UNITED STATES DEPARTMENT OF AGRICULTURE

U.S. WEATHER BUREAU

INSTRUCTIONS

FOR

AIRWAY METEOROLOGICAL SERVICE

CIRCULAR N, AEROLOGICAL DIVISION

[*Third Edition*]

1935

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PREFACE

It has been increasingly apparent that there is definite need for the assembling of all instructions pertaining to the conduct of the airway meteorological service, including those concerning administration, the taking and transmission of all types of surface observations, the issuing of forecasts, the entry of data on forms, etc., in one publication. Accordingly, this general circular has been prepared and will become effective on July 1, 1935.

It will be found that practically all matters pertaining to airway service now covered by separate circulars, except those concerning pilot-balloon and airplane observations, are included herein.

In preparing this circular, action has been taken to revise and incorporate, or incorporate directly when revision was not necessary, all the current circulars regarding airway meteorological service. For the information of all concerned, there follows a list of circulars which are entirely superseded by this circular, and a list of those which were merely incorporated in order to make it complete and which, therefore, are not superseded.

This circular supersedes instructions given in the following circulars and any supplements thereto:

"Instructions for Airway Observers", Circular N, 1932. (Revised instructions in I–XII of this circular.)

"Instructions Regarding Airway Observations with Relation to Entries on Forms and Use in Sequences and Broadcasts", dated April 28, 1934. (Several changes made in paragraphs relating to the taking of special observations; revised instructions in XIV of this circular.)

"Permanent Record of Pressure Reduction Data for the 4-Hourly Airway Network", dated April 3, 1933. (No material changes; contained in XX of this circular.)

"Instructions for the Preparation and Issuance of Airway Forecasts", dated June 16, 1934. (Assignments of airways for forecast purposes are not included but will correspond with assignments of general supervision which are given in XXIX–XXXI; incorporated in XXI–XXVII of this circular.)

"Broadcast of 4-Hourly Airway Forecasts by Radio Stations of the Bureau of Air Commerce on 236 KC", dated September 1, 1934. (List of forecasts broadcast from each point involved is not included. Incorporated in XXVIII of this circular.)

The above-named circulars will, therefore, no longer be used after the effective date of this circular.

The provisions of the following current circulars have been incorporated herein without material change:

"Supervision and Inspection of Airway Weather Service", dated October 20, 1934. (Incorporated in XXIX–XXXI of this circular.)

"Instructions for Making Off-Airway Reports and for Adding Special Data to Radio and Teletype Sequence Reports", dated October 16, 1934. (The two sections of the original circular have been separated and placed in XV and XIII, respectively, of this circular.)

The use of present supplies of the individual circulars given in the latter list for convenience in ready reference, where needed, may, therefore, be continued after the effective date of this circular. However, no action will be taken to have further issues printed for distribution.

Form 1133–Aer., "Instructions for Airway Observers" (short form), will be used in conjunction with this revised edition of Circular N. The short form will be posted conspicuously at each airway weather-reporting station, for instant use, and Circular N will be available for ready reference in cases involving points not covered by the short form.

To accommodate changes in instructions contained in this circular that may become necessary from time to time, corrections will be printed and distributed for pasting over, or in place of, present pages.

The Weather Bureau has complete jurisdiction over all weather reports, forecasts, and warnings issued for public use on Federal airways and will exercise supervision in regard thereto. Matters concerning these will, therefore, be taken up with the proper Weather Bureau officials or offices.

The general circulation of this circular among pilots, transport operators, and others concerned is urged in order that all concerned may become familiar with the basis of terms and data used and details concerning the organization of the service.

INSTRUCTIONS FOR THE TAKING, FILING FOR TRANSMISSION, AND ENTRY ON FORMS OF AIRWAY WEATHER OBSERVATIONS

The following instructions supersede those contained in Circular N, 1932 (obsolete), and "Instructions Regarding Airway Observations with Relation to Entries on Forms and Use in Sequences and Broadcasts", dated April 28, 1934. The instructions contained in the circular "Instructions for Making Off-Airway Reports and for Adding Special Data to Radio and Teletype Sequence Reports", dated October 16, 1934, have been incorporated herein without change.

INTRODUCTION

1. Changes in airway service during the past 2 years indicate the necessity for a revision of specific instructions for making, transmitting and recording airway weather observations. This circular is designed to meet this need.

2. Effort has been made to make all instructions contained herein as clear as possible. However, in the event that any of these are not understood, the matter will be brought to the attention of the Central Office—through proper channels when necessary—for interpretation. Weather Bureau field officials will not issue such interpretations without the prior approval of the Central Office.

3. The observations made in accordance with instructions herein will conform with the exacting standards of accuracy required in all Weather Bureau observational work. It shall be the duty of the field officials charged with this responsibility to see that such work is kept up to this standard.

NOTE.—The term "Central Office", as used throughout this circular, refers to the main office of the Weather Bureau at Washington, D. C.

I. GENERAL INSTRUCTIONS

4. The elements of an ordinary airway weather observation will be reported in the following order:

(*a*) CEILING (when other than "unlimited").
(*b*) SKY.
(*c*) VISIBILITY.
(*d*) WEATHER.
(*e*) OBSTRUCTIONS TO VISION.
(*f*) TEMPERATURE.
(*g*) DEW POINT.
(*h*) WIND.
(*i*) BAROMETRIC PRESSURE.
(*j*) FIELD CONDITIONS.
(*k*) REMARKS.

5. The observations will be written out on the original record, Form 1130–Aer., in English, using the authorized abbreviations listed in this circular. Teletype symbols will *not* be used on Form 1130–Aer., but will be used exclusively on Form 1130A–Aer.

6. Any element regularly included, but not available for any particular report by reason of broken or defective instruments or other causes, will be indicated by the word "missing", inserted at the proper point. Stations regularly not reporting certain elements will make no mention of these, i. e., they will be omitted. The order of the report will be kept the same, however, e. g., if the dew point is not included, the temperature will be followed by the wind, etc.

II. CEILING

7. In the meaning of these instructions, the "ceiling" is the altitude in feet of the base of any clouds present at or below an altitude of 9,750 feet above the station, which cover an area of more than five-tenths of the sky, except that under conditions of heavy precipitation, dense fog, or other factors which preclude direct observation of any cloudiness which may be present, the "ceiling" will be for practical purposes at the surface, i. e., zero altitude. (See rule (*d*) below.)

8. The lower the ceiling the more carefully will the observer estimate or measure its height, as low ceilings often require flying at low levels with attendant restricted choice of landing points in case of motor failure and the necessity for clearing all obstacles safely. For practical purposes, a ceiling height of 2,000 feet over any particular point on an airway is considered as ample for all usual flying operations.

9. The following are the specific rules regarding the reporting of this element:

(*a*) The ceiling will be considered "unlimited" and no report made thereof when (1) the sky is clear; (2) there is no cloudiness present below an altitude of 9,751 feet above the station covering over five-tenths of the sky. (It will be obvious that any amount of clouds at an altitude of 9,751 feet or more above the station may be present and the ceiling would still be "unlimited.")

(*b*) The ceiling height to the nearest 100 feet up to 5,000 feet and above that to the nearest 500 feet up to and including 9,750 feet above the station will be reported when the total cloudiness below 9,751 feet above the station covers over five-tenths of the sky.

(*c*) If the "sky" condition is given as "scattered clouds", or if the last part of a combination "sky" condition term is given as "* * * lower scattered clouds", i. e., if the term in question represents a layer of clouds covering from one-tenth to five-tenths, inclusive, of the sky at an altitude of less than 9,751 feet above the station, the height of this stratum shall be indicated to the nearest 100 feet up to 5,000 feet and above that to the nearest 500 feet up to and including 9,750 feet above the station, immediately following the term in all cases, e. g., "high broken, lower scattered clouds 14 hundred"; "scattered, lower scattered clouds 2 thousand"; "scattered clouds 3 thousand", etc. It will be noted that this rule does not apply to "high scattered clouds" nor to "scattered clouds" forming the first part of a com-

bination term. It is obvious that this height will be estimated in most cases and indication of this need not, therefore, be made.

(*d*) The ceiling will be reported "zero" when (1) dense fog is present; (2) heavy precipitation, blowing snow, dust or sand; thick haze, smoke or dust, etc., prevent observation of the sky and reduce the visibility to one-fifth mile or less; (3) the base of clouds present is 50 feet or less above the station. In this latter case it is possible to have zero ceiling with good visibility reported, and since this would be confusing it will be necessary to explain the condition under "Remarks", e. g., "clouds 30 feet above station", etc.

(*e*) A ceiling height will always be included in airway weather reports when appropriate, but no mention will be made of the ceiling element when the ceiling is "unlimited." When the height is estimated, this fact shall be indicated in reports transmitted by radio and teletype by use of the symbol E, and in telegraphed reports by inclusion of the word "estimated" immediately preceding the height. The word "estimated" will *not* be used in connection with the height of scattered clouds reported.

(*f*) When ceiling balloons are being used to determine the ceiling height and these are blown out of sight *before reaching the clouds*, the ceiling will be reported as the last observed altitude of the balloon "plus", e. g., "Plus, one thousand."

10. The height of the ceiling may often be estimated by observing the unobscured portions of towers, mountains, or other tall objects, of which the height and distance from the station are known. Each station will therefore prepare and maintain a table of these visible from that station.

11. The ceiling is one of the most important elements in airway weather observations and observers should use all possible care and diligence to determine it accurately. Where ceilings are estimated and the observer is in some doubt as to its height within say a hundred feet, it is believed advisable to report the lower rather than the higher figure, but this should not be carried to the extreme that ceilings are reported consistly at lower altitudes than they actually are.

III. SKY

12. The extent to which the sky is covered by clouds and an indication of the stratification of such cloud covering is of interest and importance to the pilot, as this determines whether all or a part of his course may be flown in full sight of the ground as he stays below all cloud layers, or all or a part of his flight must be above or in cloud layers, or other dense obscuring elements such as fog, thick blowing snow, dust, etc., with consequent limited or entirely absent sight of the surface. In the latter event, it is essential that he plan his flight according to reports which will definitely show whether there are breaks in such coverings through which he may ascend to any altitude necessary, may check his course by occasional glimpses of the ground during the flight and descend at his destination. For determining whether or not it will be necessary to fly between cloud layers, if they exist, it is also essential that the available reports indicate whether or not the visible cloudiness is composed of more than one layer, and if so, whether or not higher layers completely or partly cover openings in the lower layers. Consequently, the proper reporting of

the sky element is of great importance and care should be taken to see that it is reported properly. The reporting of stratification is to be avoided when there is only one layer of clouds with a rough or furrowed base; a remark, such as "ceiling ragged", is to be used in such cases.

13. The principle of sky observations stated in the foregoing paragraph is carried out in airway weather reports by making observations of the sky element in accordance with the five following general types of sky:

(*a*) **Clear.**—When less than one-tenth of the sky is covered by clouds.

(*b*) **Scattered clouds.**—When from one-tenth to five-tenths, inclusive, of the sky is covered by clouds.

(*c*) **Broken clouds.**—When more than five-tenths but not more than nine-tenths of the sky is covered by clouds.

(*d*) **Overcast.**—When more than nine-tenths of the sky is covered by clouds.

(*e*) **Dense fog, dense ice fog (sky cannot be seen overhead), thick smoke, thick haze, thick dust, thick blowing snow, thick blowing dust, thick blowing sand,** *and all types of heavy precipitation.*—When the condition is such that the visibility has been reduced to one-fifth mile or less, and/or the ceiling to zero. Under these conditions, the sky proper, i. e., cloudiness, is omitted as a separate term, inasmuch as the presence of an intense type of obstruction to vision or precipitation precludes direct observation of the sky, and the proper term provided in this paragraph is reported in its place.

14. "Scattered", "broken", and "overcast" describe cloudiness and are based on the visible amount of cloudiness observed at the time of observation compared with the amount of open sky. In such an instantaneous observation, the sum of the tenths of the sky which are covered by clouds, plus those of open sky, is always ten-tenths. The amount, in tenths, of open or covered sky is obtained by estimation and is a matter of experience and good judgment on the part of the observer. If he is able to estimate the tenths, it is readily possible to obtain an accurate value of the amount of cloudiness.

15. If all the clouds are substantially at one level, *one* term suffices to describe the sky, although this one term may be modified under certain conditions by the addition of the adjective "high", which refers to the altitude rather than the amount of clouds in this one particular level. This term will be either "scattered clouds", "high scattered clouds", "broken clouds", "high broken clouds", "overcast", or "high overcast."

16. It will be clearly evident that there will be no stratification of "clear", "dense fog", "thick smoke", etc., as given in the first and last definitions in paragraph 13, and these will therefore always be used exactly as given there.

17. The word "high" will be entered preceding the terms whenever the clouds referred to are within the 10,000-foot ceiling interval, or higher. The "10,000-foot ceiling interval" is from 9,751 to 10,000 feet, inclusive, above the station.

18. The word "lower" will be entered immediately preceding the terms whenever the clouds are below the 10,000-foot ceiling interval and the term which it modifies is the last part of a combination term, e. g., it would not be entered if the term were "broken clouds",

but would be entered if the "broken clouds" term was preceded by a term such as "high scattered." In other words, the word "lower" is omitted in cases where the cloud term is sent alone, or as the first part of a combination term.

19. If clouds are observed at different altitudes, one stratum within the 10,000-foot ceiling interval or higher and others below that altitude, they will be described by a combination of the terms "high" and "lower", as for example, "high scattered, lower broken clouds." However, if two layers of clouds are each below the 10,000-foot ceiling interval, then the word "high" will be omitted and two sky-condition terms will be recorded, as for example, "broken, lower broken clouds." In each case the first term will describe the upper layer and the second term the lower layer. This is of great importance and when properly used will permit accurate description of the stratification of the cloudiness.

20. Not over two terms will be used in any sky condition report. Low, scattered clouds which may form a *third* layer, should be mentioned under "Remarks", giving their approximate altitude. Special attention is called to the fact that this is *not* a repetition of instructions in paragraph 9 (*c*).

21. In cases when two layers of clouds are observed, the observer will first estimate the number of tenths of the sky covered by the lower clouds, and will record either "clear", "lower scattered clouds", "lower broken clouds", or "overcast" in accordance with the definitions given in paragraph 25. If "overcast" is recorded and upper clouds are visible through breaks, this fact will be reported under "Remarks" as "high clouds visible through breaks." If either "lower scattered clouds" or "lower broken clouds" are recorded, then it will next be necessary to record the proper term descriptive of the upper cloud layer, and the observer will proceed as follows:

(*a*) The total tenths of both upper and lower clouds will be estimated and if the estimate falls between one-tenth and five-tenths, inclusive, then the upper cloud layer will be "scattered" and so will the lower one. Example:

(1) **Scattered, lower scattered clouds,** or **high scattered, lower scattered clouds.**—When the total cloudiness does not exceed five-tenths of the sky and each layer separately covers one-tenth or more.

(*b*) If the total tenths of upper and lower clouds is over five-tenths and not more than nine-tenths, then only three possible combinations can be used. Example:

(1) **Broken, lower scattered clouds** or **high broken, lower scattered clouds.**—When the lower layer is one-tenth to five-tenths, inclusive, and the total tenths of the sky covered is as given in the first sentence of this subparagraph (*b*).

(2) **Scattered, lower broken clouds** or **high scattered, lower broken clouds.**—When the lower layer is over five-tenths but not more than nine-tenths, and it is clearly evident to the observer that the higher layer is actually "scattered", although partially obscured by the lower layer. Such a fine distinction may not always be possible at night.

(3) **Broken, lower broken clouds** or **high broken, lower broken clouds.**—When the lower layer is over five-tenths but not more than nine-tenths, and it is clearly evident to the observer that the higher

layer is actually "broken", although partially obscured by the lower layer. Such a fine distinction may not always be possible at night.

(*c*) If the total cloudiness contained in both upper and lower layers is more than nine-tenths, then only two possible combinations can be used. Example:

(1) **Overcast, lower scattered clouds** or **high overcast, lower scattered clouds.**—When the lower layer is one-tenth to five-tenths, inclusive, and the total tenths covered is as given in the first sentence of this subparagraph (*c*).

(2) **Overcast, lower broken clouds** or **high overcast, lower broken clouds.**—When the lower layer is over five-tenths but not more than nine-tenths, and the total tenths covered is as given in the first sentence of this subparagraph (*c*).

22. Any of the foregoing terms may be modified by the insertion of the words "thin" or "dark" where appropriate. It is proper to use the term "thin" in describing the cloudiness whenever the solar or lunar disk or stars are faintly visible through them, and the term "dark" whenever the clouds are of an unusually dark or threatening appearance. These terms will be inserted following the altitude term, if any, and immediately preceding the cloudiness term proper, e. g., "high thin overcast", "high overcast, lower thin broken clouds", "dark overcast", etc.

23. If the clouds are noted to be moving unusually rapidly or to be in a highly turbulent condition, proper entry of this fact should be made under "Remarks", e. g., "clouds moving rapidly", "clouds turbulent", etc.

IV. VISIBILITY

24. In the meaning of these instructions, the visibility is the greatest distance toward the horizon that prominent objects, such as mountains, buildings, towers, etc., can be seen and identified by the unaided eye.

25. The proper reporting of this element is extremely important, and it will never be omitted from any airway weather report.

26. Each station will have a table of distances of various prominent objects observable from the usual observation point which will be used to determine the values reported. This table should include objects suitable for determining the visibility at night as well as day. In this connection, the most suitable objects for use at night are moderate lights at known distances which are usually burning; automobile lights which may be visible at some point on a road of which the distance is known; the silhouette of mountains or hills against the sky, and the brilliancy with which stars near the horizon can be observed. The use of airway beacons as visibility checking points is not favored, inasmuch as these have great penetrating power and often give values far in excess of the actual ones. However, the "course light" (red or green) of airway beacons may be used. For accurate determinations during daylight hours it is advisable to confine the choice of marks to black, or nearly black, objects against the horizon sky, rejecting light-colored marks and those appearing against terrestrial backgrounds.

27. The observer should always keep in mind that the absence of daylight does not materially affect the visibility as such, this being actually a measure of the transparency of the atmosphere. Thus, a large daily rise and fall of the values of visibility given for hours of

daylight and darkness should be avoided. However, diurnal changes of wind and atmospheric stability will cause some variation in the visibility between hours of daylight and darkness.

28. Report the visibility in accordance with the following:

(*a*) The value will be reported in miles and/or fractions thereof when less than 4 miles, to the nearest whole mile from 4 to 15 miles, inclusive, and to the nearest 5 miles when greater than 15 miles. Fractions of miles will be reported as follows: ⅛, ⅛, ¼, ½, ¾, 1, 1¼, 1½, 1¾, 2, 2½, 3, 3½, and 4 miles.

(*b*) If the actual visibility is evidently much greater than the distance of the farthest visible object, and such object is less than 15 miles distant from the observer, an estimate of the value will be made, based on the transparency of the atmosphere between the observer and the object. If then the estimated value is greater than 15 miles, it will be reported "fifteen miles plus" (15+), and if 15 miles or less, it will be reported in whole miles. Obstructions to vision would continue to be reported if the visibility were known or estimated to be 6 miles or less. The letter E will *not* be used to show that the visibility is estimated.

(*c*) If the farthest visible object is more than 15 miles distant, its distance to the nearest 5 miles *without the plus sign* will be given as the visibility, even though it is known that the visibility is greater than this distance.

(*d*) If the visibility is locally reduced in any one direction by smoke, fog, etc., the visibility prevalent in other directions will be given in the report proper and a suitable entry made under "Remarks" concerning the limited visibility, specifically mentioning the direction in which it is observed.

29. In making estimates of the visibility in cases where the farthest object is only a comparatively short distance from the observer, it will be helpful in the interest of accurate reports if the observer notes the sharpness with which the checking points stand out. When objects at some distance stand out sharply with little blurring of color, this indicates fairly well that the air is free of haze and the visibility quite high. On the other hand, if objects are blurred or indistinct and seem to have a gray or purplish hue, this would indicate the presence of haze, or other obstructions, with a consequent reduced visibility. Practice and careful observation will enable the observer to become quite proficient in making such estimates of visibility.

V. WEATHER

30. In the meaning of these instructions, the "weather" element of the report consists of those phenomena occurring in connection with active or imminent precipitation, or meteorological disturbances of more or less localized extent and effect.

31. From the foregoing it will be seen that this element will include the reporting of the occurrence of all rain, snow, sleet, hail, freezing rain, etc.; and all thunderstorms, tornadoes, etc., observed from the station.

32. The following will govern the reporting of the "weather" element:

(*a*) The phenomena will be reported immediately following the visibility, except that when a heavy degree of precipitation reduces the

visibility to one-fifth mile or less and/or the ceiling to "zero", it will be reported in place of the "sky" condition.

(*b*) The absence of the conditions treated in this chapter are assumed unless reported.

(*c*) Identify and report precipitation when occurring in accordance with the following table:

TABLE 1.—*Precipitation intensity equivalents*

Kind of precipitation	Degree of intensity term	Specifications for estimating degree of intensity of precipitation
Rain.—The falling from clouds of water in drops of appreciable size.	Light	When the amount falling within 3 minutes is judged by the observer to be not sufficient to wet through cloth such as that used in making an ordinary suit; individual drops can be identified; spray does not form over pavements, roofs, etc.; sound on roofs ranges from rapid pattering to gentle swishing.
	Moderate	Ordinary suit cloth wetted through in from 1 to 3 minutes; individual drops not clearly identifiable; spray observable just above surfaces of pavements, roofs, etc.; puddles form fairly rapidly; ordinary run-off channels such as gutters, ditches, etc., accumulate water; down-spouts on buildings run from ¼ to ½ full; sound on roofs ranges from swishing to gentle roar.
	Heavy	Ordinary suit cloth wetted through in less than 1 minute; rain seemingly falling in sheets, individual drops not identifiable; heavy spray to height of several inches forms over pavements, roofs, etc.; ordinary run-off channels or down-spouts on buildings accumulate water very rapidly and run nearly full to overflowing; water accumulates in streets due to inability of run-off channels to accommodate it rapidly enough; puddles form rapidly; wavelets on water surfaces beaten flat; visibility impaired; sound on roofs resembles continuous roll of drums or distinct roar.
Freezing Rain.—The falling from clouds of water drops which instantly freeze to objects in the open which they strike. At the surface, however, the fall may be so rapid that run-off occurs as in the case of rain.	Light	Same as "light rain."
	Moderate	Same as "moderate rain."
	Heavy	Same as "heavy rain."
Sprinkling.—When a few drops of rain are falling.		Fall not sufficient to wet objects appreciably.

TABLE 1.—*Precipitation intensity equivalents*—Continued

Kind of precipitation	Degree of intensity term	Specifications for estimating degree of intensity of precipitation
Mist.—The falling from clouds of fine water droplets which individually do not make wet spots over 1/16 inch in diameter on pavements, boards, etc. Often resembles fog, but is identified by the occurrence of drops of a size appreciable to the face or hands.	Light	When mist is occurring and is the only vision-limiting factor present and the visibility is over ¾ mile.
	Heavy	When mist is occurring and is the only vision-limiting factor and the visibility is ¾ mile or less. NOTE.—If fog occurs along with the mist, the observer will estimate the intensity of the mist in accordance with the above as well as possible.
Freezing Mist.—The falling from clouds of fine water droplets which instantly freeze to objects in the open which they strike	Light	Same as "light mist."
	Heavy	Same as "heavy mist."
Snow.—The falling from clouds of white or translucent ice crystals, hexagonal in structure, often frozen together in the form of feathery flakes.	Light	When snow is falling and is the only vision-limiting factor present and objects more than ¾ mile distant are distinguishable.
	Moderate	When snow is falling and is the only vision-limiting factor present and objects in excess of ⅛ but not exceeding ¾ mile distant are distinguishable.
	Heavy	When snow is falling and is the only vision-limiting factor present and objects not exceeding ⅛ mile distant are distinguishable.
Sleet.—The falling from clouds of clear ice pellets, formed by the freezing of rain drops. Colloquially this is often confused with "freezing rain," but examination of the description of each will show their wide essential difference.	Light	When the amount falling is approximately the same as would be classed "light rain" if rain were falling.
	Moderate	When the amount falling is approximately the same as would be classed "moderate rain" if rain were falling.
	Heavy	When the amount falling is approximately the same as would be classed as "heavy rain" if rain were falling.
Hail.—A fall from clouds of ice pellets or stones of greatly varying size (large pea to size of a baseball) *always* attended by thunderstorm conditions. Extremely dangerous to aircraft.	Light	When only a few pellets or stones are falling.
	Moderate	When sufficient numbers are falling to give a rattle on roofs similar to rapid gunfire or the rattle of a stick drawn very rapidly along a picket fence; some accumulation on ground.
	Heavy	When such numbers are falling as to produce a deafening roar on roofs; accumulation on ground rapid; leaves of trees and crops shredded.

(*d*) The occurrence of precipitation will always be reported when appropriate. When occurring in connection with thunderstorms, it will be reported under "Weather" in addition to, not in place of, that phenomenon, the thunderstorm being placed *first*. When two or more types are falling together at the time of observation, both will be reported, the predominating type being placed first, the lesser type last, and the degree of intensity of each being given. If the mixture has been observed at intervals, but is not occurring at the time of observation, then only the type occurring at the time of observation will be reported under "Weather" and proper entry will be made under "Remarks" concerning the other.

(*e*) Care should be used in determining whether or not dense fog occurs with heavy snow. It ordinarily does not occur with heavy snow, but the restricted visibility is often mistakenly attributed to it under these conditions. There are times, however, when fog is present with the snow; rime then invariably results and is a hazardous flight condition, mostly confined to mountain ridges.

(*f*) For the reporting of "snow flurries", "graupel", and other kinds of precipitation of minor importance, see XII, "Remarks."

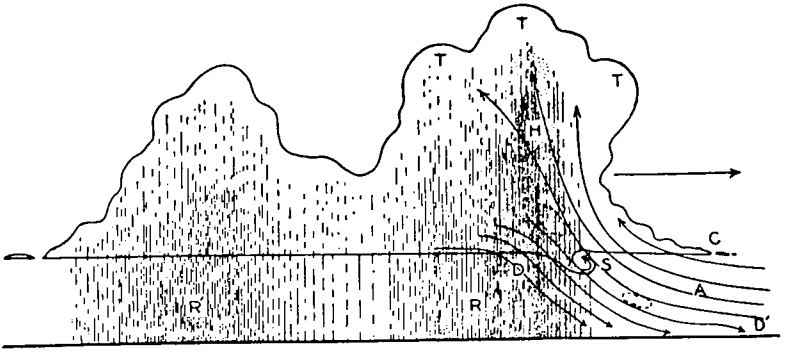

FIGURE 1.—Ideal cross section of a typical thunderstorm. *A*, ascending air; *D*, descending air; *C*, storm collar; *S*, roll scud; *D'*, wind gust; *H*, hail; *T*, thunderheads; *R*, primary rain; *R'*, secondary rain (after Humphreys).

(*g*) **Thunderstorms** shall be reported as the first element under "Weather" when occurring at the station or in such close proximity thereto as to constitute a dominating element in the weather at the station at that time; otherwise they will be reported under "Remarks." If approaching the station, the direction from which it is approaching will be given under "Remarks" in all cases. A thunderstorm is considered to be in progress whenever lightning, if observed in close proximity to the station, or thunder is heard. They will be reported in the following three degrees:

(1) **Mild Thunderstorm.**—When most of the lightning occurs within the cloud, the rainfall accompanying it, if any, is only light or moderate; no hail occurs; the wind occurring at the beginning of the storm, if any, does not exceed 25 to 30 miles an hour and is of short duration, possibly 3 to 5 minutes at the most; the storm is more in the nature of a gentle or moderate shower than of a storm, in the strict sense of the latter term.

(2) **Moderate Thunderstorm.**—When fairly frequent flashes of lightning occur between the cloud and ground, as well as cloud to

cloud; loud peals of thunder occur; moderate to heavy rain occurs; an onrush of wind may precede the storm, reaching velocities as high as 40 miles per hour; light or moderate hail may occur; the storm is distinctly recognizable as a well-developed phenomenon of this nature.

(3) **Severe Thunderstorm.**—When nearly incessant, sharp thunder and lightning occur; heavy rain occurs, possibly accompanied by moderate or heavy hail; the wind preceding the storm may reach velocities in excess of 40 miles per hour and continues over a considerable time, possibly as much as 15 minutes; a rapid drop in temperature occurs, possibly as much as 20° in 5 minutes.

(*h*) **Tornadoes** will be reported under "Weather" whenever observed. They are recognized by their characteristic funnel-shaped cloud and the noise and destruction accompanying them. Their direction from the station will be given. No abbreviation will ever be used for the word "tornado" when reporting these, it being written out in full and reported as follows, for example, "tornado

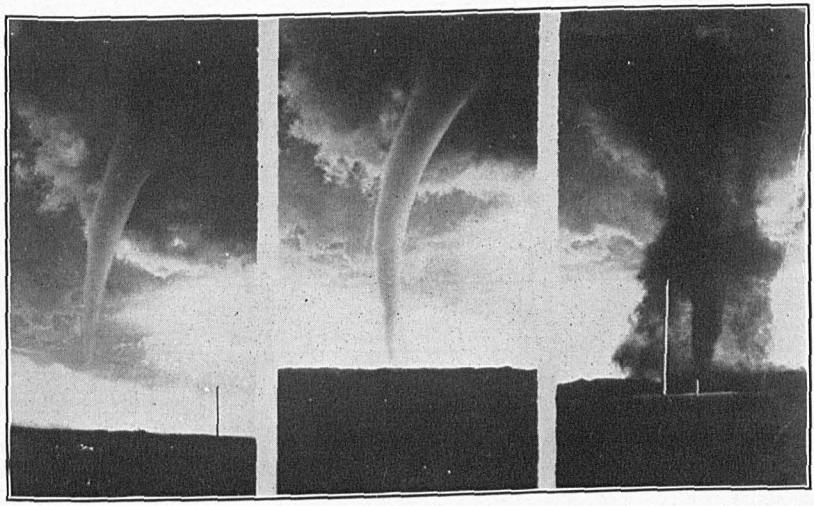

FIGURE 2.—Tornado forming and in progress. (Photographed by Mrs. Roy Homer at Gothenburg, Nebr., autumn, 1930.)
Left: Tornado cone forming. Center: Fully developed cone as it reached the earth. Right: Tornado striking farmhouse, which appears to explode.

SW", "tornado NW", etc. (See description of this type storm under fig. 2.)

33. For the reporting of sandstorms and duststorms, see chapter VI, "Obstructions to Vision"; wind-shift line, thunder, lightning, rain or snow squalls, and snow flurries, see chapter XII, "Remarks."

VI. OBSTRUCTIONS TO VISION

34. It is commonly known that distant objects are more clearly seen at some times than at others, the degree of the phenomenon varying quite widely. Conditions causing such limitation of vision are designated as "obstructions to vision" in the meaning of these instructions.

35. From the foregoing it will be seen that, strictly speaking, any form of precipitation is an obstruction to vision, but as the report-

ing of that element has been fully discussed in the preceding chapters, it will not be necessary to go into this further in this chapter, except to state that when precipitation is reported to be occurring and no other vision-limiting factor is reported, it will be assumed by all using the report that the precipitation is the only cause of the limited vision.

36. Obstructions to vision will be reported in accordance with the following:

(*a*) If the prevailing visibility is more than 6 miles, no mention need be made of any obstructions present, except that if 6 miles or less in any one direction and more than this in other directions, this fact will be reported under "Remarks", e. g., "fog bank southeast visibility 2", "visibility 3 north smoke", etc.

(*b*) If the prevailing visibility is 6 miles or less, the cause of the restricted vision must be reported, unless precipitation is the only vision-limiting factor present and has previously been reported under "Weather" or "Sky."

(*c*) Identify and report "obstructions to vision" immediately following the "weather", or the "visibility" if no weather is reported, in accordance with the following table, except that when any of the conditions listed therein are present in such a degree as to reduce the visibility to one-fifth mile or less and preclude direct observation of the sky, they shall be reported as the "sky" condition and omitted from the "obstructions to vision" position. The "ceiling" in such cases shall be reported as "zero."

TABLE 2.—*Obstruction to vision equivalents*

Kind of obstruction	Term to be used in reporting	Specifications for estimating degree of intensity
Haze.—The presence of foreign particles in the air of such character as to render distant objects bluish or purplish in hue and render blue sky somewhat grayish in hue.	Hazy	When haze is present and the visibility is from 1 to 6 miles, inclusive.
	Thick haze	When haze is present and the visibility is less than 1 mile.
Smoke.—The presence of particles of foreign matter in the air resulting from combustion. In light amounts it may be confused with haze or fog, but usually can be easily differentiated from these by its odor. Sun's disk at sunrise and sunset is very red and during daytime has a reddish tinge.	Smoky	When smoke is present and the visibility is from 1 to 6 miles, inclusive.
	Thick smoke	When smoke is present and the visibility is less than 1 mile.

TABLE 2.—*Obstruction to vision equivalents*—Continued

Kind of obstruction	Term to be used in reporting	Specifications for estimating degree of intensity
Dust.—The presence of particles of foreign matter uniformly distributed in the air consisting essentially of finely divided earth, such as clay, loam, and humus. It imparts (usually) a tannish or grayish hue to distant objects. The sun's disk is pale and colorless or perhaps a yellow tinge at all periods of day.	Dusty	When dust is present and the visibility is from 1 to 6 miles, inclusive.
	Thick dust	When dust is present and the visibility is less than 1 mile.
Blowing Snow.—When snow is picked up from the surface by the wind and blown about in clouds or sheets. Care must be taken not to record this element as such when the snow is actually falling from a cloud layer.	Blowing snow	When the condition described is occurring and the visibility is from 1 to 6 miles, inclusive.
	Thick blowing snow.[1]	When the condition described is occurring and the visibility is less than 1 mile.
Blowing Dust.—When dust is picked up from the surface by the wind and blown about in clouds or sheets.	Blowing dust	When the condition described is occurring and the visibility is from 1 to 6 miles, inclusive.
	Thick blowing dust.[1]	When the condition described is occurring and the visibility is less than 1 mile.
Blowing Sand.—When sand is picked up from the surface by the wind and blown about in clouds or sheets.	Blowing sand	When the condition described is occurring and the visibility is from 1 to 6 miles inclusive.
	Thick blowing sand.[1]	When the condition described is occurring and the visibility is less than 1 mile.
Fog.—Water vapor condensed to exceedingly fine particles of water in the lower part of the atmosphere and interfering with its transparency. It differs from cloud only in its being near or at the surface. It is easily distinguished from haze, dust, or smoke by its essential wetness.	Light fog	When fog is present, and the visibility is over ¾ mile.
	Moderate fog	When fog is present and the visibility is in excess of ⅛ mile but not exceeding ¾ mile.
	Dense fog	When fog is present and the visibility is ⅛ mile or less. *This term will not be reported as an "Obstruction to vision" but when occurring will be reported as the "Sky condition," the ceiling being reported as "zero" in all cases.*

[1] "Thick blowing snow", "thick blowing dust", "thick blowing sand" are descriptive terms used respectively, to indicate "blizzard", "duststorm", and "sandstorm."

TABLE 2.—*Obstruction to vision equivalents*—Continued

Kind of obstruction	Term to be used in reporting	Specifications for estimating degree of intensity
Ice Fog.—The occurrence of fog in the form of ice crystals or spicules, usually under conditions of clear, windless weather, and low temperature. Occurrence practically confined to the higher latitudes. Sun usually visible but horizontal visibility considerably restricted. Colloquially termed "frost in air", "frozen fog", etc.	Light ice fog	When ice fog is present and the visibility is over ¾ mile.
	Moderate ice fog.	When ice fog is present and the visibility is in excess of ⅛ mile but not exceeding ¾ mile.
	Dense ice fog	When ice fog is present and the visibility is ⅛ mile or less. NOTE.—If "Sky" is given with "Dense ice fog", it will be understood that the condition is similar to "Dense ground fog", but if "Sky" is not given and "Dense ice fog" is given in lieu thereof, it will be understood that the condition is similar to "Dense fog".
Ground Fog.—Same as fog, except that it is in the form of a shallow layer, through which the sky clouds, or heavenly bodies at night, may be observed. When reported, the sky conditions and actual visibility will also be reported. The ceiling will be reported in the same manner as if no fog of any kind were present, and in no case will the ceiling be reported as "zero" in the same observation in which "ground fog" is also reported.	Light ground fog	When ground fog is present and the visibility is over ¾ mile.
	Moderate ground fog.	When ground fog is present and the visibility is in excess of ⅛ mile but not exceeding ¾ mile.
	Dense ground fog.	When ground fog is present and the visibility is ⅛ mile or less. This will always be placed in the report as an "Obstruction to vision".

NOTE.—When combinations of the foregoing phenomena occur, the predominating condition will be entered as the "Obstruction to vision", and proper note of other conditions will be made under "Remarks" if considered necessary. Also, if haze, smoke, or dust is distributed to great heights with evidence of less visibility vertically than horizontally, a remark, "Thick dust, smoke, or haze aloft, sky condition questionable", should be added to the report.

37. The importance of the proper reporting of fog and ground fog can hardly be overemphasized from an airway viewpoint, and all observers are expected to be diligent in the observation of these phenomena.

38. For the guidance of those stations equipped to make psychrometric observations, fog rarely, if ever, is present in an area where the depression of the dewpoint exceeds 4°. This is particularly true as regards the formation stage of fog.

VII. TEMPERATURE

39. The temperature is the condition of the air with respect to heat, i. e., the degree of heat expressed in figures.

40. It is measured for use in airway weather reports by means of a standard Weather Bureau Fahrenheit thermometer, exposed in a

shelter so located as to protect the thermometer from the direct rays of the sun during the day and radiation at night.

41. The following instructions will govern the reporting of the temperature element:

(*a*) The thermometer will be read to *tenths* of a degree, the number of tenths to be estimated by eye observation by the observer. In doing this, the following two rules will apply:

(1) *When the temperature is above zero.*—Estimate the number of tenths that the mercury or alcohol column stands above the lower degree mark involved (the "lower degree mark" referred to is the one toward the bulb of the thermometer in all cases) and *add* these to the value of the lower degree mark. For example, if the top of the mercury or alcohol column stands half way between the 75° and 76° marks, the reading would be 75.5°; if it stood three-tenths of the way between 0° and 1°, the reading would be 0.3°, etc.

(2) *When the temperature is below zero.*—Estimate the number of tenths that the top of the mercury or alcohol column stands above the lower degree mark involved and *subtract* these from the numerical value of the lower degree mark. For example, if the top of the mercury or alcohol column stands seven-tenths of a degree above the −4° graduation, the reading would be −3.3°; if four-tenths of a degree above the −1° graduation, the reading would be −0.6°, etc.

(*b*) The above rules will apply to the reading of both the wet- and dry-bulb thermometers of a psychrometer at places where this instrument is used for obtaining the current and wet-bulb temperatures (see VIII concerning the wet-bulb temperature and its use). However, a correction for instrumental error must be applied to mercurial or alcohol thermometers under certain conditions, irrespective of whether used as a wet- or dry-bulb thermometer, in order that the readings of them will indicate the true dry or wet temperature. Correction cards are supplied with each thermometer, and the corrections for instrumental error for any particular thermometer in use given thereon will be applied to its readings under the following conditions:

(1) Whenever the temperature indicated by the thermometer is above 42° and the instrumental correction is plus or minus three-tenths (0.3°) of a degree or more in the case of mercurial thermometers or plus or minus five-tenths (0.5°) of a degree or more in the case of spirit-filled thermometers.

(2) Whenever the temperature indicated is 42° or less.

(3) Whenever the wet-bulb thermometer has an indicated reading higher than that of the dry-bulb thermometer.

(4) The corrections furnished are for each 10° interval and will be applied algebraically to the scale readings of the thermometers before recording the same. For a scale reading between those for which corrections are given, an interpolated value of the correction will be used. (This would constitute "single interpolation", an explanation of the processes involved in which is given in paragraph 43i.) For example:

Reading of the thermometer	62.1°
Correction to be applied	−0.5°

Now, the rule for applying corrections algebraically is that whenever the signs of the two values in question—in this case the reading of the thermometer and the instrumental correction for that thermometer—are the *same*, they will be added, and when the signs are

different, they will be *subtracted*. Therefore, subtracting 0.5° from 62.1° gives a temperature of 61.6°.

Reading of the thermometer	−8.2°
Correction to be applied	−1.2°

Applying the rule given above that values of like sign are to be added, the temperature would be −8.2° plus −1.2° which equals −9.4°.

Reading of the thermometer	−28.3°
Correction to be applied	+7.8°

Applying the rule that values having unlike signs are to be subtracted, the lesser from the greater, of course, the temperature would be −28.3° minus 7.8°, which equals −20.5°.

(5) The corrections on thermometers are given on the cards as low as the comparisons have been made with substandards. If it should happen that a reading for a thermometer is obtained at a point lower than for which any of its corrections are given, then the corrections will be determined by continuing the same ratio of increase or decrease as between the last 30° for which the corrections are given. For example, the correction at 2° is −0.6°, and at −28° is −2°. The change of correction between 2° and −28° is, therefore, −1.4°. For 7° range it is, from the foregoing, about −0.3°. Therefore, if the scale reading of the thermometer was −35.0°, which is 7° lower than −28.0°, the correction is −2.3° and the true temperature is −35.0° plus −2.3°, which equals −37.3°.

(*c*) After the reading of the thermometer to tenths of a degree has been determined and the instrumental correction applied, if required, the temperature will be entered on Forms 1001–Met'l and 1135–Aer., when used, in degrees and tenths, but on all other airway forms and in the reports to the *nearest whole degree*, e. g., if the reading were 75.6°, the temperature used would be 76°; if the reading were −2.4°, the temperature used would be −2°, etc. If the reading is exactly half way between two degree marks, it will, of course, not be nearer to one than the other and the following rule will then apply, whether the reading is *above zero or below zero:* The value of the lower degree mark will be used when this is even and the value of the higher degree mark when it (the lower degree mark) is odd, e. g., 76.5° would be reported as 76; 75.5° would be reported also as 76°; −35.5° would be reported as −36°; −36.5° would be reported also as −36°, etc. "Zero" is considered as an "even" figure.

(*d*) When the temperatures are below zero, an indication of the negative character of the value will be made by the entry of the minus sign immediately preceding the value on all forms and in transmission by teletype, but the word "minus" should be spelled out in telegrams.

(*e*) "Zero" temperature will be reported as the word "zero" in telegrams and the figure naught (0) on all forms and in transmission by teletype.

(*f*) The temperature will be reported only from those stations equipped with a standard Weather Bureau Fahrenheit thermometer, either as a single instrument or as the dry bulb of a psychrometer.

VIII. DEW POINT

42. The dew point is that temperature to which a given mixed volume of air and water vapor must be reduced before saturation occurs, resulting, after further reduction of temperature, in the condensation of some of the moisture in the form of dew, frost, fog, clouds, or precipitation.

43. Accuracy in determining the dew point is quite important, inasmuch as this element is of considerable value to forecasters, and others concerned, in anticipating the formation of fog, thunderstorms, cloudiness, etc. The following instructions concerning the determination and reporting of this element will, therefore, be carefully adhered to:

(*a*) The dew point will be reported only from those stations equipped with a Weather Bureau psychrometer of some type.

(*b*) When the temperature is *above the freezing point*, the cloth around the wet bulb will be moistened *just prior* to the taking of a reading. *This cloth or muslin on the wet bulb will always* be kept clean, and should be changed at least once each week. At some stations it will be necessary to do this oftener, particularly at those located where there is considerable dirt and smoke or where the usual water supply is rather heavily charged with mineral matter, such as where surface well water is used. The consequence of using such water on the thermometer bulb is that the muslin has to be changed and the bulb cleaned off. The latter is sometimes difficult to do and involves risk of breaking the thermometer and is really the principal objection to using impure water. To obviate this latter difficulty, all stations should obtain a small supply of mineral-free water to be kept in a bottle from which the small bottle or container actually used to wet the wet bulb can be replenished occasionally. Distilled water is best, but rain water or melted snow, preferably filtered to remove dust particles, will do just as well. A catch of water during a fairly heavy fall of rain or snow should give enough water to last almost a year. When temperatures are extraordinarily high and the relative humidity is quite low, the cloth on the wet bulb should be thoroughly wetted, resulting in the formation of a drop of water on the cloth-covered bulb that should be allowed to remain for several minutes before whirling. This is necessary in order that the temperature of the wet bulb may be reduced considerably before whirling, or rapid rotation of the shelter fan is begun. This will insure a true reading which, of course, would not be possible if the cloth were dried out before the whirling was completed.

(*c*) When the current temperature *is at, or below, the freezing point*, the cloth will be moistened *from 5 to 10 minutes* prior to the taking of a reading, the greater interval being used when temperatures are near the freezing point. This is necessary in order that the latent heat released when water freezes may be dissipated and the wet-bulb temperature brought down to or below the current temperature prior to the whirling of the psychrometer. If this is not done the observer will find that a considerable period of time will be consumed in obtaining a depression, which may result in late or missed observations. During periods when the temperature is below freezing, it will be found that ice will accumulate on the bulb of the wet-bulb thermometer, which condition should be avoided. The cup of water used to wet the wet-bulb should be kept in the office room between observations so

that the water will be lukewarm. The wet bulb should be thoroughly soaked in this each time it is to be wetted until all the ice on the wet bulb has been melted. If this is done it will be found that a thin and thoroughly cooled ice coating will have formed before the reading must be taken. This procedure is mandatory at intermediate airway stations. Also, during periods when the temperature is below freezing, but particularly when it is near or below zero, it will be found that the depressions obtained are quite small and that the difference in values of the dew point are quite large for small differences in the depressions of the wet-bulb temperatures. It will, therefore, be necessary that the readings be made with extreme care at such times, the psychrometer being carefully whirled, or the shelter fan rotated, until it is certain that the lowest reading has been obtained. Care must be used at all times when taking an observation that the observer's breath does not enter the shelter.

(*d*) During a dense or moderate fog it will often be found that no depression of the wet-bulb thermometer can be obtained. In such cases the temperature of the dew point is the same as the current temperature and will be reported as the same.

(*e*) The psychrometer will be whirled, or the shelter fan rotated, until successive readings of both thermometers indicate that the readings have reached their lowest points.

(*f*) The thermometers will then be read to tenths of a degree as directed in chapter VII, after which the depression of the wet-bulb thermometer will be obtained as follows:

(1) When *both* wet- and dry-bulb temperatures are *above zero*, *subtract* the wet-bulb temperature from the dry-bulb temperature.

(2) When the *dry-bulb temperature is at or above zero* and the *wet-bulb temperature is at or below zero*, *add* the dry-bulb temperature to the wet-bulb temperature without regard to sign. For example, if the dry bulb reads 1.2° and the wet bulb reads −0.7°, add 1.2° to 0.7°, which gives the depression 1.9°. If either temperature is exactly zero, the depression will be the value of the reading of the other theremometer without regard to sign, e. g., if the dry bulb reads 0.0° and the wet bulb −1.2°, obviously 0.0° added to 1.2° gives 1.2°.

(3) When *both* wet- and dry-bulb temperatures are *below zero*, *subtract* the *dry-bulb temperature* from the *wet-bulb temperature*, disregarding the minus signs, e. g., if the dry bulb reads −3.4° and the wet bulb reads −4.7°, then the depression would be 4.7 minus 3.4°, or 1.3°.

(*g*) After the wet-bulb depression is obtained, the proper column marked "depression of the wet-bulb thermometer" will be found along the top of the psychrometric tables. The dry-bulb temperature will be found in the column headed "Air temperature" at the left of the tables. The figure given in the tables at the intersection of the two lines of figures therein thus indicated will be the dew point to be reported, provided that the depression of the wet bulb and the air temperature used both correspond with a value given at the top or at the left of the tables for a line of figures therein. However, in the majority of cases, the values for the dry-bulb reading and the depression of the wet bulb, obtained when the wet- and dry-bulb thermometers are read to tenths of a degree, will lie in between the values for those given at the left and top of the tables, requiring interpolation to secure the correct result.

(*h*) Interpolation is the process of obtaining values that lie between the values given in the tables and falls into two classes, viz, double and single. However, the mathematical processes involved in double interpolation are somewhat complicated and will not be explained here, but if the observer is familiar with the process, it should invariably be used by him when required by the circumstances surrounding the determination of the dew point. If the observer is not familiar with the process, it will be necessary for him to adhere to the following rule:

RULE.—An examination of the dew-point tables will show that diagonal lines exist therein, inclining downward and to the right, along which the tabulated values of the dew point are constant, or change very little. As a result of this circumstance, when the observed values of the air temperature and the depression of the wet-bulb thermometer fall between the values of these, as given at the left and top of the tables, the observer will obtain a result by going to the next lower numerical values of temperature and depression given at the left and top of the tables, respectively, and, using the horizontal and vertical lines of figures indicated by these, find the corresponding dew point, as explained in paragraph 43 (*g*). For example, let us assume that the following values are involved:

Air temperature	45. 8°
Depression of the wet bulb	2. 7°

and the tabulated values available are—

Air temperature	Depression of wet-bulb thermometer (degrees)			
	2. 0	2. 5	3. 0	3. 5
44	40	38	37	36
45	41	40	38	37
46	42	41	40	38

Now, by dropping the fractions in the temperature and depression values given so as to obtain the "next lower" values of those given at the left and top of the table, we have the values of 45° for temperature and 2.5° for depression. Consulting the table for the intersecting point of figures in the body of the tables thus indicated, we find the figure 40, which would be the value of the required dew point. Actual double interpolation would give a value of 40.32°, which would, of course, be included in the report as 40°.

(*i*) If one of the values obtained, i. e., the air temperature or the depression of the wet-bulb thermometer, corresponds to a respective value given at the left or top of the tables, but the other falls between the values given there, then *single interpolation* is involved. In this type of interpolation it is necessary to apply the proportional fraction involved in the direction in which it lies. Specifically, this means that the difference in value between any two figures in the body of the table, taken either horizontally or vertically as required, will be multiplied by the value of the proportional fraction, and this result will be added to, or subtracted from, the first figure as may be proper.

Examples:

(1) Temperature ..... 44. 0°
Depression of the wet bulb ..... 2. 3°

(See table given in par. 43 (*h*).)

The figure 44 is found in the "Air temperature" column at the left of the tables, and the line of figures thus indicated is followed to the right until the vertical column for depressions of the wet bulb for 2.0° is reached. The figure given there is 40. Since the depression 2.3° lies between 2.0° and 2.5°, the line of 44° is followed one more column to the right and this contains values of dew point for depressions of 2.5°. The figure given there is 38. The difference between 40 and 38 is 2, while the depression 2.3° represents three-fifths or 0.6 of the difference between 2.0° and 2.5°. Multiplying 2 by three-fifths or 0.6 gives 1.2. *Subtracting* this from 40—as this is the direction in which the proportional fraction lies—gives 38.8°, which is the actual dew point to tenths of a degree and which would be included in the report as 39°.

(2) Temperature ..... 44. 8°
Depression of the wet bulb ..... 2. 5°

(See table given in par. 43 (*h*).)

The figure 44 is found in the "Air temperature" column at the left of the tables, and the line thus indicated is followed to the right until the column for depression 2.5 is reached. The figure there is 38. Dropping down one line in the same depression column—this will be the line for temperature 45°, 44.8° lying between 44° and 45°—the figure 40 is found. The difference between 40 and 38 is 2, while 44.8 represents 0.8 of the difference between 44 and 45. Multiplying 2 by 0.8 gives 1.6. *Adding* this to 38—as this is the direction in which the proportional fraction lies—gives 39.6°, which is the actual dew point to tenths of a degree and which would be included in the report as 40°.

NOTES.—The procedure of dropping the tenths of the dry-bulb temperature described in 43 (*h*) is intended for use only in determining the dew point and will *not* be used in reporting the temperature element of the airway observation. The nearest whole degree, Fahrenheit, as directed in chapter VII, will be used for that purpose.

The figures quoted in the foregoing examples were taken from tables of dew points for a pressure of 30 inches and may not correspond to those for pressures lower than this, but the principle outlined will be adhered to.

44. In studying the examples given in paragraph 43, the observer will have a table of dew points at hand for reference and study, as the actual working of the methods explained therein cannot be understood merely by a cursory reading of the text of the instructions. Several other examples should be worked by the observer until he is sure that the process is completely understood.

45. The observer will read both wet- and dry-bulb thermometers to tenths of a degree accurately and without bias in the matter of whether or not these come out in values corresponding to those given at the left and top of the tables, which methods might thus eliminate the necessity for interpolation.

IX. WIND (DIRECTION, VELOCITY, CHARACTER)

46. Wind is the horizontal natural movement of air, i. e., air naturally in motion with any degree of velocity. Vertical movements of air are not considered as wind, in the true sense of the word, but as air currents, or as wind with a vertical component, which need not be discussed in these instructions.

47. The wind direction and velocity will be included in every report, and the character, when appropriate. These will be estimated in accordance with instructions given later in this chapter at those stations not equipped with wind-indicating equipment.

48. The following instructions will govern the reporting of the wind element:

(*a*) The *direction* of the wind is that direction *from which* it is moving, i. e., if the wind is coming from the northwest, its direction would be reported as "northwest."

(*b*) The direction of the wind will be reported to 16 points of the compass, as follows:

North.	South.
North-northeast.	South-southwest.
Northeast.	Southwest.
East-northeast.	West-southwest.
East.	West.
East-southeast.	West-northwest.
Southeast.	Northwest.
South-southeast.	North-northwest.

(*c*) When the station is not equipped with wind-indicating equipment, the direction may be determined by observing the drift of smoke, or the direction in which twigs, leaves, etc., are swaying, or, if the station is located at an airport, the direction can be obtained from the wind cone or tee.

(*d*) Stations equipped with wind-direction indicators can easily obtain the intermediate directions by observation of the indicator during the taking of a reading, e. g., if the west lamp burns steadily and the north lamp flashes intermittently, this would indicate a west-northwest wind; if the north and west lamps are burning most of the period of the reading, but the west lamp flashes off occasionally, this would indicate a north-northwest wind direction, etc.

(*e*) The *velocity* of the wind will be reported in miles per hour as obtained from a reading of Weather Bureau wind-indicating instruments, or by estimation. The wind-indicator boards, electrically connected with the exposed wind instruments, commonly furnished to airway and airport stations, give one buzz a minute for each mile of wind blowing, it only being necessary to count the buzzes for 1 minute to obtain the indicated velocity in miles per hour. The indicated velocity must be corrected to obtain the true velocity in accordance with table 3.

TABLE 3.—*Corrections for indicated wind velocities*

Velocities indicated			Correction in whole miles per hour
By 3-cup anemometer, m. p. h.	By 4-cup anemometer, m. p. h.	By 4-cup anemometer with beaded cups, m. p. h.	
0 to 16 [1]	0 to 8	0 to 5	+1
17 to 26	9 to 12	6 to 13	0
27 to 35	13 to 16	14 to 20	−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

[1] Inconsequential variation from the rule for disposal of decimals disregarded at 3 and 4 m. p. h. Reprint from Instructions No. 1, 1935.

NOTE.—Corrections to be applied to wind velocities determined by anemometers. Correction to be added when the sign is plus and subtracted when the sign is minus.

If no wind-velocity-indicating equipment is available, the velocity may be estimated by application of the values given in the following table (usually known as the "Beaufort scale" of wind velocities):

TABLE 4.—*Wind velocity equivalents*

Descriptive word [1]	Velocity (miles per hour)	Specifications for estimating velocities
Calm	Less than 1	Smoke rises vertically.
Light	1 to 3	Direction of wind shown by smoke drift, but not by wind vanes.
	4 to 7	Wind felt on face; leaves rustle; ordinary vane moved by wind.
Gentle	8 to 12	Leaves and small twigs in constant motion; wind extends light flag.
Moderate	13 to 18	Raises dust and loose paper; small branches are moved.
Fresh	19 to 24	Small trees in leaf begin to sway; crested wavelets form on inland waters.
Strong	25 to 31	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
	32 to 38	Whole trees in motion; inconvenience felt in walking against the wind.
Gale	39 to 46	Breaks twigs off trees; generally impedes progress.
	47 to 54	Slight structural damage occurs (chimney pots and slate removed).
Whole gale	55 to 63	Trees uprooted; considerable structural damage occurs.
	64 to 75	Rarely experienced; accompanied by wide-spread damage.
Hurricane	Above 75	

[1] Except "calm", these terms not to be used in reports of velocity.

(*f*) If the cups of the anemometer are not moving, or if smoke rises vertically, the velocity will be zero and the wind will be reported as "calm."

(*g*) If necessary to estimate the wind velocity as outlined, this will be indicated by the entry of the word "estimated", or abbreviation therefor if a teletype report, immediately following the velocity.

(*h*) The *character* of the wind will be indicated immediately following the velocity, when appropriate, by use of the following terms:

Variable.—When velocities are low and direction and velocity fluctuate irregularly.

Fresh gusts.—Whenever sudden, intermittent increases in velocity reach 19 to 24 miles per hour, with variations in velocity of 10 miles per hour or more.

Strong gusts.—Whenever sudden, intermittent increases in velocity reach 25 to 38 miles per hour, with variations in velocity of 10 miles per hour or more.

Severe gusts.—Whenever sudden, intermittent increases in velocity reach 39 or more miles per hour, with variations in velocity of 10 miles per hour or more. "Severe gusts" include the "gale", "whole gale", and "hurricane" forces, given in table 4.

49. The proper reporting of the wind element is of great importance in connection with the landing of aircraft and the preparation of weather charts from which forecasts are made. It will be necessary, therefore, that all observers exercise care in the determination of this element.

X. BAROMETRIC PRESSURE

50. The atmospheric pressure is a measure of the weight of the ocean of air above the earth and is measured in inches of mercury by a barometer; thus we call it barometric pressure.

51. Its proper reporting is of such high importance that accuracy in making readings cannot be too strongly expressed. The following general rules will govern the reporting of this element:

(*a*) The barometric pressure will be reported only from stations specifically authorized to do so by the general supervising station. It is contemplated that ultimately all airway weather-reporting stations will report only pressures reduced to sea level in the airway weather reports, as such. The airway barometry program provides for eventually furnishing tables to each station for the reduction of pressure to sea level. The official in charge of the general supervising station will give instructions in regard to the use of the tables at the time the change is made. Special instructions, such as reading a mercurial barometer, reductions of the pressure to sea level, proper care of barometers, etc., will be given in individual cases by a properly trained Weather Bureau official. (See paragraph 321, page 124)

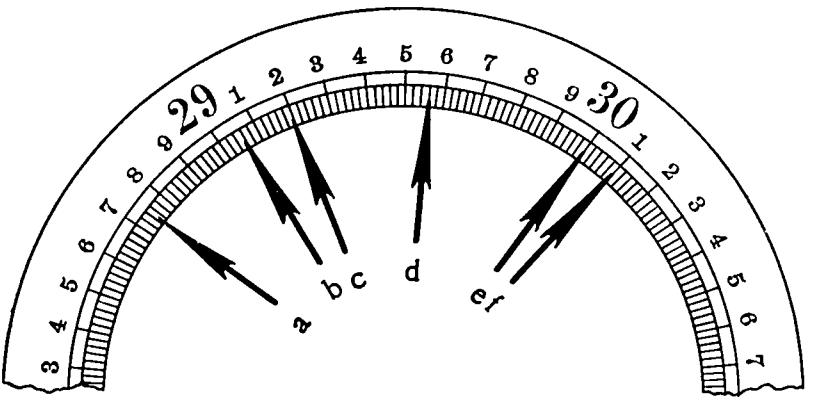

FIGURE 3.—Illustrating six different readings of the aneroid barometer.

(*b*) When reported, the pressure will be indicated in inches and hundredths thereof, all Weather Bureau barometers of any type being graduated in this manner. For example, a pressure of 30 inches would be reported as "30.00"; a pressure of $29\frac{84}{100}$ inches would be reported as 29.84, etc.

(*c*) The barometric pressure is obtained at a number of stations from the readings of an aneroid barometer. The following method should be used for obtaining the pressure by means of this instrument:

(1) The barometer should be hung indoors at a level of about 5 feet above the floor so that it will be on a level with the eyes of the observer, and where it will not be subject to extremes of heat and cold, or rapid changes in temperature, and especially where it is not likely to be jarred or disturbed.

(2) Before making a reading, tap the face of the barometer very gently with the finger, or eraser end of a pencil; this will take the needle to its true settling point.

(3) Write down reading of needle at scheduled time of making report. The entry should be in inches, tenths, and hundredths; thus, "29.52", "28.02", "30.00", etc. A correction will be applied to this reading, when necessary, as described under (*d*) below.

(4) These instruments are usually graduated to every two hundredths of an inch, and reading of them to hundredths is, therefore, easy. Care, however, should be taken not to confuse the tenths divisions with those for hundredths. Figure 3 is a reproduction of a portion of the dial of a common type of aneroid barometer, to which has been affixed a series of imaginary positions of the needle marked "*a*", "*b*", "*c*", etc. The following are the correct readings corresponding to these positions:

(*a*) 28.75 inches.
(*b*) 29.06 inches.
(*c*) 29.20 inches.
(*d*) 29.56 inches.
(*e*) 30.00 inches.
(*f*) 30.10 inches.

(*d*) The aneroid is at times subject to a slow change or "creeping." In such cases the matter will be reported to the supervising Weather Bureau official for the airway. *Under no circumstances will the observer attempt to adjust the instrument.* Upon receipt of advice that the aneroid is reading inaccurately, the supervising Weather Bureau official will issue instructions concerning a correction to be applied to the instrumental *readings*. The correction will be changed from time to time by the supervising Weather Bureau station as circumstances warrant. The observer will make certain that the correction is applied to all readings before using them for any purpose, including reductions to sea level.

(*e*) At other stations the pressure is obtained by use of a mercurial barometer. There is no need, nor is it considered advisable, to give instructions here in the use of this instrument, as at all stations so equipped the observer will be properly instructed in its use by experienced Weather Bureau officials.

XI. FIELD CONDITIONS

52. Field conditions are, as the name implies, a report of the condition of the landing field, or airport. They would include such statements as—

Field soft, caution advised.
Field muddy.
6 inches new snow on field.
Field flooded.
Field frozen, deep ruts.
Field ice covered and slippery.
Field snow covered, 3-foot drifts.
Field soft on south end.

53. The following will govern the reporting of field conditions:

(*a*) When reported they will accurately describe landing conditions as regards the field itself.

(*b*) They need not be reported from stations not located at airports or landing fields, except that snow depths will be reported daily in accordance with 53*e*.

(*c*) Also, they need not be reported from stations located at airports and landing fields so long as the condition of the field remains good.

(*d*) If the field conditions at the stations located at airports and landing fields become other than "good", i. e., unsafe or dangerous, report of this will be included in the next record or special observa-

tion, and in the report nearest 8 a. m., E. S. T., daily thereafter, so long as it remains so. Upon becoming safe or good again, the report, "field good", will be included in the next record or special observation, and field conditions then omitted from subsequent reports.

(*e*) The depth of snow, slush, or ice on level ground will be reported in the observation nearest 8 a. m., E. S. T., daily as a field condition from all stations, *including those not located at airports or landing fields.* Measurements will be made in the open and the average of several representative ones will be used in the report.

(*f*) All stations will report field conditions whenever a change of 2 inches or more of snow depth—either increase or decrease—occurs between the observation in which it was last reported and any subsequent observation, or when no snow was originally on the ground but subsequent falls reach a depth of 2 inches.

XII. REMARKS

54. It is intended that the "Remarks" contain all pertinent weather information which cannot properly be given in the reporting of a specific element of the report. As such, they have a very broad use and the observer will take full advantage of this to the end that a complete and accurate picture is presented of all conditions obtaining at the time the observation is taken.

55. The "Remarks" will constitute the last part of the observation proper, and will always be written in English, using authorized abbreviations and figures on forms and in transmissions made by teletype or radio.

56. Under no circumstances will a remark be omitted to save the trouble of including it, or because it is not specifically mentioned herein. If it has a bearing on the weather conditions at the time it will be included in all cases. Transmissions of such remarks on teletype circuits will not be monitored with respect to the actual phenomenon reported, or the manner in which it is reported, except that proper abbreviations must be used and procedure observed.

57. In the following, remarks pertaining to certain elements have been listed under those headings. However, this is not to be considered as requiring that only the remarks given be reported concerning those elements, as it is impracticable to list here all the remarks which might be sent. The observer will, however, invariably add a proper remark when any of the following conditions occur:

(A) Ceiling

(1) The ceiling is below 2,000 feet and has been changeable with respect to height. This condition usually occurs during periods when low stratus clouds (scud) are present, probably accompanied by precipitation. Report, "ceiling variable", "changeable ceiling", etc.

(2) The ceiling is observed to be on or below the tops of mountains, high buildings, etc. Report, "clouds on ridges, hills, etc.", or "clouds below ridge tops", "mountains to west cloud covered", etc. The following remarks are defined for use in extremely mountainous regions:

"*Clouds above mountains*" indicates clearance below clouds with top of clouds not extending to high altitudes.

"Heavy clouds above mountains" indicates clearance below clouds with top of clouds extending to high altitudes.

"Clouds topping mountains" indicates top of highest peaks obscured with clearance in passes and with top of clouds not extending to high altitudes.

"Heavy clouds topping mountains" indicates top of highest peaks obscured with clearance in passes and top of clouds extending to high altitudes.

"Heavy clouds obscuring mountains" indicates apparently no clearance in passes with clouds extending to high altitudes.

"Clouds layer(s) topping mountains" indicates cloud layer(s) extend(s) from the station to the mountains obscuring the highest peaks with clearance in passes.

"Clouds layer(s) obscuring mountains" indicates the cloud layer(s) extend(s) from the station to the mountains obscuring them and apparently no clearance in passes.

"Cloud banks along mountains" indicates the highest peaks are above the cloud banks.

"Cloud banks in (south) pass" indicates apparently no clearance in pass but highest peaks evidently above cloud bank.

"Heavy cloud bank (south) pass" indicates apparently no clearance in pass and clouds extend to high altitudes.

(3) Low, scattered clouds, constituting a *third* layer not reported under "Sky conditions" covering one-tenth or over of the sky and whose altitude is less than 9,751 feet are present, e. g., "scud at 3 hundred", etc.

(B) Sky

(1) The amount of clouds present require the reporting of "overcast", but there are breaks in this, e. g., "breaks in overcast", "few breaks", etc.

(2) The sky is reported as overcast, but it is observed to be beginning to clear, e. g., "clearing in west", etc.

(3) Heavy cloud banks are observed near the horizon in any direction, e. g., "heavy cloud bank to east", etc.

(4) The clouds are unusually dark in any direction, e. g., "dark in southwest", "darkening rapidly in northwest", etc.

(5) The heavenly bodies are observable *through* any cloud layer present, e. g., "sun dimly visible", "stars visible through overcast", etc., when "thin" has not been used in sky condition given.

(6) The clouds are moving unusually rapidly or they are observed to be unusually turbulent, e. g., "clouds moving rapidly", "clouds turbulent", etc.

(C) Visibility

(1) The visibility fluctuates rapidly due to the passage of rain or snow squalls, or other intermittent conditions, e. g., "visibility variable."

(2) The visibility in one direction is less than the prevailing visibility, e. g., "smoky west, visibility 2", "fog bank to east, visibility 1½", etc.

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(D) Weather

(1) *Cumulo-nimbus clouds* (thunderheads) are observed in the distance and no thunderstorm is occurring at the station, e. g., "thunderheads in southwest", "thunderheads to north and west", etc.

(2) *Showers or other types of precipitation* are observed in the distance, e. g., "shower to west", "snow squalls over lake", etc.

(3) Distant *lightning* is observed, e. g. "lightning in southwest", "lightning in north and east", etc.

(4) *Precipitation* is falling and is reported, but occasionally increases in intensity, e. g., "occasional heavy showers (rain, snow, sleet, etc.)."

(5) *Rain or snow squalls* occur. These are occasional brief falls of rain or snow, accompanied by gusts of wind ranging from "strong" to "severe", but not usually by lightning or thunder. For example, "occasional snow squalls", etc.

(6) *Mammato-cumulus clouds* are observed. These clouds are direct evidence of great instability in the upper atmosphere and usually occur in the area near forming or active tornadoes or severe wind-shift lines. Their characteristic form (see fig. 18) makes them easy to identify. The importance of reporting these clouds cannot be over-emphasized. For example, "mammato-cumulus overhead."

(7) *Alto-cumulus castellatus* clouds (see fig. 12) are observed. These are turreted cumuliform clouds observed at high altitudes, which indicate instability at those levels and are usually the fore-runner of thunderstorm or unsettled conditions. These should be reported as "alto-cumulus castellatus increasing."

(8) A *wind-shift line* passes over the station. At hourly weather-reporting stations this will always be the occasion for a special report, which will contain the actual weather conditions under "Weather" and appropriate remarks at the end of the report concerning the passage of the wind-shift line. At stations not rendering special reports, the passage of the wind-shift line will be reported in the next regular report under "Remarks", provided such report is filed within 6 hours of the passage of the line over the station. These latter type of stations would include off-airway and intermittently reporting on-airway stations. The occurrence of a wind-shift line is to be reported whenever the wind has suddenly shifted from a southerly or easterly to a westerly or northwesterly direction, accompanied by strong, gusty winds, rapid temperature drop, and, in summer, usually by severe lightning and thunder and possibly hail, intense rain, or snow squalls at frequent intervals, and a rapid lowering of the ceiling. A westerly or northwesterly wind will continue to blow steadily after it has passed, and the sky will usually clear rapidly, except in a mountainous region. When the wind shifts from an easterly or southerly quadrant to a westerly or northerly quadrant, accompanied by cloudiness or precipitation, it is a strong indication that a wind-shift line has passed the station and the observer should be on the alert for the characteristic changes in other elements of the report in order that the reporting of the wind-shift line will not be missed. Likewise, if in a mountainous country, cloudiness increases, ceiling lowers, precipitation begins or increases markedly, the temperature drops, and the barometer rises, all within a short period of time, it is a strong indication that a wind-shift line is passing over the station

and the observer should confirm it by noting whether the wind direction changes clockwise, the velocity increases, or whether the direction of low clouds veers. Orographic influences may cause cloudiness, and even dense fog, to continue for several hours after the passage of the wind-shift line. In a flat region, dry wind-shifts sometimes occur, accompanied by strong winds and blowing dust, which greatly restricts visibility over extensive areas. They thus are a real aviation hazard, not only from the dust, but also from the gales attending them. The proper remarks to be added to a special or record observation taken during the passage of the wind-shift line would follow the line of thought expressed in the following examples:

"Severe wind shift in progress, 60 mile gusts."

"Wind shift reached station 1203ES."

"Severe wind shift passing station, severe lightning."

"Extreme turbulence, ceiling and visibility extremely variable."

(9) *Snow flurries* occur: These are occasional brief falls of snow, usually light. For example, "snow flurries", etc.

(10) *Graupel* falls: Graupel is also known as "soft hail", and consists of pellets of rather closely packed ice needles. It occurs under thunderstorm or other conditions of strong convection. It has a rate of descent more nearly comparable with snow than hail. For example, "rain mixed with graupel." If occurring alone, report snow, not hail, in the body of the report and add the necessary remark, "graupel type snow."

(11) In cases where two or more types of precipitation have been falling together, at intervals, but are not doing so at the times of observation, this condition will be reported under "Remarks", e. g., "Sleet occasionally mixed with rain", "occasional wet snow", etc.

(12) Character of snow may be indicated, e. g., "snow wet", "snow dry and fine", etc.

(E) Obstructions to Vision

(1) If dense ground fog is reported, indication of whether or not the heavenly bodies are visible through it shall be made, e. g., "stars visible overhead", "sun visible", etc.

(2) Mixtures of fog, haze, smoke, dust, etc., occur. The predominant condition will be given in the body of the report, and the other conditions noted under "Remarks", e. g., "Smoke mixed with fog", etc.

(3) Haze, smoke, dust, etc., are distributed to great heights with evidence of less visibility vertically than horizontally, e. g., "Thick dust aloft; sky condition questionable", etc.

(4) Fog present is dissipating, thickening, etc. For example, "fog thickening", "fog dissipating", etc.

58. Remarks in connection with other elements of the airway observation will be of rather infrequent occurrence, but would include those such as—

"Temperature falling rapidly."

"Barometer unsteady."

"Barometer falling rapidly."

"Wind increasing."

"Snow drifting", etc.

59. It is again desired to impress upon the observer that any condition of importance not covered in the body of the report is to be reported under "Remarks", and that diligence and care must be exercised to see that such remarks are made. The importance of remarks in amplifying the basic report is so great that the necessity for the conscientious reporting of these cannot be overemphasized.

XIII. INSTRUCTIONS FOR ADDING SPECIAL DATA TO RADIO AND TELETYPE SEQUENCE REPORTS

60. In connection with the issuance of airway forecasts at regular intervals, it is necessary that the officials making the forecasts be provided certain special data not contained in the regular reports. The following therefore deals with this subject:

61. All Weather Bureau first-order and airport stations making regular report by radio or teletype will add to the reports nearest the even hours of 2 and 8 a. m. and p. m. daily, E. S. T., pressure change, cloud, and thunderstorm data.

62. Intermediate stations manned by Weather Bureau airway observers or Department of Commerce radio operators or airway keepers making regular reports by radio or teletype will add pressure change and thunderstorm data in all cases. *Cloud data will be added by these stations only as specifically* directed to do so by the general supervising station for the airway. Forecast centers desiring this information from stations not under their general supervision may arrange with the general supervising station concerned to have this done.

63. The data shall be added in the following order:

(1) Pressure change.
(2) Clouds.
(3) Thunderstorms.

64. *Pressure change and characteristic,* including 5,000-foot pressure at selected stations. (See par. 104 relative to the selection of stations for including the 5,000-foot pressure.)

65. The data will be obtained and added to the reports in accordance with the following:

(*a*) Station has a barograph.

1. The *net change* in the *station pressure* for 3 hours immediately preceding the observation will be indicated by figures representing the proper number of hundredths of an inch.

2. Following this, without space, will be a letter taken from the following list (formed of initial letters of the 1931 Weather Code for pressure characteristic, pp. 5, 37–46) indicating the pressure characteristic.

Barometer same or higher than 3 hours previous to observation:

(A) * Rising, then falling.
(B) Rising, then steady.
(D) Unsteady, rising.
(F) Steady, or steadily rising.
(G) Falling, or steady, then rising.

Barometer lower than 3 hours previous to observation:

(M) Falling, then rising.
(N) Falling, then steady.

*The characteristic, "rising, then falling", is indicated by the absence of a consonant, the letter (A) to be used in those cases.

(R) Unsteady, falling.
(S) Steadily falling.
(T) Steady, or rising, then falling.

3. If no net change occurs, the figure naught (zero) will be sent, followed by the proper characteristic letter.

4. If a station in the western Plateau region has been selected to transmit the "pressure reduced to the 5,000-foot plane", this pressure will be indicated by two numbers representing the hundredths of an inch in the 5,000-foot pressure (whole inches omitted) immediately following the characteristic letter, without space or oblique.

5. *Examples:*

Station which *does not* transmit 5,000-foot pressure, "7R" signifies "Barometer unsteady and falling, 0.07 inch lower than 3 hours previously."

Station which *does* transmit 5,000-foot pressure, "10S79" signifies "Barometer steadily falling, 0.10 inch lower than 3 hours previous; pressure at 5,000-foot plane 24.79 inches."

(*b*) Station has no barograph.

1. The net *station pressure* change for the 3 hours preceding the observation will be given in figures representing the proper number of hundredths of an inch.

2. Immediately following this will be given a plus (+) or minus (−) sign to indicate the direction of the pressure change. Zero change will be indicated by the word "none" where the station does not transmit the 5,000-foot pressure. If the station does transmit the 5,000-foot pressure, zero change will be indicated by a naught (zero) followed by an oblique.

3. If the 5,000-foot pressure is to be transmitted, the hundredths of an inch (omitting whole inches) in this pressure will be indicated following the (+) or (−) sign (or oblique if the change is zero), without a space between them.

4. *Examples:*

Station which *does not* transmit 5,000-foot pressure, "4+" indicates "Barometer rose net amount of 0.04 inch in the last 3 hours."

Station which *does* transmit 5,000-foot pressure, "8–88" signifies "Barometer fell net amount of 0.08 inch in the last 3 hours; pressure at 5,000-foot plane 24.88 inches." "0/06" signifies "Net change in barometer, zero; pressure at 5,000-foot plane 25.06 inches."

66. *Clouds.*—The amount, type, and direction of any clouds present will be reported by stations directed to do so immediately following the pressure-change data. These data are intended to represent an instantaneous view of the distribution of various types of clouds over the sky at the moment of observation, i. e., the observer will report the amounts and types of cloudiness actually visible as projected against the plane of the sky, the amounts to be determined by the estimation to tenths of the amount of the whole sky covered by each type. No clouds will be reported when "dense fog" has been reported under "Sky conditions."

67. The total amount of clouds reported in any one observation shall not exceed ten-tenths.

68. One cloud group only will be used to report clouds higher than 10,000 feet above the station. These clouds will consist of the cirrus, cirro-stratus, and cirro-cumulus types, and occasionally clouds

of the alto-stratus or alto-cumulus types. Only the predominating type will be reported when more than one type is present, but the amount indicated will be the sum of the amounts of the sky covered by all high types and the direction given will be that of the predominant type present.

69. In reporting lower clouds, i. e., those below 10,000 feet, the level or stratum will be regarded as the unit to be reported rather than indication of each of the various types present. Therefore—

(*a*) If only one stratum of clouds below this level is present, one group will be used to report them.

(*b*) If two strata are present, two groups will be sent, except that in case both strata are composed of the same type of clouds only one group will be sent, the amount given being the sum of the two strata and the direction that of the stratum covering the most sky. In the event that the amounts are equal, the direction given will be that of the lower layer.

70. If clouds above 10,000 feet are present and clouds below this level are also present, the lower strata will be reported as prescribed in paragraph 69 and the upper strata as prescribed in paragraph 68.

71. If more than two levels or strata of clouds are present below 10,000 feet, the lowest stratum and the predominant stratum will be reported. If these are the same, the next higher stratum will be reported.

72. The groups will be placed in the order of the altitude of the clouds reported, the highest being reported first and the lower-most last.

73. The following rules concerning radio or teletype transmission will apply:

(*a*) The number of tenths of the sky covered by the stratum of clouds in question will be indicated by the proper figure. In the event the amount is less than one-tenth, i. e., a few, this will be indicated by the use of the letter F in place of the amount, this to be separated from the cloud-type symbol by an oblique.

(*b*) The type (or predominant type in a stratum) of clouds will be indicated by the following symbols:

CI	Cirrus.	STCU	Strato-cumulus.
CIST	Cirro-stratus.	MCU	Mammato-cumulus.
CICU	Cirro-cumulus.	CU	Cumulus.
AST	Alto-stratus.	NB	Nimbus.
ACU	Alto-cumulus.	ST	Stratus.
ACC	Alto-cumulus-castellatus.	CUNB	Cumulo-nimbus.
		FRST	Fracto-stratus.

(*c*) The direction from which the clouds are moving will be indicated by the regular direction abbreviation in radio transmissions or by the direction arrows if transmitted by teletype, separated from the cloud type by an oblique in the first case.

(*d*) Where the direction is not known, or cannot be determined, the letter U will be used in place of the direction. If the clouds are not moving, i. e., they are calm, this will be indicated by using the letter Z in place of the direction. In either case an oblique will be used to separate these from the cloud abbreviation.

(*e*) If the clouds reported in any group are observed to be moving unusually rapidly, the letter R will be added immediately following the direction.

(*f*) The directions will be given to 16 points.

74. For example, 8CIST/N or 8CIST ↓ would indicate eight-tenths of the sky covered by cirro-stratus moving from the north: 3STCU/SSE or 3STCU ↑ ↖ would indicate three-tenths of the sky covered with strato-cumulus moving from the south-southeast; F/ACC/Z would indicate a few alto-cumulus-castellatus present and these are calm, etc.

75. *Thunderstorms.*—All stations making regular sequence reports by radio or teletype, including those manned by Department of Commerce personnel, will add data concerning thunderstorms observed at the station during the 6-hour period immediately preceding the observations nearest 2 and 8 a. m. and p. m., E. S. T., in accordance with the following, *except when (a) thunderstorm(s) is (are) reported under "Weather" in the current report:*

(*a*) The letter T will be used to indicate "thunderstorm."

(*b*) Immediately following this will be entered a figure 1, 2, 3, 4, 5 or 6, indicating the hour in which a thunderstorm(s) was (were) last observed, "1" applying to the first hour *preceding* the present report, "2" to the second hour, etc.

(*c*) Following this, without space or oblique, will be entered the proper *English direction abbreviation,* to four directions only, for the direction from the station in which the storm(s) was (were) last observed.

76. For example, under the foregoing system T3N would indicate that a thunderstorm(s) was (were) last observed in the third hour preceding the current observation in a direction to the north of the station; T1E would indicate a thunderstorm(s) was (were) last observed in the first hour preceding the current observation in a direction east of the station, etc.

77. All the information required under the foregoing can be obtained at hourly reporting stations by inspection of the data entered on Form 1130-Aer. for the 6 hours preceding the current observation.

XIV. INSTRUCTIONS REGARDING AIRWAY OBSERVATIONS WITH RELATION TO ENTRIES ON FORMS AND USE IN SEQUENCES AND BROADCASTS

78. Regular airway observations fall into three classes, as follows:

(*a*) *Record observation.*—The first observation taken in the hour period, beginning 31 minutes past each hour. This observation will be complete for all elements.

(*b*) *Check observation.*—A check of the visual elements of a report, but using the instrumental readings of the previous *record* or *special observation.* (Although it is entered separately on Form 1130-Aer., it is not to be considered as a separate observation, as it merely brings up to date the visual elements of the previous observations.)

(*c*) *Special observation.*—An entirely new observation taken when a marked change in weather conditions occurs. If such a change occurs at the time of the *record observation,* this observation will be designated a "*special observation*" for broadcast and transmission purposes.

79. The following will govern the period between the taking of the observation and its use in sequences and broadcasts:

(*a*) One *record observation* will be taken each hour at stations where teletype and radio are located during the period these facilities are normally in operation. The observation shall be the one taken for use in the first sequence or broadcast occurring in the period between 31 minutes past one hour and 30 minutes past the next hour.

(*b*) The *record observation* shall be taken within the 5-minute period immediately preceding its *placing* in the sequence or broadcast in which it is to be used, except that in case special data, such as mercurial barometer readings, pressure change, clouds, etc., are required, these may be obtained immediately prior to the beginning of this 5-minute period. The use of ceiling balloons will require additional time and this work may be started 15 minutes before the taking of the regular portions of the report.

(*c*) At stations where only one sequence occurs each hour and no broadcasts are made, the *record observation* will be the only one to be taken, except, of course, that *special observations* will be taken and reported as required by conditions. In this latter connection, the importance of all personnel being alert to report special observations cannot be overemphasized and officials in charge of general supervising stations shall fully instruct all stations that omissions in this regard cannot be tolerated. Failures to send *special observations* will be reported by the direct supervising officials to the Central Office for corrective action when in their judgment this is warranted.

(*d*) At stations located at points where two sequences are run—one immediately following the other—of which the local observation forms a part of each sequence and is broadcast locally with them, the *record observation* will be taken as directed in (*a*) above and this will serve, unless changed conditions require a *special observation*, for the first sequence and its broadcast and the second sequence. However, just before the broadcast of the second sequence, a *check observation* will be taken and filed for the broadcast if *any* change has occurred in the visual elements of the report. Changes falling in this category would include appearance of breaks in overcast, change from clear to scattered clouds, reduction or increase of visibility above 7 miles, etc. For example, under this plan, at a station where sequences were run at 42 and 52 minutes past the hour, the *record observation* would be taken just prior to the placing of the report in the 42-sequence and a *check observation* taken just prior to the broadcast after the second sequence has been run.

(*e*) In case three sequences are run and broadcast, the procedure outlined in (*d*) above will be followed without variation.

(*f*) In the case of 2 sequences being run, such as a "red" and a "brown" sequence—with an interval of time greater than 10 minutes between them—the only change in the plan outlined under (*d*) will be to check the *record observation* as closely as possible to the time of the beginning of the second sequence.

(*g*) At points where broadcasts of local weather are made at 30 minutes past each hour, a *check observation* will be taken just prior to this.

80. *Special observations.*—The foregoing will not eliminate the necessity for maintaining a constant watch of conditions and that *special observations* be filed when required by changed conditions. A *special observation* will be taken and filed without fail whenever the following changes, or combinations of them, occur:

(*a*) Precipitation begins or ends, indicating a change from a period of no precipitation to one with continuous or intermittent precipitation, and vice versa. Under showery conditions it will not be necessary to report each beginning or ending, suitable entry concerning such conditions to be made under "Remarks" of any observations.

(*b*) A thunderstorm not previously reported is observed or occurs, or one previously reported shows marked increase in intensity.

(*c*) A change *from clear to broken* or *from scattered to overcast*, and vice versa, with cloudiness below 10,000 feet i. e., if the sky was originally clear, a special observation will be filed if it becomes broken; if originally scattered, a special will be filed if it becomes overcast, or the reverse.

(*d*) Beginning or ending of fog, and the beginning or ending of dense fog, including dense *ground* fog or dense *ice* fog.

(*e*) A marked increase or decrease in the intensity of precipitation occurs, i. e., light to heavy, or vice versa. Care should be used in classifying precipitation as "heavy", since it is a common error to mistake "moderate" precipitation as "heavy."

(*f*) Any change from one to the other of rain, snow, freezing rain, or sleet.

(*g*) Hail occurs (beginning and ending).

(*h*) A wind-shift line as described in paragraph 57*d* passes the station.

(*i*) Tornadoes, sandstorms, etc., are observed, beginnings and endings if within 7 miles of the station. *Special observations on tornadoes to be reported every 10 minutes.*

(*j*) The ceiling, when originally less than 6,000 feet, lowers one-half or more, or rises two or more times the height given in the previous *record or special observation*, except that when the ceiling lowers to below 500 feet or rises above 500 feet a *special observation* will be filed.

(*k*) The visibility, when originally less than 7 miles, lowers one-half or more or increases two or more times the distance given in the previous *record* or *special observation*, except that when the visibility lowers to 1 mile or rises to above 1 mile a *special observation* will be filed.

(*l*) Sudden and marked increases in wind velocity—a doubling of velocity—when the increases are to velocities exceeding 30 miles an hour; marked shift in wind direction, accompanied by an increase in velocity, particularly from east or south to west or north.

(*m*) Whenever the landing field becomes hazardous for landing under conditions of mud, flood, snow, ice, washouts, etc.

81. The foregoing will not, of course, cover all conditions under which a *special observation* should be filed and this is left to the judgment of the observer as to whether this should be done when conditions not specifically covered in the foregoing occur. For example, it is held that a *special observation* should be filed if the ceiling should lower from 1,000 to say 600 feet, but not reaching 500 feet, even though this is not specifically covered above, etc. The intention is that any change of meteorological importance will be reported as soon as it occurs.

82. *Time of observation.*—(*a*) The time given to any *record* or *check observation* at points where teletype and radio are located and hourly observations are taken throughout the 24 hours, or any portion of them, will be the time of the *beginning* of the sequence or

broadcast in which it is first used. For example, if used first in the sequence beginning at 3:42 a. m. it will be given the time of 0342ES (CS, MS, PS). The time of a *special observation* will be that of the filing of the report.

(*b*) Observations will be timed on the 24-hour-clock basis.

(*c*) At points from which observations are telephoned or telegraphed to another point to be placed in the sequences, the time of observation will be that of the filing of the message.

(*d*) At points forwarding 6-hourly reports by telegraph or telephone, the time of observation will be 45 minutes past the local hours corresponding to 1 and 7 a. m. and p. m., E. S. T.

83. Terminal stations will see to it that the weather observations of that station broadcast at any time shall not have been taken or completely checked more than 15 minutes prior to the beginning of the broadcast, i. e., *record observations* or *check observations* broadcast at any point shall have been taken within 15 minutes of all broadcast schedules. This is not a repetition of instructions given in paragraph 79, except in case those instructions cover all cases at particular stations.

84. *Entry of data on Form 1130–Aer.*—All *record, check and special observations* will be entered in chronological order on Form 1130–Aer., using ditto marks whenever the preceding data in a column is the same, and designated in the "Date" column by the letters R, C, and S, respectively. In order that the *check observation,* as required under paragraph 79, may be indicated, the *record observation* will be entered with its proper time and immediately below this will be entered the *check observation* with the time. For example:

R 1142ES 1500 OVC 8 LGT RAIN (record observation).
C 1200ES " " " " " (check observation).
C 1230ES " " 6 " " HAZY (check observation).

85. The observations will be entered in English, using figures and authorized abbreviations. The use of symbols is not authorized on this form, but, where the data entered in a column is the same for one observation and any following observations, ditto marks may be used to indicate this. When a *special observation* is entered this will be followed by a *check observation* at ensuing checking periods in the hour in place of the *record observation* which it has supplanted. For example:

R 1142ES 1500 OVC LGT RAIN 8 (record observation).
S 1150ES 600 " 2 HVY RAIN (special observation).
C 1200ES " " " " " (check observation).
S 1210ES 1000 " 5 LGT RAIN (special observation).
C 1230ES " " 7 " " (check observation).

The observations shall be entered on Form 1130A–Aer., in symbol form, in the same order.

86. The official in charge of airport and first-order stations furnishing reports on an hourly basis shall inspect the forms daily to see that the above program is carried out. If it is indicated from such inspections that observations are not made as required or that other laxity in the carrying out of the program is evident, he shall inquire into the circumstances thoroughly and caution the observer, or observers, responsible, if necessary. Repeated laxity in this respect upon the part of any of the personnel shall be called to the attention of the Central Office for action. If the fault lies with Department of Commerce personnel, who may be making all or a part of the observations,

the matter should be reported to the Central Office for reference to the proper office of that Department.

87. If laxity in the observational work at any Weather Bureau intermediate point becomes apparent, the general supervising official for the airway will take the matter up with the direct supervising station for corrective action, or direct with the airway observers if the general supervising station is also the direct supervising station. If a station manned by Department of Commerce employees is involved, the general supervising station will take the matter up with the Central Office where it will be taken up with the Department of Commerce.

88. In the event that the transmission of reports by radio or teletype is not practicable from any particular reporting station, due to the failure of these facilities, the next hourly report will be telegraphed, using the check "WEA," or telephoned, collect, to the station on the airway designated by the supervising station for the airway to receive it, and thereafter at 30 minutes past the hours of 1 and 7 a. m. and p. m., E. S. T., so long as the failure continues. Hourly records on Form 1130–Aer. will be kept as usual during such periods. "Special" observations will be reported as required under the conditions. A brief statement concerning the cause of the teletype failure will be included in the first report sent after the failure.

89. Stations reporting by telegraph or telephone, and where *specifically* instructed to do so by the Weather Bureau supervising official for the airway, will *not* forward reports under the following conditions:

(*a*) The sky is clear, or—

(1) Only scattered clouds are present.

(2) Only high clouds (10,000 feet or higher) in any amount are present.

(*b*) No precipitation is occurring or observed and no thunderheads, thunderstorms, squalls, or other conditions tending to hamper or endanger flying are observable from the station.

(*c*) The visibility is not less than 4 miles.

(*d*) The temperature of the dew point (at stations furnishing these data) is not less than 3° lower than the current temperature.

90. At the discretion of the responsible Weather Bureau official, any or all of the reports that would normally be withheld can be called for by him when, in his opinion, conditions warrant such action, and, in fact, this system will only be placed into effect at his discretion after prior approval therefor has been obtained from the Central Office.

91. The observations will be taken and entered on Form 1130–Aer. by the observer just the same as if the reports were transmitted during such periods. The letters "NF" should be entered on Form 1130–Aer. instead of "R", "S", or "C" for such observations as are made but "not filed" for transmission; these would invariably be *record* observations. False entries on these forms for the reason of avoiding the taking of observations at the regular times are easily detected by comparison with surrounding station reports and will occasion the immediate dismissal of the observer responsible, after due investigation.

XV. INSTRUCTIONS FOR MAKING OFF-AIRWAY REPORTS

92. In connection with the issuance of airway forecasts, it is necessary that the forecasters be provided with reports from stations off the airways. To telegraph these in English without code would require a great mnay words and accordingly all stations authorized to forward such reports by telegraph or as a special message by radio will follow the instructions given below.

93. Reports sent by telegraph, or telephone and telegraph and as special messages by radio, will be filed about 20 minutes preceding the hours of 2 and 8 a. m. and p. m. E. S. T., daily, except in cases where specific authority for varying this time has been issued, and except that stations rendering regular SGL D&A reports and telegraphing or/and telephoning 6-hourly reports will not send a report at 8 a. m. and p. m. unless they have been specifically authorized to do so.

94. The following "order of elements" will be used:

(*a*) CEILING, when other than unlimited (uncoded).
(*b*) SKY (uncoded).
(*c*) VISIBILITY (uncoded).
(*d*) WEATHER (uncoded).
(*e*) OBSTRUCTIONS TO VISION (uncoded).
(*f*) TEMPERATURE and DEW POINT (coded).
(*g*) WIND (direction and velocity, coded) (character, uncoded).
(*h*) BAROMETRIC PRESSURE, sea level (coded).
(*i*) REMARKS (uncoded).
(*j*) 3-HOUR STATION PRESSURE CHANGE AND CHARACTERISTIC, including 5,000-foot pressure at designated stations (coded).
(*k*) CLOUDS (coded).
(*l*) THUNDERSTORMS not included under "Weather" (coded).
(*m*) DEPTH OF SNOW, at 8 a. m., E. S. T. (coded).

If for any reason any element or data for enciphering an entire code word are missing, the word "missing" will be sent in its place.

Reports transmitted by telegraph and then relayed by teletype or radio will be placed in the form of sequence reports before being so transmitted, the pressure change, cloud, and thunderstorm data being added in the form prescribed for transmission of such data as an addition to sequence reports in chapter XIII. The height of scattered clouds telegraphed in accordance with paragraph 111 (f) of this chapter will be placed in proper position in the relayed reports, i. e., following the "sky" condition symbol, the average value of the interval indicated by the code word being used, i. e., ONE would be sent as 500, THREE as 2,500, etc. The amount, kind, and direction of the clouds would be transmitted in the special cloud data added to the report in accordance with the instructions in chapter XIII. If the height of a third layer is reported, it will be relayed as a "remark."

95. *Ceiling, sky, visibility, weather,* and *obstructions to vision* will be reported in accordance with the terms and instructions contained in paragraphs 7–11, 12–23, 24–29, 30–33, and 34–38, respectively, of this circular, except that the word "clouds" will not be sent in "sky" reports, and that the height of scattered clouds will be given in the cloud data as prescribed in paragraph 111 (f) rather than in English words for numbers following the "sky" condition.

96. *Temperature and dew point.*—These data will be reported by use of the regular barometer/temperature code words on pages 19–28, inclusive, of the 1931 Weather Code, the first element of the words to represent the temperature and the second the dew point. Thus, DEBOUCH would indicate a temperature of 24° and a dew point of 18°. Stations reporting temperature only will do so by adding LUB to the words for zero or 100° temperature, except in case the words end in L, when UB will be added. This method will also be used at stations which regularly report dew point, but which, for any reason, such as breakage of thermometers, etc., are temporarily unable to do so. Thus, DAMPLUB would indicate a temperature of 22° and the dew point not sent.

97. The values of the temperature and dew point will be coded in accordance with the regular Weather Bureau rule for dropping decimals or figures to meet the limitations of the code, i. e., if the value was 47.0, it would be coded as 46, if 47.2 as 48, if 60.8 as 60, if −13.5 as −14, etc.

98. Below-zero temperatures and dew points will be indicated in the usual manner, i. e., by use of the same code with the value being subtracted from 100. There is practically no opportunity of confusing values under this system, as they occur in all localities in this country at different periods of the year. Thus, SOUSING in winter would indicate a temperature of 12° below zero and a dew point of 14° below zero.

99. *Wind.*—The direction and velocity of the surface wind will be determined in accordance with chapter IX of this circular and will be coded by use of the regular barometer/temperature code on pages 20 to 27, inclusive, of the 1931 Weather Code, using—

BA words for north.
BI words for north-northeast.
DA words for northeast.
DI words for east-northeast.
FA words for east.
FI words for east-southeast.
GA words for southeast.
GI words for south-southeast.
MA words for south.
MI words for south-southwest.
NA words for southwest.
NI words for west-southwest.
RA words for west.
RI words for west-northwest.
SA words for northwest.
SI words for north-northwest.

100. The character of the wind, i. e., fresh, strong or severe gusts, variable, etc., will be indicated in English, immediately following the code word for direction and velocity, when appropriate, in accordance with the terms and instructions given in chapter IX of this circular. For example, BANGING SEVERE GUSTS would indicate a wind from the north, velocity 46 miles per hour, severe gusts occurring. For velocities of 100 miles, use the words for zero or 100° temperature, e. g., SAY would indicate a 100-mile velocity from the northwest. For velocities over 100 miles an hour, the word ONE will be inserted before the code word, e. g., ONE SAVIOR would indicate a velocity

of 106 miles an hour from the northwest. Calm will be indicated by sending the word CALM. Only even velocities will be coded, the next lower even figure being used when the value of the velocity is odd.

101. *Barometric pressure.*—The sea-level barometric pressure will be reported by use of the code words for zero or 100° temperatures taken from the regular barometer/temperature code on pages 19 to 28 of the 1931 Weather Code, only the hundredths being enciphered. Thus, BULK would indicate a pressure of 29.10, 30.10, or 31.10; DEBT, 29.24, 30.24, etc.

102. *Remarks.*—These will be reported in English, when appropriate, immediately following the barometric pressure code word, in accordance with the terms and instructions given in chapter XII of this circular.

103. *Pressure change and characteristic* (including 5,000-foot pressure at designated stations).—These data will be entered immediately following the "Remarks", or the "Barometric pressure", if no remarks are sent.

104. Certain selected stations in the western Plateau and mountain region will transmit pressures reduced to the 5,000-foot plane in their 6-hourly airway weather reports, enciphering these data in conjunction with the pressure-change data. The Weather Bureau Airport Station, Oakland, Calif., has been designated to carry out the 5,000-foot-pressure project. Stations which are not selected to transmit 5-000-foot pressures will merely transmit the pressure-change data, while stations selected for this purpose will transmit both the pressure-change data and the 5,000-foot pressures. *The latter stations will be notified regarding their selection by correspondence,* wherein the necessary instructions for reducing the pressures to the 5,000-foot plane will also be given.

105. The system of coding the data is somewhat different at stations having a barograph from that at stations where this instrument is not available. Stations will be governed, therefore, in accordance with the following:

(*a*) Station has a barograph.

1. The *station pressure* change and pressure characteristic will be enciphered in accordance with instructions given in paragraphs 33 to 39, inclusive, of the 1931 Weather Code, using the code words given on pages 37 to 46 of the same code. Stations not transmitting the 5,000-foot pressure will use the appropriate code words for 100° to 0°, while stations transmitting the 5,000-foot pressure will encipher this datum (hundredths only, omitting whole inches) by the code words corresponding to a maximum (or minimum) temperature numerically equal to the 5,000-foot pressure (hundredths only).

2. *Examples:*

Station which *does not* transmit 5,000-foot pressure, "Debt" signifies "barometer unsteady, but 0.03 or 0.04 inch higher than 3 hours previous."

Station which does transmit 5,000-foot pressure "Deserve" signifies "barometer unsteady, but 0.03 or 0.04 inch higher than 3 hours previous; pressure at 5,000-foot plane 24.84 inches."

(*b*) Station has no barograph.

1. The net 3-hourly *station pressure* change and the direction of the change will be indicated by selecting either an F (for *rising* pressure) or an S (for *falling* pressure) word from pages 40 or 45 of the 1931

Weather Code. Stations not transmitting the 5,000-foot pressure will use the appropriate code words for 100° or 0°, while stations transmitting the 5,000-foot pressure will encipher this datum by using the F or S code words corresponding to a maximum (or minimum) temperature numerically equal to the 5,000-foot pressure (hundredths only, omitting whole inches).

2. *Examples:*

Station *does not* transmit 5,000-foot pressure "Fish" signifies "barometer rose net amount of 0.05 or 0.06 inch during previous 3 hours."

Station *does* transmit 5,000-foot pressure, "Finance" signifies "barometer rose net amount of 0.50 or 0.06 inch during previous 3 hours; pressure at 5,000-foot plane 24.62 inches."

106. If the 3-hourly pressure change is 0.10 inch or more, it will be enciphered as "0.07 or more", but an appropriate K word will be added as the next word to indicate the total change. K words appear on page 47 of the 1931 Weather Code. (See par. 39 and following example, 1931 Weather Code.)

107. Stations which do not make hourly observations but do make 6-hourly observations, and have no barograph, will compute the net *3-hourly pressure change* as one-half of the change between the previous *6-hourly station pressure* and the *current station pressure.*

108. When reports are to be relayed from the telegraph to the teletype or radio, the code words in question must be converted to the proper numerical and letter code described in chapter XIII.

109. *Clouds.*—The amount, type, and direction of any clouds present will be reported in code immediately following the pressure-change word. Opportunity is taken here to stress the importance of accurate cloud observations in forecasting work, recent indications being that those have not always been as accurate as might be, particularly those taken at night. Such observations themselves should and are intended to represent an instantaneous view of the distribution of cloudiness over the sky at the moment of observation, i. e., the observer will report the amounts and types (as outlined below) of cloudiness *actually visible* as projected against the plane of the sky, the amounts to be determined by independent estimates of the amount of cloudiness and the amounts of blue or open sky, when appropriate.

110. The total amount of clouds reported in any one observation shall not exceed ten-tenths.

111. The following will govern the use of the code words:

(*a*) Not more than 3 code words will be used in any one report; not more than 1 being for clouds at or above 10,000 feet altitude and not more than 2 being for clouds below that altitude. The C words from the 1931 Weather Code will be used, but as it is important that the odd tenths of sky covered be enciphered, the letter "s" or the suffixes "es" or "ies", as required, will be added to the code words to indicate this, except those for amount of one-tenth or less. For instance, the code words for cirrus or cirro-stratus from the northwest would read as follows under this system:

CURTSY	one-tenth.	CURSING	six-tenths.
CUPSAIL	two-tenths.	CURSINGS	seven-tenths.
CUPSAILS	three-tenths.	CURSORY	eight-tenths.
CURSER	four-tenths.	CURSORIES	nine and ten-tenths.
CURSERS	five-tenths.		

(*b*) One word only will be used to report the clouds at or above 10,000 feet altitude. These clouds will consist of the cirrus, cirro-stratus, and cirro-cumulus types, and occasionally intermediate clouds of the alto-stratus and alto-cumulus types. The predominating *type* only will be enciphered when more than one type is present, but the *amount* indicated will be the *sum* of the amount of sky covered by the various types and the direction given will be that of the predominant type present.

(*c*) In reporting lower clouds, i. e., those below 10,000 feet, the level or stratum will be regarded as the unit to be reported rather than indication of each of the various types present. Therefore, if only one stratum (by stratum is meant a layer of clouds at the same altitude) of lower clouds covering one-tenth or more of the sky is present, one code word will be used to encipher them, the code word to indicate the predominant type in the stratum. If two strata are present, each covering one-tenth or more of the sky, two code words are to be used, the predominating type in each stratum to be enciphered, except that in case both strata are of the same type of clouds only one code word will be used, the amount given being the sum of the two strata and the direction that of the stratum covering the most sky. In the event that amounts are equal, the direction given will be that of the lower layer.

(*d*) If clouds at or above 10,000 feet are present, and clouds below that height are also present, the lower strata will be reported as prescribed in (*c*) above and the upper clouds as prescribed in (*b*), making sure that the total of lower and upper clouds enciphered does not exceed ten-tenths.

(*e*) If more than two levels or strata of clouds are present below 10,000 feet, each covering one-tenth or more of the sky, the lower stratum and the predominant stratum will be enciphered. If these are the same, the next higher stratum will also be coded.

(*f*) Since the forecaster does not have any information as to the height of the lower stratum of clouds present, unless these constitute a ceiling covering six-tenths or more of the sky, the altitude of the lowest layer of clouds enciphered in a code word will be indicated by insertion of the proper term from the following table, immediately preceding the cloud code word referred to, *providing that* this code word is for less than six-tenths of sky covering:

ONE	From the surface to 1,000 feet (average, 500 feet).
TWO	From 1,001 to 2,000 feet (average, 1,500 feet).
THREE	From 2,001 to 3,000 feet (average, 2,500 feet).
FOUR	From 3,001 to 4,000 feet (average, 3,500 feet).
FIVE	From 4,001 to 5,000 feet (average, 4,500 feet).
SIX	From 5,001 to 6,000 feet (average, 5,500 feet).
SEVEN	From 6,001 to 7,000 feet (average, 6,500 feet).
EIGHT	From 7,001 to 8,000 feet (average, 7,500 feet).
NINE	From 8,001 to 9,000 feet (average, 8,500 feet.)
TEN	From 9,001 to 9,750 feet (average, 9,500 feet).

For example: CURRENCY ONE CHAINSAWS would indicate four-tenths cirrus and three-tenths stratus present, the latter being at an altitude between the surface and 1,000 feet above the surface.

(*g*) The words enciphered for the various levels shall be put in the same order as provided in the 1931 Weather Code, i. e., the highest

clouds first and then following in the order of altitude, with the lowermost last.

(*h*) When the motion of any clouds enciphered is unusually rapid, the word "RAPID" shall be inserted immediately following the code word to which it refers.

(*i*) The following code words will be used for "calm" and "unknown":

CALM

Cloud type	⅛o or less	2 or 3 tenths	4 or 5 tenths	6 or 7 tenths	8, 9, or 10 tenths
Ci. or Ci.-St.	Cull.	Curval.	Curley.	Cupid.	Cuckoo.
Ci.-Cu. or A.-Cu.	Catch.	Calvar.	Cake.	Caking.	Callow.
A.-St.	Cent.	Cellar.	Celeste.	Ceiling.	Cesspool.
Cu.	Circum.	Cicala.	Cicero.	Cilium.	Cinco.
St.-Cu.	Cocky.	Collar.	Copper.	Coppice.	Coco.
St.	Chilly.	Choppage.	Chopper.	Choaking.	Chico.
Nb. or Cu.-Nb.	Clanky.	Clovak.	Clapper.	Craking.	Crimpole.

UNKNOWN

Ci. or Ci.-St.	Cuzzy.	Cuzald.	Cuzel.	Cuzilt.	Cuzolp.
Ci.-Cu. or A.-Cu.	Cazy.	Calzan.	Cazell.	Cazif.	Cazole.
A.-St.	Cezule.	Cezayo.	Cezery.	Cezist.	Cezode.
Cu.	Cirzule.	Cizalm.	Cilzer.	Clpzil.	Cilzor.
St.-Cu.	Cozup.	Cozate.	Cozener.	Cozine.	Cozorp.
St.	Chozy.	Chizam.	Chazol.	Chezipe.	Chazop.
Nb. or Cu.-Nb.	Clazule.	Clazart.	Crazed.	Clozir.	Cruzol.

112. Mammato-cumulus or alto-cumulus castellatus clouds will not be reported separately but will be coded as cumulus and alto-cumulus, respectively, when observed. Fracto-stratus will be coded as stratus.

113. *Thunderstorms.*—Thunderstorms occurring at the station or in the distance at the time of observation will, of course, be reported under "Weather", as provided in chapter V of this circular. However, it is important to the forecaster receiving the reports to have information concerning storms which may have been observed in the interval between reports from a particular station. It is especially important that he have information as to when thunder was last heard, and the direction from the station in which the storm was last observed, i. e., if the last storm observed in the period between the observations occurred 2 hours ago and was last observed in the northeast, this information would indicate that the condition causing the storms had disappeared as regards that particular station. Therefore, the last thunder heard and the direction of the storm from the station will be reported in code words built up in accordance with the following, *provided no storm is reported under "Weather" in the current observation:*

(*a*) The first two letters will be TH.

(*b*) Following this will be a vowel selected from the following list. This will indicate the number of hours to the nearest hour preceding the current observation that a thunderstorm(s) was (were) last observed from the station.

A=first hour preceding current observation.
E=second hour preceding current observation.
I=third hour preceding current observation.
O=fourth hour preceding current observation.

U=fifth hour preceding current observation.
Y=sixth hour preceding current observation.

(*c*) Following the time letter the abbreviations for 1 of the 4 cardinal directions, i. e., north, east, south, and west, will be entered. This will indicate the direction from the station in which the last storm(s) visible from the station was (were) observed.

114. For example, under the foregoing system THAN would indicate that the last thunderstorm visible from the station was last observed in the hour preceding the current observation in a direction north of the station; THIS would indicate that the storm last observed from the station occurred in the third hour preceding the present observation south of the station, etc. *Code words as prescribed above will not be sent if a thunderstorm is reported in the current observation under "Weather."*

115. *Depth of snow.*—This will be reported from stations forwarding reports by telegraph or as a special message by radio at 8 a. m., E. S. T., by use of the "Depth of Snow" words taken from the list given on page 72 of the 1931 Weather Code.

116. *Examples of reports.*—The letters in the first column refer to the same letters and elements under paragraph 94.

(A) (8 a. m. observation). Station has barograph and reports 5,000-foot pressure.

Words entered:	Translation.
(*a*) ———	Ceiling, unlimited.
(*b*) CLEAR	Sky, clear.
(*c*) THREE	Visibility, 3 miles.
(*d*) ———	Weather omitted, none to report.
(*e*) BLOWING SNOW	Obstructions to vision.
(*f*) BACILLUS	Temperature, 12°; dew point, 6°.
(*g*) BANGER SEVERE GUSTS	Wind, north, 44 miles per hour; severe gusts.
(*h*) FULL	Barometer, 30.30.
(*i*) ———	Remarks omitted, none to report.
(*j*) FINANCE	Pressure change. Barometer steady or rising, rose net amount of 0.05 or 0.06 inch during previous 3 hours; pressure at 5,000-foot plane, 24.62.
(*k*) ———	No clouds.
(*l*) ———	No thunderstorms.
(*m*) YULGUF	4 inches snow on ground.

Body of message sent:

CLEAR THREE BLOWING SNOW BACILLUS BANGER SEVERE GUSTS FULL FINANCE YULGUF.

(B) (2 a. m. observation). Station has no barograph and does *not* report 5,000-foot pressure.

Words entered:	Translation.
(*a*) THREE THOUSAND	Ceiling, 3,000 feet.
(*b*) BROKEN, LOWER SCATTERED	Sky condition; broken, lower scattered clouds.
(*c*) FOUR	Visibility, 4 miles.
(*d*) LIGHT RAIN	Weather condition.
(*e*) HAZY	Obstructions to vision.
(*f*) RUNNING	Temperature, 70°; dew point, 66°.
(*g*) RIBBED	Wind, west-northwest, 14 miles per hour.
(*h*) US	Barometer, 30.00.
(*i*) DARK IN WEST	Remarks.

Words entered:	Translation
(*j*) SING	Pressure change, 0.05 to 0.06 inch lower than 3 hours previous.
(*k*) COGNIZANT	6/10 strata-cumulus, southwest.
TWO CHINAS	3/10 stratus, southwest, between 1,000 and 2,000 feet.
(*l*) THAN	Thunderstorm last observed during first hour preceding this observation, north of station.
(*m*) ———	No snow.

Body of message sent:

THREE THOUSAND BROKEN LOWER SCATTERED FOUR LIGHT RAIN HAZY RUNNING RIBBED US DARK IN WEST SING COGNIZANT TWO CHINAS THAN.

(C) (2 p. m. observation.) Station has barograph but does not report 5,000-foot pressure.

Words entered:	Translation
(*a*) FIFTEEN HUNDRED	Ceiling, 1,500 feet.
(*b*) HIGH SCATTERED LOWER BROKEN.	Sky condition; high scattered, lower broken clouds.
(*c*) EIGHT	Visibility, 8 miles.
(*d*) ———	Weather omitted, none to report.
(*e*) ———	Obstructions to vision omitted; conditions absent.
(*f*) SEROTINE	Temperature, 84°; dew point, 78°.
(*g*) GILBY	Wind, south-southeast, 10 miles per hour.
(*h*) TOLD	Barometer, 29.98.
(*i*) SHOWERS VISIBLE WEST	Remarks.
(*j*) SEEK	Pressure change; barometer falling, 0.03 to 0.04 inch lower than 3 hours previous.
(*k*) CARAMEL	2/10 alto-cumulus, west.
CONTRITE	6/10 strato-cumulus, west.
(*l*) THOE	Thunderstorm last observed east of station fourth hour preceding present observation.
(*m*) ———	No snow.

Body of message sent:

FIFTEEN HUNDRED HIGH SCATTERED LOWER BROKEN EIGHT SEROTINE GILBY TOLD SHOWERS VISIBLE WEST SEEK CARAMEL CONTRITE THOE.

XVI. CLOUDS

117. It is very desirable and necessary that the observer be entirely familiar with the various cloud types which he will observe during the course of rendering airway observations. This will be of great assistance to him in estimating ceiling heights and in determining whether or not a particular type of clouds observed may be classed as "high" or "lower" merely by inspection. Also, the reporting of cloud types is required in the special 6-hourly data from designated stations, and the observer must be familiar with them before he can make accurate reports. Further, the cloud types are to any one somewhat versed in meteorology a good indicator of imminent weather, and are thus of great value to the forecaster. All observers will, therefore, carefully study the cloud illustrations, descriptions, and table following.

CIRRUS (Ci.)

118. Detached clouds of delicate and fibrous appearance, often showing a featherlike structure, generally of whitish color. Cirrus clouds take the most varied shapes, such as isolated tufts, thin filaments on a blue sky, threads spreading out in the forms of feathers,

FIGURE 4.—Tufted cirrus. (F. Ellerman.)

curved filaments ending in tufts, etc. They are invariably composed of ice crystals, their average height being, winter and summer, about 30,000 feet. In the interpretation of this circular they would be designated as "upper" or "high" type clouds.

CIRRO-STRATUS (Ci.–St.)

119. A thin, whitish sheet of clouds, sometimes covering the sky completely and giving it only a milky appearance; at other times presenting, more or less distinctly, a formation like a tangled web. This

FIGURE 5.—Cirrus (top half) and cirro-stratus (bottom half). (A. J. Weed.)

sheet often produces halos around the sun and moon. These clouds, like cirrus, are composed of ice crystals, have an average height, winter and summer, of about 30,000 feet, and are classified as "upper" or "high" type clouds.

CIRRO-CUMULUS (Ci.–Cu.)

120. Sometimes called "mackerel sky." Small globular masses or flakes without shadows, or showing very slight shadows, arranged in groups and often in lines. Like the other cirrus forms, these are composed of ice crystals The average height, however, is somewhat

FIGURE 6.—Cirro-cumulus, overhead. (E. E. Barnard.)

lower, averaging, winter and summer, about 22,000 feet, although they may be as low as 10,000 or as high as 35,000 feet. They are "upper" or "high" type clouds.

ALTO-STRATUS (A.-St.)

121. A thick sheet of gray or bluish color, sometimes forming a compact mass of dark-gray color and fibrous structure. At other times the sheet is thin, resembling thick Ci.-St., and through it the sun or moon may be seen dimly, as through ground glass. These clouds are usually composed of water vapor and have an average height of 20,000 feet in summer and 14,000 feet in winter, but may

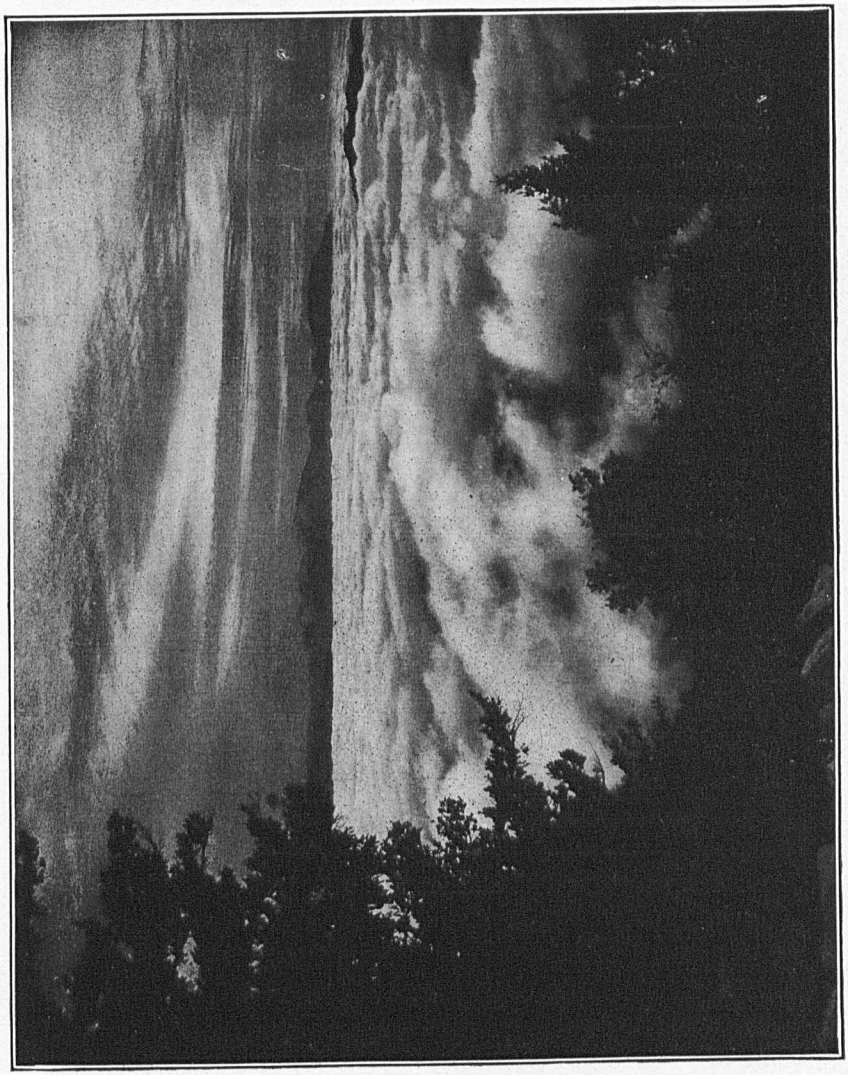


FIGURE 7.—Alto-stratus above a layer of fog or stratus. (F. Ellerman.)

be as low as 8,000 feet and as high as 32,000 feet in summer, and as low as 4,000 feet and as high as 32,000 feet in winter. They are classed as "intermediate" type clouds. For the purposes of this circular, if these clouds are estimated to be over 9,750 feet, they will be termed "high"; if below, they will be termed "lower", in accordance with paragraphs 17 and 18.

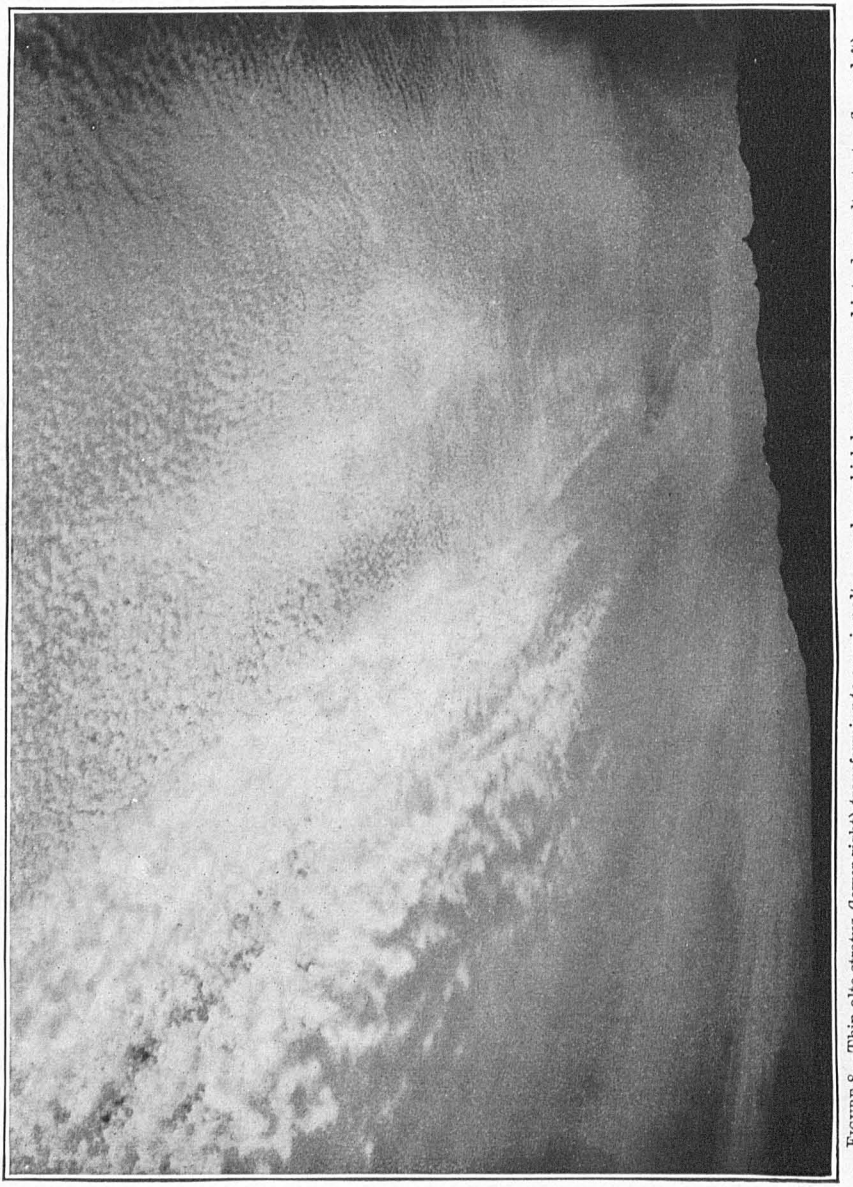


FIGURE 8.—Thin alto-stratus (lower right) transforming to growing alto-cumulus, which becomes merged into dense alto-stratus (lower left).
(Ebro Observatory.)

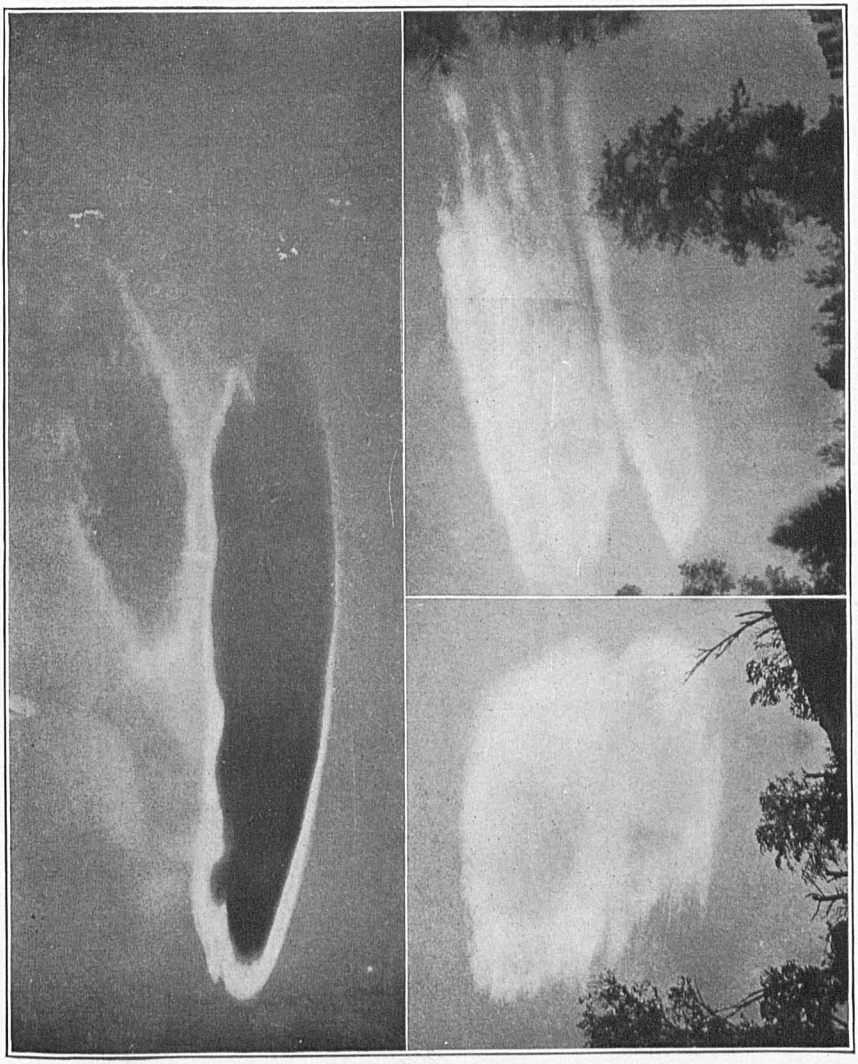


FIGURE 9.—Lenticular alto-stratus. (First two, C. F. Brooks.)

ALTO-CUMULUS (A.-Cu.)

122. Large globular masses, white or grayish partly shaded, arranged in groups or lines, and often so closely packed that their edges appear confused. The detached masses are generally larger and more compact (resembling St.-Cu.) at the center of the group, but the

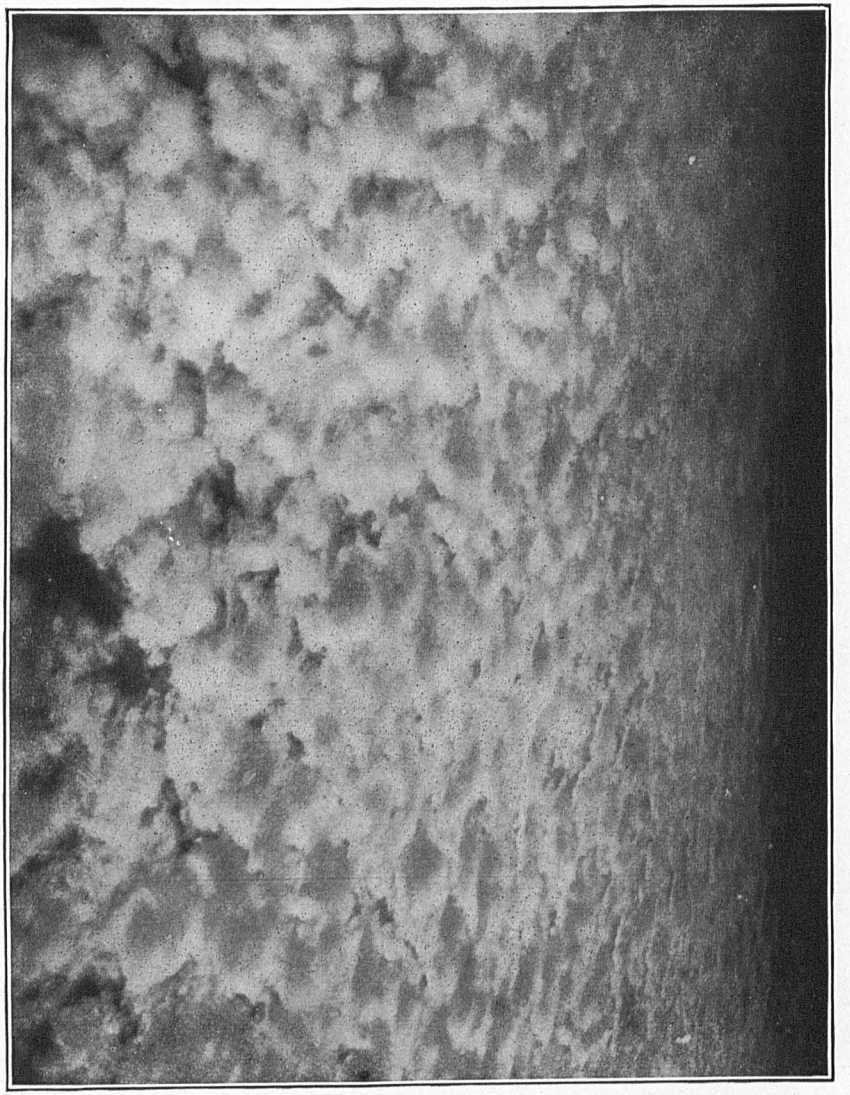


FIGURE 10.—Alto-cumulus. (A. J. Weed.)

thickness of the layer varies. These clouds are classed as an "intermediate" type. For the purposes of this circular, if these clouds are estimated to be over 9,750 feet, they will be termed "high"; if below, they will be termed "lower", in accordance with paragraphs 17 and 18.

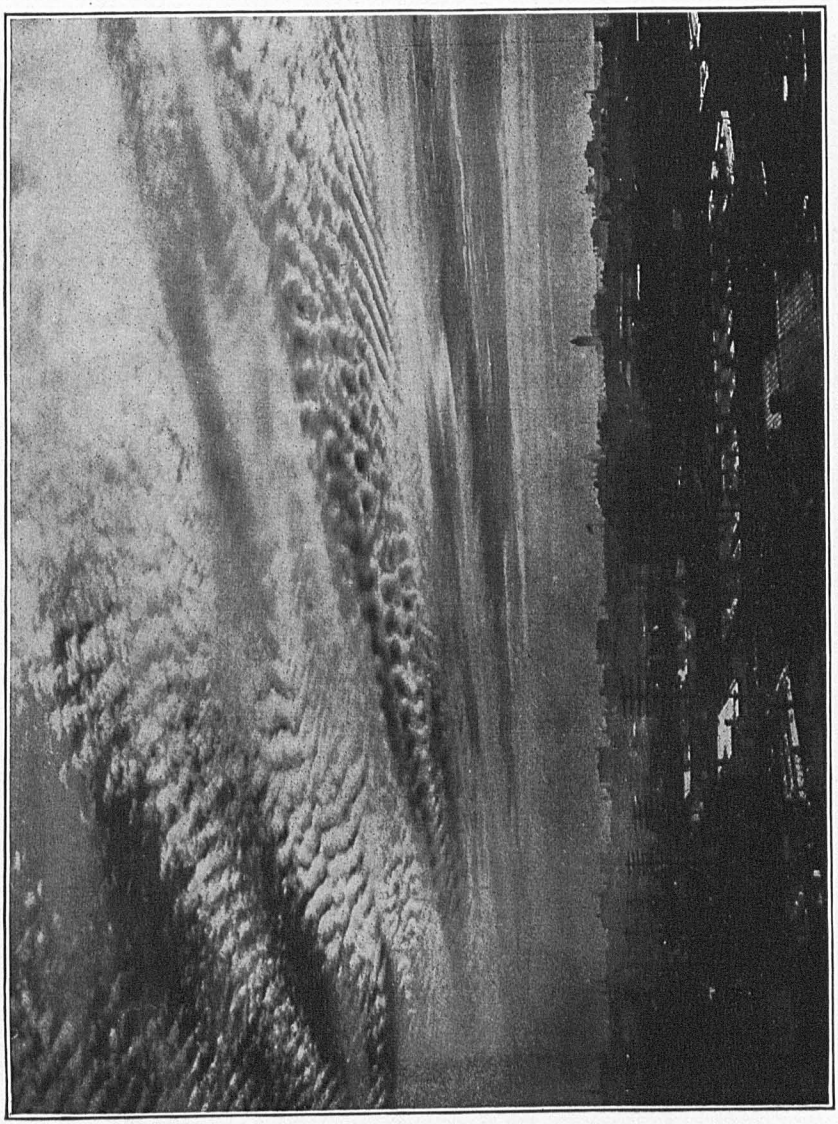


FIGURE 11.—Undulated alto-cumulus. (A. J. Henry.)

ALTO-CUMULUS CASTELLATUS (ACC)

123. Generally composed of a series of small cumuliform masses with more or less vertical development, arranged in line and resting on a common horizontal base; this gives the cloud a crenellated appearance. Their average height covers approximately the same range as that of true alto-cumulus. These clouds are evidence of

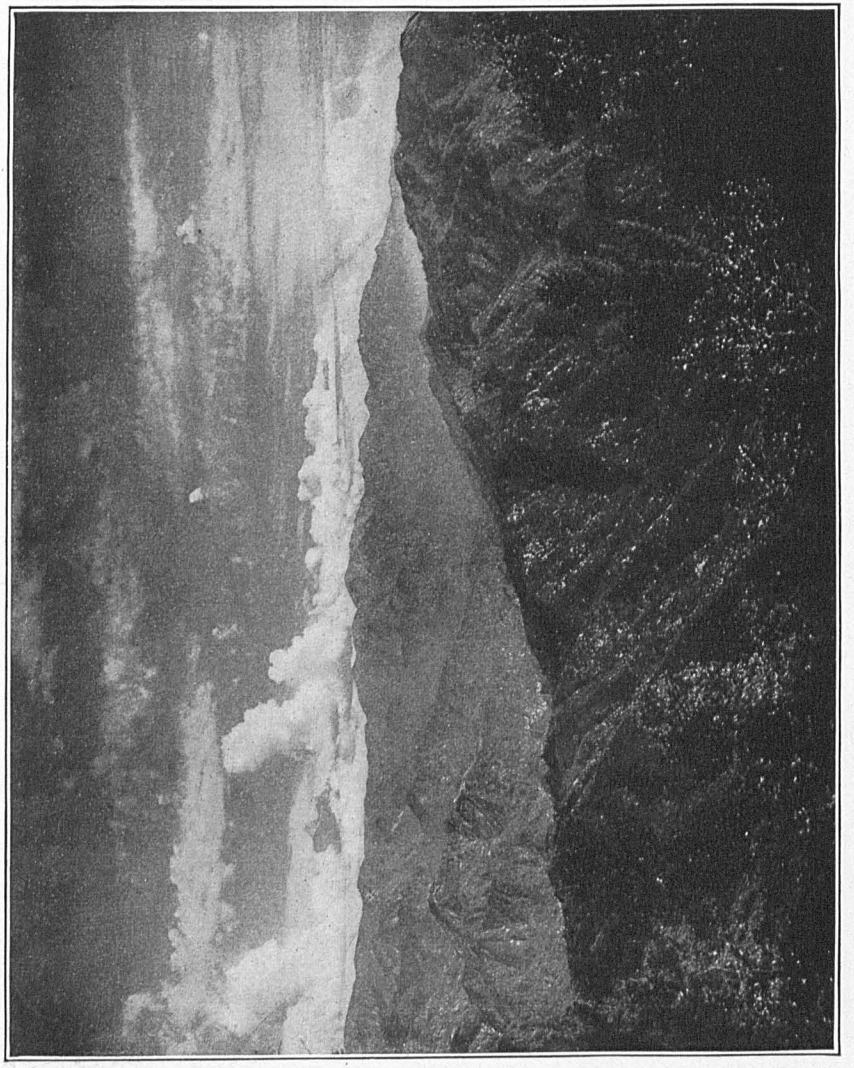


FIGURE 12.—Alto-cumulus castellatus (turreted alto-cumulus). Tall cumulus below. (Turreted alto-cumulus usually grow up from a base of thin, usually undulated alto-stratus.) (F. Ellerman.)

atmospheric instability and are the precursers of thunderstorms, the variety described first above often appearing considerably in advance of the formation of the storms. Care should be taken by the observer to add a "remark" to regular reports on the first appearance of these clouds, and they are to be reported under the cloud data which are added to the regular reports at the 6-hourly periods.

STRATO-CUMULUS (St.-Cu.)

124. Large globular masses, or rolls, of dark clouds, often covering the whole sky, especially in winter. Sometimes these clouds present the characteristic appearance of great rolls arranged in parallel lines and pressed against one another. Blue sky may be seen through the

FIGURE 13.—Ragged strato-cumulus rolls below fibrous alto-stratus. (Ebro Observatory.)

intervening spaces which are of much lighter color. St.-Cu. clouds may be distinguished from cumulus by their globular or rolled appearance, and by the fact that they are not generally associated with rain. Average heights and other data are given in table 5.

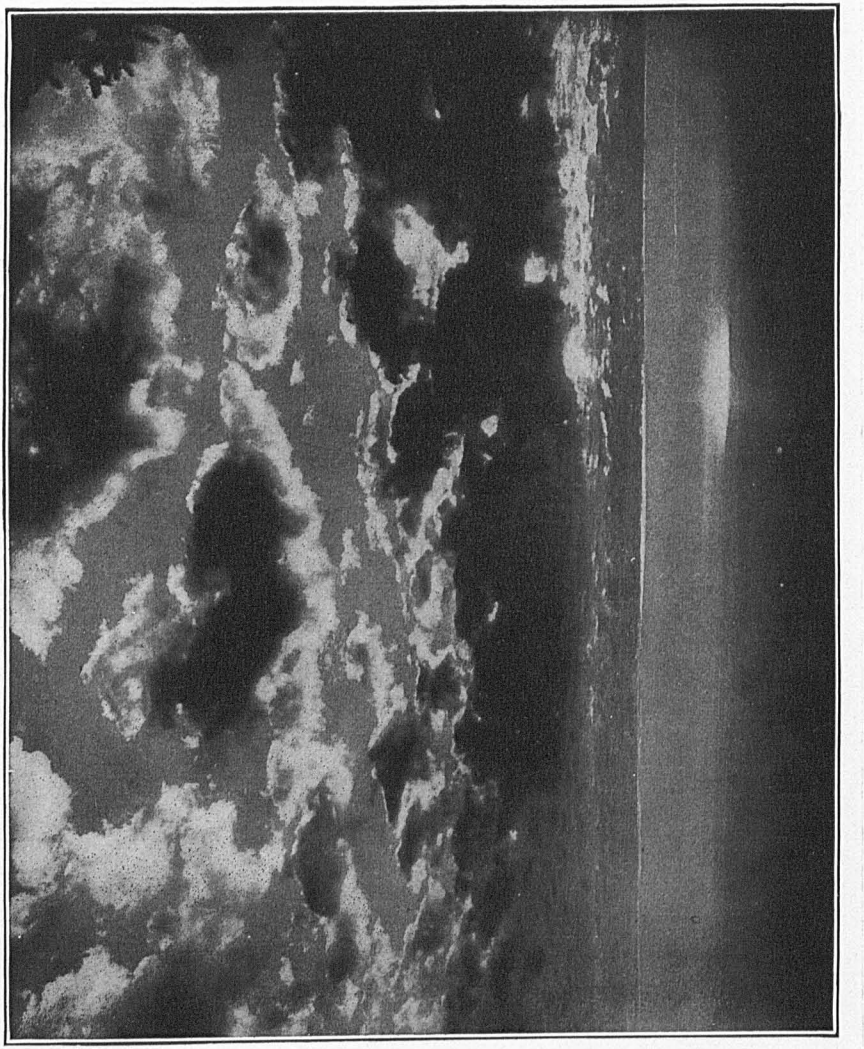


FIGURE 14.—Strato-cumulus. (F. Ellerman.)

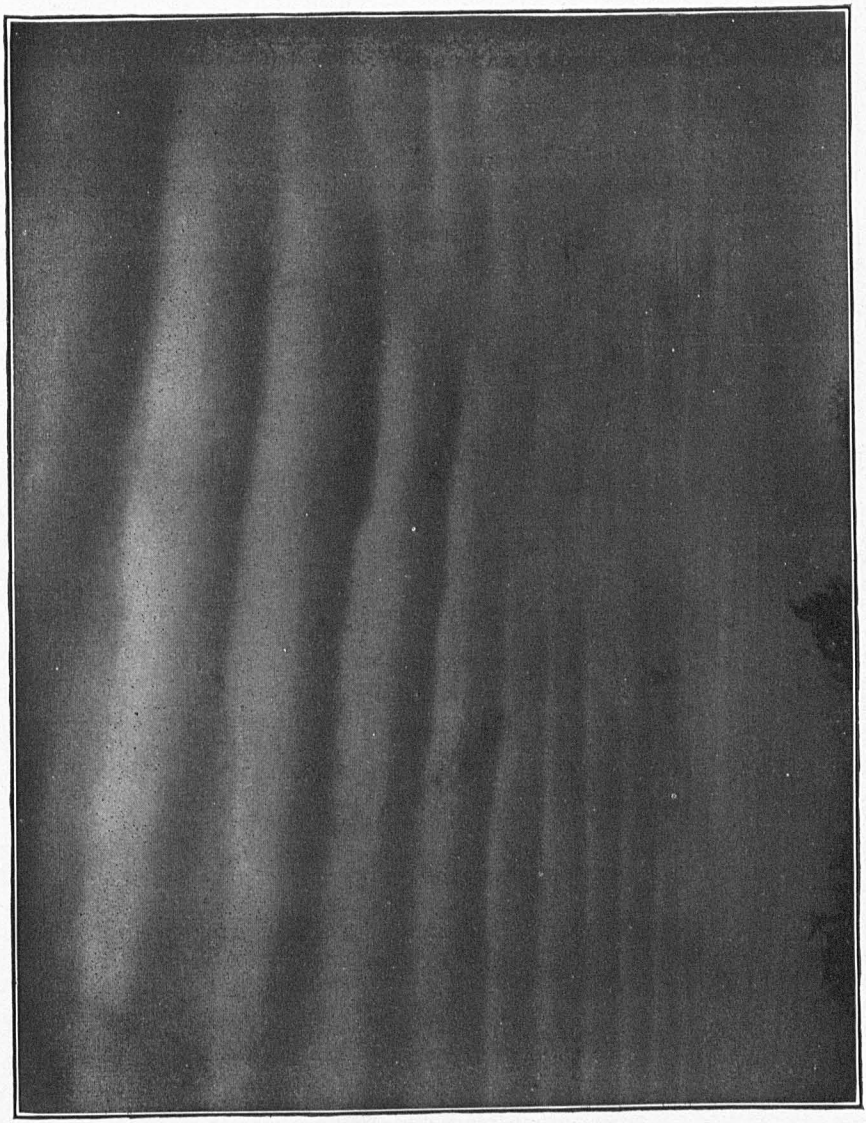


FIGURE 15.—Strato-cumulus rolls. (W. S. Davis.)

CUMULUS (Cu.)

125. Sometimes referred to as "wool-pack clouds." Thick clouds, of which the upper surface exhibits protuberances, while the base is horizontal. These clouds appear to be formed by a diurnal ascensional movement of the air, which is always noticeable. True cumulus has well-defined upper and lower limits, but in strong winds, this cloud sometimes breaks and undergoes continual changes. They are generally a fair-weather cloud, and each is usually quite distinct from others surrounding it.

CUMULO-NIMBUS (Cu.-Nb.)

126. Also known as "thunderhead" or "shower cloud." Heavy masses of cloud, rising in the form of mountains, turrets, or anvils, generally surrounded by a sheet or screen of fibrous appearance (false cirrus) and having at its base a mass of cloud similar to nimbus. From the base, local showers of rain or snow (occasionally of hail or soft hail) usually fall. This cloud is quite easily distinguished by the observer and is a source of thunderstorms. The observation of these clouds from the station should always be reported under "Remarks" as "thunderheads", giving their direction from the station.

MAMMATO-CUMULUS (M.-Cu.)

127. A sheet of cloud from which bulbous appendages apparently hang. These clouds are evidence of great atmospheric instability and usually form in the neighborhood of intense local disturbances, such as violent thunderstorms, tornadoes, etc. For this reason they will be reported under "Remarks" whenever observed, irrespective of whether or not they are also reported as a cloud type present in the cloud data added to the reports at the 6-hourly periods, e. g., "mammato-cumulus overhead", "mammato-cumulus in west", etc.

NIMBUS (Nb.)

128. Rain clouds. A thick layer of dark clouds, without shape and with ragged edges, from which steady rain or snow usually falls. Through any openings in these clouds an upper layer of cirro-stratus or alto-stratus may be seen almost invariably. They are almost always quite low, usually under 2,000 feet. Observers should be extremely careful in reporting ceiling heights when these are present, as their height is hard to estimate or measure, due to their lack of definite form.

STRATUS (St.)

129. A uniform layer of cloud, resembling a fog, but not resting on the ground. These clouds also are usually quite low and rain or snow frequently accompanies them. They are frequently associated with "icing" conditions in winter.

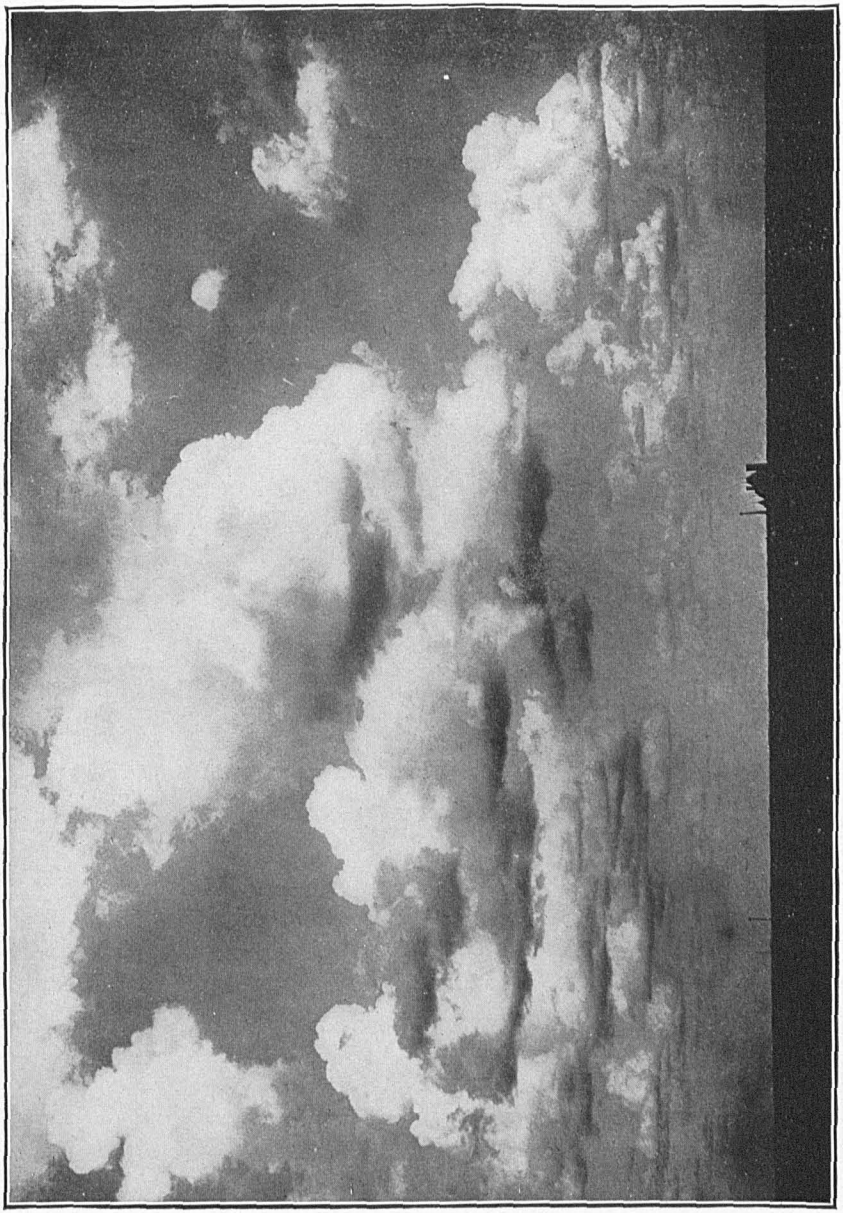


FIGURE 16.—Cumulus. (W. M. Lyon.)

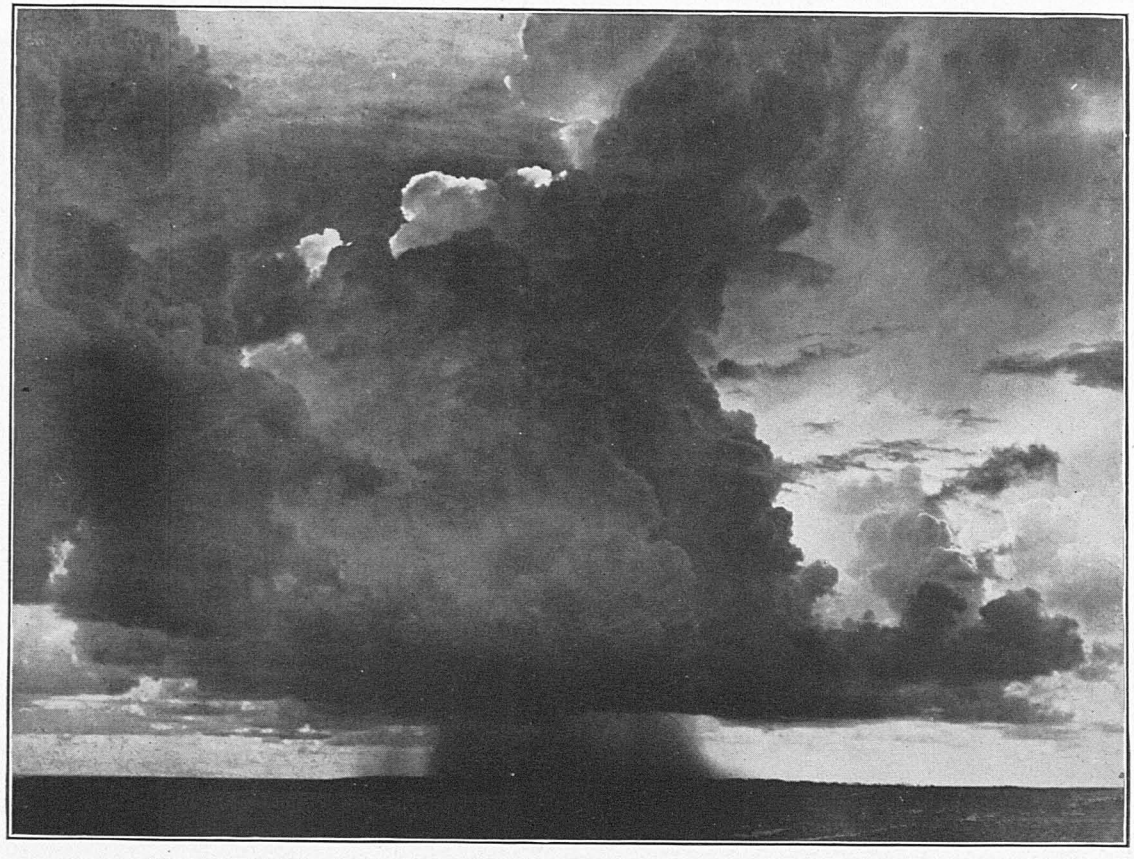


FIGURE 17.—Cumulo-nimbus. Extremely well developed. Note heavy shower. (Air Service, U. S. N.)

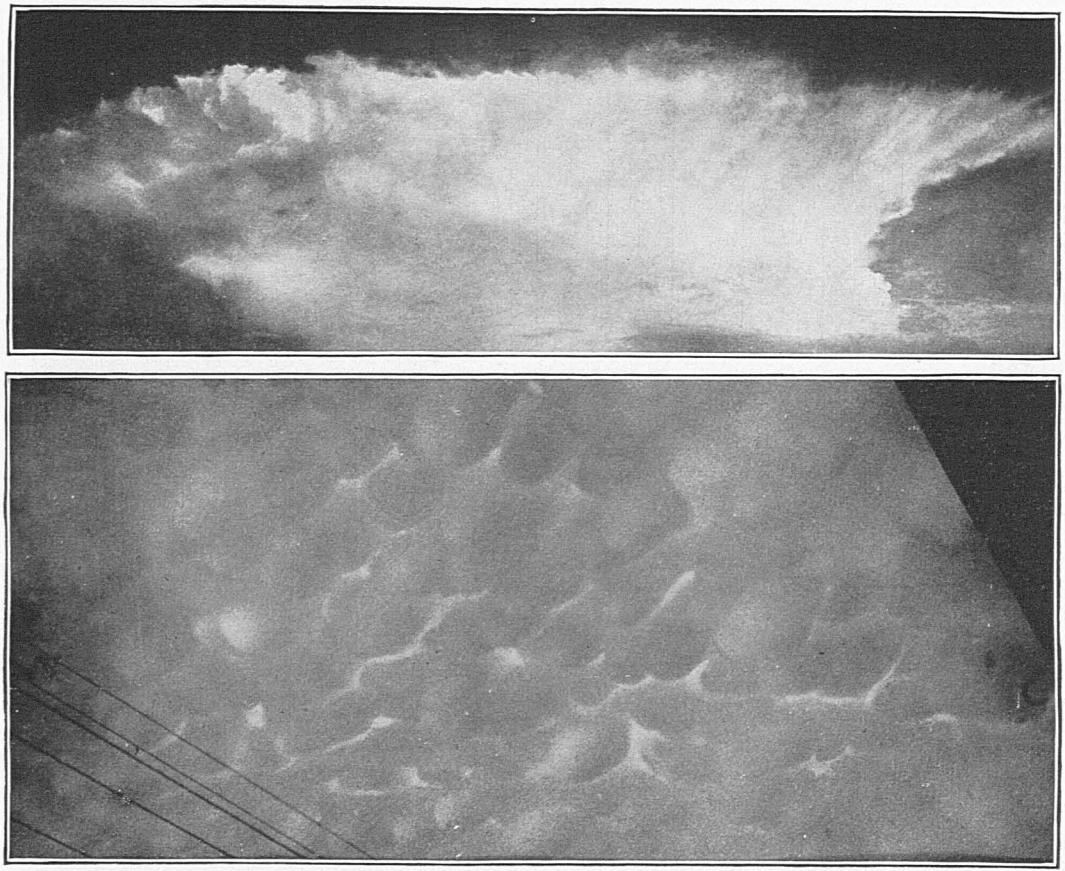


FIGURE 18.—Anvil top of cumulo-nimbus (upper). Mammato-cumulus on under side of cumulo-nimbus overflow in vicinity of tornado (lower). (J. Loisel, L. C. Twiford.)

FRACTO-STRATUS (Fr.-St.)

130. Ragged, wind-blown stratus clouds, usually termed "scud", and with approximately the same elevation and other characteristics as stratus clouds.

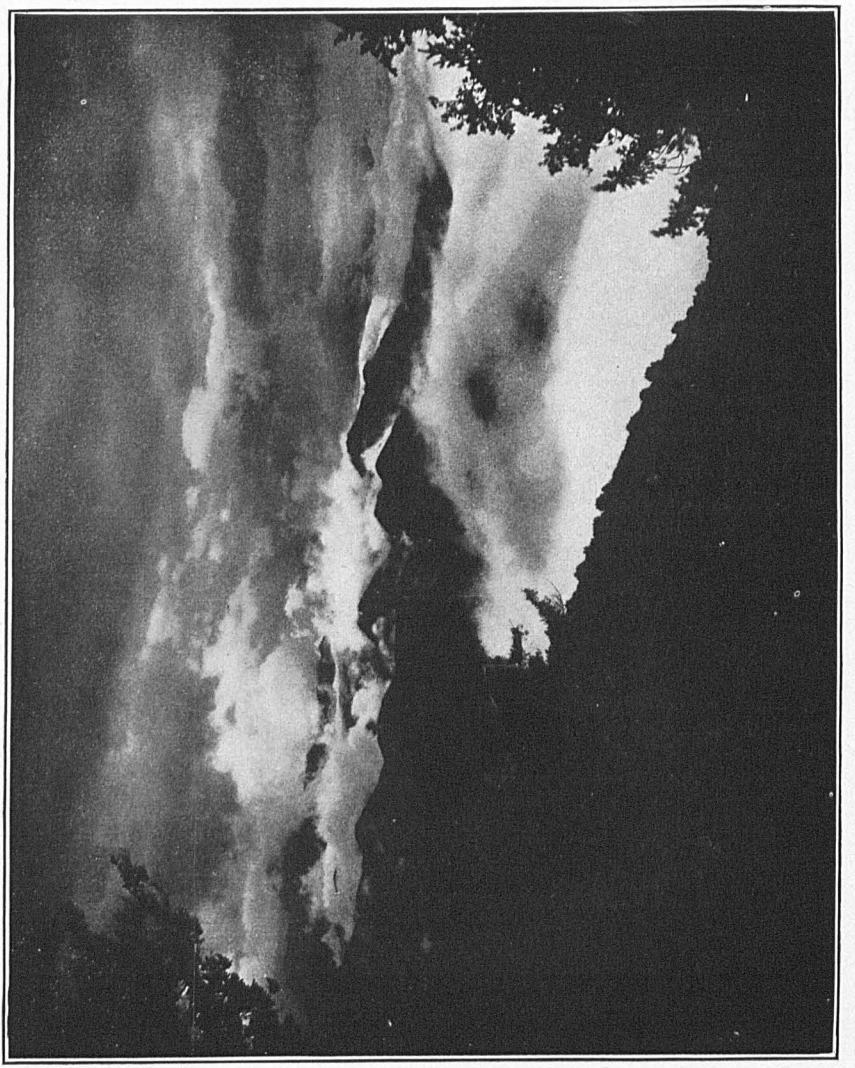


FIGURE 19.—Nimbus, with fog or stratus below. (F. Ellerman.)

131. When any of the first three forms appear (Ci., Ci-St., and Ci-Cu.) it can be safely assumed that the ceiling is unlimited, as the lowest possible altitudes of these types of clouds are well above the usual range of airplanes. This will also very often be the case with the next two forms classified, i. e., A.-St., and A.-Cu., although it will be noted that these clouds are sometimes as low as 2,500 to 4,000 feet.

132. It is sometimes hard to distinguish between A.-St. and St.; also, there will sometimes be doubt as to whether cloud is A.-Cu., St.-Cu., or Cu. In such cases it is better to err on the safe side, and consider the clouds as being of the lower type and estimate the height of their base accordingly.

133. Cu.-Nb. is usually a detached cloud, covering but a small portion of the sky. Its presence in the sky is, therefore, of importance not so much from the standpoint of ceiling, as that it often portends the occurrence or development of a thunderstorm. The nimbus is the rain cloud, and is nearly always low. The stratus base is also usually low, varying from a few hundred feet above the ground to a few thousand feet.

TABLE 5.—*Height above ground of base of various types of clouds*

Name of clouds	Type	Summer (April–September)		Winter (October–March)	
		Range in height (feet)	Usual height (feet)	Range in height (feet)	Usual height (feet)
Cirrus	Upper	20, 000–40, 000	30, 000	20, 000–40, 000	30, 000
Cirro-stratus	do	20, 000–40, 000	30, 000	20, 000–40, 000	30, 000
Cirro-cumulus	do	10, 000–35, 000	22, 000	10, 000–35, 000	22, 000
Alto-stratus	Interm'd'te	8, 000–32, 000	20, 000	4, 000–32, 000	14, 000
Alto-cumulus	do	2, 500–28, 000	10, 000	5, 000–20, 000	10, 000
Strato-cumulus	Lower	500–12, 000	2, 000	500–12, 000	2, 000
Cumulus	do	1, 000–11, 000	5, 000	1, 200– 9, 000	4, 000
Nimbus	do	700–13, 000	800	700–12, 000	1, 000
Stratus	do	200– 6, 000	1, 000	200– 6, 000	1, 000

XVII. SYMBOLS USED IN TELETYPE AND RADIO TRANSMISSIONS

134. We have in the foregoing chapters considered the taking of the observations. In order to shorten their *transmission* as much as possible, a system of symbols has been developed for use on the teletype and radio circuits of the Bureau of Air Commerce. This system is used in the transmission of all weather reports on the teletype and radio circuits and observers should, therefore, be thoroughly familiar with their use and translation. Symbols used for the various elements of airway weather observations are as follows:

(*a*) *Ceiling.*—(1) Unlimited ceiling is indicated by the absence of a symbol or figures for the value of this element.

(2) The height of the ceiling between 50 and 9,751 feet above the station is indicated by figures representing the number of *hundreds*

of feet which apply, e. g., "35" indicates 3,500, "8" indicates 800, "95" indicates 9,500, etc.

(3) When the ceiling is zero, the figure naught (0) is used.

(4) When the height is estimated, the letter E for "estimated" is placed immediately preceding the figures. This is used only in connection with ceiling heights estimated to be between 50 and 9,751 feet above the station and is never applied to the height of scattered clouds given following the sky condition, when appropriate.

(5) When a ceiling balloon is blown out of sight before reaching the clouds, a plus sign is entered preceding the ceiling figures, which represents the last observed height of the balloon. For example, "+10", would indicate that the ceiling was over 1,000 feet, this figure being the last observed height of the balloon.

(*b*) *Sky.*—(1) The sky condition is indicated by the following symbols:

○ Clear.
◑ Scattered clouds.
◐ Broken clouds.
⊕ Overcast.
◑/High scattered clouds.
◐/High broken clouds.
⊕/High overcast.
⊕/◐ High overcast, lower broken clouds.
⊕/◑ High overcast, lower scattered clouds.
◐/◐ High broken, lower broken clouds.
◐/◑ High broken, lower scattered clouds.
◑/◐ High scattered, lower broken clouds.
◑/◑ High scattered, lower scattered clouds.
⊕ ◐ Overcast, lower broken clouds.
⊕ ◑ Overcast, lower scattered clouds.
◐ ◐ Broken, lower broken clouds.
◐ ◑ Broken, lower scattered clouds.
◑ ◐ Scattered, lower broken clouds.
◑ ◑ Scattered, lower scattered clouds.

F+	Dense fog.	These are used as the sky condition whenever their presence reduces the ceiling to zero, and/or the visibility to one-fifth mile or less. In case of combinations use predominant condition.
IF+	Dense ice fog.	
S+	Heavy snow.	
R+	Heavy rain.	
ZR+	Heavy freezing rain.	
SL+	Heavy sleet.	
HL+	Heavy hail.	
M1+	Heavy mist.	
ZM1+	Heavy freezing mist.	
BS+	Thick blowing snow.	
BD+	Thick blowing dust.	
BSA+	Thick blowing sand.	
K+	Thick smoke.	
H+	Thick haze.	
D+	Thick dust.	

(2) The use of the plus (+) or minus (−) sign *preceding* the cloudiness symbols indicates "dark" and "thin", respectively.

(3) Whenever the "scattered clouds" symbol occurs as the last symbol in a sky condition report (the slant mark is considered as a

symbol), whether used singly or in combination, the height of such scattered clouds is indicated by the insertion of the proper figure, or figures, following the symbol without space or oblique. This figure is then separated from the visibility figures by an oblique.

(*c*) *Visibility.*—The value of the visibility is indicated by figures representing the number of miles, and/or fractions of miles. When followed by a plus (+) sign (which invariably will be after the figure "15") this indicates that the visibility is *estimated* to be more than 15 miles, such estimation being made from observation of an object at less than 15 miles distance from the station.

(*d*) *Weather.*—The "weather" element of the report is indicated, when appropriate, by the following symbols:

R—	Light rain.	ZMI—	Light freezing mist.
R	Moderate rain.	ZMI+	Heavy freezing mist.
R+	Heavy rain.	SL—	Light sleet.
S—	Light snow.	SL	Moderate sleet.
S	Moderate snow.	SL+	Heavy sleet.
S+	Heavy snow.	HL—	Light hail.
ZR—	Light freezing rain.	HL	Moderate hail.
ZR	Moderate freezing rain.	HL+	Heavy hail.
ZR+	Heavy freezing rain.	T—	Mild thunderstorm.
SP	Sprinkling.	T	Moderate thunderstorm.
MI—	Light mist.	T+	Severe thunderstorm.
MI+	Heavy mist.		

TORNADO (always written out in full).

NOTE.—Heavy rain, snow, freezing rain, etc., which reduce the ceiling to zero and/or the visibility to one-fifth mile or less, are reported as the "Sky" condition.

(*e*) *Obstructions to vision.*—The "obstructions to vision" element of the reports is indicated, when appropriate, by the following symbols:

F—	Light fog.	D+	Thick dust.
F	Moderate fog.	BS	Blowing snow.
F+	Dense fog.	BS+	Thick blowing snow.
GF—	Light ground fog.	BD	Blowing dust.
GF	Moderate ground fog.	BD+	Thick blowing dust.
GF+	Dense ground fog.	BSA	Blowing sand.
H	Hazy.	BSA+	Thick blowing sand.
H+	Thick haze.	IF—	Light ice fog.
K	Smoky.	IF	Moderate ice fog.
K+	Thick smoke.	IF+	Dense ice fog.
D	Dusty.		

NOTE.—Thick haze; thick smoke; thick dust; thick blowing snow; thick blowing dust; thick blowing sand; dense ice fog; and dense fog, which reduce the visibility to one-fifth mile or less and/or the ceiling to zero, are reported as the "Sky" condition.

(*f*) *Temperature.*—This is indicated by figures, giving its value to the nearest degree Fahrenheit.

(*g*) *Dew point.*—This is indicated by figures, giving its value to the nearest degree Fahrenheit. When sent, it follows the temperature and is separated therefrom by an oblique (slant mark).

NOTE.—Values below zero Fahrenheit are indicated by the entry of a minus sign (—) immediately preceding the figures for temperature and/or dew point.

(*h*) *Wind.*—The wind direction, velocity, and character (the latter when appropriate) are indicated as follows:

1. *Direction.*—Indicated by arrows, as follows:

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

2. *Velocity.*—The velocity is indicated by figures representing its value in miles per hour, "calm" being indicated by the letter C. If estimated, this is indicated by the entry of the letter E immediately following the figures, without space or oblique.

3. *Character.*—The character of the wind is indicated, when appropriate, by entry of the following symbols immediately following the velocity, without space or oblique:

G— Fresh gusts.
G Strong gusts.
G+ Severe gusts.
V Variable.

(*i*) *Barometric pressure.*—The barometric pressure is indicated by a group of three figures, the first one of which represents the inch and the last two of which represent the number of hundredths of an inch involved. Thus the pressure of "30.00" would be written as "000"; of "25.91" as "591"; of "29.62" as "962"; etc.

(*j*) *Field conditions and remarks.*—These are transmitted in English, *using authorized abbreviations.*

135. In the transmission of the reports, this is begun by entry of the station designator, after which follows—

One space

CEILING*
SKY
VISIBILITY
WEATHER
OBSTRUCTIONS TO VISION } as one group

One space

TEMPERATURE
DEW POINT
WIND } as one group

One space

BAROMETRIC PRESSURE as one group

One space

* The absence of "ceiling" indicates that it is "unlimited."

FIELD CONDITIONS (when appropriate)

One space

REMARKS

Elements normally sent, but for some reason missing from the teletype or radio transmissions, will be indicated by the letter "M" entered in the report in place of the missing data.

Pressure change and characteristic (including 5,000-foot pressure at selected stations), cloud, and thunderstorms data would be added at the proper periods by the stations designated to do this as a separate group and in the form prescribed for this in chapter XIII.

Examples:

E12⊕2T+R+HL+ 75/73→30G 991 FIELD FLOODED THDRSTM MVG E

Ceiling estimated 1,200 feet; sky overcast; visibility 2 miles; severe thunderstorm; heavy rain; heavy hail; temperature 75°; dew point 73°; wind, west, 30 miles per hour, severe gusts; barometric pressure 29.91 inches; field flooded; thunderstorm moving east.

○1/8GF+ 59/59C 004 STARS VSB

Ceiling unlimited; clear; visibility ⅛ mile; dense ground fog; temperature 59°; dew point 59°; wind calm; barometric pressure 30.04 inches; stars visible.

136. The foregoing symbols and abbrevations will be used hereafter in this circular when considered necessary for the giving of proper illustrations or examples.

XVIII. ABBREVIATIONS AUTHORIZED FOR USE IN METEOROLOGICAL TRANSMISSIONS BY RADIO AND TELETYPE

137. The following listed abbrevations are authorized and will be used in all transmissions of forecasts, summaries, "remarks" and 'field conditions" in sequence and special reports, 6-hourly data at the end of regular reports, etc., made by teletype and/or radio.

DAYS	
Sunday	SUN
Monday	MON
Tuesday	TUE
Wednesday	WED
Thursday	THURS
Friday	FRI
Saturday	SAT

MONTHS	
January	JAN
February	FEB
March	MAR
April	APR
May	MAY
June	JUN
July	JUL
August	AUG
September	SEPT
October	OCT
November	NOV
December	DEC

CLOUDS

Cirrus	CI
Cirro-stratus	CIST
Cirro-cumulus	CICU
Alto-stratus	AST
Alto-cumulus	ACU
Alto-cumulus-castellatus	ACC
Strato-cumulus	STCU
Mammato-cumulus	MCU
Cumulus	CU
Nimbus	NB
Cumulo-nimbus	CUNB
Stratus	ST
Fracto-stratus	FRST

DIRECTIONS AND VARIATIONS

North (ern) (erly) (ward)	N, NRN, NLY, NWD
North northeast (ern) (erly) (ward)	NNE, NNERN, NNELY, NNEWD
Northeast (ern) (erly) (ward)	NE, NERN, NEWD
East northeast (ern) (erly) (ward)	ENE, ENERN, ENELY, ENEWD
East (ern) (erly) (ward)	E, ERN, ELY, EWD
East southeast (ern) (erly) (ward)	ESE, ESERN, ESELY, ESEWD
Southeast (ern) (erly) (ward)	SE, SERN, SELY, SEWD
South southeast (ern) (erly) (ward)	SSE, SSERN, SSELY, SSEWD
South (ern) (erly) (ward)	S, SRN, SLY, SWWD
South southwest (ern) (erly) (ward)	SSW, SSWRN, SSWLY, SSWWD
Southwest (ern) (erly) (ward)	SW, SWRN, SWLY, SWWD
West southwest (ern) (erly) (ward)	WSW, WSWRN, WSWLY, WSWWD
West (ern) (erly) (ward)	W, WRN, WLY, WWD
West northwest (ern) (erly) (ward)	WNW, WNWRN, WNWLY, WNWWD
Northwest (ern) (erly) (ward)	NW, NWRN, NWLY, NWWD
North northwest (ern) (erly) (ward)	NNW, NNWRN, NNWLY, NNWWD

STATES

Alabama	ALA
Arizona	ARIZ
Arkansas	ARK
California	CALIF
Colorado	COLO
Connecticut	CONN
Delaware	DEL
District of Columbia	DC
Florida	FLA
Georgia	GA
Idaho	IDA
Illinois	ILL
Indiana	IND
Iowa	IA
Kansas	KAN
Kentucky	KY
Louisiana	LA
Maine	ME
Maryland	MD
Massachusetts	MASS
Michigan	MICH
Minnesota	MINN
Mississippi	MISS
Missouri	MO
Montana	MONT
Nebraska	NEB
Nevada	NEV
New Hampshire	NH
New Jersey	NJ
New Mexico	NM
New York	NY
North Carolina	NC
North Dakota	ND
Ohio	OHIO
Oklahoma	OKLA
Oregon	OREG
Pennsylvania	PA
Rhode Island	RI
South Carolina	SC
South Dakota	SD
Tennessee	TENN
Texas	TEX
Utah	UTAH
Vermont	VT
Virginia	VA
Washington	WASH
West Virginia	WVA
Wisconsin	WIS
Wyoming	WYO

ENDINGS

Variations of root words may be formed as follows:

able	BL
al	L
ally, erly, ly	LY
(Add Y if word ends in L)	
ance, ence	NC
der	DR
ed, ied	D
(Add ED if word ends in D)	
ening	NG
er, ier	R
ern	RN
ically	CLY
iest	ST
iness, ness	NS
ing	G
(Add NG if word ends in G)	
ity	TY
ive	V
ment	MT
ous	US
s, es, ies	S
tion, ation	N
ward	WD

ABBREVIATIONS FOR WORDS

A	
Above	ABV
Accompany (ied) (ing)	ACPY
Account	ACCT
Acting	ACTG
Action	ACTN
Addition (al)	ADN
Advance (s) (d) (ing)	ADVN
Advise (s) (d) (ing)	ADVZ
Affect (s) (ed) (ing)	AFCT
Afternoon	AFTN
Aircraft	ACFT
Airway	AWY
Aloft	ALF
Along	ALG
Altitude	ALT
Amount (ing)	AMT
Appear (s) (ed) (ing)	APPR
Approach (es) (ed) (ing)	APCH
Arrive (s) (d) (al) (ing)	ARV
Around	ARND
Attend (s) (ed) (ing)	ATD
B	
Barometer	BRM
Barometric	BRMC
Become (s) (ing)	BCM
Before	BFR
Begin (s) (ing)	BGN
Beneath	BNTH
Better	BTR
Between	BTWN
Beyond	BYD
Blanket (ing)	BLKT
Blow (ing)	BLW
Break (ing)	BRK
Broken	BRKN
Build (ing)	BLD
C	
Ceiling	CIG
Center (ing) (ed)	CNTR
Central	CNTRL
Change (ing) (ed) (able)	CHG
Clear (ing) (ed)	CLR
Cloud (s) (iness)	CLD
Coast (al)	CST
Commence (ing)	CMNC
Condition	CND
Confine (d) (ing)	CFN
Consider (ed) (able) (ing)	CSDR
Continue (d) (ing) (ous)	CONT
Cover (ed) (ing)	CVR
D	
Decrease (s) (ing)	DECR
Dense	DNS
Deepen (ing)	DPEN
Depend (ing)	DPND
Depth	DPTH
Develop (s) (ing) (ment)	DVLP
Diminish (ed) (ing)	DMSH
Dissipate (ing)	DSIPT
Distribution	DRBTN
District	DIST
Disturb (ing) (ance)	DSTB
Division	DIVN
Drift (ing)	DRFT
Dropping	DROPG
During	DURG
E	
Effect (s) (ed) (ing)	EFCT
Elevate (ing) (tion)	ELV
Elsewhere	ELSW
Entire (ly)	ENTR
Envelop (ed) (ing)	ENVP
Estimated	ETD
Excellent	XLNT
Except (ing)	XCPT
Exist (ing)	XIST
Extend (s) (ed) (ing)	XTND
Extension	XTNSN
Extensive	XTNV
Extreme (ity) (ly)	XTRM
Evening	EVE
F	
Flurry (ies)	FLRY
Follows (s) (ed) (ing)	FLW
Forecast (ing)	FCST
Form (s) (ed) (ing) (ation)	FRM
Forward	FRWD
Freeze (ing)	FRZ
Frequent (ly)	FREQT
Fresh	FRSH
Frozen	FRZN
G	
General (ly)	GNRL
Gradual (ly)	GRDL
Ground	GRND
Gust (y) (iness)	GST
H	
Half	HLF
Hang (ing)	HNG
Heavy (ier) (iest)	HVY
High	HI
Humid (ity)	HMD
Hundred	HND
I	
Important	IMPTNT
Importance	IMPTNC
Improve (ing) (ment)	IPV
Include (ing)	INCL
Inclusive	INCLV
Increase (ing)	INCR
Indicate (ing) (tion)	INDC
Intense (ity)	INTS
Intermediate	INTMD
Intermittent (ly)	INTMT
Interior	INTR
Irregular (ly)	IREG

J

Junction	JCTN

L

Lake	LKE
Last	LST
Later	LTR
Latter	LTTR
Level(ing)	LVL
Lift(ing)	LFT
Light(en) (ening) (ly)	LGT
Lightning	LTNG
Likely	LKLY
Limit(ing) (ation)	LMT
Local(ly) (ity)	LCL
Locate(tion)	LCT
Lower(ing)	LWR

M

Middle	MID
Midnight	MIDN
Mild(ly)	MLD
Missing	MISG
Mistake	MSTK
Moderate(ly)(ing)(ation)	MDT
Morning	MRNG
Most(ly)	MST
Mountain	MTN
Move(ing)	MOV

N

Next	NXT
Night	NGT

O

Obscure(d) (ing) (ation)	OBSC
Observe(r) (d) (ation)	OBS
Occasion(al) (ally)	OCN
Occlude(d) (ing)	OCLD
Open(ing)	OPN
Otherwise	OTHRW
Over	OVR
Overcast	OVC
Overhead	OVHD

P

Partly	PTLY
Passage	PASG
Patch	PTCH
Period(ically)	PRD
Persist(ing) (ed)	PERST
Point	PNT
Portion	PTN
Possible(y) (ity)	PSBL
Precede(d) (ing)	PRCD
Precipitation	PRECIP
Pressure	PRES
Prevail(ed) (ing) (s)	PRVL
Prevalent	PVLNT
Probable (ly)	PBL
Progress(ing) (ive) (ed)	PGRS

Q

Quadrant	QUAD
Quarter	QTR

R

Ragged(ly)	RAGD
Rapid(ly) (ity)	RPD
Region(al)	RGN
Regular (ly) (ity)	REGL
Remain(ing) (der)	RMN
Report(ing)	RPT
Return(s) (ing)	RTN
Ridge	RDG
Right	RGT
Rising	RSG
River	RVR
Route	RTE

S

Scattered	SCTD
Section(al)	SECT
Separate(ly) (ing)	SPT
Settled	STLD
Severe(ly)	SVR
Shift(ing)	SHFT
Shower(ing) (y)	SHWR
Situate(d) (ation)	SIT
Sleet(ing)	SLT
Slight(ly)	SLGT
Slow(ly) (ing)	SLW
Snow(ing)	SNW
Somewhat	SMWHT
Special(ly)	SPL
Spread(ing)	SPRD
Sprinkle(ing)	SPKL
Squall(y)	SQAL
Stop	STP
Storm(y) (iness)	STM
Strong(ly)	STG
Subside(s) (ing)	SUBSD
Surface	SFC

T

Temperature	TMP
Tend(ing)	TND
Tendency	TNCY
Terminate(ing) (tion)	TERM
Thereafter	THRFTR
Thicken(ing)	THKN
Thinning	THNNG
Thousand	THSD
Threaten(ing)	THTN
Through	THRU
Throughout	THRUT
Thunder(ing)	THDR
Thunderhead	THDRHD
Thundershower	THDRSHWR
Thunderstorm	THDRSTM
Today	TDA
Tomorrow	TMW
Tonight	TNGT
Toward	TWRD
Trend	TRND
Turbulence	TURBC
Turbulent(ly)	TURBT

U

Unlimited	UNL
Unsettled	UNSTLD
Unsteady	UNSTDY
Unusual(ly)	UNUSL

V	
Valley	VLY
Vapor	VPR
Variable	VRBL
Veering	VRG
Vicinity	VCNTY
Violent(ly)	VLNT
Violence	VLNC
Visibility	VSBY
Visible	VSB

W	
Warm(er) (ing)	WRM
Weaken(ing)	WKN
Weather	WEA
Wind(y)	WND
Worse	WRS

MISCELLANEOUS

"Ceiling and visibility unlimited" ..... CAVU

Abbreviations for suffixes, i. e., abbreviations for variations in the endings of words, given *in parenthesis* in the foregoing list, will be formed as indicated and added to the root abbreviation. For example:

Change(ing) (d) (able) ..... CHG, CHGNG, CHGD, CHGBL

XIX. EXAMPLES OF REPORTS

138. In order to make clear the foregoing instructions, there is included in this chapter an illustration of Form 1130–Aer., carrying observations such as might be made at a terminal station where broadcasts of the observations from several airways are made. At such points, of course, it is necessary that *check* observations of the *record* and *special* observations be made at regular intervals, as directed in chapter XIV, and these have, therefore, been included. However, the *record* and *special* observations carried thereon are excellent examples of such reports to be made at any station and will, therefore, be studied carefully by all observers.

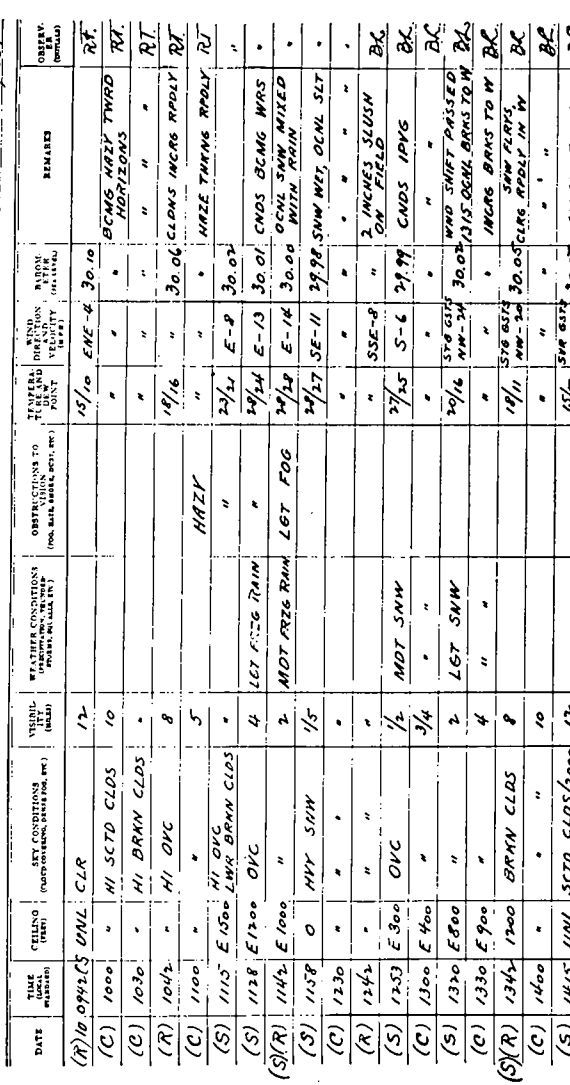
139. In doing so it will be noted that the letters R, C, and S have been used to indicate the type of observations, these letters standing for "Record", "Check", and "Special", respectively. This is excellent practice at any station as it enables persons studying the forms to identify the various types of observations without trouble and facilitates the extraction of data. Therefore, beginning with the effective date of this circular, all stations will follow this practice. Further, it will be noted that the 1442 *record* observation illustrated carries certain data in parenthesis. This is the 6-hourly pressure change and cloud data, which is added at all stations specifically directed to do so. The practice of placing these in parenthesis is believed to be advisable and will be followed at all stations concerned.

140. The forms do not need to be typewritten, and in fact this practice is not favored, as it involves the expenditure of too much additional work and time. Fairly hard pencil should be used in all cases.

141. It will be noted that the regular authorized abbreviations are used throughout, the only exception being the use of the letter E instead of ETD for "estimated" preceding the ceiling heights, which is necessary because of the limited space. This will be the practice at all stations where the forms are prepared.

142. The condition illustrated by the observations entered on the form is one in midwinter prior to, during, and after the passage of a wind-shift line. It was selected as offering the best possibilities for examples, but any number of conditions at other seasons of the year might have been used just as well. It is realized that ordinarily the condition illustrated would not occur as rapidly as indicated, but it was done in this case because of lack of space. However, by close

study of these examples, the activating idea behind the rendering of accurate and complete reports will be clearly seen and should serve to impress upon the observer that *each observation is separate in itself and cannot be made merely as a routine matter.* To do so may mean the missing of some important feature which may spell disaster to a pilot. The observer should feel that his work is extremely valuable and necessary to the safety of others, and that every report should be



U.S. DEPARTMENT OF AGRICULTURE — Weather Bureau — Form No. 1130-Aer.

AIRWAYS WEATHER REPORT

(To be recorded in place of regular observations and figured to nearest data hours)

STATION SAINT LOUIS, MO. MONTH AND YEAR JANUARY 1934

DATE	TIME (LOCAL STANDARD)	CEILING (HEIGHT)	SKY CONDITIONS (CLOUD FORMATIONS, AMOUNT AND KIND, ETC.)	VISIBILITY (MILES)	WEATHER CONDITIONS (PRECIPITATION, THUNDER-STORMS, ETC.)	OBSTRUCTIONS TO VISION (FOG, HAZE, SMOKE, DUST, ETC.)	TEMPERATURE AND DEW POINT	WIND DIRECTION AND VELOCITY (M.P.H.)	BAROM. CORR. (SEA LEVEL)	REMARKS	OBSERV. (INITIAL)
(R)/0	0942 (CS)	UNL	CLR	12			15/10	ENE-4	30.10		R.T.
(C)	1000	"	HI SCTD CLDS	10			"	"	"	BCMG HAZY TWRD HORIZONS	"
(C)	1030	"	HI BRKN CLDS	"			"	"	"	" " "	"
(R)	1042	"	HI OVC	8			18/16	"	30.06	CLDS INCRG RPDLY	R.T.
(C)	1100	"	"	5		HAZY	"	"	"	HAZE THINS RPDLY	"
(S)	1115	E 1500	HI OVC LWR BRKN CLDS	"		"	23/4	E-8	30.02		"
(S)	1128	E 1200	OVC	4	LGT FRZG RAIN	"	28/24	E-13	30.01	CNDS BCMG WHS	"
(S)(R)	1142	E 1000	"	2	MDT FRZG RAIN	LGT FOG	28/28	E-14	30.00	OCNL SNW MIXED WITH RAIN	"
(S)	1158	0	HVY SNW	1/8			28/27	SE-11	29.98	SNW WET, OCNL SLT	"
(C)	1230	"	" "	"			"	"	"	" " " "	"
(R)	1242	"	" "	"			"	SSE-8	"	2 INCHES SLUSH ON FIELD	R.C.
(S)	1253	E 300	OVC	1/2	MDT SNW		27/25	S-6	29.99	CNDS IPVS	R.C.
(C)	1300	E 400	"	3/4	" "		"	"	"	" "	R.C.
(S)	1330	E 800	"	2	LGT SNW		20/16	S-6 G15 NW-24	30.02	WND SHFT PASSED 1315 OCNL BRKS TO W	R.C.
(C)	1330	E 900	"	4	" "		"	"	"	INCRG BRKS TO W	R.C.
(S)(R)	1342	1200	BRKN CLDS	8			18/11	S-6 G15 NW-20	30.05	SNW FLRYS CLRG RPDLY IN W	R.C.
(C)	1400	"	"	10			"	"	"	" " "	R.C.
(S)	1415	UNL	SCTD CLDS/2000	12			15/7	SW G25 NW-30	30.07	SLUSH FRZN	R.C.
(C)	1430	"	"	"			"	"	"		R.T.
(R)	1442	"	HI SCTD CLDS	"			14/3	SW G25 NW-36	30.08	(86, 1CI/NW)	R.T.
(C)	1500	"	" " "	"			"	"	"		R.T.
(C)	1530	"	" " "	"			"	"	"		R.T.
(R)	1542	"	CLR	13			9/2	SW G35 NW-36	30.11		R.T.
(C)	1600	"	"	"			"	"	"		R.T.

Anemometer raised — Each week. Anemometer cleaned — Each month.

R. Thomas, Airways Observer.

FIGURE 20.—Illustrating the entry of observations and other data on form 1130-Aer. (Examples shown are representative types of airway weather observations.)

complete in every detail. *The broad, possible scope of "Remarks" is again called to attention in this respect—any feature which the observer thinks important to be included thereunder.*

143. Following is illustrated the manner in which some of the *record* and *special* observations shown on the form would be sent by telegraph or as a special message by radio, or as sequence reports by teletype and/or radio.

144. The observer should carefully compare these with the examples on the form to see that this is fully understood. In any type of report the names of the various elements are never included, it only being necessary to include the data for each element in its proper order. Careful reference to preceding chapters of this circular will clarify any doubtful points. *Check* observations are not transmitted to other points and are therefore not included hereunder.

145. The times given are on the basis of the 24-hour clock, local standard time. In transmission by radio or teletype, these are to be entered for each individual *special* observation sent, but not in telegraphed reports, as the time of the filing of the telegram will always appear thereon. For teletype and radio sequence reports, the time will be entered at the beginning of the sequence by the Department of Commerce operator.

146. The place of origin of telegrams is shown thereon and will not, therefore, be included in the body of the report. Reports made by teletype and/or radio must include the station designator.

(*a*) *Record observation* at 0942.

Telegraph: CLEAR TWELVE FIFTEEN TEN EAST NORTHEAST FOUR THIRTY TEN

Teletype and/or radio: ○12 15/10←↙4 010

(*b*) *Record observation* at 1042.

Telegraph: HIGH OVERCAST EIGHT EIGHTEEN SIXTEEN EAST NORTHEAST FOUR THIRTY ZERO SIX CLOUDINESS INCREASING RAPIDLY

Teletype and/or radio: ⊕/8 18/16←↙4 006 CLDNS INCRG RPDLY

(*c*) *Special observation* at 1115.

Telegraph: ESTIMATED FIFTEEN HUNDRED HIGH OVERCAST LOWER BROKEN FIVE HAZY TWENTY THREE TWENTY ONE EAST EIGHT THIRTY ZERO TWO

Teletype and/or radio: SPL 1115CS E15⊕/⊕5H 23/21←8 002

(*d*) *Special observation* at 1128.

Telegraph: ESTIMATED TWELVE HUNDRED OVERCAST FOUR LIGHT FREEZING RAIN HAZY TWENTY EIGHT TWENTY FOUR EAST THIRTEEN THIRTY ZERO ONE CONDITIONS BECOMING WORSE

Teletype: SPL 1128CS E12⊕4ZR-H 28/24←13 001 CNDS BCMG WRS

(*e*) *Record and special observation* at 1142.

Telegraph: ESTIMATED ONE THOUSAND OVERCAST TWO MODERATE FREEZING RAIN LIGHT FOG TWENTY EIGHT TWENTY EIGHT EAST FOURTEEN THIRTY ZERO ZERO OCCASIONAL SNOW MIXED WITH RAIN

Teletype and/or radio: SPL 1142CS E10⊕2ZRF— 28/28←14 000 OCNL SNW MIXED WITH RAIN

(*f*) *Special observation* at 1158.

Telegraph: ZERO HEAVY SNOW ONE FIFTH TWENTY EIGHT TWENTY SEVEN SOUTHEAST ELEVEN TWENTY NINE NINETY EIGHT SNOW WET OCCASIONAL SLEET

Teletype and/or radio: SPL 1158CS 0S+1/5 28/27↖11 998 SNW WET OCNL SLT

(*g*) *Record observation* at 1242.

Telegraph: ZERO HEAVY SNOW ONE FIFTH TWENTY EIGHT TWENTY SEVEN SOUTH SOUTH SOUTHEAST EIGHT TWENTY NINE NINETY EIGHT TWO INCHES SLUSH ON FIELD

Teletype and/or radio: 0S+1/5 28/27↑↖8 998 2 INCHES SLUSH ON FIELD

(*h*) *Special observation* at 1253.

Telegraph: ESTIMATED THREE HUNDRED OVERCAST ONE HALF MODERATE SNOW TWENTY SEVEN TWENTY FIVE SOUTH SIX TWENTY NINE NINETY NINE CONDITIONS IMPROVING

Teletype and/or radio: SPL 1253CS E3⊕1/2S 27/25↑6 999 CNDS IPVG

(*i*) *Special observation* at 1320.

Telegraph: ESTIMATED EIGHT HUNDRED OVERCAST TWO LIGHT SNOW TWENTY SIXTEEN NORTHWEST TWENTY FOUR STRONG GUSTS THIRTY ZERO TWO WIND SHIFT PASSED THIRTEEN FIFTEEN OCCASIONAL BREAKS TO WEST

Teletype and/or radio: SPL 1320CS E8⊕2S— 20/16↘24G 002 WND SHFT PASSED 1315 OCNL BRKS TO W

(*j*) *Record and special observation* at 1342.

Telegraph: TWELVE HUNDRED BROKEN CLOUDS EIGHT EIGHTEEN ELEVEN NORTHWEST TWENTY STRONG GUSTS THIRTY ZERO FIVE SNOW FLURRIES CLEARING RAPIDLY IN WEST

Teletype and/or radio: SPL 1342CS 12⊙8 18/11↘20G 005 SNW FLRYS CLRG RPDLY IN W

147. The foregoing are believed to be enough examples for purposes of illustration.

148. In all cases, determine from study of this circular why *special* observations were necessary when shown on the illustration of Form 1130–Aer. (fig. 20).

XX. INSTRUCTIONS FOR THE USE AND DISPOSITION OF AIRWAY FORMS

149. The conduct of the airway meteorological service requires that certain forms be prepared and rendered at all types of stations engaged in this work. These forms are mainly records of observations or compilations of observational data and constitute the only available records for use in studies, court cases, etc. As such, they are highly important and all personnel will take care to see that the forms assigned to them shall be neatly and legibly prepared and that the data entered thereon is accurate. Instructions for the preparation and disposition of all these forms follow:

FORM 1130 AER., AIRWAY WEATHER REPORTS

150. (*a*) *Preparation.*—This form is regarded as the actual original record of all airway weather observations and will be so used at all stations rendering any type of airway surface observations. This does not mean that the data must be entered directly thereon, as it may be inconvenient to carry it while making an observation in windy or rainy weather, but rather that the data entered thereon will be considered as constituting the original record of the observation itself.

(*b*) Entries on Form 1130–Aer. shall be made by use of a moderately hard pencil. The data shall be entered as required by the headings on the form, using figures and/or authorized abbreviations, as is proper for the element concerned, except that ditto marks may be used when the data to be entered in any column are the same as the immediately preceding data in the same column.

(*c*) The name of the station and the month and year shall be entered in the space provided in the top right corner of the form. This applies to *all* forms, irrespective of whether or not more than one sheet is used for entry of one day's observations. The day of the month will be entered in the column provided.

(*d*) The local time of observation shall be entered on the basis of the 24-hour clock in the column provided. Under this system 4 figures, the first 2 representing the hour and the last 2 the minutes, are always entered, the first hour after midnight being designated "00"; the second, "01"; the third, "02"; the fifteenth, "14", etc., e.g., "0001" indicates 12:01 a. m., "0235" indicates 2:35 a. m., "1346"

indicates 1:46 p. m., "2305" indicates 11:05 p. m., etc. The standard of local time in use shall be indicated by entry of the letters "ES" for eastern, "CS" for central, "MS" for mountain, and "PS" for Pacific standard time, following the time figures for the first entry on each sheet, e. g., "0042ES" indicates 12:42 a. m., E. S. T.; "1515CS" indicates 3:15 p. m., C. S. T., etc.

(*e*) "Record", "Check", and "Special" observations, as defined in this circular, will be indicated by entry of the letters "R", "C", and "S", respectively, at the extreme left edge of the form in the "Date" column.

(*f*) The ceiling shall be entered in figures in the "Ceiling" column. When estimated, i. e., not measured by use of a ceiling projector or balloon, the letter E, meaning "estimated", will be entered preceding the figures.

(*g*) Sky, weather, and obstructions to vision will be entered in English, using authorized abbreviations. The height of scattered clouds, recorded in accordance with instructions herein, will be entered in figures in the sky-condition column following the sky condition. Visibility, temperature, dew point, and barometer will be entered in figures.

(*h*) The wind direction will be entered by use of the authorized abbreviations. The velocity will be entered in figures immediately following the direction. The character, when appropriate, will be entered above the direction and velocity, using authorized abbreviations.

(*i*) Remarks will be entered in English, using authorized abbreviations, except that numerical values will be entered in figures.

(*j*) The initials of the observer taking the observation will be entered in each case.

(*k*) If the station is equipped with an anemometer, it will be oiled once a week and cleaned once a month, the date that this is done being entered in the space provided in the lower left-hand corner on the particular day on which the duty is performed.

(*l*) The form will be signed by the official or operator in charge, or an employee designated by them to do this.

(*m*) Special 6-hourly data added to sequence reports, or included in coded form in telegraphed reports, will be entered in figures and abbreviations in the "Remarks" column and set off from any other data therein by parentheses, e. g., "(7R 9STCU/W)." Stations making reductions to sea level of mercurial or corrected aneroid barometer pressure readings by means of tables, will at the 6-hourly periods (2 and 8 a. m. and p. m., E. S. T.), enter the station pressure above the sea-level pressure and the vapor pressure above the dew point, provided that Form 1135–Aer. is not prepared at the station.

151. *Disposition.*—The disposition of Form 1130–Aer. will vary with respect to whether or not the station concerned is manned by *paid* Weather Bureau observers, whether or not the station renders Forms 1136–1140 or 1141, and whether or not it constitutes a combination of these. The disposition of forms rendered by Army and Navy stations will be arranged in each case by the Central Office upon recommendation of the general supervising station. The following, therefore, contains specific instructions covering all other classes of stations.

(*a*) *Stations manned by Department of Commerce personnel or Weather Bureau airway observers serving without pay not rendering Forms 1136-*

1140 or 1141.—Stations falling in this class shall, as a rule, prepare only one copy of Form 1130, and shall forward these to the general supervising station for filing within 5 days after the end of each calendar month. In cases, however, where a Weather Bureau city office in the same city exercises direct supervision of a substation of this class, a carbon copy will be prepared and forwarded to the city office within 5 days after the end of each calendar month.

(*b*) *Stations manned by Department of Commerce personnel or by Weather Bureau observers serving without pay rendering Forms 1136–1140 or 1141.*—In general, only one copy of form 1130 will be prepared and this will be forwarded along with Forms 1136–1140 or 1141 to the Weather Bureau station to which it has been directed that the Forms 1136–1140 or 1141 shall be forwarded within 5 days after the end of each calendar month. This latter station will then forward it with a copy of Form 1141 to the general supervising station. In cases, however, where a Weather Bureau office in the same city exercises direct supervision of a substation of this class, a carbon copy will be prepared and forwarded to that city office within 5 days after the end of each calendar month.

(*c*) *Stations manned by Weather Bureau airway observers being paid for their services not rendering Forms 1136–1140 or 1141.*—Two copies of Form 1130 will be prepared, 1 original and 1 carbon. The original shall be forwarded to the general supervising station and the carbon copy to the direct supervising station within 5 days after the end of each calendar month. If the general and direct supervision are exercised by one station, only one copy, the original, will be made and this will be forwarded to that station within 5 days after the end of the calendar month.

(*d*) *Stations manned by Weather Bureau airway observers being paid for their services rendering Forms 1136–1140 or 1141.*—Two copies of Form 1130 will be prepared at such stations, the original being forwarded to the station to which it has been directed that Forms 1136–1140 or 1141 will be sent for checking. The latter station will then forward it with the checked copies of Form 1141 to the general supervising station. The carbon copy shall be sent to the direct supervising station within 5 days after the end of each calendar month for use in checking pay rolls, etc. This copy shall be kept on file at the direct supervising station. If the general and direct supervision of a substation are assigned to one Weather Bureau first-order or airport station, and Forms 1136–1140 or 1141 from the substation are also checked there, only one copy of Form 1130 need be made at the substation, and this shall be forwarded with the Forms 1136–1140 or 1141 to the supervising station within 5 days after the end of each calendar month.

(*e*) *Weather Bureau first-order or airport stations not having general supervising duties assigned to them.*—Only one copy of Form 1130 will be prepared, and this will be filed at the station. However, if any general supervising station desires a copy for their files, it will be proper to furnish a carbon copy upon receipt of request for it. The foregoing will also apply to first-order stations off the airways rendering 6-hourly reports.

(*f*) *Weather Bureau airport stations having general supervising duties assigned to them.*—One copy of Form 1130 shall be prepared, and this will be filed at the station. It will be proper to furnish carbon copies

to other contiguous general supervising stations upon receipt of request for them.

152. Carbon paper and no. 3 pencils will be furnished by the direct supervising station to substations required to prepare carbon copies, if necessary.

153. Because of the expense involved, the furnishing of copies from substations, other than those prescribed in the foregoing, is not favored. However, general supervising stations desiring copies from substations under the general supervision of another station should make proper recommendations to the Central Office for consideration, and, if approved, may make arrangements through the other general supervising stations concerned to receive them.

154. Under the foregoing plan, the general supervising station will be the final depository of all the original Forms 1130 prepared at intermediate stations under the general supervision of that station. This, of course, will require considerable storage space, and the necessary transfer storage cases will be furnished as required from the Central Office upon receipt of a stores requisition.

155. All originals of Form 1130 for all types of substations in current operation now held at first-order or airport stations will be placed in proper chronological order and forwarded to the general supervising station concerned. Forms for closed stations will continue to be kept in file at the stations now holding these, unless the general supervising station concerned requests that they be forwarded to that place.

FORM 1130A–AER., "AIRWAY WEATHER REPORT (IN SYMBOLS)"

156. This form is designed to enable the airway observations to be placed in symbol form for transmission by teletype. It is to be used at all points where the observations are to be transmitted by teletype by Department of Commerce personnel, irrespective of whether or not the observations are made by Weather Bureau or Department of Commerce personnel. The data placed thereon in pencil will be in the exact form in which it will be transmitted by teletype, i. e., in symbols in the proper order. The form is designed to facilitate this. When the observations are made by Weather Bureau personnel, a carbon copy will be made and retained at the Weather Bureau station for 6 months, the original being retained in the Department of Commerce files. When both the observation and transmission are made by Department of Commerce or by Weather Bureau personnel, only one copy will be made, and this will be retained at the station in question for a period of 6 months. Where observations are received from other stations by telephone, telegraph, or radio, for later relay by teletype, these should be entered on Form 1130A–Aer., in the proper order of receipt, the station designator to be entered in the "date" column.

FORM 1133–AER., "INSTRUCTIONS FOR AIRWAY OBSERVERS"

157. This is a printed card, carrying condensed instructions (extracted from Circular N) concerning the taking of surface airway weather observations. This form shall be posted for ready reference at all types of stations rendering such observations.

FORM 1135–AER., "SPECIAL DATA FOR AIRWAY OBSERVATIONS"

158. (*a*) This is a form designed to facilitate the computation of data required in connection with the reduction of mercurial barometer readings to sea level, or to the 5,000-foot plane, or both, and other elements such as dew point, vapor pressure, etc. It will be used at all stations having mercurial barometers for the recording of the data called for thereon at observations when it is necessary to read the mercurial barometer. Under present conditions this means at the 6-hourly periods. The use of this form under the conditions prescribed above is mandatory, as it is desired that a complete record of the computations required in these observations be available for use or study, if required. The computations made on this form will invariably be checked by some person other than the one taking the observation—always by Weather Bureau commissioned personnel where these are located and by Weather Bureau observers or Department of Commerce personnel where Weather Bureau commissioned personnel are not located.

(*b*) Inasmuch as an aneroid barometer is usually used for obtaining station pressure at intermediate observations and computations are thus reduced to a minimum, Form 1135 will not be used at those times.

(*c*) Data will be entered in pencil.

(*d*) The forms will be filed in chronological order at the station making the observations. In the event the station is discontinued, the forms will be forwarded to the general supervising station for filing. Final disposition of the forms by destruction of them will depend upon recommendations from the general supervising station and approval by the Central Office.

FORMS 1136–1140–AER., "MONTHLY SUMMARIES"

159. As is indicated by the titles thereof, these forms are monthly entries and summarizations of data for important elements of airway observations. Directions for the preparation of these forms are carried on the covers thereof. These will all be carefully followed, except those on the present edition relating to the number of copies to be made and the disposition thereof, instructions concerning which have been issued in a circular, dated December 10, 1934, and except those relating to the entries of summaries at the bottom of the forms, which summaries are to be entered on Form 1141–Aer.

FORM 1141–AER., "MONTHLY SUMMARY OF AIRWAY METEOROLOGICAL OBSERVATIONS"

160. This form will be used for the entering of the summaries of diurnal and monthly data from Forms 1136–1140. All entries will be made in pencil. Airway stations preparing this form will make an original and two carbons and will forward these with Forms 1136–1140 to the station to which they have been directed to do so. The checking station will retain one carbon, forward one to the general supervising station and forward the original to the Central Office. First-order and airport stations at which Forms 1136–1140 are prepared will follow the same procedure. General supervising stations

will prepare an original and one carbon, the original being forwarded to the Central Office and the carbon being retained at the station.

FORM 1144–AER., "AIRWAY, AIRPORT, OR OFF-AIRWAY STATION RECORD"

161. This is a card form used at the central office and general supervising stations for the keeping of a record of the general details concerning stations which are necessary for the proper administration of those stations. As such it is quite important that the data thereon be kept current, and, in order to assure this, notice of any changes occurring at stations are to be forwarded to the Central Office and the general supervising stations on paper forms, which are exact duplicates of the card form, only the changed data being entered thereon. This is to be done by stations having direct supervision of substations and by the personnel of first-order and airport stations concerned. If a new station is opened, a new form is to be rendered. Officials making inspections will forward a paper form to the central office for each station inspected along with the required report of travel, irrespective of whether or not any changes have occurred at the stations inspected. Also, if the card for any station becomes illegible or unsightly, due to numerous changes made thereon, and the general supervising station prepares a new card form for their files, an additional card form should be prepared and rendered to the Central Office. In other words, it is intended that the card records of stations carried at the general supervising stations and the Central Office be exact duplicates, erasures and all.

FORM 1146–AER., "PRESSURE-REDUCTION DATA"

162. (*a*) All stations which make observations for transmission over the 4-hourly airway network, and which also have mercurial barometers, will record daily on Form 1146 the following data for each such observation:

(1) B_o=sea level (reduced) pressure (inches and hundredths).
(2) B=station pressure (inch and hundredths).
(3) t=dry-bulb temperature (°F.).
(4) e=vapor pressure (thousandths of an inch).

(*b*) Sums and means of the data need not be computed. The latitude and longitude of the station will be indicated only on the first form prepared, but the "station elevation" (see Circular F, Instrument Division) will be indicated on each form. In those cases where all of the four daily observations in question are not made at the same place, i. e., city office or airport, the respective places and station elevations at which the observations are made should be indicated. Changes in location, or in exposures, of instruments made during any month should be noted on the form for that month.

(*c*) All entries must be made in ink. Special care must be taken to insure that the data entered at the top of the form is correct.

(*d*) First-order stations having supervision of substations falling in the above category will see that each carries out instructions properly in this regard. Such substations will forward their filled-out monthly forms to the supervising station for inspection. The forms will then be mailed by the first-order station to the Central Office, in envelops

marked "Forms for Aerological Division", not later than the end of the following month.

(*e*) Copies of the completed forms need not be retained at the station. Form 1135, or other records, retained at the stations and containing any of the above observational data will not be destroyed for at least 6 months after the end of the month in which the observations are made. The station pressure and the vapor pressure will be entered above the sea-level pressure and the dew point, respectively, on Form 1130 (see paragraph 150 m) if Form 1135 is not prepared.

163. The object of the tabulation of the data under discussion is to provide a basis for study of the problem of pressure reductions, regard being taken of the diurnal variations of temperature.

INSTRUCTIONS FOR THE PREPARATION AND ISSUANCE OF AIRWAY FORECASTS

XXI. DESCRIPTION OF THE GENERAL CHARACTER OF THE SHORT-PERIOD AIRWAY FORECAST SERVICE

164. The purpose of the airway forecast service is to provide short-period forecasts of weather elements having a direct bearing on the safety and efficiency of flying activities at regular intervals for all traffic over Federal or other airways in the United States. Because of the short period involved, these forecasts are relatively precise and definite, giving expected airway weather conditions in greater detail than is possible in the case of the daily forecasts covering an advance period of 24 to 36 hours.

165. The airway forecasts shall be divided into two parts: First, a forecast for an entire region, which may include several airways and give a word-picture of the changes to be expected in the general meteorological situation affecting general weather along airways; second, specific forecasts for each important terminal or landing point on airways in the region as may be necessary.

166. The forecasts will be as brief as possible and worded in such a manner as to express their meaning clearly without the use of punctuation, except for the use of the word "stop" at the end of sentences. The text of regional forecasts should not exceed seven full lines of transmission on the page-type teletype machine, if at all possible to avoid it, followed by terminal forecasts.

167. The current State forecasts and those issued 12 hours previously by the district forecast centers will be used as a guide in all cases, particularly with regard to "weather" conditions.

168. (*a*) Names of counties for indicating sections of the region being dealt with should be avoided. The region should not be divided into north, east, south, or west portions, because such descriptions are too indefinite. Sections of the regions being dealt with will be indicated by specific mention of names of States, river valleys, or geographical features. Instead of specifically mentioning the terminals at Chicago and Newark, Cleveland will state "Near Chicago" and "Near Newark" for the Chicago and Newark areas, Kansas City will state "Near Chicago" for the Chicago area, Oakland will state "Near Great Salt Lake" for the Salt Lake City, and "San Fernando Valley" for the Burbank area. The purpose of this instruction is to prevent specific forecasts being made by one center for a terminal which is also a forecast center. For example, "Clearing Ruby Mountains eastward", "Ceiling will lower rapidly Mississippi River eastward", "Dense fog San Fernando Valley", "Clearing near Great Salt Lake", etc. This will also apply to terminals on the boundary between two forecast regions where such terminals are assigned to one of the forecast centers.

(*b*) Terminal forecasts will be prepared for the local terminals by the forecast centers at Newark, Chicago, Salt Lake City, and Burbank. Such forecasts will be transmitted to the adjoining forecast centers which do not mention specifically these local terminals in forecasts prepared by them, i. e., the Newark terminal forecast will be transmitted to Cleveland; the Chicago terminal forecast will be transmitted to Cleveland and Kansas City; the Salt Lake City and Burbank terminal forecasts will be transmitted to Oakland. Such forecasts will be worded similarly to other terminal forecasts and designated TERML (terminal forecast) for the point for which they are issued, using the station call letters to indicate the latter.

XXII. GENERAL INSTRUCTIONS

169. The following elements will be included in each terminal forecast:

(*a*) Sky (sky covering).
(*b*) Weather (precipitation, thunderstorms, etc.).
(*c*) Obstructions to vision (fog, smoke, haze, etc.).
(*d*) Ceiling and visibility.

170. All forecasts for terminals will contain specific mention of ceiling and visibility, except that when "clear" or "scattered clouds" are expected to obtain over the entire region no mention need be made of the ceiling, it being understood then that the ceiling is to be unlimited.

171. Some latitude may be used in arranging the order of the elements discussed in the terminal forecast.

172. Each terminal forecast will be complete in itself, i. e., it is not enough to say, "Little change indicated, etc.", as it is possible that the preceding forecast may not have been noted by the person desiring to use the current forecast.

173. *Special forecasts* will be issued when extensive developments (decided improvement or conditions becoming worse) occur more rapidly than expected in the last regular forecast. The special forecasts shall not extend beyond the current period and the necessity for their issue will be determined 3 hours after each synoptic map.

174. (*a*) *Trip forecasts* for periods not in excess of 6 hours from the time of issue may be made for unlighted airways or other routes by station officials specifically designated to do so. If trip forecasts for specified routes are to be issued regularly, recommendation for authority to do this will be made to the Central Office, i. e., occasional trip forecasts for a flight may be made by designated officials without specific authorization in each case, but regular issue of forecasts for a specified route shall not be made without authority. It will be satisfactory to begin such service prior to receipt of authority from the Central Office only if time does not permit the obtaining of this. In no case will an official issue trip forecasts without having been authorized previously to make this type of forecast, excepting those officials who regularly issue short-period forecasts.

(*b*) *Special trip forecasts for long or transcontinental flights.*—All requests for trip forecasts involving more than one airway, or other routes, which necessitate forecasts for a period greater than 6 hours (no forecast shall be for a period longer than 30 hours), except flights into foreign countries or over oceans, wherever and whenever

received, shall be referred to the airway forecast center in whose area such flights originate. Officials having full airway forecast authority at the airway forecast centers at Newark, Cleveland, Atlanta, Chicago, Kansas City, Dallas, Salt Lake City, Portland, Oakland, and Burbank are authorized to prepare such forecasts. Requests for trip forecasts involving flights into or over a foreign country and/or over oceans will be referred to the Central Office where arrangements for the issuing of the forecasts from the appropriate district forecast centers or airway forecast centers will be made, if no international difficulties are involved.

175. In general, one regional forecast will cover all airways assigned to any one forecast center, but in certain cases it may be advisable to group airways under two or more regional forecasts, and this is left to the judgment of the forecasting official concerned.

176. The regular regional and terminal forecasts will cover a period of 8 hours, beginning 2 hours after the regular collection periods at 2 and 8 a. m. and p. m., E. S. T.

177. The forecasts as transmitted will be identified by headings in accordance with the following:

(*a*) Where only one forecast is involved, the heading will consist of the name of the airway, using the regular call letters for designation of the terminals; the period covered by the forecast on the basis of the 24-hour clock and local time; the abbreviation, "AWY FCST", and the month and day, using figures. For example:

WA CV 1600 0000ES AWY FCST 10/16 ----------

This type of heading would also be used for trip, special trip, special, and the other types of airway forecasts, except that the proper abbreviations would be used in place of that given above.

(*b*) Where forecasts for several airways can be grouped under one regional forecast, a general heading consisting of the time, the abbreviation, "AWY FCSTS", and the date will be used for the group, and the individual forecasts therein will be indicated by the proper terminal designators. For example:

1600 0000ES AWY FCSTS 10/16
WA CV
CG CV
CV NK

Following the regional forecast, the terminal forecasts will be entered, using the proper designator for the name of the terminal in question and the word "Terminal", e. g. "CV TERML". If the same forecast applies to a group of terminals, the designators for each terminal will be entered in the same manner as that provided for indicating several airways in the regional forecasts.

178. Distribution will be accomplished by radio and teletype where practicable. Forecasts will not be transmitted at Government expense, except under specific prior authority or in an emergency. In all other cases they will be furnished at the expense of the person requesting them.

179. Forecasts for a particular region and terminals will be sent by the issuing station only along the airway for which they are intended, except as it may be necessary in reaching another airway. Relays by radio or teletype may then be arranged, if practicable, at the other stations concerned, subject to the usual procedure in such cases.

XXIII. TERMINOLOGY

180. The terms, **Clear, Scattered clouds, Broken clouds, Overcast,** or any obstruction to vision, such as **Dense fog, Thick blowing dust,** etc., which may reduce the visibility to one-fifth mile or less and the ceiling to "zero", will be used to forecast the "sky" element. The terms will have the same limits and meanings as are indicated for their use in the regular airway weather reports.

181. The "weather" element of the forecasts will include types of precipitation and local atmospheric disturbances, as follows:

(*a*) **Light, moderate,** or **heavy rain, snow, hail, showers.**

(*b*) **Mild, moderate,** or **severe thunderstorms.**

(*c*) **Light** or **heavy mist.**

(*d*) **Sleet.**

(*e*) **Snow flurries.**

(*f*) **Snow** or **rain squalls,** or **severe snow** or **rain squalls,** if unusually heavy falls of snow or rain, accompanied by strong, gusty winds, are foreseen.

(*g*) **Moderate** or **severe blizzard conditions,** when intensely cold northerly or northwesterly gales, accompanied by greatly reduced visibility, or ceiling and visibility, due to the falling and/or blowing about of snow, are foreseen.

(*h*) **Icing conditions** or **severe icing conditions,** if conditions are unusually favorable for the occurrence of this phenomenon. To be used when the temperature, amount of water vapor, or other factors will be such as to favor the formation of ice on aircraft while in flight through clouds, freezing rain (glaze), etc.

(*i*) **Mild, moderate,** or **severe wind-shift line** will always be forecast if this phenomenon is expected to move over the region during the period covered by the forecast. The *rate* and *direction of movement* are to be indicated.

(*j*) **Mild, moderate,** or **severe sandstorms** or **duststorms** are to be forecast when conditions are considered favorable for their occurrence.

(*k*) Conditions not covered, but occurring at times, will be forecast in accordance with the judgment of the forecaster, following as nearly as possible the same line of thought as is expressed in the terms listed above.

(*l*) **Tornadoes** are *not* to be forecast, but when reported as occurring on or near an airway this fact will be stated in the next regular or special forecast.

182. The "obstructions to vision" element of the forecasts will be confined generally to the expected formation, continuation, or dissipation of *fog*. It will be proper to mention "thick haze", "thick smoke", "thick dust", "blowing dust", and "blowing sand" as a continuing, moving, or dissipating condition when these are present. The same terms and limits will be used in forecasting fog, including ground and ice fog, or when mentioning haze, smoke, dust, etc., as are given for these phenomena for use in regular airway weather observations.

183. The "ceiling" element should be forecast with the visibility when practicable. The use of the term "CAVU" (ceiling and visibility unlimited) is authorized whenever the visibility is expected to be greater than 15 miles and the ceiling to be unlimited.

184. In forecasting the ceiling, use the following terms for expected values from zero to 1,000 feet, provided no higher ceiling range is to be specified therewith:

ZERO	Less than 100 feet.
VERY LOW	100 to 500 feet, inclusive.
LOW	500 up to and including 1,000 feet.

All other ceilings will be forecast by specifying the range of ceiling heights the forecaster has in mind, e. g., "ceiling 500 to 2,000"; "ceiling generally 3 to 4 thousand, but lowering to 2,000 to 1,500 near, etc."; "ceiling low to very low near Kansas City, 800 to 2,000 other sections"; "ceiling above 6,000 all sections".

The following terms are defined for use in describing expected changes during the period of the forecast:

SLOWLY LOWERING CEILING	Ceiling expected to lower, becoming approximately 2/3 its initial height during the period.
MODERATELY LOWERING CEILING	Ceiling expected to lower, becoming approximately 1/2 its initial height during the period.
RAPIDLY LOWERING CEILING	Ceiling expected to lower, becoming approximately 1/3 or less, of its initial height during the period.
SLOWLY RISING CEILING	Ceiling expected to rise, becoming approximately 3/2 of its initial height during the period.
MODERATELY RISING CEILING	Ceiling expected to rise, becoming approximately 2 times its initial height during the period.
RAPIDLY RISING CEILING	Ceiling expected to rise, becoming approxiamtely 3 times its initial height during the period.

The above terms may be reversed, as for example, CEILING RISING MODERATELY.

185. The "visibility" element will be forecast by specifying the range in miles. Example: "Visibility 1 to 6 miles", etc. Visibilities of 2 miles or less may be described in words as follows, provided no higher visibility range is to be specified therewith:

ZERO	⅛ mile or less.
VERY LOW	⅛ to ¾ mile, inclusive.
LOW	¾ to 2 miles.

Visibilities over 15 miles will be designated as "unlimited." The following terms, which have, respectively, the same change values as those given for the ceiling terms in paragraph 184 may be used when a change is expected to occur during the period:

SLOWLY DECREASING VISIBILITY.
MODERATELY DECREASING VISIBILITY.
RAPIDLY DECREASING VISIBILITY.
SLOWLY INCREASING VISIBILITY.
MODERATELY INCREASING VISIBILITY.
RAPIDLY INCREASING VISIBILITY.

186. The "Remarks" element will form the last portion of the forecast, when appropriate, and will include forecasts of unusually strong winds, surface and aloft, rapid pressure changes, and field and landing conditions as discussed following:

(*a*) *Wind.*—Due to the large influence of local factors of terrain, etc., on the surface wind, this element will not be forecast unless

velocities and gustiness, dangerous to aircraft landings, are foreseen. Winds aloft will not be forecast, except when unusual velocities are expected to occur, or a radical change in direction is expected to take place during the period at levels below 14,000 feet above sea level. No terminology for wind forecasts is specified, but such terms as "strong", "gales", "gusty", etc., are suggested.

(*b*) *Pressure.*—An expected rise or fall of one-tenth inch or more within the forecast period will be included and designated. "Rapidly rising/falling pressure."

(*c*) "Field conditions" will be included in the forecast whenever it is expected that a definite change toward better or worse conditions will occur generally within the forecast period.

187. It will be proper to indicate an expected continuation of current conditions by the use of such inferential terms as "continued", "continuing", "persisting", etc.

188. The forecasts are to be as specific as it may be practicable to make them. The words "generally" and "mostly" should be used sparingly, and the use of the modifying term "possibly" will be limited to precipitation, and then only in cases of extreme uncertainty.

189. The *warning* term "CAUTION ADVISED" is authorized to be used if extremely unfavorable conditions are forecast. Judgment and discretion are to be exercised in the use of this term. Ordinarily it will be used infrequently, but it will be considered justified when the following conditions are forecast:

(*a*) Heavy snow, sleet, or rain over extensive areas, with zero ceiling and visibility.

(*b*) Severe blizzard conditions.

(*c*) Icing conditions or severe icing conditions.

(*d*) Moderate or severe wind-shift line.

(*e*) Severe thunderstorms, with heavy rain or hail.

190. The term "locally" is authorized for use whenever the condition referred to is of minor extent and is definitely located, as, for instance, "Locally low Lexington."

191. The term "occasional" is to be used whenever a condition is expected to occur at intervals of time. The term "scattered" in connection with forms of precipitation may be used.

192. An airway is to be considered as a strip 50 miles wide with the line of beacons along its center when trip forecasts are involved.

XXIV. SPECIAL AIRWAY SUMMARIES

193. At forecasting centers where there is not sufficient qualified personnel to maintain 24-hour forecasting service it will be proper during the forecast periods in which this condition exists for the personnel to issue *summaries* of current conditions *along* the airways assigned, using the terminology above outlined, and substituting the term "AWY SUMMARY" in the heading. However, verbs must be used in the present tense, in order to indicate that the conditions described are existent and not anticipated ones. No forecasts are to be included in the summaries when issued by personnel not authorized to make such forecasts. At stations where there are three or more employees in the professional or other grades who have been authorized to make forecasts, there will be no justification for the issuance of summaries.

XXV. AUTHORIZATIONS AND RECOMMENDATIONS

194. Only employees in the professional grades having had at least 2 years' practice forecast work with a satisfactory record will be authorized, as a rule, to issue forecasts. Professional employees now assigned to stations for the purpose of issuing airway forecasts were indirectly authorized at the time they were assigned. Other employees will not be permitted to make forecasts without specific authorization from the Central Office.

195. If new airways are established or old ones discontinued in a forecast area, the airway forecast center concerned will make recommendation to the Central Office for the issue or discontinuance of forecasts covering these airways.

XXVI. EXAMPLES OF FORECASTS

196. The following example is intended to illustrate the proper usage of terms and possible methods of clear and concise rendition of forecasts:

1600 0000ES AIRWAY FORECASTS 1/18
CG CV
ID PT
TL DT
LV CV
CC WA
WA CV
CV NK
KM PT
DT DMS
CG DT
CV BU
SEVERE DISTURBANCE CENTERED OVER ILLINOIS WILL CONTINUE TO MOVE RAPIDLY NORTHEASTWARD ATTENDED BY HEAVY SNOW AND SHIFTING GALES STP SEVERE WIND SHIFT WILL ENTER INDIANA AND KENTUCKY DURING SECOND HOUR ADVANCING EASTWARD TO CLEVELAND COLUMBUS CINCINNATI LINE BY END OF PERIOD STP SNOW WILL END AND SKIES CLEAR THROUGH NORTHERN INDIANA NORTHWESTERN OHIO AND OVER MICHIGAN BY SIXTH HOUR OF PERIOD AND CONSIDERABLE IMPROVEMENT WILL OCCUR CENTRAL OHIO BY END OF PERIOD STP SNOW WILL ADVANCE OVER ALLEGHENY MOUNTAINS BY END OF PERIOD ACCOMPANIED BY RAPIDLY LOWERING CEILINGS AND VISIBILITIES BECOMING ZERO WESTERN MOUNTAIN RIDGES DURING SIXTH AND SEVENTH HOURS AND ZERO ALL RIDGES BY END OF PERIOD STP SEVERE ICING CONDITIONS ALL SNOW AREAS CAUTION ADVISED STP TOP OF CLOUDS PROBABLY OVER 20 THOUSAND.

CO
CC
CV TERMINALS STP OVERCAST LIGHT SNOW CEILING ONE TO TWO THOUSAND VISIBILITY THREE TO FOUR FIRST TWO HOURS CHANGING TO HEAVY SNOW CEILING AND VISIBILITY ZERO NEXT THREE HOURS STP WIND SHIFT WILL PASS SIXTH HOUR AND GRADUAL IMPROVEMENT THEN OCCUR BECOMING SNOW FLURRIES CEILING 500 TO 1000 VISIBILITY 6 TO 12 BY END OF PERIOD STP SEVERE GALES AND EXCESSIVE TURBULENCE SURFACE AND ALOFT LAST HALF OF PERIOD.
PT TERMINAL STP OVERCAST CEILING 1500 VISIBILITY 4 FIRST HOUR STP SNOW BEGINNING SECOND HOUR INCREASING IN INTENSITY TO ZERO CEILING AND VISIBILITY BY FIFTH HOUR AND CONTINUING FOR BALANCE OF PERIOD STP SEVERE ICING CONDITIONS.
DHS TERMINAL STP OVERCAST CEILING 2 TO 4 THOUSAND VISIBILITY OVER 6 FIRST HALF OF PERIOD STP LIGHT TO MODERATE SNOW WITH RAPIDLY LOWERING CEILING AND VISIBILITY REACHING 500 FEET AND 2 MILES LAST HALF STP SEVERE ICING CONDITIONS.
TL
DT TERMINALS STP OVERCAST WITH HEAVY SNOW CEILING AND VISIBILITY ZERO FIRST HALF STP WIND SHIFT WILL PASS AND SKIES CLEAR BY END OF FIFTH HOUR WITH CAVU BALANCE OF PERIOD STP SEVERE WESTERLY GALES AND TURBULENCE SURFACE AND ALOFT LAST HALF OF PERIOD.
HX
BF TERMINALS STP OVERCAST CEILING 3 TO 4 THOUSAND VISIBILITY 4 TO 6 FIRST HALF STP LIGHT SNOW BEGINNING FIFTH HOUR WITH RAPIDLY LOWERING CEILING AND VISIBILITY BECOMING HEAVY BY END OF PERIOD WITH ZERO CEILING AND VISIBILITY STP SEVERE ICING CONDITIONS LAST HALF.

Abbreviations provided under paragraph 137 shall be used in transmissions of forecasts on radio and teletype circuits. Figures, except zero, shall be used for indicating numerical values.

XXVII. ASSIGNMENT OF AIRWAYS FOR FORECAST PURPOSES

197. The assignment of airways to stations for forecasting purposes will correspond with the assignments of general supervision given under chapter XXXI, with the exception of a few cases. If and when, however, forecasting is assigned to these excepted airways, the assignments will correspond with the current assignments of general supervision.

XXVIII. BROADCAST OF AIRWAY FORECASTS BY RADIO STATIONS OF THE BUREAU OF AIR COMMERCE ON 236 KILOCYCLES

198. In order that pilots in flight might obtain the latest airway forecasts, arrangements were made by the Bureau of Air Commerce

to broadcast such forecasts on a frequency of 236 kilocycles at scheduled times announced in bulletins of that Bureau.

199. While broadcasts of the forecasts were being made, the radio range remained in operation. Only radio stations equipped to broadcast on the alternate frequency of 236 kilocycles broadcast the airway forecasts.

200. At the conclusion of a year's test of this system the various air-transport companies were requested to indicate the use made of it. Replies received indicated that very little use was made of the service, largely because it involved the changing of radio frequencies on the part of the pilot while in flight. In view of this, the broadcast of forecasts has been discontinued.

201. The present arrangement provides that the forecasts will be broadcast on the regular frequency upon request by radio from a pilot in flight.

SUPERVISION AND INSPECTION OF AIRWAY WEATHER SERVICE

This section incorporates instructions contained in the circular "Supervision and Inspection of Airway Weather Service", dated October 20, 1934.

XXIX. GENERAL SUPERVISION OF AIRWAY WEATHER SERVICE

202. General supervision of airway service is assigned only to the 10 present 6-hourly airway forecast centers, as experience has shown that inspections and other details of organization and administration can be most efficiently handled therefrom. The assignments of general supervision to these stations correspond to the assignments for 6-hourly forecasting, except in a few cases involving airways for which no regular forecasting service is now assigned.

203. The general supervising station will be responsible for organizing, administering, and coordinating the service over the airways assigned to them for general supervision in such a way as best to meet the needs of the air traffic using the airways. *In general*, this means that they will perform the following functions:

(*a*) Make recommendations to the Central Office for—

(1) Opening or closing of substations.

(2) Additional reports involving commercial tolls.

(3) Increased or decreased compensation to airway observers.

(4) Inspections of airways or individual stations.

(5) Disposition of instruments of closed stations.

(6) Instrumental equipment for new stations or additions to that of stations already established.

(7) Additions or reductions in personnel at airport or airway stations in their districts.

(8) Assignment of checking work on Forms 1136–1140.

(9) Other such matters as may arise and require such action.

(*b*) Conduct correspondence with other first-order or airport stations, or with substations, as may be required by circumstances. When referring to stations under the general supervision of another station, the correspondence shall be sent through that station. Also, when referring to substations under the direct supervision of

a first-order or airport station, the matter shall be taken up through that station.

(*c*) Conduct all correspondence with the district managers of the Department of Commerce. Stations other than general supervising stations are not authorized to do this, questions arising at those points requiring such action to be referred to the general supervising station.

NOTE.—Copies of correspondence as outlined above will be sent to the Central Office when the matter is considered to be of sufficient importance.

(*d*) Advise the Central Office of *general* increases or decreases of air traffic or necessity for service over the airways assigned. This does not mean the reporting of the elimination or addition of one or two schedules, or substitution of one for another, etc., but rather changes of some magnitude affecting the service as a whole, such as discontinuance of airways, new airways, proposed new airways, rerouting of old airways, etc.

(*e*) Consider recommendations, requests, etc., of direct supervising stations as concerns airway matters, indicating concurrence or nonconcurrence.

(*f*) Assume property accountability for all Weather Bureau property located at stations manned by Department of Commerce personnel, except when, in the opinion of the general supervising official, this may be handled best by a local Weather Bureau office or airport station. The final arrangement will be presented to the Central Office for approval before becoming effective.

204. Other Weather Bureau stations on these airways will send *all* recommendations, correspondence, etc., concerning matters involving these airways to the Central Office through the official in charge of the general supervising station, who will indicate by proper endorsement his approval or disapproval of the matter, except that in cases of emergency the matter may be forwarded directly to the Central Office and a copy of the correspondence, or advice as to action taken, forwarded to the general supervising station. When the action is recommended, the general supervising station official may so indicate by writing the word "Recommended" at the head of the letter and initialing under this; if disapproved, proper typewritten endorsement will be forwarded to the Central Office with the correspondence and a copy sent to the originating station. The Central Office will not consider recommendations made by other than general supervising stations through other than these channels.

205. The general supervising station will have the direct supervision of any or all intermediate weather-reporting stations on the airways assigned to their general supervision at which reports are made by employees of the Department of Commerce, and the station is equipped with Department of Commerce teletype and radio. In this connection, and that of the transfer of general supervision, when required, attention is called to the necessity for the former general supervising station to request authority from the Central Office, through channels as outlined in paragraph 204, to transfer property at such stations from their accountability to that of the new general supervising station, except that, if recommended by the general supervising station and approved by the Central Office, this accountability may be held by a local Weather Bureau office or airport station.

Officials concerned are to make certain that the regular procedure covering such transfers is conformed with.

206. The direct supervision of each individual Weather Bureau airway station, which includes the carrying of property accountability, preparation of pay rolls, rendering Form 4076 for new observers or discontinuance of old, selecting new observers, and other administrative matters concerning the station, will be under the first-order or airport station to which this has been assigned.

207. The responsibility delegated to the general supervising stations under the foregoing procedure makes it imperative that officials having charge of these stations work with the best interests of the Bureau in mind at all times. Requests for service or changes in service should be considered carefully from this viewpoint. Further, this responsibility requires that the officials exercising it, use judgment in connection with matters transmitted to the Central Office. In many cases these are received containing no definite recommendations and shifting the entire matter from the station concerned to the Central Office, which, in the large majority of instances, has no detailed knowledge of the matter. This, of course, results in delay and additional correspondence. The Central Office is an extremely busy place and the details to be handled and remembered are numerous, with the result that such procedure on the part of station officials badly aggravates the situation. All matters concerning service referred to the Central Office will, therefore, be accompanied by definite recommendations for consideration, preferably arranged in numbered paragraphs at the end of the letter or endorsement.

208. The general supervising station may delegate any of the duties outlined under paragraph 203, except correspondence with other general supervising stations or with Department of Commerce district managers, to an important airport station on the airway concerned, such delegation to have the prior approval of the Central Office. These latter stations would, of course, address all letters through the general supervising station.

209. Visits to individual airway stations for purposes of installing equipment, obtaining new observers, etc., will be made when necessary and advisable by the personnel of the direct supervising station upon specific authority. Recommendations for such visits will be made on Form 4067 and will be sent *through* the general supervising station for the airway concerned, except in case of emergency not permitting delay.

210. Changes in the direct supervision of Weather Bureau airway stations as may be considered advisable and necessary under the terms of this section will be given consideration at the Central Office upon receipt of recommendations from the general supervising station.

211. The 6-hourly weather-reporting work at Weather Bureau first-order or airport stations and second-order stations telegraphing such reports will be under the supervision of the station to which the reports are telegraphed. This supervision will consist of inspection of the reports and the issuing of error forms when required.

XXX. INSPECTION OF AIRWAY WEATHER SERVICE

212. Within the limits of available funds the following policy with regard to inspections of airways will obtain:

(*a*) Inspections of airways equipped with teletype, or radio, at intermediate points reporting hourly in a manner similar to that of a teletype-equipped airway, will be made semiannually by the personnel of the general supervising stations concerned, provided that the whole, or at least half of them, can be inspected in company with the Communication Supervisors of the Department of Commerce and in the automobile provided for that official. This arrangement has the approval of the Department of Commerce. In all cases the responsibility for making arrangements to accompany the supervisors will rest with the officials of the Weather Bureau, except that the District Managers of the Bureau of Air Commerce have been instructed by their Washington office to advise the Weather Bureau station concerned 2 or 3 weeks in advance of the date the supervisors intend to start on a trip. The Weather Bureau officials concerned should then complete the necessary arrangements with the District Managers. It will, of course, be necessary in certain cases to use public conveyance in reaching the point where the supervisor is to be met, or in returning to station. Form 4067 will be submitted to the Central Office for each trip and authority received before the trip is begun.

(*b*) Inspections of airways not included under the classifications given in "a" above will be made not less than once each year. The journeys will be made in company with the Communication Supervisors, when practicable. If not practicable, details concerning the necessity for making the inspection at that time and by public conveyance or personal car should be given on the Form 4067 submitted. In connection with travel in personal automobile on a mileage basis, it should be kept in mind that it is necessary that *both economy and advantage* be shown or travel on that basis cannot be authorized.

213. The inspection trips are to be made in all cases by the personnel of the general supervising stations, except that the general supervising official may delegate this for an airway or section thereof to the personnel of some airport station under his general supervision by recommendation to the Central Office, if considered desirable and in the public interest.

XXXI. ASSIGNMENTS OF GENERAL SUPERVISION

214. In the following assignments, each general supervising station's district has been given a number corresponding to its general location with respect to the Atlantic coast, e. g., Newark is designated as I, Atlanta as II, Cleveland as III, etc. This is done in order that the general supervision of stations at the junction points of airways can be readily indicated. This indication is made by insertion in parenthesis of the number of the general supervising station to which general supervision of the point in question is assigned following the name of the junction station in question. This system does not, of course, apply to points where the junction is another general supervising station, nor to airport or first-order stations included within the terminals of the airways indicated, but which are not airway junction points. Stations falling under this latter classification will be under

the general supervision of the station to which the general supervision of the airway is assigned. For example, "Cheyenne (VII)-Albuquerque (V)" indicates that the airway is from Cheyenne to Albuquerque and that the general supervision of the station at the Albuquerque junction point is assigned to the general supervising station for district V, i. e., to Kansas City, and that the station at the Cheyenne junction point is assigned to the general supervising station for district VII, i. e., to Salt Lake City. The general supervision of the Denver airport station would be located at Salt Lake City, inasmuch as it is on an airway assigned to that station.

NEWARK (I)

Newark–Boston (I)
Newark–Washington (I)
Newark–Buffalo (I)
Newark–Albany (I)
Albany (I)–Montreal [1]
Albany (I)–Buffalo (I)
Albany (I)–Boston (I)
Boston (I)–Bangor
Boston (I)–Montreal [1]
Newark–Atlantic City

ATLANTA (II)

Atlanta–Washington (I)
Atlanta–Murfreesboro (II)
Atlanta–Jackson (VI)
Atlanta–New Orleans (II)
Atlanta–Jacksonville (II)
Atlanta–Charleston (II)
Richmond (II)–Jacksonville (II)
Jacksonville (II)–Miami (II)–Key West (II)
Daytona Beach–St. Petersburg
Washington (I)–Norfolk
Murfreesboro (II)–Louisville (III)
Murfreesboro (II)–Washington (I)

CLEVELAND (III)

Cleveland–Newark
Cleveland–Chicago
Cleveland–Buffalo (I)
Cleveland–Washington (I)
Cleveland–Detroit (III)—Muskegon (III)
Indianapolis (IV)–Pittsburgh (III)–Camden (I)
Cleveland–Louisville (III)
Cincinnati (III)–Washington (I)
Chicago–Detroit (III)
Toledo (III)–Detroit (III)

CHICAGO (IV)

Chicago–Cincinnati (III)
Chicago–Louisville (III)
Chicago–St. Louis (V)
St. Louis (V)–Memphis (VI)
Chicago–Twin Cities (IV)
Twin Cities (IV)–Pembina
Fargo (IV)–Miles City (IV)
Twin Cities (IV)–Sioux Falls (V)
St. Louis (V)–Indianapolis (IV)
Milwaukee (IV)–Muskegon (III)

KANSAS CITY (V)

Kansas City–Bismarck (IV)
Kansas City–Chicago
Kansas City–St. Louis (V)
Kansas City–Amarillo (V)–Albuquerque (V)
Kansas City–Tulsa (V)
St. Louis (V)–Tulsa (V)–Oklahoma City (VI)
Omaha (V)–Chicago
Omaha (V)–Cheyenne (VII)

DALLAS (VI)

Dallas–Memphis (VI)–Murfreesboro (II)
Dallas–Jackson (VI)
Dallas–Galveston
Dallas–El Paso (VIII)
Memphis (VI)–New Orleans (II)
Dallas–Amarillo (V)
Dallas–Brownsville (VI)
Houston (VI)–New Orleans (II)
Dallas–Wichita (V)

[1] To International Boundary only.

SALT LAKE CITY (VII)

Salt Lake City–Great Falls
Salt Lake City–Boise (VII)
Salt Lake City–Las Vegas (VIII)
Salt Lake City–Cheyenne (VII)
Cheyenne (VII)–Billings (VII)
Cheyenne (VII)–Albuquerque (V)
Miles City (IV)–Missoula (VII)

BURBANK (VIII)

Burbank–Las Vegas (VIII)
Burbank–Albuquerque (V)
Burbank–El Paso (VIII)
Burbank–San Diego
El Paso (VIII)–Albuquerque (V)

OAKLAND (IX)

Oakland–Medford (X)
Oakland–Burbank
Oakland–Reno (IX)
Reno (IX)–Salt Lake City

PORTLAND (X)

Portland–Seattle (X)
Portland–Medford (X)
Portland–Pendleton (X)
Pendleton (X)–Spokane (X)
Pendleton (X)–Boise (VII)
Seattle(X)–Spokane(X)–Missoula(VII)
Seattle (X)–Vancouver [1]
Seattle (X)–Victoria [1]

JUNEAU (XI)

Alaskan Airways

HONOLULU (XII)

Hawaiian Island Airways

INSTALLATION AND OPERATION OF AIRWAY INSTRUMENTS

NOTE.—The information and instructions given below cover the essentials of standard installations of instrumental equipment at airway stations, and in part those at airport stations, the former being located at selected points along the airway between the airport stations. Installations at airport stations are covered by special correspondence and a circular of general information entitled "Quarters and Instrumental Equipment for Weather Bureau Stations at Airports", especially required for the initial planning.

XXXII. STANDARD INSTRUMENTAL EQUIPMENT

215. *Airway stations.*—The completeness of the equipment depends largely upon the frequency of observations, ranging from a thermometer and airway shelter for stations furnishing occasional observations on call to the complete outfit provided for a station reporting by teletype, which usually requires the following:

One shelter, airway, with thermometer support.
One exposed thermometer.
One aneroid barometer.
One one-sixtieth mile anemometer, complete with cups and wrench. (Special oils, one for summer and one for winter use, are required for use with the anemometer.)
One support, wind instrument, 12-foot, for erection on roof of building; complete with cross arm for anemometer.
One contacting wind-vane bearing.
One 3-foot metal wind vane.
One indicator, wind direction and velocity.
One projector, ceiling light.
One clinometer.
Ceiling balloons and inflation equipment.

[1] To International Boundary only.

216. When an airway station is located where a Department of Commerce beacon-light tower is available, separate supports for wind vane and anemometer for mounting on the tower platform are substituted for the above-listed 12-foot support, and no cross arm for the anemometer is used.

217. For airway stations not reporting for the teletype, the equipment is usually simplified by the omission of the contacting bearing, and also the wind vane and tower support therefor for a tower exposure, and a wind-velocity indicator is substituted for the combined wind-direction and velocity indicator. The ceiling-light projector and clinometer are omitted where night observations are not required.

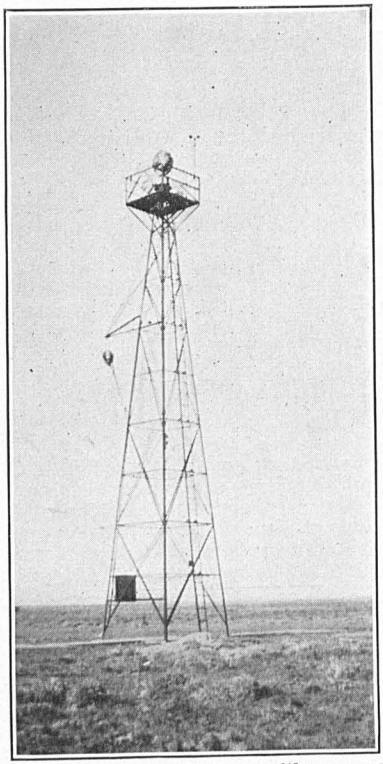


FIGURE 21.—Beacon-light tower with anemometer and wind vane mounted on separate 7-foot pipe supports erected on platform at apex.

218. *Airport stations.*—At airport stations a large-sized standard shelter with steel support is substituted for the airway shelter, or very occasionally a cotton-region shelter is employed. The large shelter is required when a whirling apparatus for wet- and dry-bulb thermometers is used. For the wind instruments a standard 18-foot pipe support is customary, usually equipped with a 4-foot vane, a Fergusson wind-vane bearing and old-style direction contacts in a cast-iron contact box; otherwise the contacting wind-vane bearing is used instead.

219. Additional equipment to that provided for an airway station includes a mercurial barometer with a board for mounting, a barograph pilot-balloon apparatus, and less frequently a telethermoscope.

XXXIII. WIND INSTRUMENTS

220. *Exposure.*—Wind instruments will be exposed where a free movement of the wind occurs, obstructed as little as possible by near-by structures or objects. This is obtained by elevating the vane or anemometer by means of vertical pipe supports, usually mounted on buildings or towers. The instruments must be readily accessible for cleaning, oiling, and occasional adjustments.

221. *Wind-instrument supports.*—Two types of supports are standard for airway weather stations: (1) A 7-foot support of 1-inch pipe for either the anemometer or the contacting wind vane used on airway beacon-light towers; and (2) a 12-foot support of 1¼-inch pipe for wind vane and anemometer for roof installation.

222. *Tower support for anemometer or wind vane.*—The tower support, figure 21, for anemometer or wind vane consists essentially of a 1-inch pipe screwed into a railing base fastened to a corner of the

square wooden or iron grating platforms of the tower. A 1-inch by ½-inch coupling surmounts the upper end of the pipe, 6 feet 9 inches high, into which coupling a brass anemometer pin or the wind-vane bearing is screwed, the former fitting the recess in the base of the anemometer casing.

223. When one support for the anemometer only is required, it should be placed over a tower corner nearest the point from which the prevailing winds come. When both anemometer and contacting wind vane are needed, the pipe supports should be located at diagonally opposite corners of the platform, if possible, the line of centers of the supports approximately normal to the prevailing wind direction. When submitting requisitions for supports, state the kind of platform with which the tower is equipped.

224. As shown in figure 22, the 1-inch pipe of the support is anchored to the tower handrailing by an 18-inch angle iron, the pipe attached to the angle iron by two hook bolts and a pipe strap, and the angle iron held in turn to the handrailing by two similar hook bolts.

225. *Twelve-foot wind-instrument support.*—The 12-foot support, figure 23, is intended for erection on the roof of the building, the combined height of building and support being sufficient usually to give the anemometer a reasonably free exposure.

226. While the support will be so installed as to secure a good exposure of the wind instruments, at the same time ample safety must be provided for the man who will have to climb it in all kinds of weather. This safety is accomplished almost entirely by the secure attachment of the guy-rod footings to the roof. Three 8-inch eye bolts, each with nut and washer, also three foot plates, are provided with each support, one bolt or plate for each footing, the bolts to be used where access can be had to the underside of the roof. Otherwise the shoes are required and fastened to the roof with lag screws, 1 shoe for each of the 3 guy rods.

227. The base plate and shoes should be placed, if practicable, over the roof rafters. If this cannot be done, or the roof is of unusually light construction, 2-inch wooden blocks or short planks should first be screwed to the roof, the shoes being attached to the blocks. Roof cement placed under the timbers or other member attached to the roof will prevent leakage. Give the support a coat of paint after erection.

228. *Eighteen-foot wind-instrument support.*—This support illustrated in figure 24 is of the same general construction as the 12-foot support but more strongly built, 2-inch pipe being used instead of 1¼-inch. The contact box near the base contains the wind-direction contacts, the rotor of which is connected by an inside pipe to the wind-vane axis above. For further details consult circular D, Instrument Division.

229. A less costly assembly, for identification called a 17-foot support, is used when a contacting wind-vane bearing is employed instead of the old-style cam-collar contacts. In this case the contact box and Fergusson bearing with inside pipe are omitted, and the contacting bearing screws into a reducing coupling at the top of the support.

230. *Anemometers.*—The anemometer consists essentially of a cup wheel rotated by the wind, rigidly attached to a vertical axis turning in bearings. Suitable gearing communicates the motion of wheel and spindle to dials graduated in miles and tenths, approximately 640 turns of the cups corresponding to a movement of 1 mile of wind

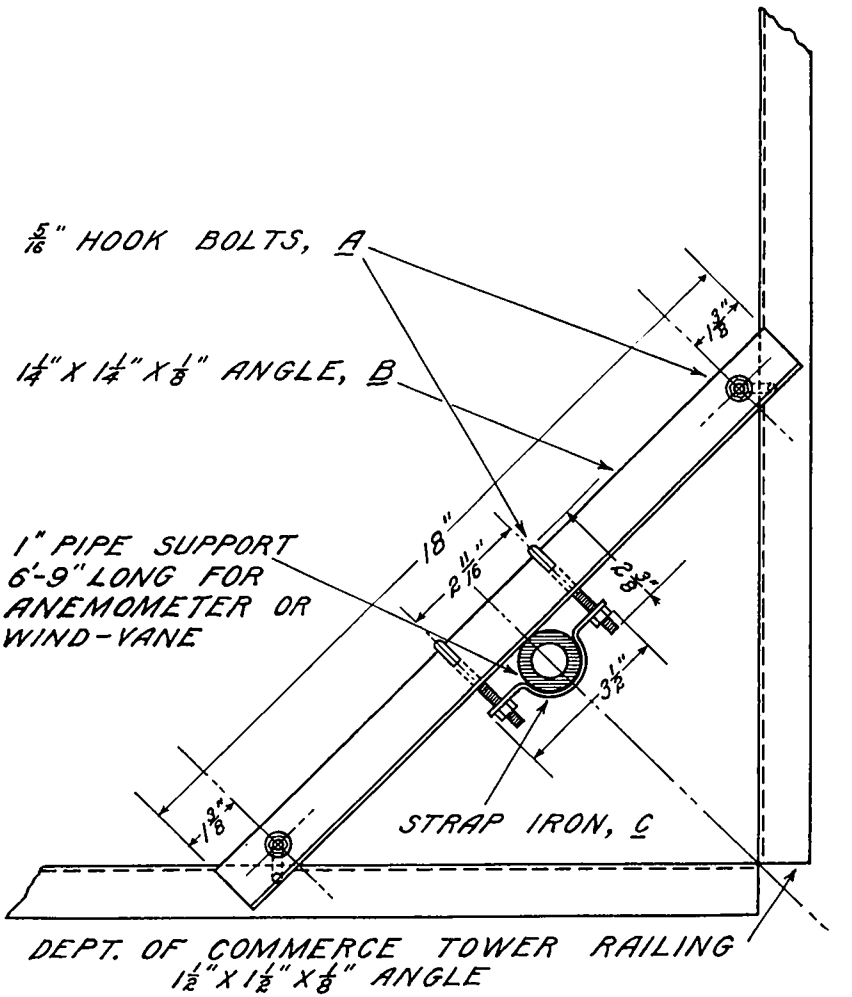


FIGURE 22.—Clamp to hold anemometer or wind-vane support to railing of beacon-light tower.

past the instrument, when a 3-cup anemometer is used having cup arms 6.29 inches long. Tables for correcting, indicated to true wind velocities, will be found in Weather Bureau Instructions No. 14, dated December 18, 1931. The correction tables are also issued as a separate on a convenient card.

231. Referring to figure 25A, the cup wheel (1) is made of four hemispherical cups of duralumin or copper mounted on steel arms. The wheel is attached by a set screw (2) to a steel spindle within the casing having a plain bearing at the upper end and a step bearing at the bottom. A steel worm on the spindle transmits motion to the wheel (3) (see fig. 25B) on the axis of which is a second worm meshing with the pinion (4) which turns the two dial wheels (5), the outer one of which has 100 teeth and the inner 99, so that for each revolution of the former, the inner wheel moves one gradation, equivalent to an indicated-wind movement of 10 miles. The inner dial therefore gives the reading to tens of miles as referred to the zero of the outer dial, and the latter gives the additional miles and tenths by reference to the index at (6). For operation of the electrical indicator, pins set into the side of wheel (3) close the circuit at spring (7).

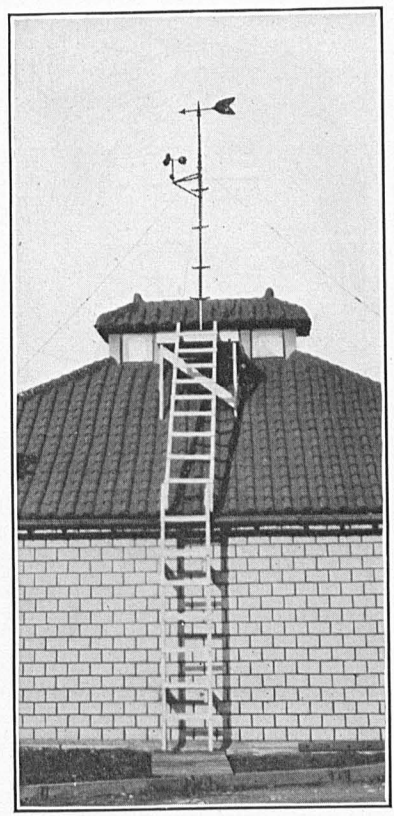


FIGURE 23.—Twelve-foot wind-instrument support on roof of building.

232. *Wind vanes.*—The vane generally used, figure 26, consists of a plate of metal forming a tail attached to one side of a vertical axis free to rotate in response to changes in wind direction. The windward part of the vane is formed of an arrow-tipped rod which points into the wind and also serves to counterweight the tail. The spindle is a steel rod about 2 feet long, the lower end turning in a pivot bearing. The bearing proper for the contacting wind-vane assembly, and that for a vane used without contacts, are alike.

233. *Contacting wind-vane bearing.*—As shown in both figures 26 and 27, the device consists of the following parts: One wind-vane bearing made of half-inch pipe, with keyway bushing to form the top bearing and a pivot support to form the lower bearing; one windvane axis with a special cam-equipped weather housing rigidly attached; one set of insulated contact springs spaced 90° apart on a collar that fits over the half-inch pipe; one wind vane; one windvane clamping nut.

234. *Installation.*—To set up the device for use, first erect the half-inch pipe bearing firm and vertical in the desired location. Then fill the bearing about half full of light automobile oil, the contents of the bottle of oil sent out with the bearing. Next slip the contact-spring assembly over the pipe and temporarily clamp it, springs upward and lower edge of brass collar between the two rings that will be found on the pipe $2\frac{13}{16}$ and 3 inches respectively below the top.

(These rings mark safe working limits and provide for longer life by occasional change of position.) Now insert the axis, being careful to rotate it slowly so as to *feel* the key in the axis through the keyway in the top bearing. This key arrangement permits withdrawal in one, and only one, position. Next put on the vane with due regard to provisions made for insuring its position relative to its axis, generally a pin extending into a hole in the brass housing of the axis.

235. *Orienting* requires that the vane be tied or otherwise temporarily secured in a true north direction. The contact-spring assembly is then rotated until one of the springs, no matter which one, comes evenly spaced opposite a notch in the housing which indicates the mid-position of the contact cam. This contact spring now becomes the north one, and should have the north wire attached. The other three wires are then clamped to the corresponding binding posts, which are sufficiently identified by their positions. The

FIGURE 24.—Eighteen-foot wind-vane and anemometer support mounted on platform on roof of observatory together with large-sized shelter on 5-foot steel support and theodolite for pilot-balloon observations.

common or battery wire is to be well grounded to the upright metal support by fastening with screw to brass ring. As in all electrical installations, it pays to take time to connect terminals carefully with well-formed loops under the binding nuts. The resulting indications should of course be verified by two observers, one holding the vane in its positions, the other observing the indications in the office. There is also a sleet shield which should be temporarily removed, then replaced after all connections have been made.

236. *Indicators* for use in making observations of the wind are of two principal kinds: One for wind velocity, the other for both the direction and velocity.

237. *Velocity indicators*, figure 28, are usually comprised simply of a board 8 by 10½ inches on which are mounted a bell-ringing transformer, the secondary of which is wired in series with a switch,

a 25-ohm rheostat, a buzzer, and two binding posts to which the anemometer leads are connected as shown under "Wiring" below. One form required where alternating lighting current is not available utilizes a buzzer and push-button switch wired in series with a 2-cell dry battery placed within the box, forming a part of the indicator.

238. *The wind-direction and velocity indicator*, figure 29, so far as the velocity part is concerned, is similar to the above, but for the indication of direction four 6–8 volt automobile-type lamps are added,

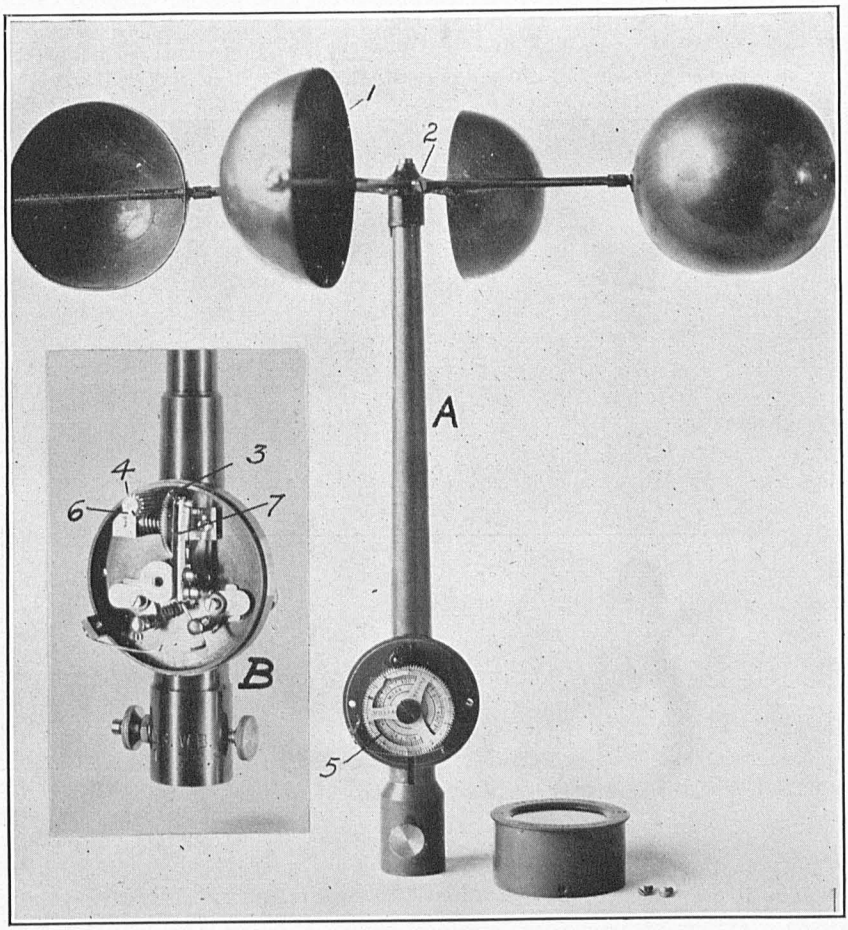


FIGURE 25.—Four-cup one-sixtieth mile anemometer, "A" showing complete instrument; "B" anemometer with dials removed.

mounted in the form of a square, so that when the board is attached to a wall, the lamps are at the cardinal points, i. e., north at the top, east at the right hand, etc. The 25-ohm rheostats are employed to adjust the current from the transformer secondary connected to the anemometer and wind-vane circuits so as to give positive operation of the buzzer but with only enough current to light two of the lamps to a moderate brightness. By thus diminishing the current flow the anemometer contacts are protected from injurious sparking.

239. *Wiring.*—The anemometers are all of the electrical-indicating one-sixtieth mile type; the wind vanes either indicating or non-indicating.

240. When using either type of indicator, wire from the two velocity-indicator binding posts to the anemometer, employing cable with no. 16 conductor wires, lead or braid-covered as desired. Two-conductor lead-covered cable is often desirable for more or less permanent installations, especially on the towers. This is essential when the circuit from the tower is to be buried underground; otherwise use the braid-covered cable. The outdoor terminals of the circuit will be firmly secured to the left-hand binding posts of the anemometer (observer facing the dials); one terminal to the large post near the base of the casing, the other to the nickeled post at the back of the dial case.

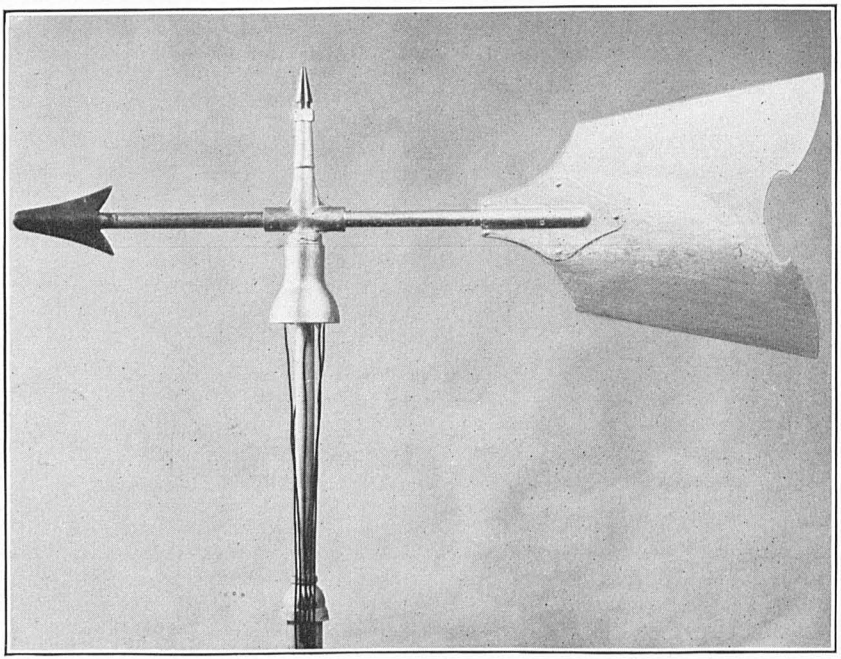


FIGURE 26.—Three-foot metal wind vane with contacting bearing.

241. As shown in the circuit diagram, figure 30, the *combined direction and velocity* indicator requires one wire to each of the direction contacts in addition to the anemometer connections, the transformer lead to the support, or battery when used, being common to both anemometer and direction circuits. Seven-conductor lead or braid-covered cable is issued for the wiring of this indicator.

242. *The transformer-operated indicator* requires connection in addition to the alternating-current lighting circuit, usually 110 volts. This connection is neatly made with No. 14 lamp cord, although other forms of conductor will do. The connection will be as short as practicable, and the light socket or other outlet or switch so placed as to be convenient to switch the current on or off. A switch is also placed in the transformer secondary circuit. A location on

or over a desk is desirable. To operate, it is only necessary to turn on the lighting current, close the switch on the indicator, and the buzzer is then free to respond to the circuit closures through the anemometer, as many times per minute as the wind is blowing miles per hour, and 1 or 2 of the direction lamps are lighted, when used, giving directions of the wind to 8 points.

243. Battery-operated anemometer indicators are similarly employed, excepting that a push-button switch on the indicator is used to close the circuit.

244. Should the lighting current fail when an observation is required, 2 dry cells may be substituted temporarily for the transformer secondary of the velocity indicator, or 4 cells for the direction and velocity indicator. The alternative is to estimate velocity and direction of the wind, employing the Beaufort scale in connection with the former.

245. A weather-proofed metal strap called Wraplock furnished on stores requisition is usually employed to attach the cable to a tower or other object.

246. The wiring of ceiling-light projectors is given below in connection with the installation and use of the projectors.

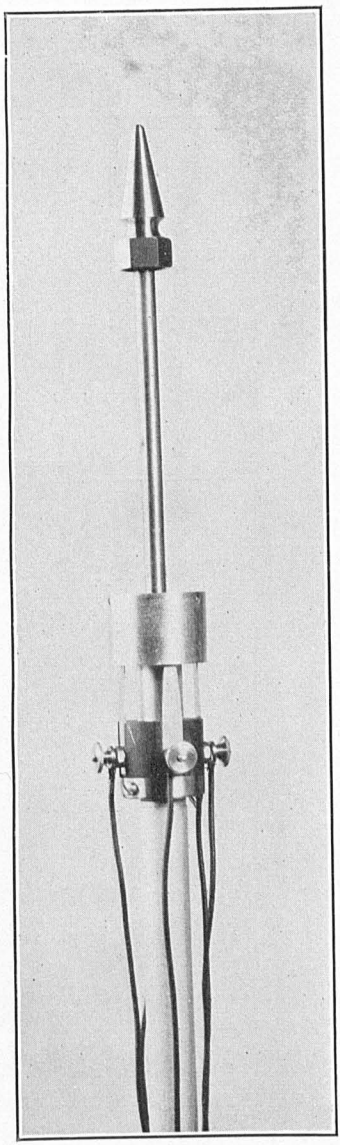


FIGURE 27.—Contacting wind-vane bearing with shield removed.

XXXIV. PRESSURE-MEASURING INSTRUMENTS

247. All airport stations and nearly all airway stations are equipped with ruggedly constructed aneroid barometers of the type described below.

248. *Aneroid barometers.*—Referring to figure 31, the essential feature of an aneroid is a metallic box or cell (1), corrugated in order to make it flexible, and exhausted of air. This cell tends to collapse under the pressure of the air, but a strong steel spring (2) balances the air pressure and prevents such collapse. As the pressure of the air changes, the upper or free surface of the cell contracts or expands slightly, and this small movement is magnified and transmitted to the hand (3) through a train of links (4) and a fine chain (5); the effects of temperature are compensated by means of a bimetallic link (6) made of brass and steel, the flexure of the link being such as to nearly offset the temperature effect on the spring and cell and connected linkage.

249. *Exposure of aneroids.*—Suspend the barometer indoors from a cup hook, screwed into the wall or woodwork where it will not be subject to extremes of heat or cold, or rapid changes in temperature, and where it will not be unduly jarred. The back of the instrument should rest flatly against the vertical surface.

250. *Mercurial barometers.*—With occasional exceptions, mercurial barometers are used only at airport stations where they are mainly required as a standard of reference for aneroids, the latter instruments

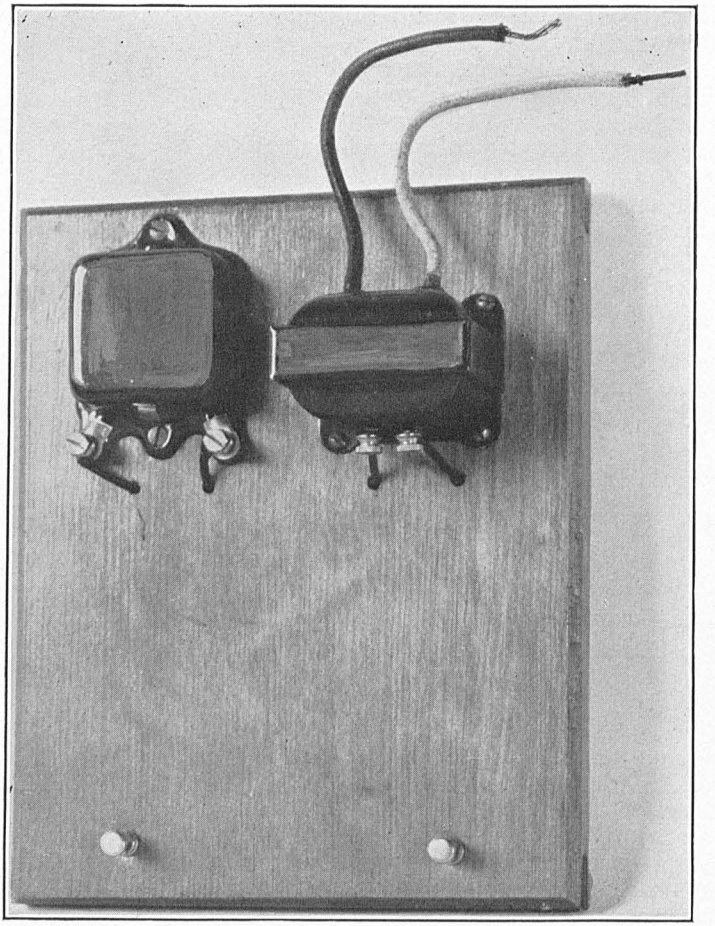


FIGURE 28.—Wind-velocity indicator, transformer type.

being employed for most of the current observations. Weather Bureau officials should be thoroughly familiar with the information regarding their construction, exposure, installation, and use given in great detail in Circular F, Instrument Division, "Barometers and the Measurement of Atmospheric Pressure." Comparisons of mercurial barometers will be submitted quarterly to the Central Office on form 1027.

251. Briefly stated, mercurial barometers should be located where they are not unduly subject to vibration, to extremes of heat or cold, and where the sun will not strike them, but at the same time the barometer should be well illuminated by both artificial and natural light.

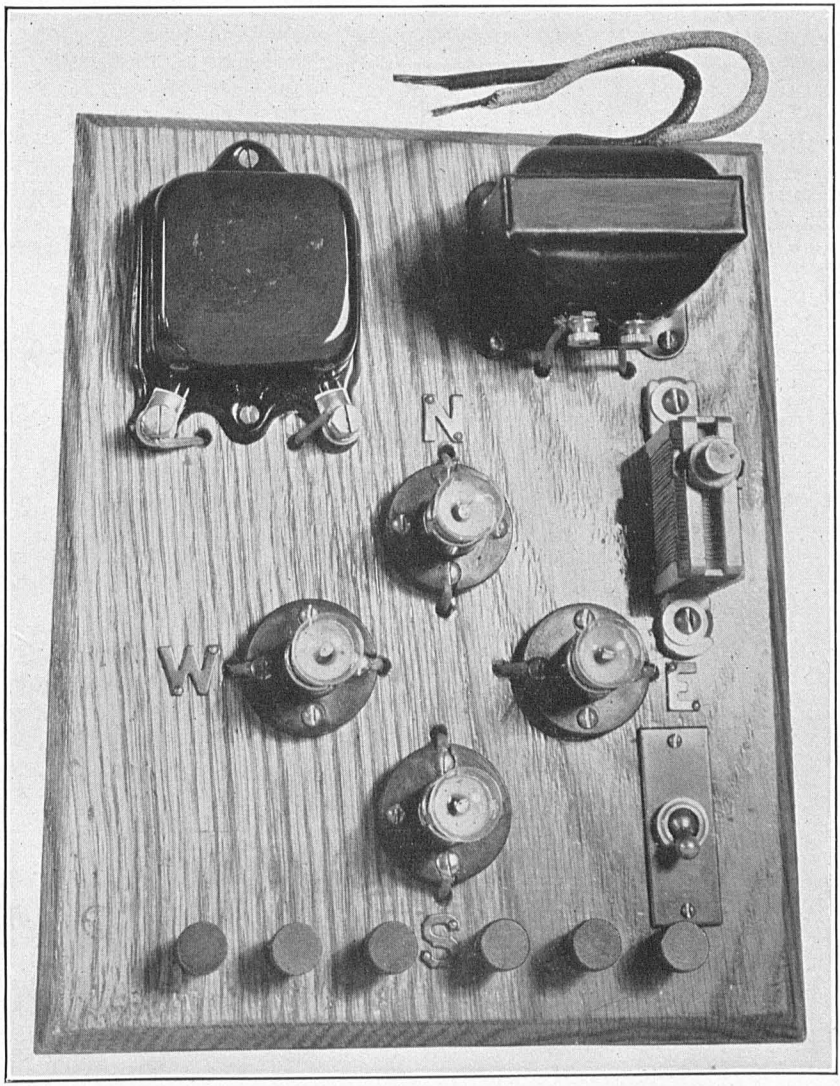


FIGURE 29.—Wind-velocity and direction indicator.

252. *Barographs*, which give a continuous record of atmospheric pressure, are employed only at airport stations. For a description, see Circular F.

XXXV. TEMPERATURE-MEASURING INSTRUMENTS

253. *Exposure.*—A thermometer, telethermoscope, or other instrument for measuring temperature, should have free exposure to the outdoor air, and at the same time be shielded from the direct or reflected rays of the sun, and be free from the effects of artificial

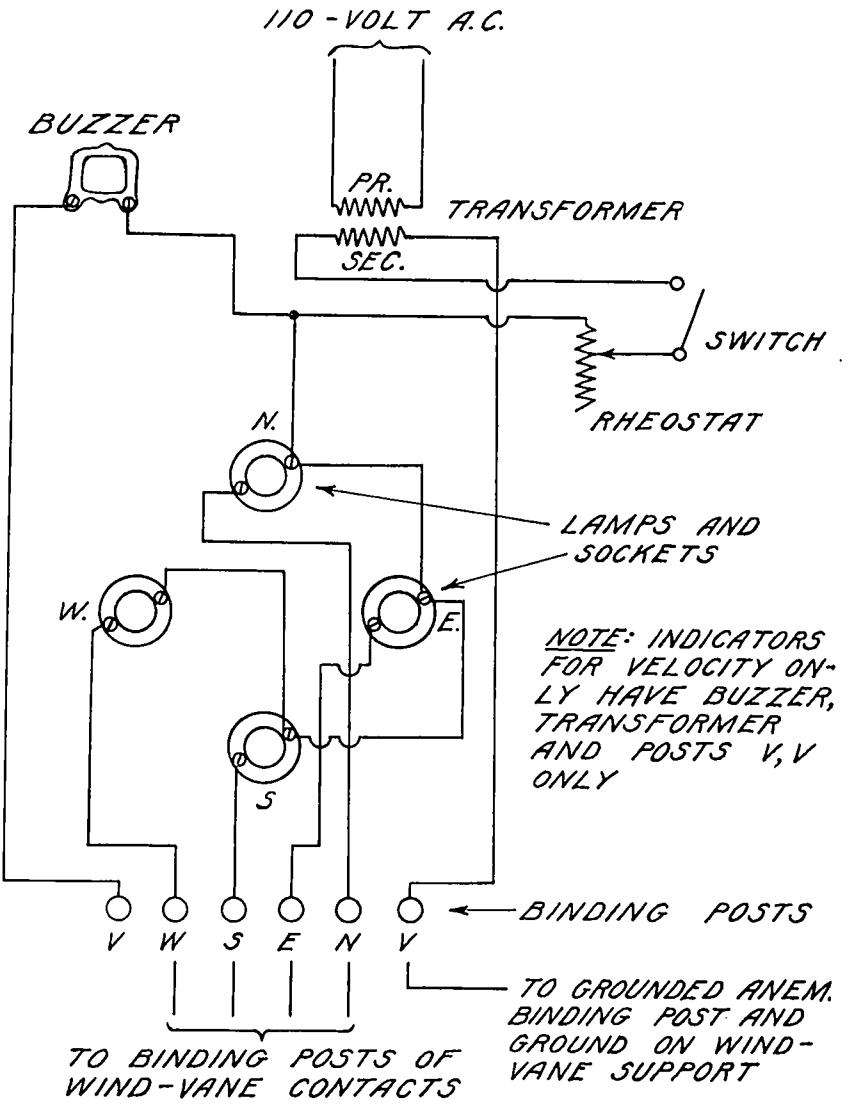


FIGURE 30.—Diagram of circuits for electrical connection of wind instruments and indicator.

heat. This is accomplished by placing the instrument in a specially constructed shelter through which the air can freely circulate, erected as described and illustrated below.

254. *Instrument shelters.*—For airway stations where a single mercurial thermometer or a ventilated psychrometer is generally used, the instrument is placed within a small shelter erected as illustrated in figure 34. The shelter is mounted over the ground, preferably sod-covered, on a 4 by 4 inch post, 8 feet long, the post fastened to the shelter by means of two five-sixteenth-inch carriage bolts. The post should be cedar or cypress when possible, or protected against decay in the ground by creosoting the lower 3 feet. Creosoted fence posts may also be used to advantage at times. After installation the post will be given two coats of white lead paint, and, if the shelter needs it, a single coat.

255. For airport stations, either a large-sized standard shelter with 5- or 10-foot steel support or a cotton-region shelter with wooden support is furnished. The large shelter costs nearly five times as much installed as the smaller, and a letter of explanation should accompany a requisition for the same. It is needed where a whirling

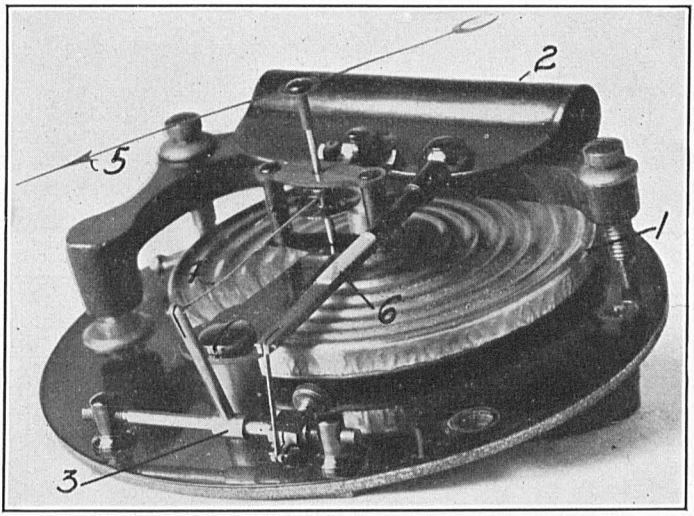


FIGURE 31.—Aneroid barometer with dials removed to show details of mechanism.

apparatus is employed for psychrometric readings, or for housing hygrographs or hygrothermographs. For further information regarding the large shelter, see "Quarters and Instrumental Equipment for Stations at Airports." See figure 24, large shelter and 5-foot steel support.

256. Shelters should be placed with the door facing approximately toward the north.

257. *Thermometers,* furnished for airways work, are mercury-in-glass instruments, or those filled with red spirits, which are exposed vertically with the bulb end down, usually by attachment to the brass support furnished with each shelter. The support is fastened to an upright wooden post near the center of the shelter. (See fig. 32B.)

258. Where temperatures below about —38° F., the freezing point of mercury, occur with some frequency, minimum thermometers

which are alcohol-filled, are substituted for the mercury thermometers during the period of low temperatures.

259. *Psychrometers.*—Ventilated wet- and dry-bulb psychrometers are used for humidity observations to determine the temperature of the dew point.

260. Two kinds are employed, one which is ventilated by whirling of the thermometers, either by means of the whirling apparatus used

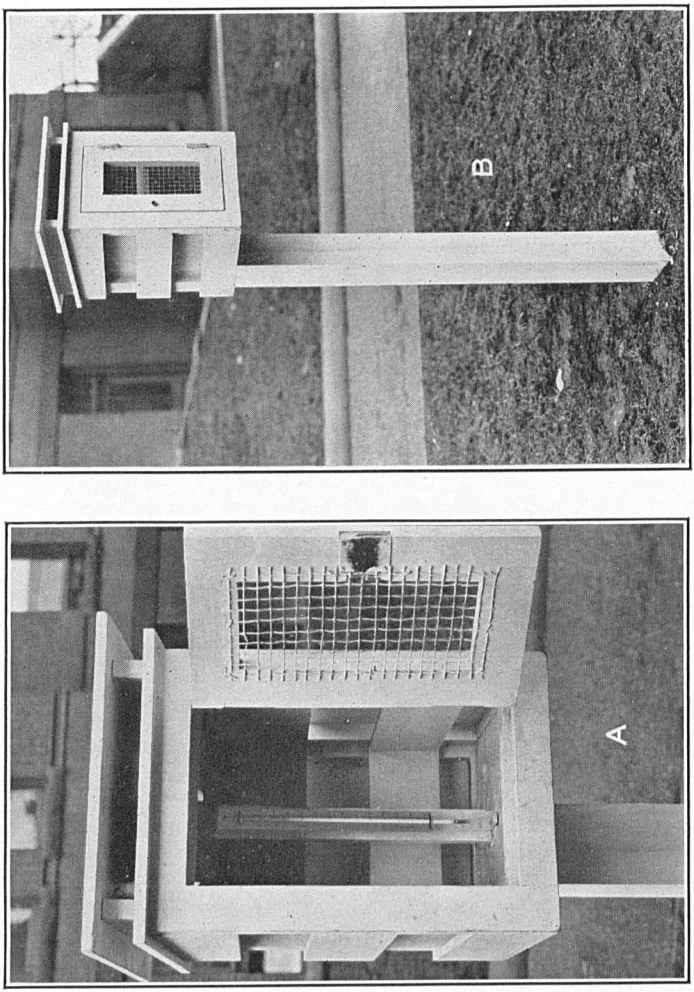


FIGURE 32.—Airway instrument shelter, *A* with door opened to show thermometer and mounting; *B* shelter and mounting complete.

in the large shelter (fig. 34) or by using a sling psychrometer (fig. 33) outside a shelter; the second, which has stationary thermometers that are ventilated by air drawn past the bulbs by means of a small hand-operated fan (fig. 36). This psychrometer fan has come into general use at airway stations. Two accurate mercury-in-glass thermometers are always required. Those used with the whirling apparatus are attached to the counter-balanced arms, the bulbs of which are pinned

to a spindle, carrying a cast-iron pinion, meshed with a bevel gear, turned by the attached crank shaft. The whirling apparatus is securely screwed to the floor of a large instrument shelter with the crank shaft projecting through the front of the shelter.

261. Psychrometer fans are in general use at airway stations and their mounting in an airway shelter is shown in figure 35. A small hand grinder has been employed to turn an 8-inch fan which draws

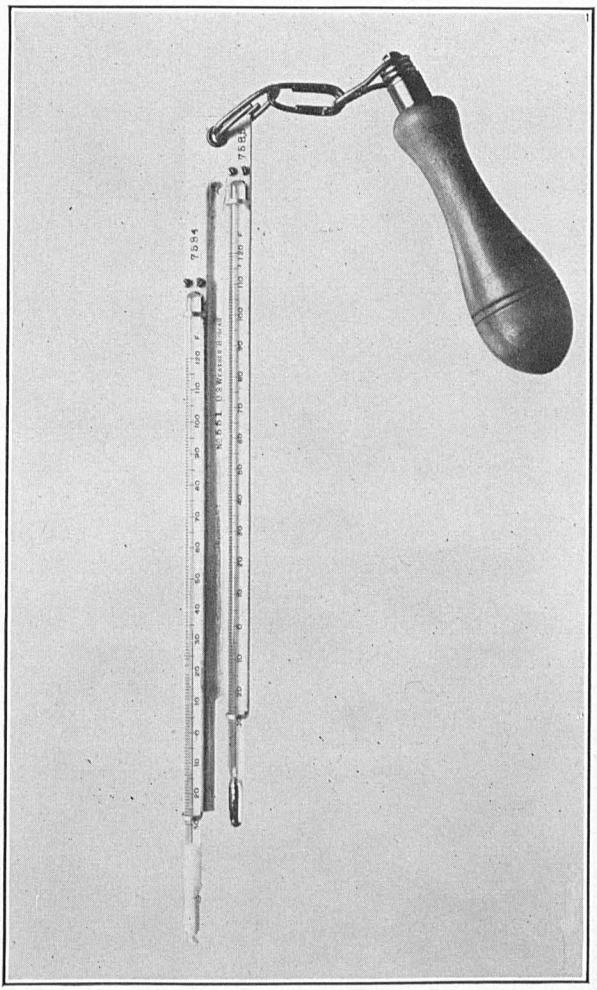


FIGURE 33.—Sling psychrometer.

air past the wet and dry bulbs of a psychrometer. Special instructions for their installation (obtainable from the Instrument Division) accompany each fan. Psychrometer fans are available for use in both airway and cotton-region shelters.

262. The wet bulb of each kind of psychrometer and a short length of the stem above the bulb are covered with fine, loosely woven muslin,

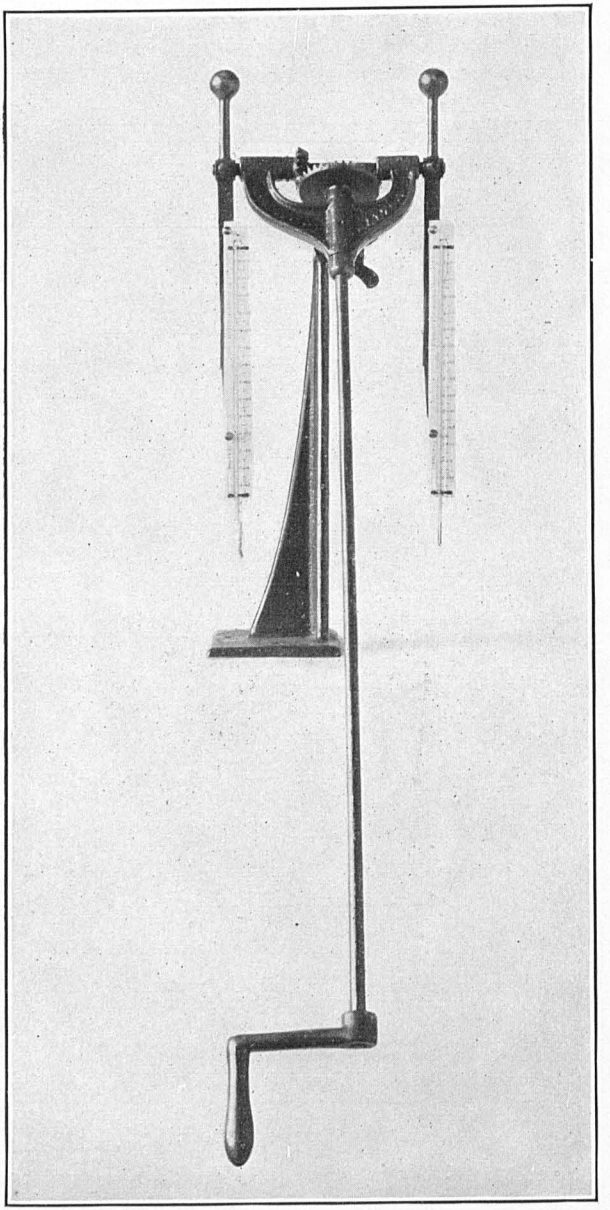


FIGURE 34.—Whirling apparatus for wet and dry bulb psychrometer.

carefully washed to remove the sizing. Pure, clean water is used for wetting, and the muslin must be replaced whenever it becomes at all

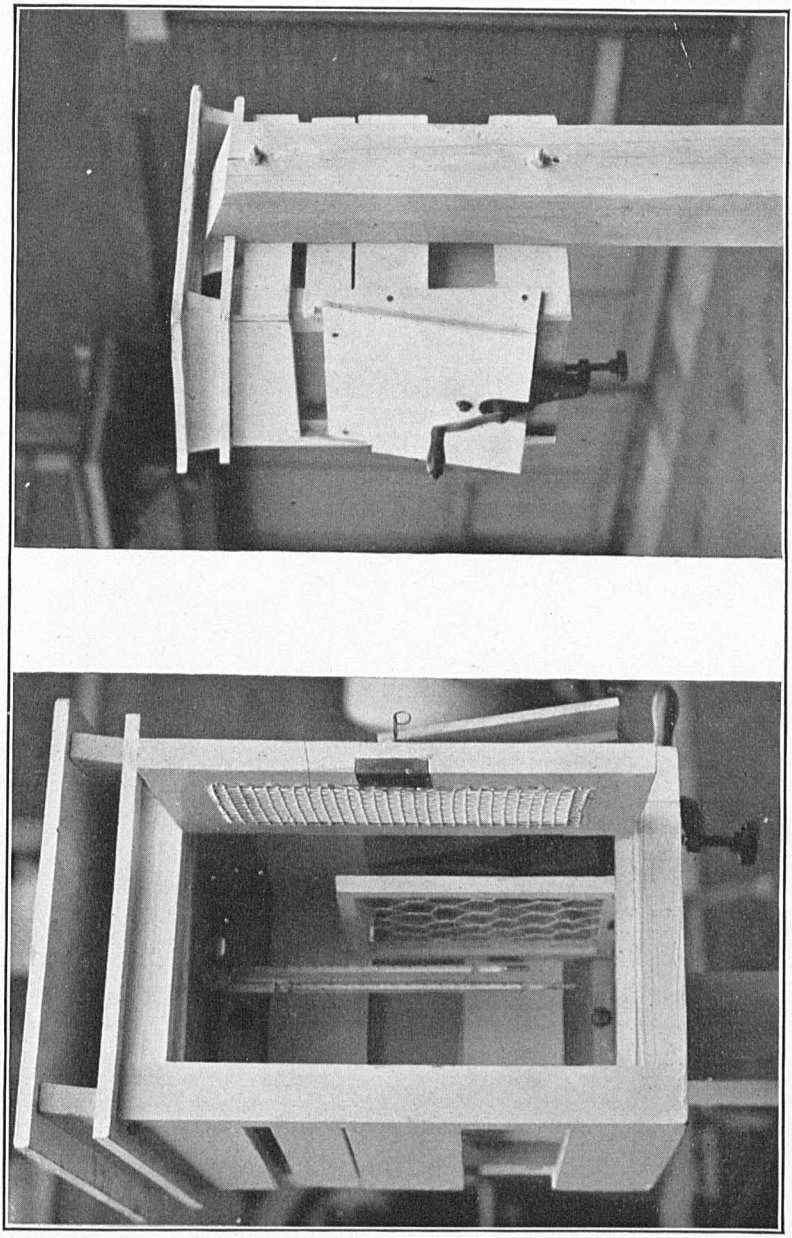


FIGURE 35.—Psychrometer fan installed in airway shelter.

dirty; otherwise the readings will be incorrect and practically valueless for the fog forecast.

263. To obtain thoroughly accurate readings with the sling psychrometer, the instrument should be whirled in the shade, and the observer face the wind so as to avoid temperature effects due to the heat of the body.

264. When a psychrometer is used, the single exposed thermometer may be dispensed with.

265. *Telethermoscopes*, illustrated in figure 36, are employed quite often at airport stations where frequent temperature observations are necessary. This is an electrical resistance thermometer, the temperature of the free air in the shelter housing the ther-

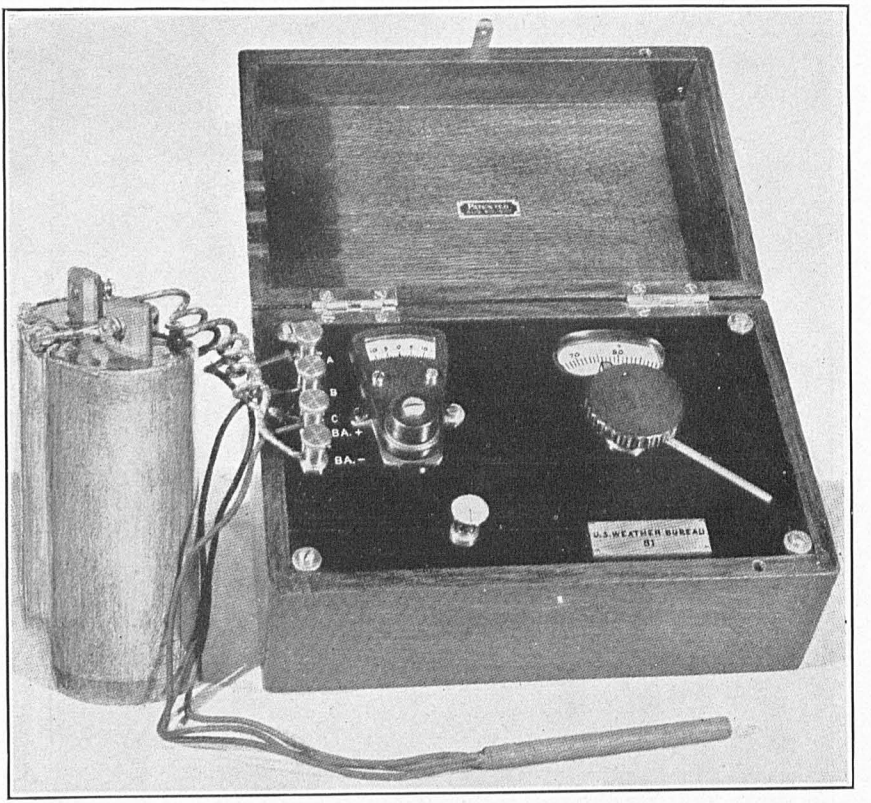


FIGURE 36.—Telethermoscope.

mometer bulb being shown by the indicator located in the office indoors. The bulb consists of a coil of nearly pure nickel wire, having a resistance of 100 ohms at ordinary temperatures, sealed with paraffin into a nickel-plated brass tube. The coil is connected through a three-wire circuit with the indicator, the changes of temperature corresponding to changes in resistance of the thermal element being shown on the indicator scale. Detailed information regarding the installation and use of telethermoscopes will be found in a separate pamphlet obtained from the Weather Bureau Instrument Division.

XXXVI. EQUIPMENT FOR MEASURING THE HEIGHT OF CEILING

266. For accurate determinations of the height of ceiling so important for safe flying, ceiling-light projectors, a form of electric searchlight, are employed at night to throw a spot of light on the underside of the cloud layer. Daytime observations are made with ceiling balloons as described below. The projector is usually located at a distance of 500 feet from the point of observation of the light spot, although it is occasionally of advantage to increase the distance to 1,000 feet or more. Knowing this fixed distance, it is only necessary to measure the angular elevation of the spot of light from the

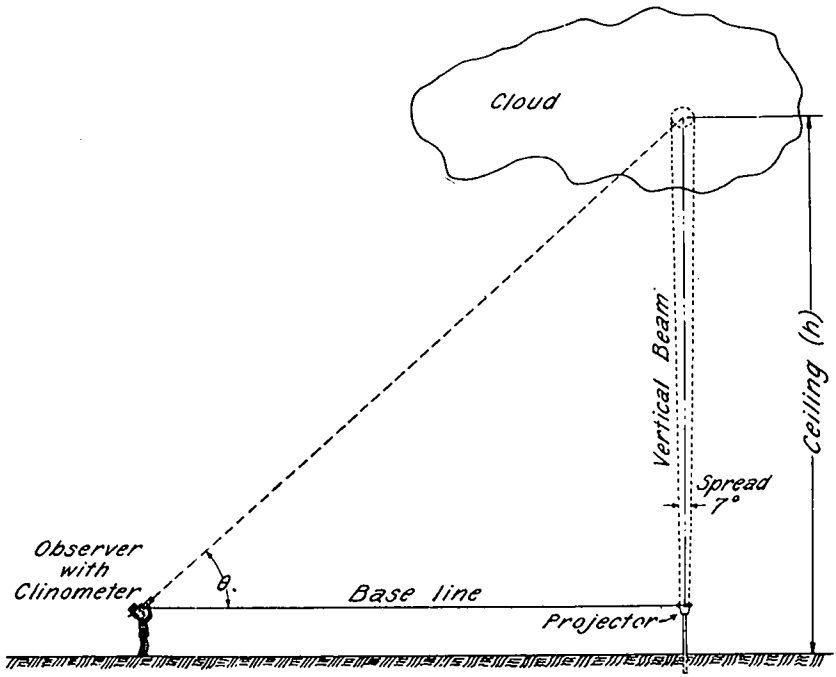


FIGURE 37.—Diagram showing relation of projector and angle-measuring device.

observing point to compute the height of the light spot or the ceiling. This is almost always accomplished by means of a clinometer, or less frequently with an alidade, although in the absence of an instrument the height is found by pacing off the distance from the projector to the point on the ground underneath the light spot in the zenith, the light beam from the projector being directed at either an angle of 45° or 63°26′ with the horizontal. For a 45° elevation the distance is equal to height of ceiling; for a 63°26′ angle, the height is twice the distance paced.

267. The arrangement of the projector and the angle-measuring device is shown diagrammatically in figure 37.

268. *Ceiling-light projector.*—Referring to figure 138, the projector drum is made of an aluminum alloy casting, mounted on a pedestal with trunnions which permit of the accurate elevation of the beam from 45° to the vertical, which latter elevation is especially required when the beam must penetrate smoky or hazy atmosphere, such as found near the large cities.

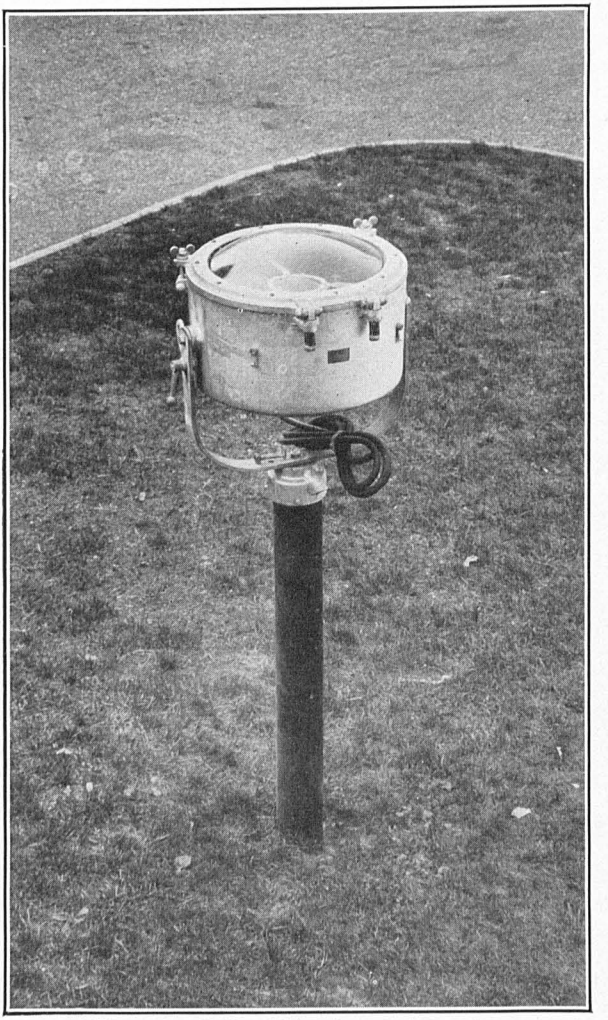


FIGURE 38.—Ceiling-light projector and mounting.

269. The projectors are usually about 14 to 16 inches in diameter, and the condensed-filament electric lamps employed are almost always 250 watts for use in level, smoke-free locations, but 500- and 1,000-watt lamps are needed in some cases in or near large cities.

The 250- and 500-watt size are special-bulb spotlight lamps; the 1,000-watt size has a T20 bulb.

270. *Projector lamp adjustments.*—The filament of the lamp is adjusted to the focus of the lens by sighting through peepholes drilled in the side of the projector drum, which, when alined with a mark on the opposite side, causes the line of sight to pass through the focus. The filament of the lamp, when brought into the line of sight, will be in focus. A desirable method also is to direct the light beam horizontally on to a vertical white screen about 42 feet distant from the projector and adjust the lamp to the focal center of lens, determined by securing a sharply defined and rounded light spot on the screen. See that the lamp provided is of voltage to suit the current, which voltage should be measured at the projector lamp socket when practicable; otherwise the socket voltage is estimated by subtracting from the service voltage 0.8 volt per 100 feet of distance of the projector from service, thus allowing roughly for line drop in potential. 250-watt, G 30, also 500-watt, G 40 spotlight lamps, are available on stores requisition for 105-, 110-, 115-, 120-, and 125-volt current.

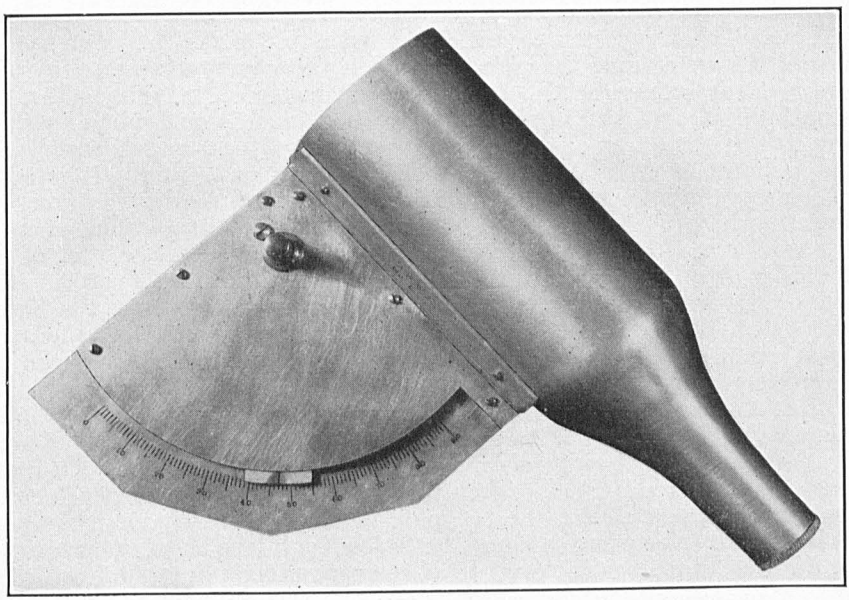


FIGURE 39.—Clinometer for measuring height of ceiling.

271. *Installation of projector.*—The installation and wiring of projectors are the subject of special correspondence and instructions, and mimeographed copies of "General specifications for installing ceiling-light projectors", are used in that connection. Briefly, the job includes the mounting of the projector on a special 4-inch pipe support, and wiring thereto from the electric service, usually by duplex parkway no. 10 cable laid underground most of the 500 feet from a switch placed conveniently to the point of observation. When an alidade is used instead of a clinometer, additional work is required to mount the same, and the switch controlling the projector circuit is usually attached to the support.

272. *Clinometers,* as illustrated in figure 39, are employed to measure the angular elevation from 0° to 90° of a spot of light pro-

jected on a cloud at night. The sighting tube is nearly 3 inches in diameter at its outer end in order that not only the light spot on the cloud but a portion of the surrounding dark sky as well may be included in the field of view for contrast. A pair of cross wires aid the eyes in centering on the light spot. A quadrant with scale zero to 90° in whole-degree graduations is rigidly attached to the underside of the tube, and a pendant is pivoted on a horizontal axis in a way to permit it to hang vertically of its own weight when the tube is sighted on an object. The zero line on the pendant matches the zero line on the quadrant when the tube is sighted on an object at the same level, and matches the 90° line on the quadrant when it is sighted to the zenith. A clutch, operated by turning a milled-head screw with the left hand, clamps the pendant in position when a sight is made. This clutch operates easily and positively with only slight pressure. Observers should practice until familiar with its action. Reasonable care should be exercised not to use too much force. Readings to the nearest whole degree are sufficient.

273. *Use of clinometer.*—When this device is used the projector will usually be adjusted to direct the light to the zenith. The horizontal distance from the point at which the observer stands to the projector is known as the base line. It has been established on a length of 500 feet at many stations. The base line multiplied by the tangent of the angle of elevation of the spot of light as measured by the clinometer equals the height of the cloud or ceiling. It is not necessary that the projector be at the same level as the observer, a feature which is likely to be an advantage in some installations where, for example, it is expedient to place the projector on the roof of a building or on ground higher or lower than the position occupied by the observer. Furthermore, it is not at all necessary that the base line be exactly 500 feet, and, therefore, advantage may be taken of local circumstances favorable to a longer base; it also becomes a simple matter to establish more than one observation point.

274. *Choice of a base line.*—The clinometer is graduated to whole degrees, and errors of 1° or possibly 2° are considered likely. Now, if in the accompanying table the column of heights for a 500-foot base be examined, it will be seen that the change in height per degree increases rapidly above the 60° part of the table. If, for example, it is desired to measure a cloud 1,800 feet high, the 2° of uncertainty in the instrument will result in a corresponding uncertainty in the height of 230 feet for a 500-foot base line, 150 feet for a 1,000-foot base line, and 130 feet for a 1,500-foot base line.

275. From this it is apparent that, since the accuracy of the angular measurement is fixed by the limits of the instrument, the accuracy of the height determination may be increased by choosing a longer base line. However, practical considerations set rather definite limits. It is not ordinarily wise to run an electric line farther than 500 feet because of the cost, and also because there is an important drop in voltage on such extensions, sometimes not recognized in the selection of the lamp. A 500-foot base line, therefore, has been made the standard. A second observation point, however, should be established by careful measurement 1,000 feet distant horizontally from the projector, and the spot marked for identification. The observer will walk to the 1,000-foot station when the clouds are found to be at a high angle.

276. A 1,500-foot column has been included in the tables below for the use of a special station located in a valley near high mountains, where the determination of clearance above the mountain justifies the employment of unusual measures. However, it is believed that frequent occasions will arise at other stations for the use of a 1,500-foot base line, and an observation point is easily established.

TABLE 6.—*Height of cloud or ceiling, feet, light beam projected vertically*

Angle	Tan	Base			Angle	Tan	Base		
		500′ h	1,000′ h	1,500′ h			500′ h	1,000′ h	1,500′ h
5	0.08749	44	87	131	45	1.0000	500	1,000	1,500
6	.10510	52	105	157	46	1.0355	518	1,036	1,554
7	.12278	62	123	185	47	1.0724	536	1,072	1,608
8	.14054	70	141	211	48	1.1106	556	1,111	1,667
9	.15838	79	158	237	49	1.1504	575	1,150	1,725
10	.17633	88	176	264	50	1.1918	596	1,192	1,788
11	.19438	97	197	291	51	1.2349	618	1,235	1,853
12	.21256	106	213	319	52	1.2799	640	1,280	1,920
13	.23087	116	231	347	53	1.3270	664	1,327	1,991
14	.24933	124	249	373	54	1.3764	688	1,376	2,064
15	.26795	134	268	402	55	1.4281	714	1,428	2,142
16	.28675	144	287	430	56	1.4826	742	1,483	2,225
17	.30573	153	306	459	57	1.5399	770	1,540	2,310
18	.32492	162	325	487	58	1.6004	800	1,600	2,400
19	.34433	172	344	516	59	1.6643	832	1,664	2,496
20	.36397	182	364	546	60	1.7321	866	1,732	2,598
21	.38386	192	384	576	61	1.8040	902	1,804	2,706
22	.40403	202	404	606	62	1.8807	940	1,881	2,821
23	.42447	212	424	636	63	1.9626	982	1,963	2,945
24	.44523	222	445	667	64	2.0503	1,025	2,050	3,075
25	.46631	233	466	699	65	2.1445	1,072	2,144	3,216
26	.48773	244	488	732	66	2.2460	1,123	2,246	3,369
27	.50953	255	510	765	67	2.3559	1,178	2,356	3,534
28	.53171	266	532	798	68	2.4751	1,238	2,475	3,713
29	.55431	277	554	831	69	2.6051	1,302	2,605	3,907
30	.57735	288	577	865	70	2.7475	1,374	2,748	4,122
31	.60086	300	601	901	71	2.9042	1,452	2,904	4,356
32	.62487	312	625	937	72	3.0777	1,539	3,078	4,617
33	.64941	324	649	973	73	3.2709	1,636	3,271	4,907
34	.67451	338	675	1,013	74	3.4874	1,744	3,487	5,231
35	.70021	350	700	1,050	75	3.7321	1,866	3,732	5,598
36	.72654	364	727	1,091	76	4.0108	2,006	4,011	6,017
37	.75355	377	754	1,131	77	4.3315	2,166	4,332	6,498
38	.78129	390	781	1,171	78	4.7046	2,352	4,705	7,057
39	.80978	405	810	1,215	79	5.1446	2,572	5,145	7,717
40	.83910	420	839	1,259	80	5.6713	2,836	5,671	8,507
41	.86929	434	869	1,303	81	6.3138	3,157	6,314	9,471
42	.90040	450	900	1,350	82	7.1154	3,558	7,115	10,673
43	.93252	466	933	1,399	83	8.1443	4,072	8,144	12,216
44	.96569	483	966	1,449	84	9.5144	4,757	9,514	14,271
					85	11.430	5,715	11,430	17,145
					86	14.301	7,150	14,301	21,451

NOTE.—Tables are also available on request for a light beam directed at an angle of 63° 26′ to the horizontal.

277. *The alidade,* figure 40, is set up permanently at a distance of 500 feet from the projector, at some place convenient for an observing spot. It consists of a bronze quadrant (1) with the readings of ceiling heights to feet engraved thereon. The quadrant is fastened to the cap of a 4-inch pipe standard (2) set in concrete. A universal joint permits of leveling. Marked triangular sights (3) attached to a movable limb are used for sighting the light spot on the clouds. To adjust the alidade, set the pointer at zero feet on the quadrant and sight on the ceiling-light projector, making the

required adjustment by means of the screws in the universal joint. Clinometers are now employed for all new installations of projectors.

278. *Ceiling balloons.*—Ceiling balloons are to be used to determine the height of clouds above the ground when the sky is completely overcast and their height is estimated to be less than 1,500 feet.

279. Ordinarily, one such observation every 2 hours will suffice for airway observations.

280. These balloons will be inflated with hydrogen gas to a free lift of 40 grams, in accordance with instructions contained herein.

281. They will be released at the scheduled time. Accurate ceiling information is highly essential for safe flying when ceiling heights are 500 feet or less.

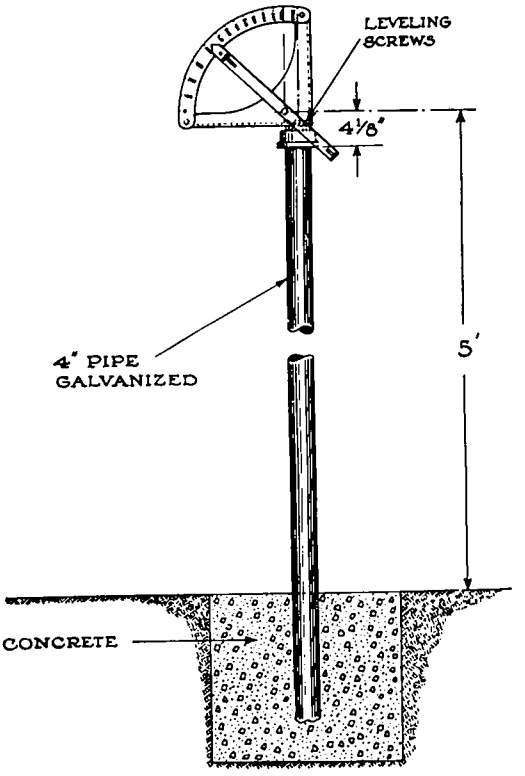


FIGURE 40.—Alidade for measuring height of ceiling.

282. The average rate of ascent of the balloons is 6 feet per second after the first 1½ minutes. A table is contained herein which gives the corresponding heights up to 3,010 feet (8 minutes). To obtain altitudes above 3,010 feet, multiply the number of seconds past 8 minutes by 6 and add to 3,010.

283. The balloons and hydrogen are relatively expensive and should, therefore, be used with discretion.

284. *Equipment.*—The equipment necessary for this work consists of: (1) Compressed hydrogen gas in cylinders, usually containing 200 cubic feet, furnished by the supervising Weather Bureau airport station; (2) hydrogen regulator; (3) Brady free-lift device; (4) timepiece, indicating seconds.

285. The above equipment (except the timepiece) will be furnished by the Weather Bureau.

286. *Color of balloons.*—The balloons are usually furnished in two colors, red and purple. In general, the darker color is best seen against a dark background.

287. *Inflation of balloons.*—A specially made booth should be constructed at a convenient place near the airways watch house. This booth should contain a rack for three hydrogen tanks and a shelf for inflating the balloon. The tank is fitted with a valve; also a reducing valve (or regulator) having two gages, one registering the

amount of pressure in the tank and the other the working pressure or pressure of the gas flowing into the balloon. A low-pressure valve on the regulator regulates the flow of gas. A ¼-inch rubber tube leads from the regulator to a three-way petcock. A small ⅛-inch rubber tube leads to the Brady free-lift device. (See fig. 41.)

288. The Brady free-lift is placed on a shelf large enough to permit the small rubber tubing to rest thereon.

289. The balloon is attached to the nozzle by means of two no. 17 rubber bands. This is accomplished by doubling two bands and placing them around the neck of the balloon after it is stretched over the nozzle of the device. All the air is expelled by opening the three-way pet cock and rolling the balloon to force the air out through the pet cock. The inflation is then begun by slowly turning the regulator handle to the right until a steady flow is maintained. The balloons should be inflated at such a rate that at least 1 minute is required for operation. The balloon is inflated until the device is just lifted from the supporting surface. When removing the balloon from the device, the neck should be twisted several times and secured by means of the two no. 17 rubber bands used to hold balloon on nozzle. The rubber bands are slipped over the twisted portion of the neck and tightly wrapped by a series of alternating half twists and loopings, accompanied by a firm tension to insure a tight joint. Cord or tape should not be used for tying neck of balloons.

290. *Observations.*—The inflated balloon should be carried to a point free from obstructions, such as houses, streets, etc. The balloon should be released on an even minute. Do not take the eyes from the balloon during its ascent and note (the time) the instant the balloon enters the clouds. The interval of time between the releasing of the balloon and its disappearance in the clouds should be accurately determined.

291. The following table, which has been divided into one-half minute intervals, is given for use in ascertaining the altitude of the clouds; fractional parts of a minute should be determined by interpolation:

Time interval	½	1	1½	2	2½	3	3½	4
Altitude (feet)	250	480	670	850	1,030	1,210	1,390	1,570
Time interval	4½	5	5½	6	6½	7	7½	8
Altitude (feet)	1,750	1,930	2,110	2,290	2,470	2,650	2,830	3,010

292. Average rate for higher ceilings, 6 feet per second.

293. The height of the ceiling should be written in the column on Form 1130–Aer. under ceiling.

294. *Danger of explosions.*—It is a well-known fact that hydrogen and air when mixed in the proper proportion make a very explosive mixture. Therefore, the following instructions should be rigidly observed:

295. Smoking should be prohibited at all times in or near the balloon shelter or room where the balloons are being filled or where hydrogen is stored.

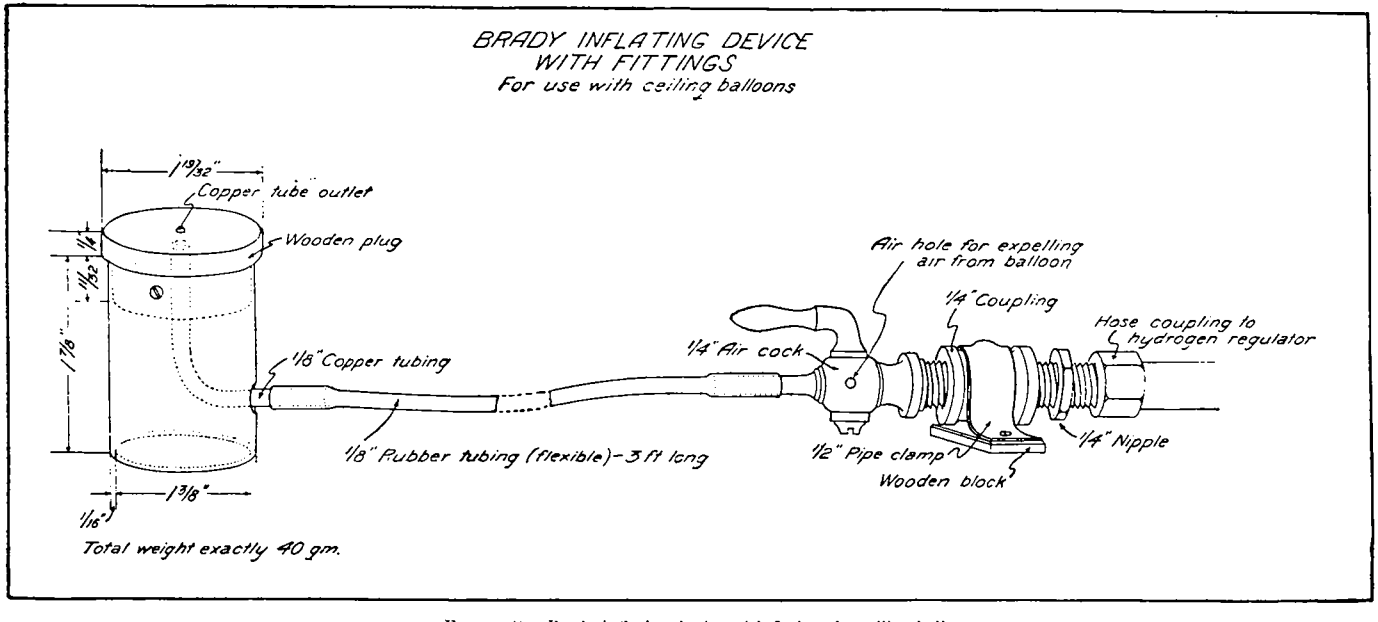


FIGURE 41.—Brady inflation device with fittings for ceiling balloons.

296. Whenever a balloon during the process of inflation is found to be leaking, it should be detached at once from the filling apparatus, taken outside, and exhausted of hydrogen in the open air.

297. In case a balloon bursts or leaks while being filled, the doors and windows of the shelter, or room used for the purpose, should be opened in order that all of the hydrogen may be driven out by the wind.

298. A sign, somewhat as follows, DANGER—NO SMOKING, should be posted in a conspicuous place where the ceiling balloons are inflated.

299. *Care of balloons.*—The balloons will deteriorate very rapidly, especially in the summer months, and they should be kept in a cool place of more or less even temperature.

300. *Supplies of hydrogen and balloons.*—Whenever the observer opens the last full cylinder of hydrogen, he will notify by teletype the airway observer of the supervising station, as follows: "Last hydrogen cylinder tapped; send ——— cylinders." When the full cylinders arrive, the empties should be returned, by freight, with Government bills of lading, which will be sent by the supervising station upon receipt of notification that the last cylinder has been tapped.

301. When the last carton of 36 balloons is opened, advise the issuing station by teletype to that effect and a new supply will be sent by mail.

302. *Cloud forms.*—Some clouds are smooth-based and a balloon rising to them disappears abruptly when it enters their base. Other types have billowy and broken bases and when a balloon enters the base at one of the lower points of these billows it represents the ceiling more accurately than when it enters into a hollow or higher place in the cloud.

303. Sometimes balloons drift into definite openings between the clouds and disappear. These disappearances do not indicate the ceiling height. If this happens, or any doubt as to the measurements is felt, another balloon should be released. The lowest of the two or more readings will be reported as the ceiling.

304. *Caution.*—When rain of greater intensity than a mist or sprinkle is falling, ceiling balloons should not be released as their ascensional rate under such conditions is inaccurate.

NOTE.—The above text on ceiling balloons is a copy in full of the card of instructions issued by the Aerological Division, May 24, 1930.

XXXVII. PILOT-BALLOON OBSERVATIONS AND EQUIPMENT

305. *Pilot balloons* are employed at airport stations to obtain reliable information of both the velocity and direction of the wind at flying altitudes. They also serve to give height of ceiling. These balloons, made of pure rubber, are inflated with hydrogen just before use to a diameter of about 24 inches to give an ascensional rate of nearly 600 feet per minute. After being released from the ground, or from the roof of a building, as may be most convenient, the path of the balloon is carefully followed, usually by means of a single theodolite, and its position observed each minute until the balloon bursts, or it passes from sight. The theodolite observations give the angular position of the balloon, and the altitude is known from

the ascensional rate. These data are usually plotted immediately, an observer at the theodolite being in telephone communication with another observer located in the office at a plotting board. However, in many cases, these observations are made by only one man, in which case he does both the observing and plotting.

306. For night observations the balloon is made visible by attaching to it a small paper lantern lighted by a paraffin candle or a small electric light.

307. Details regarding the installation and use of the equipment required will be found in Circular O, Aerological Division, and in "Quarters and Instrumental Equipment for Weather Bureau Stations at Airports", the latter giving information about the theodolite platform with windbreak, and the wiring to the same from the office.

XXXVIII. PRECIPITATION MEASUREMENT

308. Precipitation gages are not issued to airway stations as regular equipment. In their absence it is possible, however, to measure both the depth of newly fallen snow and the total depth on the ground, having in mind the reporting of the condition of the field for landing and taking-off of planes.

309. Observers will, therefore, measure the depth of snow on the field at several points, using any stick graduated in inches, to determine the average depth. To measure snow which has fallen on a field already snow-covered, the same method applies in general, except that the depth must be measured from a surface which was practically free of snow at the beginning of the storm or when the previous observation was taken. The difference of density and color of new and old snow quite often permits of separating the two layers.

XXXIX. CARE OF INSTRUMENTS

310. *Anemometer.*—The upper and lower bearings of the spindle must be oiled once a week. The upper bearing is oiled by removing the cups, and the lower bearing and the spindle worm through the orifice in the back of the anemometer casing, which must at all other times be kept closed to prevent dust and water from entering. A drop of oil, such as will adhere to a match, applied once or twice, is in most cases sufficient.

311. About once a month the anemometer should be removed from the support and cleaned. Take the anemometer apart and clean out all old oil and dirt by washing the parts in benzine or gasoline. Then wipe with a clean cotton cloth free from lint or any dirt, allow the parts to thoroughly dry, reassemble the instrument and renew the oil on all the bearings, placing a slight quantity also on the gears, worms, and wormwheels, and on the inclined face of the projection engaging the contact spring. Apply only a small quantity of oil to each bearing, using a pointed match or toothpick. Only the special oil provided should be used, two kinds of which are issued with each anemometer, one for use in warm weather, the other in cold. The former becomes thick at about 25° F., the latter at about 0° F., so that the use of cold-weather oil should begin in the fall when the temperature is likely to go below 25° for a considerable period. No oil is provided for extremely low temperatures.

312. *Wind vane.*—The wind vanes, either with or without the contacts, have a pivot bearing at the bottom end of a vertical axis which turns in a recess made in a ½-inch pipe plug at the lower end of a ½-inch pipe. Reoiling is required at intervals of about 6 months. This is accomplished by removing the wind-vane assembly from the support, then drawing the wind-vane axis (made of ⅜-inch steel rod) out of the inclosing ½-inch pipe, thoroughly washing out the pipe with gasoline, draining and drying, and then reoiling with about a teaspoonful of light engine oil. Each bearing first sent out for installation is accompanied by a bottle containing just enough oil to lubricate the bearing.

313. *Contacting wind-vane bearings.*—Care will be used to keep the lubricating oil away from the contact springs or the upper cam, for in cold weather such oil acts as an insulator and will prevent the current flow. If oil should accidentally be spilled on the contacting members it should be washed off with gasoline.

314. *Aneroid barometers.*—Aneroids quite often become inaccurate with lapse of time, and therefore require occasional comparison with a mercury barometer. This will be done by a Weather Bureau official who will visit the airway station, carrying a barometer with him for comparisons and redetermination of the correction. The airways observer will make no adjustments. If the barometer readings are believed to be in error, report should be made to the supervising Weather Bureau office and appropriate action will be taken.

315. *Thermometers and shelters.*—Thermometers will be kept clean and the graduations in the stems refilled with black pigment when required, which latter attention will usually be given by a Weather Bureau official.

316. The shelter and wooden support will be repainted occasionally to keep them white and clean, and protected against decay. Galvanized metal supports will be painted only when corrosion is becoming evident, when a coat of red lead will be applied, followed by a top coat of aluminum.

317. A small magnifying glass is often a help in reading the thermometer. Flashlights must be employed for night observations, unless the shelter is electric-lighted, which convenience is usually provided only for the larger shelters.

318. *Ceiling-light projectors, clinometers, and alidades* will be kept clean, the projector mirror, cover glass, and spot-light lamp being cleaned at least once each week so that the light beam will have maximum intensity. See that the voltage of the lamp matches the current voltage at the projector socket and the lamp is kept in focus as mentioned in paragraph 51. When alidades are used, an occasional check of the set-up with reference to the projector may be obtained by sighting the projector from the alidade when the latter is set at zero graduation. See "Alidades" above. Pipe supports for alidade and projector should be repainted when needed.

319. *Miscellaneous; reporting broken or defective instruments.*—In addition to the foregoing the airways observer will watch his equipment to see that it is maintained in good condition, reporting breakages and needs for repairs or replacements to the supervising Weather Bureau office in ample season to forestall breakdowns. Instruments that are suspected of being defective should in particular

be reported. Wind-instrument supports will need repainting occasionally. Extra lamps for projector and wind-direction and velocity indicator will be kept on hand.

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

INSTRUCTIONS FOR MAKING AIRWAY BAROMETRIC OBSERVATIONS

321. The following instructions are designed to cover the procedures to be employed in regard to the obtainment of (*A*) station pressures, (*B*) sea-level (reduced) pressures, and (*C*) pressure changes and characteristics. The instructions differ in certain respects, depending on the kind of instrumental equipment available at a station and the times at which observations are made.

A. Station pressures.—Station has a mercurial barometer and either an aneroid barometer or a barograph—

Mercurial-barometer readings should be made at least every 6 hours at the standard hours, 2 and 8 a. m. and p. m., E. S. T.

Each time the mercurial barometer is read, the aneroid barometer or the barograph, if an aneroid is not available, should be read simultaneously and the correction to be applied to the latter reading to make it agree with the "station pressure" as based on the mercurial barometer readings should be determined. This correction should be posted conspicuously, near the aneroid or barograph for instant use. Caution should be exercised to insure that the currently applicable correction is the one which is posted and not an older, inapplicable one.

At the times indicated above, "station pressures" will be based on the mercurial-barometer readings. At other times, "station pressures" should be based on the aneroid or barograph readings.

"Station pressures", whether based on mercurial, aneroid, or barograph readings, should be recorded on Form 1130 immediately above the sea-level (reduced) pressures for the same time. This should serve as the original permanent record of the data.

If both an aneroid and barograph are available, the aneroid should be given the preference in obtaining "station pressures."

Station has an aneroid but no mercurial barometer—

"Final corrections" to the aneroid readings obtained in accordance with instructions in the circular "Airways Aneroid Barometry", dated August 15, 1934, should be applied to obtain "station pressures."

"Station pressure" should be recorded on Form 1130, in accordance with instructions given above.

B. Sea-level (reduced) pressures.—(1) Sea-level (reduced) pressures, whenever required for a report, should be determined from the reduction tables on the basis of the current "station pressure" and the temperature argument equal to "½ (current temperature+12-hour preceding temperature)". (These are outdoor-shelter temperatures.) It is not permissible to apply a given, fixed reduction factor, i. e., an amount which must be added to the "station pressure" to obtain the sea-level pressure, for more than 1 hour unless the "station pressures" and the actual temperature arguments for the successive times when referred to the reduction table happen to give the same value.

2. Sea-level pressures should be recorded on Form 1130 in the spaces allotted therefor.

C. Three-hourly pressure changes and characteristics.—(See paragraphs 63, 64, 65, 103, 104, 105, 106, 107, 108.)

W. R. GREGG,
Chief of Bureau.

JULY 1, 1935.

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