability of the pen will be observed during the cycle as "pips" on the trace. These are brief changes in amplitude of about 30 seconds duration followed quickly by return of the pen to approximately the amplitude at the beginning of the cycle. The amplitude and direction of the change will depend upon the condition of the dry cell (see manufacturer's manual of instructions). Frequently a very slight readjustment in the amplitude of the trace will result from the standardization process.

A16422. Maintenance.--

(1) Dry-Cell Renewal.--Instructions for installing the dry cell (a 1.5-volt, Columbia Gray Label dry cell or equivalent) are given in the manufacturer's manual of instructions. The special flexible-resistor type lead from the negative "BAT" terminal must be handled carefully and must not be replaced except with the same type of lead. The dry cell should be renewed at least every eight months and whenever the red, dry-cell-condition index drops to the "Renew" line, or the net change in the amplitude of the trace during the standardizing cycle becomes greater than normal.

(2) Slidewire.—The slidewire will be serviced by a technician.

(3) Chart Renewal.—Each roll of chart paper has a life of about thirty days of continuous operation at the chart-feed speed of two inches per hour. Renew the paper between sunset and sunrise in accordance with the manufacturer's manual of instructions when it becomes evident that the remaining paper is not sufficient for for the following day, or at any other time if necessary to avoid loss of record.

(4) Pens.—Refill the pen whenever the chart is replaced, and more frequently if necessary to avoid loss of record. Clean the pen as frequently as necessary to insure a legible, uninterrupted record. Further instructions

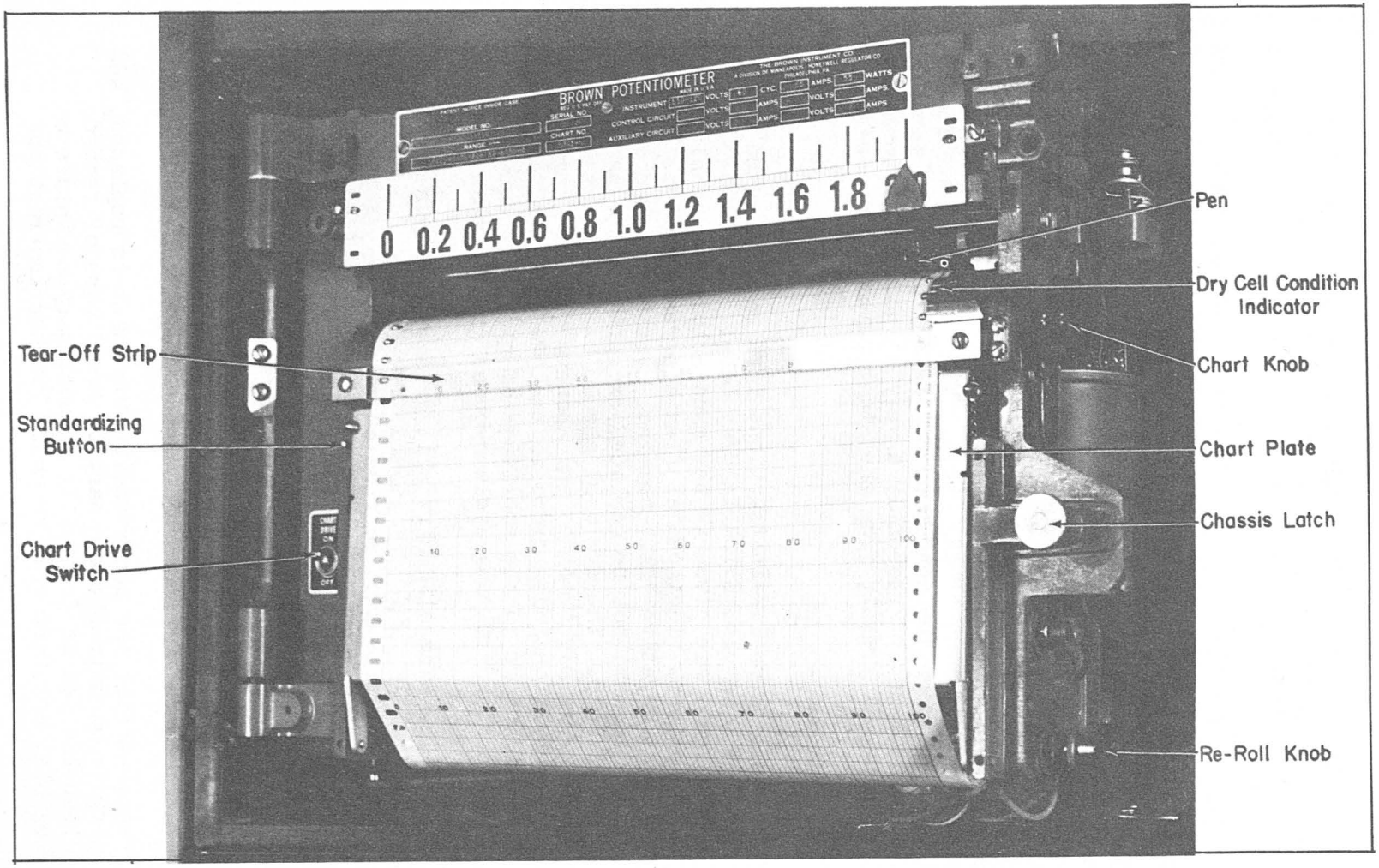


Fig. A16-10. Roll-chart recorder

for installing, filling, and cleaning the pen are contained in the manufacturer's manual of instructions.

(5) Lubrication and Cleaning.--Clean and oil the recorder each month in accordance with the manufacturer's manual of instructions under "Monthly Maintenance."

(6) Continuous Balance Unit.--Instructions for adjusting the sensitivity of the unit, and instructions supplementary to those in par. A16413 for replacing defective amplifier tubes, are furnished by the manufacturer.

A16430. Operation of the Circular-Chart Type Recorder (Brown ElectroniK Recorder - See Fig. A16-11).--

(1) To start the recorder:

(a) Turn on the instrument power switch on the lower left side of the face plate.

(b) After the amplifier tubes have warmed up for two or three minutes, standardize the dry-cell current in accordance with the manufacturer's manual of instructions for "Standardizing the Battery Current".

(c) Re-standardize the dry-cell current after the instrument has been operating approximately two hours.

(2) To stop the recorder, turn off the power switch on the lower left side of the face plate (the recorder should be stopped only for servicing, or when it is to be out of operation for 24 hours or more).

A16431. Routine Standardization.—Standardize the dry-cell current at approximately eight-hour intervals between sunrise and sunset. The cell should be standardized at sunrise, or as soon as practicable thereafter, in accordance with the manufacturer's manual of instructions.

A16432. Maintenance (See Fig. A16-12).--

(1) Dry-Cell Renewal.—Instructions for installing the dry cell (a 1.5-volt Columbia Gray-Label dry cell or equivalent) are given in the manufacturer's manual of instructions. The special flexible-resistor type lead from the negative "-BAT" terminal must be handled carefully and must not be replaced except with the same type of lead. Replace the dry cell at least every eight months and whenever the current can no longer be standardized.

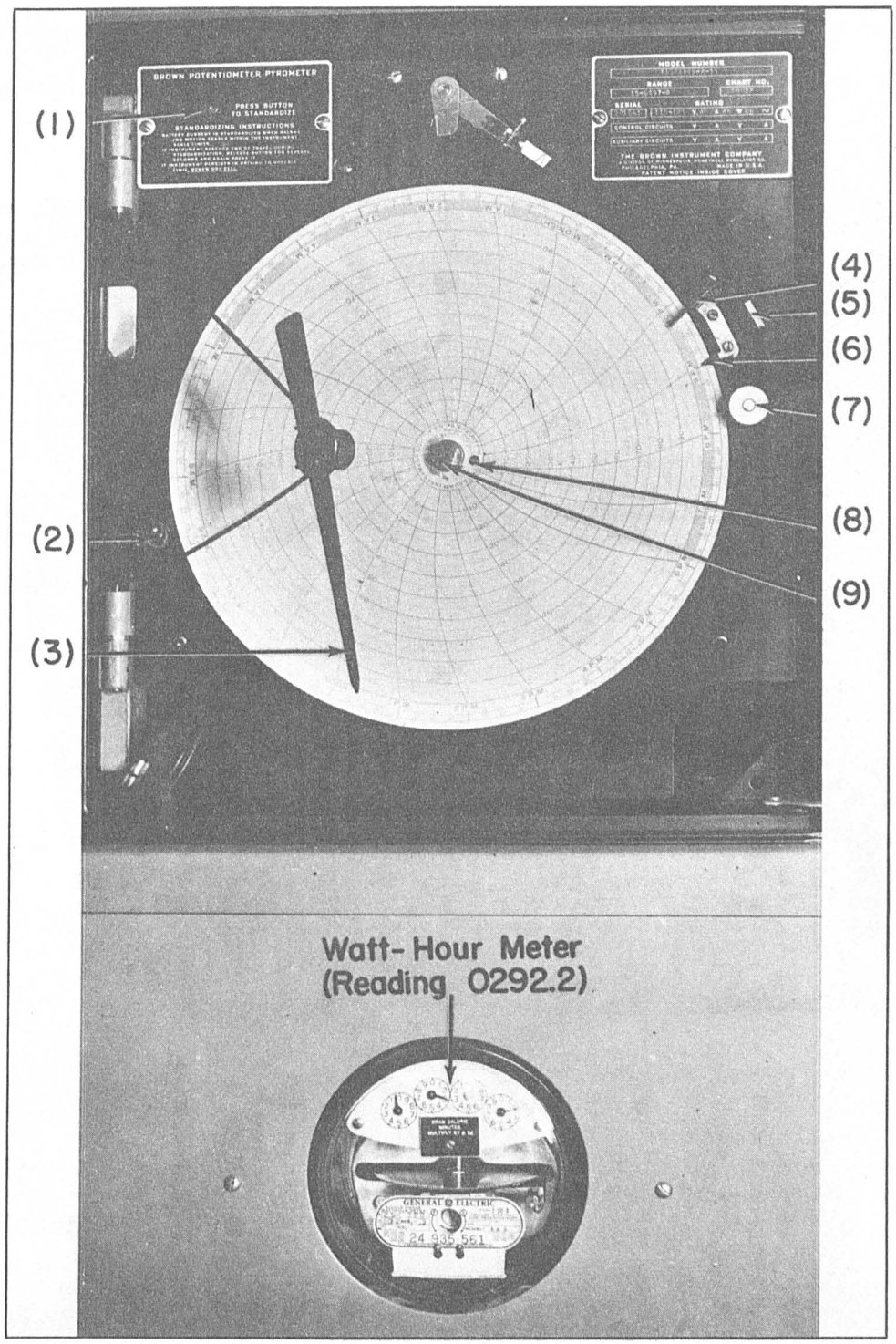
(2) Slidewire.—The slidewire will be serviced by a technician.

(3) Chart Renewal.—Circular charts will be replaced daily in accordance with the manufacturer's instructions.

(4) Pens.—Fill the pen each day at the time the chart is replaced. Clean the pen as frequently as is necessary to insure a legible record. Clean and fill the pen in accordance with the manufacturer's manual of instructions using ink provided for this instrument.

(5) Lubrication.—Oil the recorder each month in accordance with the manufacturer's manual of instructions under "Monthly Maintenance."

(6) Continuous-Balance Unit.—Instructions for adjusting the sensitivity of the unit, and instructions supplementary to those in par. A16413 for replacing defective amplifier tubes, are specified in the manufacturer's manual of instructions.



(1) Standardizing button, (2) Power switch, (3) Indicating pointer, (4) Pen holder, (5) Pen, (6) Time index, (7) Chassis latch, (8) Time index pin, (9) Chart hub.

Fig. A16-11. Circular-chart recorder (front)

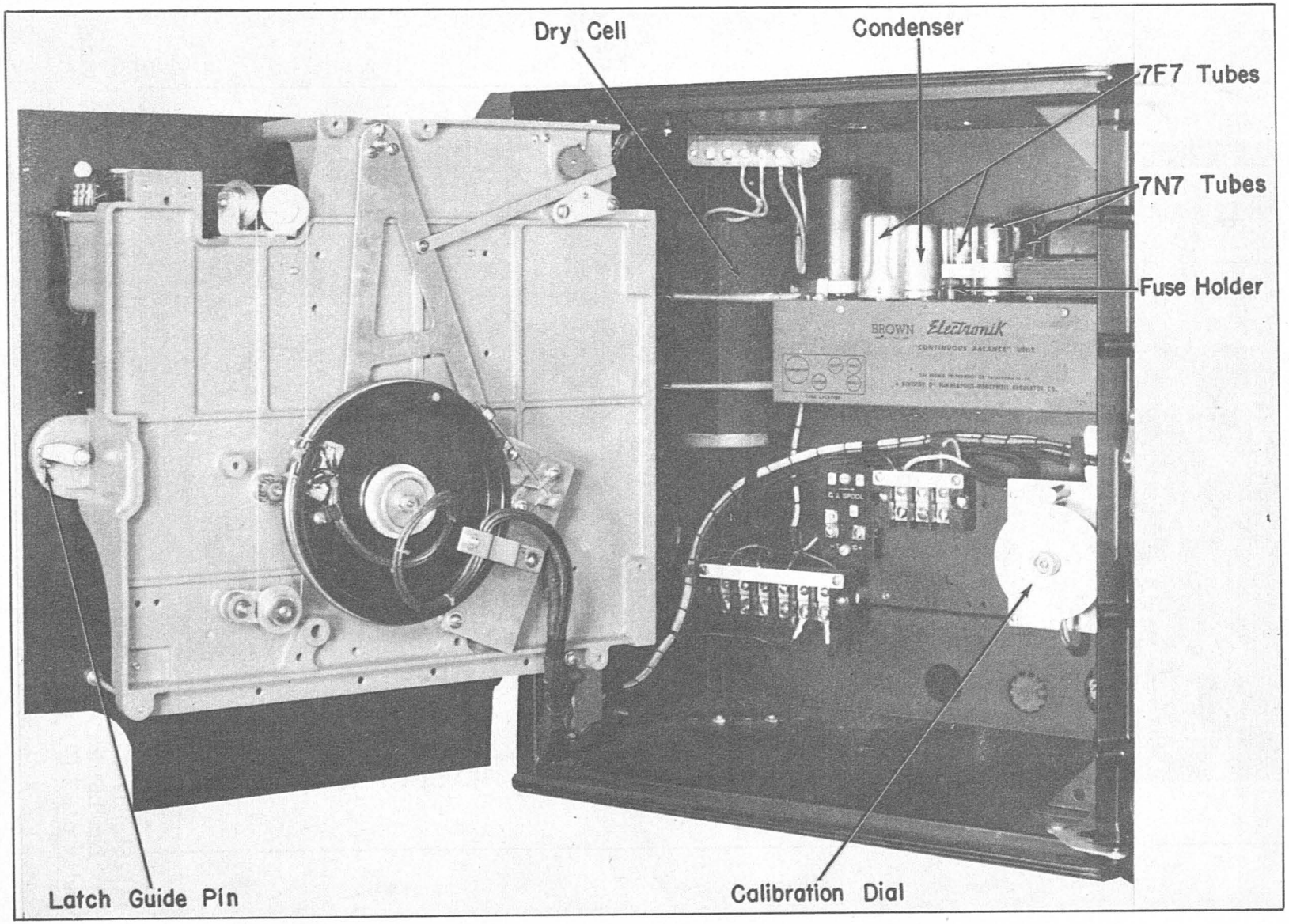


Fig. A16-12. Circular-chart recorder (inside)

Interpations

Change No. → 2

U. S. Department of Commerce
Weather Bureau

WBAN MANUAL OF SURFACE OBSERVATIONS

6th Edition

(This page may be discarded)

January 1, 1951

CHAPTER 9. AIRWAY AND SUPPLEMENTARY OBSERVATIONS

9000. GENERAL

9010. An observation is an evaluation of the meteorological situation at the point where the observation is taken. The component parts of an observation, when referred to in a general sense, are termed elements. The evaluation of the state of the various elements consists in observing them. Meteorological elements observed at or from the surface are usually limited to clouds, visibility, atmospheric phenomena, wet- and dry-bulb temperatures, precipitation, pressure, wind, and duration of sunshine.

9011. The terms "airway observation" and "synoptic observation" connote the assemblage of specified observational elements in a manner designed to satisfy meteorological and operational requirements. The instructions in this chapter are concerned principally with the various types of airway observations. Pilots' reports of meteorological phenomena encountered in flight are used to supplement airway observations.

9012. The observation of elements will be taken in the order given below, unless the sites of instrumental equipment require deviation:

(1) Sky
(2) Visibility
(3) Atmospheric phenomena
(4) Temperature
(5) Precipitation measurement
(6) Humidity
(7) Pressure
(8) Wind

Observation of the elements listed above will be taken in accordance with applicable instructions elsewhere in this manual. At designated stations visibility observations will be taken at the control tower or the approximate level of the control tower, as well as at the usual point of observation, whenever the visibility at the usual point of observation is less than three miles. Under these circumstances, visibility observations taken at the control tower will be used for all purposes, such as record, coding and summary that require visibility data (paragraph 11105.3). The observer will inform himself of the nature of the visibility-restricting phenomena at the control tower level.

9013. All scheduled observations will be started just sufficiently in advance of the time of transmission to permit accurate evaluation of all the elements.

9100. AIRWAY OBSERVATIONS

9110. GENERAL. Airway observations are primarily intended to provide (a) immediate weather information for aviation interests, and (b) data for climatologists. The observations are classified as record, special, record-special, local extra, and check. The time and conditions under which the observations are taken, and the elements observed, are specified in the following paragraphs. When two or more types of observations coincide, all the elements observed for each type will be included in the observation, with the exception specified in paragraph 9142.

9120. RECORD OBSERVATIONS. A record observation is taken at scheduled hourly intervals and will be prepared for teletype transmission at least two minutes prior to the time of entrance into the sequence in which it first appears. An observation at an off-teletype station will be telephoned or telegraphed to a relay station at a time to be specified in separate instructions.

9121. The elements listed below will be observed insofar as the instrumental equipment of the station permits:

(1) Ceiling
(2) Sky
(3) Visibility
(4) Weather
(5) Obstruction to vision
(6) Sea-level pressure
(7) Temperature
(8) Dew Point
(9) Wind direction, speed, character, and shifts
(10) Altimeter setting

9130. SPECIAL OBSERVATIONS. A special observation is taken to provide information on significant developments in meteorological conditions occurring at other than scheduled periods.

9131. The number of elements included in a special observation depends on the conditions being reported. The special observation may consist of only one element (e.g., tornado) or of most of those included in a record observation. Each of the elements that may be included in a special observation is listed in paragraph 9134.01 to 9134.10. Following each element is listed the magnitude or nature of the change in it that would require a special observation. Any element listed in paragraph 9132 may be reported alone as a special observation. When a change in one or more of the elements listed in paragraph 9133 requires a special observation, the additional elements listed beside them must also be included in the observation. When changes in two or more elements individually satisfy the criteria for a special observation, the elements will be included in a single special observation. In all cases, remarks will be added as required.

*9132. When a change in one of the following elements satisfies the criteria for a special observation, it may be reported alone as a special observation.

(1) Tornado or waterspout
(2) (Cancelled)
(3) (Cancelled)
(4) Wind shift and increases in wind speed

*9133. When a change in one or more of the following elements satisfies the criteria for a special observation, the observation will include all the elements listed to the right of them:

Elements, a specified change in any one of which requires a special observation.	All elements below to be reported with any element in opposite column.
(1) Ceiling	Ceiling
(2) Sky	Sky
(3) Visibility	Visibility
(4) Weather	Weather
(5) (Cancelled)	Obstructions to vision
	Wind

9134. CRITERIA FOR TAKING SPECIAL OBSERVATIONS. A special observation will be taken whenever one or more of the elements listed below have changed in the amount specified. The amount of change is with reference to the preceding record or special observation.

*9134.01. CEILING.

(1) (Cancelled)
(2) (Cancelled)

(3) The ceiling decreases to less than 1,500 feet, or increases to 1,500 feet or more.
(4) The ceiling decreases to less than 1,000 feet, or increases to 1,000 feet or more.
(5) The ceiling decreases to less than 500 feet, or increases to 500 feet or more.
(6) A ceiling below 500 feet changes by 100 feet or more. †
(7) The ceiling decreases to a value lower than the highest airline operating minimum for the airport. †
(8) The ceiling increases to a value equal to or higher than the highest airline operating minimum for the airport. †

*9134.02. SKY CONDITION.

(1) (Cancelled)
(2) A layer is observed below:
  (a) 1,000 feet or
  (b) the highest airline operating minimum for the airport, no layer having been previously reported below this altitude. †

*9134.03. VISIBILITY.

(1) (Cancelled)
(2) (Cancelled)
(3) The visibility decreases to less than:
  (a) 3 miles
  (b) 1 mile
  (c) 3/4 mile
  (d) 1/2 mile } †
  (e) 1/4 mile
(4) The visibility increases to equal or exceed:
  (a) 3 miles
  (b) 1 mile
  (c) 3/4 mile
  (d) 1/2 mile } †
  (e) 1/4 mile
  (f) (Cancelled)

9134.04. TORNADO.

(1) Is observed
(2) Disappears from sight
(3) Is reported by the public to have occurred within the preceding six hours.

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† Effective only at stations having scheduled air-carrier operations.

9134.05. THUNDERSTORM.

(1) Begins
(2) Increases in intensity
(3) Ends. (Special observation 15 minutes after thunder is last heard at station.)

*9134.06. PRECIPITATION.

(1) Hail begins or ends, or changes in intensity.
(2) (Cancelled)
(3) Freezing precipitation begins or ends, or changes in intensity.
(4) Sleet begins or ends, or changes in intensity. (Beginning or ending of other types of precipitation will be reported in remarks in the next succeeding record observation, but will not be reported by means of special observations; e.g., "RWB45E15" in remarks will indicate that rain shower began at 45 minutes past the previous hour and ended at 15 minutes past the current hour.)
(5) (Cancelled)

*9134.07. FOG. (Cancelled)

*9134.08. SAND-STORM, DUST-STORM. (Cancelled)

9134.09. WIND AND WIND SHIFTS.

(1) Sudden doubling of speed (over a one-minute interval) to more than 30 miles per hour (26 knots).
(2) Wind-shift.

*9134.10. ALTIMETER SETTING. (Cancelled)

*9134.11. The foregoing will be regarded as the minimum requirements for taking a special observation. In addition, any meteorological situation that, in the opinion of the observer, is of importance to the safety or efficiency of aircraft operations will be reported in a special observation. At military stations, additional criteria may also be specified by military directive.

9140. LOCAL EXTRA OBSERVATIONS. Local extra observations are taken, at designated stations, for local distribution only. The changes requiring a local extra observation are within

(Continued on next page)

narrower limits than changes requiring a special observation. When a local extra observation reveals a change in conditions that requires a special observation, the local extra observation will be classified as a special observation and treated accordingly.

9141. At designated stations, local extra observations will be taken at intervals not exceeding 15 minutes, beginning whenever:

(1) Ceiling or visibility decreases to a value equal to or less than the highest airline minimum applying to the airport.
(2) The ceiling decreases to 500 feet or less.
(3) The visibility decreases to one mile or less.

9141.1. Local extra observations will be discontinued when values above these minimums have been reported. Record or special observations coming within the 15-minute interval will also serve as the local extra observation. The 15-minute interval will begin at the time of the record or special observation.

9141.2. Except when taken in accordance with paragraph 9142 and 9143 the observation will include the following elements:

(1) Ceiling
(2) Sky
(3) Visibility
(4) Weather
(5) Obstructions to vision

Remarks will be added as required.

9142. Local extra observations of one or more elements requested for aircraft arrivals or departures will be taken and recorded at designated stations, in the usual manner, even though weather conditions do not warrant taking a special observation.* In this case the name of the agency requesting the local extra observation will be noted under "Remarks."

9143. Local extra observations will be taken whenever ceiling or visibility changes to a value above, equal to, or below

a. the minimum prescribed for the airport, or
b. any air carrier minimum applicable to the local airport.

This requirement is applicable only when takeoffs and landings impend. Suitable arrangements will be made at each station to keep informed of scheduled arrivals and departures as well as of operations involving delayed schedules.

9144. An observation of all elements ordinarily included in a record observation will be taken immediately following any aircraft accident in the vicinity of an airport at which a weather-observing station is situated. (See Fig. 8.)

9150. CHECK OBSERVATIONS. Check observations will be taken at specified stations where scheduled broadcasts of local weather are made. The local schedule of broadcasting will determine the time of taking them. The check observation will be taken within 20 minutes of the scheduled time of local broadcast, preferably as near to the time of the broadcast as practicable. The 20-minute requirement is waived when a pilot balloon observation is being taken. (See paragraph 10220.) If the broadcast equipment is inoperative, check observations will not be taken. A notation indicating the period of and reason for the suspension of check observations will be entered on WBAN 10.

9151. The check observations will include the following elements:

(1) Ceiling
(2) Sky
(3) Visibility
(4) Weather
(5) Obstructions to vision
(6) Wind
(7) Altimeter setting

9160. CORRECTED REPORTS. A corrected observation will be coded and disseminated in accordance with instructions in paragraph 10080.

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*If a special observation is also required, a local extra observation of the one or more elements requested will be filed, after which the other elements required for the special observation will be evaluated, and the special filed.

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
Washington 25, D. C.

March 4, 1949

WBAN MANUAL OF SURFACE OBSERVATIONS
CIRCULAR N, 6TH EDITION

INTERPRETATIONS -- SERIES NO. 1

Note: This is the first of a series of interpretations to be issued in accordance with Circular Letter No. 103-48. Interpretations will be bound in Circular N immediately following the Record of Changes. The number of the interpretation will be entered in the left-hand margin opposite the reference paragraph in Circular N; e.g., "1/1" will be entered in the margin opposite paragraph 1010.

1/1. Par. 1010. When instructions in Circular S and the 1932 edition of the International Cloud Atlas disagree, the instructions in Circular S will be followed. A new edition of the International Cloud Atlas is being prepared.

1/2. Table 4. The 45-gram free lift pertains to balloons inflated with helium, and the 40-gram lift pertains to balloons inflated with hydrogen. The 75-gram free lift previously authorized for use with helium will no longer be used.

1/3. Par. 5140. Corrections to thermometer readings should invariably be applied in accordance with these instructions in order to avoid large errors in psychrometric computations. Many stations have found it useful to prepare graphs of these corrections. In the future, it may be possible to issue the correction cards in graphical form. Example of possible resultant error (28" pressure):

Dry-bulb temperature	7.6°F.	
Correction	+0.6°	
Corrected dry-bulb temperature	8.2°	
Wet-bulb temperature (wick ice-covered)	6.8°	
Correction	-0.5°	
Corrected wet-bulb temperature	6.3°	
Using corrected temperatures: ($t - t' = 1.9°$)	Dew point	- 7°
	Relative Humidity	50%
Using uncorrected temperatures: ($t - t' = 0.8°$)	Dew point	0°
	Relative Humidity	71%
Error:	Dew point	7°
	Relative Humidity	21%

1/4. Par. 7260. When an altimeter setting indicator is used in accordance with these instructions, the mercurial barometer need not be read for 6-hourly synoptic observations, but a reading will be made weekly as required by Instructions for Altimeter Setting Indicators, dated August 8, 1947. The corrected altimeter setting is either (a) the actual reading when the correction at the weekly comparison does not exceed .03 inch, or (b) the reading corrected as indicated by the aforementioned instructions when daily comparisons are necessary.

1/5. Par. 7410. Summaries of 850-mb. surface data, formerly required by Circular Letter No. 30-47, are no longer necessary.

1/6. Par. 8320. Whenever squalls are reported, gusts must also be reported since the peak speed of gusts is the intensity criterion for squalls. Squalls may be reported when precipitation is not occurring, since the occurrence of squalls (a wind phenomenon) is independent of the occurrence of precipitation or other atmospheric phenomena.

1/7. Par. 8335. The second category in Table 18 should be used when (1) precipitation occurs without a decrease in cloud heights, (2) a decrease in cloud heights occurs without precipitation, or (3) neither of these phenomena occurs. The wind speeds indicated in this table are the peak gusts.

1/8. Par. 11105.3. Visibility at the usual point of observation is that existing in a horizontal plane at this point, and is not necessarily the visibility at ground level. Examples of visibility at different levels:

Observed: Ground visibility zero; control tower visibility 40 miles; ground fog 20 feet deep; sky condition from control tower level is clear, but sky condition from the ground is -X.

Recorded: Col. 4: -X; Col. 5: 40; Col. 6: no entry; Col. 14: SFC VSBY 0 GFDEP 20.

Observed: Ground visibility 1/4 mile; visibility from the roof (the usual point of observation) is 10 miles; ground fog 10 feet deep.

Recorded: Col. 5: 10; Col. 6: no entry; Col. 14: SFC VSBY 1/4 GFDEP 10.

1/9. Par. 11465. The barograph correction should be determined from the pressures entered in columns 63 and 64 of WBAN 10B. These pressures should not be changed to hundredths before the correction is determined. For example:

Correct Method	Station Pressure	(Col. 63)	29.956
	Barograph	(Col. 64)	29.965
	Correction	(Col. 65)	- .01
Incorrect	Station Pressure	(Col. 63)	29.956 (29.96)
	Barograph	(Col. 64)	29.965 (29.96)
	Correction	(Col. 65)	.00

1/10. Add to note following par. 11485.8.

Fig. 4, line 13, 0428 observation, Col. 14: Correct "0000" to read "////."

Fig. 4, line 38, 1028 observation, Col. 14: Correct "5076/2" to read "5076."

Fig. 5, 1007 observation, Col. 64: Correct "29.943" to read "29.945."

Fig. 9, line 7, Col. 21: Correct "7" to read "10."

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
Washington 25, D. C.

August 1, 1949

WBAN MANUAL OF SURFACE OBSERVATIONS
Circular N, 6th Edition

INTERPRETATIONS - SERIES NO. 3

(To be bound in Circular N following Series No. 2 dated May 23, 1949)

3/1. Paragraph A6120. When making psychrometric computations, it is important to use the correct face of the calculator (i.e., the low temperature range when the wet-bulb temperature is less than 32°F., and the high temperature range when the wet-bulb temperature is 32°F. or more).

The psychrometric calculator is based on the Psychrometric Formula given on page 9 of W.B. No. 235, Psychrometric Tables, where t = dry-bulb temperature, and t' = wet-bulb temperature. In the design of the scales, the term $(1 + \frac{t' - 32}{1571})$ was based on the constant value t' = 55°F. for the high temperature range, and t' = 14°F. for the low temperature range. These represent mean values for the respective range of wet-bulb temperature of each face. As a result of the different values of this term on the two faces, significant discrepancies in computed dew points may result if the high temperature side is used when the wet-bulb temperature is below 32°F. and the depression is large (see example below).

Example

Given: Dry-bulb temperature = 42.9°F.
Wet-bulb temperature = 30.4°F.
Depression = 12.5°F.
(Pressure = 30.00")

Computation:

	Correct Procedure (low temperature side)	Incorrect Procedure (high temperature side)
Dew Point	-7.3°F.	-9.8°F. (error = -2.5°F.)
Relative Humidity	11%	10% (error = 1%)

3/2. Paragraph 7242. When the barograph correction is entered in column 64 of Form 1130B, posting of the barograph correction in the manner indicated in paragraph 7242 is not required.

3/3. Paragraph 7260. For convenience in obtaining station pressure from the altimeter setting indicator, a table of station pressures may be prepared, using as arguments altimeter setting readings. Such a table is, of course, the reverse of the present altimeter setting table from which altimeter settings are obtained, using as arguments station pressures. Although the Central Office is unable to prepare such tables for all stations at the present time, preparation by field personnel is recommended at those stations using the altimeter setting indicator for station pressure determinations. These tables should be carefully verified, and a copy furnished the Central Office for review.

3/4. Paragraph 8311. The peak gust is the highest speed momentarily indicated by the pointer on the direct reading indicator, regardless of the period during which this peak speed is maintained. The requirement that the indicator be observed for a period of one minute pertains only to the average wind speeds, which are entered in column 11 of Form 1130A, and does not pertain to peak gusts.

3/5. Paragraph A9012. (a) The instructions in this paragraph concerning control tower visibility observations apply also at locations where official weather observations are taken by CAA communications personnel. Arrangements should therefore be made at these locations for visibility observations from the control tower whenever the visibility at the usual point of observation is less than 3 miles.

(b) Use of Form 1130A is not mandatory at control towers taking only visibility observations. If the control tower does not have a telautograph, and if Form 1130A is not suitable, visibility observations may be recorded on a tabulation sheet in the control tower. The minimum data to be entered on this sheet are:

1. Date and time of observation.
2. Prevailing visibility.
3. Remarks (such as visibility in different quadrants).
4. Observers' initials.

These observations should be furnished immediately to the Weather Bureau Office (or the CAA observing station) and recorded there on Form 1130. The tabulation sheets prepared in the control tower may be destroyed after ninety days.

3/6. Paragraph A9120.02. If the sky condition changes during a pibal from scattered tc overcast (cr clear to broken) with clouds above 10,000 feet, the balloon should not be abandoned for the purpose of filing a special observation. However, a special should be filed after the balloon is no longer visible, provided the change in sky condition still exists.

3/7. Paragraph A9216. The log of differing weather observations should be kept by all stations, including CAA observing stations. No special format is prescribed for this log, but the log should contain all information that, in the judgment of the observer, is pertinent to any subsequent investigation of differing weather observations.

3/8. Paragraph 11001. (a) The monthly preparation of Form 1130D is not required from CAA observing stations, provided there has been no change in instrumental equipment or exposures since the previous rendition of the form. However, annual renditions will be made by these stations effective December 31 of each year.

(b) Preparation of Form 1130B is not required from stations that would ordinarily record on this form only dry- and wet-bulb temperatures in columns 18 and 19, and total sky cover in column 21. Such stations should use only Form 1130A, entering dry- and wet-bulb temperatures in columns 14A and 14B, and total sky cover in column 14 immediately adjacent to column 14A. Note that this requirement will apply to most SAWRS, but will not apply to any station reporting pressure data.

3/9. Paragraphs A11005 and A12011. Stations equipped with triple registers, and at which only a limited staff can be provided on Saturday, have reported difficulty in completing the required computations on Forms 1017 and related forms in sufficient time to mail Forms 1130A and B or 1001B on Saturday. Under such circumstances, it will be satisfactory to defer mailing Forms 1001B or 1130A and B for the week ending with Friday, until the following Monday, if necessary in order to compute and check the data obtained from Form 1017. However, it is important that all forms for the month be mailed not later than the second working day of the following month.

3/10. Paragraph 11422. (a) Separate entries will not be made in columns 4 or 22-35 of Form 1130A and B to describe cirrus attached to cumulonimbus, even though the cirrus may cover 1/10 or more of the sky. This procedure is in accordance with instructions in Circular S, which preclude coding M6 or H3 for altocumulus or cirrus attached to cumulonimbus. Under such

circumstances, when 6/10 or more of the sky is covered by the base of a cumulonimbus in combination with the tops and sides of the same cloud, the ceiling will be considered as the height of the base, since observation of separate layers is impossible, and appropriate remarks will be made to indicate that a significant part of the sky is also obscured by the tops and sides of the cloud. Also, only one cloud layer will be recorded in columns 22-35 unless, of course, there are additional layers that are completely detached from the cumulonimbus.

Example

Given: 9+ sky covered by one cumulonimbus cloud; approximately 4/10 of the sky is covered by the base, while the remainder of the sky is covered by the sides and tops; the height of the base is estimated at 5,000 ft. and the top at 18,000 ft.

Entries on Form 1130A and B:

(1) Ceiling and sky conditions (column 3 and 4): E50⊕
(2) Remarks (column 14): CB BASE NW TOP SE E180 BINOVC
(3) Clouds and obscuring phenomena (columns 22-35):
(i) Amount (column 22): 9+; (ii) Type (column 23): CB; (iii) Height (column 24): E50. (Note that no additional cloud layers will be recorded in succeeding columns since separate cloud layers detached from the cumulonimbus were not observed.)

(b) The ceiling classification designators defined in paragraphs 1431-1436 are primarily associated with layers constituting a ceiling, and are therefore defined in terms of ceiling measurements. However, these designators are also used in columns 24, 27, 31, and 35 to indicate heights of cloud layers that may not constitute a ceiling. Under such circumstances, the letter which is most nearly appropriate, in the opinion of the observer, should be selected. For example, in prefixing a symbol to the height of the base of a thin obscuration, which of course does not constitute a ceiling, the symbol "M" may be selected if the height of the base is determined from the known height of unobscured objects; "E" may be selected if the height of the base is determined from natural landmarks; "W" if the description in paragraph 1434(3) most nearly describes the method of determination, etc.

3/11. Paragraph A11438. In entering hourly precipitation in column 38, consider the hour identified as "00" in column 16 as beginning at 0000 LST and ending at 0059 LST; the hour identified as "01" as beginning at 0100 and ending at 0159, etc. When precipitation is reported as ending by a special observation filed on or after the hour, the amounts of precipitation entered in column 38 should be ascribed to the hour during which the precipitation actually

fell, even though the special reporting the ending of the precipitation was filed during a subsequent hour. For example, if the ending of rain was reported in a special filed at 1701, precipitation should be entered for the period identified by the figure 17 in column 16 only if precipitation actually fell after 1659. (See also paragraph 11482.)

3/12. Paragraph 11444. If no rain has fallen during the 6 hours preceding the actual time of the 6-hourly precipitation observation, but if rain begins shortly thereafter and before the coded synoptic observation is filed, "T" should be entered in column 44 for the synoptic observation and a trace of precipitation coded in groups $7RRR_ts$ and appRR. If the 6-hourly observation concerned is the first one following midnight, "T" should also be entered in column 44 under the caption "midnight to." This procedure will be followed regardless of the type of precipitation gage in use at the station, or the intensity or amount of the precipitation.

3/13. Paragraph A11485(c). Excessive precipitation will be computed only at stations using the tipping bucket as the official precipitation gage; it will not be computed from weighing gages.

3/14. Paragraphs A12107, A12316 and A12317. (a) The average hourly sky cover will be entered in whole numbers at the bottom of column 7 of Form 1001B. The average daily sky cover will be entered to one decimal place at the bottom of columns 16 and 17 of Form 1001C (see figures A5 and A6).

(b) "9+" will not be used as an average sky cover on Form 1001C. The entries of "9+" in columns 16 and 17 of figure A6 should be changed to "10;" the totals increased to 255 and 243; and the means changed to 8.2 and 7.8, respectively.

3/15. Paragraphs A12310 and A12311. At stations taking one to 23 hourly observations daily, entries should be made in columns 10 and 11 of Form 1001C only if the station is equipped with a multiple register.

3/16. Paragraph A12361. The monthly average station pressure should be entered to thousandths on Form 1001C.

3/17. Paragraph A13010. Gust recorder charts completed during the month should be included with the shipment of other recording instrument forms listed in this paragraph. The station name and date should be entered on the charts near the termination of the trace.

3/18. Paragraph A13610. At stations entering hourly temperatures on Form 1001B and 1130B, as obtained from the thermograph, the thermograph may be changed on Saturday in order that these forms may be completed and forwarded to WRPC's on the prescribed dates.

3/19. Paragraph A13720. At stations where records from the weighing rain gage must be evaluated before hourly precipitation values can be entered on Forms 1001B or 1130B, the rain gage chart may be changed on Saturday in order that these forms may be forwarded to the WRPC's on the prescribed dates.

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
Washington 25, D. C.

May 23, 1949

WBAN MANUAL OF SURFACE OBSERVATIONS
Circular N, 6th Edition

INTERPRETATIONS - SERIES NO. 2

(To be bound in Circular N following Series No. 1, dated March 4, 1949)

2/1. Paragraph 1210.(a)Clouds covering less than 1/10 of the sky should be reported in remarks whenever their presence is considered significant. Since clouds covering less than 1/10 of the sky do not constitute a layer, their presence above a lower layer will not be reflected by means of the sky condition symbols.

Example

Given: 9/10 stratocumulus clouds, height estimated 5,000; less than 1/10 altocumulus castellatus clouds, height estimated 10,000.
Reported: Column 3,4— E50CD
Column 14 — FEW ACC E100

(b)In the case of multiple layers, the upper layer may obscure the sun, moon, or stars, and thus prevent use of these criteria in determining whether the lower layer should be classified "thin". Under such circumstances, if the beam from the ceilometer or ceiling light projector completely penetrates the lower layer and casts a clearly visible spot on the upper layer, the lower layer should be classified "thin."

2/2. Paragraph 1447.2. The dew-point temperature lines in Figure 1 are with respect to ice at dew-point temperatures below freezing. When using this diagram, convert sub-freezing dew-point temperatures with respect to water to their equivalent values with respect to ice by means of Table 9, page 44, and use this converted value as indicated in Step (1) of the reference paragraph.

2/3. Paragraph 9134.02. Item (2) refers only to a change in sky condition below 1,000 feet, and does not refer to total sky cover. For example, if 2/10 stratus appeared at 500 feet beneath a previously reported overcast at 2,500 feet, a special would be required because the clouds below 1,000 feet increased from none to scattered.

2/4. Paragraph 9150. Check observations are to be taken in accordance with this paragraph at all Weather Bureau and CAA stations where scheduled broadcasts of local weather are made. This requirement applies even though there has been no significant change in weather conditions since the previous record observation.

2/5. Paragraph 9211. Note that, unless the currently reported ceiling value is classified "measured," pilots' reports of ceiling will be accepted as the official ceiling value and immediately disseminated, regardless of indications of instrumental equipment. Since there have been several recent indications that this basic principle for dissemination of pilots' reports of ceiling might not be completely understood, observers are requested to review the reference paragraph and the amplifying instructions in Circular Letter 83-48.

2/6. Paragraph 10230. When a single airport communications system is available, such as the telautograph system described in Circular Letter 47-49, observations will usually be distributed over this single system only. This does not preclude, of course, replying to special requests for particular observations by means of telephone, etc.

2/7. Paragraph 11105.3. Requirements for reporting variable visibility and visibility differing in various quadrants pertain both to the visibility at the usual point of observation and to that at the control tower level.

Example:

Given: (a) At control tower level: prevailing visibility 1 1/2 miles; visibility variable from 1 to 2 miles.
(b) At usual point of observation: prevailing visibility 1 1/2 miles; visibility variable 3/4 to 2 1/2 miles

Reported: Column 5 -- 1 1/2V
Column 14 -- VSBY VRBL 1 TO 2 SFC VSBY VRBL 3/4 TO 2 1/2

(Note: With reference to Item 1/8 on Interpretations, Series No. 1, concerning control tower visibility reports, it should be noted that the sky condition would be properly reported as -X only if some other obscuration in addition to the ground fog were present. If ground fog only were present, the sky condition could not be reported as -X since, by definition, ground fog covers less than 6/10 of the sky.)

2/8. Paragraph 11106. If the visibility value entered in column 5 is 7 miles or more, obstructions to vision will not be recorded in column 6.

2/9. Paragraph 11422.1. Data pertaining to clouds or obscuring phenomena entered in columns 22-27, 29-31, and 33-35 are required for climatological purposes and should represent the actual tenths of clouds in each layer. In entering data pertaining to layers that are partially obscured by a lower layer, it is not necessary that all data be observed at the actual time of the observation, but

2/9. (cont.)
an estimate should be made, based on any preceding observations that are still considered representative, such as pilots' reports. Note that these procedures are not followed in entering summation totals in columns 21, 28, and 32, or in reporting sky condition in column 4; data entered in these columns are primarily for operational purposes, and must reflect the sky condition as actually visible at the time of the observation.

2/10. Paragraph 11422.11. When higher clouds are seen through breaks in a lower overcast, but it is not possible to identify them as to type, "U" may be entered in columns 25, 29, or 33, even though the presence of the higher clouds has been reported in column 14.

2/11. Paragraph 11445. Since ice crystals are a form of frozen precipitation, snowfall and snow depth data entered in columns 45, 46, 69, and 70 will include data pertaining to ice crystals.

2/12. Paragraph 11458. When the altimeter setting indicator is used to determine the station pressure for the synoptic observation, entries will be omitted in columns 60-62. The time of reading the altimeter setting indicator will be entered in column 59; and the station pressure, determined in accordance with paragraph 7260, will be entered in column 63 to the nearest hundredth.

2/13. Paragraph 11482. The time of ending of precipitation or thunderstorms, recorded in column 84, should be the actual time of cessation of the phenomenon, rather than, for example, fifteen minutes after thunder was last heard.

Example:

Given: Thunder heard at 1018E, but not heard in succeeding fifteen minutes.

Reported: (a) Record observation at 1028E continued to report thunderstorm.
(b) Special observation at 1033E reported ending of thunderstorm.
(c) Time of ending of thunderstorm recorded in column 84: "1018"

2/14. Paragraph 11483. Entries in columns 86-88 refer only to obstructions to vision prevailing at the usual point of observation. Data pertaining only to phenomena occurring at the control-tower level will not be recorded in these columns.

2/15. Paragraph A12319. Visibility values recorded in column 19 of Form 1001C will be based on the values recorded in column 5 of Form 1130A, regardless of whether these values pertain to the usual point of observation or to the control tower level.

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
Washington 25, D. C.

October 24, 1949

WBAN MANUAL OF SURFACE OBSERVATIONS
Circular N, 6th Edition

INTERPRETATIONS - SERIES NO. 4

(To be bound in Circular N following Series No. 3, dated August 1, 1949)

4/1. Paragraph 1210. The instructions in Interpretation 2/1 apply also when several cloud fragments at more than one level are observed, each covering less than 1/10 of the sky, even though the total amount of sky covered is 1/10 or more. For example, if 1- altocumulus and 1- cirrus were noted, with a total sky cover of 1/10, the sky condition in column 4 would still be reported as clear, since neither of these cloud fragments constituted a layer. If the presence of such cloud fragments appears significant, a remark such as "FEW AC AND CI" should be included.

4/2. Paragraph 3435. As a convenience in using Table 8, it is suggested that the equivalent values in statute miles be entered in this Table. These values are 5/8 of a mile for 1100 yards and 5/16 of a mile for 550 yards. Similar entries should be made in the Condensed Table of Critical Values.

4/3. Paragraph 3501. The statement in this paragraph concerning the improbability of fog formation if the temperature-dew point spread is more than 4° is intended only for guidance of observers in detecting fog. If, in the observer's opinion, fog is beginning to form, it will be reported even though the temperature-dew point spread is more than 4°.

4/4. Paragraph 4030. Note that, at stations having both a shielded weighing gage equipped with the proper gears and an unshielded 8-inch gage or tipping bucket, the weighing gage will be used for all official precipitation measurements except excessive precipitation, since it is the only shielded gage at the station. The statement in the legend beneath Figure A9 refers only to stations having both a tipping bucket and a shielded weighing gage equipped with suitable gears and was not intended to imply that excessive precipitation would be computed from weighing gage charts. Similarly, Interpretation 3/13 referred only to stations equipped with one or the other type of gage, not with both.

4/5. Paragraph 6010. If the dry- and wet-bulb temperatures are outside the range of the psychrometric calculator, WB Form 235 will be used to obtain relative humidity and dew point, and the corrections indicated in Tables 9 and 10 applied as necessary.

4/6. Paragraphs 9134-9134.11, and 9143.

(a) Special observations will be taken at SAWRS only under the following conditions:

(1) To report changes in ceiling and visibility in accordance with paragraphs 9134.01 and 9134.05 during the period beginning one hour before the expected time of an aircraft's arrival and ending one hour after the aircraft's departure.

(2) To report changes in meteorological conditions that, in the opinion of the observer, are of importance to the safety or efficiency of impending aircraft operations.

(3) Whenever requested by operational interests.

(The above items correspond to the instructions in Circular Letter 91-48, with the exception that the paragraph references to Circular N have been changed to correspond to those of the 6th edition.)

(b) When a sliding scale of minimums applies to an airport, the "highest airline operating minimum" refers to the highest ceiling and visibility values used as minimums by any air carrier operating at the field, even though the respective values for ceiling and visibility are not companion values on the sliding scale.

Example:

Given: The following sets of minimums for an airport:

Operator No. 1	Operator No. 2
400 - 1	500 - 1 1/2
600 - 3/4	700 - 1 1/4
1000 - 1/2	1000 - 1

4/6. (cont.)

Procedure: The highest airline operating minimum in the above case is 1000 feet and 1 1/2 miles. A special observation would therefore be required at this airport when the ceiling decreased to 1000 feet or less or increased to 1000 feet or more. This provision applies only to the highest minimum, and a special observation would not be required by this rule if the ceiling decreased from 700 to 500 feet. However, local extra observations would be required in accordance with paragraph 9143.

(c) A special observation should be taken whenever a sandstorm or duststorm is no longer in sight within 6 miles of the station. A special observation is not necessary when a sandstorm more than 6 miles from the station completely disappears from sight.

(d) At stations not taking airway observations throughout a 24-hour period, special observations as required by these paragraphs should usually be begun following the first scheduled record observation for the operating period. For example, if the station is taking observations only during the period 0400-2000, special observations will be taken, whenever required by these instructions, following the first record observation at 0430. An exception to this procedure should be made if, during the period 0400-0430, any meteorological condition believed to be of importance to the safety and efficiency of aircraft operations is observed, in which case a special observation should be filed immediately.

4/7. Paragraph 9213. Pilots' reports of ceiling more than 1 1/2 miles from the boundaries of the field will be disseminated immediately in accordance with item (8) of this paragraph. Since such reports cannot be used for official ceiling values, they should be distributed immediately even though the ceiling at the airport is classified "measured."

4/8. Paragraphs 10322, 10325. Contractions currently authorized by the CAA manual of contractions should be used even though they differ from those in Circular N illustrations. For example, the currently authorized CAA contraction for Navy pilot reports is NAREPS, and this abbreviation should be used in current weather reports rather than NYREPS, which is used in the illustrations in these paragraphs.

4/9. Paragraphs 11001, A11001. The monthly preparation of Form 1130D is not required for SAWRS and other second-order airway stations. The instructions in Interpretation 3/8 apply to these stations, as well as to CAA observing stations.

4/10. Paragraph A11050. As a result of the introduction of automatic scanning procedures on all Service A circuits, two or more special observations may frequently be available for transmission during a scanning period. Under such circumstances, only the latest observation will be transmitted during the scanning period on Service A, and observations not transmitted will be marked "FIBI" in accordance with this paragraph. For example, if special observations were taken at 1340 and 1348, only the observation at 1348 would be transmitted during the scanning period beginning at 50 minutes past the hour.

4/11. Paragraph 11105.2. At stations where there are no intermediate visibility markers, it may not be practicable to estimate visibility in the intermediate ranges. For example, at certain stations in mountain areas, the only visibility markers beyond the immediate vicinity of the station are sometimes distant mountain ranges approximately 100 miles away which are visible only under very unusual meteorological conditions. Estimations of visibility in 5-mile increments in the ranges from 15 to 100 miles are therefore not practicable. In such cases, if the visibility is estimated to be more than 15 miles but a more precise estimation cannot be made because of lack of suitable markers in the intermediate ranges, the visibility should be recorded as 15+.

4/12. Paragraph 11106.

(a) If rain or any other form of precipitation is recorded in column 6, it is not necessary that an obstruction to vision (Table 27) be recorded, even though the prevailing visibility is six miles or less. However, if the visibility is poor and the precipitation very light, the observer should be alert to detect formation of some additional obstruction to vision, such as fog.

(b) If squalls are observed, they will be reported following items (1) to (5) in this paragraph, and preceding item (6) (obstructions to vision.)

4/13. Paragraph 11114. The instructions in item 6 of Table 29 apply also if three scattered layers are reported, i.e., the lowest of the three layers will be reported in remarks. Note also that, in the case of multiple layers, the first sky condition symbol represents the total amount of sky covered.

Examples:

Given:

	1st layer	2nd layer	3rd layer	Total
(1)	1 Cu E25	1 Ac E85	1 Ci E150	1
(2)	5 Cu E25	1 Ac E85	1 Ci E150	6
(3)	9 Cu E25	1 Ac E85	1 Ci E150	9

Reported:

	Ceiling and Sky	Remarks
(1)	⓪85 ⓪	150 ⓪25 ⓪
(2)	E85 ⓪⓪	E150⓪ 25⓪
(3)	E25 ⓪⓪	E150⓪ E85⓪

4/14. Paragraph 11417. Readings from precision aneroid barometers, which will be made to the nearest 1/10 of a millibar if the barometer is graduated only in millibars, will be converted to thousandths of inches before entry in column 17. If a precision aneroid barometer is available, hourly and 6-hourly station pressures will be obtained from this instrument rather than from an altimeter setting indicator or a microbarograph. A special table for converting tenths of millibars to thousandths of inches is being furnished stations having precision aneroid barometers.

4/15. Paragraph 11450. State of the ground observations should be omitted at stations having only concrete, macadamized, or other similar hard surfaces in the vicinity of the station. Under such circumstances, a dash should be entered in column 50.

4/16. Paragraphs 11461-11465.

(a) The instructions to enter pressure readings to the nearest .001 of an inch or .05 of a millibar apply only to readings from mercurial barometers. At stations equipped with precision aneroid barometers graduated in millibars, entries in columns 61-63 should be to the nearest tenth of a millibar, with the entry in column 61 being the uncorrected reading of the precision aneroid, the entry in

4/16. (cont.)
column 62 being the established correction, and the entry in column 63 being the corrected station pressure. (The entry in column 63 should be converted to the nearest one-thousandth of an inch, before entry in column 17.)

(b) If the precision aneroid barometer is graduated in inches or in both inches and millibars, entries in column 61 should be to the nearest .005 of an inch.

(c) If a precision aneroid is available, entries in these columns will invariably be obtained from this barometer, rather than from an altimeter setting indicator or a mercurial barometer.

(d) The value entered in column 63 will be used in establishing the barogram correction for column 65. Barograph readings will be entered in column 64 to the nearest five-thousandth of an inch at all Weather Bureau stations; the provisions for entering these data in millibars apply only to military stations (where the microbarograms are graduated in millibars).

4/17. Paragraphs 11482, 11483. Obstructions to vision not restricting the visibility at the usual point of observation, and therefore not recorded in column 6, should not be entered in columns 86-88. This procedure will be followed even though distant obstructions to vision are recorded in column 14 (e.g., "K LYRS E," "GF NW," etc.). Similarly, precipitation will not be entered in columns 82-84 unless precipitation is also reported in column 6. Entries will not be made in these columns to report distant precipitation.

4/18. Paragraph A12010. City offices preparing Form 1001C in accordance with the instructions in this paragraph, but not preparing Form 1001B, will enter data as follows on Form 1001C:

(1) Columns 2-7 will be completed from autographic records.

(2) Columns 20-22 will contain the maximum and minimum temperatures (to the nearest 0.1°F) and precipitation, respectively, for the 24-hour period preceding the time of the climatological observation. (These data will be obtained from autographic records for days on which no climatological observation was taken.)

(3) Temperature and precipitation summaries will be entered at the bottom of the form.

(4) Entries in all other columns will be omitted.

(These correspond to the instructions in C. L. 102-49)

4/19. Paragraph A12352. Instructions in paragraph 12343, concerning the entry of "greatest amount of precipitation" if the 24-hour period begins on the last day of one month and ends on the first day of the following month, apply also to snowfall.

Example:

Given: (1) 5.0 inches of snow fell on March 31-April 1, with 2.0 inches falling on March 31 and 3.0 inches on April 1.

(2) With the exception of the snowfall on March 31, the greatest snowfall in March was 1.5 inches on March 15.

(3) The greatest amount of snowfall in April was 5.5 inches on April 5.

Entries on Form 1001C - "Snowfall - Greatest in 24 Hours"

(1) For March, "1.5 inches on March 15." (Note that, although two inches fell on March 31, the total precipitation on March 31 must be ascribed to April 1 in accordance with paragraph 12343.)

(2) For April, "5.5 inches on April 5."

(3) In both instances, explanatory notes should be entered at the bottom of Form 1001C indicating that 5 inches of snow fell during the period March 31 to April 1, with 2 inches falling on March 31 and 3 inches on April 1.

4/20. Paragraph A12353. If the greatest depth of snow on the ground during the month is a trace, "T" will be entered in the space provided for this datum.

4/21. ParagraphA13720. The instructions in this paragraph concerning the time of changing charts should be followed by CAA and other second-order stations as well as by first-order Weather Bureau stations insofar as practicable. Local exceptions to this procedure may be made if personnel are not normally scheduled on duty at these periods.

4/22. Paragraph A14330. The permanent file of Forms 5066 will be retained at the Regional Office only if the Regional Office is also headquarters for the field aide customarily visiting the station concerned. Otherwise, the permanent file of completed

4/22. (cont.)
Form 5066 will be sent to the field aide's headquarters and included in the permanent inspection folder. In the latter case, Regional Offices are requested to furnish verifying stations the addresses to which completed Forms 5066 should be sent. Completed copies of Form 5066 may be destroyed by field aides after two years from the date of preparation.

4/23. Paragraph A15312.2. In the coded message, the AZRAN group should be "27/100" rather than "27/10."

4/24. SectionA15500.

(a) In Figure A12 for "No change in tendency," read "Tendency - no change."

(b) In Figure A19 in the 3rd line of the coded message, delete "no."

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
Washington 25, D. C.

February 1, 1950

WBAN MANUAL OF SURFACE OBSERVATIONS
Circular N, 6th Edition

INTERPRETATIONS - SERIES NO. 5

(Note: Inspection reports have indicated that some stations have overlooked the entry of marginal notations opposite appropriate paragraphs in accordance with the note preceding Interpretation 1/1. Station officials are requested to review these instructions to insure that such numbers are entered for each item.)

5/1. Paragraphs 1431, 1434. Inspection reports have indicated that many low ceilings are being classified "indefinite," possibly because of the greater angular penetration of the ceilometer or ceiling light beam into low clouds as compared with higher clouds. This relatively greater beam penetration into lower clouds is not a valid criterion for determining ceiling classification. As indicated in paragraphs 1431 and 1434(1), the determination of a ceiling classification of "measured" or "indefinite" must be based on whether the beam penetration is normal for that usually experienced with the particular cloud height. For example, a penetration of 5° into a cloud base at 7500 feet would usually require a ceiling classification of "indefinite" because this penetration is in excess of that normally experienced for clouds at this height; while a penetration of 5° into a cloud base at 500 feet would usually require a classification of "measured" because this penetration is normal for clouds at this height.

Investigations are being conducted to establish objective criteria for determining ceiling classifications that will not depend largely on observer experience and judgment. In the meantime, station officials are requested to review classifications assigned locally to ceilings below 1000 feet. If most of the ceilings that are determined by a ceilometer or ceiling light are not classified "measured," it is probable that the above procedures for determining ceiling classification are not understood by all observers, and local action should be taken accordingly to insure that proper techniques are being used.

5/2. Paragraph 1442. The authorized free lifts for ceiling and pilot balloons are given in the following table. No other free lifts are authorized for these balloons when used for ceiling-measuring purposes. Ordinarily, only 10-gram balloons will be used for ceiling-measuring purposes, with 30-gram balloons furnished selected stations only. Inflation nozzles, rather than balances, will be used in inflating both types of balloon.

Type of Balloon	Gas	Total Free Lift
Ceiling (10-gram)	Helium	45 grams
Ceiling (10-gram)	Hydrogen	40 grams
Pilot Balloon (30-gram)	Helium	139 grams
Pilot Balloon (30-gram)	Hydrogen	125 grams

The following ascensional rates apply to 30-gram balloons inflated with either of the above lifts. Heights corresponding to intermediate time intervals should be obtained by interpolation.

Min.	Ft.	Min.	Ft.	Min.	Ft.
1/2	350	3 1/2	2320	6 1/2	4130
1	710	4	2630	7	4430
1 1/2	1030	4 1/2	2940	7 1/2	4720
2	1360	5	3250	8	5020
2 1/2	1680	5 1/2	3540	8 1/2	5320
3	2010	6	3840	9	5610

5/3. Paragraph 6120. Inspection reports have indicated that procedures for computing dew-point temperatures when the wet-bulb temperature is below 32°F. are not understood at all stations. The following important points are, therefore, being re-emphasized:

(a) Whenever the wet-bulb temperature is less than 32°F., the index of the D-scale on the psychrometric calculator will invariably be set opposite the wet-bulb temperature on the T_i scale, regardless of the current dry-bulb temperature. If the wet-bulb wick is not obviously ice-covered, ice should be caused to form on the wick by touching it in accordance with paragraph A5131.1.

(b) The dew-point temperature is always read on the T_w scale (i.e., with respect to water) regardless of the current dry- or wet-bulb temperatures.

5/4. Paragraphs 8110, 11114. Magnetic directions should be entered on Form 3024B (or the telautograph record) in parenthesis following the last element of the observation, except that this entry may be omitted at stations not needing it for broadcast purposes. (For example, the entry will not be necessary at stations where communications personnel obtain wind directions directly for all broadcast purposes from separate indicators in the communications station.) Magnetic wind directions will not be entered on Form 1130 unless this form is used directly for broadcast purposes, in which case these directions may be recorded in column 14 in parenthesis.

Magnetic directions are determined in accordance with the following instructions:

A. From wind direction indicators calibrated in degrees:

(1) If the magnetic declination is west, add it to the true direction.

(2) If the magnetic declination is east, subtract it from the true direction.

B. From wind direction indicators not calibrated in degrees:

Declination	Conversion Procedure
East:	
0-11°	No conversion necessary.
12°-34°	The first compass point (on a 16-point scale) in a counterclockwise direction from the true direction (as observed on the 9-light indicator)
35°-56°	The second compass point in a counterclockwise direction from the true direction.
West:	
0-11°	No conversion necessary.
12°-34°	The first compass point (on a 16-point scale) in a clockwise direction from the true direction (as observed on the 9-light indicator).
35°-56°	The second compass point in a clockwise direction from the true direction.

(Apply corresponding increments for larger declinations.)

EXAMPLES

(1) True wind direction: NW
(2) Magnetic declination: 15° West
(3) Wind direction (magnetic compass): NNW

(1) True wind direction: SE
(2) Magnetic declination: 35° East
(3) Wind direction (magnetic compass): E

5/5. Paragraph A8233. Wind speeds below 2.5 miles per hour are not indicated on the Electric Speed, Instrument Corporation, or Weather Bureau-Design wind equipment. At stations using this equipment, wind speeds below this value should be estimated by observing the relative speed of rotation of the cups.

5/6. Paragraph 8311. A new type of direct-reading wind equipment, the F411 Wind System, has been recently distributed to selected field stations. Although this equipment physically resembles the condenser-discharge type of equipment, its performance characteristics are different. Peak speed of gusts should be determined directly from the F411 Wind System in the same manner as for other types of direct-reading wind equipment. Zero corrections apply throughout the entire scale range.

5/7. Paragraph 9012. The instructions in this paragraph concerning the use of control tower visibility observations for coding purposes apply only to the coding of airway observations and associated summaries. The visibility at the usual point of observation, rather than at the control tower level, will be coded in the synoptic observation. (These instructions are being included in a forthcoming revision of the synoptic code.)

5/8. Paragraph 9144. Local arrangements should be made for the control tower, communications station, or airport operations office to inform the observing station of aircraft accidents in order that the local extra observation required by this paragraph may be taken promptly. If notification of such an accident is not received immediately, the observation should be taken immediately after notification, unless there has been an intervening record observation. An explanatory note should be entered in column 90 of Form 1130B whenever this observation has been delayed.

5/9. Paragraphs 9213, 11300-11311.1. In accordance with Circular Letter 142-49, PIREPS will be entered on Service A in summary form only, with the exception of those entered by Weather Bureau stations that operate Service A send-receive facilities and have no means other than Service A to communicate with the ARTC or an adjacent INSAC. All pilots' reports, regardless of whether they are entered directly on Service A at the station of origin or are forwarded to ARTC for inclusion in the summary prepared by FAWS, will be recorded on Form 1130 by the originating station in accordance with Section 11300. The term "local extra" as used in Circular Letter 142-49 refers only to the type of distribution to be given these PIREPS, and does not alter the manner in which these observations are recorded on Form 1130. A supplementary form must still be used for PIREPS more than 1 1/2 miles from the boundaries of the field, as prescribed in Section 11300; elements will be entered in the order indicated in paragraph 10320, using the abbreviations listed in the following paragraphs, etc.

5/10. Paragraph A10080. Inspection reports have indicated that the purpose of Form 3069 may not be understood at all stations and that this form is therefore not being systematically rendered. Form 3069 is extensively used at the WBAN Analysis Center, as well as at some field forecast stations, for correcting manuscript maps in historical files. Since Form 5066 is not generally available to these offices, it is important to the accuracy of historical maps that Form 3069 be forwarded promptly in accordance with instructions in paragraph A10080.

5/11. Paragraph A11005.2. The authorization for field aides to destroy retained carbon copies of Form 1130 applies at CAA as well as at other second-order stations.

5/12. Paragraph 11202. This paragraph was generally applicable at all stations before the scheduled transmission time for synoptic observations on Service C was advanced to 35 minutes past the hour. Since synoptic observations are now usually transmitted following the record observation, the procedures outlined in this paragraph now apply only at those few stations where special arrangements have been made for earlier transmission of synoptic observations by telephone or telegraph.

5/13. Paragraph 11445. Entries in column 45 of Form 1130B are obtained by actual stick measurements, in accordance with paragraph 4230, and are not the sum of hourly values.(Hourly snowfall measurements are made at designated stations only.)

Example:

Given: Hourly measurements for the period 0115 to 0715 EST totaled 9.3 inches; no melting occurred, but stick measurement at 0715 indicated total depth on ground of new snow since 0115 to be only 7.2 inches.

Entry in column 45: 7.2 (i.e., the 6-hourly stick measurement, rather than 9.3, the sum of hourly values for the preceding 6 hours).

5/14. Paragraph A12316. Observations of sky cover that are made after sunset will not be considered in computing average sky cover entries in column 16 of Form 1001C. For example, if sunset occurs at 1722 EST, an observation of sky cover made at 1727 will not be included in the daily average for this column.

5/15. Paragraph A12362. At high altitude stations, the lowest (or highest) station pressure indicated on the barograph may not represent lowest sea-level pressure because of the temperature factor involved in the sea-level reduction. At such stations, the hourly computations of sea-level pressure should be inspected, in addition to the barograph charts, to determine that the lowest (or highest) sea-level pressure has been selected.

5/16. Paragraph A13110 At stations west of the 135th standard meridian time zone, missing record may result if the barometer charts are changed at 1830 GCT as specified in this paragraph. At such stations, the charts should be changed at the standard synoptic time (0030 GCT, 0630 GCT, etc.) nearest to noon, local standard time.

CORRECTIONS

(1) Table A2, following paragraph A5544, column headed "Telepsychrometer Dry-Bulb Higher Than 20°F., Wet-Bulb 33°F. or Lower," line headed "Relative Humidity" --- change "from telepsychrometer dry-bulb and standard psychrometer wet-bulb" to read "from telepsychrometer dry-bulb and standard psychrometer dew-point."

(2) Figure 5, second line, column 23 --- prefix a minus sign (-) to "F."

(3) (a) Paragraph A15120, Item 1(a), change "0110GCT" to read "0135GCT."

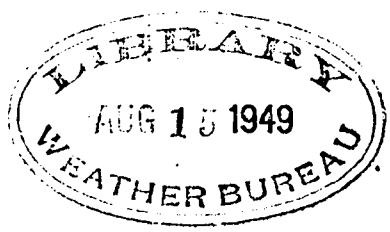
(b) Paragraph A15511, delete "between 27 and 30 minutes past each hour. Additional observations may be transmitted at 10 minutes of, or 10 minutes past, each hour."

(The changes in (3) above have been necessitated by the recent revision of scheduled transmission times for SW reports on Service A. Revised pages of Circular N will be forwarded for these and other changes at a later date.)

U. S. DEPARTMENT OF COMMERCE
Charles Sawyer, Secretary
WEATHER BUREAU
F. W. Reichelderfer, Chief

MANUAL OF

RADAR METEOROLOGICAL OBSERVATIONS



Washington, D.C., August 1, 1949

CHAPTER A15. RADAR METEOROLOGICAL OBSERVATIONS.

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CHAPTER A15. RADAR METEOROLOGICAL OBSERVATIONS

A15010. GENERAL. Radar (radio direction and ranging) equipment consists essentially of a directional radio transmitter and a radio receiver that picks up the transmitted energy reflected by meteorological and non-meteorological phenomena. The types of radar equipment commonly used for meteorological observations employ a wave length of 3 cm. or 10 cm. The received impulses are presented in typical patterns upon an oscilloscope (termed "scope" in these instructions). The search for meteorological phenomena is termed "scanning." The reflected energy as presented on the scope is termed an "echo." Echoes are evaluated in terms of range, or distance from the station; azimuth bearings; intensity; tendency; height; width; and direction and speed of movement. These data are entered upon forms and coded either in the modified plain language RAREP code used at land stations, or the standard RAREP code used at ocean stations.

A15011. It should be noted that most radar scopes now used for weather search are calibrated in nautical miles. Conversion to statute miles prior to entry on the forms will therefore be required in these cases.

A15012. Radar equipment assists the surface observer to evaluate meteorological situations within the range of the set. Limitations of the equipment must be understood when evaluating and using radar data. Certain forms of precipitation and lithometeors may be detected by radar but wind and pressure systems associated with tornadoes, hurricanes, and thunderstorms cannot be detected. Correlation of the radar indications with the existing synoptic situation must therefore be carefully done. Furthermore, the absence of radar indications will not justify the inference that precipitation is not occurring, for water on the radar dome and precipitation may exclude indications of more distant precipitation areas, especially if 3 cm. radar is used.

A15013. The following paragraphs contain instructions for evaluating the echoes observed on the scope and for entering data on Form 3200A, "Radar Weather Observations," and Form 3200B, "Marine Radar Weather Observations." Most of the material in this section applies to Form 3200A. Observers aboard ocean station vessels will follow these instructions to the extent that they are applicable to Form 3200B. Additional instructions for entry of data not directly bearing on the observation are included in Section A15400, together with instructions for disposition of the completed forms.

A15014. The Central Office is interested in obtaining photographs, drawings or sketches of unusual echoes, especially those of precipitation areas associated with hurricanes, frontal systems, tornadoes and thunderstorms. The following suggestions are offered to personnel who wish to attempt to photograph the radar scope:

(1) Use fast film, similar to Kodak Super XX or Agfa Super Pan Press.

(2) Mount the camera on a tripod or other firm mount as close to the scope as the camera can be accurately focused.

(3) Exclude as much extraneous light as possible from the camera lens.

(4) Make a time exposure, using an aperture of F4.5 or F5.6. The duration of the time exposure should be the exact number of seconds required for one complete revolution of the radar antenna.

The Central Office will be glad to develop the film and return it with prints to the photographer. The material will be most useful if a complete airway observation, taken at the time of the echo, is forwarded with the film or drawing. All material should be identified with reference to the exact time and date of occurrence, location of the observing station, type of radar equipment, range setting and orientation.

A15100. OBSERVATION SCHEDULE

A15110. GENERAL. Radar equipment is a valuable observational facility that will be used to the greatest possible extent whenever echoes are observed on the scope, and especially when hurricanes and other disturbances of unusual severity are forecast or reported in the vicinity. The scope will be observed for a minimum of three minutes. After echoes have been initially detected, the equipment will be maintained in operating or standby position until echoes are no longer observed. Unless otherwise specified, "echoes" as used in these instructions will refer to those having their origin in meteorological phenomena.

A15120. TIME OF OBSERVATIONS. Depending upon the prevailing meteorological situation, observations will be taken as follows:

1. (a) Land stations - at 0110 GCT and every three hours thereafter.

   (b) Ocean stations - immediately after each three-hourly observation.

2. In addition to (1) above, when echoes are observed, and when frontal activity or precipitation is occurring or forecast, observations will be taken at ten minutes past each hour.

3. In addition to (1) and (2) above, additional observations will be taken when:

   (a) Echoes are noted on a previously clear scope.

   (b) Speed of movement, after increasing by twice or more since the previous observation, equals or exceeds thirty miles per hour.

   (c) Direction of movement changes by 45° or more since the previous observation.

   (d) Scattered echoes become a solid line or a solid line changes to scattered echoes.

   (e) The scope becomes clear.

A15200. PREPARATION OF RADAR FOR USE

A15210. GENERAL. The radar equipment will be turned on and operated in accordance with instructions appropriate to its type. The following instructions concern adjustments of the controls and evaluation of scope patterns to secure optimum performance for weather search.

A15220. TUNING PROCEDURE. Direct the antenna by manual control to a known ground obstruction that will return an echo. Adjust the antenna in azimuth and elevation for maximum return, and reduce the gain of the receiver until the echo is just discernible on the scope. This point is termed the "threshold level." Turn the A.F.C.-manual switch (automatic frequency control) to the manual position. Retune the receiver and reduce the gain as necessary to maintain the signal at the threshold level. Turn the A.F.C.-manual switch to the A.F.C. position. If an increase in echo intensity is noted, repeat the above procedure. When no difference is noted, the equipment is correctly tuned, and the switch will be left in the A.F.C. position while taking the observation. Any decrease in signal strength when the switch is turned from manual to A.F.C. indicates malfunctioning of the equipment, which will be reported immediately to the technician.

A15221. After adjustments have been made in accordance with the previous paragraph, increase the gain of the receiver to as high a point as is consistent with prevailing interference. Tilt the antenna to about 3° above the horizon or to an angle that yields the best results for the station at the range being used.

A15300. DETECTION AND EVALUATION OF ECHOES

A15301. GENERAL. A map of permanent obstructions through 360° around the station will be prepared to aid in distinguishing echoes of meteorological from those of non-meteorological origin. It is recommended that a transparent insert, upon which are plotted echoes of all permanent obstructions in terms of azimuth and range, be constructed to fit over the face of the scope. One insert should be made for each range.

A15302. SCANNING. Scan all ranges, starting with the longest, through several angles of antenna tilt during each observation. To obtain the most accurate and the best defined presentation of an echo, use the shortest range which will include it.

A15303. SPURIOUS ECHOES. Spurious echoes may occasionally be received when meteorological conditions are such that the normal range of the ground pattern is greatly extended. This condition is often associated with inversions and is manifested by echo patterns not typical of the synoptic situation. Spurious echoes will be noted on Forms 3200 but will not be transmitted.

A15304. CHARACTER. Classify the echoes in accordance with the following list and enter the corresponding contraction on Form 3200A.

Character	Contraction
Scattered echoes	SCTD
Solid echo	SLD
Line of scattered echoes	LINE SCTD
Solid line of echoes	SLD LINE
Spiral band	SPRL BND

A15305. POSITION. The shape and size of each echo will be evaluated in terms of range, or distance from the station, and azimuth bearings. To facilitate observing in these terms, the echoes will be visualized in one of the typical patterns:

(1) Azimuth and range of ellipse pattern (see Figures A12 and A13)

(2) Azimuth and range of circular pattern (see Figures A14 and A15)

(3) Azimuth and range of combinations of individual echoes (see Figures A17 and A18)

(4) Azimuth and range of spiral bands (see Figures A19 and A20)

The echoes will be evaluated in terms of whichever pattern fits best. Each pattern is discussed below. After the azimuth and range have been observed in accordance with the following instructions, enter the data on Form 3200A under the captions Azimuth and Range. Enter azimuth to the nearest ten degrees and range to the nearest whole statute mile. The azimuth and associated range will be entered in adjacent columns. As many additional data as are necessary will be entered similarly.

A15305.1. ELLIPSE. The scope pattern will be evaluated in terms of an ellipse when the major axis (length) through an echo or group of echoes is two or more times the minor axis (width), provided that the distance between adjacent echoes in a group is the same as or less than the distance through the largest echo.

A15305.11. Read the azimuth, and corresponding range, of lines extending from the center of the scope to each end of the major axis.

A15305.2. CIRCLE. The scope pattern will be evaluated in terms of a circle when an echo or group of echoes is so situated that the major axis could lie in more than one position through the area, provided that the distance between adjacent echoes in a group is the same as or less than the distance through the largest echo.

A15305.21. Read the azimuth and corresponding range of a line extending from the center of the scope to the center of the circle.

A15305.22. When precipitation at the station causes a bright, diffuse echo that completely covers the central portion of the scope, make range readings to the edges of the echo at several points. No azimuth readings are required. The range values will not be entered on Form 3200A, but will be used for a later determination of the width of the area (see Figure A16)

A15305.3. INDIVIDUAL ECHOES. If, in a group of echoes, the distance between adjacent echoes is greater than the distance through the largest echo, the echoes will be described individually.(see Figure A17)

A15305.31. When an individual precipitation area is the same size as, or smaller than, the width of the radar beam, the echo will appear as a short line. In this case, the major and minor axes will not be determined. The azimuth and range of the echo will be reported in terms of the azimuth and range of the center of the echo with respect to the station (see Figure A18)

A15305.4. SPIRAL BANDS. Echoes reflected from precipitation areas associated with typhoons and hurricanes often approximate spiral bands. No attempt should be made to classify these echoes as ellipses or circles. Rather, azimuth and range readings will be recorded for as many points (usually at least three) on the center line of the echo as

are necessary to define its extent accurately. When multiple bands exist, separate azimuth and range readings will be recorded for each band (see Figures A19 and A20)

A15305.41. Information pertaining to the eye of the storm will be reported in remarks. (See paragraph A15312.2.)

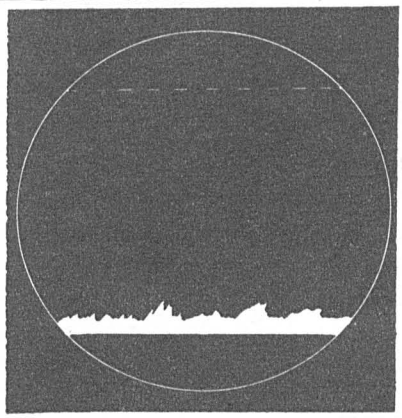
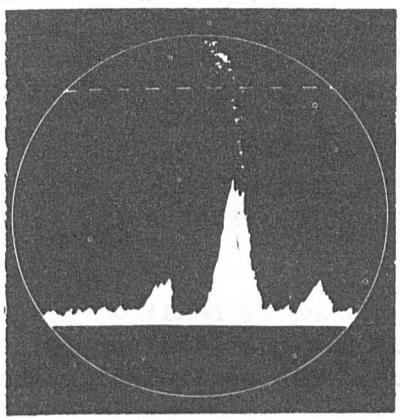
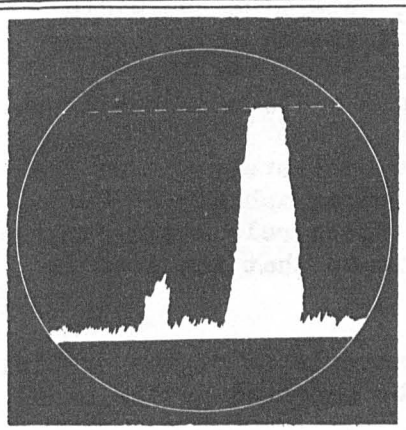
A15306. INTENSITY. Observations of intensity will be made only at stations equipped with 10 cm. radar. Whenever available, an A-scope will be used to observe intensity. When an A-scope is not available, intensity will be estimated from careful observation of the PPI scope.

A15306.1. Enter on Form 3200A, under the caption "Intensity," the appropriate contraction selected from the following list:

Intensity	Contraction
Weak	WK
Moderate	MDT
Strong	STRG

A15306.2. Use the following table to relate the appearance of the A-scope to the intensity.

TABLE A6 - RELATION OF THE APPEARANCE OF A-SCOPE TO INTENSITY

Appearance of A-scope	Intensity
 Echo can be detected at or near the noise level.	Weak if range is less than 50 miles. Moderate if range is more than 50 miles.
 Echo easily distinguished above noise level but fails to reach or exceed saturation.	Moderate if range is less than 50 miles. Strong if range is more than 50 miles.
 Echo completely saturates scope.	Strong if range is more than 20 miles. Moderate or strong if range is less than 20 miles.

A15307. TENDENCY. The tendency will be based upon consecutive observations of intensity. Enter on Form 3200A, under the caption "Tendency," the appropriate contraction selected from the following list:

Tendency	Contraction
Increasing	INCRG
Unchanging	NO CHG
Decreasing	DCRG
Slowly	SLOLY
Rapidly	RPDLY

A15308. WIDTH. The width of scope patterns will be described in terms of the diameter of a circle, the length of the minor axis of ellipse, or the mean width of spiral bands, whichever is appropriate. Enter the width to the nearest whole statute mile under the caption "Width" on Form 3200A.

A15308.1. The width of scope patterns, when the size of the precipitation area is equal to, or less than, the width of the radar beam, will not be recorded.

A15308.2. Determine the width of a circular pattern by reading the range of the nearest point of the circle and of the most distant point. Subtract the nearer from the more distant value. The remainder is the width.

A15308.3. When the minor axis of an ellipse is parallel or nearly so to a radial line from the center of the scope, determine the width similarly to that of a circle. Otherwise, estimate the distance by comparison with the distance between range markers. (see Figure A13) Note that the minor axis is equal to the maximum width of the ellipse.)

A15308.4. When a roughly circular bright echo completely covers the central portion of the scope (as described in paragraph A15305.22), the width will be reported as the diameter of the circle and a remark will be added at the end of the report to indicate that the echo is centered at the station.

A15308.5. The width of the spiral bands characteristic of the precipitation areas associated with hurricanes will be reported as the mean width of each band.

A15309. DIRECTION OF MOVEMENT. Direction of movement is expressed in terms of the direction from which the echo is moving, and is based upon two consecutive observations taken about fifteen minutes apart.

A15309.1. To determine the direction of movement, plot the location of the center of the echo at each observation on a plotting board or an aeronautical chart covered with transparent material. Draw a line through the centers of both echoes. Determine the bearing from the second position to the first. This bearing is the direction of movement.

A15309.2. Enter on Form 3200A, under the caption "Direction," the direction of movement to the nearest ten degrees from true north.

A15310. SPEED OF MOVEMENT. The speed at which an echo moves will be expressed in miles per hour by dividing the distance in statute miles between the centers of the plotted echoes by the elapsed time between observations.

A15310.1. When the movement of the echo patterns is not uniform, adjust the antenna and receiver gain controls until all but the strongest or largest echoes have been excluded from the scope. A more uniform rate of movement will usually be obtained by tracking and plotting these echoes.

A15310.2. Enter the speed on Form 3200A under the caption "Speed" to the nearest whole statute mile per hour.

A15311. HEIGHT. The height of echoes will be determined at stations supplied with equipment appropriate to the purpose. All values of height refer to the uppermost limit of visible moisture that may be detected by radar. Therefore, it will not be assumed that height data refer to the tops of clouds. Moreover, height data at long ranges are inaccurate because the elevation angles are very small, and corrections are not made for the curvature of the earth and for deviations of the radar beam from normal propagation. At very close ranges, the vanishing point of an echo may occur at the leading edge of a storm, whereas the actual top of the storm is higher in the center. To limit the magnitude of these inaccuracies, determinations of height will be made only between the ranges of 15 to 50 miles.

A15311.1. If the vertical angle of the antenna beam can be varied, determine the apparent height of the echoes as follows:

(1) Using manual control, center the antenna on the most intense portion of the echo.

(2) Tilt the antenna and read the angle when the echo first disappears.

(3) Subtract half the vertical beam width from the angle read in (2).

(4) Multiply the sine of the angle found in (3) by the range. The product will be the height in nautical miles.

(5) Convert the value found in (4) from nautical miles to feet by multiplying the value by 6080. Add to the converted value the height of the station above mean sea level.

A15311.2. Enter the height on Form 3200A under the caption "Height" to the nearest hundreds of feet; e.g., 25,000 would be entered as 250.

A15312. REMARKS. Enter under "Remarks" such data as will support and amplify the observation and such additional data as has not been reported by a surface observation station. Authorized contractions will be used so far as possible in making entries. Remarks which are not transmitted will be entered in parentheses.

A15312.1. Enter data pertaining to unusual echo formations, e.g., inversions, precipitation areas centered at station, etc.

A15312.2. Enter data pertaining to echoes characteristic of the precipitation areas associated with hurricanes. The azimuth to the nearest whole degree, range, direction and speed of movement of the apparent eye will be recorded. If the eye of the storm is off the edge of the scope (out of range of the radar set), no attempt will be made to give the position of the eye. The terms "hurricane," "tropical storm," etc., will not be used in describing the echoes, either in public contacts or transmitted reports.

Example

Observed data: Thunderstorm reported 10 miles west of Washington National Airport moving from the southwest. Strong echo identified as tornado, azimuth 270 degrees, range 100 miles, moving from 135 degrees at 25 miles per hour.

Entry under Remarks: TSTM RPRTD 10 W DCA MOVG FM SW STG ECHO IDNFYD AS TORNADO AZRAN 27/10 MOVG FM 135/25

A15400. FORMS

A15410. GENERAL. This section concerns instructions for entry of identification data on Form 3200A, "Radar Weather Observations," and for entries on Form 3200B, "Marine Radar Weather Observations."

A15411. Enter the month, inclusive dates for all observations entered on the form, and year, in the appropriate space in the upper right corner of the form, e.g., June 14-17, 1949.

A15412. Enter the name of the station in the space in the upper left corner of the form.

A15420. FORM 3200A. This form will be started at 0000 LST on the first day of each month. Data pertaining to more than one day may be entered on a single form. The following paragraphs are captioned to correspond with similarly captioned columns on Form 3200A. When echoes are observed but data required by the captions on Form 3200A are missing or unknown, omit entries. If the equipment is inoperative, all entries will be omitted between the reports of cessation and resumption of operation.

A15421. DATE. Enter the date of the observation.

A15422. TIME. In the blank space at the head of the column, enter a letter to indicate the standard of time in use. Enter the time of completing the observation, to the nearest minute, in terms of the 24 hour clock.

A15423. RAREP NUMBER. The first radar report (RAREP) of the day will be numbered "1." The second will be numbered "2," etc. A new series of numbers will be started at 0000 LST.

A15424. OPERATIONAL STATUS. Enter a contraction pertaining to the operational status of the equipment as required by the table below. In the following list, "PPI" refers to the scope (plan position indicator); the additional letters refer to "no echo" (NE), "out of service for maintenance"(OM), etc. These contractions may be used separately or in combination with echo reports.

Status	Contraction
Equipment performance normal, echoes not observed.	PPINE
Equipment out of service for maintenance. (Follow the contraction with a figure to indicate the number of hours that equipment is expected to be inoperative.)	PPIOM

Status	Contraction
Equipment inoperative owing to breakdown.	PPINO
Normal operation is resumed.	PPIOK
Observation omitted for a reason other than those above.	PPINR

A15425. INITIALS. The observer's initials will be entered in this column.

A15430. FORM 3200B. Entries on Form 3200B, "Marine Radar Weather Observations," will be in terms of numbers taken from appropriate tables of the Standard Radar Storm Detection Code. A new form will be started at the beginning of each month and at the beginning of each patrol. If equipment is inoperative, all entries will be omitted between the reports of cessation and resumption of operation.

A15431. To determine the position of echoes in terms of latitude and longitude rather than of azimuth and range, plot the ranges and corresponding bearings from the station on an aeronautical or navigational chart. The units used - nautical or statute miles - must be the same as those upon which the scale of the chart is based.

A15432. When echoes are observed but data required by the captions on Form 3200B are missing or unknown, enter "X" or "9," as taken from the code tables,in the corresponding columns.

A15433. Enter the width of the echo in statute miles.

A15434. Enter the speed of the echo movement in statute miles per hour.

A15435. When performance of the equipment is normal but no echoes are observed, enter "No echoes" in the remarks column of Form 3200B.

A15440. DISPOSITION OF FORMS. At the end of each month (or each patrol), mail the completed forms to the Central Office, attention SF&MO Division.

A15500. TRANSMISSION OF RADAR REPORTS

A15510. FORM 3200A. RAREPS (radar reports) will be transmitted to report (1) echoes and associated data regarding location, height, intensity and movement, and (2) reports of inoperative equipment and resumption of service. When the scope becomes clear after one or more

RAREPS, transmit "no echoes" (PPINE). A RAREP will not be transmitted thereafter until echoes are observed or the equipment fails. When the equipment fails, transmit the appropriate contraction once only; when operation is resumed, transmit the contraction "PPIOK" once only.

A15511. TRANSMISSION SCHEDULES. Regular RAREPS will be transmitted on the SW teletype collection of Service A, between 27 and 30 minutes past each hour. Additional observations may be transmitted at 10 minutes of and 10 minutes past, each hour. The reports will be filed for transmission on Form 3024B or a suitable message blank.

A15512. ORDER AND CONTENT. The content of RAREPS will vary with the meteorological situation being reported. Data will be reported and transmitted in the order listed below to the extent that they are available. The arrangement of material in a RAREP indicates the nature of the data; therefore, the omission of data will not be explained by code groups or special devices. All required entries in the following list will be taken from Form 3200A on which the necessary data will have been recorded in units and phrase contractions appropriate to direct use in the code; e.g., data entered in statute miles will be coded in statute miles, and data entered in hundreds of feet will be coded in hundreds of feet, etc. Only such remarks as have not been reported by a surface observing station will be included in the transmitted report. A sample RAREP follows to illustrate the spacing and separation of the elements:

DCA 080240E RAREP3 SLD LINE MDT SLOLY INCRG AZRAN 27/25 19/20 15 MOVG FM 27/25 240 PPIOM3

Breakdown of this message for identification follows:

	CONTENTS OF RAREP	CODED DATA	EXPLANATION
1.	Station identification-------	DCA	Washington National Airport
2.	Date and time, L.S.T.--------	080240E	Eighth day of month, 2:40 A.M., Eastern Standard Time
3.	The term "RAREP" followed by a serial number----------	RAREP3	To identify the observation as the third radar report of the day.
4.	Character of the echo--------	SLD LINE	Solid line of echoes
5.	Intensity of the echo--------	MDT	Moderate intensity
6.	Tendency of the echo---------	SLOLY INCRG	Slowly increasing
7.	Identification of data-------	AZRAN	Contraction to identify immediately following data as azimuth (bearing) and range (distance) of the echo from the station.
8.	Azimuth and range, separated by a slant, to each end of major axis of the ellipse---	27/25 19/20	Azimuth 270°, range 25 statute miles to one end of major axis; 190°, 20 miles to other end. Note that if the scope pattern had been circular instead of elliptical, only one azimuth-range datum (which would refer to the center of the circle) would be coded.
9.	Width-----------------------	15	15 statute miles as width of ellipse (or diameter of circle, if circle was coded in immediately preceding group).
10.	The direction from which, and speed with which, the echo is moving. Direction and speed separated by a slant.--------	MOVG FM 27/25	Moving from 270° at 25 mph.
11.	Height-----------------------	240	24,000 feet MSL
12.	Remarks----------------------	------	As appropriate, see par. A15312
13.	A contraction to report inoperative equipment or resumption of service----------	PPIOM3	Equipment out of service for maintenance for next three hours.

A15520. FORM 3200B. RAREPS will be transmitted from ocean stations in accordance with current instructions.

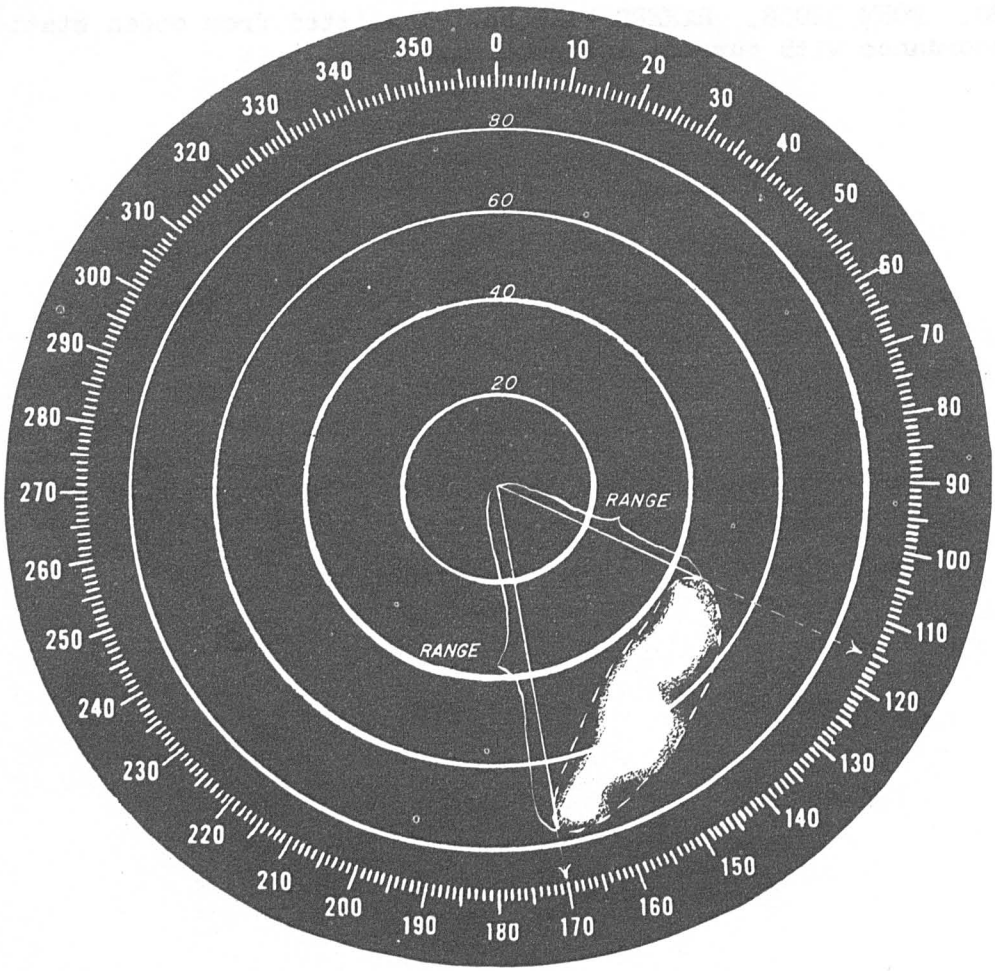


Fig. A12

The solid echo line is visualized as an ellipse. Ragged edges are not enclosed. The range is the distance from the center of the scope to each end of the major axis of the ellipse. The width is the length of the minor axis. When the direction and speed of movement, and the type of radar in use, permit measurement of intensity and height, this echo would be evaluated as:

> Solid line of moderate echoes, no change in tendency; azimuth and range readings (AZRAN) to the ends of the echo 120 degrees, 47 miles, and 170 degrees, 78 miles; width 22 miles, moving from 140 degrees at 20 miles per hour; height of the tops of the echoes 28,000 ft. MSL.

This would be coded as:

> DCA 150810E RAREP3 SLD LINE MDT NO CHG AZRAN 12/47 17/78 22 MOVG FM 14/20 280.

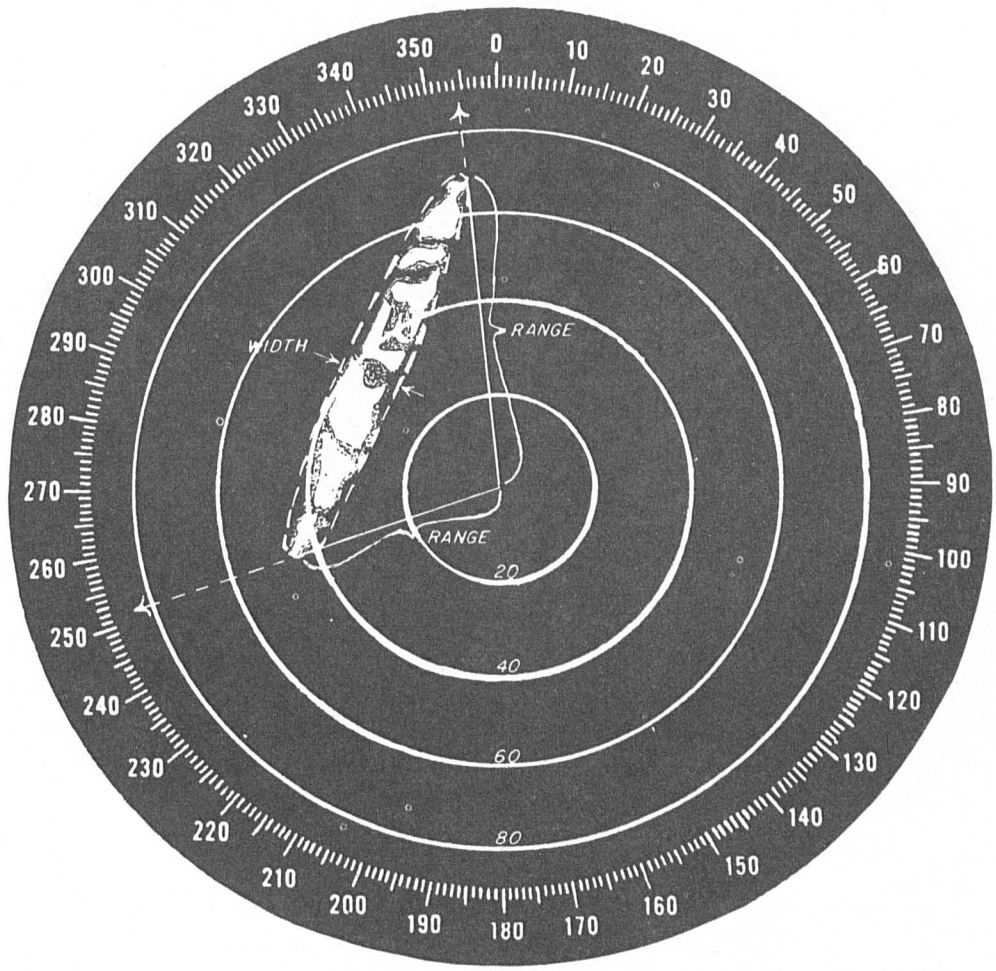


Fig. A13

The line of scattered echoes is visualized as an ellipse, since the distance between adjacent echoes in the group is less than the distance through the largest echo, and since the major axis is more than twice the minor axis. The azimuth bearings are recorded to the nearest 10 degrees and range readings to the nearest statute mile. The report of this echo would be evaluated as:

> Line of scattered echoes of moderate intensity; tendency - increasing slowly; azimuth and range readings (AZRAN) 250 degrees 45 miles, 350 degrees 69 miles; width 15 miles; moving from 310 degrees at 30 miles per hour; top of echoes 20,000 ft. MSL; Remarks, pilot of a DC-3 reports line of thunderstorms 40 miles northwest of the station at 1430C.

This would be coded as:

> ICT 201510C RAREP2 LINE SCTD MDT INCRG SLOLY AZRAN 25/45 35/69 15 MOVG FM 31/30 200 PIREP 1430C LINE TSTMS 40 NW STN DC-3.

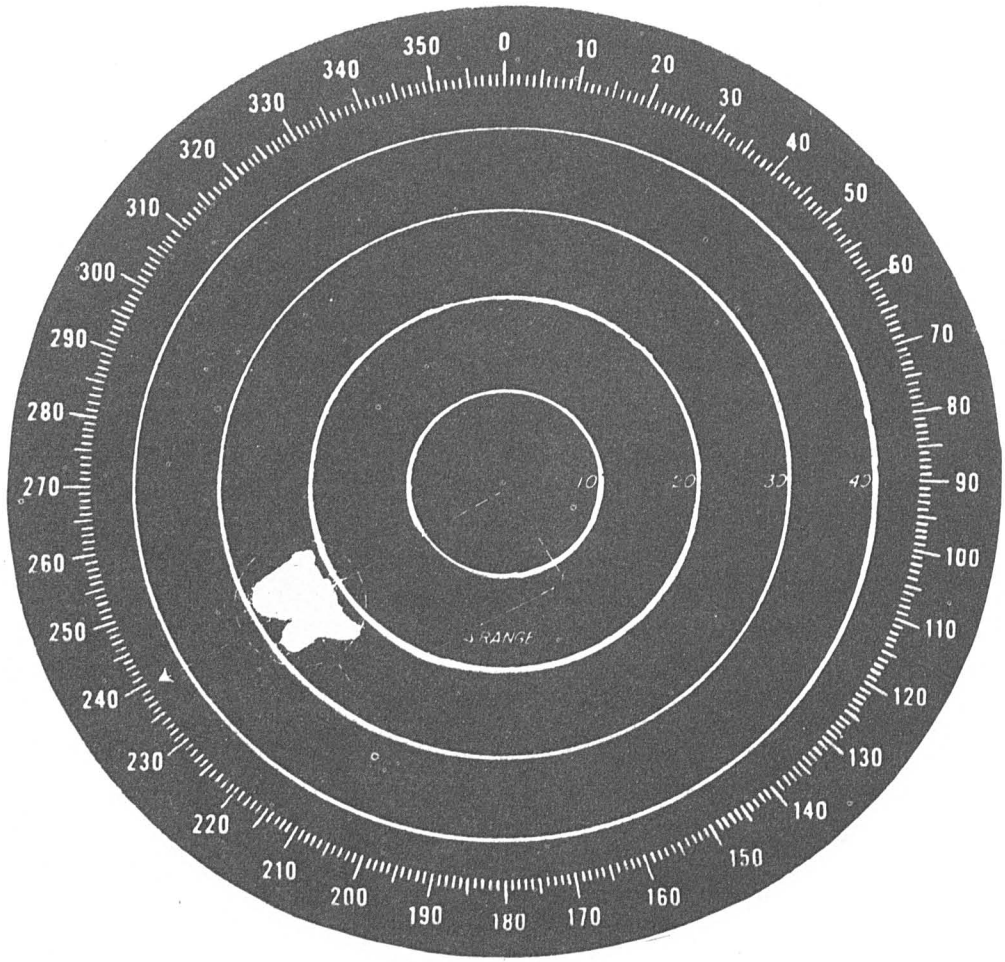


Fig. A14

The single echo is visualized as a circle, since the major axis might lie in several directions. The azimuth and range pertain to the center of the circle. This report would be evaluated as:

Solid, weak echo; tendency - decreasing; azimuth and range 240 degrees, 25 miles; diameter 16 miles, moving from 120 degrees at 15 miles per hour, height of tops of echo 12,000 ft. MSL.

This would be coded as:

ICH 010910C RAREP6 SLD WK DCRG AZRAN 24/25 16 MOVG FM 12/15 120.

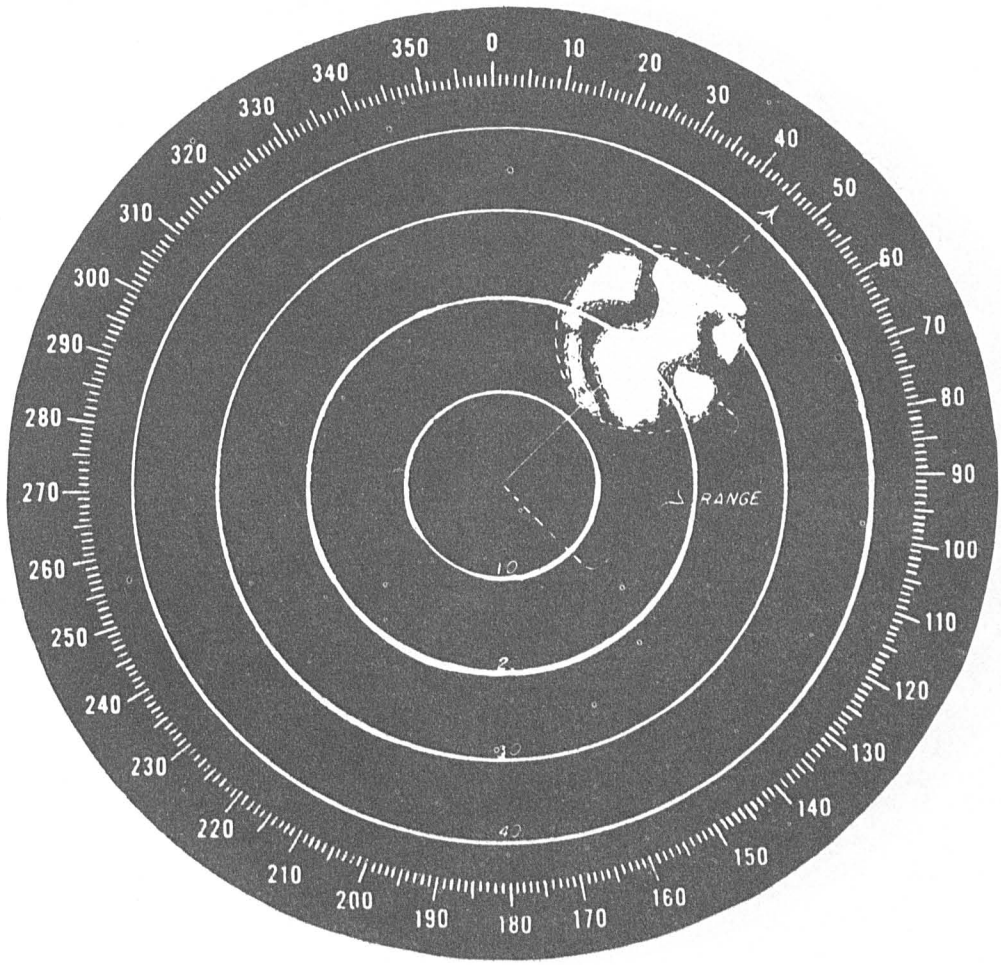


Fig. A15

The echo is visualized as a circle. The distance between the echoes in the group is less than the distance through the largest echo, and the major axis could lie in several directions through the group. Ragged edges of the echo may extend beyond the circle. This echo would be evaluated as:

> Scattered echoes of moderate intensity; tendency - increasing rapidly; azimuth and range 50 degrees, 22 miles; diameter 20 miles; moving from 60 degrees at 25 miles per hour; height of tops of the echo 30,000 ft. MSL.

This would be coded as:

> AOE 100410C RAREP8 SCTD MDT INCRG RPDLY AZRAN 05/22 20 MOVG FM 06/25 300.

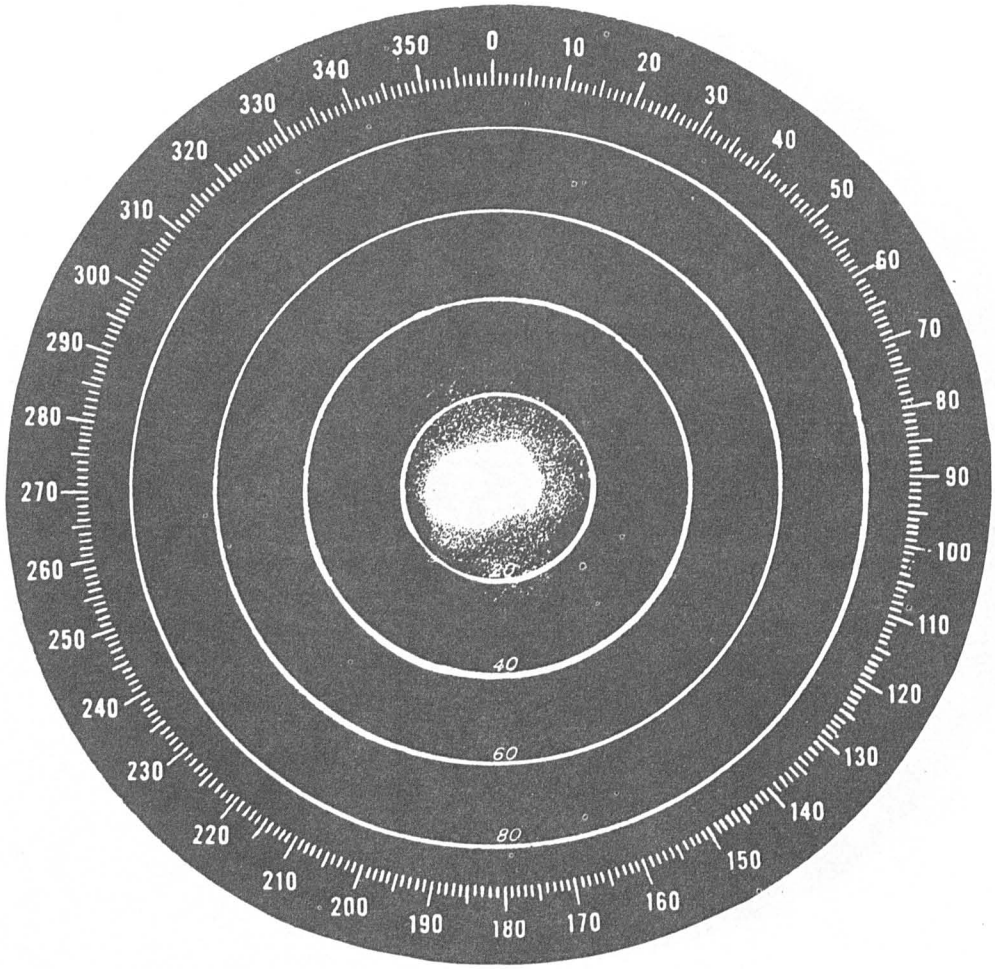


Fig. A16

The echo is typical of one observed at a station equipped with 3 cm. radar when heavy precipitation is occurring at the station. It is possible that more distant echoes are blocked from the radar view by attenuation from moisture on the radome and by the precipitation. The circle in this case includes all the echo except the ragged edges. This echo would be evaluated as:

Solid echo; width 40 miles; centered at the station.

This would be coded as:

LGA 211112E RAREP4 SLD WDTH 40 CNTRD AT STN.

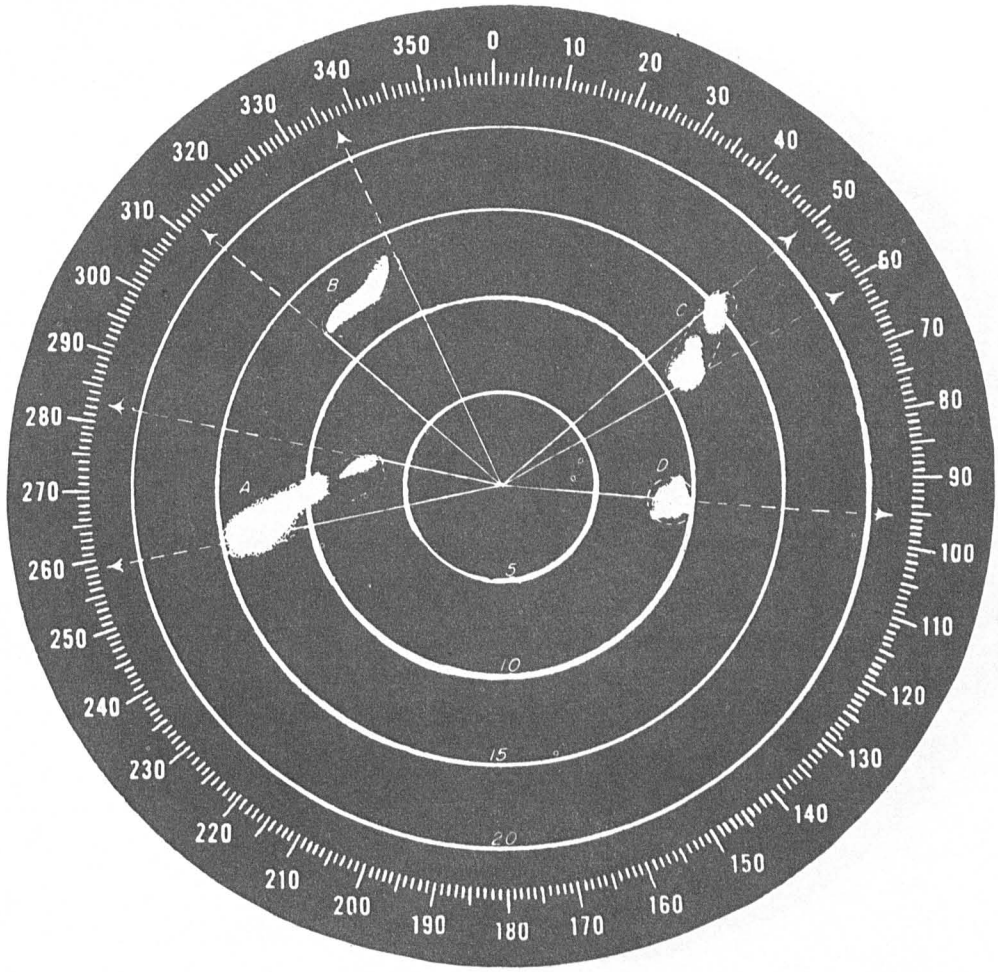


Fig. A17

Echoes A, B, and C are visualized as ellipses; and echo D is visualized as a circle. These patterns must be evaluated separately, since the distance between them in each case is more than the distance through the largest echo.

This report would be coded as:

CRP 141310C RAREP3 SCTD MDT NO CHG AZRAN 26/15 28/06 3 SLD MDT INCRG 31/12 34/14 2 SCTD STRG NO CHG 05/16 06/11 2 SLD STRG NO CHG 10/09 2 MOVG FM 24/20 SCTD SHWRS VSBL NW AND NE QUADS.

(see Figures A12 through A15 and paragraph A15512 for decoding instructions)

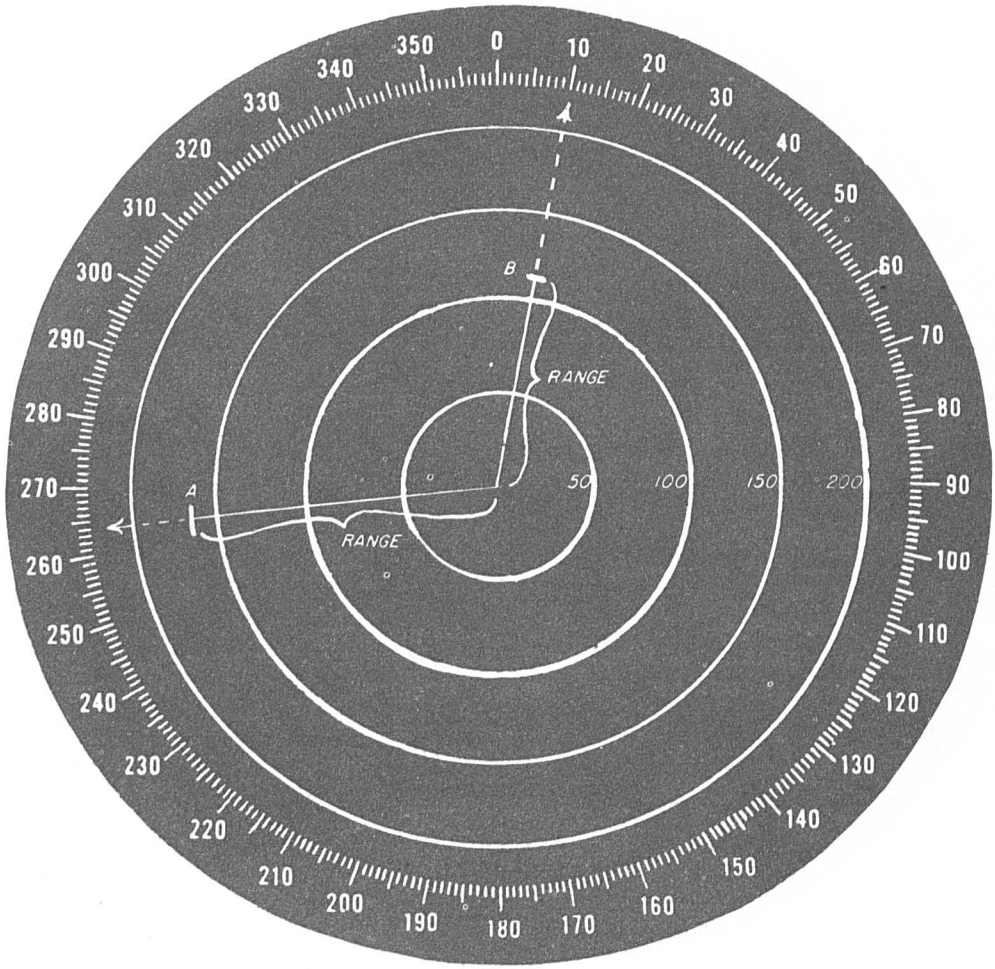


Fig. A18

The short dashes at A and B are the echoes of small, isolated precipitation areas having a dimension the same as, or less than, the width of the radar beam. The bearing and range to the center of the echo are observed. Width is not observed. These echoes would be evaluated as:

Solid weak echo; intensity - decreasing; azimuth and range 260 degrees, 170 miles. Solid weak echo; intensity - decreasing; azimuth and range 10 degrees, 120 miles.

This would be coded as:

AOE 312347C RAREP2 SLD WK DCRG 26/170 SLD WK DCRG 01/120.

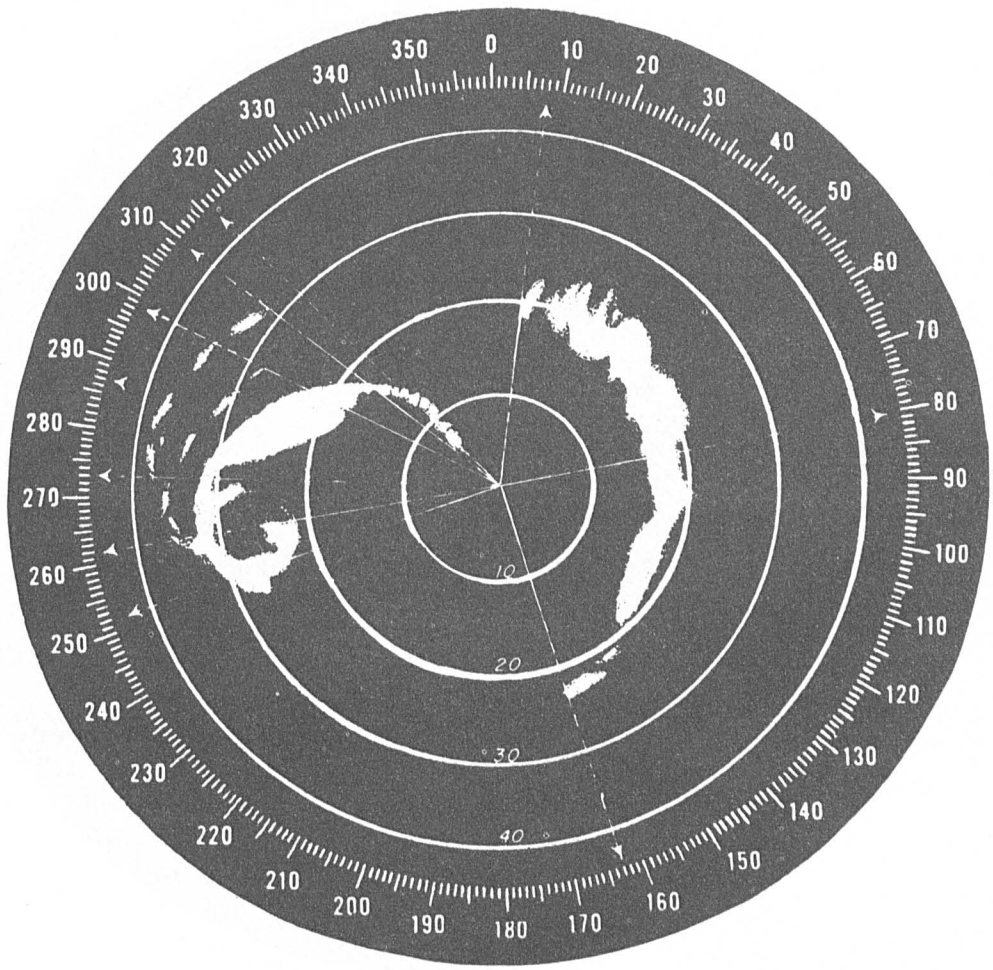


Fig. A19

Echoes of spiral precipitation bands similar to these sometimes result from typhoons or hurricanes. The position, diameter, direction and speed of movement, of the center, or "eye" of the storm, are reported in Remarks.

This echo would be coded as:

BRO 100510C RAREP9 SPRL BND STRG NO CHG AZRAN 26/23 25/26 29/24 32/06 3 SCTD SPRL BND AZRAN 26/33 27/35 30/28 1 SCTD SPRL BND AZRAN 27/37 29/37 31/32 1 SPRL BND STRG no NO CHG AZRAN 01/20 08/17 16/22 4 CNTR AZRAN 262/27 DIA 8 MOVG FM 22/30 400.

(See paragraph A15512 for decoding instructions.)

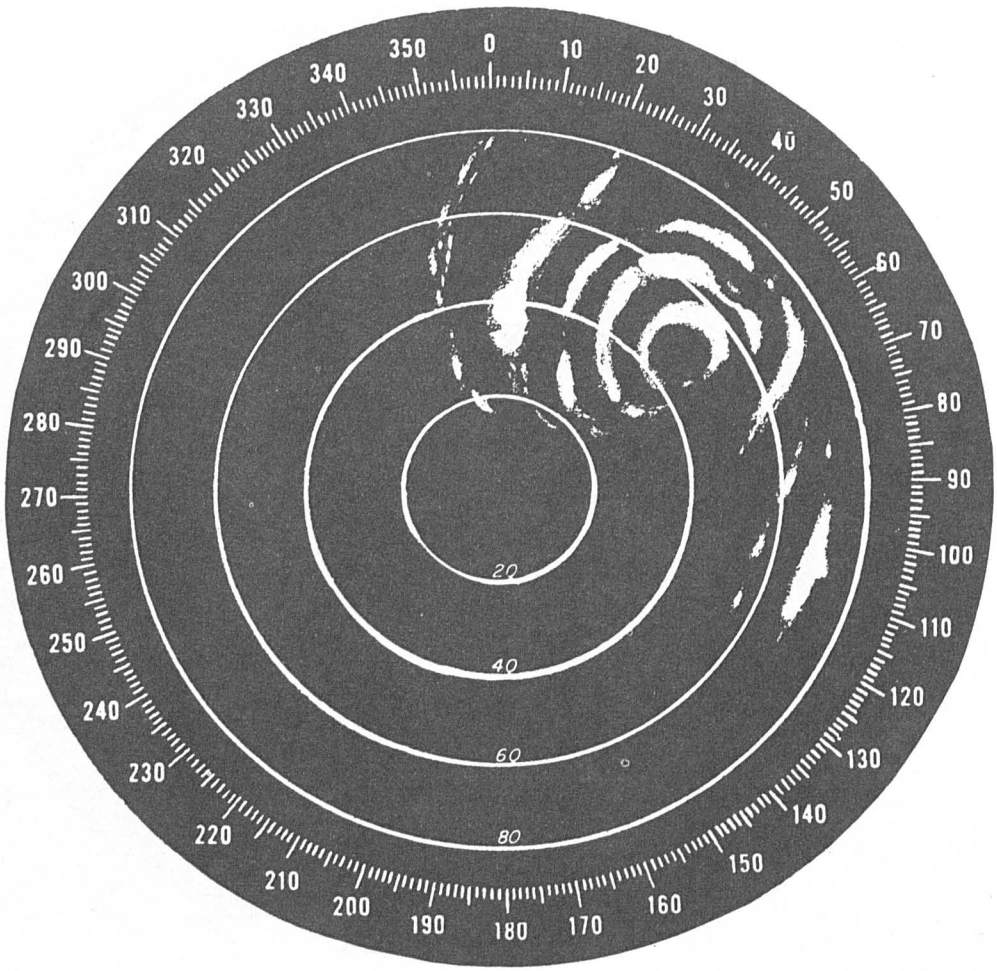


Fig. A20

Echoes of spiral precipitation bands similar to these sometimes result from typhoons and hurricanes. The center may not be as well defined as this; however, the apparent center is observed if it is on the scope.

This echo would be coded as:

BRO 201115C RAREP12 SPRL BND STRG NO CHG AZRAN 06/40 04/50 06/50 5 SPRL BND AZRAN 06/38 03/50 04/65 06/61 6 SCTD SPRL BND AZRAN 06/25 02/50 04/75 08/55 5 SCTD SPRL BND AZRAN 04/18 01/50 02/80 8 SCTD SPRL BND AZRAN 00/18 35/55 00/79 5 SCTD SPRL BND AZRAN 08/68 12/56 3 SPRL BND 09/70 12/68 5 CNTR AZRAN 054/48 DIA 7 MOVG FM 12/28 450.

(See paragraph A15512 for decoding instructions.)