UNITED STATES DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

INSTRUCTIONS FOR AIRWAY METEOROLOGICAL SERVICE

CIRCULAR N, AEROLOGICAL DIVISION
FOURTH EDITION, 1939

National Oceanic and Atmospheric Administration

ERRATA NOTICE

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages
Faded or light ink
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library and the Climate Database Modernization Program, National Climate Data Center (NCDC). To view the original document, please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or www.reference@nodc.noaa.gov.

LASON
Imaging Contractor
12200 Kiln Court
Beltsville, MD 20704-1387
March 21, 2005

Blank page retained for pagination

CONTENTS

PART VI.—6-HOURLY AND 3-HOURLY WEATHER-REPORTING SERVICE

PART VII.—INSTRUCTIONS FOR THE PREPARATION AND DISPOSITION OF AIRWAY METEOROLOGICAL FORMS

PART VIII.—AIRWAY FORECASTS

PART IX.—INSTRUCTIONS FOR INSTALLATION AND OPERATION OF INSTRUMENTS FOR AIRWAY AND OFF-AIRWAY STATIONS

APPENDICES

LIST OF TABLES

LIST OF ILLUSTRATIONS

Blank page retained for pagination

PREFACE

This general circular, covering instructions for the airway meteorological service will become effective on June 1, 1939.

In preparing the circular, action has been taken to revise and incorporate, or incorporate directly when revision was not necessary, all the current circulars except those concerning pilot-balloon, airplane, and radiometeorograph observations regarding the 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 For the information of all concerned, there follows a list of circulars which are entirely superseded by this circular, and a list of those which were merely incorporated in order to make it complete and which, therefore, are not superseded.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 Meteorological Service, Circular N, 1935. (Revised instructions contained in this circular.)

Changes in Airway General Supervising and Forecast Districts, December 20, 1935.

Changes in Reporting Field Conditions, Snow Depth, and Remarks in Airway and Off-Airway Weather Reports, January 24, 1936.

Changes in Transmission of Airway Weather Reports on Bureau of Air Commerce Teletype and Radio Circuits, March 5, 1936.

Three-Hourly Pressure Changes from Hourly Weather-Reporting Stations not Equipped with Barographs, June 1, 1936.

Amendment to Circular Changes in Reporting Field Conditions, Snow Depth, and Remarks in Airway and Off-Airway Weather Reports, June 25, 1936.

Instructions for Six-Hourly Airway Service, Beginning January 15, 1937, December 15, 1936.

Disposition of Forms 1083–Met'l for Second-Order Six-Hourly Stations, August 10, 1937.

Classification of Weather Reports, November 1, 1937.

Instructions for Advising Pilots and Others Concerning the Classification of Weather Reports, December 31, 1937.

The following circulars have been incorporated, as a whole or in part, into this circular without any material changes having been made in their contents:

Changes in Time of Six-Hourly Airway Forecasts, January 15, 1936.

Revised Heading of Airway Forecasts, September 1, 1936.

Instructions for the Installation and Operation of a Barograph, October 16, 1936.

Instructions Pertaining to the Time of Taking and Telegraphing Coded Observations, December 18, 1936.

Conditions Under which Pilots' Observations May Be Accepted as Official Airway Weather Reports, March 1, 1937.

Improper Reading of Wet- and Dry-Bulb Temperatures, September 9, 1937.

Amendment to circular of March 1, 1937, Conditions Under Which Pilots' Observations May Be Accepted as Official Airway Weather Reports, September 24, 1937.

Instructions for Six-Hourly Airway Service, February 1, 1938.

Classification of Weather Reports, March 15, 1938.

Instructions Concerning Special Observations Required by Changes in Classification of Weather Reports and the Taking and Handling of Local Extra Observations, July 1, 1938.

This circular is being published in loose-leaf form for the use of Weather Bureau stations and others closely connected with the airway meteorological service. The purpose of such a procedure is to keep Circular N up to date at all times by issuing any changes in instructions relating thereto in a loose-leaf form for insertion in the circular. Bound copies of the circular are available for distribution to the general public.

Effort has been made to insure that all instructions contained herein are as clear as possible. However, in case 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 shall not issue such interpretations without the prior approval of the Central Office.

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

PART I.—THE WEATHER BUREAU'S METEOROLOGICAL SERVICE IN AID OF AIR NAVIGATION

CHAPTER I

AUTHORITY FOR THE SERVICE

101. By authority of the Air Commerce Act of 1926, and the Civil Aeronautics Act of 1938, the Weather Bureau is charged with the responsibility of furnishing an adequate meteorological service for aviation in order "to promote the safety and efficiency of air navigation in the United States and above the high seas."

CHAPTER II

AIRWAY WEATHER SERVICE

102. A successful solution of the weather problem for aviation requires, first of all, a dense network of surface and upper-air observation stations, manned by trained observers, and the rapid transmission of frequent reports from these. Secondly, it requires a technical staff of employees at terminal airports to prepare frequent weather maps, upper-air charts, and diagrams from which a picture of the changing weather situations may be presented; and, thirdly, it requires competent meteorologists to analyze the current weather conditions, anticipate the development of new situations, compute the movement of pressure systems, and to issue, on the basis of these, short-period forecasts for the route to be flown. In constantly endeavoring to maintain as complete a service as possible the Weather Bureau has established several hundred stations at fairly regular distances apart along the civil airways in the United States, Alaska, and Hawaii, and, in addition, a large number of stations rather uniformly distributed off the airways for reporting weather. Reports are collected by teletype and radio from airway stations and by telegraph and telephone from off-airway stations, and are relayed to required points along the airways by the Bureau of Air Commerce radio and teletype systems. There are well-distributed stations, equipped for taking upper-air wind observations, and additional stations at which upper-air observations are made by airplanes and by instruments which are carried aloft by balloons and report conditions through the medium of radio signals (radiosonde). At important airway terminals, qualified meteorologists of the Weather Bureau are on duty 24 hours a day charting and analyzing weather reports and discussing the meteorological conditions with pilots.

103. Supervision of the airway weather service in the field is exercised by general supervising stations, each one of which has a certain district for which it issues forecasts, maintains an inspectional service, and has general authority in regard to supervision of stations in that district, while the central office at Washington, D. C., has administrative control and exercises supervision of the service as a whole.

CHAPTER III

SURFACE WEATHER OBSERVATIONS

104. Weather observations are taken hourly throughout the 24 hours at most of the stations located on civil airways. Special observations are taken at these stations whenever marked changes in weather conditions occur. At stations located off the

airways, observations are taken every 6 hours, and every 3 hours at a few designated to do this. Reports from ships at sea, made twice daily, are also available. Observations generally consist of ceiling (height of cloud layer above the ground) in feet; sky conditions; visibility in miles; weather conditions (including precipitation, squalls, etc.); obstruction to vision (fog, haze, etc.); temperature; dew point; wind direction and velocity; barometric pressure; pressure change tendency; amount, type, and direction of clouds, and miscellaneous information (thunderstorms, line-squalls, etc.). To facilitate the transmission of the reports, they are put into a symbol, word, or figure code, depending upon the type of observation and whether the station making the report is on an airway, is an "off-airway" station, or a ship at sea.

CHAPTER IV

UPPER-AIR OBSERVATIONS

105. Weather Bureau first-order stations at airway terminals and a number of stations off the airways are equipped to take observations of directions and velocities of upper-air winds. These are called "pilot-balloon observations." They are made at 6-hour intervals and are accomplished by means of a strong, but light, rubber balloon, which is inflated with the proper amount of hydrogen or helium to make it rise at a known rate of speed. This balloon is released and its progress in the upper air followed by means of a theodolite, which is a special telescope devised to enable the reading of the horizontal and vertical angles from the observer of the object being sighted. These angles, representing the path of the balloon, are read at regular intervals until the balloon passes from sight, reaches a sufficient height for a satisfactory report, or bursts, due to the excess of internal over external pressure acting on the thin rubber walls of the balloon in the upper air. The readings thus obtained, when computed in connection with the rate of ascent, readily give the velocity and direction of the wind at the various desired altitudes. Such information is broadcast by radio to pilots. It is also transmitted by figure code on teletype and radio circuits and, when charted for a number of stations, gives the pilot a picture of the winds he will encounter.

106. Upper-air observations are also made by means of airplanes at a number of stations in the United States, through cooperation of the Weather Bureau, War, and Navy Departments. In most cases the flights are made daily. The airplanes carry a self-registering instrument (aerometeorograph) which records the barometric pressure, temperature, and humidity throughout the flight. The records made by the instrument are coordinated with the conditions observed by the pilot (icing, precipitation, etc.), and the information obtained is transmitted in a code form by teletype and radio and is useful in identifying air masses, tracing their movement, and defining their boundaries, as well as indicating stability, water vapor content of the air, likelihood of clouds, or precipitation, etc. These observations also give pilots information regarding the height of the top of cloud layers, regions of icing conditions, etc.

107. Observations of conditions in the upper air are made daily at a number of stations by means of the radiosonde. This is a lightweight instrument, with a radio transmitter, which, after being attached to a balloon and released, will transmit a record by radio of the barometric pressure, temperature, and relative humidity as it ascends. Such information is used in the same way as reports from airplane observations.

108. Upper-air observations, made by air-line pilots in flight, are received by the Weather Bureau stations and used in completing cross sections of the atmosphere and in perfecting their analyses of meteorological conditions.

CHAPTER V

COMMUNICATIONS

109. A system of teletype and radio circuits is provided by the Civil Aeronautics Authority for the rapid collection and distribution of weather information. Such a communication system is essential for an effective airway weather service. The

weather observations are collected in sequences each hour, beginning with the first station on each circuit and continuing station after station, in their proper order along the airway, until all reports of that circuit are collected. The reports of each circuit are then automatically relayed to such other circuits as require them. Complete weather information is thus made available at every important airway terminal as soon as the sequence collections and relays have been completed, which is only a few minutes after the meteorological observations represented by the report have been made. The reports are broadcast by radio to pilots in the air, posted on Weather Bureau bulletin boards, entered on meteorological charts and maps, and disseminated by telephone and interphone systems as they are received, so that pilots and air-line dispatchers have a constant knowledge of the latest developments in meteorological conditions.

110. Stations off the airways report by telephone and telegraph and these reports are collected at designated centers and relayed to teletype circuits for distribution to all stations where required.

CHAPTER VI

WEATHER MAPS AND CHARTS

111. In order that the information received from a collection of hundreds of weather reports may be transformed from a picture of instantaneous weather conditions at each station to a picture of the general conditions over a large area, the reports are entered on maps, covering large areas of the country and adjacent regions, and are also plotted on various other meteorological charts. From these maps, drawn for surface observations and charts plotted from the information received from airplane, radiosonde, and pilot-balloon observations, the trained meteorologist is enabled to make his analysis of weather conditions pertinent to aviation, including determining the characteristics and boundaries of the various types of air masses present. Surface maps are made available to the air transport companies.

CHAPTER VII

AIRWAY FORECASTS

112. From careful study and analysis of meteorological charts and maps the forecasts are made. Airway forecasters are on duty 24 hours a day at the general supervising stations, which are also forecast centers for their respective districts. At these stations airway forecasts are made every 6 hours for periods of 8 hours in advance for all airways and all terminals within the district. Such forecasts include ceiling heights, visibility, sky conditions, precipitation, fog, smoke, haze, icing, thunderstorms, squalls, etc., expected to occur over the airways or at the terminal within the district during the period of the forecast. Special forecasts are issued when conditions change rapidly. In some instances, forecasts for a period longer than 8 hours in advance are made, when required, for long cross-country flights.

CHAPTER VIII

MISCELLANEOUS SERVICES RENDERED

113. The Weather Bureau has also special and miscellaneous duties in regard to aviation, such as maintaining meteorological service for air meets, air races, massed flights of Army and Navy planes, etc. In addition, meteorological data are compiled for air line and aircraft companies and Government agencies, to be used in helping to solve the problems of aviation as affected by the weather. Pilots or operators may consult with trained meteorologists for information concerning their weather problems. This consultation service is available at important airway terminals at all hours of the day or night.

CHAPTER IX

ALASKAN SERVICE

(As of July 1, 1938)

114. Special mention should be made of the Weather Bureau's service to air navigation in Alaska because of the importance and rapid growth of aviation in that territory. While a large part of its area covered by airways presents no more serious weather conditions for flying than are experienced in the United States, there are localities where fog at subfreezing temperatures, which deposits ice on exposed objects, rolls in from the open inlets in a matter of minutes. Fully realizing the need for an adequate system of frequent weather reports to safeguard this rapidly developing air transportation in Alaska, the Weather Bureau maintains a network of stations in the territory from which observations are sent twice a day at present. Additional stations are in the so-called "on-call" category, stations which render observations when such are specially called for. General supervision of all stations in Alaska, which render service to more than 3,000 miles of airways, is assigned to Juneau. Direct supervision of stations is maintained by Fairbanks and Nome. At present all transmission of weather reports is by radio, railroad telegraph, or telephone. Most of the reports are collected for broadcast to aircraft from radio stations. New weather reporting and radio communication stations are being established as funds are made available.

CHAPTER X

THE WEATHER SERVICE BEHIND THE SCENES

115. The workings of the service can probably best be illustrated by an actual example. Let us suppose, therefore, that we were passengers en route on an airline plane from Newark to Chicago. If we could look behind the scenes we would see a large force of men busy at the work of guiding and guarding the plane in its flight. One of the most important factors of such service would be to determine weather conditions and to make certain that all available information was used to the best advantage. We would find that long before we left Newark the airline's dispatcher had been checking with the Weather Bureau meteorologists there to determine whether the weather conditions would be such as to make it advisable to plan the flight. Since, up to an hour or so before the scheduled departure, clouds had been low on the mountains in New York and Pennsylvania, and the ceiling was below landing limits at Cleveland, it was necessary to have a forecast prepared by the Weather Bureau meteorologists, based on hundreds of reports, to determine whether the flight should be attempted. From a study of the current weather map and supplementary charts the meteorologists determined that the ceiling at Cleveland would rise, and, from a study of airplane and radiosonde observations, they found that the pilot could fly above the clouds blanketing the mountains without having to ascend to a point of discomfort to the passengers or poor operation of the plane. Therefore, the plan for the flight was made and our reservation accepted for seats on the plane. The consultations between meteorologists and the dispatcher were not complete, however, because of the requirement of a clearance sheet for the flight showing the weather at various terminals and intermediate airports, as well as the winds aloft, the latter based on the latest pilot-balloon observations. Also, the requirement of the entry of the latest available forecast for the airway and the terminal on the clearance sheet had to be fulfilled. Before the take-off the pilot checked with the Weather Bureau on the wind and weather at Newark, the conditions over the mountains and at Cleveland, and made sure that conditions all along the route could be flown satisfactorily and with safety. Also, he studied the winds-aloft map, which had been prepared from numerous pilot-balloon observations, in order to take advantage of any favorable winds or to mitigate the effects of adverse ones. After the take-off he would receive, by radio, the latest forecasts and weather reports for the airline ahead. All of these things would be done for many other planes and their passengers while we would ride comfortably and securely, served by a Federal weather service, which is doing everything possible within the limits of available appropriations to make air navigation safe and efficient.

PART II.—ADMINISTRATION OF THE SERVICE

CHAPTER I

THE WEATHER BUREAU'S CENTRAL OFFICE ORGANIZATION WITH THE ORGANIZATION OF THE AEROLOGICAL DIVISION IN DETAIL

201. The following is a brief outline of the central office organization of the Weather Bureau:

Office of the chief.
Office of the assistant chief.
Administrative Division.
    Stations and accounts.
    Printing.
    Supplies.
    Telegraph.
Aerological Division.
    Chief of Division and Assistants.
    Airway section.
    Airplane and sounding-balloon observation section.
    Pilot-balloon observation section.
    Aerological investigations.
    Airport station (Arlington, Va.).
Climate and Crop Weather Division.
Forecast Division.
Forecasting.
Instrument Division.
Library.
Marine Division.
Meteorological Research Division.
River and Flood Division.

CHAPTER II

REGULATIONS

202. **Topics and Personnel.**—This publication is issued monthly by the central office and is a means of presenting to the service any topics of current interest and instructions pertinent to general administration, such as opening and closing of stations, changes in personnel, etc. Topics and Personnel copies shall be preserved in a loose-leaf file until the end of the year, when they shall be bound by means of round-head paper fasteners, in heavy paper covers, which will be furnished for the purpose by the central office upon request. Indexes for Topics and Personnel are furnished by the central office at the end of each year and these should be bound with the file. Instructions contained in Topics and Personnel have the same importance as other instructions issued from the central office; therefore, a card index should be kept of Topics and Personnel in order that administration as directed by this publication may be effectively carried out.

203. **Circulars and Printed Instructions Received.**—Circulars and printed instructions shall be preserved until the end of the year in loose-leaf files and then bound separately in the same manner as Topics and Personnel. Circulars shall be currently indexed by subject and the index bound with the file. Indexes for printed instructions are furnished by the central office and these should be bound with that file.

204. **Letters Received Containing More of Less Permanent Instructions.**—Letters received containing instructions of a permanent nature shall be initialed by all members of the station force and filed with circulars after suitable entry has been made in correspondence files to show the receipt and disposition of such letters.

205. **Circulars Issued.**—At stations where circular letters are issued a file of such letters shall be preserved. These will be indexed and bound, as provided in the case of printed instructions and circulars issued from the central office.

206. **Station Regulations.**—These are regulations for the conduct of the Weather Bureau, which are published for the information and guidance of all concerned. Station regulations are bound in loose-leaf form in order that any amendments may be inserted. The regulations must be kept up to date and must be rigidly adhered to. The procedure, as outlined in paragraph 314 of Station Regulations, is to be followed in reporting aircraft accidents.

207. **Department Regulations.**—These are regulations for the conduct of the Department of Agriculture. They are bound in loose-leaf form and are to be kept strictly up to date by the insertion of any amendments thereto. Department Regulations must be rigidly followed.

208. **Government Travel Regulations.**—These are regulations to be observed by anyone on official Government travel. They must be carefully studied by anyone contemplating travel at Government expense and/or on Government business.

CHAPTER III

ADMINISTRATION AND SUPERVISION OF AIRWAY WEATHER SERVICE

209. **General and Direct Supervision.**—General supervision of airway service is assigned to 11 centers, namely, Arlington, Va., Atlanta, Ga., Burbank, Calif., Chicago, Ill., Cleveland, Ohio, Fort Worth, Tex., Kansas City, Mo., Newark, N. J., Oakland, Calif., Seattle, Wash., and Salt Lake City, Utah. The assignments of general supervision to these stations are made directly from the central office, and those now current are shown on the Airway Meteorological Service map inserted at the end of this circular.

210. **Duties of General Supervising Stations.**—The general supervising station will be responsible for organizing, administering, and coordinating the service over the airways and the district 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*) *Recommendations.*—Make recommendations to the central office and carry out the project upon receipt of approval for—

1. Opening and closing of substations.
2. Additional reports involving commercial tolls.
3. Increased or decreased compensation to airway observers.
4. Disposition of instruments of closed stations.
5. Instrumental equipment for new stations or additions to that of stations already established.
6. Additions or reductions in personnel at airport or airway stations in their districts.
7. Administration of the checking system for 6-hourly observational forms.
8. Other such matters as may arise and require such action.

(*b*) *Inspections.*—Make inspections of airways or individual stations in the district.

(*c*) *Certificates of Authority.*—Issue certificates of authority for taking airway weather observations. These certificates are to be issued after an observer passes a suitable examination given by a supervising official.

(*d*) *Correspondence With Other Stations or The Central Office.*—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.

(*e*) *Correspondence With Regional Supervisors.*—Conduct all correspondence with the regional supervisors of the Civil Aeronautics Authority. Stations other than general supervision stations are not authorized to do this. Questions arising at those points and requiring such action should 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.

(*f*) *Reports and Recommendations Regarding Air Traffic and Airways.*—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.

(*g*) *Recommendations From Direct Supervising Stations.*—Consider recommendations, requests, etc., of direct supervising stations as concerns airway matters, indicating concurrence or nonconcurrence.

(*h*) *Property Accountability at C. A. A. Stations.*—Assume property accountability for all Weather Bureau property located at stations manned by Civil Aeronautics Authority 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.

211. **Procedure In Connection With Recommendations Made By Direct Supervising Officials.**—Other Weather Bureau stations on these airways or in the district will send all recommendations, correspondence, etc., *concerning airway service of any nature* to the central office through the official in charge of the general supervising station, who will indicate by proper indorsement 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 indorsement 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.

212. **Direct Supervision of Stations Manned by C. A. A. Personnel.**—Unless direct supervision is delegated to some other station, 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 stations reports are made by employees of the Civil Aeronautics Authority, and there is Civil Aeronautics Authority teletype or 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 211 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.

213. **Direct Supervision of Stations Manned by Weather Bureau Personnel.**—The direct supervision of each individual Weather Bureau airway station, which includes the carrying of property accountability, preparation of pay rolls, rendering of Form 4076 for appointment of new observers or resignation of old, and other administrative matters concerning the station, will be under the first-order or airport station to which this has been assigned.

214. **Responsibilities Entailed by General Supervision.**—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 some cases these are received containing no definite recommendations and shifting the entire matter from the general supervising 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.

215. **Delegation of Duties by General Supervising Stations.**—The general supervising station may delegate any of the duties outlined under paragraph 210, except correspondence with other general supervising stations or with Civil Aeronautics Authority 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.

216. **Visits to Substations by Direct Supervising Officials.**—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.

217. **Changes in Direct Supervision.**—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.

218. **Supervision of 6-Hourly Work.**—The 6-hourly weather-reporting work at Weather Bureau first-order or airport stations telegraphing such reports will be under the supervision of the general supervising station for the district in which they are located. Any airway work at any other type of station will be under the supervision of the general supervising station in whose district they are located, unless the delegation of this to some other first-order or airport station is approved.

219. **Areas and Airways Included in General Supervising Districts.**—The areas of, and stations and airways included in, each of the general supervising districts are shown on the Weather Bureau Airway Meteorological Service maps, new issues of which are published from time to time as required. The outlines of the districts shown on these maps will in all cases be regarded as the official delimitations of the districts.

220. **Inspection Service.**—The making of regular inspections of all airway, 6-hourly, airport, etc., stations in the various districts is highly important and is a function of the general supervising station for the district concerned. Detailed instructions in regard to making inspections are not suited to this circular, but will be treated as special instructions to be forwarded to the stations concerned and appended to this circular.

CHAPTER IV

PERSONNEL

221. **Hours of Duty.**—The normal workweek for Weather Bureau employees is composed of at least 39 hours. Officials in charge of airport stations shall plan a schedule of work for a period at least 2 weeks in advance. This schedule must detail at least 39 hours work each week to each employee and, if it is necessary for employees to work over this limit, the extra time must be equally divided among all personnel of the station. Assignment of hours of duty must be fair and impartial. Because of the necessity of maintaining a 24-hour service, it is to be desired that the hours of night duty be evenly distributed. Officials in charge may designate a responsible assistant to arrange the hours of duty at any airport station, but work schedules so planned must have the prior approval of the official in charge before being put into operation.

222. **Commissioned Employees.**—Commissioned personnel of the Weather Bureau are appointed from civil-service registers after having passed a civil-service examination for the position to which they desire appointment. After serving a probationary

period of 12 months they are eligible for permanent appointment if their record is satisfactory. During the probationary period an appointee shall be instructed in all the duties pertaining to his position. Appointees to the airway service must be thoroughly familiar with all phases of weather-reporting procedure before they are allowed to take official observations.

223. **Airway Observers.**—Observers in this category are not required to pass a civil-service examination but are appointed under Schedule A, paragraph 9 (h) of the Rules and Regulations of the Civil Service Commission. They must have certain qualifications and abilities, and be able to pass oral or written tests. Airway observers are paid widely varying rates of salary, depending on the number and character of the observations required, and also whether the observers are assigned responsibility for teletype and communications work. Recommendations for appointment of these observers shall be made to the central office on form 4076 by supervising officials. Airway observers should study this circular N thoroughly and be given instruction at a Weather Bureau airport station or by an airway inspector of the Weather Bureau. After passing an examination, called the "Airway Meteorological Service Test," which examination shall be taken under the supervision of a commissioned Weather Bureau employee, the observer shall be issued a "Certificate of Authority to Take Airway Observations." In cases of emergency, when the observer can satisfy an examiner that he is capable of taking observations, a "Twenty-Day Letter of Authority" for taking airway observations shall be issued by the supervising official.

224. **Pay Rolls for Airway Observers.**—Pay rolls for payment of airway observers shall be submitted by the supervising station to the central office on form 1013D or 1013E.

225. **C. A. A. Personnel Required to Hold "Certificates of Authority."**—Commissioned employees of the Civil Aeronautics Authority who are assigned the responsibility for taking airway weather observations shall be subject to the same requirements as airway observers regarding the obtaining and holding of "Certificates of Authority to Take Airway Weather Observations" or "Twenty-Day Letters of Authority."

CHAPTER V

OFFICE ADMINISTRATION

226. **Correspondence.**—Officials in charge of airport stations at which Weather Bureau commissioned personnel are assigned are authorized to conduct correspondence direct with the central office, or other Weather Bureau station officials. When correspondence involves a matter of policy of the Weather Bureau, however, it must be conducted through the general supervising station. Letters addressed to or mailed from airport stations will be sent in duplicate (original and carbon) in one envelope, except that in letters addressed to the central office only the original copy will be mailed. An official in charge of an airport station will be responsible for mailing copies of sufficiently important correspondence written or received by him to the official in charge of any local city office for his information. Carbon copies of all letters written shall be prepared for the station's files and, when appropriate, also for the information of all stations not provided for in the foregoing, including the proper general supervising station and the central office. In the preparation of letters, paragraph 136 of Station Regulations should be adhered to.

227. **Filing System for Correspondence.**—All correspondence will be filed in accordance with the detailed instructions given in the pamphlet entitled "Weather Bureau Correspondence Files." For filing purposes, administrative telegrams and radiograms will be treated in all respects as letters.

228. **Procedure When Letters Permanently Removed from File.**—When a letter is permanently removed from the file a memorandum slip, showing its file number, date, subject, action taken, and disposition, must be filed in its place.

229. **Procedure Concerning Letters of Routine Nature.**—Letters of a purely routine nature and of only transient value, may, in the discretion of the official in charge, be acted on and filed without entry. Authority to destroy such letters may be obtained

from the central office when they become sufficiently numerous to crowd available filing space.

230. **General Care of Office and Station.**—The manner in which airport stations are conducted must reflect credit on the Weather Bureau. Therefore, officials in charge are directed, in administering their stations, to take action which assures that the office shall be kept neat and presentable, the instruments clean and in efficient condition, the files in order, and that there shall be "a place for everything and everything in its place."

PART III.—INSTRUCTIONS FOR MAKING AIRWAY WEATHER OBSERVATIONS

CHAPTER I

PURPOSE AND IMPORTANCE OF OBSERVATIONS

301. The establishment of weather-reporting stations along the airways is dictated primarily by the necessity for obtaining accurate, current weather data for use in connection with flights over such airways. It follows, therefore, that the most important function of such reporting stations is the rendering of accurate, reliable, up-to-the-minute observations of weather conditions observed at that place, and it is desired to impress upon all observers the fundamental importance of this. Accordingly, at stations where duties other than observational are assigned to observers, such duties, except possibly the preparation of weather maps and charts, or others absolutely essential to the work of the station, should be deferred during periods of low ceilings and visibilities so that the observer may devote practically his entire time to watching the weather and filing observations as may be required. The work thus deferred may then be performed during periods of good weather when so much of the observer's time will not be required in connection with taking weather observations.

302. All statements following are to be regarded as instructions to observers and such instructions will be adhered to by all concerned when taking, entering on forms, or transmitting airway weather observations.

CHAPTER II

DEFINITION OF "AIRWAY WEATHER OBSERVATION"

303. An "airway weather observation" is an observation of existing weather conditions made in accordance with the provisions and instructions of this circular, at a station *on an airway*, the primary purpose of which is to provide immediate information for transport and itinerant flying over the airway on which the reporting station is located

CHAPTER III

TYPES OF AIRWAY OBSERVATIONS REQUIRED AT STATIONS LOCATED ON TELETYPE OR RADIO CIRCUITS

304. In order that the weather information from any *hourly* weather-reporting station equipped with teletype or radio will be up to date at all times and that no important change will miss being reported, the observations required at such stations are divided into "Record observations," "Check observations," "Special observations," and "Local extra observations," definitions, descriptions, and instructions for the rendering of which follow:

(*a*) *Record observations.*—(See pars. 322 and 376 for examples.) The first observation *regularly* taken in the 60-minute period, which period begins with the 20th minute past each hour and extends through the 19th minute past the next hour. A "record" airway observation shall always include—in the order shown—elements as listed below, insofar as the instrumental equipment of the station rendering the report, or other circumstances require, or will permit:

TOTAL AMOUNT OF SKY COVERED BY CLOUDS.

CLASSIFICATION OF REPORT (when the station at which observation is taken is within a "controlled" zone).

CEILING (when other than "unlimited").

SKY (except when precipitation or obstructions to vision reduce the ceiling to zero and/or the visibility to ⅛ mile or less and make the sky unobservable).

VISIBILITY (when less than 10 miles).

WEATHER (when such conditions are present).

OBSTRUCTIONS TO VISION (when such conditions are present).

SEA LEVEL BAROMETRIC PRESSURE (millibars, when station is equipped with approved mercurial barometer).

TEMPERATURE (°F. when station is equipped with an approved thermometer).

DEW POINT (°F. when station is equipped with an approved psychrometer).

WIND DIRECTION, VELOCITY, and CHARACTER (to be estimated when station is not equipped with wind-measuring instruments).

ALTIMETER SETTING (inches, when station is equipped with approved mercurial barometer).

REMARKS (pertinent information not contained elsewhere in the report).

(*b*) *Check Observation.*—A comparison by actual observation of the present existing values of ceiling, sky, weather, obstructions to vision, and wind with those currently reported and in use; made at designated times between the hourly "record" observations, in conformity with the local Civil Aeronautics Authority schedule of broadcasts, to determine whether there has been any change in these elements and to bring the data up to date. If no change has occurred, the current observation will continue to be used in broadcasts with the time designated as that of the "check" observation. If the "check" observation indicates that conditions have changed, but not enough to warrant a designation of "special" observation, then these changed values will be used in place of those given in the current report in subsequent broadcasts until the next "record," or "special" observation. If conditions have changed enough to warrant a "special" observation, the observation will be so designated when entered on Form 1130, when broadcast locally, and/or transmitted by teletype or radio. Whether change has occurred or not, such observations will be entered separately on Form 1130 (as specifically prescribed further on in these instructions).

(*c*) *Special Observation.*—(See pars. 322 and 376 for examples.) A new observation taken when a *marked* change in weather conditions (as defined following) from those reported in the previous "record," "check," or "special" observation occurs. If such a change occurs at the time of the "record" observation, the "record" observation will then be designated as "special" observation for all purposes. In this case "special" observations shall be complete for all *elements.* However, since the large majority of "special" observations will be made at times other than those of "record" observations, and weather changes requiring the filing of the "special" may not involve temperature, dew point, altimeter setting, and barometric pressure, these data *need not be included* in the "special" report unless, the temperature falls or rises at the rate of 10° an hour or more and the pressure falls or rises at the rate of 1 millibar in 45 minutes (1.3 millibars per hour) or more. For example, in a "special" being made specifically because of lowering or rising ceiling, decreasing or increasing cloudiness, rising or lower visibility, beginning or ending of precipitation, increases in wind velocity, etc., the temperature, dew point, altimeter setting, and barometer might not show such large changes and except under conditions named above, may be omitted. In such cases the "special" observation would include only a ceiling, sky, visibility, weather, obstructions to vision, and wind elements. It is reiterated, however, that if the "special" coincides with a "record" observation, such observations will invariably include the temperature, dew point, and barometer if ordinarily rendered at the station in question and if the instruments are in working order. "Special" observations shall invariably be recorded on Form 1130.

(*d*) *Local Extra Observation.*—(See par. 376 for examples.)

1. These observations shall be taken at terminal and intermediate airports where the Weather Bureau maintains weather-reporting stations manned by Weather Bureau commissioned or airway-observer personnel. The stations to take such observations have been and will be so designated by notification from the central office.

2. At these stations "local extra observations" shall be made each 15 minutes, beginning with the first 15 minutes following a "record," "check," or "special" obser-

SKY (except when precipitation or obstructions to vision reduce the ceiling to zero and/or the visibility to ½ mile or less and make the sky unobservable).

VISIBILITY (when less than 10 miles).

WEATHER (when such conditions are present).

OBSTRUCTIONS TO VISION (when such conditions are present).

SEA LEVEL BAROMETRIC PRESSURE (millibars, when station is equipped with approved mercurial barometer).

TEMPERATURE (°F. when station is equipped with an approved thermometer).

DEW POINT (°F. when station is equipped with an approved psychrometer).

WIND DIRECTION, VELOCITY, and CHARACTER (to be estimated when station is not equipped with wind-measuring instruments).

ALTIMETER SETTING (inches, when station is equipped with approved mercurial barometer).

REMARKS (pertinent information not contained elsewhere in the report).

(*b*) *Check Observation.*—A comparison by actual observation of the present existing values of ceiling, sky, weather, obstructions to vision, and wind with those currently reported and in use; made at designated times between the hourly "record" observations, in conformity with the local Civil Aeronautics Authority schedule of broadcasts, to determine whether there has been any change in these elements and to bring the data up to date. If no change has occurred, the current observation will continue to be used in broadcasts with the time designated as that of the "check" observation. If the "check" observation indicates that conditions have changed, but not enough to warrant a designation of "special" observation, then these changed values will be used in place of those given in the current report in subsequent broadcasts until the next "record," or "special" observation. If conditions have changed enough to warrant a "special" observation, the observation will be so designated when entered on Form 1130, when broadcast locally, and/or transmitted by teletype or radio. Whether change has occurred or not, such observations will be entered separately on Form 1130 (as specifically prescribed further on in these instructions).

(*c*) *Special Observation.*—(See pars. 322 and 376 for examples.) A new observation taken when a *marked* change in weather conditions (as defined following) from those reported in the previous "record", "check", or "special" observation occurs. If such a change occurs at the time of the "record" observation, the "record" observation will then be designated as a "special" observation for all purposes. Since the large majority of "special" observations will be made at times other than those of "record" observations, and weather changes requiring the filing of the "special" may not involve temperature, dew point, altimeter setting, and barometric pressure, these data, as included in the "special" report, will have the same value as in the last previous "record", "check", or "special" observation, unless the temperature falls or rises at the rate of 10° an hour or more and the pressure falls or rises at the rate of 1 millibar in 45 minutes (1.3 millibars per hour), or more, in which case the new values will be reported in the "special" observation. For example, in a "special" being made specifically because of lowering or rising ceiling, decreasing or increasing cloudiness, decreasing or increasing visibility, beginning or ending of precipitation, increases in wind velocity, etc., the temperature, dew point, altimeter setting, and barometer might not show such large changes and, except under conditions named above, would be entered as the same values previously reported. However, if the "special" coincides with a "record" observation, such an observation would include the new values for temperature, dew point, altimeter setting, and barometer, even though these have not changed at the rates given above.

(*d*) *Local Extra Observation.*—(See par. 376 for examples.)

1. These observations shall be taken at terminal and intermediate airports where the Weather Bureau maintains weather-reporting stations manned by Weather Bureau commissioned or airway-observer personnel. The stations to take such observations have been and will be so designated by notification from the central office.

2. At these stations "local extra observations" shall be made each 15 minutes, beginning with the first 15 minutes following a "record," "check," or "special" obser-

vation which shows a ceiling of less than 600 feet or a visibility of less than 1¼ miles, and continuing until an observation shows a ceiling of 600 feet or more and a visibility of 1¼ miles or more.

3. "Local extra observations" will include only the ceiling, sky, visibility, weather, obstructions to vision, and remarks, and will be entered on form 1130 in proper chronological order with such "record," "check," or "special" observations as are made in accordance with instructions. The time of the observations will be the time of the filing of the report in cases where a filing takes place, either directly on the local teletype or interphone system, or by delivery to a Civil Aeronautics Authority communications station, and in other cases will be the time of completion of the entries on form 1130, such entries being made immediately following the observation of the weather elements.

4. If any "local extra observation" shows a change, either increase or decrease, from the values in the immediately preceding observation amounting to as much as to require reporting the ceiling 100 feet higher or lower, or the visibility one-fourth mile higher or lower, or both, the observation shall be given to the local Civil Aeronautics Authority communications station (by the means usually effective in filing weather reports) for local broadcast, placing on the local teletype circuit, and/or giving to the local traffic-control officer or station. Lacking this facility, the observation will be given directly to the local traffic-control officer or station by the usual means of communication. Lacking this facility, the observation will be filed on the local teletype circuit and/or placed on the local interphone system by the observer. Lacking any of the above facilities, the observation will be telephoned or otherwise communicated to the local airline, airport, aviation charter, or private flying officials who have indicated that they will wish to be informed of such changes during periods when they are expecting landings or departures of aircraft in which they are concerned at that point. "Local extra observations" will not, as such, be transmitted on the long-line teletype circuits.

5. At terminal or intermediate airports, at which there are no Civil Aeronautics Authority teletype or radio and there are airway observers or commissioned Weather Bureau personnel on duty continuously over the periods when aircraft are due to land or depart, the procedure outlined above for hourly reporting stations will apply at such stations for those periods.

6. When the observation indicates a change from reported values in the last "record" or "special" observation which warrants a "special," a "special" shall, of course, be filed and treated as directed by instructions herein.

7. When special observations are called for by airlines, War or Navy Department officials, or private flyers, or others, for bona fide landings or departures, even though the weather conditions do not warrant a "special" or "local extra," the observation requested shall be taken and handled in the same way as a "local extra." In this case the reason for taking the "local extra" shall be entered in parentheses under the "remarks" column on form 1130, thus: (Local extra for Eastern Airlines), (Local extra for United Airlines, trip 6), (Local extra for War Department plane), etc.

8. In transmissions made over a local teletype circuit the character of "local extra observations" shall be indicated by the use of "LCL" immediately preceding the time of observation.

CHAPTER IV

RULES GOVERNING ALLOWABLE TIME AT HOURLY WEATHER REPORTING STATIONS BETWEEN THE TAKING OF OBSERVATIONS AND THEIR USE IN SEQUENCES AND BROADCASTS

305. The following will govern the period at hourly reporting stations between the taking of the observation and its use in sequences and broadcasts:

(*a*) *Purpose and use of record observations.*—One record observation will be taken each hour at stations where teletype or radio are located during the period these facilities are normally in operation. The observation shall be the one taken for use in the regular sequence beginning at 30 minutes past each hour.

(*b*) *Time of taking record observations.*—The *record observation* shall be taken within the 10-minute period immediately preceding its placing in the sequence, 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 10-minute period. The use of ceiling balloons will require additional time and this work may be started 15 minutes before the determining of other data regularly included in the report.

(*c*) *Observations required at stations where no broadcasts are made.*—At stations where no broadcasts are made by radio, the *record observation* is the only observation required to be taken, except 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 omissions in this regard will not be tolerated. Failures to take *special observations* will be reported by the direct supervising officials through the general supervising station to the central office for corrective action when, in their judgment, this is warranted.

(*d*) *Observations required at stations where broadcasts are made.*—At stations located at points where broadcasts of local weather are made by Civil Aeronautics Authority radio the *record observation* will be taken as directed in (*a*) above, and this will serve, unless conditions require a *special observation* or a *local extra observation*, for the sequence and its broadcast. However, just before the broadcast of the local weather, at about 10 minutes after each hour, a *check observation* will be taken and filed for the broadcast. For example, under this plan the *record observation* would be taken just prior to the placing of the report in the sequence and a *check observation* taken just prior to the broadcast of the local weather. If, however, a *special* or *local extra observation* had been taken between these times and this was within 15 minutes of the broadcast time, and conditions had not changed since, the *check observation* would merely consist of the data in the current observation, with time brought up to the time of the broadcast.

CHAPTER V

RULES FOR TAKING AND FILING SPECIAL OBSERVATIONS

306. The foregoing will not eliminate the necessity for maintaining a constant watch of conditions so that *special observations* may be filed when required by changed conditions. A *special observation* will be taken and filed without fail at all hourly weather-reporting stations whenever the following changes, or combinations of them, occur:

(*a*) *Special observations required in connection with changes in classification of reports.*—At stations in control zones, whenever the weather changes so as to result in a changed classification from that last reported, except that a special is not required for a change of classification due to the occurrence of sunrise or sunset.

(*b*) *Special observations required in connection with precipitation.*—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 observation

Any *definite* change from one to the other of periods of rain, snow, freezing rain, or ice pellets, or any *definite* change from one type of precipitation to combinations of these types, or *definite* changes from one combination to another. (Frequent fluctuations between types to be explained under "Remarks.")

Hail occurs ("special" at beginning and ending).

(*c*) *Special observations required in connection with thunderstorms.*—A thunderstorm not previously reported occurs, or one previously reported shows marked increase in intensity. Also, the cessation of a thunderstorm previously reported.

(*d*) *Special observations required in connection with sky conditions.*—A change from *clear to broken* or from *scattered to overcast*, and vice versa, *with cloudiness below 10,000 feet;* that is, if the sky was clear at the last previous record or special observation, a special observation will be filed if it becomes broken below 10,000 feet; if scattered at

the last previous record or special observation, a special will be filed if it becomes overcast below 10,000 feet; or the reverse.

(*e*) *Special observations required in connection with fog.*—Beginning or ending of light, moderate, or thick fog; dense fog; thick or dense *ground* fog; or thick or dense *ice* fog; or the change from one type of fog to another.

(*f*) *Special observations required in connection with wind-shifts, tornadoes, etc.*—A wind-shift passes the station.

Tornadoes, sandstorms, duststorms, *specials* at beginnings and endings if observed within 7 miles of the station.

(*g*) *Special observations required in connection with ceilings.*—The ceiling, when 6,000 feet or more at the last previous record or special observation, lowers to 3,000 feet or less; or when less than 6,000 feet at the last previous record or special observation, lowers one-half or more, and when 3,000 feet or below rises two or more times the height given in the previous record or special observation, except that when the ceiling *definitely* lowers to below 500 feet or rises to above 500 feet; a special observation will be filed. If the ceiling is fluctuating at frequent intervals between values slightly above and slightly below 500 feet, it may be characterized as "variable" by entry of the symbol (as shown later herein) for this word following the ceiling value and a special observation need not then be filed for each individual change, provided that a special will always be filed if such fluctuations reduce the ceiling to 450 feet or less or raise it to 550 feet or more. When the sky condition goes from scattered below 10,000 feet to broken or the reverse and the clouds remain practically the same height, the ceiling thereby goes from unlimited to the height of the clouds, or vice versa. Under this condition it is not necessary to file a special, as this is regarded as a change in *amount* of cloudiness of a degree insufficient to require a special. However, if the clouds are low enough to make a change of this type significant, then, under paragraph (*j*) below, a "special" should be filed.

(*h*) *Special observations required in connection with visibility.*—The visibility when 7 miles or more at the last previous record or special observation lowers to 3 miles, or when originally less than 7 miles lowers one-half or more, or when less than 4 miles increases two or more times the value in the previous record or special observation, except that when the visibility definitely lowers to 1 mile or rises above 1 mile, a special observation will be filed. If the prevailing visibility is fluctuating rapidly between limits from slightly below 1 mile to slightly above 1 mile, it may be characterized as "variable" by entry of the symbol (as shown later herein) for this word following the visibility value, and a special observation covering each change need not then be rendered, provided that a special will always be filed if such fluctuations reduce the visibility to ¾ mile or less or raise it to 1¼ miles or more.

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

(*j*) *Special observations required but not specifically covered by instructions.*—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 it 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 importance to the safety of air traffic will be reported as soon as it occurs.

CHAPTER VI

INSTRUCTIONS GOVERNING "TIME OF OBSERVATION"

307. The time of observation will be determined in accordance with the following:

(*a*) *Time to be ascribed to record, check, local extra, and special observations.*—The time given to *record* or *check* observation at points where teletype or 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 3:30 a. m. it will be given the time of 0330E (C, M, P). The time of a *special observation* or a *local extra observation* will be that of the filing of the report.

(*b*) *Basis and standard of time to be used.*—The time ascribed to the observations will be on the 24-hour-clock system, local standard time. For example, 1:30 a. m., E. S. T., would be 0130E; 3:30 p. m., C. S. T., would be 1530C; 11:30 p. m., P. S. T., would be 2330P, etc.

(*c*) *Time to be ascribed to reports sent by telephone or telegraph.*—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.

CHAPTER VII

INSTRUCTIONS REGARDING ALLOWABLE PERIODS BETWEEN THE TAKING OF RECORD OR CHECK OBSERVATIONS AT TERMINAL STATIONS AND THEIR BROADCAST AT THOSE STATIONS

308. Terminal stations will see to it that the weather observations of that station broadcast at any time shall have been taken or completely checked not more than 15 minutes prior to the beginning of the broadcast; that is, *record observations* or *check observations* broadcast at any point shall have been taken within 15 minutes of all broadcast schedules in which they are used.

CHAPTER VIII

INSTRUCTIONS FOR ENTRY OF OBSERVATIONS ON FORM 1130–AER.

309. All *record, check, local extra,* and *special observations* will be entered in chronological order on Form 1130–Aer. at the time of taking the observations, using ditto marks, except in *record observations,* whenever the preceding data in a column is the same. The different classes of observations will be designated in the second column of the form by the letter "R" for "record," a check mark for "check," the letter "L" for "local extra," and the letter "S" for "special," in parentheses, and in the next column will be entered the proper letter for the Civil Air Regulation classification (if the station is located within a controlled zone) of the report. In order that the *check observation* 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. When a *special* or *local extra observation* is made and entered on the form, this will be followed by a *check observation* at any ensuing checking period. If a *check observation* indicates changes or conditions requiring a *special* or *local extra,* it shall be designated as the type required and treated according to instructions for *specials* or *local extras.* The actual entry of observations on Form 1130–Aer. will be different for the two general classes of observations, as follows:

(*a*) *Entries on Form 1130–Aer. at teletype and radio points.*—At teletype and radio points, entries will be made in authorized teletype symbols and authorized English abbreviations so that the record will be in the same form as the subsequent teletype or radio transmission of the report, except that each element of the report will be entered in the column assigned for it.

(*b*) *Entries on Form 1130–Aer. at stations reporting by telegraph or telephone.*—At points from which observations are transmitted by telegraph or telephone, the entries will be in authorized English abbreviations and figures.

310. **Inspection of Forms 1130–Aer.**—The official in charge of airport and first-order stations furnishing reports on an hourly basis, or someone designated by him, shall inspect the forms daily. 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.

CHAPTER IX

PROCEDURE IN CASES OF LAXITY IN OBSERVATIONAL WORK

311. If laxity in the observational work at any Weather Bureau intermediate point becomes apparent, the general supervising official for the airway will take up the matter 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 Civil Aeronautics Authority employees is involved, the general supervising official will take up the matter with the district manager concerned.

CHAPTER X

PROCEDURE IN CASES OF FAILURE OF COMMUNICATIONS FACILITIES

312. The following shall govern procedure in cases of failure of communications facilities:

(*a*) *Teletype and radio.*—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 following the breakdown will be telegraphed, using the check "WEA," or telephoned, collect, to another station on the airway which will be designated by the general supervising official to receive it, and thereafter at 25 minutes past the hours of 1 and 7 a. m. and p. m., E. S. T. (4 and 10 a. m. and p. m., P. S. T.; 5 and 11 a. m. and p. m., M. S. T.; 6 and 12 a. m. and p. m., C. S. T.), so long as the failures continue. Hourly records on form 1130–Aer., will be kept as usual during such periods. "Special" observations will be telegraphed or telephoned as required by conditions.

(*b*) *Telephone and telegraph.*—Stations rendering airway reports regularly by telephone or telegraph will follow the above procedure with regard to the entry of observation.

CHAPTER XI

OBSERVATIONS TO BE TAKEN AT STATIONS REPORTING BY TELEPHONE OR TELEGRAPH

313. Practically all observations at stations reporting by telephone or telegraph are classed as "record," with the same rules for the taking of this type of observation at hourly stations also applying at these stations. No "check" observations are to be taken, and "special" observations will be taken only in accordance with specific instructions issued by the supervising Weather Bureau station.

CHAPTER XII

AUTHORITY OF GENERAL SUPERVISING OFFICIALS TO CALL FOR SPECIAL OBSERVATIONS FROM STATIONS REPORTING BY TELEPHONE OR TELEGRAPH

314. The general supervising official will have authority to issue instructions to airway stations, either directly or through a direct supervising official, to render special observations at such times and under such conditions as he may deem advisable for providing the greatest measure of efficient meteorological service to flights over the airway.

CHAPTER XIII

INSTRUCTIONS REGARDING WITHHOLDING OF REPORTS UNDER SPECIAL CONDITIONS FROM STATIONS REPORTING BY TELEPHONE OR TELEGRAPH

315. Stations reporting by telephone and telegraph, and where *specifically* instructed to do so by the Weather Bureau general supervising official for the airway, who must have received prior central office approval for such action, will forward reports only when one or more of the following conditions prevail at the time of observation:

(*a*) *Ceiling and sky.*—When over 5/10 of the sky is obscured by clouds at an altitude of 9,750 feet or lower above the station.

(*b*) *Precipitation.*—Precipitation is occurring at the station or is observed in the vicinity thereof.

(*c*) *Squalls, thunderstorms, etc.*—Thunderheads, thunderstorms, squalls, or other conditions tending to hamper or endanger flying are occurring at, or are observable from, the station.

(*d*) *Visibility.*—The visibility 4 is miles or less.

(*e*) *Dew point.*—The temperature of the dew point (at stations furnishing this datum) is 3° or less below the current temperature.

316. 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, the system of withholding reports will only be placed into effect at the discretion of the general supervising official after prior approval therefor has been obtained from the central office.

317. 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 in the second column on Form 1130–Aer. for such observations as are made but "not filed" for transmission. False entries on these forms for the purpose of avoiding the taking of observations at the regular times are easily detected by comparison with surrounding station reports and when verified may occasion the immediate dismissal of the responsible observer.

CHAPTER XIV

TRANSMISSION OF AIRWAY WEATHER REPORTS

318. It is necessary, of course, that airway observations be transmitted from the station at which they are made to other points where the information is needed. At many points this is done by placing the observations on the teletype or radio circuits of the Civil Aeronautics Authority, while at others it is done by forwarding them by commercial telephone or telegraph, thus requiring differing methods of composing the observations for transmission.

A. Instructions for the Transmission of Airway Weather Reports by Teletype and Radio

319. In order to shorten transmissions of reports over the teletype and radio circuits as much as possible, there has been developed a system of symbolizing the observational data therein. This system is to be used invariably when reports are transmitted by teletype and radio, and all concerned should therefore be thoroughly familiar with the use and translation of the symbols. Symbols to be used for the various elements of an airway observation are as follows:

(*a*) *Station designator.*—This is to be indicated by use of the proper group of two or three letters representing the name of the station at which the report originated.

(*b*) *Total amount of sky covered by clouds.*—This is to be indicated by use of a figure representing the total number of tenths of the sky covered with clouds, taken from the following:

Code figures	Proportion of sky covered (regardless of kind of clouds)
0	No clouds.
1	Less than 1 tenth (few clouds).
2	1 tenth.
3	From over 1 tenth to and including 3 tenths.
4	From over 3 tenths to and including 6 tenths.
5	From over 6 tenths to and including 8 tenths.
6	From over 8 tenths to and including 9 tenths.
7	More than 9 tenths, but with openings.
8	Sky completely covered with clouds (10 tenths).
9	Sky obscured and not observable.

(*c*) *Classification of report.*—This is to be indicated by use of one of the proper letters assigned for this purpose when conditions at a controlled airport in a controlled zone

fall within the classification standards. No classifying letter is sent by stations not in controlled zones.

(*d*) *Type of report.*—This is to be indicated by the letters "SPL" meaning "special observation" and "L" meaning "local extra observation" when such types of reports are being transmitted.

(*e*) *Time of report.*—This is to be indicated (in "special" and "local extra" observations only) by a group of figures representing the time on the 24-hour clock followed without space or oblique by a letter representing the time zone in which the station rendering the report is located, e. g., "1354E" indicates 1:54 p. m., E. S. T.; "0022P" indicates 12:22 a. m., P. S. T.; etc.

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

2. The height of the ceiling up to and including 9,750 feet above the station is to be indicated by figures representing the proper 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 to be used.

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

5. When a ceiling balloon is blown out of sight before reaching the clouds, a plus sign is to be entered preceding the ceiling figures, which represent 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.

6. When the ceiling is below 2,000 feet and is changeable with respect to height, this is to be indicated by entering the letter "V" immediately following the ceiling value. For example, "E5V——."

(*g*) *Sky.*—1. The sky condition, when observable, is to be indicated by the following symbols:

(*h*) *Visibility.*—1. A visibility of 10 miles or more is to be indicated by the *absence of a value* for this element. If between 9 and 10 miles, the visibility is reported as 9 miles.

2. Visibilities from zero up to but not including 10 miles are to be indicated by the proper figures representing the values in miles and/or fractions thereof [as prescribed in paragraph 344 (b)], e. g., "0" indicates a zero visibility; "1¼" indicates a visibility of 1¼ miles; "3" indicates a visibility of 3 miles, etc.

3. If the visibility is 2 miles or less and is changeable or fluctuating, this is to be indicated by entry of the letter "V" immediately following the value. For example, "E6V⊕11/2V——"

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

R—	Light rain.	AP—	Light small hail.
R	Moderate rain.	AP	Moderate small hail.
R+	Heavy rain.	AP+	Heavy small hail.
S—	Light snow.	OP—	Light snow pellets.
S	Moderate snow.	OP	Moderate snow pellets.
S+	Heavy snow.	OP+	Heavy snow pellets.
ZR—	Light freezing rain.	T—	Mild thunderstorm.
ZR	Moderate freezing rain.	T	Moderate thunderstorm.
ZR+	Heavy freezing rain.	T+	Severe thunderstorm.
L—	Light drizzle.	SQ—	Mild snow squall.
L	Moderate drizzle.	SQ	Moderate snow squall.
L+	Heavy drizzle.	SQ+	Severe snow squall.
ZL—	Light freezing drizzle.	RQ—	Mild rain squall.
ZL	Moderate freezing drizzle.	RQ	Moderate rain squall.
ZL+	Heavy freezing drizzle.	RQ+	Severe rain squall.
E—	Light sleet.	SW—	Light snow showers.
E	Moderate sleet.	SW	Moderate snow showers.

(*k*) *Barometric pressure.*—The barometric pressure is to be indicated by a group of three figures, the first two of which represent the tens and units of millibars and the last of which represents the tenths of a millibar involved. Thus, a pressure of 987.2 millibars would be sent as "872"; of 1001.5 as "015"; of 1000.0 as "000"; etc.

(*l*) *Temperature.*—This is to be indicated in figures giving its value to the nearest degree Fahrenheit.

(*m*) *Dew point.*—This is to be indicated in 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.—Temperature below zero Fahrenheit is to be indicated by the entry of a minus sign (−) immediately preceding the figures for temperature and/or dew point.

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

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

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

−Fresh gusts
+Strong gusts

(*o*) *Altimeter setting.*—This is to be indicated by a group of three figures, the first of which will represent the inch and the last two will represent the number of hundredths of an inch of the pressure setting for sensitive altimeters.

(*p*) *Remarks.*—Remarks are to be entered by use of proper symbols and English abbreviations.

320. **Grouping of symbols in teletype and radio transmissions.**—Transmission of the reports in symbols by teletype or radio shall be in the order shown below:

(*a*) STATION DESIGNATOR
(*b*) TOTAL AMOUNT OF SKY COVERED BY CLOUDS } as one group

One space

(*c*) CLASSIFICATION (1) one letter

One space

(*d*) TYPE OF REPORT (2)

One space

(*e*) TIME OF REPORT (3)

One space

(*f*) CEILING (4)
(*g*) SKY (5)
(*h*) VISIBILITY (6)
(*i*) WEATHER (7)
(*j*) OBSTRUCTIONS TO VISION (7) } as one group

One space

(*k*) BAROMETRIC PRESSURE (8)
(*l*) TEMPERATURE
(*m*) DEW POINT
(*n*) WIND and WINDSHIFTS
} as one group

One space

(*o*) ALTIMETER SETTING (8)

One space

(*p*) REMARKS in symbols and English abbreviations.

(1) Sent only by stations at controlled airports within controlled zones.
(2) "Type of report" given only in cases of "special" and "local extra" observations.
(3) "Time of report" given only in cases of "special" or "local extra" observations.
(4) The absence of a value for "ceiling" indicates that it is "unlimited."
(5) The absence of sky condition symbols indicates that the true condition of the sky is not observable owing to the presence of intense types of precipitation or obstructions to vision.
(6) The absence of a value for visibility indicates that this is 10 miles or more.
(7) The absence of an entry for "weather" or "obstructions to vision" indicates that phenomena classified as such are not occurring.
(8) Sent only from stations equipped with mercurial barometers.

321. **Reporting Missing Elements.**—Elements normally sent, but for some reason missing from the teletype or radio transmission, will be indicated by the letter "M" entered in the report in place of the missing data. Stations regularly not reporting certain elements will omit these, the order of the report being kept the same. For example, if the dew point is not sent, the temperature will be followed by the wind, etc.

322. **Examples.**—The following examples indicate the manner in which observations are placed in the symbol form for transmission by teletype. Letters in the left columns correspond to those given to the various elements above:

Element	Teletype symbol	Translation	Element	Teletype symbol	Translation
(*a*)	CG	Chicago, Ill.	(*i*)	S	Moderate snow.
(*b*)	8	Sky completely covered with clouds.	(*j*)	----------	None, except the snow.
			(*k*)	982	998.2 millibars.
(*c*)	X	Closed.	(*l*)	28	28° F.
(*d*)	SPL	Special report.	(*m*)	26	26° F.
(*e*)	1612C	4:12 p. m., C. S. T.	(*n*)	↙20—	Northeast, 20 miles per hour, fresh gusts.
(*f*)	E3V	Estimated 300 ft. variable.	(*o*)	945	29.45 inches.
(*g*)	⊕	Overcast.	(*p*)	S+ ocnly.	Snow occasionally heavy.
(*h*)	1/2V	½ mile, variable.			

Written on teletype thus:
CG8 X SPL 1612C E3V⊕1/2VS 982/28/26↙20— 945 S+ OCNLY

Element	Teletype symbol	Translation	Element	Teletype symbol	Translation
(a)	CV	Cleveland, Ohio.	(j)		None, except precipitation.
(b)	8	Sky completely covered by clouds.	(k)	991	999.1 millibars.
(c)	N	Satisfactory for instrument flight.	(l)	75	75° F.
(d)	SPL	Special report.	(m)	73	73° F.
(e)	0020E	12:20 a. m., E. S. T.	(n)	→30+↖0015E	West 30 miles per hour, strong gusts, moderate windshift from southeast at 12:15 a. m., E. S. T.
(f)	12	1,200 feet (measured ceiling).	(o)	950	29.50 inches.
(g)	⊕5Ⓓ	Overcast, lower scattered clouds at 500 feet.	(p)	T+ M O V G EWD	Thunderstorm moving eastward.
(h)	2	2 miles.			
(i)	T+R+A+	Severe thunderstorm, heavy rain, heavy hail.			

Written on teletype thus:
CV8 N SPL 0020E 12⊕5Ⓓ2T+ R+A+ 991/75/73→30+↖0015E 950 T+ MOVG EWD

Element	Teletype symbol	Translation	Element	Teletype symbol	Translation
(a)	GI	Grand Island, Nebr.	(g)	○	Clear.
(b)	0	No clouds.	(h)	1/8	1/8 mile.
(c)		Not a controlled airport.	(i)		None to report.
(d)		Regular sequence report, no "type of report," required.	(j)	GFF	Dense ground fog.
			(k)	204	1020.4 millibars.
			(l)	59	59° F.
(e)		Regular sequence report, no "time of report" required.	(m)	59	59° F.
			(n)	C	Wind calm.
			(o)	014	30.14 inches.
(f)		Ceiling unlimited.	(p)		None.

Written on teletype thus:
GI0 ○⅛GFF 204/59/59C 014

Element	Teletype symbol	Translation	Element	Teletype symbol	Translation
(a)	SL	Salt Lake City, Utah.	(g)		Sky not observable, due to "heavy drizzle" and "dense fog."
(b)	9	Sky obscured.			
(c)	X	Closed.			
(d)		Regular sequence report, no "type of report" required.	(h)	0	Visibility zero
			(i)	L+FF	Heavy drizzle, dense fog.
			(j)		
(e)		Regular sequence report, no "time of report" required.	(k)	077	1007.7 millibars.
			(l)	40	40° F.
			(m)	40	40° F.
(f)	0	Ceiling zero.	(n)	←4	East, 4 miles per hour.
			(o)	976	29.76 inches.
			(p)		None.

Written on teletype thus:
SL9 X 00L+FF 077/40/40←4 976

NOTE.—As a graphical illustration of symbolized weather reports, see insert, "Explanation of Symbol Weather Reports," at back of Circular.

323. **Use of Symbols in Circular.**—The foregoing symbols will be used hereafter in this circular when considered necessary for the giving of proper illustrations or examples.

B. Method of Telephoning or Telegraphing Reports

324. **Telegraph.**—Airway weather reports will be transmitted by telegraph in accordance with the following rules:

(*a*) All words will be spelled out.

(*b*) The station name and the time of filing in cases of "special" observations, will not be included in the body of the message since these will be indicated in the message as transmitted by the telegraph company.

(*c*) Separate groups of five figures or less may be sent as one word in telegraphed messages. Therefore, figures in groups of five or less shall be used wherever possible in transmitting numerical values of data in the reports. However, the word "minus" must be used preceding the temperature and dew-point figure groups to indicate below-zero values. Since fractions cannot be sent as figures under this plan, they will be sent in words.

(*d*) The word "clouds" will not be sent when giving the "sky" conditions. For example, "broken clouds" would be sent as "broken"; "high broken, lower scattered clouds" as "high broken, lower scattered," etc.

(*e*) Any element ordinarily included in reports from a particular station, but which cannot be determined for use in a particular report because of broken or defective instruments or other causes, will be indicated by the word "missing" being inserted at the proper point in the message.

(*f*) Stations regularly not reporting certain elements will omit these, the order of the report being kept the same. For example, if the dew point is not included, the temperature will be followed by the wind, etc.

325. **Examples of Telegraphed Reports.**—For example, the following reports would be telegraphed as indicated:

(*a*) Ceiling estimated 1,200 feet; sky overcast (solid); visibility 2 miles; severe thunderstorm; heavy rain; heavy hail; barometric pressure 999.1 millibars; temperature 75°; dew point 73°; wind west, 30 miles per hour, strong gusts; moderate southeast wind shift at 12:15 a. m., E. S. T.; thunderstorm moving east;

Sent as—

"8 Estimated 1200 overcast 2 severe thunderstorm heavy rain heavy hail 9991 75 73 west 30 strong gusts moderate southeast wind shift 0015 Eastern Standard thunderstorm moving east."

(*b*) Ceiling unlimited; clear (no clouds); visibility ⅛ mile; dense ground fog; barometric pressure 1020.4 millibars; temperature 59°; dew point 59°; wind calm;

Sent as—

"None Clear one eighth dense ground fog 10204 59 59 calm"

(*c*) Classification, airport closed to operations; ceiling 500 feet, variable; sky overcast (solid), lower scattered clouds at 200 feet; visibility one and a half miles, variable; light freezing rain; light fog; barometric pressure 1002.2 millibars; temperature 31°; dew point 31°; wind east, 12 miles per hour; altimeter setting 29.60;

Sent as—

"8 X closed 500 variable overcast lower scattered 200 one and one half variable light freezing rain light fog 10022 31 31 east 12 2960."

(*d*) Ceiling estimated 5,000 feet; sky overcast (with breaks), lower broken clouds; visibility 4 miles; light rain; light smoke; barometric pressure 1018.3; temperature 62°; dew point 50°; wind west northwest, 8 miles per hour;

Sent as:

"7 Estimated 5000 overcast lower broken light rain light smoke 10183 62 50 west northwest 8"

326. **Telephone.**—When reports are telephoned to telegraph offices they will be telephoned in exactly the same form as outlined above, so that the body of the telegram will be as prescribed. When, however, they are telephoned direct to some terminal or station for use there, they will be given in the proper order of elements with inclusion of the specific names of elements as may be required for making the report clear to the one receiving it. No specific rules for doing this can be cited here, it only being necessary that the receiver of the report clearly understand it. There should be no difficulty in the two people concerned arranging a proper system for accomplishing this.

CHAPTER XV

ABBREVIATIONS FOR USE IN METEOROLOGICAL TRANSMISSIONS BY RADIO AND TELETYPE

327. Lists of abbreviations authorized to be used in all transmissions by teletype and/or radio of forecasts, summaries, "remarks," in sequence and special reports, etc., will be issued by the Civil Aeronautics Authority. Such lists will be strictly adhered to by all personnel making meteorological transmissions by teletype and/or radio.

CHAPTER XVI

OBSERVING AND REPORTING ELEMENTS OF AIRWAY WEATHER OBSERVATIONS

328. Instructions for observing and reporting each element follow in detail.

NOTE.—Since the "total amount of sky covered by clouds" is directly related to observations of "sky" conditions, instructions for observing and reporting that element are included under XVI(c)—"Sky".

XVI (A)—CLASSIFICATION

329. **General Limits of Classification.**—All airway weather observations, made in accordance with current instructions, at any controlled airport will be classified as follows:

Class C—Contact.—Weather equal to or better than the minima specified for the particular airport for flight in accordance with contact flight rules. (Satisfactory for contact flight.)

Class N—Instrument.—Weather less than the minima specified for the particular airport for contact flight (Class C, above) and down to the minima prescribed for the particular airport for suspension of flight operations. (Requiring observance of instrument flight rules, unless flight in accordance with contact flight rules has been authorized as provided for in CAR 60.440 and 60.441.)

Class X—Closed.—Weather below the minima specified for the particular airport, wherein any landing or take-off other than a flight of public aircraft or scheduled airline aircraft if otherwise authorized, is suspended. (Take-off and landing of nonscheduled civil aircraft suspended, unless authorized as provided for in CAR 60.540.)

330. **Prescribed Minima and Rules for Classification.**—(a) The following minima for weather conditions for each of the above classes are prescribed. If these are changed for any particular airport, proper notice will be forwarded to the station concerned:

Class C—Contact.—Within control zones (day):

Ceiling—800 feet or more (1,000 feet or more if precipitation is occurring in any form).

Visibility—3 miles or more.

Within control zones (night):

Ceiling—1,000 feet or more.

Visibility—3 miles or more.

Class N—Instrument.—Within control zones (day or night): Below Class C minima but not below 500 feet ceiling and 1 mile visibility.

Class X—Closed.—Within control zones (day or night): Below 500 feet ceiling and 1 mile visibility.

151480—39—3

(*b*) If either the ceiling or visibility falls below the minimum for one of the classes described above, the weather report will be given the next lower classification. For example, within control zone, ceiling 600, visibility 4 miles, Class N instead of Class C.

(*c*) Weather conditions will be classified at the time the observations are made. The letter "C," "N," or "X" denoting such classification will be entered on forms 1130-Aer. in the proper column.

(*d*) The symbols, C, N, and X will be used for classifying weather conditions in teletype or radio transmissions, such symbols corresponding to Class "C," "N," and "X" of weather conditions, respectively. These symbols will be entered immediately following the station designator, separated therefrom and from following entries by one space, thus—

WA8 X SPL 1325E 3 ⊕1/2R–F_____etc.

(*e*) The importance of properly classifying weather conditions cannot be overemphasized. Pilots on the ground or in flight, and air-line companies, will depend upon and be guided by the classification of weather conditions and will make flight plans and dispatch planes accordingly, or may need to change or alter plans already made if the classification in airway weather sequences changes. Airway weather observing personnel must, therefore, become thoroughly familiar with the classifications of weather conditions outlined above and also with weather conditions minima as set for the particular airport station at which they are employed. It is the responsibility of personnel giving out weather reports orally to pilots and others to make certain that the classification of the report or reports is distinctly and clearly given and that there is no misunderstanding on the part of the inquirer which may lead to later confusion or difficulty.

331. **List of controlled airports.**—A list of airway weather-reporting stations at controlled airports within controlled zones has already been issued, and, as this list may be changed from time to time, stations concerned will be advised accordingly.

332. **Stations which are to classify reports.**—It should be remembered that only airway weather-reporting stations within controlled zones are required to classify their weather reports, and, further, that the inclusion of the symbol C, N, or X automatically indicates that the report is from a controlled airport.

XVI (B)—CEILING

333. **Concept and definition of ceiling.**—The fundamental concept of the existence of a ceiling is that during a flight being made in clear air at an altitude of 10,000 feet above a particular station, at any given instant, the pilot would be able, due to the presence of clouds below him, to see less than one-half of the total area of the surface of the earth that would be visible to him from that height if clouds were not present. However, all reported observations must be made from the viewpoint of the observer on the ground and it is necessary that this concept is reversed in the actual practice of taking observations. Therefore, in the meaning of these instructions, THE CEILING IS THE HEIGHT IN FEET OF THE LOWEST LEVEL BELOW TEN THOUSAND FEET ABOVE THE STATION AT WHICH THE TOTAL CLOUDINESS (AS PROJECTED AGAINST THE ENTIRE DOME OF THE SKY) BETWEEN THE SURFACE OF THE EARTH AT THE STATION AND THAT LEVEL (10,000 FEET) COVERS MORE THAN ONE-HALF OF THE ENTIRE AREA OF THE SKY, EXCEPT THAT IN THE PRESENCE OF HEAVY PRECIPITATION, DENSE FOG, OR OTHER CONDITIONS WHICH PREVENT THE OBSERVER FROM SEEING ANY CLOUDINESS THAT MAY BE PRESENT, THE CEILING WILL BE AT ZERO ALTITUDE; THAT IS, AT THE SURFACE. It follows from the above, therefore, that the ceiling to be reported will, in general, coincide with the base of the lowest stratum of clouds below 10,000 feet, the area of which, added to that of any cloudiness that may be present below this stratum, covers an area in excess of five-tenths of the entire dome of the sky.

334. **Estimation of Ceiling Heights.**—If instruments are not available, the height of a ceiling may often be *estimated* with reasonable accuracy by observing the unobscured portions of towers, mountains, or other tall objects, of which the height and the distance from the station are known. Each station shall, therefore, prepare and maintain

a table of such objects visible from that station. 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 value, but this should not be carried to the extreme that ceilings are reported consistently at lower altitudes than they actually are.

335. **Indicating Estimated Ceiling in Reports.**—Except when the ceiling is unlimited, a ceiling-height value will be included in every airway weather report. If this value is estimated, indication of this will be made in reports transmitted by teletype and radio by use of the symbol "E," and in telegraphed or telephoned reports, by inclusion of the word "estimated" immediately preceding the height given.

336. **Rules for observing and Reporting Ceilings.**—Rules for observing and reporting the ceiling element follow:

(*a*) *Point of observation.*—The observer must go outside to a point where a view of the entire sky may be had. All ceiling heights will refer to the ground level at the station, and if ceiling measurements are made from the roof of a building the height of the roof above the ground will be added to the value obtained.

(*b*) *Use of ceiling-measuring instruments.*—If the station is equipped with ceiling-measuring instruments (ceiling projector and/or ceiling balloons) and a ceiling is adjudged by observation of the sky to be present, the ceiling-measuring instruments *must* be used, if practicable. Ceiling balloons will not be used (1) during heavier than "light" precipitation; (2) at intervals of less than 2 hours when ceilings are 2,000 feet or more; (3) during other than daylight hours. However, except under the above conditions, they will be used as often as may be necessary to maintain an accurate check on the ceiling at stations taking "local extra" observations, beginning with any observation showing a ceiling of less than 600 feet and continuing until the ceiling rises to 600 feet or more; and the use of ceiling balloons is *required* at all hourly reporting stations at intervals of not more than 1 hour, beginning with any observation showing a ceiling of 1,000 feet or less and continuing until an observation shows that the ceiling has risen above 1,000 feet.

Further, (1) use of ceiling balloons should be made at least every 2 hours to determine the ceiling whenever overcast or broken clouds are reported and their height is estimated to be 2,000 feet or less; and (2) balloons may be used at the discretion of the observer to determine the height of the overcast layer whenever this is estimated to be above 2,000 feet. In conformity with the above rules, ceiling balloons will be used at other than hourly reporting stations (when such stations are equipped with ceiling balloons) to determine the ceiling given in each report forwarded by such stations.

(*c*) *Condition under which the ceiling is unlimited.*—The ceiling will be considered "unlimited" and no report made thereof when (1) the sky is clear, (2) there is no cloudiness present covering over five-tenths of the sky below an altitude of 9,751 feet above the station, and (3) any number of tenths of cloud covering at an altitude of 9,751 feet or more above the station are present alone.

(*d*) *Ceiling values to be reported.*—The ceiling height to the nearest 100 feet up to 5,000 feet and above that to the nearest 500 feet up to 9,751 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.

(*e*) *Reporting height of scattered clouds.*—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," that is, 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 9,751 feet above the station, immediately following the term in telegraphed reports and immediately preceding the "scattered clouds" symbol in reports transmitted by teletype. For example, (1) as telegraphed "high broken, lower scattered 14 hundred;" "scattered, lower scattered 2 thousand;" "scattered clouds 3 hundred;" (2) as transmitted by teletype, "◍/14◍" "◍20◍," "3◍." It will be noted that this rule does not apply to "high scattered clouds" nor to "scattered clouds" forming the *first part*

of a combination term. It is obvious that the height given in these cases almost always will be estimated, but indication of this need not be made.

(*f*) *Conditions under which ceiling is reported "zero."*—The ceiling will be reported "zero" when (1) dense or thick fog is present; (2) heavy precipitation, blowing snow, dust or sand; thick 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 in 50 feet or less above the station. In the latter case (3) it is possible to have zero ceiling with the visibility greater than one-fifth mile and, since this would be confusing, it will be necessary to explain the condition under "Remarks." For example, "clouds 30 feet above station," etc.

(*g*) *Reporting ceiling when balloon blown out of sight before reaching clouds.*—When a balloon is being used to determine the ceiling height, and is blown out of sight before reaching the clouds, the ceiling will be reported as over the last observed altitude of the balloon. For example, "over one thousand."

(*h*) *Reporting variable, changeable, or fluctuating ceiling.*—When the ceiling is variable or changeable this will be indicated by entry of the word "variable" in reports sent by telephone or telegraph and the letter "V" in reports sent by teletype or radio immediately following the ceiling value. Cloudiness changeable as to amount, unless the height were changing, would not require a "V" but would be placed under "Remarks."

XVI (C)—SKY

337. **Purpose and Importance of Reporting Sky Conditions.**—The extent to which the sky is covered by clouds and an indication of the stratification of such cloud covering are of interest and importance to a pilot as they determine whether all or 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 obstructed view 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 descent at his destination. For determining whether it will be necessary to fly between cloud layers, 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. It follows, therefore, that the reporting of sky conditions accurately and completely is of great importance and care must be taken by the observer to see that they are so reported. All sky-condition observations are made visually without the use of instruments, although sometimes at night it is advantageous, in order to obtain an accurate conception of the extent and stratification of any cloudiness present, to turn on the ceiling projector and observe the nature of the cloudiness passing through the beam over a period of a few minutes.

338. **General Types of Sky Conditions.**—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 following four general types of sky:

Clear.—When there are no clouds present, or less than one-tenth of the sky is covered by clouds. ["Total amount of sky covered by clouds" (TAC) always to be reported as 0 or 1.]

Scattered.—When from one-tenth to five-tenths, inclusive, of the sky is covered by clouds. ("TAC" always to be reported as 2, 3, or 4.)

Broken.—When more than five-tenths but not more than nine-tenths of the sky is covered by clouds. ("TAC" always to be reported as 4, 5, or 6.)

Overcast.—When more than nine-tenths of the sky is covered by clouds. ("TAC" always to be reported as 7 or 8.

NOTE.—The sky symbols given in the report will indicate whether a "scattered" or "broken" condition exists when "4" is reported as the code figure for the "total amount of sky covered by clouds," (TAC).

339. **Rules for Observing and Reporting Sky Conditions.**—Specific instructions for observing and reporting the sky conditions follow:

(a) *Point of observation.*—The observations will always be taken at a point from which a view of the entire sky may be had.

(b) *Estimating amounts of sky covered by clouds.*—"Scattered," "broken," and "overcast" describe cloudiness and are based on the total visible amount of cloudiness (as projected flatly against the dome of the sky) 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, if any, 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.

(c) *Reporting one layer of clouds.*—If all of 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," as explained later). The term to be used will be either "scattered clouds," "high scattered clouds," "broken clouds," "high broken clouds," "overcast," or "high overcast." 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" or "ceiling irregular" is to be used in such cases.

(d) *Use of modifying term "high."*—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.)

(e) *Use of modifying term "lower."*—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. For example, 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.

(f) *Reporting the sky condition when several layers of clouds are present.*—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 the 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. It is often convenient to divide all clouds that may be present into two main groups according to elevation—clouds 9,751 feet or higher above the station being called "high clouds" and those 9,750 or lower being called "low clouds." Since all "high" clouds are grouped into one layer when reporting the sky condition, the word "lower" when used in a combination of sky-condition terms will refer invariably to a layer of "low clouds."

(g) *Number of terms to be used in reporting the sky condition.*—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 336 (e).

(h) *Rules for determining terms to be used when two layers of clouds are present.*—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 338. If "overcast" is recorded and upper clouds are visible through breaks, this fact will be reported under "remarks" as "upper 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:

1. 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, with the "Total amount of sky covered by clouds" always to be reported as 2, 3, or 4. For example:

(a) *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.

2. 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, with the "total amount of sky covered by clouds" always to be reported as 4, 5, or 6. Examples:

(a) *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 paragraph (339 (h) 2) above.

(b) *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.

(c) *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.

3. If the total cloudiness contained in both upper and lower layers is more that nine-tenths, then only two possible combinations can be used, with the "total amount of sky covered by clouds" always being reported as 7 or 8. Examples:

(a) *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 (339 (h) 3) above.

(b) *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 (339 (h) 3) above.

(i) *Table of sky classifications.*—Table 1 classifies by cloud-layer amounts the combination sky conditions outlined in the foregoing paragraph (h). The values in the horizontal lines marked "U" represent tenths of sky visibly covered by the upper of two cloud layers, and in the lines marked "L" the tenths of sky covered by the lower of two cloud layers. The values in the line marked "B" indicate the amount of blue or open sky visible. If there are three layers, the lower two are combined in such cases into one amount and that considered in this table (as mentioned under (h) above) as the "L" or lower layer. If the "U" layer happens to be a layer above 9,750 feet, the modifier "HIGH" will be the first word of the combination term.

TABLE 1.—*Sky classifications*

(1) SCATTERED; LOWER SCATTERED CLOUDS, or HIGH SCATTERED, LOWER SCATTERED CLOUDS. (Ceiling always UNLIMITED. Altitude of "L" clouds entered on Form 1130 as directed in paragraph 336 (e)).

U —	4	3	3	2	2	2	1	1	1	1	Total cloudiness always 4/10 or less; "TAC" always to be reported as 2, 3, or 4.
L —	1	2	1	3	2	1	4	3	2	1	
B —	5	5	6	5	6	7	5	6	7	8	

(2) BROKEN, LOWER SCATTERED CLOUDS, or HIGH BROKEN, LOWER SCATTERED CLOUDS. (Ceiling is at the "U" cloud level. Height of "L" clouds reported as under (1) above.)

U —	8	7	7	6	6	6	5	5	5	5	4	4	4	4	3	3	3	2	2	1	Total cloudiness is always 5/10, 6/10, 7/10, or 8/10; "TAC" always to be reported as 4, 5, or 6.
L —	1	2	1	3	2	1	4	3	2	1	5	4	3	2	5	4	3	5	4	5	
B —	1	1	2	1	2	3	1	2	3	4	1	2	3	4	2	3	4	3	4	4	

(3) SCATTERED, LOWER BROKEN CLOUDS, or HIGH SCATTERED, LOWER BROKEN CLOUDS. (Ceiling is at the "L" cloud level.)

U —	3	2	2	1	1	1	Total cloudiness is always 3/10, 4/10, or 5/10. (See note below.) "TAC" always to be reported as 5 or 6.
L —	6	7	6	8	7	6	
B —	1	1	2	1	2	3	

151480—39——5

TABLE 1.—*Sky classifications*—Continued

(4) BROKEN, LOWER BROKEN CLOUDS, or HIGH BROKEN, LOWER BROKEN CLOUDS. (Ceiling is at the "L" cloud level.)

U — 3 2 2 1 1 1
L — 6 7 6 8 7 6 } Total cloudiness is always 7/10, 8/10, or 9/10; "TAC" always to be reported as 5 or 6.
B — 1 1 2 1 2 3

(5) OVERCAST, LOWER SCATTERED CLOUDS, or HIGH OVERCAST, LOWER SCATTERED CLOUDS. (Ceiling is at the "U" cloud level. Height of "L" clouds reported as under (1) above.)

U — 9 8 7 6 5
L — 1 2 3 4 5 } Total cloudiness always 10/10; "TAC" always reported as 7 or 8.
N — 0 0 0 0 0

(6) OVERCAST, LOWER BROKEN CLOUDS, or HIGH OVERCAST, LOWER BROKEN CLOUDS. (Ceiling is at the "L" cloud level.)

U — 4 3 2 1
L — 6 7 8 9 } Total cloudiness always 10/10; "TAC" always reported as 7 or 8.
B — 0 0 0 0

NOTE.—It should be noted that this grouping of cloud-layer amounts may also be termed BROKEN, LOWER BROKEN CLOUDS or HIGH BROKEN, LOWER BROKEN CLOUDS, and should usually be so termed unless the observer is quite sure that the upper layer of clouds is of very limited extent. A series of frequent observations will often show the extent of the upper cloud layer as the layer of lower broken clouds passes across it.

(j) *Use of special modifying terms.*—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 ugly, threatening appearance. These terms will be inserted following the altitude term, if any, and immediately preceding the cloudiness term proper. For example, "high thin overcast," "high overcast, lower thin broken clouds," "dark overcast," etc. If the clouds are noted to have an unusually rapid motion, or to be in a highly turbulent condition, proper entry of this fact should be made under "remarks." For example, "clouds moving rapidly," "clouds turbulent," etc.

(*k*) *Omission of sky condition.*—When dense or thick obstructions to vision or heavy precipitation, or combinations of these, are present and reduce the ceiling to zero and/or the visibility to ¼ mile or less, thus making the sky condition unobservable, no term will be employed in the report to represent the sky condition; that is, it will be omitted. The "total amount of sky covered by clouds" will always be reported as 9 in such cases.

XVI (D).—VISIBILITY

340. **Definition of Visibility.**—It is quite obvious that it is extremely important to a pilot to know how far he will be able to see during take-off, during the flight, and in landing at his terminal, since upon this, chiefly, will depend his ability to determine landmarks ahead and below, to see obstacles in time to avoid these, etc. To provide this information, the element known as "visibility" is included in airway weather reports. In the meaning of these instructions, the "VISIBILITY" IS THE MEAN GREATEST DISTANCE TOWARD THE HORIZON THAT PROMINENT OBJECTS, SUCH AS MOUNTAINS, BUILDINGS, TOWERS, ETC., CAN BE SEEN AND IDENTIFIED BY THE NORMAL EYE UNAIDED BY SPECIAL OPTICAL DEVICES, SUCH AS BINOCULARS, TELESCOPES, GLARE-ELIMINATING GOGGLES, ETC., AND WHICH DISTANCE MUST PREVAIL OVER A RANGE OF HALF OR MORE OF THE HORIZON. The above is postulated on the basis that if the eyes of the observer are deficient in any respect this will be corrected by proper eyeglasses.

341. **Table of Visibility Checking Points.**—In accordance with the foregoing, each station will have on public display a table of various prominent objects, observable from the usual observation point, which will be used to determine the visibility values. This table should include objects suitable for determining the visibility at night as well as by day.

(a) *Objects for determining visibility at night.*—The most suitable objects for determining visibility at night are moderate lights at known distances, the silhouettes of mountains or hills against the sky, etc. The brilliancy with which stars near the horizon can be observed may also be useful in this connection. The use of airway beacons as visibility checking points is not favored, as these have great penetrating power and often give values in excess of those actually existing. However, the "course light" (red or green) of such beacons, or any unfocussed light, may be used.

(b) *Objects for determining visibility during daylight.*—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.

342. **Reporting of Daylight Visibility as Compared With Night Visibility.**—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, any considerable 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 may cause some variation in the visibility between hours of daylight and darkness. It is preferable to determine visibility along a line nearly at right angles to the line of sight from the observer toward the sun or bright moon.

343. **Estimating Visibility From Appearances of Objects at Short Distances.**—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.

344. **Instructions for Observing and Reporting Visibility.**—Specific instructions for observing and reporting visibility follow:

(a) *Point of observation.*—All observations will be taken from a point where a view of the entire horizon may be had; or, if this is not practicable, the observer will move about in such manner as to obtain a view of the horizon in all directions. This observation point should be on the ground, if at all practicable; otherwise, at the lowest point above the surface at which a satisfactory observation can be made.

(b) *Visibility values to be reported.*—After viewing the horizon in all directions, if it is decided that the mean visibility is 10 miles or more (the "mean visibility" is the greatest average visibility prevailing over more than half of the horizon), a value will be entered on retained Form 1130–Aer., but no value will be included in the report as transmitted. If, however, the prevailing visibility is adjudged to be less than 10 miles, it will be reported to the nearest whole mile and/or fraction of miles, as follows: 0, ⅛, ¼, ⅜, ½, ¾, 1, 1¼, 1½, 2, 3, 4, 5, 6, 7, 8, 9, except that if the visibility exceeds 9½ miles, but is less than 10 miles, it will be reported as 9 miles. If the visibility falls half way between two of the above values, the lower will be used.

(c) *Reporting greater or less than the average visibility in specified directions.*—If the visibility toward any one-quarter of the horizon is twice or more, or half or less of the average visibility prevailing toward the other quarters, a remark to indicate this will be made, giving the direction from the station, and, if necessary to completely explain the condition, the cause thereof.

(d) *Reporting estimated visibility.*—If the actual visibility is evidently much greater than the distance of the farthest visible object, and such object is less than 10 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 10 miles or more, no value for the visibility will be included in the report; but if less than 10 miles, it will be reported to the nearest whole mile and/or fraction thereof. The letter "E" or the word "estimated" will *not* be used in the transmitted reports to show that the value is estimated.

(e) *Reporting fluctuating visibility.*—If the visibility is 2 miles or less and is changing or fluctuating rapidly, the visibility prevailing at the time of observation shall be reported, followed by the word "variable" in telegraphed or telephoned reports, and by the letter "V" in reports sent by teletype or radio.

345. **Importance of Accurate Observations of Visibility.**—In view of the importance of accurate information concerning visibility to the safety of flying, it is again impressed upon the observer that his observations of this element should be made with extreme care, particularly when the visibility is 2 miles or less.

XVI (E)—WEATHER

346. **Definition and Importance of "Weather."**—In the meaning of these instructions, THE "WEATHER" ELEMENT OF AN AIRWAY OBSERVATION CONSISTS OF THOSE PHENOMENA OCCURRING IN CONNECTION WITH ACTIVE OR IMMINENT PRECIPITATION, OR METEOROLOGICAL DISTURBANCES OF MORE OR LESS LOCALIZED EXTENT AND EFFECT. Therefore, the reporting of this element will include the occurrence of all rain, snow, sleet, hail, freezing rain, etc., and all thunderstorms, squalls, tornadoes, etc., observed at or from a particular station. Reports of the occurrence of the phenomena treated in this section are of importance to the pilot in order that he may be prepared for the lowering of visibility, accumulations of ice, rough air, etc., which may result. Observations of these phenomena are made visually without the aid of instruments, except where wind velocities are involved as a measure of intensity of the phenomenon in question, in which cases an anemometer is sometimes used.

347. **Instructions for Observing and Reporting Weather.**—The following will govern the observing and reporting of the "weather" element:

(*a*) *Point of observation.*—All observations of this element will be made from a point where a view of the entire sky and horizon can be had. If this is not entirely practicable, the observer is to move until a view of the entire sky and horizon has been obtained.

(*b*) *Position of "weather" data in report.*—When any "weather" phenomena are occurring they will be reported immediately following the visibility, or following the sky conditions if the visibility is not reported due to its being 10 miles or more.

(*c*) *Reports when weather conditions absent.*—When "weather" phenomena, as defined herein, are not occurring, no report will be made of this element. Conversely, the absence of "weather" phenomena is assumed unless they are included in the report.

(*d*) *Rules for reporting tornadoes.*—Tornadoes will be reported invariably as the first element under "Weather" whenever observed. They are recognized by their characteristic funnel-shaped cloud and the noise and destruction accompanying them. The 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 SW," "Tornado NW." (See description of this type of storm under fig. 1.)

(*e*) *Rules for reporting thunderstorms.*—1. Any thunderstorm in progress at time of observation shall be reported as the first element under "Weather," except when a tornado is also observable from or occurring at or near the station, in which case the tornado will be reported before any thunderstorm, as prescribed in paragraph 347 (*d*). A thunderstorm is considered to be "in progress at the time of observation" if thunder is heard or has been heard within 15 minutes preceding the time of that observation.

2. It is proper and desirable that under "Remarks" there shall appear information concerning the thunderstorm which will complete the word-picture already partly drawn by the elements of ceiling, sky, visibility, etc., but such remarks shall be in addition and not in lieu of the report of "thunderstorm" under "Weather." If the thunder is but slightly audible and the thunderstorm, therefore, fairly distant from the station, a remark, such as "Thunder distant southwest," should be made; if the thunderstorm is marked by a limited area of dark clouds, rain curtains, and the lightning is near and sharp, this condition will be clear to the recipient of the report if the proper degree of severity is shown under "Weather," and a remark, such as "storm rapidly approaching station," is made.

3. If lightning is observed, but no thunder is heard, this condition does not constitute a "thunderstorm in progress" nor one within the range of the observation station. This condition may be described under "Remarks," but the distinction must be made that a thunderstorm requires that thunder be heard, and a lightning storm, or the mere observation of lightning, does not occasion other remarks than those concerned with lightning.

4. The direction of movement of thunderstorms is usually difficult to observe, and more difficult the nearer the storm. Unless the observer is confident that the direction of movement has been accurately determined by him, the reports of the thunderstorm should show, in remarks, the direction in which the heaviest thunder is heard, together with any appropriate remark which will indicate the approach or retreat of the thunderstorm as to the station. Individual judgment and discretion by the observer will govern the use of the proper remarks. Such remarks as "Thunderstorm in NW, apparently approaching and increasing in intensity," are of value and appropriate, provided that the observer has carefully observed the action of the storm.

5. To obviate the difficulty occasionally involved at times when an observer sees considerable lightning fairly near to his station but cannot hear thunder, the use of appropriate remarks is proper. Here the description of the storm should never be

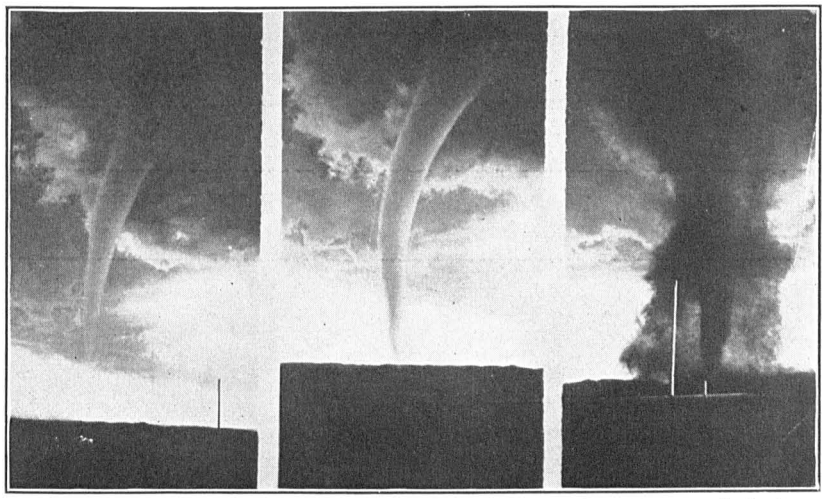


FIGURE 1.—Tornado forming and in progress. (Photographed by Mrs. Roy Homer at Gothenburg, Nebr., autumn, 1930.)

Left: Tornado cone forming. Center: Fully developed cone as it reached the earth. Right: Tornado striking farmhouse, which appears to explode.

given to contain the word "thunder" or "thunderstorm," but such descriptive terms as "dark," "frequent lightning," "thunderheads with lightning," "lightning and rainfall in west," should be used in remarks, and covers the cases where the observer strongly suspects a thunderstorm but has not the required fact of hearing thunder to permit the reporting of a thunderstorm. It should be borne in mind that the conditions of ceiling, sky, visibility, and weather usually show clearly what are the accompaniments to any thunderstorm properly reported. Thus, a condition of "scattered clouds" with fairly large visibility attending a "thunderstorm" clearly indicates the thunderstorm is at some distance from the station; similarly, a low ceiling and visibility with heavy precipitation is a condition accompanying a thunderstorm which is about over the station and surrounding it.

6. Care should be taken to describe a thunderstorm by use of the proper "degree of intensity." Most distant thunderstorms are obviously rated as "mild" so far as the station is concerned, but as soon as the storm reaches the station the intensity of it, which is determined by the accompanying conditions, as well as the electrical display, may be closely judged and should be reported as closely as possible in accordance with the following guide:

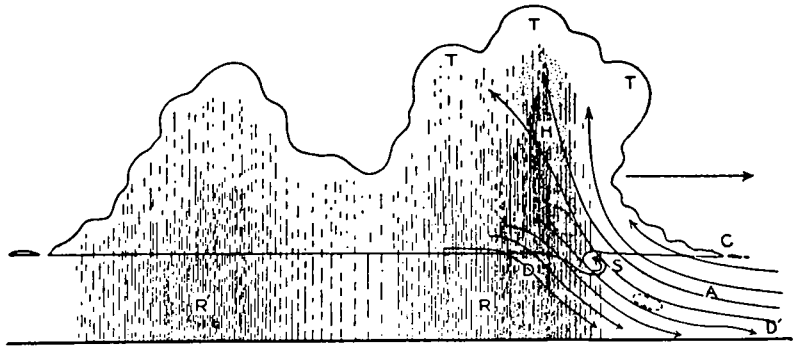


FIGURE 2.—Ideal cross section of a typical thunderstorm. *A*, ascending air; *D*, descending air; *C*, storm collar; *S*, roll scud; *D'*, wind gust; *H*, hail; *T*, thunderheads; *R*, primary rain; *R'*, secondary rain (after Humphreys).

TABLE 2.—*Thunderstorm intensity equivalents*

Degree of intensity	Specifications for estimating degree of intensity
Mild thunderstorm	When most of the lightning occurs within the cloud, and 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; 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.
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.
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 continue over a considerable time, a rapid drop in temperature occurs, possibly as much as 20° in 5 minutes.

NOTE.—The above is intended as a guide and not an absolute rule for determining intensities of thunderstorms. Obviously, with so many factors to consider it will depend largely upon the observer as to whether a storm is considered "mild," "moderate," or "severe," but he should make every effort to conform as far as possible with the above in making such classifications.

(*f*) *Identifying precipitation and estimating its degree of intensity.*—Identify precipitation and estimate its degree of intensity, when occurring, in accordance with the following table:

TABLE 3.—*Precipitation intensity equivalents*

Kind of precipitation	Degree-of-intensity term	Specifications for estimating degree of intensity
Rain.—The falling from clouds of drops of water (in the liquid state) in which most drops are larger—or if not larger, then much sparser—than the drops in drizzle; that is, diameter of most drops is greater than 1/50 inch (one and a quarter 64ths), they fall in still air faster than 10 feet per second.	Light (R−)	When the rate of fall per hour is from a trace to 0.10 inch (maximum 0.01 inch in 6 minutes).
	Moderate (R)	When the rate of fall per hour is from 0.11 to 0.30 inch (more than 0.01 inch to 0.03 inch in 6 minutes)
	Heavy (R+)	When the rate of fall per hour is over .30 inch (more than 0.03 inch in 6 minutes). NOTE.—The observer should practice estimating the degree of intensity of rain, using actual measurements as a check if possible, until he becomes proficient. If no method of actual measurement is available, then the observer shall estimate the intensity from the following criteria:

TABLE 3.—*Precipitation intensity equivalents*—Continued

Kind of precipitation	Degree-of-intensity term	Specifications for estimating degree of intensity
		Light rain.—Individual drops easily identifiable; no spray, or, at most, very slight spray, observable over pavements, roofs, etc.; puddles form very slowly; appreciable time, possibly over 2 minutes in cases of very light rain, required to wet pavements, roofs, and other dry surfaces; sound on roofs ranges from slow pattering to gentle swishing; trickles to steady small stream from gutters and downspouts. *Moderate rain.*—Individual drops not clearly identifiable; spray observable just above pavements, roofs, and other hard surfaces; puddles form fairly rapidly; downspouts on buildings run ⅛ to ½ full; sound on roofs ranges from swishing to gentle roar. *Heavy rain.*—Rain seemingly falling in sheets, individual drops not identifiable; heavy spray to height of several inches observable on roofs, pavements, etc.; downspouts on buildings run ½ to full or overflowing; puddles form rapidly; visibility impaired; sound on roofs resembles roll of drums or distinct roar.
Freezing rain.—The falling from clouds of rain which instantly freezes to objects in the open which it strikes thus generally forming glaze. At the surface, however, the fall may be so rapid that run-off occurs as in the case of rain. This condition should not be confused with sleet (ice pellets).	Light (ZR−).....	Same as "light rain."
	Moderate (ZR).....	Same as "moderate rain."
	Heavy (ZR+).....	Same as "heavy rain." NOTE.—The degree of intensity of any type of rain will invariably be ascribed on a "rate-of-fall" basis, when occurring alone, or in combination with any other form of precipitation or in combination with any obstructions to vision.
Drizzle.— Uniform falling from clouds of minute (diameter less than 1/50 inch (one and one-quarter 64ths)) and very numerous drops, which seem almost to float in the air, and thereby visibly follow even slight motion of the air. Should always be distinguished from light rain. (Designated in past issues of Circular N as "mist.")	Light (L−).....	When drizzle is occurring *alone*, and objects are distinguishable at 1¼ miles or more.
	Moderate (L).....	When drizzle is occurring *alone*, and objects are distinguishable at ⅝ but not at 1¼ miles. Visibility to be reported as ¾ or 1 mile.
	Heavy (L+).....	When drizzle is occurring *alone*, and objects are distinguishable at 1/16 mile but not at ⅛ mile. Visibility to be reported as ¼ mile. NOTE.—If drizzle is occurring with fog or any other vision-obscuring element, which prevents judging its intensity on the basis of the prevailing visibility, then the degree of intensity of the drizzle will be adjudged by the observer as well as possible on a "rate-of-fall" basis, and the intensity ascribed to the other element will be in accordance with the prevailing visibility. For example, the observer adjudges "light drizzle" to be occurring with fog present and the visibility ¼ mile, report "light drizzle, thick fog;" the observer adjudges "heavy drizzle" to be occurring with smoke present and the visibility ¼ mile, report "heavy drizzle, thick smoke," etc.

TABLE 3.—*Precipitation intensity equivalents*—Continued

Kind of precipitation	Degree-of-intensity term	Specifications for estimating degree of intensity
Freezing drizzle.—Same as "drizzle," except droplets instantly freeze to objects in the open which they strike, forming glaze or frost.	Light ZL−)	Same as "light drizzle."
	Moderate (ZL)	Same as "moderate drizzle."
	Heavy (ZL+)	Same as "heavy drizzle."
Snow.—The falling from clouds of white or translucent ice crystals, mainly in branched hexagonal shapes ("stars"), often mixed with simple ice crystals.	Light (S−)	When snow is occurring *alone* and objects are distinguishable at ⅝ mile or more. Visibility to be reported as ¾ mile or more.
	Moderate (S)	When snow is occurring *alone* and objects are distinguishable at 5/16 mile but not at ⅝ mile. Visibility to be reported at ½ mile.
	Heavy (S+)	When snow is occurring *alone* and objects are not distinguishable at 5/16 mile. Visibility to be reported as ¼, ⅛, or zero miles. NOTE.—If snow is occurring with fog, smoke, or any other vision-obscuring element which prevents judging its intensity on the basis of the prevailing visibility, then the degree of intensity of the snow will be adjudged by the observer as well as possible on a "rate-of-fall" basis, and the intensity of the other element will be in accordance with the prevailing visibility. In doing this, the rate of fall of "light snow" would constitute little or very slow accumulation on ground, "moderate snow" mod-

TABLE 3.—*Precipitation intensity equivalents*—Continued

Kind of precipitation	Degree-of-intensity term	Specifications for estimating degree of intensity
Small hail.—Semitransparent, round or conical grains of frozen water, generally consisting of a grain of soft hail as nucleus, with a very thin ice layer around it, which gives them a glazed appearance; they are not easily compressible or crisp, and even when falling on hard ground, do not generally rebound or burst. They are wet, because they mostly fall at temperatures above freezing.	Light (AP−) Moderate (AP) Heavy (AP+)	Same as "light hail." Same as "moderate hail." Same as "heavy hail."
Showers (rain or snow).—Refer to paragraph (*i*) below for rules regarding showers.	Light ((R or S) W−) Moderate ((R or S) W). Heavy ((R or S) W+).	Same as "light rain" or "light snow." Same as "moderate rain" or 'moderate snow." Same as "heavy rain" or "heavy snow."

NOTE.—Letters in parentheses following the "degree-of-intensity" terms, are the teletype symbols for the phenomenon in question.

(*g*) *Times when precipitation is to be reported.*—Precipitation will always be reported when occurring. When this is in connection with thunderstorms or tornadoes it will be reported under "Weather," in addition to—not in place of—that phenomenon, the tornado and/or thunderstorm being placed first.

(*h*) *Reporting precipitation when two or more types are occurring together.*—When any two or more types of precipitation listed in table 3 above are falling together at the time of observation, all will be reported, the predominating type being placed first and the lesser type(s) following this. In such cases the degree of intensity ascribed to each type occurring in the combination, irrespective of whether or not any of these are defined in terms of visibility when occurring alone, will be determined on a "rate-of-fall" basis as provided for in table 3 above to the best of the observer's ability. For example, if snow and rain are occurring together, the visibility being ½ mile, and the observer adjudges on a "rate-of-fall" basis that the snow is "light" and the rain is heavy, report "heavy rain, light snow." If a 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 remarks will be included concerning the other. For example, "snow occasionally mixed with rain."

(*i*) *Rules for reporting showers.*—Showers are characterized by the suddenness with which the precipitation (rain, snow, snow pellets, etc.) starts or stops and its rapid changes of intensity; but, also, by the aspect of the sky—rapid changes between dark, threatening clouds and clearings of the sky (of short duration, often with an intensely blue sky). Sometimes no definite clearing occurs between the showers, or the precipitation does not even stop entirely between them; the shower character of the precipitation is then revealed by the more or less rapid alterations of lighter and darker clouds. When such conditions occur this shall be indicated by entry of the word or symbol for the type of precipitation, followed by the word, or symbol for "showers." In telegraphed reports the degree of intensity will be given preceding the type of precipitation. For example, "heavy snow showers" (the intensity applies to the precipitation in the showers), while in teletype or radio reports the intensity will be indicated by a minus sign for "light" and a plus sign for "heavy" immediately following the shower symbol, the symbol itself standing for "moderate" precipitation; for example, "RW+" "heavy rain showers." Showers are not to be confused with squalls, as gusty winds ordinarily do not occur. "Sprinkling" of the shower type will be reported as "light rain showers." (A "snow shower" is the same as what is popularly termed a "snow flurry.")

(*j*) *Observations of fog with heavy snow.*—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 snow; rime then invariably results and is a hazardous flight condition, mostly confined to mountain ridges.

(*k*) *Rules for reporting snow or rain squalls.*—These will be reported under "Weather," following any other "weather" phenomena that may be included in that particular report. As the names imply, these conditions are intermittent, but when occurring they indicate an important state of turbulence near the surface. If it is snowing, sleeting, or raining at the time of observation and squalls have been experienced at the station within the past 15 minutes, the rain or snow will be entered in the report in the prescribed manner, followed by a report of the squalls, e. g., "Fifteen hundred, overcast, five, moderate rain, severe rain squalls." If it is not raining or snowing at the time of observation, but this is occurring intermittently and squalls have occurred at the station within the past 15 minutes, rain or snow squalls will be reported under "Weather" as a current condition. For example, "Fifteen hundred, overcast, five, severe snow squalls, ———." Entries of squalls under "Weather" in the report proper will be made only when these are occurring at the station itself. Squalls observed to be occurring at some distance from the station, such as over lakes or mountain ridges, or squalls which are observed to be approaching the station but which have not reached there, will be reported only under "Remarks." "Squalls" will be reported in accordance with the degrees of intensity given below, when brief falls of rain or snow, or brief intensifications of occurring rain or snow, accompanied by fresh or strong gusts of wind but not attended by thunderstorm conditions, occur:

TABLE 4.—*Squall-intensity equivalents*

Type of squall	Degree of intensity term	Specifications for estimating degree of intensity
Rain squall	Mild (RQ−)	When the gusts do not exceed a velocity of 24 miles per hour.
	Moderate (RQ)	When the gusts do not exceed a velocity of 39 miles per hour.
	Severe (RQ+)	When the gusts exceed a velocity of 39 miles per hour.
Snow squall	Mild (SQ−)	When the gusts do not exceed a velocity of 24 miles per hour.
	Moderate (SQ)	When the gusts do not exceed a velocity of 39 miles per hour.
	Severe (SQ+)	When the gusts exceed a velocity of 39 miles per hour.

(*l*) *Gust velocities to be used as final criterion in estimating degree of intensity of squalls.*—If it should occur that the precipitation occurring with the squall was "light," while the gust velocities would indicate a classification of "severe" for the squall, or any other combination along these lines should occur, then the gust velocities will be used as the criterion for classification of the degree of intensity of the squall. For example, in the case given above, the squall would be classed as "severe."

(*m*) *Reporting two or more types of precipitation in squalls.*—If two or more kinds of precipitation occur together with the squalls, the predominating type will be given for classification of the squall in the body of the report and a proper note made under "Remarks" concerning the other type or types of precipitation; for example, if rain and snow occurred together, with rain predominating, then rain squalls would be reported in the body of the report, and a remark, such as "snow mixed with rain in squalls," would be added to the report.

(*n*) *Description and rules for reporting wind shifts.*—These are to be reported immediately following the last element of "wind" data whenever the wind has suddenly shifted from a southerly or easterly to a westerly or northerly quadrant, accompanied by gusty winds, rapid dew-point and/or temperature drop, and, in summer, usually lightning and thunder, and possibly hail, intense rain; and in winter, snow squalls at frequent intervals and a rapid lowering or lifting of the ceiling. A westerly or northwesterly wind will continue to blow steadily after it has passed, and the sky will usually

clear rapidly and the air feel dryer and cooler, 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 will not be missed. Likewise, if in a mountainous country, cloudiness increases, ceiling lowers, precipitation begins or increases markedly, the dew point—and usually 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. At hourly weather-reporting stations the occurrence of a wind shift will always be the occasion for a special report, while at stations not making special reports the occurrence of a wind shift within the past 6 hours will be reported in the next regular report. In making reports of wind shifts, give the intensity and the direction the wind was blowing from prior to the shift, followed by the words "wind shift" and the local time on the 24-hour clock, and local time zone; for example, "severe south wind shift fourteen thirty eastern standard." Identify and report wind shifts in the following three degrees:

TABLE 5.—*Wind-shift intensity equivalents*

Kind of wind shift	Specifications for estimating degree of intensity
Mild	(*a*) When precipitation and a lowering of the ceiling occur and the maximum velocity of the wind gusts accompanying the shift does not exceed 24 miles per hour. (*b*) When precipitation and lowering of ceiling do *not* occur and the maximum velocity of the gusts does not exceed 34 miles per hour.
Moderate	(*a*) When precipitation and a lowering of the ceiling occur and the maximum velocity of the wind gust accompanying the shift exceeds 24 miles per hour but does not exceed 39 miles per hour. (*b*) When precipitation and lowering of ceiling do not occur and the maximum velocity of the gusts exceeds 34 miles per hour but does *not* exceed 49 miles per hour.
Severe	(*a*) When precipitation and lowering of the ceiling occur and the maximum velocity of the wind gusts accompanying the shift exceeds 39 miles per hour. (*b*) When precipitation and a lowering of the ceiling do *not* occur and the maximum velocity of the gusts exceeds 49 miles per hour.

NOTE.—There are, of course, other criteria, such as intensity of precipitation, severity of thunderstorms, rapidity with which ceiling and visibility are altered, etc., upon which to base an estimate of the intensity of wind shifts. However, these, in nearly every case, are subordinate to the turbulence and wind occurring in a shift and cannot be used without exception and reservation as absolute factors for determining its intensity.

XVI (F)—OBSTRUCTIONS TO VISION

348. **Definition of Obstructions to Vision.**—It is commonly known that distant objects are more clearly seen at some times than at others, the degree of this varying quite widely. CONDITIONS CAUSING LIMITATION OF VISION ARE DESIGNATED AS "OBSTRUCTIONS TO VISION," in the meaning of these instructions.

349. **Precipitation as an Obstruction to Vision.**—From the foregoing it will be seen that, strictly speaking, any form of precipitation is an obstruction to vision. When, therefore, precipitation is reported to be occuring with no other vision-limiting factor being reported it will be assumed by all using the report that the precipitation is the only obstruction to vision present. Strict agreement of any type of obstruction to vision or of any type of precipitation defined in terms of visibility with the visibility reported is required when each is occurring alone.

350. **Use of Instruments in Observing Obstructions to Vision.**—All observations of obstructions to vision are made without the aid of instruments.

351. **Rules for Observing and Reporting Obstructions to Vision.**—Obstructions to vision are to be observed and reported, when appropriate, immediately following "Weather" or following "Visibility" if no "Weather" is reported, in accordance with the following:

(*a*) *Point of observation.*—All observations will be taken at a point on the ground from which a view in all directions may be had. If this is not possible, then the observations should be taken from the lowest elevation possible, and the observer should move about until he has had a clear view in all directions.

(*b*) *Reporting obstructions to vision when prevailing visibility is more than 6 miles.*—If the visibility is more than 6 miles over most of the horizon, no mention should be made under "obstructions to vision" of any obstructions present, except that if the visibility is 6 miles or less in one or more directions and this is one-half or less than the average in all directions, this fact will be reported under "Remarks," e. g., "Fog bank southeast, visibility 2," "Visibility 3 north, smoke," etc.

(*c*) *Reporting obstructions to vision when prevailing visibility is 6 miles or less.*—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."

(*d*) *Identifying and reporting types and degrees of intensity of obstructions to vision.*—Identify and report "obstructions to vision" when these are occurring in accordance with the following table. 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, the "ceiling" shall be reported as "zero."

TABLE 6.—*Obstructions to vision intensity equivalents*

Kind of obstruction	Term to be used in reporting	Specifications for estimating degree of intensity
Dry haze.—Dust or salt particles which are dry and so extremely small that they cannot be felt or discovered individually by the unaided eye; however they diminish the visibility and give a characteristic smoky (hazy and opalescent) appearance to the air. This phenomenon produces a uniform veil over the landscape and subdues its colors. This veil has a bluish tinge when viewed against a dark background such as a mountain, but has a dirty yellow or orange tinge against a bright background, such as the sun, clouds at the horizon, or snow-capped mountain peaks. It is thus distinguished from grayish light fog, the thickness of which it may sometimes attain.	Hazy (H)----------	When there is an obstruction to vision present which limits the visibility to 6 miles or less and which cannot be identified as any other obstruction to vision, such as, smoke, dust, fog, etc.
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. Smoke from a distance, such as from forest fires, usually is of light grayish or bluish color and evenly distributed in the upper air. City smoke may be brown, dark gray, or black.	Light (K−)--------	When smoke is present *alone* and objects are visible at 1¼ miles or more.
	Moderate (K)-------	When smoke is present *alone*, and objects are visible at ⅝ but not at 1¼ miles. Visibility to be reported as ¾ or 1 mile.
	Thick (K+)--------	When smoke is present *alone* and objects are not visible at ⅝ mile, visibility to be reported as ½, ¼, ⅛, ⅛, or zero miles.

TABLE 6.—*Obstructions to vision intensity 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, but not being picked up from the surface locally, 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 has perhaps a yellow tinge at all periods of the day. Depositions of dust may be observed on shiny surfaces and when rain or drizzle occur, a muddy residue on car finishes, windows, etc., may be noted.	Light (D−)	When dust is present *alone* and objects are visible at 1¼ miles or more.
	Moderate (D)	When dust is present *alone* and objects are visible at ⅝ but not at 1¼ miles. Visibility to be reported as ¾ or 1 mile.
	Thick (D+)	When dust is present alone and objects are not visible at ⅝ mile. Visibility to be reported as ½, ¼, ⅛, 1/16, or zero miles.
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. The snow is carried so high that the vertical visibility is reduced considerably.	Light (BS−)	When the condition described is occurring *alone* and objects are visible at ⅝ mile or more.
	Moderate (BS)	When the condition described is occurring *alone* and objects are visible at 5/16 but not at ⅝ mile. Visibility to be reported as ½ mile.
	Thick (BS+)	When the condition described is occurring *alone* and objects are not visible at 5/16 mile. Visibility to be reported as ¼, ⅛, 1/16, or zero miles.
Drifting snow.—Snow raised from the ground and carried by the wind, so that the horizontal visibility becomes reduced although no real precipitation is falling. The snow is drifting so low above the ground that the vertical visibility is not appreciably diminished. (Distinguished from "blowing snow" by the vertical visibility.)	Light drifting snow (GS−).	Same as "light blowing snow."
	Moderate drifting snow (GS).	Same as "moderate blowing snow."
	Thick drifting snow (GS+).	Same as "thick blowing snow."
Blowing dust.—When dust is picked up from the surface by the wind and blown about in clouds or sheets.	Light (BD−)	Same as "light dust."
	Moderate (BD)	Same as "moderate dust."
	Thick (BD+) [1]	Same as "thick dust."
Blowing sand.—When sand is picked up from the surface by the wind and blown about in clouds or sheets.	Light (BN−)	Same as "light dust."
	Moderate (BN)	Same as "moderate dust."
	Thick (BN+) [1]	Same as "thick dust."
Damp haze.—Small water droplets or very hygroscopic particles suspended in the atmosphere, but the horizontal range of visibility is usually considerably more than 1¼ miles. Similar to a very thin fog, but the droplets or particles are more scattered than in light fog and presumably also smaller. This phenomenon is usually distinguished from dry haze by its grayish color, the "greasy" appearance of clouds seen through it as though viewed through a dirty window pane, and the generally high relative humidity. Commonly observed on seacoasts and in Southern States, most frequently with onshore winds and in the vicinity of tropical disturbances.	Damp haze (F−−)	Same as "dry haze."

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

TABLE 6.—*Obstructions to vision intensity equivalents*—Continued

Kind of obstruction	Term to be used in reporting	Specifications for estimating degree of intensity
Fog.—Water vapor condensed to minute water droplets 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 by its essential wetness.	Light (F−)	When fog is present *alone* and objects are visible at ⅝ mile or more. Visibility to be reported as ¾, 1, 1¼, 1½, etc., miles.
	Moderate (F)	When fog is present *alone* and objects are visible at 5/16 mile but not at ⅝ mile. Visibility to be reported as ½ mile.
	Thick (F+)	When fog is present alone and objects are visible at ⅛ mile but not at 5/16 mile. Visibility to be reported as ¼ or ⅛ mile.
	Dense (FF)	When fog is present *alone* and objects are not visible at ⅛ mile. Visibility to be reported as ⅛ or zero miles
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 most frequent in the higher latitudes. Sun usually visible but horizontal visibility considerably restricted. Colloquially termed "frost in air," "frozen fog," etc.	Light (IF−)	Same as "light fog."
	Moderate (IF)	Same as "moderate fog."
	Thick (IF+)	Same as "thick fog."
	Dense (IFF)	Same as "dense fog." NOTE.—If "sky" is given with "dense ice fog," it will be understood that the condition is similar to "dense ground 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 (GF−)	Same as "light fog."
	Moderate (GF)	Same as "moderate fog."
	Thick (GF+)	Same as "thick fog."
	Dense (GFF)	Same as "dense fog." NOTE.—"Alone" as used in the above specifications means that no precipitation of any type, or any other type of obstruction to vision is occurring in combination with the condition described.

NOTE.—If haze, smoke, or dust is observed aloft 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.

(*e*) *Method of reporting combinations of obstructions to vision (including precipitation).*—When combinations of obstructions to vision (including precipitation) occur, the following rules will apply:

1. If two obstructions are present, one being precipitation, both will be reported (the precipitation being entered first), with the intensity ascribed to the precipitation being determined on a "rate-of-fall" basis, irrespective of whether or not its degrees of intensity (see table 3) are defined in terms of visibility. The degree of intensity then ascribed to the obstruction to vision shall correspond to the prevailing visibility. For example, if the observer adjudges on a "rate-of-fall" basis that "light snow" is falling, and fog is occurring, with the visibility being one-fourth mile, then he would report "light snow, thick fog."

2. The same rules as given under "1" above would apply in cases where three types of obstructions were occurring together, two being precipitation. For example, with rain and snow falling together, fog present, and the visibility being one-fifth mile, the observer adjudges on a "rate-of-fall" basis that the rain is "light" and the snow "moderate," he would report "light rain, moderate snow, thick fog."

3. If two types of obstructions to vision are occurring together, neither of them being precipitation, both will be reported, the predominating type being placed first, the lesser type following this, with the degree of intensity ascribed to the predominant type corresponding to the prevailing visibility and that ascribed to the lesser type being judged as well as possible by the observer from actual observation of the condition. For example, if fog and smoke are occurring together, fog being the predominant type, and there is smoke mixed with the fog, which the observer judges to be "light," the visibility being one-half mile, he would report "moderate fog, light smoke."

352. **Importance of Proper Reporting of Fog.**—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.

353. **Relation of Fog and Dew Point.**—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 dew point exceeds 4°. This is particularly true as regards the formation stage of fog.

XVI (G).—TEMPERATURE

NOTE.—Meteorological sea-level barometric pressure will be entered in reports ahead of temperature. Instructions concerning obtaining and reporting it will be found beginning on page 53, paragraph 364.

354. **Importance and Definition of Temperature.**—The temperature of the air is of interest and importance in flying operations from the viewpoint of determining whether icing conditions will exist, determining the mixture ratios for operation of aircraft engines in taking off and landing, being prepared for slow or fast landings according to whether the air immediately over the airport is unusually heated and rarefied or unusually cold and dense, etc. Also, it is extremely important in airway and other forecasting work. Accordingly, it is essential that it be observed and reported properly. For the purpose of these instructions, the TEMPERATURE IS DEFINED AS THE CONDITION OF THE AIR WITH RESPECT TO HEAT, I. E., THE DEGREE OF HEAT EXPRESSED IN FIGURES.

355. **Method of Measuring Temperature.**—Temperature is measured for use in airway weather reports by readings 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.

356. **Instructions for Observing and Reporting Temperature.**—The following instructions will govern the observing and reporting of the temperature element:

(*a*) *Method of obtaining temperature from readings of thermometer.*—The thermometer will be read to degrees and *tenths* of a degree, the number of tenths to be determined from eye estimate by the observer. In doing this it is highly important, in the interest of accurate readings, that the eye of the observer be on a line perpendicular to the thermometer at the top of the mercury or alcohol column. If this is not done erroneous readings up to one-half degree or more will result, owing to the foreshortening of the column when seen from any considerable angle. In determining the temperature indicated by the thermometer, the following two rules will apply:

1. *When the temperature is above zero,* estimate the number of tenths, if any, 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, if any, 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*) *Methods of applying instrumental corrections to thermometer readings.*—The above rules will apply to the readings 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. However, a correction for instrumental error must be applied

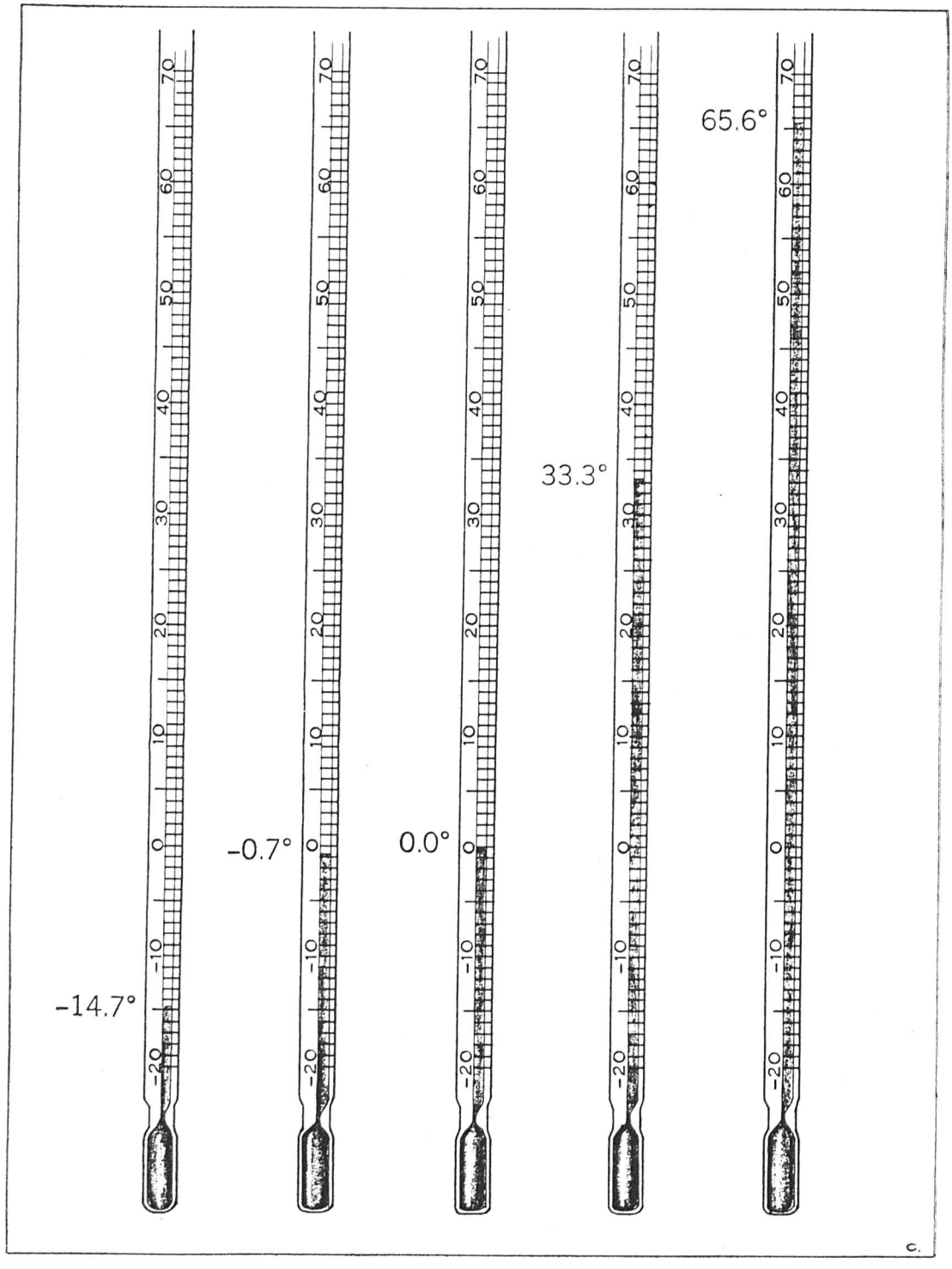


FIGURE 3.—Illustrating five different readings of the thermometer.

to mercurial or alcohol thermometers under certain conditions, irrespective of whether used as a wet- or dry-bulb thermometer, in order that the readings 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 a 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 359 (*i*).)

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 signs are to be added, the temperature would be −8.2° plus −1.2° which equals −9.4°.

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°, or approximately 0.047 per degree. For 7° range it is, from the foregoing, about −0.3° (7×0.047=0.329). 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*) *Method of entering temperature data on forms and in reports.*—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 1083–Met'l, 1001–Met'l, 1001A–Met'l, and 1135–Aer., when used, in degrees and tenths, and on Form 1130–Aer. in degrees and tenths in the special columns provided for this, with entry to whole degrees being made in the "temperature and dew point" column in the body of the report. In transmitted reports, temperature shall be entered to the nearest whole degree. For example, in transmitted reports or in the "temperature and dew point" column of Form 1130 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, for example, 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.

151480—39——7

(*d*) *Indicating below-zero temperatures in reports and on forms.*—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*) *Indicating "zero" temperature in reports and on forms.*—"Zero" temperature will be reported as the word "zero" in telegrams and the figure naught (0) on all forms and in transmission by teletype (or "0.0" where the temperature is required to be entered in tenths.)

(*f*) *Stations which are to report temperature.*—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.

XVI (H).—DEW POINT

357. **Importance and Definition of Dew Point.**—Knowledge of the moisture content of the air is of extreme importance to forecasters, pilots, and others in anticipating the formation of fog, thunderstorms, cloudiness, etc. In airway weather reports such information is contained in an element known as the "dew point." THE DEW POINT IS THAT TEMPERATURE TO WHICH A GIVEN MIXED VOLUME OF AIR AND 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, FOG, FROST, CLOUDS, OR PRECIPITATION.

358. **Instruments Used in Determining the Dew Point.**—The dew point is determined from the readings of ventilated wet- and dry-bulb psychrometers.

359. **Rules for Observing, Computing, and Reporting Dew Point.**—Instructions for reading the wet- and dry-bulb thermometers and computing and reporting the dew point follow:

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

(b) *Cloth on wet bulb required to be clean.*—The cloth or muslin on the wet bulb of such psychrometers 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.

(c) *Use of psychrometer when temperature is above freezing.*—When the temperature is above the freezing point (32° F.) the cloth around the wet bulb will ordinarily be moistened *just prior* to the taking of a reading. However, 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, and will insure a true reading which, of course, would not be possible if the cloth were dried out before the necessary whirling was completed.

(d) *Use of psychrometer when temperature is at or below freezing.*—When the current temperature *is at or below the freezing point* (32° F.) 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 tempera-

ture 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 time, 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, and that proper instrumental corrections are applied to readings of both thermometers.

(e) *Dew point temperature when no depression of the wet bulb can be obtained.*—During a dense or moderate fog it will often be found that, after proper instrumental corrections have been applied to the readings, no depression of the wet-bulb thermometer results. In such cases the temperature of the dew point is the same as the current temperature and will be reported as the same.

(f) *Lowest possible readings of wet- and dry-bulb thermometers required.*—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.

(g) *Rules for reading thermometer and obtaining depression of the wet bulb.*—The thermometers will then be read to tenths of a degree and proper instrumental corrections applied to the readings, as directed in the chapter on "temperature," 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 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 thermometer without regard to sign; for example, 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 bulbs reads —3.4° and the wet bulb reads —4.7°, then the depression would be 4.7 minus 3.4°, or 1.3°.

(h) *Obtaining the dew point from the psychrometric tables.*—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 correspond with a value given at the top and at the left of the tables, respectively. 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 between* values given at the left and top of the tables, respectively, requiring interpolation to secure the correct result.

(i) *Interpolating between values given in psychrometric tables.*—"Interpolation" is the process of obtaining values that lie between the values given in the tables and falls into two classes, namely, double and single. If the observer is familiar with the process of double interpolation it should be used by him when required by the circumstances surrounding the determination of the dew point. If the observer is not familiar with this process, which merely involves interpolating between two values previously obtained by "single" interpolation he will be given thorough instruction upon the next visit of a Weather Bureau inspector, but, in the meantime, 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 359(h). For example, let us assume that the following values are involved:

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

Air temperature (degrees)	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 value at the intersection of the two lines of figures 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, in accordance with previous instructions herein, be included in the report as 40°.

(j) *Obtaining dew-point values by use of single interpolations.*—If one of the values obtained, that is, 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 figure, as may be proper.

Examples:

1. Temperature ..... 44. 0°
   Depression of wet bulb ..... 2. 3°
   (See table given in paragraph 359 (i).)

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 paragraph 359 (i).)	

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 of 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 paragraph 359 (i) 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 XVI (G), 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 remains unchanged, of course, when using tables for any other pressure.

360. **Practice in Obtaining Dew Points From Tables.**—In studying the examples given in paragraph 359, the observer should have a table of dew points at hand for reference and study, as the actual working of the methods explained therein can not 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.

361. **Reading Thermometers Accurately to Tenths Required.**—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.

XVI (I).—WIND

(Direction, velocity, character)

362. **Importance and Definition of Wind.**—Data concerning the direction, velocity, and character of air, moving horizontally, is of importance to the pilot in determining take-off and landing procedure, and as an indication of wind that he may encounter aloft; and to the forecaster in preparing airway and other forecasts. Therefore, it is necessary that a report of the wind element be included in every airway observation. For purposes of identification in these instructions, WIND IS THE HORIZONTAL, OR NEARLY HORIZONTAL, NATURAL MOVEMENT OF AIR, that is, AIR NATURALLY IN HORIZONTAL MOTION WITH ANY DEGREE OF VELOCITY. Vertical movements of air are not considered as wind but as "air currents."

363. **Rules for Observing and Reporting Wind.**—The following instructions will govern the observing and reporting of the wind element:

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

(*b*) *Method to be used in reporting "direction of wind."*—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.

151480—39——8

(c) *Estimating the "direction of wind" when the station is not equipped with wind instruments.*—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) *Determining the wind direction from wind-direction indicators.*—Stations equipped with 4-point-wind-direction indicators can easily obtain the intermediate directions by observations of the indicator during the taking of a reading. For example, 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. With the 8-point direction indicator it is possible to get an even more definite refinement of direction.

(e) *Method of determining wind velocity with instruments.*—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-indicators, 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 7. Buzzes will *always* be counted over periods of 1 minute, as doing this over shorter periods is certain to result in inaccurate wind-velocity values in practically all cases.

TABLE 7.—*Corrections for indicated wind velocities*

VELOCITIES INDICATED				
By 3-cup anemometer, m. p. h.	By 4-cup anemometer, m. p. h.	By 4-cup anemometer with beaded cups, m. p. h.	By small airway anemometer, m. p. h.	Corrections in whole miles per hour
0 to 16 [1]	0 to 8	0 to 5	0 to 35	+1
17 to 26	9 to 12	6 to 13	35 to 57	0
27 to 35	13 to 16	14 to 20	(Corrections under higher velocities not yet determined; use zero.)	−1
36 to 44	17 to 20	21 to 27		−2
45 to 52	21 to 24	28 to 34		−3
53 to 61	25 to 28	35 to 41		−4
62 to 70	29 to 32	42 to 48		−5
71 to 79	33 to 36	49 to 55		−6
80 to 87	37 to 39	56 to 62		−7
88 to 96	40 to 43	63 to 69		−8
97 to 105	44 to 47	70 to 75		−9
106 to 114	48 to 51	76 to 82		−10
115 to 122	52 to 54	83 to 89		−11
123 to 132	55 to 58	90 to 96		−12
133 to 139	59 to 62	97 to 103		−13
140 to 149	63 to 65	104 to 110		−14
150 to 157	66 to 69	111 to 117		−15
158 to 166	70 o 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

[1] Inconsequential variation from the rule for disposal of decimals disregarded at 2 and 4 m. p. h. Reprint from Instructions No. 1, 1935.

TABLE 7.—*Corrections for indicated wind velocities*—Continued

By 3-cup anemometer, m. p. h.	By 4-cup anemometer, m. p. h.	By 4-cup anemometer with beaded cups, m. p. h.	By small airway anemometer, m. p. h.	Corrections in whole miles per hour
	122 to 125			−30
	126 to 128			−31
	129 to 132			−32
	133 to 136			−33
	137 to 140			−34
	141 to 143			−35

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.

(*f*) *Method of estimating wind velocity.*—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 8.—*Wind velocity equivalents*

Descriptive word[1]	Velocity (miles per hour)	Specifications for estimating velocities
Calm	Less than 1	Smoke rises vertically.
	1 to 3	Direction of wind shown by smoke drift but not by wind vanes.
Light	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 sway; crested wavelets form on inland waters.
	25 to 31	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
Strong	32 to 38	Whole trees in motion; inconvenience felt in walking against the wind.
	39 to 46	Breaks twigs off trees; generally impedes progress.
Gale	47 to 54	Slight structural damage occurs (chimney pots and slate removed).
	55 to 63	Trees uprooted; considerable structural damage occurs.
Whole gale	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.

(*g*) *Determining and reporting zero wind velocities (calms).*—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."

(*h*) *Method of indicating estimated velocities in reports and on form 1130.*—If necessary to estimate the wind velocity as outlined, this will be indicated by the entry of the word "estimated," immediately following the velocity in reports made by telephone or telegraph and by entry of the letter "E" after the velocity in teletype and radio reports. Such entries would also be made on Form 1130.

(*i*) *Method of Indicating Character of Wind in Reports and on form 1130.*—The *character* of the wind will be indicated immediately following the velocity, when appropriate, in reports and on Form 1130 by use of the following terms:

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

2. *Strong gusts*, when sudden, intermittent increases in velocity reach 25 or more miles per hour, with variations in velocity of 10 miles per hour or more.

(*j*) *Determining degree of gustiness.*—It should be kept in mind when reporting gusts that the velocity of the wind at the peak of the gusts determines whether the gustiness will be reported as "fresh" or "strong." Further, gusts should never be reported, no matter what the velocity, unless the peak velocity is 10 miles per hour, or more, greater than the velocity between gusts. For example, if the velocity is 19 to 24 miles per hour at the *peak* of gusts, the gustiness will be "fresh," and if the velocity is 25 miles per hour or more at the *peak* of gusts, the gustiness will be "strong." The velocity will be reported in each case as that recorded at the observation, the type of gustiness will be determined by the velocity at the peak of gusts, and no gustiness will be reported unless there is a fluctuation in velocity of 10 miles per hour, or more. Unless the station is equipped with the pressure type of wind-velocity indicator it will be necessary for the observer to employ a great deal of care in estimating the degree of gustiness. However, constant practice and diligence will make it possible for the observer to give an accurate report of gustiness as obtained from the buzzer type of indicator.

XVI (J)—METEOROLOGICAL BAROMETRIC PRESSURE

364. **Importance and Definition of Barometric Pressure.**—Accurate data concerning the barometric pressure is of high importance to the forecaster in the preparation of his weather maps and forecasts. Therefore, it can not be too strongly impressed upon the observer concerning the need for care in the observing and reporting of this element. THE BAROMETRIC PRESSURE AT A GIVEN LEVEL IS THE FORCE WHICH THE VERTICAL COLUMN OF AIR ABOVE THAT LEVEL EXERTS ON A UNIT AREA AT THE LEVEL BY REASON OF THE WEIGHT OF THE AIR IN THE VERTICAL COLUMN. For example, suppose the area of the inside of a barometer tube to be just 1 square inch, then a 30-inch barometric column will contain just 30 cubic inches of mercury. Now, 1 cubic inch of mercury weighs 0.4906 pound, which, multiplied by 30, gives the ordinary sea-level pressure of the air to be 14.718 pounds per square inch. This quantity is frequently used by engineers, and is called a pressure of one "atmosphere." In the main, it is nothing more than the weight of an air column having a sectional area of 1 square inch and extending vertically to the upper limits of the atmosphere. For meteorological purposes the force exerted by this weight is to be expressed in terms of "millibars," a millibar being a measure of force exerted over a specified unit area.

365. **General Rules for Reporting Barometric Pressure.**—The following general rules will cover the reporting of the barometric pressure:

(*a*) *Stations required to report barometric pressure.*—The barometric pressure will be reported only from stations which are equipped with mercurial barometers.

(*b*) *Procedure to be employed in obtaining station and sea-level pressures.*—Special instructions, such as reading a mercurial barometer, reductions of the pressure to sea level, or standard atmosphere, proper care of barometers, etc., will be given in individual cases by a properly trained Weather Bureau official. The following instructions are designed to cover the procedure to be employed in regard to the obtainment of (I) "station pressure," (II) "sea-level" (reduced) pressure.

(I) STATION PRESSURES

1. *Station has a mercurial barometer and either an aneroid barometer or a barograph*: (*a*) Mercurial barometer readings are to be made every 6 hours at the 1:30 a. m. and 7:30 a. m. and p. m., eastern standard time, map observations.

(*b*) Each time the mercurial barometer is read, the aneroid barometer and/or the barograph, 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.

(c) 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.

(d) "Station pressures," whether based on mercurial, aneroid, or barograph readings, will be recorded on Form 1130 in the column provided thereon for these data. This will serve as the original permanent record of the data on these forms.

(e) If both an aneroid and an open-scale barograph are available, the barograph should be given the preference in obtaining "station pressures"; otherwise the aneroid should be used.

(II) 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 "one-half (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.

3. Unless special instructions are given to the contrary, the temperature argument used in the reduction of barometric pressure to sea level should be obtained as illustrated in the following example, in conformity with standard procedure in the past:

	°F.
Current temperature	64. 8
Temperature 12 hours previous	52. 6
Sum	117. 4
Mean=Sum÷2	58. 7

	°F.
Clear the decimal in accordance with regular rule, making the temperature used in referring to the pressure-reduction table	59

4. When the thermograph readings (corrected) are used for either the current or 12-hour preceding temperature, they shall be taken to the nearest whole degree.

(c) *Values to be reported.*—When reported. the pressure will be indicated in millibars and tenths of millibars.

(d) *Use of aneroid barometer in obtaining barometric pressure.*—The following method should be used for obtaining the pressure by means of an aneroid barometer; bearing in wind that aneroid barometers are not to be used for original determinations of pressure, except at stations where readings of a mercurial barometer are made at least every 6 hours.

1. The barometer should 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. A correction will be applied to this reading, when necessary, as described under "d" below.

3. 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 4 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 (973.6 millibars).
(b) 29.06 inches (984.1 millibars).
(c) 29.20 inches (988.8 millibars).
(d) 29.56 inches (1001.0 millibars).
(e) 30.00 inches (1015.9 millibars).
(f) 30.10 inches (1019.3 millibars).

(e) *Applying corrections to readings of aneroid barometers.*—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.

XVI (K).—ALTIMETER SETTINGS

366. **General Rules for Determining and Reporting Altimeter Settings.**—This is essentially a value for the current standard atmosphere sea level pressure, and will be determined in accordance with instructions in appendix VI to this circular.

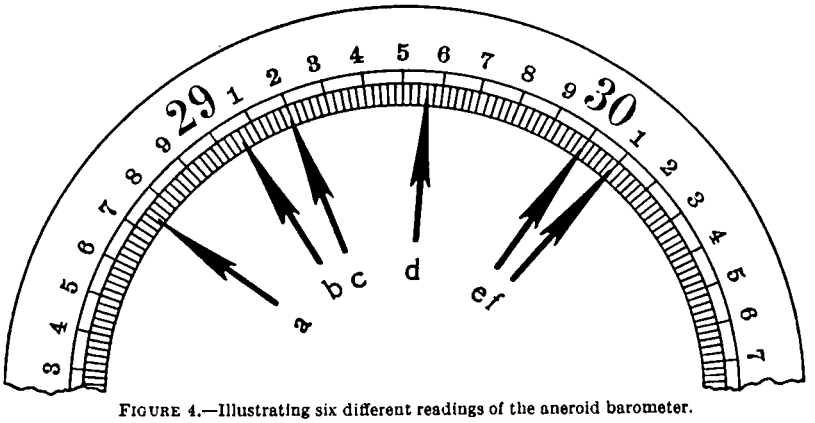


FIGURE 4.—Illustrating six different readings of the aneroid barometer.

XVI (L).—REMARKS

367. **Scope and Purpose.**—It is intended that the "Remarks" contain all pertinent weather information which cannot properly be given in the reporting of specific elements 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, or immediately prior thereto, and for which no special report could be filed showing the change.

368. **Position and Methods of Entry of Remarks in Reports.**—The remarks will constitute the last part of the observation proper, and will be entered by use of symbols, figures, and English abbreviations representing the remark or remarks to be included in the report.

369. **Any Remarks Having a Bearing on Weather Conditions to be Included in Reports.**—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. If no symbol and figure group can be assigned for a remark to cover a particular condition which may arise, then the remark shall be written out in English, using authorized abbreviations and figures. 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.

370. **Remarks Concerning the Various Elements.**—Examples of standard remarks and the proper methods of composing these for entry in the reports are contained in appendix IV to this circular.

371. **Extreme Importance of Proper Remarks.**—It is again desired to impress upon the observer that any conditions of importance not covered fully in the body of the report are 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 reports is so great that the necessity for the conscientious reporting of these cannot be overemphasized.

CHAPTER XVII

CONDITIONS UNDER WHICH PILOTS' OBSERVATIONS MAY BE ACCEPTED AS OFFICIAL AIRWAY WEATHER REPORTS

372. **Necessity and Purpose and Rules Governing Use of Pilots' Reports.**—Cases have arisen where observations of ceilings and other elements made by the Weather Bureau personnel at a particular point have been at variance with the opinions of pilots and transport operators at the same point concerning the values of these same elements. In order that there will be no confusion with regard to the proper procedure in such cases, the following instructions will be adhered to:

(*a*) *Conditions under which Weather Bureau reports will govern.*—The Weather Bureau reports of ceilings and other elements shall govern in all cases where official observations are taken at the point in question by personnel holding a "Certificate of Authority to Take Airway Weather Observations," or regular Weather Bureau personnel, and when the values used in such reports have been obtained by approved methods of measurement. Approved methods of measurement of ceiling include values obtained by use of ceiling projectors, ceiling balloons, pilot balloons, or observation of the obscured portions of land elevations, towers, buildings, etc., the heights of which are definitely known and which are in such proximity to the station that the values thus obtained are representative of those prevailing at the station.

(*b*) *Conditions under which transport pilots' reports accepted for official use.*—Transport pilots' reports of ceiling values may be accepted as official and used in airway reports under the following conditions:

1. When such reports are made while in flight over any point at which there is no official airway weather-reporting station within a radius of 1½ miles.

2. When such reports are made from the ground at a landing point at which there is no official airway weather-reporting station.

3. When such reports are made at a point where there is an official airway weather-reporting station and the personnel have not been able to obtain a direct measurement by approved methods and the pilot has obtained his value within a radius of 1½ miles of the station through direct observation while *taking off* from the field in question, provided that the official weather observer has no reason to question the accuracy of the report.

(*c*) *Adding of pilots' reports to regular reports.*—Reports of the type outlined in "b (1) and (2)" above may be added as remarks to the regular report, using symbols and abbreviations "PIREPS 6⊕3 MUSCATINE," "PIREPS 8⊕◐2 SE STN," etc., while reports of the type outlined under "b (3)" above should be used as the official ceiling value—without the word "estimated"—in the body of the report.

(*d*) *Reports by other than authorized Weather Bureau observers where an official weather-reporting station is located.*—Estimates or measurements of ceiling made by ground personnel of any transport or aviation company, or of the airport personnel, or of pilots on the ground at any point where there is an official weather-reporting station within a radius of 1½ miles, cannot be accepted as official and included in any airway weather report unless verified or accepted by the official observer on duty.

(*e*) *Clearance of pilots' reports through the Weather Bureau.*—All reports made by pilots must be cleared through the Weather Bureau before being placed in official use.

(*f*) *Basis of pilots' reports of ceiling values.*—Pilots' reports of ceiling values made from the ground must be in terms of feet above the surface at the point at which the observation is taken, and in this case only the proper figures will be entered. Pilots' reports of ceiling made while in flight must be in feet above sea level. Such values which will be reported under "Remarks" must carry the abbreviation "MSL" to indicate the reference plane is mean sea level. Care must be exercised by the official observers to see that misunderstandings in this connection do not occur when ceiling-height reports are accepted.

(*g*) *Holding of "Certificates of authority" by pilots and ground personnel.*—From the above it will be seen that it is not necessary for pilots to hold Weather Bureau "Certificates of authority to take airway weather observations." Moreover, ground personnel of airports or air-transport operators should not hold "Certificates of authority

to take airway observations" when such personnel are regularly employed within a radius of 1½ miles of an official airway weather-reporting station, operated by Army, Navy, Coast Guard, Weather Bureau, or Civil Aeronautics Authority personnel.

373. **Adding data from pilots' reports in "Remarks."**—The foregoing instructions will permit the adding of important data from pilots' observations in the remarks of the station receiving the reports. The right to include such data should not, however, be exercised by any station to the extent that sequence or reports are unduly lengthened, only reports of interest to *all concerned* being handled in this manner.

374. **Examples.**—Illustrations of application of the foregoing instructions follow:

(*a*) *Pilot reporting while in flight.*—Pilot reporting from over Ashland, about 20 miles west of Omaha, with his report being added to Omaha report:

OH8 X 3⊕2⊙1R–F– 061/32/32←5 967 PIREPS ASHLAND NEBR 1035 MSL 1S⊕ 1/2ZR–F 30 TOP 6 THSD SVR ICING.

(*b*) *Pilot reporting when on the ground at point where no Weather Bureau station is located.*—A pilot down at Kearney, Nebr., intermediate field, where there is no official weather-reporting station reports to his Omaha office by radio from where it is communicated to Weather Bureau at airport and included in next report:

OH7 C 20⊕5H 159/76/68⁄12 003 PIREPS KEARNEY NEBR 1050C E2⊕1/4T+R ⧹35E+↑1035C

375. **Miscellaneous Data From Pilots.**—In addition, individual reports of tops of clouds, turbulence, and other flight phenomena which may be received may be included under "Remarks" when deemed of sufficient importance by the observer. The regular order as prescribed herein should be adhered to as far as possible in all cases. It is not practicable to give detailed instructions to cover all cases and the personnel concerned must, therefore, use their own judgment concerning just which reports or portions of reports from pilots are included. In any case, the information so included should be of general interest and add to the value of the report of the station concerned.

CHAPTER XVIII

EXAMPLES OF AIRWAY REPORTS AS TRANSMITTED BY TELETYPE AND RADIO OR BY TELEGRAPH AND TELEPHONE

376. In order that observers may have a clear understanding of the foregoing instructions, there follows a number of examples in which attempt has been made to present as many typical weather situations as possible. The observer should study these very carefully and in each case determine to his own satisfaction why the various elements were required to be entered as shown. The letters given in the left-hand column represent the respective elements of a report, as follows:

(*a*) =Station.
(*b*) =Total amount of sky covered by clouds.
(*c*) =Classification.
(*d*) =Type of report.
(*e*) =Time of report.
(*f*) =Ceiling.
(*g*) =Sky.
(*h*) =Visibility.
(*i*) =Weather.
(*j*) =Obstructions to vision.
(*k*) =Barometric pressure.
(*l*) =Temperature.
(*m*) =Dew point.
(*n*) =Wind (followed by wind-shift data when appropriate).
(*o*) =Altimeter setting.
(*p*) =Remarks.

.to take airway observations" when such personnel are regularly employed within a radius of 1½ miles of an official airway weather-reporting station, operated by Army, Navy, Coast Guard, Weather Bureau, or Civil Aeronautics Authority personnel.

373. **Adding data from pilots' reports in "Remarks."**—The foregoing instructions will permit the adding of important data from pilots' observations in the remarks of the station receiving the reports. The right to include such data should not, however, be exercised by any station to the extent that sequence or reports are unduly lengthened, only reports of interest to *all concerned* being handled in this manner.

374. **Examples.**—Illustrations of application of the foregoing instructions follow:

(*a*) *Pilot reporting while in flight.*—Pilot reporting from over Ashland, about 20 miles west of Omaha, with his report being added to Omaha report:

OH8 X 3⊕2⊙1R–F– 061/32/32←5 967 PIREPS ASHLAND NEBR 1035 MSL 18⊕ 1/2ZR–F 30 TOP 6 THSD SVR ICING.

(*b*) *Pilot reporting when on the ground at point where no Weather Bureau station is located.*—A pilot down at Kearney, Nebr., intermediate field, where there is no official weather-reporting station reports to his Omaha office by radio from where it is communicated to Weather Bureau at airport and included in next report:

OH7 C 20⊕5H 159/76/68/12 003 PIREPS KEARNEY NEBR 1050C E2⊕1/4T+R \35E+↑1035C

375–R. **Miscellaneous Data from Pilots.**—In addition, individual reports of tops of clouds, turbulence, icing conditions, and upper-air winds of over 60 miles per hour should be included under "Remarks". It should be emphasized here that the reporting of weather conditions by airline pilots is not mandatory but rather in the spirit of cooperation which exists between the Weather Bureau, the Civil Aeronautics Authority, and the airlines. It is not practicable to give detailed instructions to cover all cases, but the instructions which follow will govern when pilots' reports of icing conditions and upper-air winds of over 60 miles per hour are to be transmitted.

(1) ICING CONDITIONS

1. Intensity of icing condition, using the word "ICE" to indicate moderate icing.
"−ICE" [word ICE, preceded by minus sign (−)] to indicate light icing, and
"+ICE" [word ICE, preceded by plus sign (+)] to indicate heavy icing.

2. Location and geographical extent of icing area.

The location and geographical extent of the icing area will be expressed in miles, followed by appropriate abbreviations indicating its direction from either the reporting station or another well-known teletype or radio point. If pilot reports icing conditions with respect to some little known place, it will be the responsibility of the person preparing the report for teletype or radio transmission to express the conditions with respect to some well-known geographical location. However, if icing conditions are restricted to a limited and well-known area, such as over a definite mountain top or range, it will be satisfactory to give this area in the report.

3. The top and base of the icing area, expressed in hundreds of feet above sea level, will be given in a figure group at the end of the report, as follows:

"85–40" = Top 8500; base 4000.
"115–//" = Top 11,500; base unknown.
"//–65" = Top unknown; base 6500.

EXAMPLES

(*a*) Pilot flying between Cheyenne, Wyo., and Salt Lake City, Utah, reports to Cheyenne heavy icing conditions 15 to 80 miles west of Cheyenne, with base at 7000 feet MSL and top 8500 feet MSL.

This report will be added to the next regular or special CX report, as follows:

PIREPS + ICE 15–80 W CX 85–70.

(*b*) Pilot flying between Seattle and Oakland reports to Medford moderate icing conditions 5 to 20 miles north of Eugene, Oreg., with base at 2000 feet MSL, top unknown.
Medford will add the following to its next regular or special report:

PIREPS ICE 5–20 N EU //–20.

(*c*) Pilot flying between Oakland and Burbank reports light icing conditions over mountain tops north of Burbank, with top at 11,500 feet MSL, base unknown.
This report will be added to the next Burbank report, as follows:

PIREPS–ICE MTNS N BU 115–//.

(II) WINDS OF OVER 60 MILES PER HOUR

1. Wind data in pilots' reports will be introduced by the abbreviation "WND" following the abbreviation "PIREPS".
2. The direction from which wind is blowing will be indicated in teletype reports by figures representing the degrees of the compass from which the wind is blowing, which will be followed immediately by figures indicating the force in miles per hour.
3. As high winds are not so localized horizontally or vertically as icing conditions, only the approximate location and altitude of such winds need be indicated. For instance, a report need indicate only that winds of over 60 miles per hour were encountered east, west, norrh, or south of a certain station, or between two stations on an airway, at a certain altitude.

EXAMPLE

Pilot flying between Fargo and Billings reports to Bismarck he encountered a northwest wind of 95 miles per hour west of Bismarck at 6,000 feet.
Bismarck will add the following to its next regular or special report:

PIREPS WND 315 95 W RK 60.

CHAPTER XVIII

EXAMPLES OF AIRWAY REPORTS AS TRANSMITTED BY TELETYPE AND RADIO OR BY TELEGRAPH AND TELEPHONE

376. In order that observers may have a clear understanding of the foregoing instructions, there follows a number of examples in which attempt has been made to present as many typical weather situations as possible. The observer should study these very carefully and in each case determine to his own satisfaction why the various elements were required to be entered as shown. The letters given in the left-hand column represent the respective elements of a report, as follows:

(*a*) =Station.
(*b*) =Total amount of sky covered by clouds.
(*c*) =Classification.
(*d*) =Type of report.
(*e*) =Time of report.
(*f*) =Ceiling.
(*g*) =Sky.
(*h*) =Visibility.
(*i*) =Weather.
(*j*) =Obstructions to vision.
(*k*) =Barometric pressure.
(*l*) =Temperature.
(*m*) =Dew point.
(*n*) =Wind (followed by wind-shift data when appropriate).
(*o*) =Altimeter setting.
(*p*) =Remarks.

Element	Teletype symbol	Form if same report telegraphed	Translation, example No. 1, "record" observation
(a)	CX		Cheyenne, Wyo.
(b)	0	None	No clouds.
(c)	C	Contact	Satisfactory for contact flight.
(d)			Not a "special" or "local extra" observation; therefore, no "type of report" designation required.
(e)			Same as above no "time of observation" required in teletype report; telegraphed report will show time filed on message as received.
(f)			Ceiling unlimited, value omitted.
(g)	○	Clear	Sky clear.
(h)			Visibility over 10 miles, no report required.
(i)			No weather.
(j)			No obstructions to vision.
(k)	163	10163	1016.3 millibars.
(l)	0	Zero	Temperature 0° F.
(m)	−3	Minus 3	Dew point −3° F.
(n)	↓9	North 9	North, 9 miles per hour.
(o)	964	2964	29.64 inches.
(p)			None.

Written thus on teletype:
CX0 C ○ 163/0/-3 ↓9 964
Sent thus as body of telegram:
None Contact Clear 10163 Zero Minus 3 North 9 2964

Element	Teletype symbol	Form if same report telegraphed	Translation, example No. 2, "record" observation
(a)	GI		Grand Island, Nebr.
(b)	5	5	Sky 7 to 8 tenths clouded.
(c)			Not a controlled airport.
(d)	}		{ Not a "special" or "local extra" observation, therefore no "type of report" or "time of report" designation required.
(e)	}		
(f)	E30	Estimated 3000	Estimated 3000 feet.
(g)	◑/◐	High scattered lower broken.	High scattered, lower broken clouds.
(h)	4	4	4 miles.
(i)	R—	Light rain	Light rain.
(j)	K—	Light smoke	Light smoke.
(k)	159	10159	1015.9 millibars.
(l)	70	70	70° F.
(m)	66	66	66° F.
(n)	→15	West 15	West 15 miles per hour.
(o)	003	3003	3003 inches.
(p)			None.

Written thus on teletype:
GI5 E30◑/◐4R-K- 159/70/66→15 003
Sent thus as body of telegram:
5 Estimated 3000 High Scattered Lower Broken 4 Light Rain Light Smoke 10159 70 66 West 15 3003

Element	Teletype symbol	Form if same report telegraphed	Translation, example No. 3, "local extra" observation
(a)	TO	NOTE.—Since this is a "local extra" report, it would not be telegraphed.	Toledo, Ohio.
(b)	8		Sky completely overcast.
(c)	N		Satisfactory for instrument flights.
(d)	LCL		"Local extra" observation.
(e)	1215E		12:15 p. m., E. S. T.
(f)	E7V		Estimated 700 feet, variable.
(g)	⊕2Ⓓ		Overcast, lower scattered clouds at 200 feet
(h)	½V		½ mile, variable.
(i)	SSQ		Moderate snow; moderate snow squalls occurring, but none at time of observation.
(j)			Not required in "local extra" observations.
(k)			
(l)			
(m)			
(n)			
(o)			
(p)			None.

Written thus on teletype:
TOS N LCL 1215E E7V⊕2Ⓓ½VSSQ

Element	Teletype symbol	Form if same report telegraphed	Translation, example No. 4, "special" observation
(a)	CG		Chicago, Ill.
(b)	9	9	Sky obscured (by snow).
(c)	X	Closed	Closed to landings and take-offs.
(d)	SPL	Special	Special observation.
(e)	0312C		3:12 a. m., C. S. T.
(f)	0	Zero	Ceiling zero.
(g)			Omitted, actual sky condition not observable due to heavy snow.
(h)	⅛	One eighth	⅛ mile.
(i)	S+	Heavy snow	Heavy snow.
(j)			None, other than snow.
(k)	061	10061	1006.1 millibars.
(l)	30	30	30° F.
(m)	25	25	25° F.
(n)	↘40+↑0308C+	Northwest 40 Strong gusts severe south wind shift 0308 Central Standard.	Northwest 40 miles per hour, strong gusts, severe wind shift from south to northwest at 3:08 a. m., C. S. T.
(o)	967	2967	29.67 inches.
(p)			None.

Written thus on teletype:
CG9 X SPL 0312C 0⅛S+ 061/30/25↘40+↑0308C+ 967
Sent thus as body of telegram:
9 CLOSED SPECIAL ZERO ONE EIGHTH HEAVY SNOW 10061 30 25 NORTHWEST 40 STRONG GUSTS SEVERE SOUTH WIND SHIFT 0308 CENTRAL STANDARD 2967

NOTE.—In this case the temperature, dew point, and barometric pressure had changed sufficiently to warrant their inclusion in this "special" report.

Element	Teletype symbol	Form if same report telegraphed	Translation, example No. 5, "record" observation
(a)	PS		Memphis, Tenn.
(b)	4	4	Sky 6 tenths clouded.
(c)	C	Contact	Satisfactory for contact flight.
(d)			Regular sequence record observation, no "type of report" or "time of report" designation required.
(e)			
(f)	12	1200	1,200 feet (measured).
(g)	◍	Broken	Broken clouds.
(h)	8	8	8 miles.
(i)	SW—	Light snow showers	Light snow showers.
(j)			None.
(k)	152	10152	1015.2 millibars.
(l)	25	25	25° F.
(m)	19	19	19° F.
(n)	↘20—	West northwest 20, fresh gusts.	West northwest 20 miles per hour, fresh gusts.
(o)	997	2997	29.97 inches.
(p)			None.

Written thus on teletype:
PS4 C 12◍8SW— 152/25/19↘20— 997
Sent thus as body of telegram:
4 CONTACT 1200 BROKEN 8 LIGHT SNOW SHOWERS 10152 25 19 WEST NORTHWEST 20 FRESH GUSTS 997

Element	Teletype symbol	Form if same report telegraphed	Translation, example No. 6, "record" observation
(a)	JM		Jamestown, N. Dak.
(b)	3	3	Sky 2 to 3 tenths clouded.
(c)			Not a controlled airport.
(d)			Regular sequence "record" observation, no "type of report" or "time of report" designation required.
(e)			
(f)			Unlimited.
(g)	10◍	Scattered 1000	Scattered clouds at 1,000 feet.
(h)	¼V	One fourth variable	¼ mile, variable.
(i)			None.
(j)	BS+	Thick blowing snow	Thick blowing snow.
(k)	193	10193	1019.3 millibars.
(l)	12	12	12° F.
(m)	—2	Minus 2	—2° F.
(n)	→28+	West 28 strong gusts	West 28 miles per hour, strong gusts.
(o)	999	2999	29.99 inches.
(p)			None.

Written thus on teletype:
JM3 10◍¼VBS+ 193/12/—2→28+ 999
Sent thus as body of telegram:
3 SCATTERED 1000 ONE FOURTH VARIABLE THICK BLOWING SNOW 10193 12 MINUS 2 WEST 28 STRONG GUSTS 2999

Element	Teletype symbol	Form if same report telegraphed	Translation, example No. 7, "special" observation
(a)	WA		Arlington, Va.
(b)	9	9	Sky obscured (by fog).
(c)	X	Closed	Closed to landings.
(d)	SPL	Special	Special observation.
(e)	1122E		11:22 a. m., E. S. T.
(f)	0	Zero	Zero.
(g)			Sky condition not observable.
(h)	0	Zero	Zero.
(i)			None.
(j)	FF	Dense fog	Dense fog.
(k)			Not required in special observation.
(l)			Not required in special observation.
(m)			Not required in special observation.
(n)	←2	East 2	East, 2 miles per hour.
(o)			Not sent in special reports unless sea level barometric pressure also sent due to rapid change.
(p)			None.

Written thus on teletype:
WA9 X SPL 1122E 00FF ←2
Sent thus as body of telegram:
9 CLOSED SPECIAL ZERO ZERO DENSE FOG EAST 2

Element	Teletype symbol	Form of same report telegraphed	Translation, example No. 8, "record" observation
(a)	NA		Nashville, Tenn.
(b)	9	9	Sky obscured (by fog and smoke).
(c)	X	Closed	Closed to landings and take-offs.
(d)			"Record" observation, no "type of report" or "time of report" designation required.
(e)			
(f)	0	Zero	Zero.
(g)			Sky not observable.
(h)	⅛	One eighth	⅛ mile.
(i)	ZL+	Heavy freezing drizzle.	Heavy freezing drizzle.
(j)	FFK	Dense fog moderate smoke.	Dense fog, moderate smoke.
(k)	142	10142	1014.2 millibars.
(l)	31	31	31° F.
(m)	31	31	31° F.
(n)	←↙4	East northeast 4	East northeast, 4 miles per hour.
(o)	992	2992	29.92 inches.
(p)	VSBY OCNLY ½ N	Visibility occasionally one half north.	Visibility occasionally ½ mile to north.

Written thus on teletype:
NA9 X 01/8ZL+FFK 142/31/31←↙4 992 VSBY OCNLY 1/2 N
Sent thus as body of telegram:
9 CLOSED ZERO ONE EIGHTH HEAVY FREEZING DRIZZLE DENSE FOG MODERATE SMOKE 10142 31 31 EAST NORTHEAST 4 2992 VISIBILITY OCCASIONALLY ONE HALF NORTH

Element	Teletype symbol	Form of same report telegraphed	Translation, example No. 9, "special" observation
(a)	NO		New Orleans, La.
(b)	8	8	Sky completely overcast.
(c)	X	Closed	Closed to landings.
(d)	SPL	Special	Special report.
(e)	1518C		3:18 p. m., C. S. T.
(f)	E3	Estimated 300	Estimated 300 feet.
(g)	+⊕1⊘	Dark overcast lower scattered 100.	Dark overcast, lower scattered clouds at 100 feet.
(h)	2	2	2 miles.
(i)	TORNADO SW TRA−	Tornado southwest, moderate thunderstorm, moderate rain, light hail.	Tornado to southwest of station moderate thunderstorm, moderate rain, light hail.
(j)			None.
(k)	095	10095	1009.5 millibars.
(l)	80	80	80° F.
(m)	76	76	76° F.
(n)	↗25+	Southwest 25 strong gusts.	Southwest 25 miles per hour, strong gusts.
(o)	980	2980	29.80 inches.
(p)	DRK SW	Dark southwest	Dark to southwest.

Written thus on teletype:
NO8 X SPL 1518C E3+⊕1⊘2 TORNADO SW TRA− 095/80/76↗25+ 980 DRK SW
Sent thus as body of telegram:
8 CLOSED SPECIAL ESTIMATED 300 DARK OVERCAST LOWER SCATTERED 100 2 TORNADO SOUTHWEST MODERATE THUNDERSTORM MODERATE RAIN LIGHT HAIL 10095 80 76 SOUTHWEST 25 STRONG GUSTS DARK SOUTHWEST
NOTE.—Temperature, dew point, and barometer changes were of sufficient importance to require their inclusion in this special observation.

Element	Teletype symbol	Form of same report telegraphed	Translation, example No. 10, "record" observation
(a)	BW		Boston, Mass.
(b)	7	7	Sky overcast but with breaks.
(c)	C	Contact	Satisfactory for contact flight.
(d)			Regular sequence "record" observation, "type" and "time" of report designation not required.
(e)			
(f)	10	1000	1,000 feet (measured).
(g)	⊕1⊘	Overcast, lower scattered 100.	Overcast lower scattered clouds at 100 feet.
(h)	3	3	3 miles.
(i)	R−	Light rain	Light rain.
(j)	F−	Light fog	Light fog.
(k)	135	10135	1013.5 millibars.
(l)	47	47	47° F.
(m)	46	46	46° F.
(n)	↑↖10	South southeast 10	South southeast, 10 miles per hour.
(o)	992	2992	29.92 inches.
(p)			None.

Written thus on teletype:
BW7 C 10⊕1⊘3R−F− 135/47/46↑↖10 992
Sent thus as body of telegram:
7 CONTACT 1000 OVERCAST LOWER SCATTERED 100 3 LIGHT RAIN LIGHT FOG 10135 47 46 SOUTH SOUTH EAST 10 2992

Element	Teletype symbol	Form of same report telegraphed	Translation, example No. 11, "special" observation
(a)	OA		Oakland, Calif.
(b)	8	8	Sky completely overcast.
(c)	C	Contact	Satisfactory for contact flight.
(d)	SPL	Special	Special observation.
(e)	1519P		3:19 p. m., P. S. T.
(f)	E10	Estimated 1000	Estimated 1,000 feet.
(g)	⊕ ◍	Overcast, lower broken.	Overcast, lower broken clouds.
(h)	3	3	3 miles.
(i)	AP—	Light small hail	Light small hail.
(j)	H	Hazy	Hazy.
(k)			Special report, omitted; change less than rate of 1 mb. in 45 minutes.
(l)			Special report, omitted; change less than rate of 10° per hour.
(m)			Special report, omitted.
(n)	↓8	North 8	North, 8 miles per hour.
(o)			Special report, omitted.
(p)			None.

Written thus on teletype:
OA8 C SPL 1519P E10⊕◍3AP—H ↓8
Sent thus as body of telegram:
8 CONTACT SPECIAL ESTIMATED 1000 OVERCAST LOWER BROKEN 3 LIGHT SMALL HAIL HAZY NORTH 8

Element	Teletype symbol	Form of same report telegraphed	Translation, example No. 12, "special" observation
(a)	SL		Salt Lake City, Utah.
(b)	8	8	Sky completely overcast.
(c)	C	Contact	Satisfactory for contact flight.
(d)	SPL	Special	Special observation.
(e)	1722M		5:22 p. m. M. S. T.
(f)	E15	Estimated 1500	Estimated 1,500 feet.
(g)	⊕ ◍	Overcast lower broken.	Overcast, lower broken clouds.
(h)	5	5	5 miles.
(i)	T—A—	Mild thunderstorm light hail.	Mild thunderstorm, light hail.
(j)			None other than hail.
(k)	102	10102	1010.2 millibars.
(l)	62	62	62° F.
(m)	50	50	50° F.
(n)	→↘35+	West northwest 35 strong gusts.	West northwest 35 miles per hour, strong gusts.
(o)	993	2993	29.93 inches.
(p)	BRM RSG RPDLY	Barometer rising rapidly.	Barometer rising rapidly.

Written thus on teletype:
SL8 C SPL 1722M E15⊕◍5T—A— 102/62/50→↘35+ 993 BRM RSG RPDLY
Sent thus as body of telegram:
8 CONTACT SPECIAL ESTIMATED 1500 OVERCAST LOWER BROKEN 5 MILD THUNDERSTORM LIGHT HAIL 10102 62 50 WEST NORTHWEST 35 STRONG GUSTS 2992 BAROMETER RISING RAPIDLY

PART IV.—ADDING OF SPECIAL DATA TO RADIO AND TELETYPE SEQUENCE REPORTS MADE AT 4:30 AND 10:30 A. M. AND P. M., E. S. T. (3-HOURLY PERIODS)

CHAPTER I

DATA TO BE ADDED

401. Special data as given below will be added to radio and teletype sequence reports, when appropriate, by stations reporting hourly by teletype or radio, immediately following the report proper, in the order in which they are listed below and at the times and under the conditions outlined specifically in appendix V to this circular:

(*a*) *Pressure change and characteristic.*
(*b*) *Clouds*, when appropriate.

CHAPTER II

TIMES AND CONDITIONS UNDER WHICH DATA SHALL BE ADDED

Only data as outlined above—and these only under specific conditions and times as outlined in appendix V—are authorized to be added to such reports.

PART V.—CLOUDS

CHAPTER I

REPORTING OF CLOUDS IN OBSERVATIONS

501. Stations authorized to report clouds as data added to sequence reports at the 3-hourly or 6-hourly periods shall do so according to instructions contained in parts IV and VI of this circular.

CHAPTER II

GENERAL INSTRUCTIONS REGARDING CLOUD OBSERVATIONS

502. **Necessity of Thorough Knowledge of Cloud Types.**—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 map-sequence and 3 hourly reports (see pts. IV and VI) from designated stations, and the observer must be familiar with them before he can make accurate reports. Further, the cloud types are to anyone somewhat versed in meteorology a good indication of imminent weather, and are thus of great value to the forecaster. All observers will, therefore, carefully study the cloud illustrations and descriptions as given in "Cloud Forms, According to the International System of Classification" (3d edition, 1938). This bulletin, known as W. B. No. 956, is furnished to all concerned and is also available at the central office.

503. **Ceiling When Cirrus Cirro-Stratus or Cirro-Cumulus Present.**—When any of the first three forms appear (cirrus, cirro-stratus, and cirro-cumulus), 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 classification, i. e., alto-stratus and alto-cumulus, although it will be noted that these clouds are sometimes as low as 2,500 to 4,000 feet.

504. **Distinguishing Between High and Low Cloud Types.**—It is sometimes hard to distinguish between alto-stratus and stratus; also, there will sometimes be doubt as to whether the cloud is alto-cumulus, strato-cumulus, or cumulus. 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.

505. **Some Characteristics of Lower Cloud Types with Relation to Ceilings.**—Cumulo-nimbus 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 nimbo-stratus is the rain cloud, and is nearly always low. The stratus base is also

low, varying from a few hundred feet above the ground to a few thousand. Study the following table carefully:

TABLE 9.—*Height above ground of base of various types of clouds*

Name of clouds	Type	Summer (April–September)		Winter (October–March)	
		Range in height	Usual height	Range in height	Usual height
		Feet	*Feet*	*Feet*	*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	Intermediate	8, 000–32, 000	20, 000	4, 000–32, 000	14, 000
Alto-cumulus and alto-cumulus-castellatus.	do	2, 500–28, 000	10, 000	5, 000–20, 000	10, 000
Stratocumulus	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 (nimbo-stratus)	do	700–13, 000	800	700–12, 000	1, 000
Stratus	do	200– 6, 000	1, 000	200– 6, 000	1, 000

151480—39——10

PART VI.—6-HOURLY AND 3-HOURLY WEATHER-REPORTING SERVICE

(A) 6-HOURLY SERVICE

CHAPTER I

TYPES OF 6-HOURLY REPORTS

601. **Need for and Definitions of Various Types of 6-Hourly Reports.**—The primary purpose of the 6-hourly system is to provide adequate data for the preparation of weather maps upon which to base airway weather forecasts. Accordingly, the collections must be quite comprehensive. The following major groups of reports are transmitted on all teletype and radio circuits for this purpose:

(*a*) *Map sequence reports* ("*S*").—Regular hourly airway sequence reports to which certain data are added in code to make them complete for use on synoptic maps. Sequences run on individual teletype and radio circuits are then relayed to all other circuits in the country.

(*b*) *Map reports* ("*M*").—These are complete meteorological reports made at stations not located on teletype or radio circuits and enciphered in the authorized numerical weather code. Their method of distribution differs from that of map-sequence reports in that they are collected by various methods (SGL D&A, special message, etc.) and transmitted in groups from Chicago, Washington, and Oakland.

CHAPTER II

INSTRUCTIONS FOR 6-HOURLY SERVICE

602. Complete description of and instructions for 6-hourly service are contained in appendix V to this circular.

(B) 3-HOURLY SERVICE

CHAPTER III

INSTRUCTIONS FOR MAKING AND TELEGRAPHING 3-HOURLY REPORTS

603. Three-hourly reports shall be telegraphed by those stations which have been designated to do so at 4:30 and 10:30 a. m. and p. m., eastern standard time, to the general supervising station in whose district they are located, unless otherwise arranged. These reports will consist of a regular coded reports, made in accordance with instructions contained in appendix V to this circular. Such reports shall be recorded on a separate Form 1083–METL.

PART VII.—INSTRUCTIONS FOR THE PREPARATION AND DISPOSITION OF AIRWAY METEOROLOGICAL FORMS

CHAPTER I

IMPORTANCE OF AIRWAY METEOROLOGICAL FORMS

701. The conduct of the airway meteorological service requires that certain forms be prepared and rendered at all types of stations engaged in this work which have been directed to do so. 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 shall 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:

CHAPTER II

FORM 1130-AER., AIRWAY WEATHER REPORTS

702. **Purpose and Use of Form 1130.**—This form is to be used for the recording of airway weather observations and shall be used for this purpose at all stations rendering such observations. Accordingly, it constitutes the original record of airway observations. However, this does not mean that the data must be entered directly on the form, as it may be inconvenient to carry it while making an observation in windy or rainy weather, but rather that the data entered shall be considered as constituting the original record of the observation itself.

703. **Method of Making Entries.**—Entries on Form 1130-Aer. shall be made by use of a moderately hard pencil. Observations shall be entered in chronological order, placing data in the proper columns as indicated in the headings on the form, using symbols, authorized English abbreviations, and figures. Ditto marks may be used, *except in record observations*, when the data to be entered in any column are the same as the immediately preceding data in the same column.

704. **Entry of Station Name and Date of Form.**—The name of the station and the month and year shall be entered in the space provided in the top right-hand corner of the form. This applies to all forms, irrespective of whether or not more than one sheet is used for entry of 1 day's observations. The day of the month shall be entered in the column provided at the left of the form.

705. **Entry of "Type-of-Observation" Designation.**—Types of observations shall be designated in the second column from the left, as follows: "R" for "record," a check mark ($\surd$) for "check," "L" for "local extra," and "S" for "special."

706. **Entry of "Classification" Symbols.**—If the station is within a "control zone" as defined by current circulars of the Bureau regarding this, the observations shall be classified according to the existing rules to indicate whether the weather is suitable for "contact" or "instrument" flying or whether the airport is "closed to operation" of aircraft. These classifications shall be entered in the column so indicated and shall be "C," "N," or "X," respectively, for "contact," "instrument," or "closed."

707. **Entry of "Time of Observation."**—The local time of observation shall be entered on the basis of the 24-hour clock in the column provided. Under this system

four figures, the first two representing the hour and the last two the minutes, are always entered, the first hour after midnight being designated "00;" the second, "01;" the third, "02;" the fifteenth "14," etc. For example, "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 "E" for eastern, "C" for central, "M" for mountain, and "P" for Pacific standard time, following the time figures for the first entry on each sheet, e. g., "0042E" indicates 12:42 a. m., eastern standard time; "1515C" indicates 3:15 p. m., central standard time, etc.

708. **Entry of "Ceiling" Data.**—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," shall be entered immediately preceding the figure. At stations located on teletype or radio circuits the ceiling value may be entered only to hundreds of feet, i. e., the figures for the tens and digits shall be dropped. For example, 3,000 feet would be entered as '30," 1,500 feet would be entered as "15," 300 feet as "3," zero as "0", etc. Stations reporting by telephone or telegraph will enter the complete figures for the value.

709. **Entries of "Sky," "Weather," and "Obstructions to Vision."**—At stations on teletype or radio circuits, sky, weather, and obstructions to vision shall be entered according to symbols given in this circular. At other stations these elements may be entered in authorized English abbreviations. The height of scattered clouds, recorded as instructed in this circular shall be entered at teletype stations in the sky-condition column preceding the "scattered" symbol and following the word "scattered" at stations reporting by the telephone or telegraph.

710. **Entries of "Visibility," "Temperature," "Dew Point," and "Barometer."**—Visibility, temperature, dew point, and barometer shall be entered in figures. Temperature and dew point shall be separated by a slant mark (/), the temperature being entered first. The station pressure shall be entered in inches and hundredths in the column provided. The sea-level pressure is to be entered in millibars and tenths of millibars. At stations on teletype or radio circuits, if a copy of Form 1130–Aer. is prepared for the operator to use in transmission of the report, the station pressure shall not be entered on this copy. Further, the sea-level pressure on the operator's copy shall be entered in three figures representing the tens, units, and tenths of millibars, the thousands and hundreds figures being dropped, i. e., 1000.2 would be entered as "002," 996.8 would be entered as "968," etc. Corrected readings of the wet- and dry-bulb thermometers are to be entered to tenths in the column provided.

711. **Entries of "Wind" Data.**—At stations on teletype and radio circuits the wind direction shall be entered by use of arrows. At other stations wind directions shall be entered by use of authorized abbreviations. The velocity shall be in figures immediately following the direction. Character of gustiness, when appropriate, shall be entered immediately following the velocity, by use of a minus (—) sign to indicate "fresh" and of a plus (+) sign to indicate "strong" gusts, at teletype and radio stations and by the abbreviated words "Frsh gsts" or "Stg gsts" at other stations.

712. **Entries of "Remarks" and Miscellaneous Data.**—Remarks shall be entered by use of figure groups assigned in Appendix IV for this purpose. Remarks shall be entered in English, using authorized abbreviations, except that numerical values shall be entered in figures. At stations adding special data to 3-hourly observations, these data shall be entered in the prescribed form in the "remarks" column, following any remarks entered therein and set off by parentheses. This same procedure shall also be used at stations which add special data to their observations at the 6-hourly period but which do *not* take complete "map sequence" observations at such times. On the retained Form 1130 (if not provided thereon) a column shall be inserted under "remarks," adjacent to the column for observer's initials and shall be headed "Dry- and wet-bulb readings (corrected)." In this column shall be entered the dry- and wet-bulb readings, to tenths, at stations which make such readings. The dry reading shall be entered above that of the wet-bulb thermometer for that hour. Such entries shall not be made on the copy of Form 1130 which is given to the teletype or radio operator.

713. **Entry of Initials of Observer.**—The initials of the observer taking the observation shall be entered in each case in the column provided at the right of the form in his (or her) own handwriting.

714. **Entries Required Regarding Care of Instruments.**—Instruments shall be properly cared for as instructed in this circular, and the dates when this work is done shall be entered in the spaces provided at the bottom of the form. These dates must be carried forward to each new sheet in order that any sheet will show the dates when instruments were last cleaned, oiled, checked, etc.

715. **Corrections to Entries.**—All Weather Bureau personnel taking weather observations and entering these on Form 1130 for transmission or broadcast by Civil Aeronautics Authority personnel are instructed to make certain that original observations are entered on Form 1130, to which a specific time has been assigned, and which are given to the Civil Aeronautics Authority personnel for use in a specific transmission or broadcast, are not changed subsequent to giving them to the operator. If a change must be reported, due to error in the original entries, then a complete new observation containing the revised data, with the time of entry, shall be entered on Form 1130 below the original observation. It will not, of course, be necessary to take a complete new observation but only to enter applicable data from the original observation, along with the revised data. Any such changes shall be given immediately to the Civil Aeronautics Authority as, in many cases, it may be that the transmission or broadcast in which the original observation is included may not be finished and the operator will be able to include the revised data as a correction. Such observations will be indicated by entry of the letters "CQN" in the second column of Form 1130, signifying "correction." If the revision is made, due to a change in weather conditions since the original observation was taken and such change is of such nature as to require a "special observation, then instructions regarding the rendering of "special" observations will apply. The same would be true as concerns "check" observations and "local extra" observations.

716. **Disposition of Form 1130.**—Dispostion of Form 1130–Aer. prepared at airway substations will vary with respect to whether or not the station concerned is manned by paid Weather Bureau observers. The disposition of forms rendered by Army and Navy stations shall be arranged in each case by the central office, upon recommendation of the general supervising station. The following contains specific instructions covering all other classes of stations:

(*a*) *Stations manned by Civil Aeronautics Authority personnel or Weather Bureau airway observers serving without pay.*—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 shall be prepared and forwarded to the city office within 5 days after the end of each calendar month.

(*b*) *Stations manned by paid Weather Bureau observers.*—Two copies of Form 1130 shall be prepared, one original and one 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.

(*c*) *Weather Bureau first-order or airport stations not having general supervising duties assigned to them.*—Only one copy of Form 1130 shall be prepared, and this shall 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 a request for it. The foregoing shall also apply to first-order stations off the airways rendering 3-hourly reports at 4:30 and 10:30 a. m. and p. m., E. S. T.

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

(*e*) *Preparation of copies for file.*—In addition to the copies of Form 1130–Aer. indicated above to be prepared, it shall be proper for any station which would not otherwise have a retained copy to prepare one extra carbon copy of this form for their files.

Form No. 1130—Asv.
U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU
(This form effective June 1, 1939)

AIRWAY WEATHER REPORTS

At hourly teletype and radio stations, enter observations in group form as transmitted, in the columns indicated by solid lines. At other stations enter data in columns indicated by dotted and solid lines.

Station Arlington (City), Va. (State)

Month and year June, 1939

Day of month	Type	Time E. S. T.	Sky code	Character-istics	Ceiling (feet)	Sky	Visibility (miles)	Weather and/or obstructions to vision	Sea-level pressure (millibars)	Temperature and dew point	Wind direction, velocity, character, shifts	Altimeter setting (inches)	Remarks and 6- or 3-hourly coded data	Station pressure (inches)	Thermometers Dry	Thermometers Wet	Observer's initials
1	✓	0210	0	C		08			156	69/67	→3	000		29.99	69.1	67.5	MSM
"	S	0220	5	N	6-	⊕ 5GF-			156	68/67	→3	000		29.99	68.2	67.1	MSM
"	R	0230	7	N	6-	⊕ 4F-			156	68/67	→↘5	000		29.99	68.3	67.4	MSM
"	✓	0310	"	N	7-	⊕3⊙4F-			"	"	"	"		"	"	"	MSM
"	S	0318	5	X	3V	⊕⊙ 2½F+			156	68/67	↘5	999		29.98	67.9	67.0	MSM
"	R	0330	6	X	.3	-⊙ 2½F-			156	69/68	↘5	999		29.98	68.9	67.8	MSM
"	S	0343	6	N	6-	⊕3⊙ 2½F-			"	"	"	"		"	"	"	MSM
"	✓	0410	"	"	"	"	"	"	"	"	"	"		"	"	"	MSM
"	R	0430	7	N	6-	⊕2F-			156	69/68	↓↘4	999		29.98	69.1	68.2	MSM
"	S	0500	7	N	5	⊕ 1VF-			"	"	→↘6	"	Ocnly F	"	"	"	MSM
"	S✓	0510	7	X	4	⊕ 1VF-			"	"	"	"	" "	"	"	"	MSM
"	L	0525	"	"	"	" " "			"	"	"	"	" "	"	"	"	MSM
"	R	0530	7	X	4	⊕ 1¼F-			156	69/68	↓↘4	000		29.99	69.3	68.2	MSM
"	L	0545	"	"	"	" " "			"	"	"	"		"	"	"	MSM
"	L	0600	7	X	4	-⊕ 1½F-			"	"	"	"		"	"	"	MSM
"	✓	0610	"	"	"	" " "			"	"	"	"		"	"	"	MSM
"	L	0625	"	"	"	" " "			"	"	"	"		"	"	"	MSM
"	R	0630	7	X	4	-⊕1¼F-			166	69/68	→↘4	001		30.00	69.4	68.5	MSM
"	L	0645	"	"	"	" " "			"	"	"	"		"	"	"	MSM
"	L	0700	"	"	"	" " "			"	"	"	"		"	"	"	MSM
"	✓	0710	"	"	"	" " "			"	"	"	"		"	"	"	MSM
"	S	0720	6	N	6-	⊕ 2F-			166	69/67	→↘4	001		30.00	69.4	67.5	MSM
"	(S) R	0730	5	N	6-	⊕5F-			166	70/68	→↘4	001	303 60036 65704 6876	30.00	70.0	67.9	MSM
"	✓	0810	"	"	"	" " "			"	"	"	"		"	"	"	MSM

Anemometer oiled May 25, 1939 Cleaned May 10, 1939 Ceiling projector cleaned and checked May 25, 1939 Wind vane checked May 10, 1939 Psychrometer muslin changed May 25, 1939

Note.—See Circular N, 1939, for instructions for preparing this form. Begin new form with first observation in any month; at other times a date will, if necessary, be carried forward from one sheet to the next.

SIX-HOURLY OBSERVATIONS ENTERED ON FORM 1083-METL WILL BE ENTERED ON THIS FORM IN ACCORDANCE WITH INSTRUCTIONS IN APPENDIX V OF CIRCULAR N, 1939

FIGURE 5.—Illustrating the entry of observations and other data on the retained copy of Form 1130 at a station equipped with teletype.

(*f*) *Furnishing of extra copies.*—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.

CHAPTER III

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

717. **Purpose and Instructions for Use of Form 1135.**—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. *Except for those stations which render coded 6-hourly reports,* or map sequence reports, this form shall 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 Civil Aeronautics Authority personnel where Weather Bureau commissioned personnel are not located.

718. **Form 1135 Not To Be Used in Connection With Aneroid Readings.**—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.

719. **Entry of Data.**—Data will be entered in pencil.

720. **Filing and Disposition of Forms 1135.**—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.

CHAPTER IV

FILING OF FORMS

721. In connection with the filing of forms, officials in charge at general supervising stations should take action which shall result in the consolidation of all forms for any district at its general supervising station or at a designated general filing point to be determined at a later date. In this connection, if any forms are on file for a station in another district, those forms should be forwarded to the general supervising station for that district.

CHAPTER V

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

722. This is a 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. A new form shall be completed and forwarded to the central office and the general supervising station on April 1 of each year. It is very important that the data on this form be kept current; and, in order to assure this, notice of any changes occurring at stations are to be forwarded, within 6 days of such changes, to the central office and the general supervising stations on these forms, 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 shall forward the 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. The station records carried at the general supervising stations and the central office are to be exact duplicates.

CHAPTER VI

FORM 1146-AER. "PRESSURE-REDUCTION DATA"

723. **Stations Which Shall Prepare Form 1146 and Data To Be Entered.**—All stations which have mercurial barometers, but are not required to prepare Form 1001 or 1001-A in connection with 6-hourly observations, shall record daily on Form 1146 the following data for each observation in which the mercurial barometer is used to determine the barometric pressure:

(*a*) B_0=Sea level (reduced) pressure (millibars and tenths).
(*b*) B=Station pressure (inches and hundredths).
(*c*) t=Dry-bulb temperature (°F.).
(*d*)*d.p.*=Dew point (°F.).

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

725. **Entry of Data In Ink; Correctness of Data at Top of Form.**—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.

726. **Disposition of Forms 1146.**—First-order stations having supervision of substations falling in the above category shall see that each carries out instructions properly in this regard. Such substations shall forward their filled-out monthly forms to the supervising station for inspection. The forms shall then be mailed by the first-order station to the central office, in envelopes marked "Forms for Aerological Division," not later than the end of the following month.

727. **Copies Not To Be Retained at Station.**—Copies of the completed Forms 1146-Aer. need not be retained at the station.

PART VIII.—AIRWAY FORECASTS

CHAPTER I

GENERAL DESCRIPTION OF FORECASTS

801. **Purpose and Points Issued From.**—In order that pilots, transport operators, and other aviation interests concerned, may have information at all times concerning weather conditions which may be expected to be encountered in flights along civil airways and in landing or departing from airway terminals, the Weather Bureau airway forecast centers at Atlanta, Ga.; Arlington, Va., Newark, N. J., Cleveland, Ohio, Chicago, Ill., Kansas City, Mo., Fort Worth, Tex., Salt Lake City, Utah, Seattle, Wash., Oakland, Calif., and Burbank, Calif., issue short-period forecasts covering the airways and terminals in their respective districts, in accordance with specific instructions issued as an appendix to this circular to stations concerned from the central office of the Weather Bureau. (Districts are shown on the Airway Meteorological Service map inserted at the end of this circular.)

802. **Types of and Periods Covered by Forecasts.**—There are two types of airway forecasts issued for general use, namely, (1) regional or route, and (2) terminal forecasts. These are issued for periods of 8 hours in advance, beginning at 4:30 and 10:30 a. m. and p. m., eastern standard time. The regional forecasts may include statements concerning expected weather conditions over an area including several airways, while a route forecast would give similar information for a specified single route. The terminal forecasts are statements of weather conditions expected to prevail at particular terminals and landing points during the period of the forecasts.

803. **Terms and Abbreviations Used.**—The terms used in all these forecasts are generally similar to and have the same limits and meanings as those prescribed elsewhere in this circular for use in airway observations. To save time on the teletype circuits, authorized abbreviations are used for many of the more frequently used words, lists of such abbreviations being available in publications of the Civil Aeronautics Authority. (See Manual of Operations, chapter B—communications section, part 4—"Abbreviations and phrase contractions; 'Q' signals and teletype call letters", effective July 15, 1938, which may be obtained from the Civil Aeronautics Authority.)

804. **Headings Used for Identifying Forecasts.**—Forecasts are identified for teletype and radio transmission by a heading made up as follows: (1) The period covered by the forecast on the basis of the 24-hour clock and local time at the point of issuance; (2) the abbreviation "AWY FCST", and (3) the month and day, using figures. A single airway or route covered by a forecast is then designated by combining the call letters of the two terminal stations and entering these as the first part of the body of the forecast. For example:

0430 1230M AWY FCST 10/16 SLCX STP ----------

which translated reads "4:30 a. m. to 12:30 p. m., mountain standard time, airway forecast, October 16, for Salt Lake City to Cheyenne airway." Where more than one airway is included, the terminal designators for all such airways are entered as the first part of the body of the forecasts. For example:

0430 1230M AWY FCST 10/16 MXMY CXBI SLCX SLGT SLBE SLLQ STP-------

Terminal forecasts are identified by the call letters for the station and the abbreviation "TRML" entered as the first part of the body of the forecast. For example:

HX TRML STP ----------

If more than one terminal is covered by one forecast, designators are entered for each terminal so included.

805. **Practice When Large Number of Forecasts Transmitted.**—In actual practice, where a large number of forecasts are transmitted at one time, the "time-AWY FCST-date" group constitutes a general heading for the whole group and individual forecasts in the transmission are identified by the side heading—as described above—entered as the first part of the body of the forecast.

CHAPTER II

EXAMPLES OF FORECASTS

806. The following examples are intended to illustrate the proper usage of terms and methods of rendition of forecasts:

(*a*) *Regional Forecasts.*—Examples of regional forecasts follow:

0830 1630M AWY FCST 4/15
MXMY CXBI SLCX SLGT SLBE SLLQ STP WND SHFT XTNDG SWWD NWRN MONT IDA SERN OREG NWRN NEV INTO CNTRL CALIF WILL CONT TO MOV RPDLY SEWD TO ABT HAVRE BURLEY ELKO LINE BY 1230 AND LEWISTON LOCOMOTIVE ELY BY 430 PRCDED BY THKNG AND LWRG HI CLDS WITH CIG 6 THSD OR ABV AND SPKLG OVR ERN IDA BUT ACPYD AND FLWD BY RPDLY LWRG CIGS WITH LGT RAIN CHGNG TO SNW AND CONTG RATHER LOW TO END OF PRD WITH CIGS 1 TO 2 THSD AND VSBY 1 TO 4 STP ALL MTNS CLD CVRD BUT CLDNS BRKG SWRN IDA BY AFTN AND PCPN BCMG SHWRY STP CIGS WILL RMN ABV 6 THSD SWRN UTAH SRN NEV CNTRL AND ERN WYO AND ERN MONT THRU PRD BUT WITH CLDNS THKNG AND LWRG STP

The above forecast would be translated as follows: "8:30 a. m. to 4:30 p. m., mountain standard time, airway forecast for April 15, Missoula to Miles City, Cheyenne to Billings, Salt Lake City to Cheyenne, Salt Lake City to Great Falls, Salt Lake City to Boise, Salt Lake City to Las Vegas. Wind shift extending southwestward across northwestern Montana, Idaho, southeastern Oregon, northeastern Nevada into central California will continue to move rapidly southeastward to about Havre-Burley-Elko line by 12:30 p. m. and Lewiston-Locomotive Springs-Ely line by 4:30 p. m., preceded by thickening and lowering high clouds with ceiling 6 thousand or above and sprinkling over eastern Idaho, but accompanied and followed by rapidly lowering ceilings with light rain changing to snow and continuing rather low to end of period, with ceilings 1,000 to 2,000 and visibility 1 to 4. All mountains cloud-covered but cloudiness breaking southwestern Idaho by afternoon and precipitation becoming showery. Ceilings will remain above 6,000 southwestern Utah, southeastern Nevada, central and eastern Wyoming and eastern Montana through period but with cloudiness thickening and lowering."

1530 2330C AWY FCST 10/7
CGID CGLS CGKC CGCX CGPB FOMY MPHR STP LOW PRES AREA OVR OKLA WILL ADVN SLWLY EWD UNTIL ABT 8PM CURVING NEWD AND RCHG SRN MO THRFTR WITH WND SHFT OMAHA ROCHESTER ADVNG 50 TO 75 MILES SEWD STP RELATIVELY MOIST AIR TO S WILL CONT TO INCR IN MSTR CONTENT OVRNG AND CAUSING SOLID SHEET OVC IND ILL NRN MO SERN MINN SRN WIS AND ERN IA STP INTMT SCTD LGT RAINS OCCURRING OVR ERN NEBR AND THRU MO IA AND SRN WIS WILL BCM MORE GNRL AND INCR IN INTSTY ATNDD BY INCRG FOG CNDS CNTRL AND ERN IA NEWD TO SWRN WIS STP CIGS 3 TO 6 THSD AND VSBY 3 TO 6 MILES THIS AREA XCPT 5 HND TO 1 THSD AND ¾ TO 1½ MILES ERN NEBR WRN IA LWRG TO THESE LMTS BY 7PM CNTRL IA AND BY 11PM NWRN MO ERN IA AND SWRN WIS STP SCTD TO BRKN CLDS CIGS 3 THSD OR HIR VSBY 6 MILES OR BTR ERN AND WRN MINN NRN WIS WRN IA ERN MONT AND OVR THE DAKOTAS AND NEBR STP

The above forecast would be translated as follows: "3:30 p. m. to 11:30 p. m., central standard time, airway forecast, October 7, Chicago to Indianapolis, Chicago

to St. Louis, Chicago to Kansas City, Chicago to Cheyenne, Chicago to Pembina, Fargo to Miles City, Minneapolis to Huron. Low pressure area over Oklahoma will advance slowly eastward until about 8 p. m., curving northeastward and reaching southern Missouri thereafter with wind shift Omaha-Rochester advancing 50 to 75 miles southeastward. Relatively moist air to south will continue to increase in moisture content over-running and causing solid sheet overcast Indiana, Illinois, northern Missouri, southeastern Minnesota, southern Wisconsin, and eastern Iowa. Intermittent scattered light rains occurring over eastern Nebraska and through Missouri, Iowa, and southern Wisconsin will become more general and increase in intensity attended by increasing fog conditions central and eastern Iowa northeastward to southwestern Wisconsin. Ceilings 3,000 to 6,000 and visibility 3 to 6 miles this area except 500 to 1,000 and ¾ to 1½ miles eastern Nebraska, western Iowa lowering to these limits by 7 p. m. central Iowa and by 11 p. m. northwestern Missouri, eastern Iowa, and southwestern Wisconsin. Scattered to broken clouds ceilings 3,000 or higher visibility 6 miles or better eastern and western Minnesota, northern Wisconsin, western Iowa, eastern Montana, and over the Dakotas and Nebraska."

0330 1130C AWY FCST 4/5
KCOH KCAB KCTS KCID LSOL LSPS STP WK WRM FRONT DVLPG OVER CNTRL KAN WILL MOV SLWLY NEWD CAUSING CLDNS TO THKN AND LWR ERN KAN NWRN MO AND SWRN IA AS THE WRM AIR OVRNS THE COLD AIR TO THE NE WITH CIGS LWRG TO 4 TO 6 THSD STP UNSTABLE AIR OVR IND CAUSING BRKN TO OVC CLDNS AT 2 TO 3 THSD WITH SNW FLRYS BCMG MORE STABLE AFTR ABT 7AM WHEN CLDNS WILL DCRS STP BRKN OR SCTD HI CLDS WILL PVL ERN AND SRN MO NEBR OKLA AND NWRN ARK WHILE CLR OR SCTD HI CLDS WILL CONT NWRN TEX AND NERN NM STP VSBYS WILL DCRS TO ½ TO 1 MILE FROM NWRN TEX NEWD OVR KAN ACCT STG GSTY WNDS CAUSING DUSTY CNDS STP VSBYS NM MO ERN OKLA SRN ILL SWRN IND WILL RMN ABV 6 MILES STP

The above forecast would be translated as follows: "3:30 a. m. to 11:30 a. m., central standard time, airway forecast, April 5. Kansas City to Omaha, Kansas City to Albuquerque, Kansas City to Tulsa, Kansas City to Indianapolis, St. Louis to Oklahoma City, St. Louis to Memphis. Weak warm front developing over central Kansas will move slowly northeastward causing cloudiness to thicken and lower eastern Kansas northwestern Missouri and southwestern Iowa as the warm air overruns the cold air to the northeast with ceilings lowering to 4,000 to 6,000. Unstable air over Indiana causing broken to overcast cloudiness at 2,000 to 3,000 with snow flurries becoming more stable after about 7 a. m. when cloudiness will decrease. Broken or scattered high clouds will prevail eastern and southern Missouri, Nebraska, Oklahoma, and northwestern Arkansas while clear or scattered high clouds will continue northwestern Texas and northeastern New Mexico. Visibilities will decrease to ½ to 1 mile from northwestern Texas, northeastward over Kansas account strong gusty winds causing dusty conditions. Visibilities New Mexico, Missouri, eastern Oklahoma, southern Illinois, southwestern Indiana will remain above 6 miles."

2230 0630P AWY FCST 3/12
PDSA PDMD PDSL SAMX POSM STP WRM FRONT CSDRBL DSTC OFF OREG WASH CST CAUSING PREFRONTAL RAIN WHICH WILL CONT TO INCR IN INTSTY WRN OREG AND SPRD SLWLY NWD AND EWD RCHG PUGET SOUND AREA BY 2AM AND OREG IDA BDR BY END OF PRD STP OVC WILL CONT IN OREG AND SW WASH WITH BRKN CLDS NW WASH BCMG OVC BY 3AM STP SCTD HI CLDS SW IDA WILL INCR TO OVC AFTER 3AM STP OVR XTRM ERN WASH NRN AND ERN IDA NWRN UTAH AND WRN MONT THERE WILL BE SCTD TO BRKN INCRG HI CLDS STP CIGS OREG 2 TO 4 THSD WITH SCUD AT 1 THSD W OF CASCDS STP CIGS WRN WASH WILL LWR FROM UNL AT BGNG TO 4 TO 2 THSD AFT 4AM STP CIGS ERN WASH IDA ERN MONT AND NRN UTAH ABV 4 THSD BUT LWRG SLWLY SW IDA AFTR FRMG OVC STP VSBY 3 TO 6 IN RAIN AREA IN OREG AND WRN WASH AND LCLY ZERO TO ½ MILE

IN FOG PTCHS SW OREG STP CIG ZERO TO 3 HND AND VSBY ZERO TO ½ MILE OVR SUMMITS OREG CASCDS AND BLUE MTNS WITH LGT TO MDT SNW STP VSBY IDA NRN UTAH ERN WASH AND WRN MONT UNL STP

The above forecast would be translated as follows: "10:30 p. m. to 6:30 a. m., Pacific standard time, airway forecast, March 12. Portland to Seattle, Portland to Medford, Portland to Salt Lake City, Seattle to Missoula, Pendleton to Spokane. Warm front considerable distance off Oregon–Washington coast causing prefrontal rain which will continue to increase in intensity western Oregon and spread slowly northward and eastward reaching Puget Sound area by 2 a. m. and Oregon, Idaho border by end of period. Overcast will continue in Oregon and southwest Washington with broken clouds northwest Washington becoming overcast by 3 a. m. Scattered high clouds southwest Idaho will increase to overcast after 3 a. m. Over extreme eastern Washington, northern and eastern Idaho, northwestern Utah, and western Montana there will be scattered to broken increasing high clouds. Ceilings Oregon 2,000 to 4,000 with scud at 1,000 west of Cascades. Ceilings western Washington will lower from unlimited at beginning to 4,000 to 2,000 after 4 a. m. Ceilings eastern Washington, Idaho, eastern Montana, and northern Utah above 4,000 but lowering slowly southwest Idaho after forming overcast. Visibility 3 to 6 in rain area in Oregon and western Washington and locally zero to one-half mile in fog patches southwest Oregon. Ceiling zero to 300 and visibility zero to one-half mile over summits Oregon Cascades and Blue Mountains with light to moderate snow. Visibility Idaho, northern Utah, eastern Washington, and western Montana unlimited."

(*b*) *Terminal forecasts.*—Examples of terminal forecasts follow:

CV TRML STP CLR TO SCTD HI CLDS STP VSBY OVER 6 UNTIL 1AM LWRG THRFTR TO 3 TO 4 ACCT SMOKE

OH TRML STP OVC WITH LGT RAIN AND MXD SMOKE AND FOG CIG 2 TO 4 HND VSBY ½ TO 1 MILE UNTIL 10AM WHEN SVR WIND SHFT WITH RAIN CHGNG TO SNOW AND SVR SQALS WILL OCCUR LWRG CIG AND VSBY TO ZERO STP GRDL IPVT AFT 11AM BCMG CIG 5 THSD OR MORE VSBY 6 OR BTR WITH SNW ENDING BY END OF PRD STP STG GSTY SFC WNDS DURG AND AFT PSG SHFT SVR ICG IN CLDS PRIOR TO PSG OF SHFT

CG PI ZD TRMLS STP HI AND LWR BRKN CLDS TO OVC AT 5 THSD OR HIR THKNG AND LWRG TO NEAR 3 THSD WITH SHWRS AND MLD TSTM ACTVTY AFT 1PM STP VSBY 6 MILES OR BTR XCPT NEAR 3 DURG RAINS

HR TRML STP STP BRKN CLDS TO OVC AT 3 THSD OR HIR SLWLY CLRG AFT 2PM STP VSBY 6 MILES OR BTR

The above terminal forecasts would be translated as follows:

"Cleveland Terminal. Clear to scattered high clouds. Visibility over 6 until 1 a. m. lowering thereafter to 3 to 4 account smoke."

"Omaha Terminal. Overcast with light rain and mixed smoke and fog; ceiling 2 to 4 hundred visibility ½ to 1 mile until 10 a. m., when severe wind shift with rain changing to snow and severe squalls will occur lowering ceiling and visibility to zero. Gradual improvement after 11 a. m. becoming ceiling 5,000 or more, visibility 6 or better with snow ending by end of period. Strong gusty surface winds during and after passing shift; severe icing in clouds prior to passing of shift."

"Chicago, Peoria, Springfield Terminals. High and lower broken clouds to overcast at 5,000 or higher thickening and lowering to near 3,000, with showers and mild thunderstorm activity after 1 p. m. Visibility 6 miles or better except near 3 during rains."

"Huron Terminal. Broken clouds to overcast at 3,000 or higher slowly clearing after 2 p. m. Visibility 6 miles or better."

PART IX.—INSTRUCTIONS FOR INSTALLATION AND OPERATION OF INSTRUMENTS FOR AIRWAY AND OFF AIRWAY STATIONS

901. The information and instructions given below cover the essentials of standard installations of instrumental equipment at airway, code-sequence and off-airway stations, and in part for those at airport stations. Installations at airport stations are handled mostly by special correspondence and a circular of general information entitled, "Quarters and Instrumental Equipment for Weather Bureau Stations at Airports," is especially required for the initial planning.

CHAPTER I

STANDARD INSTRUMENTAL EQUIPMENT

902. **Airway Stations.**—The completeness and scope of equipment depends largely upon the frequency and kind 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 frequently by teletype or other means. Airway stations are usually equipped as follows:

One shelter, airway, with thermometer or psychrometer.
One exposed thermometer; or one psychrometer (without handle).
One psychrometer fan (when needed).
One one-sixtieth mile anemometer, complete with cups and wrench, when used. (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; or supports, for erection on beacon-light towers.
One contacting wind-vane bearing, 4-contact or 8-contact.
One 3-foot metal wind vane.
One indicator, wind direction and velocity, 4-light or 9-light.
One projector, ceiling light.
One clinometer.
Ceiling balloons, inflation equipment and timing (Wasp) clock.

903. When code-sequence observations are required at airway stations, the equipment is expanded to include the instruments, etc., listed below for 6-hourly reporting stations, a cotton-region shelter and psychrometer fan being substituted for the small airway shelter.

904. **Six-Hourly or Off-Airway Reporting Stations.**—Observations from this network of stations are required primarily in connection with weather forecasts along airways, and their instrumental equipment is essentially as follows:

One cotton-region instrument shelter with support.
One psychrometer (without handle).
One psychrometer fan.
One maximum and one minimum thermometer.
One Townsend thermometer support.
One 1/60-mile anemometer with cups and wrench (when needed); also special oil as mentioned for airway stations.
One support, wind-instrument, 12-foot, complete with anemometer cross arm.
One contacting wind-vane bearing, 4-contact or 8-contact.
One 3-foot metal wind vane.
One indicator, wind-direction and velocity, 4-light or 9-light.
One mercurial barometer with shielded board for mounting.
One barograph, open-scale.
One 8-inch rain and snow gage with box support.

905. 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.

151480—39——11

906. 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.

907. **Airport Stations.**—At airport stations a large-sized standard shelter with steel support is usually substituted for the airway shelter or very occasionally a cotton-region shelter with psychrometer fan 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 and a 17-foot support are used instead.

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

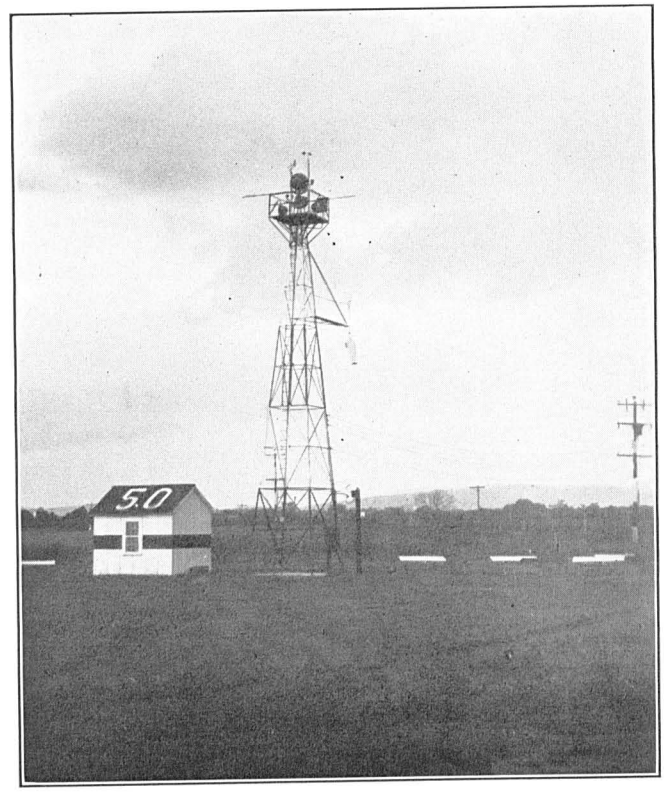


FIGURE 6.—Beacon-light tower with anemometer and wind vane mounted on separate 7-foot pipe supports erected on platform at apex.

CHAPTER II

WIND INSTRUMENTS

909. **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.

910. **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. The latter is also used at off-airway stations.

911. **Tower Support for Anemometer or Wind Vane.**—The tower support, figure 6, 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.

912. 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 sub-

mitting requisitions for supports, state the kind of platform with which the tower is equipped.

913. As shown in figure 7, the 1-inch pipe of the support is anchored to the tower handrailing by an angle iron 18 inches long, 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.

914. **Twelve-Foot Wind-Instrument Support.**—The 12-foot support, figure 8, is intended for erection on the roof of a building, the combined height of building and support being sufficient usually to give the anemometer a reasonably free exposure.

915. 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, one shoe for each of the three guy rods.

916. 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.

917. **Eighteen-Foot Wind-Instrument Support.**—This support, illustrated in figure 9, 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, or W. B. drawing No. 299.

918. 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 1½ by ½-inch reducing coupling at the top of the support.

919. **Anemometers.**—The anemometer consists essentially of a cup wheel rotated by the wind, rigidly attached to a vertical axis turning in bearings. In the large standard anemometer, figure 10, 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 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. 1, January 2, 1935, repeated in this circular as table No. 7. The correction tables are also issued as a separate on a convenient card.

920. **Description of Large 3-Cup Anemometer.**—Referring to figure 10A, the cup wheel (1) is made of three hemispherical cups of duralumin or copper mounted on arms of steel tubing. 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. 10B) 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 graduation, 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).

921. **Small One-Sixtieth Mile Airway Anemometer.**—This type of anemometer illustrated in figure 11 was introduced about the beginning of the year 1938. It is much smaller than the standard type described above, being only about 7 inches high, and equipped with 3 conical cups on arms, 733 turns of the cups corresponding to 1 mile of

wind movement. Since there are no dials in the instrument or mile contacts, its use is confined entirely to the indication of velocity, and therefore meets the need for a simple, inexpensive instrument for airway observations and similar usage. Instructions for its care and operation will be found in chapter VIII.

922. **Wind Vanes.**—The vane generally used, figure 12, consists of a plate of metal forming a tail attached to one side of a vertical axis free to rotate in response to changes

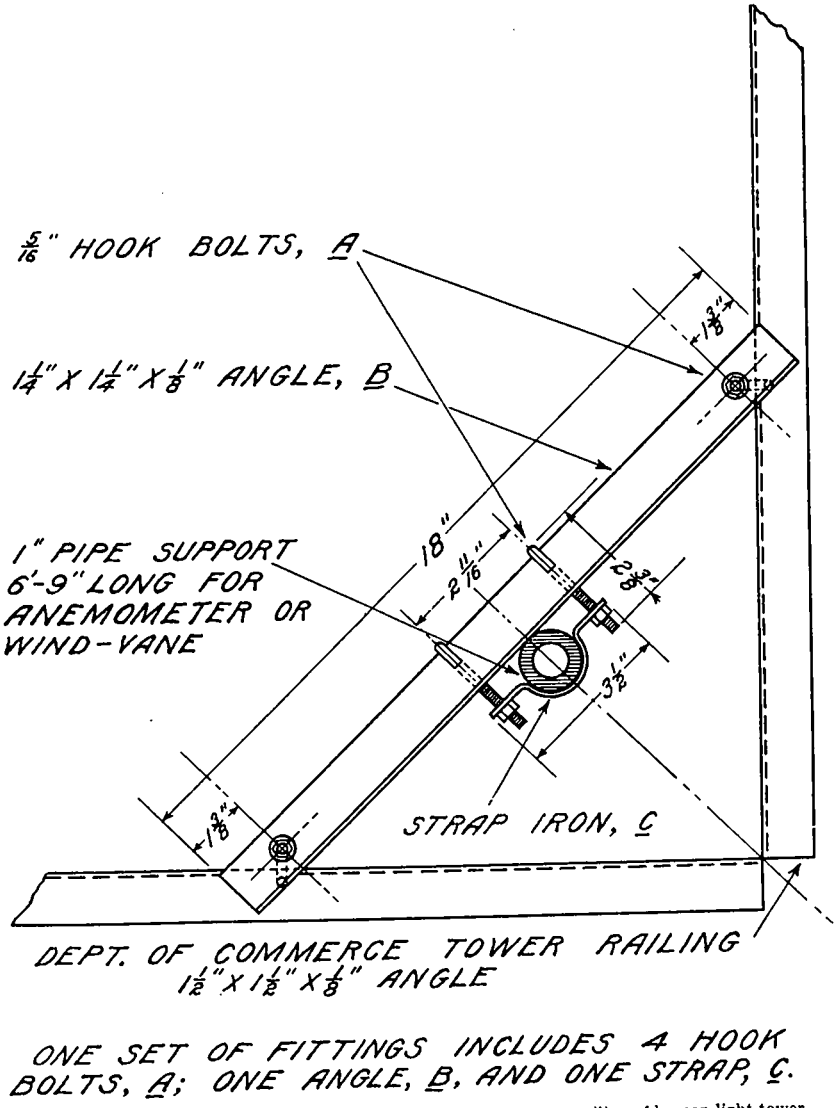


FIGURE 7.—Clamp to hold anemometer or wind-vane support to railing of beacon-light tower.

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.

923. **Four-Contact Wind-Vane Bearing.**—As shown in both figures 12 and 13, 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 wind-vane 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 wind-vane clamping nut.

924. **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.

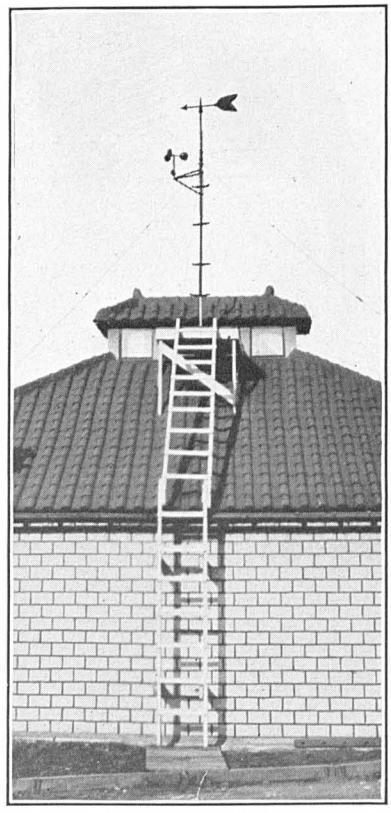


FIGURE 8.—Twelve-foot wind-instrument support on roof of building.

925. **Orienting.**—This 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 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.

926. **Indicators.**—These are for use in making observations of the wind and are of two principal kinds: One for wind velocity, the other for both the direction and velocity, the latter being much more frequently employed.

927. **Velocity Indicators.**—These are comprised simply of a board 8 by $10\frac{1}{2}$ 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. Excepting for the addition of the direction lamps and binding posts, it is essentially the same as the indicator shown in figure 15. 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.

151480—39——12

928. **Wind-Direction and Velocity Indicator, Board Type.**—This includes four 6- to 8-volt automobile-type lamps for the indication of wind direction in addition to the velocity buzzer. These lamps are 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.

929. **Eight-Contact Wind-Vane Bearing** (fig. 14).—This consists of the following parts: A short length of standard half-inch pipe, with keyway bushing forming the top bearing and a pivot support forming the lower bearing; one wind-vane axis with special cam and a rigidly attached weather housing; one set of insulated 8-contact springs mounted 45° apart on a brass collar fitted to the half-inch pipe; one wind-vane clamping nut.

FIGURE 9.—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.

930. **Nine-Light Wind-Direction and Velocity Indicator** (fig. 16).—This consists of a round metal box having a dial front with the direction lamps located around the periphery. At the center of the dial is a flashing lamp for indicating the velocity of the wind. A single direction lamp indicates the position of the vane to within 11¼°, approximately. For example, the north lamp is lighted when the position of the vane is within 11¼° on either side of the north. When two direction lamps are burning, the position of the vane is within 11¼° of a point midway between the two. In addition to the lamp for indicating the velocity, a buzzer is installed within the metal box for audible indication. The wind velocity in miles per hour is the number of flashes or buzzes per minute caused by the closing of the one-sixtieth-mile contact of the anemometer; subject, of course, to the anemometer correction. Current for the lamps and audible signal is supplied from a transformer, located within the indicator, which in turn is connected by means of an attachment plug and flexible cord to an alternating current outlet of about 110 volts. The dial may be removed from the indicator by a straight pull. When replacing dial, see that alignment pin in bottom of indicator enters slot in bezel, and press until latch buttons engage locking grooves. Lamps may be removed by pressing slightly and turning to the left.

931. The three switches projecting from the bottom of the case control, in order, from left to right, the direction lamps, the buzzer, and the velocity lamp. The switches should be turned off when the indicator is not being used in order to increase the life of the lamps.

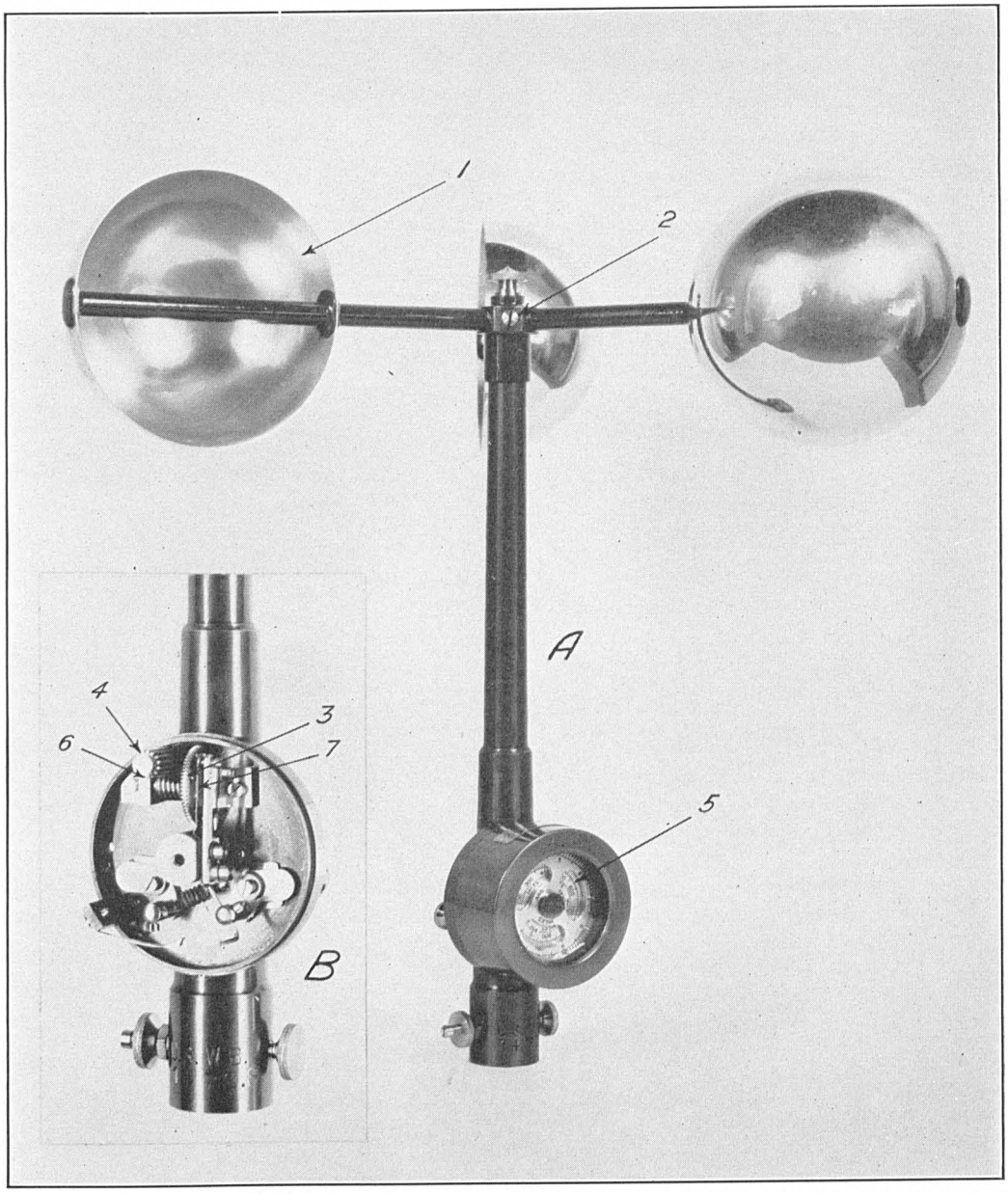


FIGURE 10.—Three-cup one-sixtieth mile anemometer, "A" showing complete instrument; "B" anemometer with dials removed.

932. **Installation and Wiring.**—To install the indicator, screw or bolt the casting in place. If bolts are used, drill two 7/32-inch diameter holes on a horizontal line, 4⅜ inches apart. A ¾-inch hole is sufficient to carry all the wires through the panel or wall; for ¾-inch conduit fitting, drill a 1 1/16-inch hole. Connect wire marked "G" to

ground connections on wind instruments, employing some convenient screw or bolt when anemometer has no ground binding post; "V" to 1/60-mile anemometer binding post, and the direction wires to proper direction contacts of the wind-vane bearing.

933. To set up the wind-vane bearing for use, screw the lower end of the half-inch pipe into a standard half-inch pipe fitting in such a manner that the bearing will be firm and vertical in the desired position. Next, loosen the two set screws in the brass ring carrying the contacts, rotate until the contact marked "N" stands truly north, and lock in place by retightening the set screws. Ten No. 16 wires, cable or single conductor, should be used between the wind instruments and the indicator at stations where no indicator has previously been installed; on old installations, cable having fewer conductors may be added to take care of the greater number of direction lamps.

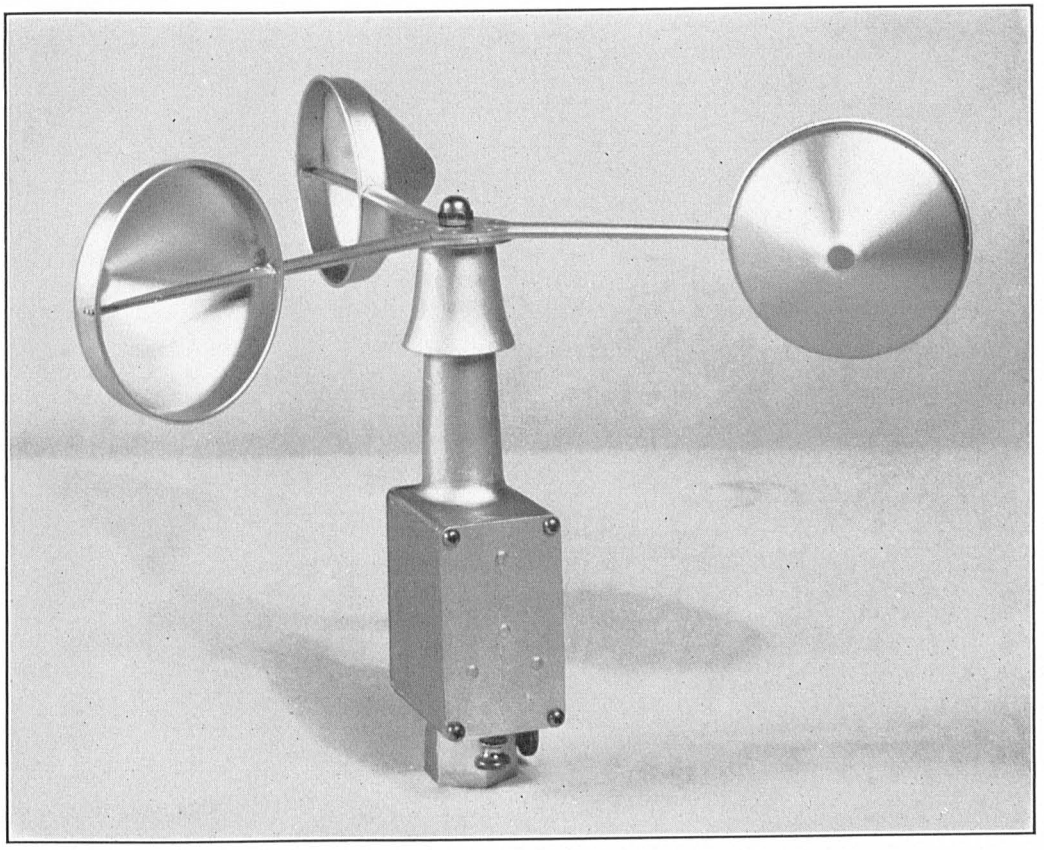


FIGURE 11.—Three-cup one-sixtieth mile anemometer, small size without dials.

934. After the wiring has been completed, insert in the pipe bearing about 1½ fluid ounces of oil of a quality that will not solidify at the winter temperature expected. Insert the wind-vane axis, being careful to rotate it slowly to *feel* the key into the keyway in the top bearing. In placing the vane on the axis, care should be exercised to see that the positional pin is properly oriented with respect to the arrow head of the vane. If the pin is found to be on the wrong side of the vane it may be reversed by removing the two set screws at the sides of the weather shield and rotating the shield 180°. After placing the vane on the axis the indications should be checked by two observers, one holding the vane in its several positions, the other observing the corresponding indications in the office.

935. **Diagram of Circuits.**—Figure 17 indicates the connections required between contacting bearing, anemometer, and indicator. For multiple operation of two or more indicators, see wiring diagram W. B. No. 339, and special instructions for installation of 8-direction and velocity indicators combined with 4-direction triple register, both obtainable from the Instrument Division.

936. For best results the eight-direction indicators should not be placed more than 375 feet (cable distance) from the wind instruments. This distance, however, may be increased up to approximately 625 feet (cable distance), provided the buzzer may be dispensed with and the lamp alone used for the velocity. Local line voltage and other conditions have a direct bearing upon the maximum distance between indicator and wind instruments; consequently this distance will not be the same in all cases.

937. **Wiring of Anemometers and Four-Light Indicators.**—The anemometers in airway service are all of the electrical-indicating one-sixtieth mile type; the wind vanes either indicating or nonindicating.

938. When using any of the several indicators, wire from the two velocity-indicator binding posts to the anemometer, employing cable with No. 16 conductor wires, lead or braid-covered as desired. Lead-covered cable is often desirable for more or less permanent installations, especially on towers and is essential when the circuit from a tower is to be buried underground; otherwise use 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.

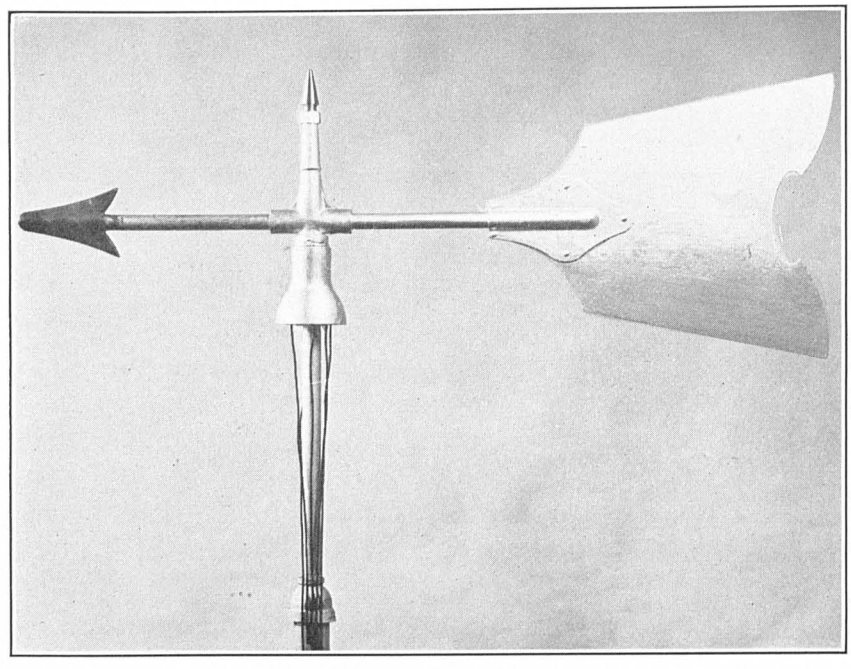


FIGURE 12.—Three-foot metal wind vane with contacting bearing, four contacts.

939. As shown in the circuit diagram, figure 18, the *combined direction and velocity* four-light indicator requires one wire to each of the four 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. Wiring of the newer nine-light indicator is covered above.

940. **Transformer-Operated Indicators.**—These require connection 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, and should be as

short as practicable, and the light socket or other outlet or switch so placed as to be convenient to the observer. 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 one or two of the direction lamps are lighted, giving the direction of the wind.

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

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

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

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

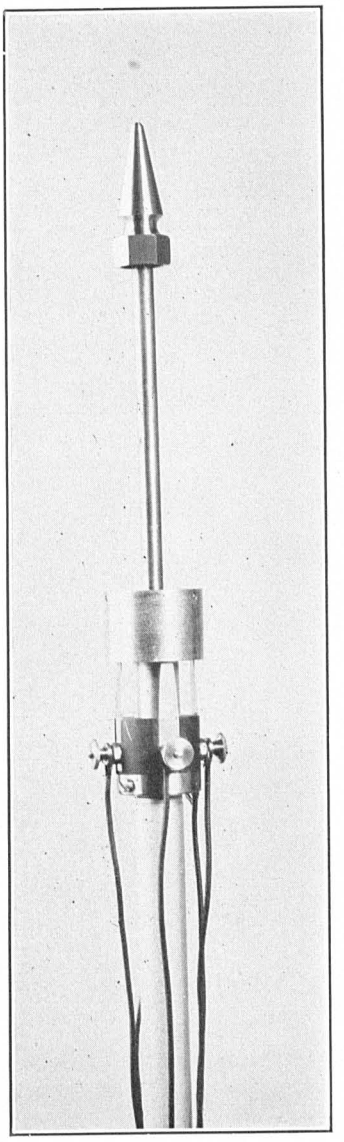


FIGURE 13.—Four-contact wind-vane bearing with shield removed.

CHAPTER III

PRESSURE-MEASURING INSTRUMENTS

945. Airport and airway stations are frequently equipped with ruggedly constructed aneroid barometers of the type described below.

946. **Aneroid Barometers.**—Referring to figure 19, 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.

947. **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.

948. **Mercurial Barometers.**—Mercurial barometers are used at airport, code-sequence and 6-hourly stations. 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."

949. Comparisons of mercurial barometers at airport stations will be submitted quarterly to the central office on Form 1027 in March, June, September, and December, on the 15th of the month, or the 16th if the 15th falls on Sunday, in accordance with special instructions.

950. **Exposure.**—Briefly stated, mercurial barometers should be located where they are not unduly subject to vibration, to extremes of heat or cold, to rapid

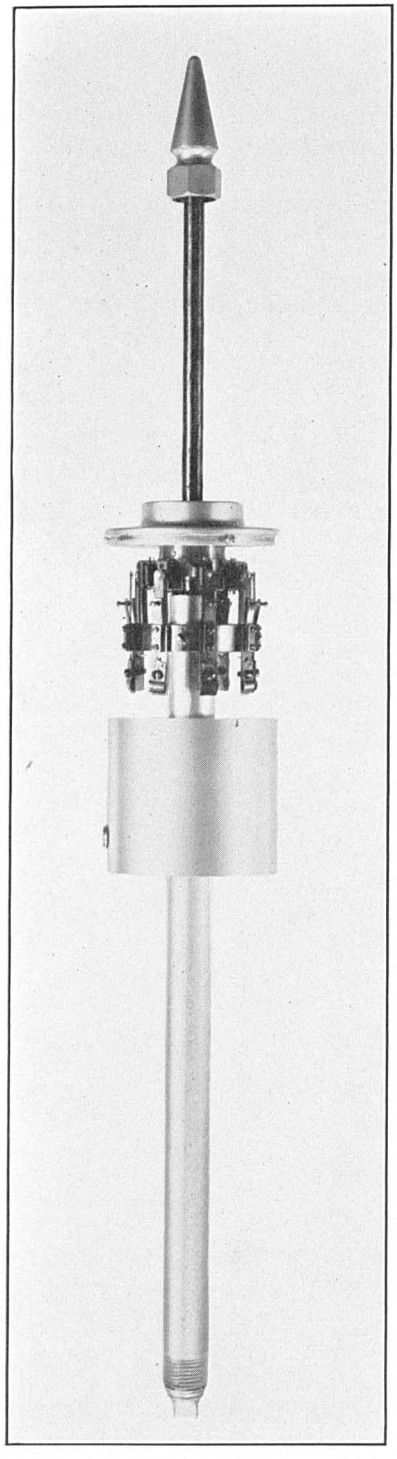


FIGURE 14.—Contacting wind-vane bearing with shield removed, eight contacts.

variations of temperature, 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.

951. **Description of Mercurial Barometer.**—Referring to figure 20, which shows the Fortin-cistern barometer, the standard in Weather Bureau service, mounted on a shielded barometer board, (1) is the glass tube having an inside diameter of nearly one-fourth inch. This is inclosed in a thin brass tube (2) having openings on opposite sides near the top through which the height of the mercury in the tube within is measured on the scale (3) and by the vernier (4) to the nearest thousandth of an inch. The vernier (4) is attached to a second tube free to slide within tube (2), the motion being produced by a rack and pinion, the knurled head of the latter being seen at (5). The attached thermometer (6) has its bulb placed between the metal case and the barometer tube proper so as to indicate approximately the mean temperature of case and mercury. The cistern (7) is of the Fortin type, the special feature being the manner of adjustment of the mercury to the fixed ivory point forming the zero of the scale. The raising and lowering of the mercury is accomplished by means of the screw (8), the inner or upper end of which acts on the kid-leather bag forming the bottom of the cistern proper. Details of the cistern are shown in figure 20 (B). Air passes into it through the flexible leather joint between the upper boxwood portion and the glass tube. The brass ring (9) figure 20 (A) engages a hook whereby the instrument is suspended from the top of the box or board used to house the barometers. Verticality of the barometer is secured by allowing it to come to rest under gravity when suspended from the hook and then clamping the cistern end by means of the three screws in ring (10) attached to the back of the box.

952. **Barometer Scales.**—These should be so chosen as to permit of reading the lowest pressures likely to occur where the barometer is used. It is customary to subtract 1½ inches from the mean station pressure to obtain this minimum pressure. Barometers are usually scaled to read to a low of 26 inches for stations at ordinary elevations. Others read to 24, 22, 20, and 14 inches, which last will care for readings at any mountain observatory in the United States.

953. **Barographs** are used to determine the trend of the pressure change and its magnitude usually over a period of 3 hours, required primarily in connection with forecasting.

954. Two principal types of aneroid barographs are in service; one, the open-scale or microbarograph, figure 21A, which provides 2½ inches of pen movement over the record sheet for each 1 inch of change as given by a mercurial barometer. All the other barographs have a 1 to 1 scale, and differ among themselves as regards the pressure element, older barographs of the Richard type, figure 21B, utilizing a pile

of aneroid shells eight in number, while a more recently developed instrument employs a sylphon element instead.

955. **Exposure of Barograph.**—The barograph should be placed where it can not easily be disturbed or jarred accidentally and in a place in which the temperature is, at the same time, as nearly constant as possible. Particular care should be taken to see that the sun does not shine on it, that it is not near a stove or radiator, and that it is not near a window or door where it can be reached by sudden drafts of air from out-

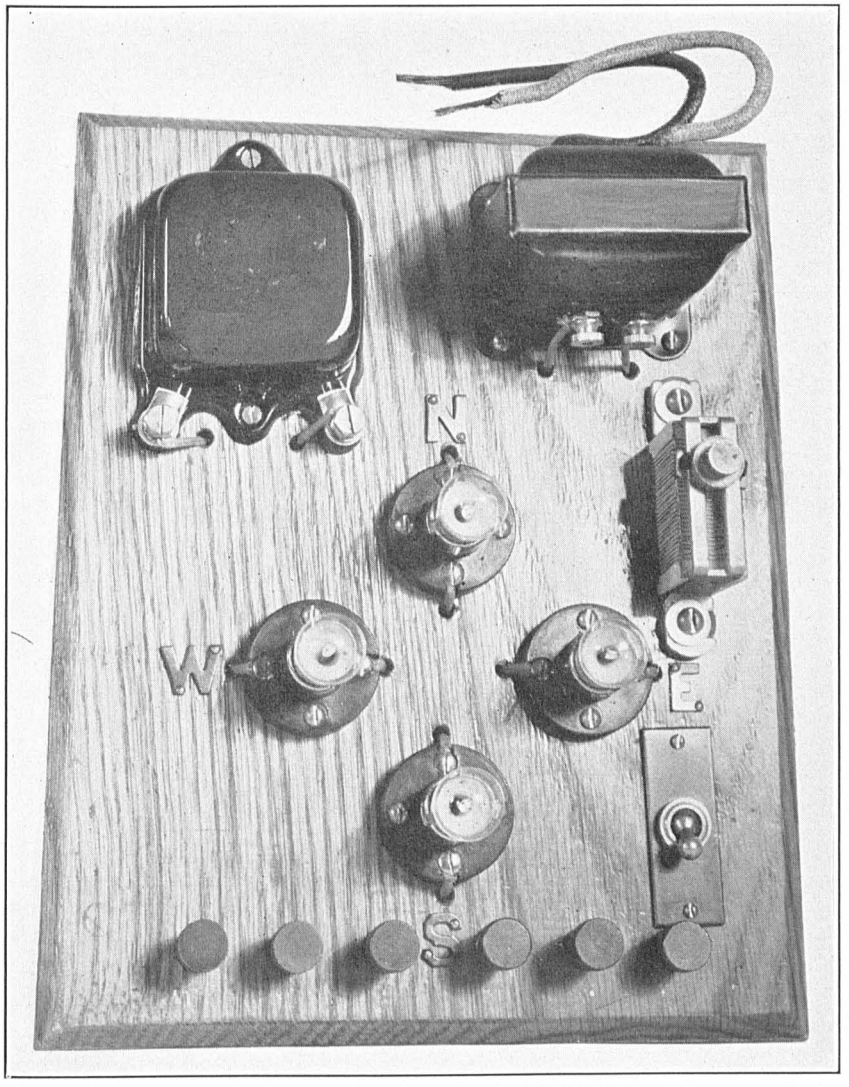


FIGURE 15.—Wind-velocity and direction indicator.

doors. If no place can be found which is free from such accidental jarring, the instrument should be supported on small sponge rubber blocks. First-order stations will inspect the records obtained from the stations which they supervise for evidences of accidental disturbances and will take steps to see that the above precaution is observed in case such evidences are found.

956. **Description of Open-Scale Barograph.**—Referring to figure 21A, the pressure element (1) consists of two joined sylphons mounted one above the other and inclosed in a cylindrical case with a thumbscrew (2) for adjusting the position of the pen (3) on

the record sheet to correspond to the true pressure as shown by synchronous readings of a mercurial barometer. Motion originating in the sylphon element due to changes in atmospheric pressure are transmitted through linkage within base (4) to the pen-arm (5). Vibrations of the stand carrying the barograph are minimized by the liquid-filled dashpot (6). The recording cylinder (7) contains a driving clock, geared to give

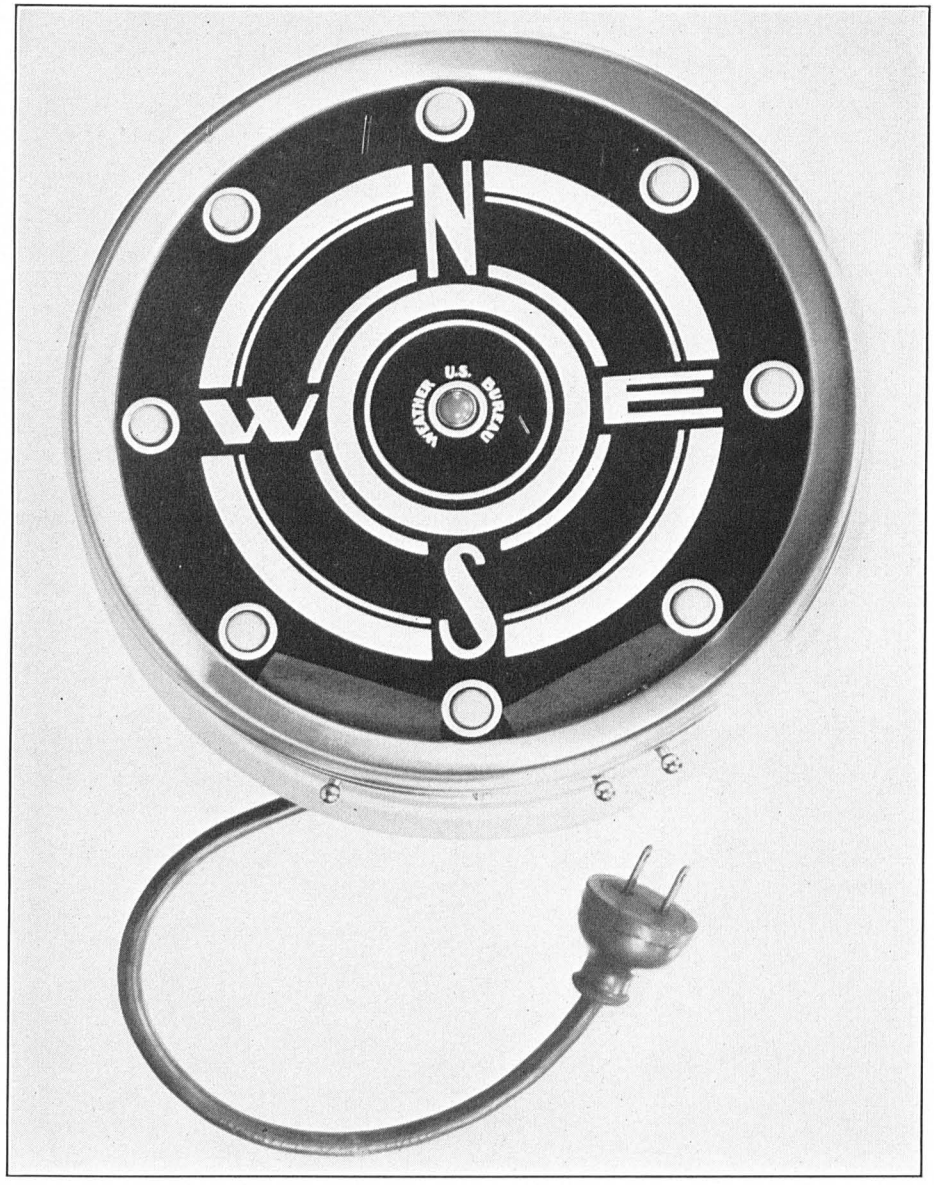


FIGURE 16.—Wind-direction and velocity indicator, nine lights.

a 4-day record in one revolution. Details regarding the charts, etc., will be found in chapter VIII. The cover (8) is made of sheet metal with glass windows, through which the record is readily seen. The device for removing the pen from the record sheet is at (9).

957. **The 1 to 1 Scale Barograph.**—(Shown in fig. 21B). In principle of operation it is the same as the larger instrument, but differing in the construction of the pressure element as above mentioned, and having all the linkage above the base. The chart

cylinder provides for a 7-day record. In the sylphon instrument, the pen adjustment is made by the thumbscrew at the extreme right hand of the base. In the Richard

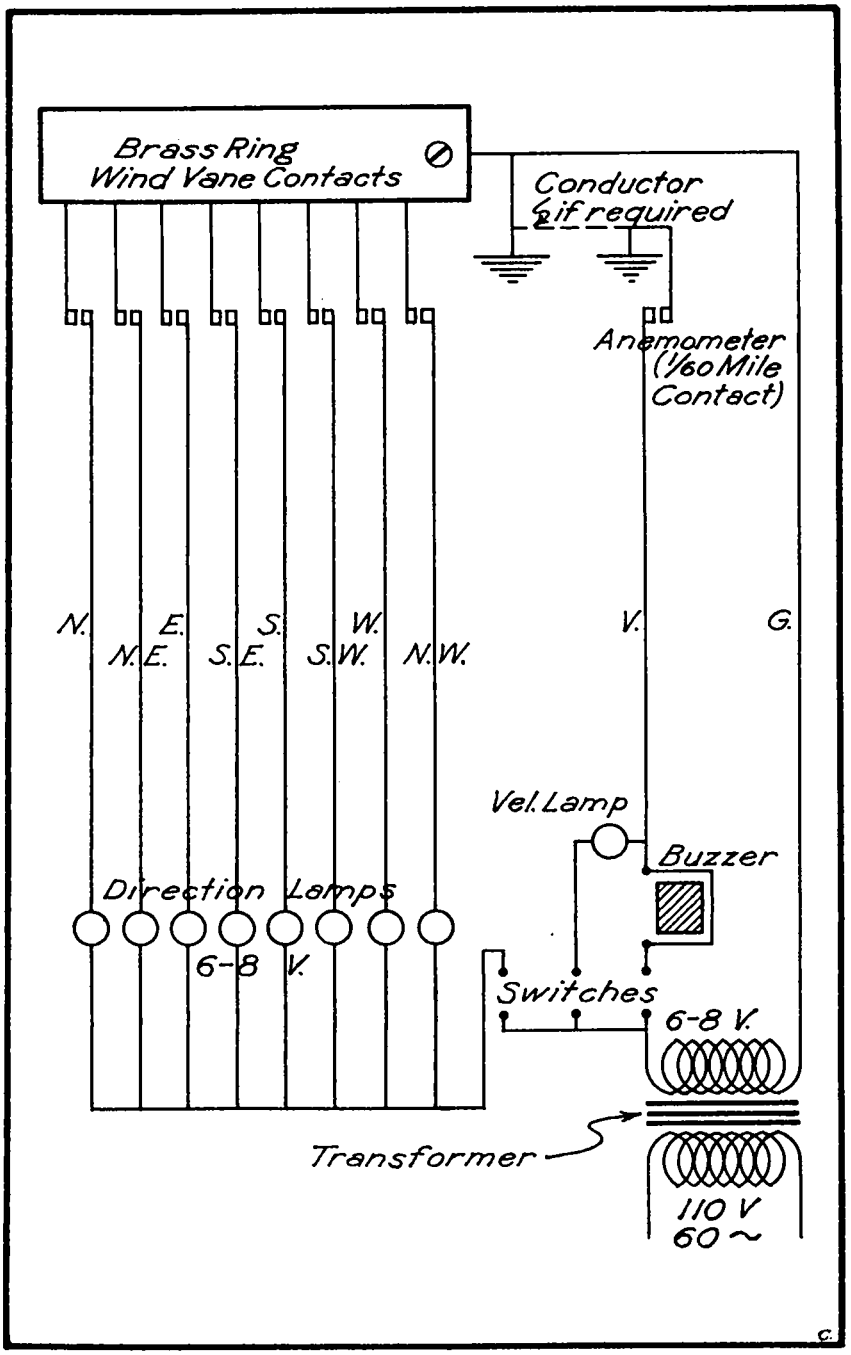


FIGURE 17.—Diagram of circuits for electrical connection of wind instruments and indicator, nine lights.

instrument a screw adjustment of the bottom aneroid shell of the pressure element reached from below is accomplished by a key to fit a squared shank, one end of a combined clock and adjustment key accompanying each instrument.

CHAPTER IV

TEMPERATURE-MEASURING INSTRUMENTS

958. **Exposure.**—A thermometer, psychrometer, 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

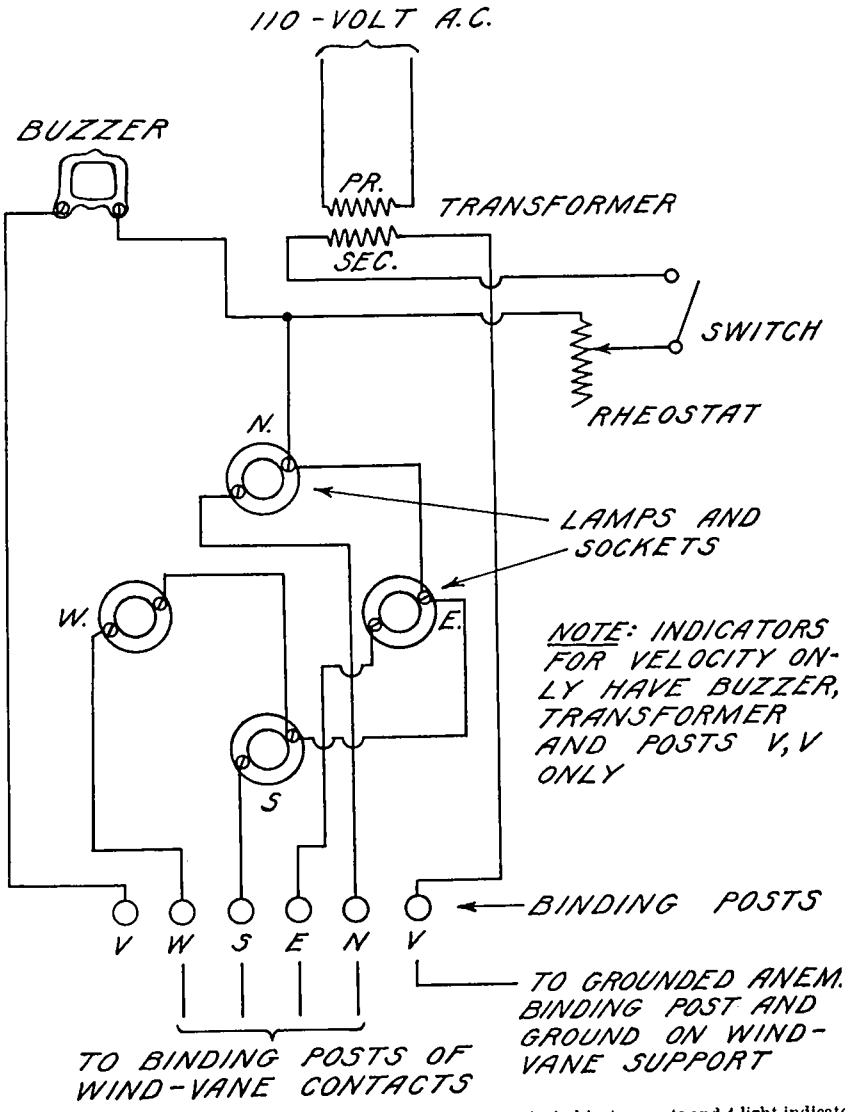


FIGURE 18.—Diagram of circuits for electrical connection of wind instruments and 4-light indicator.

the effects of artificial heat. This is accomplished by placing such instruments in a specially constructed shelter through which the air can be freely circulated. Their erection is described and illustrated below.

959. **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 22. 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.

960. For airport and off-airway reporting stations, either a large-sized standard shelter with 5- or 10-foot steel support or in most instances 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 former,

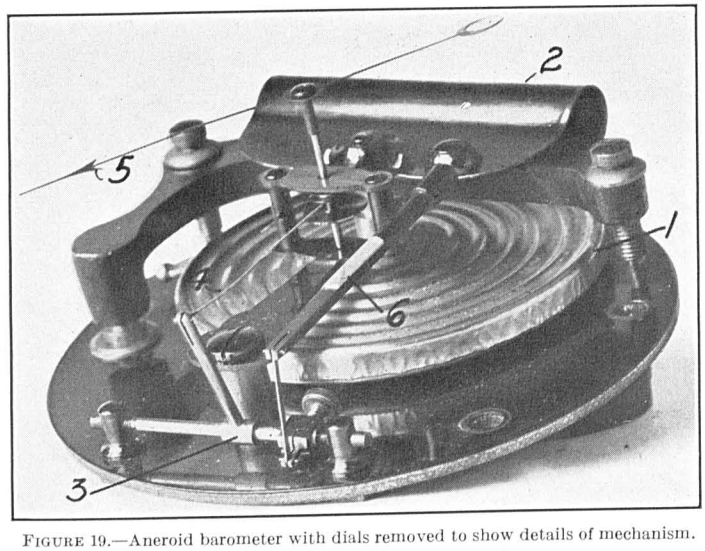


FIGURE 19.—Aneroid barometer with dials removed to show details of mechanism.

which is needed where a whirling 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." Figure 9, shows a large shelter and 5-foot steel support installed on a roof.

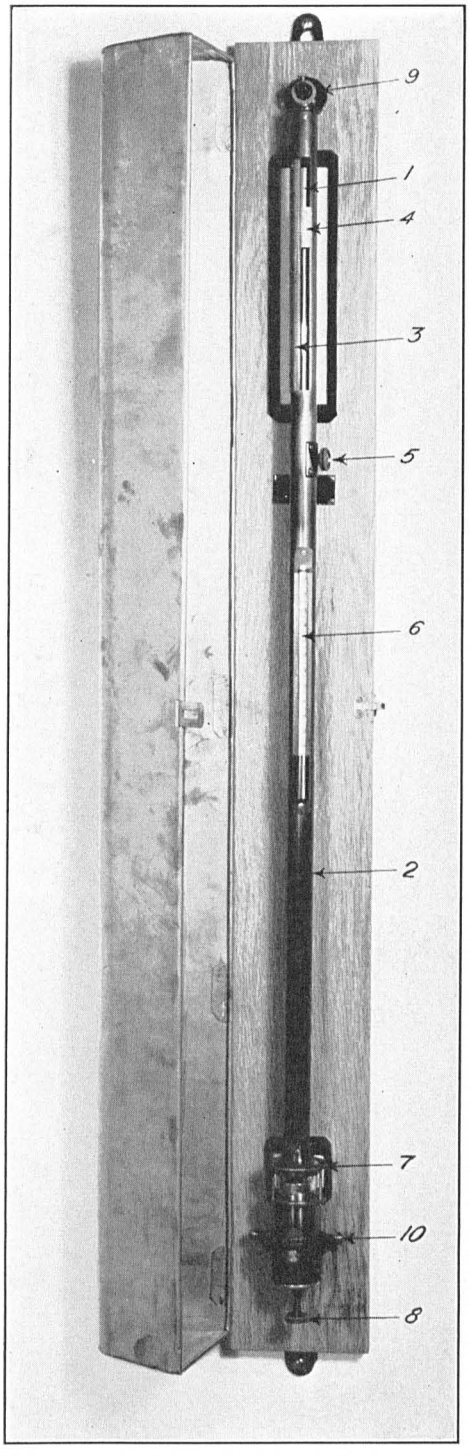
961. Shelters should be placed with the door facing approximately toward the north.

962. **Exposed Thermometers.**—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 a brass support fastened to an upright wooden post near the center of the shelter. (See fig. 22.)

963. 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.

964. **Maximum and Minimum Thermometers.**—These are included in the equipment of many reporting stations, especially the code-sequence and 6-hourly stations. In most cases the thermometers are exposed in a cotton-region shelter, mounted on a Townsend thermometer support, as is customary in the climatological service of the Weather Bureau, as illustrated in figure 25. The maximum and minimum temperatures are recorded daily. Circular B and C, Instrument Division, contains detailed information.

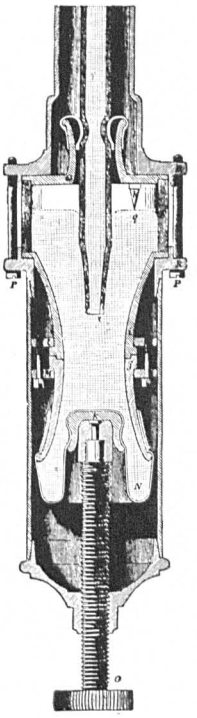
965. Where frequent observations of the psychrometer are made, requiring the use of a psychrometer fan, the ordinary exposure of the maximum and minimum thermometer support results in vibration, which, in turn, causes movement of the index of



the minimum thermometer. To avoid erroneous minimum temperature readings, the thermometer support is mounted on a post, the lower end of which is set firmly in the ground and the upper end carrying the support passes through a hole in the shelter floor enough larger than the post to prevent vibrations of the shelter from reaching the post. Either a wooden post or an iron pipe may be employed for mounting the Townsend support.

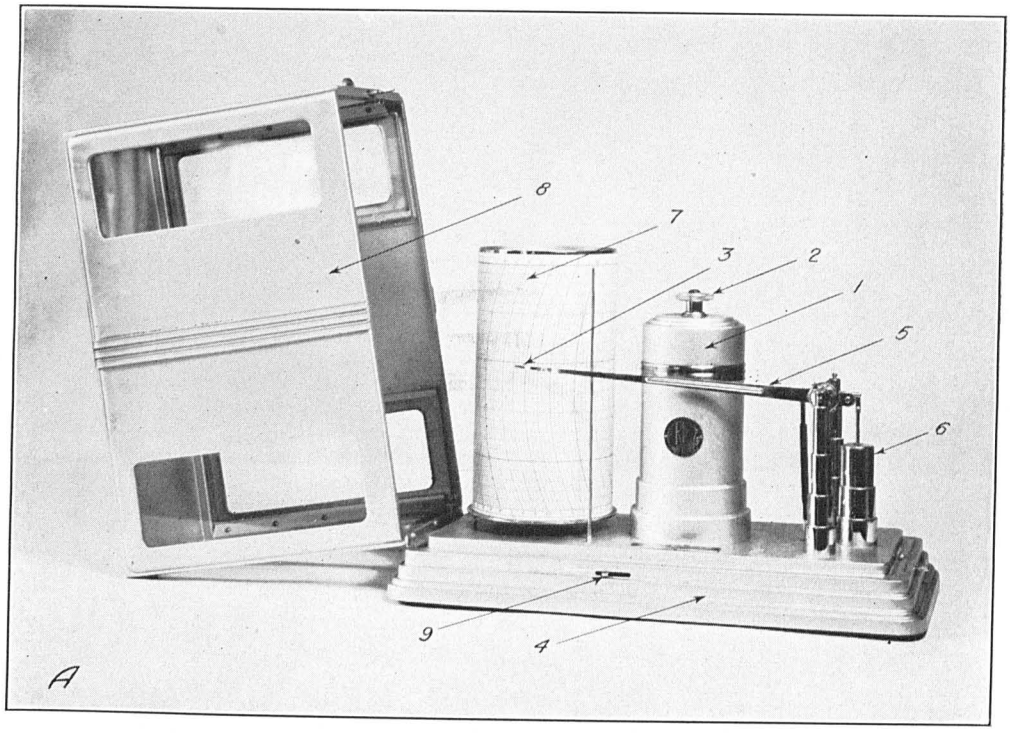
966. **Description of Maximum and Minimum Thermometers Used by the Bureau.**—All the thermometers used by the Bureau are stem-graduated by the maker, the freezing point found as usual by immersing the bulb and most of the column of mercury or alcohol in a bath of pure melting ice. The balance of the scale is determined by placing the thermometer in a temperature-controlled water or alcohol bath for temperatures above and below the freezing point, respectively, the points of the scale being fixed by comparison with a substandard thermometer, the errors of which were originally found by reference to a gas thermometer or by comparison with another mercury-in-glass thermometer whose corrections are known.

967. Corrections are found at each 10° of the scale above and below the freezing point. The range of graduations is varied to meet the great differences of temperature found in the several sections of the United States and its territories.



968. **Maximum Thermometer.**—This thermometer (fig. 26) provides a record of the highest temperature occurring at the place of exposure, from the time of setting until read. The instrument differs from an ordinary mercurial thermometer in having the bore of the tube constricted near the bulb so that mercury forced above the constriction by a rise in temperature after setting cannot readily return to the bulb, unless the thermometer is whirled about an axis near the upper end. Maximum thermometers are filled with pure mercury at a tempera-

FIGURE 20.—*A*, mercurial barometer and shielded board; *B*, cut of barometer cistern.



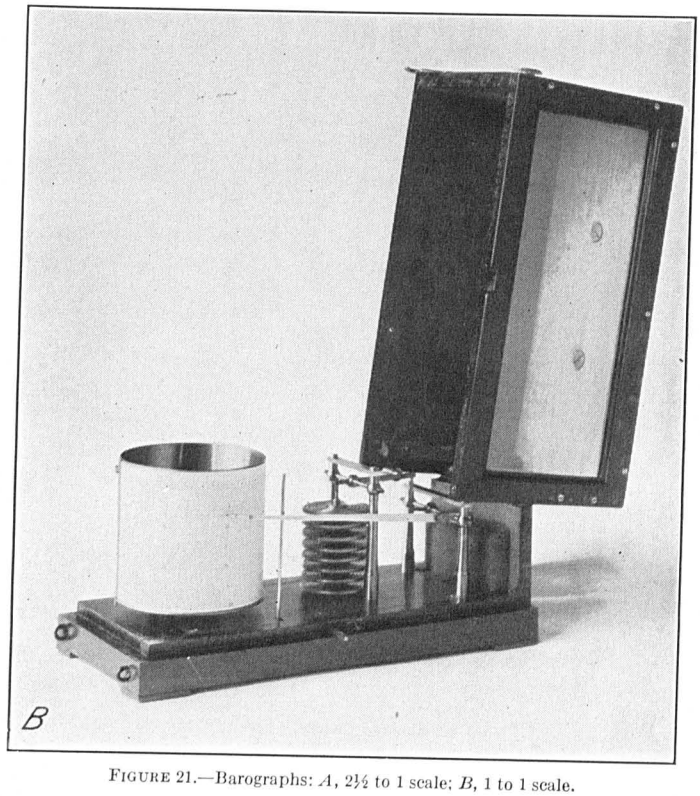


FIGURE 21.—Barographs: *A*, 2½ to 1 scale; *B*, 1 to 1 scale.

ture nearly equal to the highest the given instrument can experience, so that the space above the column at lower temperatures may be free of air. The maximum temperature for a given period after setting, usually 12 to 24 hours, is found by carefully lowering the thermometer bulb to a vertical position and reading on the scale the position of the top of the mercury column. Setting is accomplished by whirling in a suitable support until the column of mercury is continuous and no further whirling will force the mercury farther into the bulb, after which it is placed with the bulb 5° above the horizontal.

969. **Minimum Thermometers.**—These (fig. 26) provide a record of the lowest temperature occurring at the place of exposure from the time of setting until read. Uncolored ethyl alcohol is generally used to fill the tube, which is done with the bulb immersed in a mixture having a temperature of nearly zero Fahrenheit. Air is drawn into the tube at this relatively low temperature and the tube sealed, so that at higher temperatures the entrained air exerts a pressure considerably in excess of atmospheric, with the desired result that the diffusion of alcohol vapor into the air above the column and its subsequent condensation is largely prevented, thereby much increasing the accuracy of the thermometer. To provide against excessive internal air pressure at high temperatures, a small bulb is blown in the upper end of the tube. The bore of the tube is considerably larger than that of a mercury thermometer so as to provide sufficient room for the index, a double-ended piece of dark-colored glass, so shaped as to follow the movement of the upper end of the alcohol column as the temperature falls, but to remain at the lowest point when the temperature rises. As shown in figure 26, when in the set position the thermometer is placed with the bulb and about 5° above the horizontal. A scale reading of the end of the index farthest from the bulb gives the lowest temperature at the place of exposure since the instrument was last set. The setting of the thermometer is accomplished by turning it into a vertical position in the support, with bulb uppermost, when the index will fall to the end of the column. The thermometer is then returned to the original position.

970. **Exposed Thermometers.**—These are stem-graduated, mercurial thermometers employed for the measurement of free-air temperatures in a suitable shelter. When specially mounted for whirling, a pair of such thermometers comprises the wet- and dry-bulb psychrometer.

971. **Psychrometers.**—Ventilated wet- and dry-bulb psychrometers are used for humidity observations to determine the temperature of the dew point. Two kinds are employed, one which is ventilated by whirling of the thermometers, either by means of the whirling apparatus (fig. 24) installed in a large shelter (fig. 9), or by using a sling psychrometer (fig. 23) outside a shelter; the second, by drawing air past the psychrometer bulbs by means of a small hand-operated fan (fig. 22). This psychrometer fan has come into general use, psychrometer fans being adapted to both airway and cotton-region shelters. Two accurate mercury-in-glass thermometers are always required. Those used with the whirling apparatus (fig. 24) are attached to counterbalanced arms, 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. The proper ventilation of a psychrometer requires an air speed past the thermometers of about 15 feet per second, which is accomplished by the psychrometer fans in general use at airway and off-airway stations. Their mounting in an airway shelter is shown in figure 22. A small hand grinder has been adapted to turn an 8-inch fan, which draws air past a psychrometer. Instructions for their installation accompany each fan but are also given in chapter VIII. 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, carefully washed to remove the sizing. Pure, clean water is used for wetting, and the muslin must be replaced whenever it becomes at all dirty; otherwise the readings will be incorrect and practically valueless for the fog forecast. To obtain thoroughly accurate readings with a 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. When a psychrometer is used, the single exposed thermometer may be dispensed with.

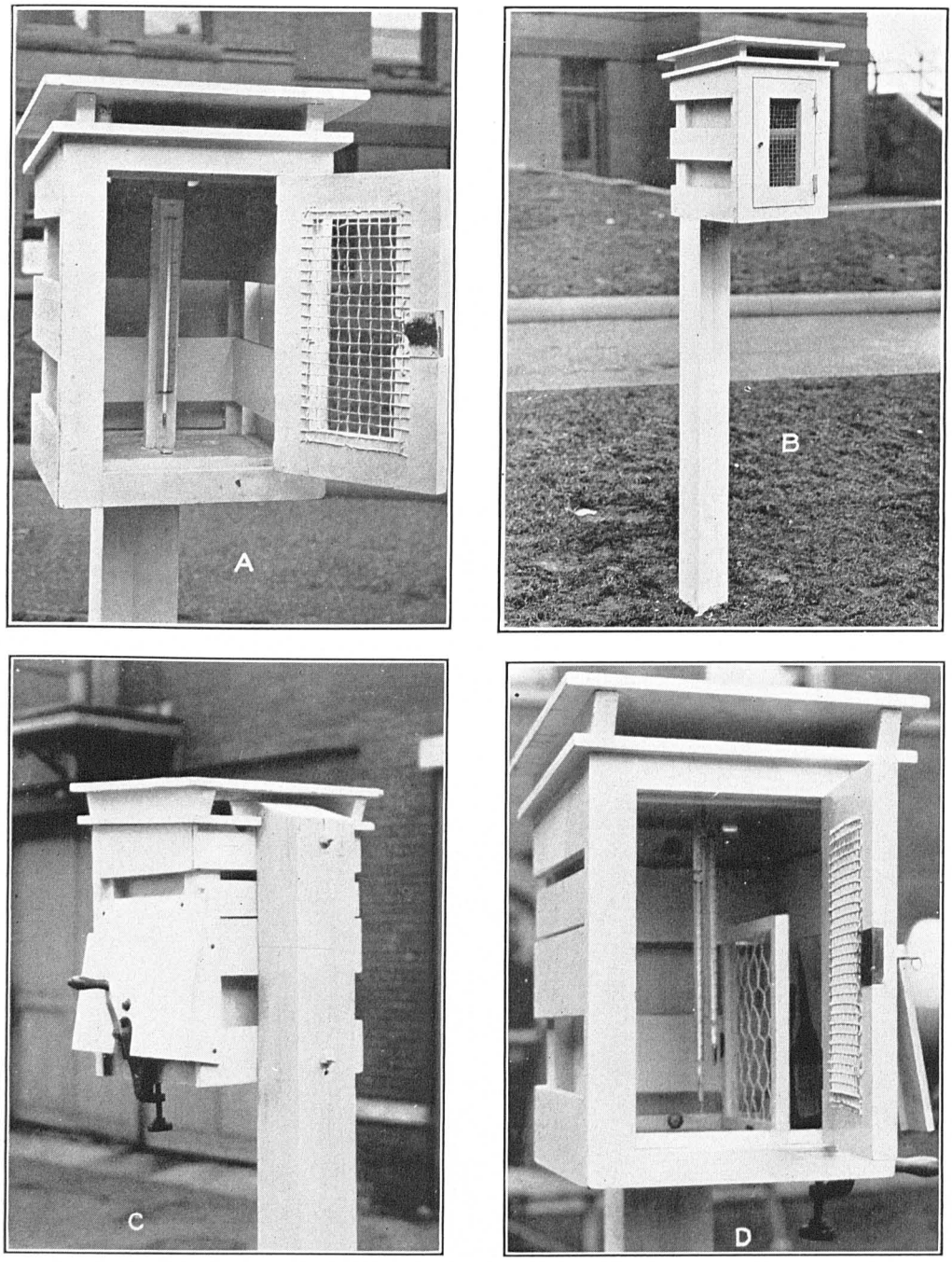


FIGURE 22.—Airway instrument shelter; *A*, showing exposed thermometer; *B*, complete shelter and post support; *C* and *D*, showing psychrometer and fan.

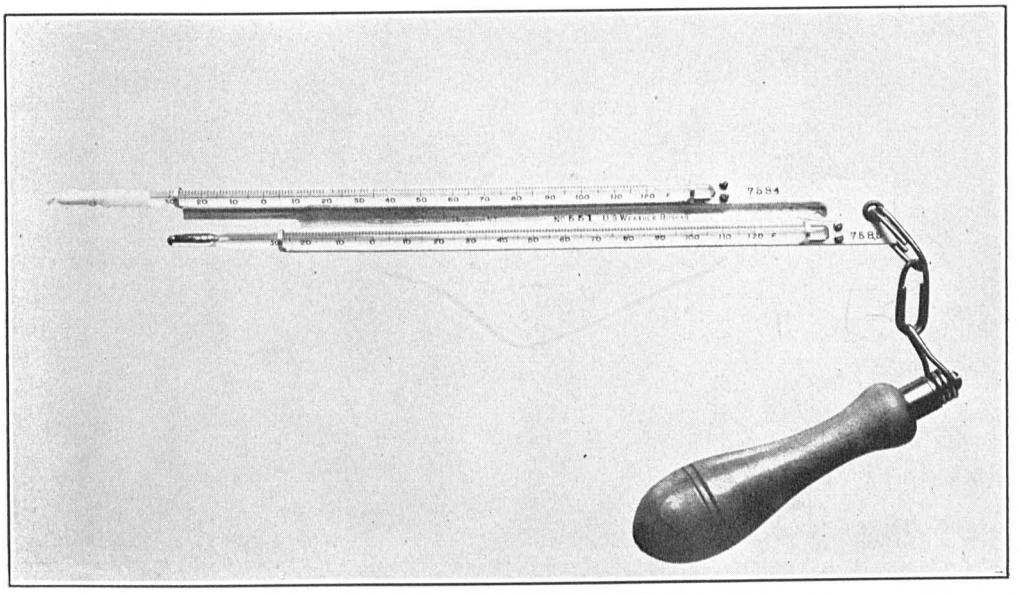


FIGURE 23.—Sling psychrometer.

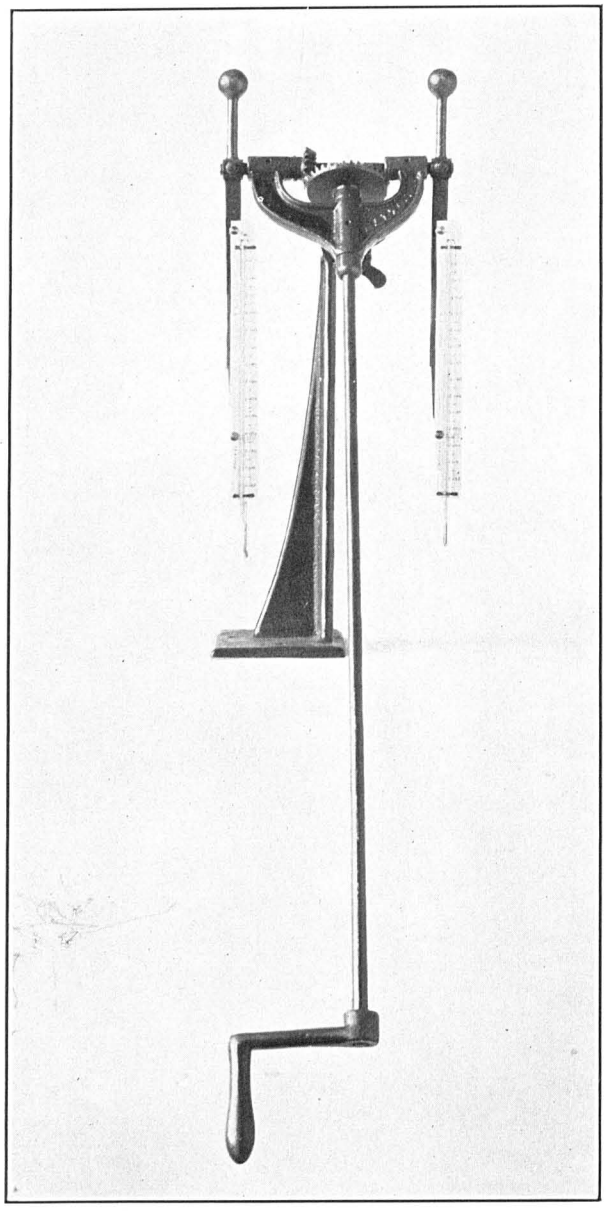
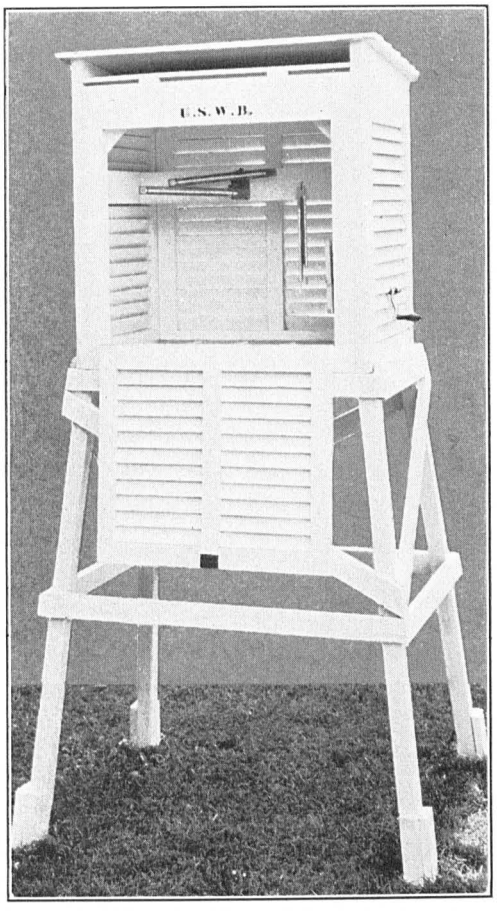


FIGURE 24.—Whirling apparatus for wet and dry bulb psychrometer



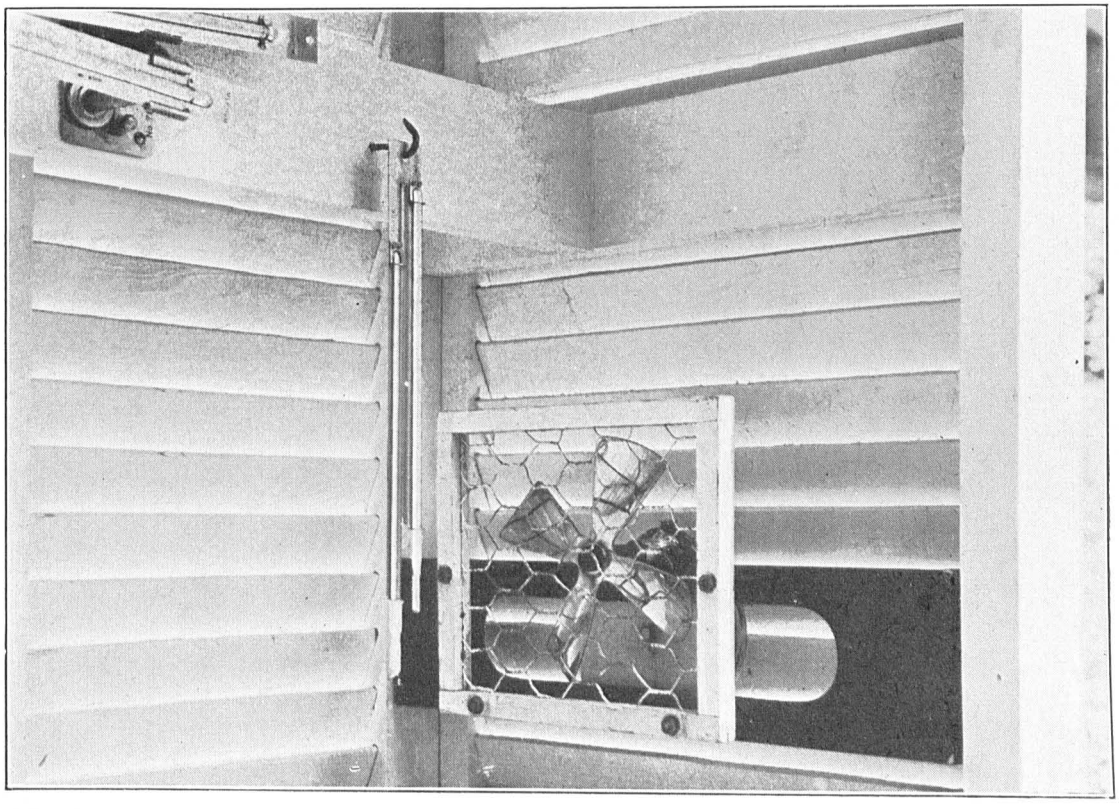


FIGURE 25.—Cotton-region shelter and psychrometer fan.

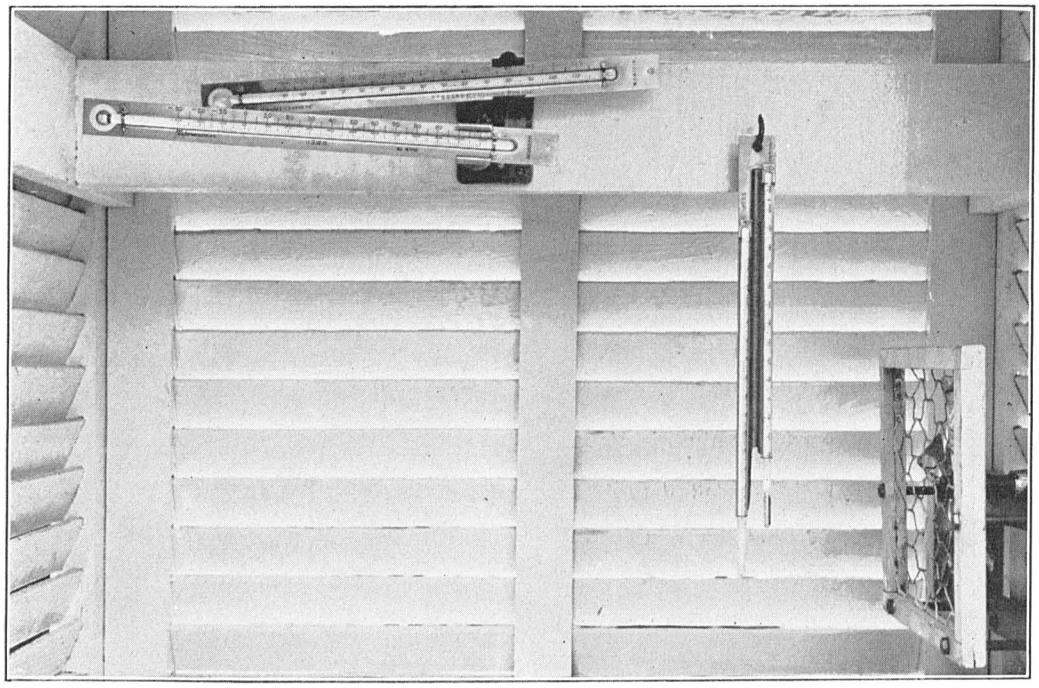


FIGURE 26.—Maximum and minimum thermometers with Townsend support at left; psychrometer fan and psychrometer at right.

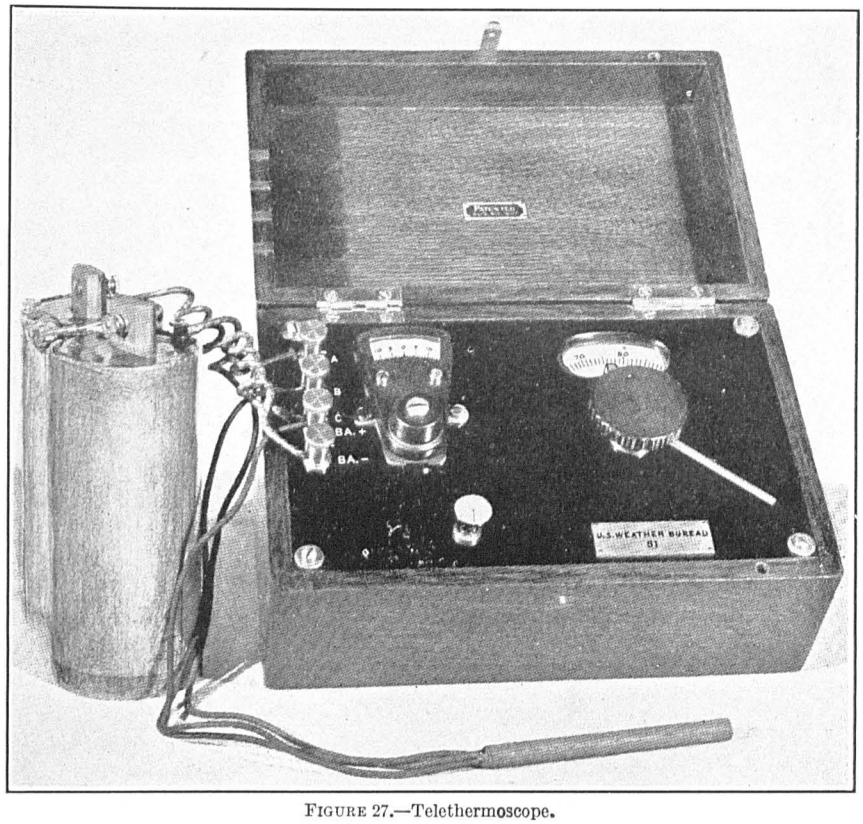


FIGURE 27.—Telethermoscope.

972. **Telethermoscopes.**—Telethermoscopes (fig. 27) 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 thermometer bulb (shown at the bottom of the picture), being read on 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 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.

CHAPTER V

EQUIPMENT FOR MEASURING THE HEIGHT OF CEILING

973. 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 located horizontally at a distance of 500 to 1,000 feet or more from the point of observation of the light spot. Knowing this fixed distance, it is only necessary to measure the angular

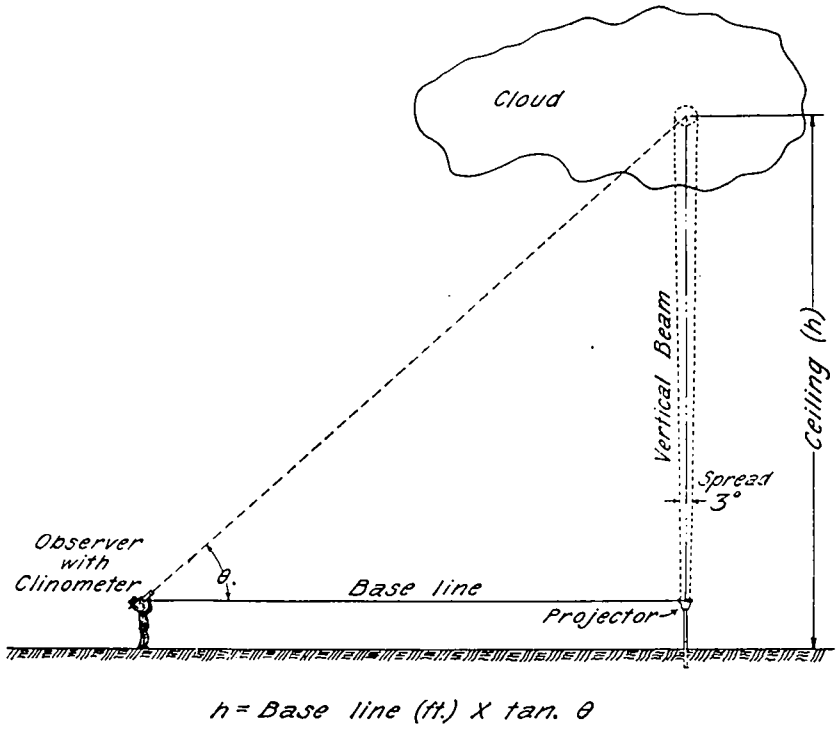


FIGURE 28.—Diagram showing relation of projector and angle-measuring device.

elevation of the spot of light from the observing point to compute the height of the light spot or the ceiling. This is accomplished by means of a clinometer, 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.

974. The arrangement of the projector and clinometer is shown diagrammatically in figure 28.

975. **Kinds of Ceiling Projectors.**—Two principal kinds are in service, essentially alike as regards the convex mirror or reflector which focuses and directs the light from a high-powered, concentrated-filament lamp upward to the cloud layer. One, the most recently placed in service, uses alternating current at approximately 12 volts at the lamp socket, transformed from 100- to 120-volt service, the transformer being mounted on the projector standard. A 420-watt, 12-volt airplane headlight lamp is required. All projectors previously used take electric current direct from service, usually through a long line, and require lamps of 105 to 125 volts, depending upon the potential drop due to the length of the service connection and the voltage at service.

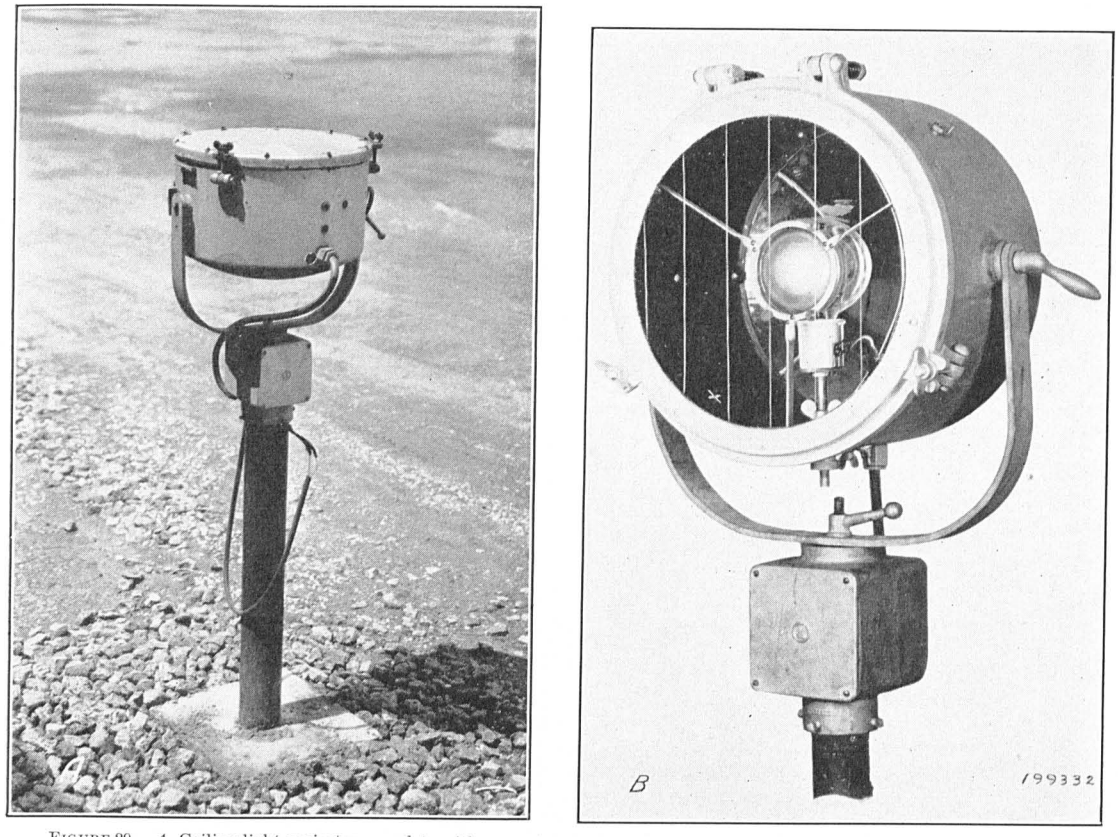


FIGURE 29.—*A*, Ceiling-light projector complete with mounting; *B*, View showing secondary reflector and lamp within drum.

For the latter, a variety of lamps are used, depending upon the intensity of light beam needed, location, and kind of projector, etc. These lamps vary from a 250-watt spotlight to 1,000-watt lamps, with either T or spherical bulbs. All lamps, of necessity, have condensed filaments, the filament being centered in the optical focus of the reflector mirror.

976. **Description of Low-Voltage Projector.**—This projector, illustrated in figure 29, is comprised of an aluminum alloy drum mounted on trunnions which permits of the accurate elevation of the beam from 45° to the vertical. Within is a primary reflector of about 16 inches in diameter, a prefocused airplane headlight lamp, a secondary reflector, and a transformer attached outside of the standard. The projector with transformer is mounted on a 4-inch pipe support, set firmly in the ground. The secondary reflector is used to prevent spill of the light beam and is more effective than methods employed on earlier types of projectors. The purpose of the transformer is

to make available suitable lamp voltage from service lines of varying potential, within the range of 100 to 120 volts, by the use of a series of taps on the primary of the transformer.

977. **Location of Projector.**—The projector will be placed not less than 500 feet for old-type projectors, and 750 feet for the 12-volt type, and as a rule not more than 1,000 feet, distant from the observing point (measured horizontally) as directed by an official of the Weather Bureau. The longer base line is preferred especially in mountainous country. Accessibility for cleaning and opportunity for running cable must be considered. It is not necessary that projector and observing point be at the same level when a clinometer is used. The line of sight from switch to projector should be out of glaring lights, and preferably with the projector to *northward* of switch in order to avoid interference by moonlight.

978. **Location of Control Switch.**—The control switch should be located outdoors in a place where the observer will be somewhat out of the glare of lights, so that by noticing the effects of turning it on and off occasionally he can be assured that the projector lamp is burning. Moreover, a faint spot on high clouds can often be detected by the observer when it is possible to switch the projector on and off at the point of observation.

979. **Setting Up Projector Over Ground.**—Projectors are provided with a slip fitter for mounting at the top of a 4-inch (nominal) iron pipe. This device slips over the top of the pipe and is then clamped to it by set screws. The pipe need not be threaded. A section of 4-inch pipe, 6 feet long, is set 3 feet in the ground. A flat stone or equivalent should be placed under the end of the pipe. The ground should be thoroughly tamped about the lower end of the pipe to make sure of rigidity. A collar of cement concrete about 4 inches thick and extending about 8 inches beyond the pipe will then be provided at the surface of the ground to hold the pipe firm.

980. **Setting up Projector Over Wood Platform, Concrete Slab or Rock.**—For such installation a 3-foot section of 4-inch pipe should be employed, the lower end being screw-threaded and fitted with a cast-iron flange (about 9 inches diameter, according to plumbers' supply catalogs). The flange should then be firmly secured by bolts or by lag screws with expansion shields, as may be appropriate.

981. **Setting up Projector Equipped With Flanged Base.**— Some of the older projectors are fitted with a flanged base. The top end of the 4-inch pipe will then be screw-threaded and a 4-inch flange screwed thereon to form a seat. The projector will be secured to this seat by three-eighths-inch through bolts. A cork gasket will be inserted between the two flanges.

982. **Cable.**—In order to keep down line drop in potential No. 10 A. W. G. will be employed for lines of 750 feet in length; No. 8 A. W. G. for lines 750 to 1,000 feet. Extensions to existing installations will be No. 8 A. W. G. Exceptions to this rule may at times be justified where it is desired to utilize surplus No. 10 cable already the property of the Government. At this time (1939) projector cable is furnished on purchase requisitions, drawn at the central office. Shipment of N. E. C. type ACL cable is made direct to station from the contractor's shipping point. This cable is No. 8 stranded, double-conductor, 0–600 volt class, rubber insulated, steel armored, with lead sheathing, for use in damp places; all in conformity with Government master specifications J–C–71 and amendment I.

983. **Control Switch.**—A post about 6½ feet long, 5 inches across the top, of wood known to last well in the ground, will be set 3 feet in the ground. At the upper part of the post a flat surface will be provided. A safety weatherproof switch 2-pole 30-ampere for outside use will be bolted to the post near the upper end.

984. **Laying Underground Cable.**—The cable will be buried in a trench deep enough to be safe from injury, the depth to be designated by an official of the Weather Bureau. This requirement may need to be modified in case of rock formation or other circumstances that render it unreasonably costly. In some instances the Weather Bureau may furnish the cable in more than one length. Joint boxes are then needed to make waterproof splices.

985. **Wiring from Cable to Switch.**—Wires from underground cable to switch will be No. 12 lead-covered, in conduit, from a suitable watertight junction box placed in the ground near the switch post.

986. **Wiring From Cable to Projector.**—The following plan is recommended where appearance is important: A rectangluar hole large enough to admit the cable will be cut in the 4-inch pipe, lower edge of hole 2 feet above lower end of pipe; also a ½-inch drainage hole will be drilled in the 4-inch pipe at a point 3 feet 1 inch above the lower end. Weatherproof leads, No. 12 copper, including 1 foot spare length, will be spliced to ends of cable conductors. Leads and cable will then be drawn upward through the rectangular hole so that splices and spare length may be coiled within the pipe near the top. In case the contractor is not prepared to cut the rectangular hole, he may thread the cable through the lower end of the 4-inch pipe, provided it be bent over a long radius and, provided also, the lower end of pipe be supported on several flat stones. The pipe will then be filled with loose, fine gravel or fine, crushed rock to a depth of 3 feet. Next, a 1-inch layer of bituminous waterproof compound will be inserted, the top of the layer to slant toward the ½-inch drainage hole. This layer of compound is designed to lessen moisture that otherwise might find entrance from the lower end of the pipe and cause trouble through condensation, while the ½-inch hole is intended to provide drainage in case water should accidentally get into the pipe. The extra length of No. 12 wire is intended for possible future requirements. The ends of leads should then be threaded through the hole in bottom of transformer box.

987. Where appearance is not important the cable may be run direct to a waterproof junction box, clamped to the outside of the 4-inch pipe. Leads will then run from junction box through a bushed hole in the pipe, thence to transformer box.

988. **Wiring, Inside.**—For inside wiring No. 10 AC will be used for dry locations; No. 10 ACL for damp locations.

989. **Code Compliance.**—All wiring shall comply with National Electrical Code requirements and with local regulations.

990. **Painting.**—Pipe in the ground will be given one coat of asphaltum. Pipe above ground will be given a prime coat of oxide paint for iron and a top coat of aluminum. The switch post will be painted to conform with surroundings.

991. **Remote-Control and Two-Projector Installations.**—These will be cared for by correspondence with the central office.

992. **Lamps.**—The projectors are all equipped with parabolic reflectors. The theoretically best lamp for use would be one in which the source of light is a brilliant point. The carbon arc is nearly a point source of light and is most brilliant, but practical considerations are against its use for the purpose. Hence, an incandescent lamp of a type in which the luminous filament is concentrated in a small space is furnished for the projector by the Weather Bureau. This lamp is of the type used in airplane-landing lights and is identified by the manufacturers as "airplane headlights." It is required for the low-voltage projectors and has the following characteristics: 420 watts, 12 volts (nominal rating), 35 amperes, mogul prefocus base; light center length, $1\frac{11}{16}$ inches; maximum over-all length, $5\frac{5}{16}$ inches; filament, C–2; rated average life, 100 hours.

Lamps most used in older types of ceiling-light projectors are as follows:

Bulb	Watts	Light, center length (inches)	Filament	Base
G–30	250	3	C–5	Mogul screw.
G–40	500	4¼	C–5	Do.
T–20	1,000	4¾	C–13	Do.
G–40	1,000	4¼	C–5	Do.

993. **Choice of lamp.**—Projectors serially numbered from 301 to 481 will take either G–30, G–40, or T–20 lamp, and other projectors of older types require lamps suitable to their construction. When changing lamps, particularly from one type to another, the socket adjustment may need to be changed because the light center length

(the distance from tip of base to luminous filament) is not the same for all lamps. The T–20 1,000-watt is recommended for use only where previous trial has established its suitability. The G–30 250-watt lamp has been most widely used in projectors, but some complaint of insufficient light from it has been made. The main reason for preferring the G or round-globe type is that such lamps are designed to be burned base horizontal. The T, or tubular-shaped lamps are designed to be burned base down; however, they are being used base horizontal at some stations without serious overheating, probably because of the short time required to make an observation; other stations have experienced distortion of the heat-softened bulb by expansion of the inclosed inert gas.

994. **Effect of Heat.**—In the use of the higher powered lamp there is serious risk of damage to mirror and to cover glass by the intense heat, particularly if turned on longer than a few minutes. Only in extreme cases where the general illumination of the sky is strong is the 1,000-watt lamp considered justified. For stations requiring this special treatment a G–40 1,000-watt lamp is also provided.

995. The airplane headlight lamp is costly and has a short life, and care should be used in its operation.

996. **Lamp Voltage.**—The G–30 and G–40 lamps are usually stocked in voltages of 105, 110, 115, and 120, in order that the measured socket voltage may be reasonably well matched. Requisitions for lamps should specify style and size of bulb, wattage, and voltage desired. If the rated lamp voltage is higher than the actual voltage, the intensity of beam will be lessened. If lower, the life of the lamp will be shortened. When screwing lamps into or out of sockets they should not be grasped by the part that has large diameter because the greater leverage may break the seal between brass and glass. It is a good plan to apply a little graphite to the threads of the brass base.

997. **Focusing of Lamps.**—New projectors are equipped with prefocussed lamps and should be ready for service without making any adjustments. The following information, however, will be useful in checking the focussing and in refocussing should occasion arise: It is of extreme importance that the lamp be in focus. Only a slight out-of-focus condition may reduce the light spot to half its intensity. A method of becoming familiar with the adjustments tried in the Instrument Division is to direct the beam upon a target which may be a sheet of white cloth 3 or 4 feet square, stretched between two rods, or some equivalent arrangement. The target need not be more than 40 feet or so distant. In nearly all projectors the lamp sockets are built upon stems that provide an adjustment of several inches transverse to the axis of the mirror; additional adjustments permit smaller movement of the lamp either transversely across the axis of the mirror or longitudinally with the axis in a way to place it nearer to or farther from the mirror. It is suggested that all employees responsible for measuring ceiling heights familiarize themselves with these adjustments. Possibly this can best be done on a cloudy day when the light spot on a screen can be observed with the adjusting screws in plain view at the same time. It is helpful to put a few drops of light machine oil on the threads of the adjusting screws to make them run free. Furthermore, mechanical features, such as springs, employed in the focussing adjustments of some projectors should be examined to make sure that they are functioning. Lamp sockets should be so firmly held that the lamp will be in the same position relative to drum whether beam is directed horizontally or vertically. Final check upon correct focus is by observation of the light spot upon a well-defined cloud layer at night, and by inspection of the vertically projected beam as it illuminates dust particles, etc., in its path. The best focus is realized with the smallest obtainable spot on a well-defined cloud layer or with the narrowest projected beam through the air. The rays should not cross each other. Projectors are provided with two peep holes and marks opposite on the inside of the drum, usually in the form of a + or of a punch mark. These marks were originally placed in the factory by sighting from the peep holes through the focussed lamp filament. Hence if any suitable lamp is thereafter so adjusted as to bring the filament within the two lines of sight, it will be very nearly in focus; but a finer adjustment should be made subsequently. The wires inside the drum that lead to the lamp socket should be free. Otherwise, they may interfere with correct focusing, or may subsequently pull the lamp out of focus.

998. **Slippage of Mirror.**—Glass mirrors are necessarily rather loosely mounted to allow for expansion and contraction. Occasions are known of a slight edgewise shift of the mirror with the beam horizontal as compared with beam vertical. This alters to some extent the setting of the quadrant. A suggested means of holding the mirror in such instances is to insert small sections of asbestos or cork between the edge of mirror and the clamps that hold it. Rigid material should not be used for this purpose because of risk of breaking the mirror.

999. **Orientation of Lamp Within Projector.**—Examination of lamps with C–5 filament will disclose that the luminous windings form roughly an incomplete circle as viewed from the end opposite the base. The complete portion should be toward the mirror. Most projectors are filled with a lamp-socket stem that may be rotated slightly for this purpose and then clamped in place.

1000. **Directing Beam to Zenith; High-Voltage Projectors.**—The mirror should first be inspected to make sure that it does not slip edgewise within its clamps when the projector is turned to position beam horizontal as compared with position beam vertical. Then the axis on which the drum rotates must be permanently fixed in an assured horizontal position. Methods that have been suggested to accomplish this are: To level across the outer flange of the closed door, the spirit level or a straight-edged strip of wood to carry it resting on blocks of wood of equal thickness, placed on opposite sides of the door flange; to level across the edges of the mirror itself, using a parallel-sided strip of wood slightly shorter than the inside diameter of the drum as a rest for a small spirit level. After the axis has been set horizontal, the correct position in the plan of rotation must be assured. Most projectors are equipped with quadrants so arranged that after the beam has been once set vertical the drum may be lowered for examination and subsequently returned to the vertical position as indicated by marks or stops on the quadrant. Also, some quadrants have faced leveling perches for a small spirit level. These devices, while helpful, are not considered entirely dependable, and hence verticality should be checked by sighting a plumbline against the beam from two positions; one in line with the axis, the other at a right angle thereto. This check by plumb line should be made with the lamp in focus. When impracticable of performance because of daytime visit by inspector, arrangements should be made to have the check made by the observer and subsequently reported to the inspector by him.

1001. **Transformer; Low-Voltage Projectors.**—The new projectors, Weather Bureau numbers 481 and above, are equipped with an autotransformer for furnishing the reduced voltage required for the airplane headlight lamp with which this type of projector is equipped. The transformer is so designed that it is possible to compensate for the drop in potential along the conductors between the power supply and the projector in order to obtain the desired voltage, 11.8, at the lamp socket by adjustment of one of the line wires to the properly chosen tap on the primary.

1002. After the projector has been set up and properly leveled, connect the alternating-current service line of 100 to 120 volts to taps 1 and 8 (120 volt connection) and connect an alternating current voltmeter of 150-volt range to the same taps; connect the leads from the lamp socket to taps *2* and *3* and insert the lamp in the socket of the projector. Turn on the current and with the lamp burning read the difference in potential on the voltmeter. Turn off the current and remove the line wire from tap No. 8 and reconnect to the tap listed for the nearest voltage above the line voltage indicated by the voltmeter, e. g., if the voltmeter read 112 volts, connect to the 115-volt tap (No. 7). To insure normal lamp life and to prevent premature lamp burnout, it is necessary that the line voltage *never exceed* the rating of the primary tap in use. The taps are numbered from one to eight. Tap No. 1 is always connected to one side of the line, Nos. 2 and 3 to the lamp circuit, and one of the remaining taps to the second line wire, the particular one to be used depending upon the difference of potential across the line *at the projector end when the lamp is burning.* Tap No. 4 is used for voltages at the transformer not exceeding 100, No. 5 for voltages between 100+ and 105, No. 6 for voltages between 105+ and 110, and No. 7 for voltages of 110+ to 115, and No. 8 for voltages of 115+ to 120. The lamp should never be connected in any manner other than to taps Nos. 2 and 3.

1003. As line voltage varies throughout the day, and from day to day, it will be necessary to check the line voltage several times during the period of normal operation to determine the maximum. The maximum voltage observed at the projector site is to be considered the voltage of the line, and under no circumstances should the line be connected to a primary tap designed for lower voltage than that of the line.

1004. **Caution.**—Some cases of severe burns have been reported due to reflection from the reflector when the sun shines upon it. A clean soft cloth or paper temporarily spread over the reflector will stop reflection while examining the projector. Or a time can be chosen when the sun is obscured by clouds.

1005. **Directing Beam to Zenith; Low-Voltage Projector.**—The trunnion axis on which the drum rotates must be permanently fixed in an assured horizontal position. The following method is suggested to direct the beam to the zenith: Level across the edges of the primary reflector, using a parallel-sided strip of wood slightly longer than the diameter of the reflector as a rest for the small spirit level. In using this method great care must be exercised to prevent the level from falling upon the reflector. Remove the level from the projector drum before making any adjustment of the set screws of the slip fitter. The projector is equipped with a device so arranged that after the beam has been once set vertical the drum may be lowered for examination and subsequently returned to the vertical position, as indicated by marks or stops. Verticality should be checked by sighting a plumbline against the beam from two positions; one in line with the axis, the other at a right angle thereto. When impracticable of performance because of daytime visit by inspector, arrangements should be made to have the check made by the observer and subsequently reported to the inspector by him. Mimeographed separates covering the installation and maintenance of projectors are available from the Instrument Division. Included are directions relative to lease of site and obtaining bids for projector installations.

1006. **Clinometers** (illustrated in figure 30).—These are employed to measure the angular elevation from 0° to 90° of a spot of light projected on a cloud at night.

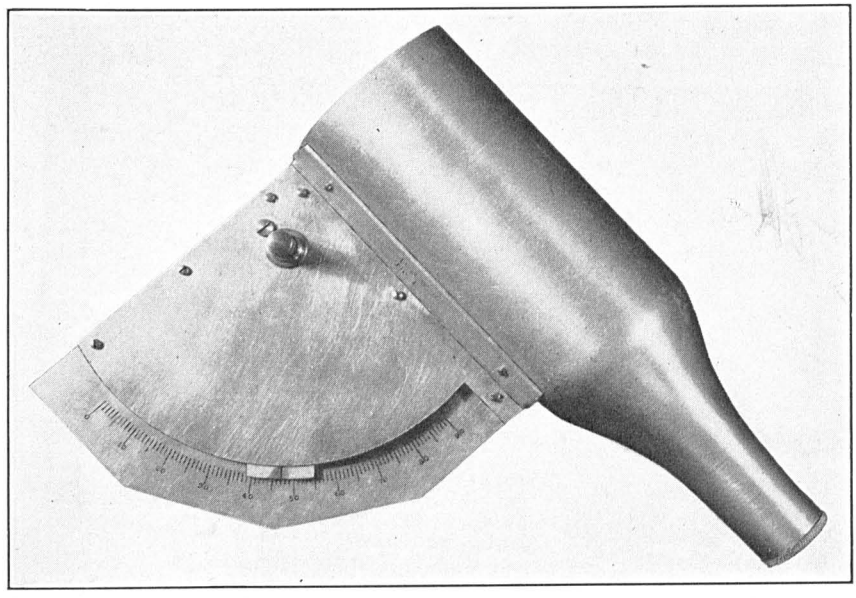


FIGURE 30.—Clinometer for measuring height of ceiling.

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.

1007. **Use of Clinometer.**—When this device is used the projector will 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. 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.

1008. **Choice of a Base Line.**—The clinometer is graduated to whole degrees, and errors of 1° or possibly 2° are considered likely. In the accompanying table (No. 10) the column of heights for a 500-foot base, 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. 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, usually 750 to 1,000 feet.

1009. Where the station is located in level country with good visibility, as a rule 500-foot base line is sufficient, but, to provide for the measurement of high ceilings when required, a second observation point at some convenient location is established which may be 1,000 feet more or less horizontally from the projector. To measure ceilings with this longer base line when clouds at the 500-foot location are at a high angle, the observer will walk to the more distant point. At this time, however (January, 1939), low-voltage projectors are frequently installed with a 1,000-foot base line, and in addition a second projector, usually for high voltage, is installed on a 500-foot base line. The observer then employs the more suitable projector.

1010. In any event, the base line chosen should be no longer than is necessary to give a reasonably accurate measurement in order to conserve costs of cable and installation. The drop in voltage over a long line is also a factor, especially when 110-volt current is used without a transformer at the projector.

1011. **Ceiling Balloons.**—These balloons are usually inflated with hydrogen gas to a free lift of 40 grams, or with helium gas to a free lift of 45 grams, in accordance with instructions contained below.

1012. 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.

1013. **Equipment.**—The equipment necessary for this work consists of: (1) Compressed hydrogen or helium gas in cylinders, usually containing 200 cubic feet, furnished by the supervising Weather Bureau airport station; (2) hydrogen or helium regulator; (3) Brady free-lift device; (4) timepiece, indicating seconds, usually a so-called wasp clock.

1014. **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.

1015. **Inflation of Balloons.**—A specially constructed inflation room is usually constructed as convenient as possible to the place of observation. This room 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. 31.)

1016. The Brady device is placed on a shelf large enough to permit the small rubber tubing to rest thereon.

TABLE 10.—*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	46	1. 0355	518	1, 036	1, 554
6	. 10510	52	105	157	47	1. 0724	536	1, 072	1, 608
7	. 12278	62	123	185	48	1. 1106	556	1, 111	1, 667
8	. 14054	70	141	211	49	1. 1504	575	1, 150	1, 725
9	. 15838	79	158	237	50	1. 1918	596	1, 192	1, 788
10	. 17633	88	176	264	51	1. 2349	618	1, 235	1, 853
11	. 19438	97	194	291	52	1. 2799	640	1, 280	1, 920
12	. 21256	106	213	319	53	1. 3270	664	1, 327	1, 991
13	. 23087	116	231	347	54	1. 3764	688	1, 376	2, 064
14	. 24933	124	249	373	55	1. 4281	714	1, 428	2, 142
15	. 26795	134	268	402	56	1. 4826	742	1, 483	2, 225
16	. 28675	144	287	430	57	1. 5399	770	1, 540	2, 310
17	. 30573	153	306	459	58	1. 6002	800	1, 600	2, 400
18	. 32492	162	325	487	59	1. 6643	832	1, 664	2, 496
19	. 34433	172	344	516	60	1. 7321	866	1, 732	2, 598
20	. 36397	182	364	546	61	1. 8040	902	1, 804	2, 706
21	. 38386	192	384	576	62	1. 8807	940	1, 881	2, 821
22	. 40403	202	404	606	63	1. 9626	982	1, 963	2, 945
23	. 42447	212	424	636	64	2. 0503	1, 025	2, 050	3, 075
24	. 44523	222	445	667	65	2. 1445	1, 072	2, 144	3, 216
25	. 46631	233	466	699	66	2. 2460	1, 123	2, 246	3, 369
26	. 48773	244	488	732	67	2. 3559	1, 178	2, 356	3, 534
27	. 50953	255	510	765	68	2. 4751	1, 238	2, 475	3, 713
28	. 53171	266	532	798	69	2. 6051	1, 302	2, 605	3, 907
29	. 55431	277	554	831	70	2. 7475	1, 374	2, 748	4, 122
30	. 57735	288	577	865	71	2. 9042	1, 452	2, 904	4, 356
31	. 60086	300	601	901	72	3. 0777	1, 539	3, 078	4, 617
32	. 62487	312	625	937	73	3. 2709	1, 636	3, 271	4, 907
33	. 64941	324	649	973	74	3. 4874	1, 744	3, 487	5, 231
34	. 67451	338	675	1, 013	75	3. 7321	1, 866	3, 732	5, 598
35	. 70021	350	700	1, 050	76	4. 0108	2, 006	4, 011	6, 017
36	. 72654	364	727	1, 091	77	4. 3315	2, 166	4, 332	6, 498
37	. 75355	377	754	1, 131	78	4. 7046	2, 352	4, 705	7, 057
38	. 78129	390	781	1, 171	79	5. 1446	2, 572	5, 145	7, 717
39	. 80978	405	810	1, 215	80	5. 6713	2, 836	5, 671	8, 507
40	. 83910	420	839	1, 259	81	6. 3138	3, 157	6, 314	9, 471
41	. 86929	434	869	1, 303	82	7. 1154	3, 558	7, 115	10, 673
42	. 90040	450	900	1, 350	83	8. 1443	4, 072	8, 144	12, 276
43	. 93252	466	933	1, 399	84	9. 5144	4, 757	9, 514	14, 211
44	. 96569	483	966	1, 449	85	11. 430	5, 715	11, 430	17, 175
45	1. 0000	500	1, 000	1, 500	86	14. 301	7, 150	14, 301	21, 441

NOTE.—Tables are also available on request for a light beam directed at an angle of 63°26′ to the horizontal.

1017. 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.

1018. **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.

1019. 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

1020. Average rate for higher ceilings, 6 feet per second.

1021. **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:

1022. 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.

1023. 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.

1024. 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.

1025. A sign, somewhat as follows, DANGER—NO SMOKING, should be posted in a conspicuous place where the ceiling balloons are inflated with hydrogen. Where helium is used such precautions are unnecessary.

1026. **Care of Balloons.**—The balloons will deteriorate quite rapidly, especially in the summer months, and they should be kept in a cool place of more or less even temperature.

1027. **Supplies of Hydrogen or Helium and Balloons.**—Whenever the observer opens the last full cylinder of gas, he will notify by teletype the airway observer of the supervising station, as follows: "Last hydrogen (or helium) cyclinder 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.

1028. When the last carton of 50 balloons is opened, advise the issuing station to that effect and a new supply will be sent by mail.

1029. **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.

1030. 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.

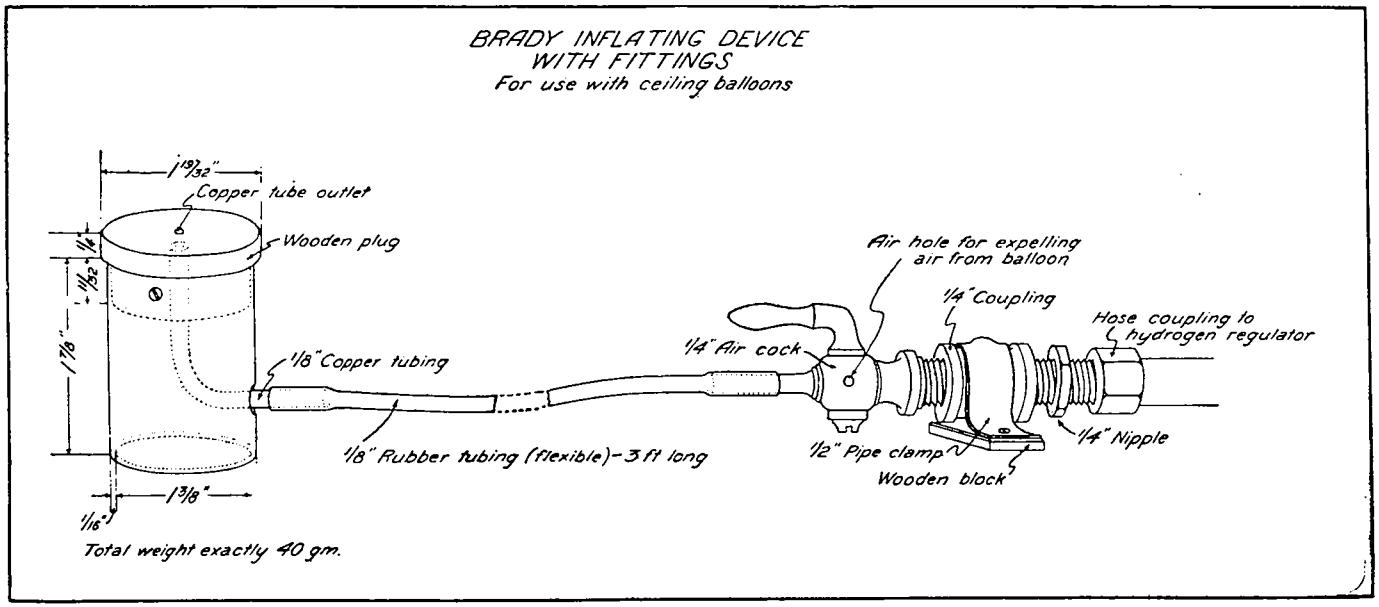


FIGURE 31.—Brady inflation device with fittings for ceiling balloons.

1031. **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.

1032. **Use of Pilot Balloons for Measurement of Ceiling Heights.**—The 30-gram pilot balloons are issued to a selected list of stations to facilitate the accurate measurement of ceiling heights when adverse conditions such as high winds, poor visibility, etc., make such observations difficult or impossible with the standard 10-gram ceiling balloons. The advantage of using the pilot balloons on such occasions is due to their greater size and more rapid ascensional rate.

1033. **Inflation.**—The procedure for inflating the pilot balloons is similar to that for inflating ceiling balloons as described above, the substitution of the pilot balloon inflation nozzle for the Brady inflation nozzle being the only variation.

1034. **Ascensional Rate.**—The following table, based on the ascensional rate of the pilot balloons, is given for use in ascertaining the altitude of the clouds:

Time interval (minutes)	½	1	1½	2	2½	3	3½	4	4½	5
Altitude (feet)	360	710	1,035	1,360	1,685	2,010	2,320	2,630	2,940	3,250
Time interval	5½	6	6½	7	7½	8	8½	9	9½	10
Altitude (feet)	3,545	3,840	4,135	4,430	4,725	5,020	5,315	5,610	5,905	6,200

1035. Fractional parts of a minute should be determined by interpolation and the average rate of 10 feet per second or 600 feet per minute should be used for ceilings greater than 6,200 feet.

1036. **Equipment.**—Attention is called to the fact that inflation nozzles of two different weights are available for issue: one for use with hydrogen gas and the other for use with helium gas. They are accordingly stamped with the letters HY and HE, respectively. All stations receiving these nozzles are requested, therefore, to make certain that they have the proper one for the kind of gas they are using.

1037. As the cost of pilot balloons is approximately three times that of ceiling balloons, stations are cautioned to not use the larger balloons except when conditions prevent satisfactory observations with ceiling balloons. It is important also that none of the pilot balloons be kept in the station stock until the quality of the rubber has deteriorated. It is requested, therefore, that whenever any such balloons have been in stock as long as 3 months they be forwarded to the nearest pilot balloon station to be used up. Supervising stations are to instruct all their substations accordingly.

CHAPTER VI

PILOT-BALLOON OBSERVATIONAL EQUIPMENT

1038. **Pilot Balloons.**—These 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 or helium 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. At certain

stations 100-gram (16-inch) pilot balloons are used having an ascensional rate of 280 meters per minute (919 feet per minute).

1039. 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.

1040. 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.

CHAPTER VII

PRECIPITATION GAGES AND MEASUREMENT

1041. **Eight-inch Rain and Snow Gages.**—These are issued to code-sequence and 6-hourly stations as regular equipment.

1042. **Exposure.**—Details regarding the exposure, construction, and use of 8-inch gages are found in Circulars B and C, Instructions for Cooperative Observers. Briefly, the gages will be placed in an open location, free from obstructions such as large buildings, trees, fences, etc. Low bushes, fences, and walls, if not appreciably higher than the top of the gage and not closer to the gage than 7 or 8 feet, such obstructions are beneficial in breaking the force of the wind which is the principal disturbing effect in collecting the rainfall. Ground exposures should be chosen whenever possible, but if a roof is used it should be flat and the gage placed centrally.

1043. **Description.**—Figure 32 shows *A*, the 8-inch gage, placed in a wooden box support, and *B*, the parts of the gage. The collector (1) is made of brass tubing with the outside beveled to a sharp edge at the top so as to properly define the area of collection, which is a circle 8 inches in diameter, or the inside diameter of the tubing. The collector is soldered to a copper funnel having an opening at the small end of five-eighths inch, just large enough to permit of the insertion of the measuring stick. The collector is alsc so formed as to fit over the upper end of the 8-inch overflow can (2), also copper, and the brass measuring tube (3) which stands centrally within the overflow. The measuring stick (4) is made of heart cedar, 24 inches long, and graduated in inches and tenths, and, since the area of cross section of the measuring tube is one-tenth that of the 8-inch collector, the depth of water finding its way into the tube is 10 times that which has fallen. Ten inches on the measuring stick, therefore, correspond to 1 inch of rainfall, and the nearest hundredth of an inch of rainfall is easily read.

1044. When the rainfall exceeds 2 inches, the capacity of the measuring tube, additional water passes into the overflow can, from which it is poured back into the tube for separate measurement and its depth added to the 2 inches already measured.

1045. **Snowfall Measurements.**—In reporting the depth of snow, observers are required to measure such depth 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.

151480—39——16

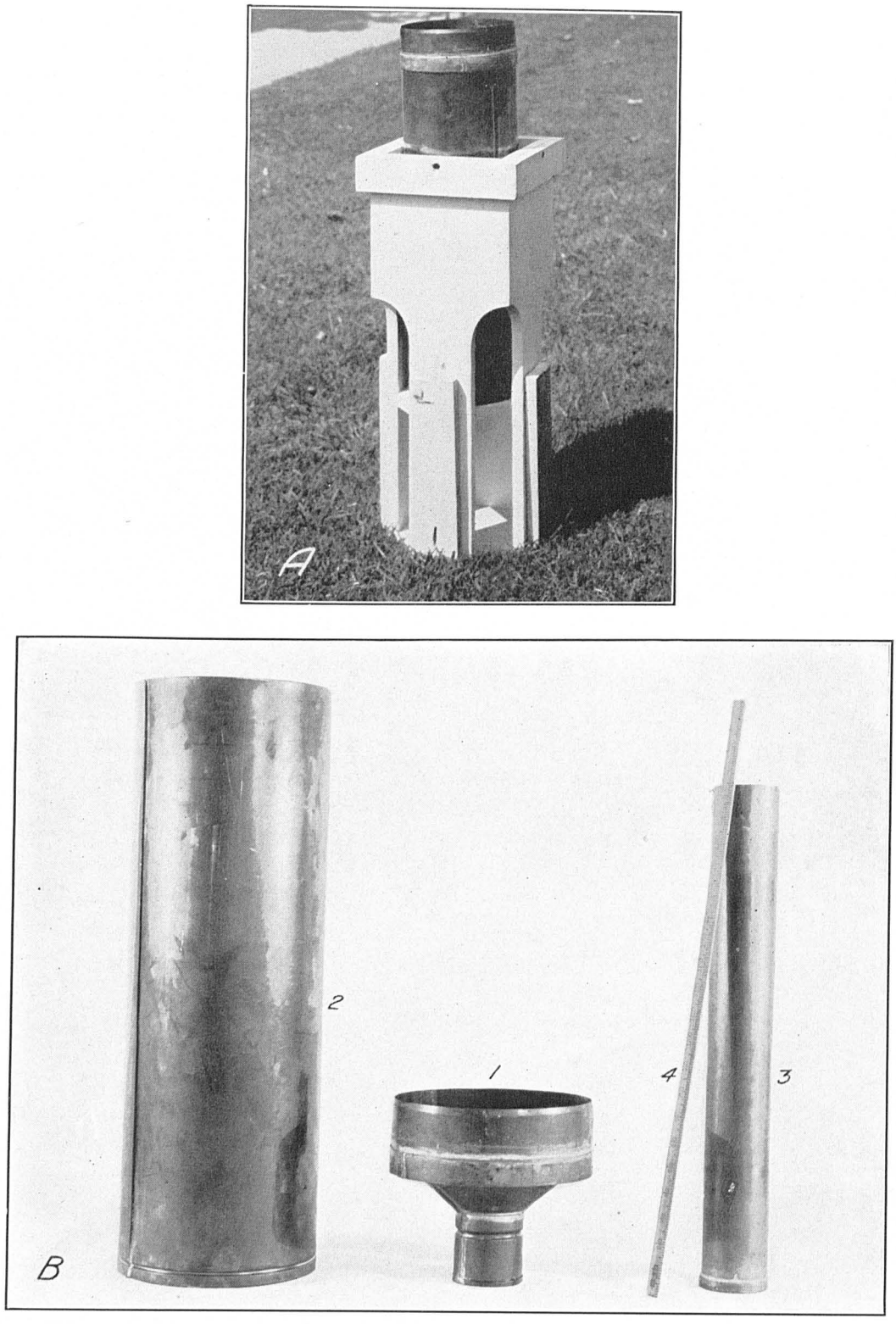


FIGURE 32.—Eight-inch rain and snow gage: *A*, gage in box support; *B*, parts of gage.

CHAPTER VIII

INSTRUCTIONS FOR OPERATION AND CARE OF INSTRUMENTS

1046. **Large Standard 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. 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.

1047. **Small 3-Cup Anemometer.**—The cup wheel, sleet shield, top ball bearing, and spindle, after having been initially assembled, may thereafter be withdrawn as an assembled unit when desired by first backing off about one-eighth inch the large fillister head screw that will be seen just above the label plate. Initial assembly of these parts is more readily made outside the anemometer body. A flat washer just above the ball cage should have its rabbeted edge downward, and the cup arms should have their convex-rounded sides upward to shed water. The top nut should be drawn snug enough to hold the sleet shield firm.

1048. **Lubrication and Care (Small Anemometer).**—The top bearing should have several drops of light machine oil applied, the worm a little oil rubbed on the threads, and the flat, lower end of the spindle a touch of oil. The oil is best applied with a match stem. While actual experience is lacking, it is believed that under average conditions of exposure the anemometer should run 3 months on one lubrication. Exception is, of course, necessary in case of dust storms.

1049. The cup-wheel spindle assembly should be rotated back and forth by hand as it is being inserted in the anemometer body in order to permit the gears to find their mesh.

1050. The lower bearing is a steel ball carried in a cup. It is factory adjusted to precisely the best position to carry a part of the load and thus insure low starting velocity and accurate indication of wind. The lower bearing adjustment should not be disturbed.

1051. **Electric Circuit (Small Anemometer).**—One side of the circuit is grounded to the framework. Hence the ground terminal from the office may be attached to any convenient part of the wind-instrument support. The insulated wire terminal should be attached to the insulated binding post apparent upon inspection. The 6-volt 5-ampere label is intended to define maximum values. As a rule, 0.25 ampere will operate indicating devices.

1052. The label plate is held by four No. 4–40 machine screws. It may be removed when necessary for inspection. The opposite plate is held by special screws, a signal that it should not ordinarily be opened because of the danger that the gears will bind upon reassembly if such work is done by one unskilled.

1053. In setting the anemometer on the standard tapered pintle, the setscrew should be tightened only moderately, since otherwise the threads may be stripped.

1054. The above is furnished to provide an understanding of the instrument, but it is expected that it will require little attention once it is installed. The rules for cleaning, oiling, etc., at regular intervals applicable to the older form do not apply at all. Examination and lubrication at times of quarterly inspection should be sufficient, as a rule.

1055. It is best to operate the indicator with minimum current needed for signals in order to lessen sparking at contacts.

1056. The contacts made in 1 minute represent the velocity of the wind in miles per hour. The correction to be applied is plus 1 mile for winds up to 35 miles. For winds above 35, the indications may be accepted for the present without correction, although it should be stated that it has not been tested above 57 M. P. H. for corrections. (See table 7.)

1057. **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.

1058. **Four-Contact 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.

1059. **Eight-Contact Wind-Vane Bearing and Nine-Light Indicator.**—The bearing contacts have been adjusted to the proper distance at the factory and, ordinarily, should not be changed. If, however, it should be found that a contact does not close, the small adjusting screw should be turned in until the gap is equal to that of the other contacts. Extreme care should be used not to bend or displace the contact springs.

1060. For inspection or renewal of electric lamps, remove dial by straight pull. When replacing, be sure the alinement pin in bottom of indicator enters slot in bezel, then push until the latch buttons enter the locking groove.

1061. Lamps are of the bayonet type, Mazda No. 64, double contact, 3 c. p., 6–8 volts; or in certain indicators Mazda lamps No. 68 are used instead, 12–16 volts. These latter are to be discontinued as soon as possible. They are removed from the socket by pressing slightly and turning to the left.

1062. Transformer and buzzer are nonadjustable, and in case of trouble should be replaced by new units.

1063. **Mercurial Barometers.**—Since the lower end of the barometer tube must be always left open, there is the ever-present possibility that air may enter and impair the vacuum in case the barometer is moved or the level of the mercury in the cistern brought below the open end of the tube. It is important, therefore, that a *mercurial barometer never be moved without authority,* and that no adjustments be made to it other than such as are required to make the observations. A mercurial barometer should not be placed on an outside wall unless no other location can be had. If such location is necessary, a board of insulating material should be placed next to the wall, and the barometer board should be spaced an inch or so from it by means of two horizontal strips of wood in order that the air of the room may circulate back of the barometer board.

1064. **Instrumental Correction.**—Each mercurial barometer is compared with the Weather Bureau substandard in the central office, and the correction necessary to make it agree with the substandard is furnished with it. Readings used as a basis for the correction are made with the ivory point just touching the mercury in the cistern, and with the front and rear sighting edges of the part that carries the vernier just grazing the top of the curve of the meniscus. Obviously the same method of reading must be followed at station to make this correction applicable.

1065. **Cleaning and Handling Barometers.**—At many airport stations two barometers are maintained, side by side—one known as station barometer for daily use, the other known as extra barometer for reference purpose and for emergency use. The extra barometer serves its reference purpose best in proportion as it is permitted to remain but little disturbed through the years. It is best that it be not cleaned more often than necessary. It will remain clean for a longer time if, when not in use, the mercury in the cistern is raised approximately to the top of the glass ring. Only in emergency should both station and extra barometer be cleaned without the intervention of at least several months' time.

1066. Because of the large effect of temperature on the indications, caution should be observed to avoid artificial heating, such as would be caused by allowing an electric lamp to burn close to the instrument. Illumination of the background is possible with the lamp well away. Temperature correction tables are based upon the assumption of a uniform temperature throughout the entire instrument.

1067. Mercurial barometers should be unpacked and placed in operating position only by experienced personnel. In case one is received in the absence of experienced personnel it should be examined to see that the shipment has been handled with care and then kept lying flat in the packing box until an inspector arrives.

1068. **Correction Cards and Tables.**—As soon as the elevation and latitude, etc., of the station (Form 1058 Met'l) is furnished the central office, a card (Form 1059 Met'l), giving the corrections that must be applied to the readings, is furnished from the instrument division. A card (Form 1080 Met'l), giving the correction for temperature applicable to a mercurial barometer, is available on requisition. At some stations local officials construct a table in which these two are combined for convenience.

1069. **Instructions for Reading a Mercurial Barometer.**—1. Read the attached thermometer to the nearest half degree. Enter the readings on the record as 71.0°, 72.5°, etc.

2. Turn the milled-head adjusting screw, which projects out of the barometer at the bottom of the cistern, slowly until the surface of the mercury in the cistern just touches the ivory point. In a newly cleaned barometer this contact can be observed by noting the meeting of the ivory point with its reflected image, or by a slight dimple in the mercury surface. In case the mercury surface has become oxidized, the correct position can best be determined by sighting across the mercury surface against a white background, such as white cardboard or paper placed back of the barometer or white glass sometimes built into the barometer.

3. Tap the barometer case smartly with the finger in the neighborhood of the meniscus. This tapping improves the evenness of distribution of the mercury at the top of the column.

4. Turn the vernier adjustment by means of the milled-head screw projecting from the right of the case until the line of sight across the front and rear sighting edges *just cuts off the light from across the extreme summit of the meniscus.* A white background is essential. White paper serves well if renewed occasionally.

5. Read the height of the column. Inches and tenths are taken from the main scale; the hundredths are taken from the vernier by selecting on the vernier the graduation that most nearly coincides with or matches a line on the main scale. When readings to thousandths of an inch are made, the third decimal figure is estimated from the vernier. Examples are shown in figure 33.

1070. **Mounting Barometers, Verticality.**—Mercurial barometers should hang plumb. Because buildings may settle, it is well to check them occasionally for plumbness. Because of the possibility of a barometer getting out of plumb, differences of view exist as to the wisdom of furnishing centering screws, but their advantage in holding the barometer steady for readings has been considered sufficient to warrant supplying them in most Weather Bureau boxes and boards. To center the barometer, advance the three screws until they almost touch the cistern. The amount by which they fall short of touching may be determined by sighting between the end of the screw and the cistern against a slip of white paper. After all screws have been thus adjusted complete the clamping by alternately advancing each screw by the same fraction of a turn. Thereafter the instrument may be loosened, if desired, by backing out only one of the three screws.

1071. **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 airway 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.

1072. **Barographs.**—*Kind of Ink.*—The pen should be filled with a special ink provided by the Weather Bureau for instruments of this sort (and no other). Upon

request the proper brand of ink will be furnished to airway observers by the general supervising station. Other Weather Bureau stations may requisition the same from the central office. The ink may be started flowing by drawing a piece of smooth writing paper, free from lint, carefully between the points so as to wet the inside faces.

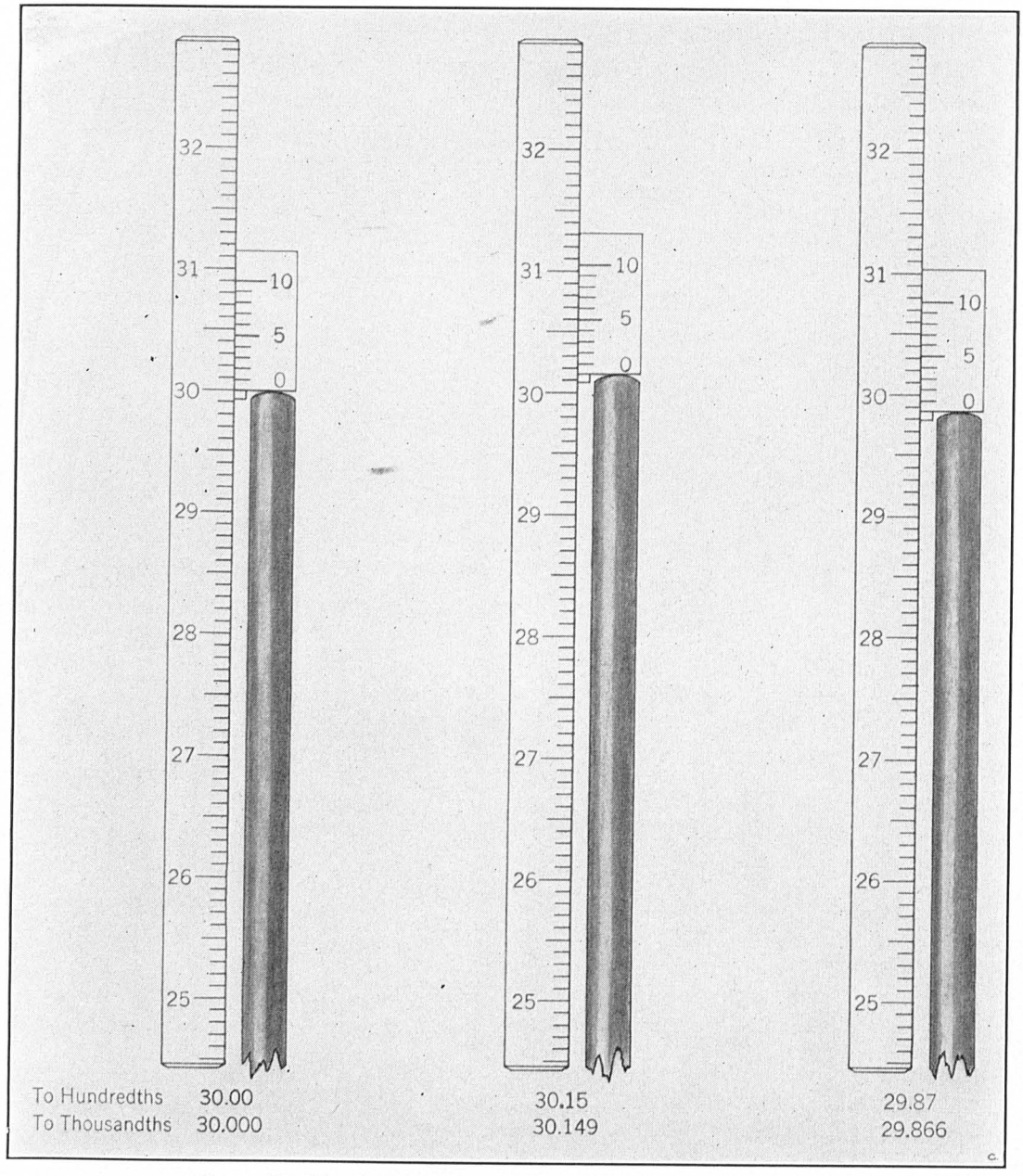


FIGURE 33.—Examples of vernier settings when reading a mercurial barometer.

Care should be taken to see that the points are not bent or deformed in the operation and that no particles of the paper are caught between the points. Ink should not be spread over the outer surface of the pen or pen arm since such a surplus of ink tends to collect dust and dirt and eventually affects the precision of the record obtained.

Enough ink, however, should be placed in the pen when changing forms to last for the entire period of the record. This avoids disturbing the record with the possible resulting change in the correction of the trace to the true barometric pressure due in part to the change in the weight of the ink in the pen.

1073. **Choice of Barograph Charts.**—For barographs with 1 to 1 scale, use Form 1068 for 0–720-foot barometer elevation; 1068–A for 1,200–1,650-foot elevation, and 1068–B for all other elevations. For the open-scale barograph, use Forms 1068–C and D, as given in table below.

1074. For the 1 to 1 scale barograph Form 1068–B has no pressure ordinate numbers, it being intended that the desired numbers should be put on in ink by the observer. These numbers should be written at the intersections of the noon time lines with the 10th, 20th, 30th, 40th, and 50th horizontal lines, counting from the bottom line of the sheet. On the lines for which the pressures end in the decimal fraction .50, the numeral 5 should be written. On those lines for which the pressures end in the decimal fraction .00, the number without the decimal fraction will be written. For example, if the elevation of the station barometer to the nearest whole foot (as obtained from the elevation given to hundredths or thousandths of a foot by use of the Weather Bureau rule for discarding decimals) is 1,670 feet, Form 1068–B would be used and the figures 28 would be written at the intersections of the 30th horizontal line from the bottom (the midway isobar) with the noon time lines. The figure 5 would be written on the 20th and 40th isobars, the figures 27 would be written on the 10th isobar from the bottom and the figures 29 would be written on the 50th isobar from the bottom.

1075. Form 1068–C for open-scale barographs has only the decimal fraction part of the pressure ordinate numbers printed on them; it being intended that the remainder of these numbers shall be filled in with pen and ink. Form 1068–C has the decimal-fraction part of the pressure ordinate numbers printed on it, so that if a horizontal line were drawn midway between the top and bottom isobars it would have a pressure ordinate number ending in the decimal fraction .25 assigned to it. Form 1068–D has the decimal fraction part of the pressure-ordinate numbers printed on it, so that this horizontal line would have a pressure-ordinate number ending in the decimal fraction .75 assigned to it. The type of chart to be used at a given station will be determined in accordance with the following table:

Elevation of station barometer (feet)	Number of form to be used	Midway isobar pressure	Elevation of station barometer (feet)	Number of form to be used	Midway isobar pressure
0–30	1068–C	30. 25	2860–3367	1068–D	26. 75
31–489	1068–D	29. 75	3368–3894	1068–C	26. 25
490–952	1068–C	29. 25	3895–4430	1068–D	25. 75
953–1515	1068–D	28. 75	4431–4975	1068–C	25. 25
1516–1879	1068–C	28. 25	4976–5536	1068–D	24. 75
1880–2360	1068–D	27. 75	5537–6121	1068–C	24. 25
2361–2859	1068–C	27. 25	6122–6710	1068–D	23. 75

1076. **Entry of Mercurial Barometer Station Pressure.**—The station pressure as obtained from reading the mercurial barometer should be entered on the sheet in ink just above the approximate position of the pen where the record is started (near the left-hand margin). The corresponding mercurial barometer station pressure should also be entered immediately above the end of the trace after the sheet has been removed.

1077. **Adjustment of Pen Reading to Mercurial Barometer Station Pressure.**—The pen reading should be made to agree approximately with the corresponding mercurial-barometer station pressure by either properly adjusting a knurled head screw on top of the instrument or by adjusting a screw underneath the base of the instrument—as required for the instrument with 1 to 1 scale. In case it is necessary to make the latter type of adjustment, the barograph should be placed with the proper end project-

ing over the edge of a table and the screw should be turned by the use of the small end of the clock key furnished with the instrument.

1078. **Trimming Sheets.**—Although an effort has been made to have the sheets trimmed, except at one end, to fit the barograph cylinders exactly, it will be found that, in many cases, the sheets need trimming on the lower edge since proper trimming of these sheets is difficult to accomplish in great numbers. Observers should, therefore, examine each sheet, and, if necessary, trim it to the correct dimensions as indicated by marginal lines, which may be seen near the edges of the imperfect sheets. (Note that this marginal line is never the bottom coordinate line, but it is always a line a little below the bottom coordinate line.) The left-hand end of the chart will not be trimmed but will be reserved for use in binding. If a metal straightedge is available, it will be found that the necessary trimming can be accomplished with greater ease and accuracy by placing the straightedge on the main part of the sheet and then cutting off the unwanted portion with a fairly sharp knife or razor blade.

1079. **Winding the Clock.**—The clock within the cylinder should be wound between the time of removing the cylinder from the barograph and placing the sheet on the cylinder. It should be rewound thereafter whenever the sheet is changed. Precautions should be taken not to wind the clock too tight. It is possible to pull the end out of the main spring.

1080. **Placing Sheet on Cylinder.**—The sheet, once trimmed, will be placed on the barograph cylinder so that it fits the cylinder tightly and its bottom edge is in contact with the flange at the bottom of the cylinder *all the way around*. If the sheet has been trimmed properly the ends of the horizontal coordinate lines will match after the sheet has been placed on the cylinder in this manner. Should they fail to do so, the sheet should be taken off and retrimmed. It should then be replaced on the cylinder so that the ends of the horizontal lines do match and so that the bottom coordinate line is the usual distance from the flange of the cylinder.

1081. **Adjusting Pen Reading for Time.**—After the clock has been wound and placed on the barograph, the cylinder should be turned forcibly either one way or the other so that the pen, if put on the sheet, would contact the sheet at a point a little to the right of the proper time line. The cylinder should then be turned in a counterclockwise direction (as viewed from above) until the pen reads correctly with respect to time.

1082. **Elimination of Frictional Effects.**—After the pen has been placed in contact with the sheet, the barograph should be jarred lightly in order to overcome any frictional effects that may be preventing the various parts and levers from settling into their normal positions. This may be done by striking the palm of the hand on the table or shelf upon which the instrument rests.

1083. **Avoiding Loss of Record.**—Whenever an observation is taken, the observer should see that the clock is running and that the ink is flowing properly.

1084. **Making Time Check Lines.**—After the barograph is put in operation, a time-check line of not over one-eighth of an inch in length will be made at a given time each day by touching the pen arm or by lightly jarring the instrument in the manner described in paragraph 1082. In the case of first-order Weather Bureau Offices, the time-check line will be made at noon, as provided for in existing instructions furnished with Form 1001. All other stations will make their check line at the time of the 8 a. m., E. S. T., observation.

1085. **Recording Time of Making the Check Line.**—The time, to the nearest minute, at which the pen is usually tocuhed will be indicated in ink on the face of the first sheet for each month. If the pen is touched more than 5 minutes from the regular time, a note will be made stating the time at which the check line was made.

1086. **Labelling Sheets.**—The name of the station and the dates of the beginning and end of the record contained on the sheet will be written on it in ink. This will be done in the upper left-hand corner of the space on the sheet covered by the coordinate lines, except when the trace interferes. Under the latter circumstance, the name of the station and dates of the beginning and end of record will be marked below the trace on the left-hand part of the sheet. The day of the month will also be put on in ink immediately above the noon-time line of each day's record.

1087. **Dates for Changing Sheets.**—If the cylinder of the barograph makes a complete revolution every 7 days, the sheets should be changed on the 1st, 8th, 15th,

22d, and 29th of each month. If the cylinder revolves once in every 4 days, the sheets should be changed on the 1st, 5th, 9th, 13th, 17th, 21st, 25th, and 29th of each month. The time required for a complete revolution of the cylinder may easily be determined by noting the number of days of record provided for on the sheets furnished for the instrument.

1088. **Lifting Pen from Sheet Prior to Removing Cylinder.**—Care should always be taken to see that the pen is lifted from the sheet before any attempt is made to remove the cylinder from the barograph. A lever integral with the instrument is provided for this purpose.

1089. **Avoiding Smearing Ink in Removing Sheets.**—In removing the sheet from the cylinder, the latter portion of the record may not be thoroughly dry. Observers should, therefore, be careful to avoid smearing the wet ink, and the sheets, after being removed from the cylinder, should be laid aside to dry.

1090. **Disposition of Sheets.**—Airway observers, or observers at off-airway stations, will forward the sheets for each month within 5 days after the end of the month to their general supervising station, except where existing instructions conflict. The general supervising stations and all other Weather Bureau stations will forward these and the barograph sheets for their own station to "Division of Climate and Crop Weather, United States Weather Bureau, Washington, D. C." on or before the 10th of the month following that of the period of record.

1091. **Adjusting Pen When it is About to Go Off Sheet.**—When the pressure is such that the record might pass off the edge of the sheet or not be included in the coordinate-line space, the numbering of the lines should be increased or decreased by one and the pen should be adjusted accordingly, i. e., the position of the pen should be changed by 1 inch of pressure either one way or the other. This adjustment is to be made in the manner prescribed in paragraph 1077.

1092. **Having Clock Cleaned or Repaired.**—In case the clock fails to run after proper winding, it should be taken to a local jeweler for repairing and cleaning. When the bill for such work is rendered to an airway station, the words "Work completed," followed by the date and signature of the observer, should be written on it in ink, and it should be forwarded to the official in charge of the general supervising station. The latter official will, in turn, voucher it with cost charged to Circular 7, paragraph 1, and forward in the usual manner to "Stations and Accounts Section, United States Weather Bureau, Washington, D. C." Bills for such work done on barographs at other stations will be handled as provided for in paragraph 99 of Station Regulations. Clocks which have stopped because of exposure to low temperatures will run again as a rule when warmed to normal room temperature.

1093. **Preserving Effective Pen-Arm Length.**—The term "effective pen-arm length" is here used to denote the distance of the point of the pen from the horizontal axis about which the pen arm moves as the pressure rises and falls, this distance being measured when the pen point is in contact with the cylinder and when the pen is on the midway isobar. Such a distance is obviously changed by bending the pen or pen arm in any way. Hence, great care should be taken to avoid any bending of this nature and to keep the distance so defined exactly the same as it was when the instrument came from the factory. The effective pen-arm length is printed on the charts.

1094. **Cleaning Pen.**—Whenever the pen fails to make a fine, clear line, it should be removed from the pen arm and cleaned. Before removing it, its exact distance from the axis about which it revolves should be noted so that its original position may be duplicated when it is replaced. Its removal may then be accomplished by holding the pen arm with the right hand and pulling the pen horizontally to the left with the left hand. It should then be thoroughly washed in water. Any dried ink remaining on it after washing should be removed by (1) scraping with a knife and (2) rewashing it before replacing it on the pen arm. Attention is again called to the fact that care should be taken to avoid bending the pen or pen arm in this process as explained in paragraph 1093.

1095. **Worn Pens.**—Whenever a pen becomes worn to the extent that it no longer makes the fine, clear record that it should, a replacement pen, if not on hand, should be ordered. When this occurs on stations at which there are no commissioned personnel,

the observers in charge will notify their general supervising stations, from which replacement pens will be forwarded Commissioned Weather Bureau personnel may sharpen pens by carefully rubbing the slanting under edge on a fine abrasive stone.

1096. **Replacing Diluted Ink.**—The ink usually used contains considerable glycerine, which is hygroscopic. Because of the absorption of water vapor, the ink sometimes becomes diluted and the trace line does not have its proper deep color. On such occasions the diluted ink should be removed and replaced by fresh ink. The ink supply should be kept stoppered.

1097. **Sheets with Imperfect Records.**—These sheets should not be destroyed under any circumstance, but should be preserved and forwarded in the regular manner.

1098. **Periodic Inspection for Abrupt Discontinuities in Record.**—First-order Weather Bureau stations will periodically examine their own barograph traces, as well as those received from second-order stations, to determine whether abrupt discontinuities in the record are in evidence. Since the presence of such discontinuities may be an indication of excessive friction in the pen-arm mechanism, the instrument should be examined with this fact in mind. If trouble of this nature is found, it should be corrected by airway inspectors or qualified personnel of first-order stations, if practicable. Otherwise, the trouble should be called to the attention of the central office and the proper steps to remedy it will be taken.

1099. **Oiling.**—Due to the fact that excessive oil on the pivots of the mechanism impairs the performance and accuracy of the instrument, *no oiling will be done by the observer.* The necessary oiling of the clock mechanism will be done by a jeweler only when the clock is cleaned or repaired.

1100. **Other Pen Arm Mechanism Adjustments.**—The observer should make no other adjustments of the mechanism operating the pen arm than those described in paragraph 1077. In the case of open-scale barographs, however, dash pots are used for damping pen-arm oscillations. If this dash pot needs any attention, special instructions will be furnished.

1101. **Use of Dash Pot.**—A dash pot will be found on the base of the open-scale barograph. It is simply a cylindrical cup in which a dasher of slightly smaller diameter attached to the train of levers moves up and down with changes of pressure. The instrument will function without any liquid in the dash pot; but where accidental changes of pressure must be reckoned with, such as are occasioned by slamming doors or by gusts from an open window, or where vibrations or jars occur, a suitable liquid, is inserted in the dash pot for the purpose of checking sudden changes in motion and at the same time permitting slow ones to take place unimpeded. Some cases of instrument failure have been traced to an air bubble under the dasher. The formation of such an air bubble can be avoided by removing the dasher and cover before filling the dashpot.

1102. **Adjusting Dash Pot.**—In case the dash pot needs adjusting, proceed as follows:

a. Turn the large milled-head adjusting nut to the left to bring pen arm near lower edge of record sheet.

b. Lift dash pot cover from dash pot, and hitch it temporarily to pen-arm shaft. A piece of strong thread may be threaded through the hole in dash pot cover for this purpose.

c. Fill dash pot within about one-half inch of top with the special liquid shipped with the barograph.

d. Replace dash pot cover and adjust pen arm to correct pressure. The dasher must be either completely covered at all times or completely free. If it should at any time coincide with the surface of the liquid, surface tension would prevent proper functioning of the barograph.

1103. The bottle of liquid supplied with the instrument is about twice the amount required for a filling. The surplus should be retained for future requirements. Owing to the well-known hygroscopic nature of such liquids, the dash pot may in time overflow through absorption of atmospheric water. In such case the level may be lowered by removing part of the liquid with a medicine dropper.

1104. **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 Weather Bureau inspectors.

1105. 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.

1106. A small magnifying glass is often a help in reading the thermometer. Flashlights must be employed for night observations, unless the shelter is electrically lighted, which convenience is usually provided only for the larger shelters.

1107. **Ceiling-light Projectors and Clinometers.**—These will be kept clean, the projector mirror, cover glass, and 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, the lamp is kept in focus and is lighted only long enough to take the observation. Pipe supports for the projector should be repainted when needed.

1108. **Care of Projectors.**—Cover glass and the exposed (concave) side of reflectors should be kept clean and dry by the methods customarily employed in cleaning glass. Ordinarily wiping off the surfaces with a soft, damp cloth will suffice, but, if oil or grease should be present, a little soap may be used if subsequently removed with clean water. Abrasive material should never be used. Regular and systematic attention at least once a week is essential. A one-fourth inch hole drilled through the center of the reflector with a corresponding hole through the drum is provided to drain water which might gain entrance to the projector and collect in the reflector. Leakage of water into the projector around the cover glass has been prevented by the use of calking compound when gaskets are not easily available.

1109. **Repairs.**—When major repairs become necessary it will probably be best to contact some trustworthy local concern who, in turn, should be able to procure parts from the manufacturer whose name appears on the projector. In ordering parts from the manufacturer, the contractor should give description and dimensions of each part needed as well as the manufacturer's serial number. Repair parts are not stocked in the central office. Expenditures must be authorized in the prescribed manner before any such work is performed. Mirrors are usually resilvered by local contractors at a nominal cost.

1110. **Painting of Projector.**—Aluminum paint is considered best for all parts except the interior of the drum, where only dead black should be used.

1111. **Miscellaneous; Reporting Broken or Defective Instruments.**—In addition to the foregoing the 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 break-downs. 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.

1112. Ordinary precautions are required in the use of instruments, and observers are requested to use every reasonable care to avoid accidents, breakage, and loss.

1113. **Instructions for the Installation of a Psychrometer Fan in the Airways Instrument Shelter.**—Materials furnished are as follows:

1 fan, psychrometer.
1 iron screw hook, No. 9, on which to hang psychrometer.
1 wooden sunshade for the right side of the airways shelter, size 9⅜ inches by 12¼ inches.
4 wood screws, flathead, three-fourth inch, No. 8, for attaching sunshade to airways shelter.
1 guard to prevent thermometers from fouling fan.
2 U-clip guides for guard.
2 woodscrews, one-half inch, No. 7, for attaching U-clips to shelter.

1114. The shelter must be securely fastened to the post, preferably by bolts, since subsequent vibration will tend to loosen it.

1115. To install the device, first remove and discard the upright thermometer post and the lower three (in some shelters four) louvre boards on the right side; then clamp the fan to the lower-right cross member of the frame of the shelter. In some shelters a 4-inch section of frame must be cut away to make room for the clamp. Next, attach wooden sunshade with its upper edge 1 inch below the top louvre and with its lower edge about 2 inches out from the frame. It will be in a slanting position and will

thus keep out the sun and at the same time admit air to the space immediately behind the fan, a requirement of importance as shown by experiments. A corner will have to be cut away from one of the rear transverse louvres. Two screws at the top and two screws through the triangular portion of the sun shade are employed to hold it to the shelter. The handle of the fan projects through an opening in the sun shade. In some of the fans the brass sleeve that slips over the projecting shaft is counterbored at one end to form a recess for the projecting metal of fan blade hub. Be sure to place the counterbored end outward. The guard is then placed in front of the fan, being held by two clips—one on the floor of the shelter, the other on the rear. Then insert screw hook on which to hang the psychrometer, which is of course used without the handle, and screw upward into the subroof. Since airway shelters are found to differ slightly in dimensions, some fittings may be found necessary. Also, two small strips of wood about 4 inches long may need to be tacked to the top of the lower-right cross frame to keep out the western sun. As planned, the pair of thermometers may be readily swung forward for the purpose of wetting the wet bulb. The fan needs to be operated at only moderate speed. A small quantity of light machine oil, such as is furnished for the anemometer, should be applied to the fan bearings occasionally.

1116. **Instructions for the Installation of a Psychrometer Fan in the Cotton Region Instrument Shelter.**—Materials furnished are as follows:

1 fan, psychrometer, assembly.
1 iron screw hook, No. 9, on which to hang psychrometer.
4 iron wood screws, 2½-inch, No. 10, flat-head, for attaching fan assembly to shelter.

1117. To install the device, first whittle slots in the center of the third and fourth louvres from the bottom at the right-hand side of the shelter, with care not to split the louvres. The slots should be just deep enough to allow for the insertion of the handle shaft and free motion for both the handle and fan hub. Next, hold assembly in position and spot the four holes for 2½-inch, No. 10 screws, which attach assembly to shelter. Attach assembly by means of wood screws and attach handle to hub by means of nut. A special brass shaft extension is included in some cases. Be sure that both handle and fan shaft move free. Insert screw hook on which to hang the psychrometer, which is, of course, used without the handle on cross bars 7½ inches from right-hand cross-bar support. As planned, the pair of thermometers may be readily swung forward for the purpose of wetting the wet bulb. The fan needs to be operated at only moderate speed. A small quantity of light machine oil, such as is furnished for the anemometer, should be applied to the fan bearings occasionally. The fan blades are properly shaped, before issue, to cause an ample air movement past the psychrometer, about 15 feet per second. The fan blades, however, may be readily shaped to give maximum air movement by twisting them with the fingers.

1118. **Observer's time signaller.**—In an effort to meet the need for a mechanical reminder to assist observers in the many observations required, a signal clock has been designed and constructed in the instrument division of the central office specifically for the purpose indicated.

1119. The clock proper, a Seth Thomas No. 10, 8-day movement, well known for ruggedness of construction, has had the customary hands removed and a brass disc wheel about 2½ inches in diameter placed upon the arbor usually occupied by the minute hand. This wheel has 12 screw sockets, equally spaced, about its circumference, and since the wheel makes a complete turn in 1 hour, it will be apparent upon examination that if screws were inserted in all the sockets a contact would be made every 5 minutes. However, in operation only the screws necessary to accomplish the number of desired contacts are to be inserted. Several extra screws are provided in a rack attached to the door. The contact maker is the standard one-sixtieth mile contact from the anemometer, chosen in the interest of subsequent servicing.

1120. The brass disc may be rotated by hand without injury to the clock, just as the hand is set. Operating current should be kept to the minimum to lessen sparking. A condenser across the terminals is an additional aid in this respect.

1121. No buzzer nor battery are supplied since these are frequently available or may easily be procured locally.

1122. It is not to be expected that this type of clock will equal a pendulum clock as a timekeeper.

Appendix I.—CODE USED IN REPORTING PILOT BALLOON OBSERVATIONS

CHAPTER 1

GENERAL INFORMATION

1. Pilot-balloon observations of upper-air wind directions and velocities are made four times each day (at 5 and 11 a. m. and p. m. eastern standard time, approximately) at about 100 points in the United States. In addition thereto, such observations are made in Alaska, Puerto Rico, and Hawaii, and are also available from Canadian stations. These reports are transmitted over the Civil Aeronautics Authority teletype circuits in regular sequences, beginning at 6:11 and 12:11 a. m. and p. m. eastern standard time each day. The code used in such transmissions, or transmissions made by telegraph, is described for the information of all concerned in the following paragraphs.

CHAPTER 2

DESCRIPTION OF CODE

2. **General Composition of the Code.**—All pilot-balloon reports are sent by means of a number code wherein the wind data are given by alternate groups of 5 and 4 digits each. The number of groups representing the surface and *even* 1,000-foot levels consists of 5 digits, the first of which indicates the level. The *odd* 1,000-foot levels consist of 4 digits, the number indicating the level being omitted.

3. **Levels for Which Data Are Given.**—The data are given, insofar as they are available, for each 1,000-foot level above *sea level* up to and including 14,000 feet. Wind directions are given to 36 points, i. e., the direction in degrees (from north, i. e., 90°=E., 180°=S, etc.) divided by 10 and rounded to the nearest 10 degrees. Velocities are given in *miles* per hour.

4. **Composition of Complete Report.**—Complete reports consist of the following: (*a*) Station designation; (*b*) time; (*c*) surface-wind data, and (*d*) wind data for each 1,000-foot level, insofar as available, up to 14,000 feet above *sea level.*

(*a*) *Station designation.*—This is the regular Civil Aeronautics Authority two- or three-letter designation for the station concerned, i. e., CV for Cleveland, WA for Washington, etc.

(*b*) *Time.*—Seventy-fifth meridian time is used for all pilot-balloon reports, and is determined as follows: Twenty minutes is added to the time of releasing the balloon; this is then changed to the nearest whole hour and converted to 75th meridian time and then to the 24-hour clock. For example: Denver, Colo., balloon released at 3:12 p. m., one hundred and fifth meridian time; adding 20 minutes gives 3:32 p. m.; the nearest hour would be 4 p. m., one hundred and fifth meridian time, or 6 p. m., seventy-fifth meridian time, and 18 on the 24-hour clock. The value reported would, therefore, be "18." The purpose of adding 20 minutes to the time of the balloon's release is to indicate more nearly the mean time of the observation. Reports filed with local Civil Aeronautics Authority operators for transmission will also have the local standard time of the balloon's release, plus 20 minutes indicated thereon for use in the radio broadcasts. In the example above this time would be 3:32 p. m.

(*c*) *Surface-wind group*—This will be 5-digit group, the first of which will always be zero, such as "02216," which would indicate a surface wind direction of 220° (SW) and a velocity of 16 miles per hour.

151480—39——17

(*d*) *Upper-air wind data.*—The wind direction and velocity for each 1,000-foot level above the sea-level altitude of the station and up to 14,000 feet are given in this part of the report. The first standard level for which wind data are given must be 200 or more feet above the sea-level elevation of the station theodolite platform. For example, if the sea-level elevation of the platform is 1,820 feet, the first level to be sent would be 3,000 feet; but if the platform elevation is 1,800 feet, the first level to be sent would be 2,000 feet, etc.

5. **Indicating Levels Included in Reports.**—The levels for which data are given will be indicated by a single digit, using the numbers 0–9 to indicate the 1,000-foot levels and repeating the series of numbers for levels above 9,000 feet, as follows:

Number	Levels in feet above sea level	Number	Levels in feet above sea level
0	Surface—10, 000	5	5, 000
1	1, 000—11, 000	6	6, 000
2	2, 000—12, 000	7	7, 000
3	3, 000—13, 000	8	8, 000
4	4, 000—14, 000	9	9, 000

In order to reduce the teletype sending time and also to facilitate the entering of these reports on aerological charts at district and airway forecast centers, the levels are indicated for the surface and the *even* 1,000-foot levels only.

6. **Indicating Wind Directions in Reports.**—Wind directions are indicated by two digits (00–36), as follows:

Code figure	Direction in degrees	Code figure	Direction in degrees	Code figure	Direction in degrees	Code figure	Direction in degrees
00	Calm	10	95–105	20	195–205	30	295–305
01	6–14	11	106–114	21	206–214	31	306–314
02	15–25	12	115–125	22	215–225	32	315–325
03	26–34	13	126–134	23	226–234	33	326–334
04	35–45	14	135–145	24	235–245	34	335–345
05	46–54	15	146–154	25	246–254	35	346–354
06	55–65	16	155–165	26	255–265	36	355–5
07	66–74	17	166–174	27	266–274		
08	75–85	18	175–185	28	275–285		
09	86–94	19	186–194	29	286–294		

It will be noted that the above code figures may be determined by dividing the direction in degrees by 10 and disposing of decimals in accordance with the usual Weather Bureau rule, wherein the decimal 0.5 is dropped from even numbers and adds one to odd numbers.

7. **Indicating Wind Velocities in Reports.**—Wind velocities in *miles per hour* will be indicated directly by the last two digits of the number groups. For velocities of 100 miles per hour or over, the direction numbers will be increased by 50 and the values above 100 indicated directly by the last two digits. For example, to code a wind direction of 290° and velocity of 112 miles per hour at 8,000 feet, add 50 to 29 (290° ÷10), making it 79, and the complete group would be "87912."

8. **Maximum-Altitude Data.**—Maximum-altitude wind data are not sent for any level greater than 14,000 feet. When the maximum altitude is less than 14,000 feet, data are sent only when the altitude is 300 feet or less below a standard level, in which case it will be coded for that standard level. Thus, a maximum altitude of 7,700 feet with a wind of 280° and 15 miles per hour would be coded as "82815."

9. **"No Observation" Reports.**—In case an observation is not made or not received at point of transmission prior to the time of filing the report, a "no observation" report is filed, consisting of the following:

(*a*) Station designation (as per paragraph 4).
(*b*) Time (as per paragraph 4).
(*c*) Reason for no observation, using one of the following words:

CONO—Low clouds, none.
RANO—Raining, none.
SONO—Snowing, none.
FONO—Foggy, none.
KONO—Smoky, none.
IONO—Instrument trouble, none.
BANO—No balloons, none.
DUNO—Thick dust, none.
HYNO—No hydrogen, none.
FINO—Not filed.

For example: "CX05 CONO" would indicate that no observation was made at Cheyenne at 5:00 a. m., eastern standard time, due to low clouds.

10. **Examples of Reports.**—Following are given some examples of representative reports:

A. *Data:*

(*a*) Station—Cheyenne.
(*b*) Time—3:22 p. m., 105th meridian.
(*c*) Surface wind 165°, 8 m. p. h. (at 6,133 feet elevation).
(*d*) 7,000 feet 172°, 14 miles per hour.
8,000 feet 175°, 16 miles per hour.
9,000 feet 185°, 20 miles per hour.
10,000 feet 195°, 22 miles per hour.
11,000 feet 214°, 20 miles per hour.
12,000 feet 235°, 17 miles per hour.
12,720 feet 248°, 25 miles per hour (maximum altitude).

Coded report:

CX18 01608 1714 81816 1820 02022 2120 22417 2525.

Note that in this report, the maximum-altitude data would be sent as the maximum altitude is within 300 feet of the next standard level.

B. *Data:*

(*a*) Station—Buffalo.
(*b*) Time—10:40 a. m., seventy-fifth meridian.
(*c*) Surface wind 230°, 18 miles per hour (at 720 feet elevation).
(*d*) 1,000 feet 235°, 22 miles per hour.
2,000 feet 265°, 25 miles per hour.
3,000 feet 272°, 28 miles per hour.
4,000 feet 275°, 32 miles per hour.
5,000 feet 282°, 44 miles per hour.
6,000 feet 285°, 52 miles per hour.
7,000 feet 288°, 67 miles per hour.
8,000 feet 295°, 78 miles per hour.
9,000 feet 304°, 87 miles per hour.
10,000 feet 306°, 94 miles per hour.
11,000 feet 315°, 102 miles per hour.
11,680 feet 322°, 108 miles per hour (maximum altitude).

Coded report:

BJ11 02318 2422 22625 2728 42832 2844 62852 2967 83078 3087 03194 8202.

Note that the maximum-altitude data would not be sent in this case as the maximum altitude is more than 300 feet below the next standard level.

Appendix II.—CODE FOR DAILY TRANSMISSION OF AIRPLANE WEATHER (APOB) AND RADIOSONDE (RAOB) OBSERVATIONS

1. **Use of Code.**—The following code was placed in use on August 1, 1938, and supersedes all previous instructions concerning the transmission of the observations referred to above. This code will apply to "apob" and "raob" messages transmitted by teletype, telegraph, or radio.

2. **Code Form For Apobs.**—The data generally to be coded in "apob" messages and the order in which they are to be grouped are shown in symbolic code form below:

$$II(I)^1(Y_1)G_1G_1$$
$$HHPPT \quad TUUm_1m_2$$
$$HHPPT \quad TUUm_1m_2$$
etc.

(for surface and successive significant levels as required).

$$P_aP_aP_bP_bP_cP_c$$
$$P_1P_1P_2P_2h_p \quad N_hCdd$$
$$P_1P_1P_2P_2h_p \quad N_hCdd$$
etc.

(for cloud types or layers—from none to maximum of three layers, as required).

$$w_3P_3P_3P_4P_4$$
$$w_3P_3P_3P_4P_4$$
etc.

(for special phenomena, as required).

3. **Code Form for Raobs.**—The code form for raobs is the same as for apobs with the following exceptions:

(*a*) Groups $w_3P_3P_3P_4P_4$ are completely omitted. (Note exceptions in Addendum I.)

(*b*) Groups $P_1P_1P_2P_2h_p$ are included only for those cases where appropriate values of P_1P_1 are obtained by observational means (for example ceiling observations, using a ceiling light projector or pilot balloon). (See Addendum I.)

4. **Explanation of Symbols.**—(Parentheses about a symbol indicate that the corresponding code numeral or letter is included only under certain conditions.)

$II(I)$=Station call letters, ordinarily two in number, used in transmission by—

(1) teletype;

(2) telegraph *only* [2] in cases where the telegraph office from which the message is dispatched does *not* have the same name as the place where the observation was made;

(3) point-to-point radio communication.

(In the aviation and commercial bulletins broadcast from Washington, D. C. (NAA/NSS) and San Francisco, Calif. (NPG), the name of the observation station spelled out (omitting the State or Territory) is used in lieu of the call letters.)

(Y_1)=Day of the week observation was made: 1=Sunday, 2=Monday, etc., 7=Saturday. The day will be reckoned according to seventy-fifth meridian time; for example, Thursday=5 will signify the period extending from 00.00 to 24.00 hours, Thursday, seventy-fifth meridian time. This code datum (Y_1) is to be included in the message *only* if the message is filed after the last "apob"-wheel schedule of the day on which the observation is made.

G_1G_1=Time of take-off (or launching) to the nearest whole hour, 75th meridian time, on the 00-23 hour basis, e. g. 04 designates 4 a. m.; 14 designates 2 p. m.

---

[1] Certain modifications regarding the group II (I) may be required in the case of telegraphic and radio transmission. See remarks concerning that group in paragraph 4.

[2] In telegraphic transmission where the telegraph office from which the message is dispatched has the same name as the observation station, the call letters are omitted, since the telegraph form indicates the place of origin of the message.

HH=Height above sea level in hundreds of meters, to the nearest whole hundred, omitting the ten thousand place digit wherever involved, e. g. 520 m is transmitted as 05, 4570 m is transmitted as 46, and 12,520 m as 25. Fifties (50's) are disposed of according to the rule of changing to the nearest *even* hundred, e. g. 2,350 m is transmitted as 24, 2,450 m is transmitted as 24, and 12,450 also as 24.

PP=Barometric pressure in whole millibars, including only tens and units digits, i. e., with hundreds and thousands digits omitted. For example: 1,020 mb. is transmitted as 20, 1,000 mb. as 00, 982 mb. as 82, 900 as 00, 705 mb. as 05, etc. (Note tables 7 and 8 in appendix regarding average relation of pressure to altitude.)

TT=Temperature of the air in whole degrees centigrade. A naught will be used for the tens digit when the temperature is 0° C. to 9° C., inclusive. When the temperature is −1° C. or lower, the minus sign will be disregarded and 50 added for coding. Where the sum of the temperature and 50 in these cases is 100 or more, the hundreds digit will be omitted.

For example:
15° C. is transmitted as 15.
5° C. is transmitted as 05.
0° C. is transmitted as 00.

SUMS (when temperatures are negative)

−1° C. (1+50=51) is transmitted as 51.
−45° C. (45+50=95) is transmitted as 95.
−50° C. (50+50=100) is transmitted as 00.
−55° C. (55+50=105) is transmitted as 05.
−65° C. (65+50=115) is transmitted as 15.
(In transmission, the TT digits are split between the end of the first group and the beginning of the second group for each significant level.)

UU=Relative humidity in whole percent. A naught will be used for the tens digit when the relative humidity is 0 to 9 percent, inclusive. Zero and 1 percent will be coded as 01, 9 percent as 09, 50 percent as 50, etc., 100 percent as 00.

m_1m_2=Mixing ratios in grams of water vapor per kilogram of dry air, where m_1 represents the units digit and m_2 represents the tenths digit, the tens digit being omitted. For example,
8.7 g/kg is transmitted as $m_1=8$ and $m_2=7$; 21.3 g/kg as $m_1=1$, and $m_2=3$; 11.3 g/kg as $m_1=1$, and $m_2=3$; 10.4 g/kg as $m_1=0$, and $m_2=4$; 0.4 g/kg as $m_1=0$, and $m_2=4$.
(Note table 9 in appendix giving saturation mixing ratios for various temperatures and pressures. The saturation mixing ratio multiplied by the relative humidity expressed decimally gives a very close approximation to the actual mixing ratio. It is thus possible to ascertain quickly the value of the missing tens figure if not already known.)

P_aP_a=Barometric pressure in whole millibars at 1,520 meters (5,000 feet) above sea level, omitting the hundreds and thousands digits, coding only the tens and units digits. The pressure at 1,520 m, m. s. l. will usually lie in the range 810 to 880 mbs. Examples: 833 mbs. will be coded as 33, 851 mbs. as 51, etc.

P_bP_b=Barometric pressure in whole millibars at 3,050 meters (10,000 feet) m. s. l., omitting the hundreds and thousands digits, coding only the tens and units digits. The pressure at 3,050 m, m. s. l. will usually lie in the range 640 to 730 mbs. Examples: 670 mbs. will be coded as 70, 695 mbs. as 95, 716 mbs. as 16.

P_cP_c=Barometric pressure in whole millibars at 4,270 meters (14,000 feet) m. s. l., omitting the hundreds and thousands digits, coding only the tens and units digits. The pressure at 4,270 m, m. s. l., will usually lie in the range 540 to 630 mbs. Examples: 573 mbs. will be transmitted as 73, 598 mbs. as 98, 617 mbs. as 17.

P_1P_1=Barometric pressure, in tens of millibars, corresponding to the height of the base of the cloud designated by the code figure for C in the immediately succeeding group. For example: 1020 mb will be coded as 02, 875 mb as 88, etc., the units digit being disposed of according to the standard Weather Bureau rule for dropping decimals. When the pressure in question is unknown P_1P_1 will be coded in accordance with table 1.

P_2P_2=Barometric pressure, in tens of millibars, corresponding to the height of the top of the cloud designated by the code figure for C in the immediately succeeding group. The rules for coding observed or estimated data are the same as those for P_1P_1. When the pressure in question is unknown, P_2P_2 will be coded in accordance with table 1.

h_vh=A characteristic numeral, coded according to table 2, to indicate whether the pressures (P_1P_1 and P_2P_2) corresponding to the height of the base and top, respectively, of the cloud type designated by the code figure for C in the succeeding group have been ascertained by observation, have been estimated, or are unknown.

N_h=Amount, in tenths, of sky covered by clouds of the type designated by the code figure for C which immediately follows in the group, and which represents clouds at a given height (see immediately preceding group in code). Ten-tenths will be coded as 0; "few" and one-tenth will be coded as 1; and amounts from two-tenths to nine-tenths will be coded by the figures 2 to 9 respectively.

C=Type of cloud (see table 3).

dd=Direction from which the clouds are coming, according to a scale 01–36, i. e. the number of degrees measured from north divided by 10 and rounded off to the nearest whole

figure. Calm=00, N=36, E=09, S=18, W=27, etc. (See paragraph 5 for substitution in case direction data are unknown or missing.)

(NOTE.—A pair of groups $P_1P_1P_2P_2h_p$ N_hCdd will be used for each type or layer of cloud for which data are transmitted in the message, except as specified in paragraph 3 with regard to raobs. As many as three cloud groups may be included in the message: for low, intermediate, and high clouds, respectively in that order. If no cloud form in any of these categories is observed, the corresponding groups $P_1P_1P_2P_2h_p$ N_hCdd are omitted.)

w_3=A characteristic numeral designating the nature of a phenomenon encountered by the airplane, coded in accordance with table 4.

P_3P_3=Barometric pressure, in tens of millibars, at the level of entry of the ascending airplane into the phenomenon given by the code figure for w_3. The rules for coding observed data are the same as those for P_1P_1. When the pressure in question is unknown, P_3P_3 will be coded in accordance with table 5.

P_4P_4=Barometric pressure, in tens of millibars, at the level of emergence of the ascending airplane from the phenomenon given by the code figure for w_3. The rules for coding observed data are the same as those for P_1P_1. When the pressure in question is unknown or there was no emergence from the phenomenon during the ascent, P_4P_4 will be coded in accordance with table 5.

NOTE.—One $w_3P_3P_3P_4P_4$ group will be used to indicate each of the w_3 phenomena observed, except as specified in paragraph 3 with regard to raobs. The phenomena will be indicated in the message in the order of increasing value of w_3; that is, in the order: Rime or frost, hard ice, haze or smoke, etc.—see table 4. Data for successive layers in which rime or frost formed will be given before data for layers in which hard ice formed, etc., and data for successive turbulent layers will be given after data for a thunderstorm heard at the station.

5. **Missing Data.**—Whenever any of the data are missing for groups to be transmitted by teletype, telegraph, or point to point radio communication, a slant (/) will be substituted for each missing digit. In the case of radio broadcasts (non-point to point communications) the letter X will be substituted for each missing digit. For exceptions to these rules see: P_1P_1, P_2P_2, P_3P_3, and P_4P_4.

6. **"No Apob" or "No Raob" Messages.**—A "No Apob" or "No Raob" message is one containing no airplane or radiosonde observational data and indicating the reason for not transmitting those data at or before the time of filing shown in the message. Such messages will be filed in accordance with current "Instructions for Making Aerological Observations by Means of Airplanes and Balloons" (W. B. Circular P, Revised), or special instructions to the station regarding this matter. "No apob" or "No raob" messages will contain two groups:

(1) $II(I)(Y_1)G_1G_1$, where these symbols have meanings similar to those of the corresponding symbols in paragraph 4, except that the "time of filing the message with the communications office" is substituted for "observation" or "take-off" time in respect to (Y_1) and G_1G_1.

(2) A group from table 6, consisting of four letters indicative of the reason for the "No apob" or "No raob" message.

7. **Correction Messages.**—Messages transmitting corrections to regular "apob" or "raob" messages begin with the abbreviation CQN.

Correction messages may be of five kinds, as indicated below (*a*–*e*). (In the following, n with a subscript designates the number of the group in the original message to which reference is made, counting II (I) (Y_1) G_1G_1 as 1, and the second group as 2, etc.)

(*a*) When it is desired to transmit a complete corrected message, regardless of extent of repetition of the original message, the code form is: CQN followed immediately by the corrected message in its entirety.

(*b*) When it is desired to correct specified groups in the original message, the code form is:

$$CQN \quad II(I)(Y_1)G_1G_1 \quad n_1/n_2/n_3/n_4 \quad - - - - - \quad - - - - - \quad - - - - - \quad - - - - -.$$

Where the dashes here represent the *correct* figures of the groups numbered n_1, n_2, n_3, etc., respectively, in the originally transmitted message. (See paragraph 9 (e) for example.) When only one group is to be corrected, the group number in question, n_1, is followed by a slant in the message; e. g. if n_1 is group 8, the code form is:

$$CQN \quad II(I)(Y_1)G_1G_1 \ 8/ - - - - -.$$

(*c*) When it is desired to insert one or more new groups between specified groups in the original message, the code form is:

$$CQN \quad II(I)(Y_1)G_1G_1 \text{ insrt } n_1/n_2 - - - - - \ n_3/n_4 - - - - -, \text{ etc.,}$$

where the abbreviation "insrt" included in the correction message designates the word "insert" and where the dashes represent the figures of new groups to be inserted between groups n_1 and n_2, and n_3 and n_4, etc., respectively, of the originally transmitted message. When, for example, one new group is to be inserted between groups 5 and 6 of the original message, and two new groups in given order are to be inserted between groups 13 and 14, the code form is:

$$CQN \quad II(I)(Y_1)G_1G_1 \text{ insrt } 5/6 - - - - - \ 13/14 - - - - - \ - - - - -$$

If one or more new groups are to be added to the end of the message, the figure represented by the *n* before the last slant in the correction message is the number of the last group of the original message, and no figure immediately follows that slant. (It will be noted that when data are to be inserted, the groups containing the numbers (*n*'s) of the groups which are to be inserted may be distinguished from the groups containing the correct figures by the fact that the *n* groups only can have one slant not at the beginning with never more than 2 digits preceding the slant, whereas the correct figure group either has no slants or the slants appear as two or more adjacent to each other or a single slant occurs at the beginning, or a single slant occurs at the end preceded by more than two digits.)

(*d*) When it is desired both to correct specified groups and to insert one or more new groups between specified groups in the original message, the code form is:

$$CQN \quad II(I)(Y_1)G_1G_1 \ n_1/n_2/n_3 - - - - - \ - - - - - \ - - - - - \text{ insrt } n_4/n_5 - - - - - \ - - - - - \ n_6/n_7 - - - - -, \text{ etc.}$$

where the data between the *II* (*I*) (Y_1) G_1G_1 group and abbreviation *insrt* refer to original groups to be corrected and the data after *insrt* refer to new groups to be inserted, as in the cases of (b) and (c), above, respectively.

(*e*) When it is desired to delete a specified group in the original message and not replace it by any other group this may be done by employing slants (/) (X's in non-point to point radio communications) for the group in the correction message, e. g. *CQN* $II(I)(Y_1)G_1G_1$ $n_1/$ ///// or, if group n_1 is to be corrected and n_2 deleted: *CQN* $II(I)(Y_1)G_1G_1$ $n_1/n_2 - - - - -$ /////

9. **Examples of Decoding.**—Examples showing methods of decoding follow:

(*a*) Message received by teletype:

EO04	12841	04842	21930	48555	
36595	69033	41115	99129	48586	
37318	52376	66213	429891	79611	
0614	08060	05//	16661	68879	98861

Coded

EO04

12841 04842

21930 48555

36595 69033

41115 99129

48586 37318

52376 66213

429891

79611 0614

08060 05//

16661

68879

98861

Decoded

El Paso, Tex. (EO), hour of apob take-off 4 a. m., Seventy-fifth meridian time

Data for levels

Level No.	Elevations m (m. s. l.)	Barometric pressure (mb)	Temperature (°C.)	Relative humidity (%)	Mixing ratio (g/kg)
Surface	*1200	884	10	48	4. 2
1	2100	793	4	85	5. 5
2	3600	659	−6	90	3. 3
3	4100	611	−9	91	2. 9
4	4800	558	−13	73	1. 8
5	5200	537	−16	62	1. 3

*Actually 1193.

Barometric pressure { 842 mbs. at 1520 m. / 698 mbs. at 3050 m. / 591 mbs. at 4270 m.

10-Stcu-direction 140°.
Base observed at 790 mb pressure.
Top observed at 610 mb pressure.

10-Ast-direction unknown.
Base and top above maximum elevation of ascent.

Hard ice formed on airplane between levels at 660 and 610 mb pressure.

Rain encountered between levels at 880 and 790 mb pressure.

Turbulence encountered between levels at 880 and 610 mb pressure.

(*b*) Message received by teletype:

NA311 02905 28628 07265 89322 21736 99310
22586 79313 35407 69107 37247 68805
53958 97102 337873 93771 0627 74665
6432 08474 79974

Coded *Decoded*

NA311 Nashville, Tenn., apob flight made *Tuesday*, take-off at 11 a. m., seventy-fifth meridian time.

Data for levels

Coded	Level No.	Elevations m. (m. s. l.)	Barometric pressure (mb.)	Temperature (°C.)	Relative humidity (%)	Mixing ratio (g/kg)
02905 28628	Surface	*200	990	−2	86	2. 8
07265 89322	1	700	926	−8	93	2. 2
21736 99310	2	2100	773	−19	93	1. 0
22586 79313	3	2200	758	−17	93	1. 3
35407 69107	4	3500	640	−26	91	. 7
37247 68805	5	3700	624	−26	88	. 5
53958 97102	6	5300	495	−39	71	. 2

*Actually 180.

337873 Barometric pressure { 833 mbs. at 1520 m. / 678 mbs. at 3050 m. / 573 mbs. at 4270 m.

93771 0627 10-Stcu-direction 270°.
Base observed at 930 mb. pressure.
Top observed at 770 mb. pressure.

74665 6432 6-Acu-direction 320°.
Base estimated at 740 mb. pressure.
Top estimated at 660 mb. pressure.

08474 Rime formed on airplane between levels at 840 and 740 mb. pressure.

79974 Snow encountered between levels at 990 to 740 mb. pressure.

(*c*) Message received by teletype:

BU09	02940	19539	05660	93325	10100
82418	18190	41912	32800	10805	58906
80601	91089	3////	27780	9////	
44360	9////	54160	6////	490303	
1135					

Coded | *Decoded*

BU09 | Burbank, Calif., raob ascent made at 9 a. m., seventy-fifth meridian time.

Data for levels

Level No.	Elevations m. (m. s. l.)	Barometric pressure (mb.)	Temperature (°C.)	Relative humidity (%)	Mixing ratio (g/kg)
Surface	*200	994	1	95	3. 9
1	500	966	9	33	2. 5
2	1000	910	8	24	1. 8
3	1800	819	4	19	1. 2
4	3200	680	1	8	. 5
5	5800	490	−18	6	. 1
6	9100	308	−43	(**)	(**)
7	12700	178	−59	(**)	(**)
8	14400	136	−59	(**)	(**)
9	15400	116	−56	(**)	(**)

*Actually 220.
**Unknown. Readings of hair hygrometer unreliable at low temperatures.

490303 | Barometric pressure { 849 mbs. at 1520 m. / 703 mbs. at 3050 m. / 603 mbs. at 4270 m.

1135 | Few or 1-Ci-direction 350°.

(*d*) Message received by teletype:

XW07 APWX

Coded | *Decoded*

XW07 | Maxwell Field, Montgomery, Ala., apob flight, message filed at 7 a. m., seventy-fifth meridian time.

APWX | Flight not made by 7 a. m., seventy-fifth meridian time on account of unfavorable weather conditions.

(*e*) Message received by teletype:

CQN CD04 10/11/16/17 26342 15880 49460 47131

Coded	*Decoded*
CQN	Correction message.
CD04	Scott Field, Belleville, Ill., ascent at 4 a. m., seventy-fifth meridian time.
10/11/16/17	Groups No. 10, 11, 16, and 17 of the original message to be replaced by the four following groups, respectively.
26342	Group to replace group 10 of original message.
15880	Group to replace group 11 of original message.
49460	Group to replace group 16 of original message.
47131	Group to replace group 17 of original message.

TABLE 1.—*Code for* P_1P_1 *and* P_2P_2 *when unknown*

When the height and pressure at the base of the cloud layer are unknown: Code P_1P_1 as—	When the height and pressure at the top of the cloud layer are unknown: Code P_2P_2 as—
05—If uncertain whether base below or above maximum (i. e. maximum elevation reached by airplane).	05—If uncertain whether top below or above maximum.
06—If certain base *below* maximum, plane being *out of clouds* at maximum.	06—If certain top *above* maximum, plane being *out of clouds* at maximum.
07—If certain base *below* maximum, plane being *in clouds* at maximum.	07—If certain top *above* maximum, plane being *in clouds* at maximum.
08—If certain base *above* maximum.	08—If certain top *below* maximum.

TABLE 2.—*Symbol* h_D—*Basis for information regarding cloud limits*

Code figure	Significance	Code figure	Significance
0	Base of clouds above maximum, top above maximum* (P_1P_1=08, P_2P_2=06).	5	Base estimated, top estimated.
1	Base observed, top observed.	6	Base estimated, top unknown.*
2	Base observed, top estimated.	7	Base unknown, top observed.*
3	Base observed, top unknown.*	8	Base unknown, top estimated.*
4	Base estimated, top observed.	9	Base unknown, top unknown.*

*See table 1.

TABLE 3.—*Symbol* C—*Type of cloud*

Code figure	Type of cloud	Abbreviations
1	Cirrus	Ci.
2	Cirrostratus	Cs.
3	Cirrocumulus	Cc.
4	Altocumulus	Ac.
5	Altostratus	As.
6	Stratocumulus	Sc.
7	Nimbostratus	Ns.
8	Cumulus or Fractocumulus	Cu or Fc.
9	Cumulonimbus	Cb.
0	Stratus or Fractostratus	St or Fs.

TABLE 4.—*Symbol* w_3—*Special phenomena*

Code figure	Phenomena	Code figure	Phenomena
0	Rime or frost.	6	Rain.
1	Hard ice.	7	Snow or sleet, i. e. ice pellets.
2	Haze or smoke.	8	Hail.
3	Dust or blowing snow (or both).	9	Thunderstorm* heard at station, or turbulence.
4	Fog.		
5	Drizzle (international definition).		

*See table 5, last 2 sentences.

TABLE 5.—*Code for* P_3P_3 *and* P_4P_4 *when unknown or there was no emergence from phenomenon during ascent*

In those cases where, *during the ascent*, the airplane encountered one of the phenomena designated by the code element w_3, and the pressure at the level of entry (P_3P_3) into the phenomenon is unknown, or the pressure at the level of emergence (P_4P_4) from the phenomenon is unknown or there was no emergence during the ascent, the code element P_3P_3 or P_4P_4, whichever is in question, will be coded as follows:

05—If uncertain whether the specified phenomenon was being encountered at the maximum elevation reached by the airplane;
06—If the specified phenomenon was encountered below the maximum elevation reached by the airplane but not at that elevation;
07—If the specified phenomenon was being encountered at the maximum elevation reached by the airplane.

When w_3 represents "thunderstorm heard at station" (code figure 9), the elements $P_3P_3P_4P_4$ are enciphered as 0000. When w_3 represents "turbulence" (code figure 9), the regular code for P_3P_3 and P_4P_4 will be used as for code figures 0 to 8 pertaining to w_3.

TABLE 6.—*Second group of "no apob" and "no raob" messages*

Group		Reason for no report
AP=Airplane	RA=Radiosonde	
APWX	RAWX	Unfavorable weather conditions.
APIT	RAIT	Instrument failure.
	RARC	Receiver failure.
APPL		No airplane.
APPI		No pilot.
APFD		Field unsafe, or closed.
APLO	RALO	Maximum altitude below 500 m above ground.
APAL	RAAL	Plane or instrument still aloft.
APLD		Airplane landed at another field.
APDD	RADD	Take-off or landing delayed and computation in progress.
APXX	RAXX	Any reason not included above.

TABLE 7.—*Pressure, in mb., at various geometric heights above sea level, in hundreds of meters, according to the United States standard atmosphere*

Geometric height, hundreds of meters above sea level	0	1	2	3	4	5	6	7	8	9
	mb.	*mb.*	*mb.*	*mb.*	*mb.*	*mb.*	*mb.*	*mb.*	*mb.*	*mb.*
−0	1, 013	1, 025	1, 038	1, 050						
+0	1, 013	1, 001	989	978	966	955	943	932	921	910
10	899	888	877	866	856	846	835	825	815	805
20	795	785	775	766	756	747	737	728	719	710
30	701	692	683	675	666	658	649	641	633	624
40	616	608	600	593	585	577	570	562	555	547
50	540	533	526	519	512	505	498	491	485	478
60	472	465	459	453	446	440	434	428	422	416
70	410	405	399	393	388	382	377	372	366	361
80	356	351	346	341	336	331	326	321	317	312
90	307	303	298	294	289	285	281	277	272	268
100	264	260	256	252	248	245	241	237	233	230
110	226	223	219	216	212	209	206	203	200	196
120	193	190	187	185	182	179	176	173	171	168
130	165	163	160	158	155	153	151	148	146	144
140	141	139	137	135	133	131	129	127	125	123
150	121	119	117	115	113	112	110	108	107	105
160	103	102	100	99	97	96	94	93	91	90
170	88	87	86	84	83	82	80	79	78	77
180	76	74	73	72	71	70	69	68	67	66
190	65	64	63	62	61	60	59	58	57	56
200	55. 2									
210	47. 2									
220	40. 4									
230	34. 5									
240	29. 5									
250	25. 2									
260	21. 6									
270	18. 4									
280	15. 8									
290	13. 5									
300	11. 5									

TABLE 8.—*Heights above sea level, in hundreds of meters, at various pressures, in mb., according to the United States standard atmosphere*

Pressure (mb.)	0	10	20	30	40	50	60	70	80	90
	100's m	*100's m*	*100's m*	*100's m*	*100's m*	*100's m*	*100's m*	*100's m*	*100's m*	*100's m*
1,000	1. 1	0. 3	−0. 6	−1. 4	−2. 2	−3. 0				
900	9. 9	9. 0	8. 1	7. 2	6. 3	5. 4	4. 5	3. 7	2. 8	2. 0
800	19. 5	18. 5	17. 5	16. 5	15. 5	14. 6	13. 6	12. 7	11. 7	10. 8
700	30. 1	29. 0	27. 9	26. 8	25. 7	24. 6	23. 6	22. 5	21. 5	20. 5
600	42. 0	40. 8	39. 5	38. 3	37. 1	35. 9	34. 7	33. 5	32. 4	31. 2
500	55. 7	54. 3	52. 8	51. 4	50. 0	48. 6	47. 3	45. 9	44. 6	43. 3
400	71. 8	70. 1	68. 4	66. 7	65. 0	63. 4	61. 8	60. 3	58. 7	57. 2
300	91. 6	89. 4	87. 3	85. 2	83. 1	81. 1	79. 2	77. 3	75. 4	73. 6
200	117. 9	114. 7	111. 8	108. 9	106. 2	103. 6	101. 0	98. 6	96. 2	93. 9
100	162. 1	156. 0	150. 4	145. 3	140. 6	136. 2	132. 1	128. 2	124. 6	121. 1
0		309. 0	264. 8	238. 9	220. 6	206. 3	194. 7	184. 9	176. 3	168. 8

TABLE 9.—*Saturation mixing ratios * for various temperatures (t°C.) and pressures (P mb.)*

t °C. \ P mb.	1,050	1,000	950	900	850	800	750	700	650	600	550	500	450	400
40	47.14	49.68	52.52	55.70	59.29	63.37	68.06	73.49	79.87	87.46	96.64			
35	35.30	37.17	39.25	41.57	44.19	47.16	50.56	54.49	59.08	64.51	71.04	79.05	89.09	
30	26.27	27.64	29.16	30.86	32.77	34.94	37.41	40.25	43.56	47.47	52.15	57.84	64.94	74.02
25	19.39	20.40	21.51	22.74	24.13	25.70	27.49	29.55	31.04	34.75	38.10	42.17	47.21	53.62
20	14.20	14.93	15.73	16.63	17.64	18.77	20.06	21.55	23.27	25.28	27.68	30.59	34.17	38.71
15	10.29	10.81	11.39	12.04	12.76	13.57	14.50	15.56	16.79	18.23	19.94	22.01	24.55	27.75
10	7.37	7.75	8.16	8.62	9.13	9.71	10.37	11.24	12.00	13.02	14.23	15.69	17.48	19.73
5	5.22	5.48	5.77	6.10	6.46	6.87	7.33	7.86	8.47	9.19	10.04	10.58	12.31	13.88
0	3.64	3.82	4.03	4.25	4.50	4.79	5.11	5.48	5.90	6.40	6.99	7.69	8.56	9.65
−5	2.51	2.64	2.78	2.93	3.11	3.30	3.53	3.78	4.07	4.41	4.82	5.30	5.90	6.64
−10	1.71	1.79	1.89	1.99	2.11	2.24	2.39	2.56	2.76	2.99	3.27	3.60	4.00	4.50
−15	1.14	1.20	1.26	1.33	1.41	1.50	1.60	1.71	1.85	2.00	2.18	2.40	2.67	3.00
−20	.748	.786	.827	.873	.925	.983	1.05	1.12	1.21	1.31	1.43	1.57	1.75	1.97
−25	.480	.504	.531	.561	.594	.631	.673	.721	.776	.841	.918	1.01	1.12	1.26
−30	.303	.318	.335	.353	.374	.397	.424	.454	.489	.530	.578	.636	.707	.795
−35	.186	.196	.206	.217	.230	.245	.261	.280	.301	.326	.356	.391	.435	.489
−40	.112	.118	.124	.131	.139	.147	.157	.168	.181	.196	.214	.236	.262	.295
−45	.066	.069	.073	.077	.081	.086	.092	.099	.106	.115	.126	.138	.154	.173

*g./Kg.

NOTE.—Saturation with respect to liquid water assumed at temperatures below 0° C.

ADDENDUM I

The indicated altimeter reading at the level of the phenomenon and the altimeter setting (Kollsman) will be obtained whenever possible from pilots flying in the vicinity near the time of the radiosonde observation. Desired information includes upper and lower limits of clouds, turbulent layers, precipitation, haze, etc. When the airplane encounters one of these limits but not the other limit of such phenomenon, "slants" will be transmitted in the report in place of pressures for the unknown limit. The pressures corresponding to these elevations will be included in the daily raob report using the apob code form.

To convert these altimeter readings to pressures, Standard Atmosphere pressure tables are furnished each station. The following example shows how the pressure will be obtained:

(*a*)	Altimeter Setting	29.78 in.
(*b*)	Standard Atmosphere elevation corresponding to 29.78 inches (See pages 11, 12, and 13 of S. A. Tables, N. A. C. A. Report No. 538, 1938)	131 ft.
(*c*)	Indicated altitude at level of phenomenon	800 ft.
(*d*)	Sum of (b) and (c)	931 ft.
(*e*)	Standard atmosphere pressure corresponding to 931 ft	28.93 in.
(*f*)	Pressure at level of phenomenon, 28.93 inches	980 mb

ADDENDUM II

Beginning February 10, 1939, the actual and condensation pressures for designated potential temperatures will be included in the daily apob or raob messages. The potential temperature for which these pressures should apply will be added to the AMAFA message sent from the Central Office on the previous day. Only one potential temperature will be indicated in the AMAFA message. However, the actual and condensation pressures for the potential temperature thus indicated, together with the actual and condensation pressures for the potential temperature 4° higher than that indicated in the AMAFA message, will be transmitted in the apob or raob reports.

The potential temperature will be indicated in the AMAFA messages for two consecutive days and will then be omitted until it is desired to use a different value of potential temperature. An exception would be made when a different potential temperature is to be used on a day following a change.

If no AMAFA message is received at a station due to transmission delay or otherwise, the station will assume that no change in potential temperature was indicated.

The actual and condensation pressures will be indicated in the apob or raob messages by a 4-figure and a 6-figure group added to the end of the message, as follows:

8571 976554

The pressures will be indicated to the nearest 10 millibars, the tens and hundreds place digits being given with the unit place digit omitted. The corresponding *lower* potential temperature is indicated by the first two numerals in the 6-figure group, the units and tens place digits being given with the hundreds place digit omitted. The above example represents an actual pressure of 850 mb. and a condensation pressure of 710 mb., which correspond to a potential temperature of 297°, the latter indicated by the first two numerals in the 6-figure group. The remaining figures represent an actual pressure of 650 mb. and a condensation pressure of 540 mb., which correspond to a potential temperature of 301°, i. e., 4° higher than 297°.

In case either or both potential temperatures are above the maximum height reached or have a lower value than the lowest potential temperature indicated in the observation, zeros will be used in place of the pressures; the potential temperature, however, should be indicated in the usual manner. Although isentropic surfaces occurring in surface inversion in early morning observations ordinarily have no significance, it is believed best to have these pressures indicated rather than omitted from the message.

The omission of a 4-figure followed by a 6-figure group at the end of a message will indicate that the latter does *not* contain the actual and condensation pressures.

Whenever the relative humidity record is not obtained or is not usable for any reason, such as occurrence of temperatures below —40° C., zeros will be included in the message in place of the condensation pressure corresponding to the missing humidity.

ADDENDUM II

The stream functions and actual and condensation pressures for two designated potential temperatures will be included in the daily apob or raob messages. The lower potential temperature for which these stream-function and pressure-data are to be given in the apob and raob messages will be specified in the AMAFA messages sent from the Central Office (see Appendix III). The higher potential temperature for which these data are to be given in the apob and raob messages will not be specified in the AMAFA messages but will be 8 degrees higher than the specified lower potential temperature.

If no AMAFA message is received at a station due to transmission delay or otherwise, the station personnel will continue use of the lower potential temperature most recently specified.

Three groups of five characters each will be sent at the end of apob and raob coded reports to show the stream function and the actual and condensation pressures found for the two potential temperatures pertinent to the given day. The first group of five characters will consist of a slant mark followed by four figures enciphering the stream functions. Of the four figures immediately following the slant, the first two figures represent the last two digits of the stream function for the lower (specified) potential temperature, and the last two figures represent the last two digits of the stream function for the potential temperature 8 degrees higher. (At apob or raob stations the respective stream functions for two potential temperatures are originally computed from the sounding data and expressed by four digits each, for example, 2982 millions of ergs/gram for potential temperature 296 degrees absolute and 3050 millions of ergs/gram for potential temperature 304 degrees absolute). The first two digits of each computed stream function are therefore omitted from the message. The first two digits of the respective stream functions which are thus omitted will be supplied by the decoder through inspection of the values of the potential temperatures pertaining to the data, taking into consideration the fact that the first three digits of the stream function will be very nearly equal in numerical value to the three digits of the potential temperature in whole degrees absolute. For example, from a transmitted first group /8250 and an indication in the message that the lower potential temperature is 296 degrees absolute, it may be deduced that the stream function corresponding to that potential temperature is 2982 millions of ergs/gram and the stream function corresponding to potential temperature 8 degrees higher, namely, 304 degrees absolute, is 3050 millions of ergs/gram.

In the second group of five characters, the first two figures will encipher the actual pressure in tens of millibars and the next two the condensation pressure in tens of millibars for the lower of the two potential temperatures in question, while the last figure of the second group will be the tens digit of the lower potential temperature.

In the third group of five characters the first figure will be the units digit of the lower potential temperature. The next two figures of the third group will be the actual pressure in tens of millibars, and the last two figures will be the condensation pressure in tens of millibars at the potential temperature 8 degrees higher than the specified lower potential temperature.

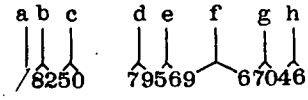
The hundreds digit of the lower potential temperature is thus omitted, and the omitted digit, generally 2 or 3 in the lower levels can be supplied by the decoder from the given tens and units digits (See "f" under Example) The three groups in question will be identified by the presence of a slant mark as the first character in the first group If part of the data are not available, those missing parts will be indicated by the use of slant marks. If all of the data are missing, the three groups will be omitted entirely, their absence indicating that the observation did not provide these.

EXAMPLE:

As an example of the three groups discussed above in this Addendum which should be included in each typical apob or raob message immediately following the groups indicated in Appendix II proper, there follow the three groups which pertain to the sample message (c) shown on Page 135 and which should be appended thereto:

/8250 79569 67046

In deciphering these groups they should be subdivided into sub groups of characters as shown by the designations a, b, c, d, e, f, g, and h below:



The significance of the sub groups designated by a, b, c, etc., is as follows:

a: / designates that this group and the two succeeding groups pertain to the respective stream functions and actual and condensation pressures corresponding to two potential temperatures (see "f" and "g" below) (The slant would thus appear as the indicative character for these last three groups of the typical message)

b: 82 designates the last two digits of the stream function corresponding to the lower potential temperature specified by "f" In this example "f" indicates that the potential temperature in question is 296 degrees absolute (The stream function in its entirety is represented by a quantity of four digits in terms of the unit 1 million ergs/gram) The omitted first two digits of the stream function are 29 in this case, hence the required stream function is 2982 millions of ergs/gram.

c: 50 designates the last two digits of the stream function corresponding to the potential temperature 8 degrees higher than the potential temperature specified by "f" Hence the higher potential temperature in question is 304 degrees absolute, and the required stream function is 3050 millions of ergs/gram.

d: 79 designates that the actual pressure corresponding to the lower potential temperature (296 degrees) indicated by "f" is 790 millibars*.

e: 56 designates that the condensation pressure corresponding to the lower potential temperature (296 degrees) indicated by "f" is 560 millibars*

f: 96 designates that the lower potential temperature specified for the stream function and pressure data is 296 degrees absolute. (The missing hundreds digit, 2 in this case, is supplied by the decoder through consideration of the fact that the lower potential temperature generally is in the neighborhood of 300 degrees absolute)

g: 70 designates that the actual pressure corresponding to the potential temperature (namely 304 degrees) which is 8 degrees higher than that specified by "f" is 700 millibars*.

h: 46 designates that the condensation pressure corresponding to the higher potential temperature (see"g") is 460 millibars*.

* The code figures for actual and condensation pressures are given in terms of the unit tens of millibars hence the required pressure data in terms of the unit millibar are secured by adding a cipher to the code figures referred to by d e g and h.

ADDENDUM III

Radiosonde observations from "STATION SHIPS" will be coded in accordance with Appendix II, except that the first group ($IIY_1G_1G_1$) which indicates the station call letters and time of observation will be replaced by the word "RAOB" and the two groups YQLLL 111GG which are taken from the International Ship Code (W B 1046) Explanation of symbol letters follows:

Y Day of the week G M T.

Q Octant of the globe.

LLL Latitude in degrees and tenths, the tenths being obtained by dividing the number of minutes by 6 and neglecting the remainder

111 Longitude in degrees and tenths, the tenths being obtained as for latitude LLL.

GG Greenwich mean time of observation (00 midnight, 06 6 a m., 12 noon, 18 6 p m)

Appendix III.—TRANSMISSION OF AIR-MASS AND FRONTAL ANALYSES BY TELETYPE AND RADIO

1. **Origin of Analyses.**—The central office of the Weather Bureau places the results of the air-mass and frontal analysis of the 7:30 a. m., eastern standard time, map on the teletype circuit at Washington daily at 11:30 a. m., eastern standard time, to be relayed to all airway communications circuits.

2. **General Composition of AMAFA and Symbols Used Therein.**—The transmissions by teletype and radio are made as follows:

(*a*) *Headings.*—The heading of the transmissions consists of the Washington designator: the symbol "AMAFA," meaning "air-mass and frontal analysis;" the time, and the date of the map analyzed, using figures. For example: "WA AMAFA 073001 . . ." would be translated as "Washington air-mass and frontal analysis of the 7:30 a. m., eastern standard time, map, for the 1st day of the month."

(*b*) *Body of AMAFA report.*—Following the heading is one space and then a type-of-air-mass-and-front symbol group, in which the numbers indicate the type of air masses lying on either side of the front and the symbol indicates the type of front separating these air masses. The location of fronts are designated according to latitude and longitude of various points along the fronts.

(*c*) *Symbols for types of air masses.*—Each air mass symbol will be a three-digit figure composed as follows:

Hundreds digit:
1. Continental or dry (c)
2. Maritime or moist (m)
0. Blank

Tens digit:
1. Arctic (A)
2. Polar (P)
3. Tropical (T)
4. Superior (S)

Units digit:
1. Warm relative to surface (w)
2. Cold relative to surface (k)
0. Questionable or Indeterminate as to thermodynamic property

(*d*) *Symbols for types of fronts.*—The symbols representing the types of fronts are as follows:

◑----------	Cold front.
◍----------	Occluded front.
⊕----------	Warm front.
↑⊕↑--------	Warm front aloft.
↑◑↑--------	Cold front aloft.
↑◍↑--------	Occluded front aloft.
◑⊕---------	Stationary front.
◑+---------	Cold front frontogenesis.
⊕+---------	Warm front frontogenesis.
◑⊕+-------	Stationary front frontogenesis.
◑—----------	Cold front frontolysis.
⊕—----------	Warm front frontolysis.
◑⊕—----------	Stationary front frontolysis.
◍—----------	Occluded front frontolysis.

(*e*) *Miscellaneous symbols.*—Other symbols are as follows:

/ Used to separate the points of latitude and longitude chosen to orient a front, or system of fronts which forms a continuous line. When placed between two air-mass numbers it indicates that the air mass to the left of the / is aloft while that to the right of the slant is at the surface (e. g. 222/111 indicates cAw at surface; mPk aloft).

. . End or intersection of front.

\+ Appears between two air-mass numbers, indicating a mixture of the two air masses

→ "Becoming" (e. g. 222→232 indicates mPk becoming mTk).

3. **Composition of Type-Of-Air-Mass-And-Front Groups.**—The type-of-air-mass-and-front group consists of an air-mass designating number, the type-of-front symbol, and another air-mass designating number, in the order named. If more than one air

mass is present on either side of the front, one being at the surface and the other aloft, this is indicated by entering the symbol number for the upper air mass, followed by an oblique and then the symbol number for the surface air mass. Also, if there is more than one type of air mass present at the surface on either side of the front, this is indicated by a symbol for the dominating type, followed by a plus sign and the symbol number for the second type of air mass. Further, if one type of air mass is changing to another type, this is indicated by a symbol number for the air mass which is changing, followed by a horizontal arrow and then a symbol number indicating the type of air mass to which the first is changing.

4. **Significance of Position of Air Mass Numbers in the Groups.**—The first air-mass number or numbers in any type-of-air-mass-and-front symbol group indicate the air mass or masses to the left of the line of the front, *assuming that in all cases the progress of the line from its point of beginning is toward the observer*, i. e., if a line is being drawn generally from the southwest to the northeast, the first symbol number or numbers would be for the air mass or masses to the south of the line and the second symbol number or numbers for the air mass or masses to the north of the line. Again, if the line is being drawn generally from the northeast to the southwest, the first symbol number or numbers would be for the air mass or masses to the north of the line and the second symbol number or numbers for the air mass or masses to the south of the line. For example, 111 ◑ 222 would indicate a continental-arctic warm air mass to the left of a cold front with a maritime-polar cold air mass to the right of the front. "121 ◑ 040/232" would indicate a continental-polar warm air mass to the left of a cold front and a maritime-tropical cold air mass at the surface, with a superior air mass aloft to the right of the front; "120 ⊕ 122→222" would indicate a continental-polar-indeterminate air mass, CP, to the left of a warm front and a continental-polar cold air mass changing to a maritime-polar cold air mass to the right of the front; "222+122 ◑ 121" would indicate a maritime-polar cold and a continental-polar cold air mass to the left of an occluded front, and a continental-polar warm air mass to the right of the front, etc.

5. **Methods of Indicating Air Masses on Either Side of Fronts Aloft.**—In the case of a front aloft, the air masses aloft on either side of the front are given in addition to the surface air mass. For example, "222/122 ↑ ◑ ↑ 221/122" would mean that there is continental polar cold air at the surface above which is a cold front acting between maritime polar cold and maritime polar warm.

6. **Methods of Indicating Coordinates of Points Along the Fronts.**—Following the type-of-air-mass-and-front group will be an oblique and then the latitude and longitude, in the order named, of the beginning point of the front, followed by the latitude and longitude of one or more (as many as are necessary to properly outline the position of the front) points on the front, the group of figures representing the latitude and longitude of any particular point, being separated from the next group by an oblique. Thus, "48105/4590" would indicate latitude 48° and longitude 105° for the beginning point, and the latitude 45° and longitude 90° for the second point, etc. The points are, in general, sent in the order in which they occur from the top to the bottom of the map for fronts extending generally north and south and from the left to the right for fronts extending generally east and west.

7. **Methods of Indicating Changes of Air Masses in Relation to Fronts.**—If a front is *continuous* but the type of air mass on either or both sides of it changes, a new type of air mass and front symbol group is inserted preceding one of the points without spacing to indicate that the type of air mass on one or both sides of the front will be different from that point on. Also, if a series of fronts are located with respect to each other so as to form a *continuous* smooth line, the transmission for the entire series is made without a break. Further, if one front is attached to another at an acute angle and is plainly not a part of a continuous smooth front, or a continuous series of fronts, the latitude and longitude of the connecting point will be given in the first series of points in its proper order, and also the second series of points will either begin or end with the latitude and longitude of the connecting point.

8. **Methods of Indicating Other Changes Between or in Fronts and Air Masses.**—Where the air mass as given along one front is the same for the corresponding sector along another front, the air-mass number is sent only for the front that is given first

and is omitted for the second front. Where the type of front between two air masses changes without the air masses themselves changing, no air-mass numbers are transmitted, only the front symbol being given immediately preceded and followed, without spacing, by the appropriate latitude and longitude numbers. For example: "121 ⊙231/4575/4183/⊕/4086/3992/⊙/3894/3796/" etc., would indicate a cold front of cPw against mTw becoming a warm front at latitude 40°, longitude 86°, and a cold front again at latitude 38°, longitude 94°. To illustrate the application of this rule to upper-air fronts, the following example is given: "121/122↑ ⊙ ↑231/122/4575/4183/↑ ⊕↑/4086/3992/↑ ⊙↑/3894/3796/" etc., which would be the same system of fronts as in the preceding example, except that the fronts would be over an cPk air mass. It will be noted that the combination of the slants separating front-location points and the vertical arrows of the front aloft symbol should make it difficult to confuse upper and surface fronts. In cases where only one of the air masses along any front changes, the symbol for that air mass is transmitted and that for the other is omitted. Where two air masses appear on the *same side* of a front, either as one aloft over the other or designated by + or →, and only one of these remains unchanged, the complete designation for both the unchanged and the new air mass are retained, as in the following example: "121 ⊙ 121 →221 /4575 /4183 / ⊕121→232/4086/3992/⊙ 121→042/3894/3796/" etc. A change of air mass on one side of the front without a change of front type is indicated by a repetition of the front symbol with only the new air mass or air mass combination indicated.

9. **Method of Indicating Separation of Various Fronts Included in Transmissions.**—Each front, or series of fronts representing a single continuous line, is set off by two periods in the transmission separating it from data for other continuous fronts preceding it in the transmission. Two periods are used also to indicate the end of the last front sent in the message.

10. **Method of Indicating Potential Temperature Surfaces for Isentropic Charts.**—Usually the AMAFA message will contain only frontal and air-mass symbols and the latitude and longitude of points along the fronts; however, whenever a change in the potential temperature surfaces to be used for plotting isentropic charts is desired the new potential temperature surfaces to be used will be indicated as follows:

Following the final latitude and longitude coordinates of the AMAFA message will be sent four periods after which will come two figures followed by two periods thus: /4183 . . . . 97 . . indicating that the *lower* of the two potential temperature surfaces to be transmitted in the raob and apob messages on the *following* day should be 297 degrees.

This same potential temperature will be indicated in the AMAFA messages for two consecutive days and will then be omitted until it is desired to use a different value of potential temperature. An exception to this would be made when a change in the potential temperature to be used is made on two consecutive days. AMAFA messages should, therefore, be carefully scrutinized daily for possible changes in the potential temperature surface desired.

Blank page retained for pagination

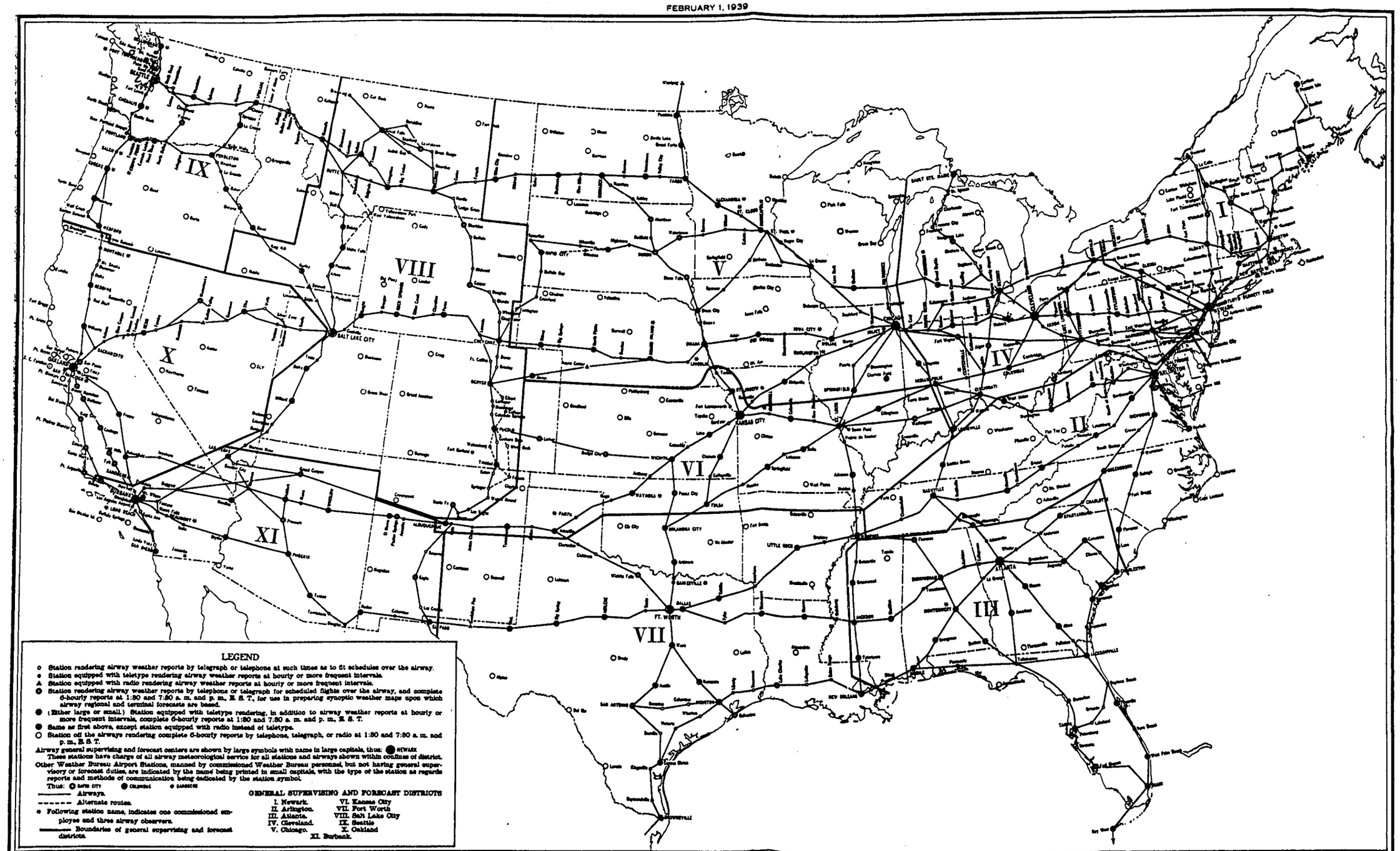
INDEX

U. S. GOVERNMENT PRINTING OFFICE: 1939

U. S. DEPARTMENT OF AGRICULTURE WEATHER BUREAU

WEATHER BUREAU AIRWAY METEOROLOGICAL SERVICE

FEBRUARY 1, 1939



LEGEND

- ○ Station rendering airway weather reports by telegraph or telephone at such times as to fit schedules over the airway.
- ◉ Station equipped with teletype rendering airway weather reports at hourly or more frequent intervals.
- ▲ Station equipped with radio rendering airway weather reports at hourly or more frequent intervals.
- ◎ Station rendering airway weather reports by telephone or telegraph for scheduled flights over the airway, and complete 6-hourly reports at 1:30 and 7:30 a. m. and p. m., E. S. T., for use in preparing synoptic weather maps upon which airway regional and terminal forecasts are based.
- ● (Either large or small.) Station equipped with teletype rendering, in addition to airway weather reports at hourly or more frequent intervals, complete 6-hourly reports at 1:30 and 7:30 a. m. and p. m., E. S. T.
- ◉ Same as first above, except station equipped with radio instead of teletype.
- ○ Station off the airways rendering complete 6-hourly reports by telephone, telegraph, or radio at 1:30 and 7:30 a. m. and p. m., E. S. T.

Airway general supervising and forecast centers are shown by large symbols with name in large capitals, thus: ● NEWARK
These stations have charge of all airway meteorological service for all stations and airways shown within confines of district.

Other Weather Bureau Airport Stations, manned by commissioned Weather Bureau personnel, but not having general supervisory or forecast duties, are indicated by the name being printed in small capitals, with the type of the station as regards reports and methods of communication being indicated by the station symbol.

Thus: ◎ SALT LAKE CITY ● CHEYENNE ◉ SACRAMENTO

——— Airways.

– – – – – – Alternate routes.

* Following station name, indicates one commissioned employee and three airway observers.

——— Boundaries of general supervising and forecast districts.

GENERAL SUPERVISING AND FORECAST DISTRICTS

I. Newark.	VI. Kansas City
II. Arlington.	VII. Fort Worth
III. Atlanta.	VIII. Salt Lake City
IV. Cleveland.	IX. Seattle
V. Chicago.	X. Oakland
	XI. Burbank.

151460—39 (Face p. 158) No. 1

U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

EXPLANATION OF SYMBOL WEATHER REPORTS
(based on instructions contained in Weather Bureau Circular N 1939)

[To illustrate the method used in transmission and deciphering of symbol weather reports, the following example of such a report is given. Each element of the report is connected by a line with a description of all symbols and conditions which might be used in that particular phase of the report. Elements of observations are always transmitted in the same order; therefore all symbol weather reports may be deciphered by reference to this chart]

WA7 C SPL 1624E E30⊕15⊙2VT-R-BD- 152/68/60→↘18-↑1618E 996 +⊕NW

Station

Lists of station names and their representative call letters are posted on Weather Bureau airport station bulletin boards for the information of all concerned.

A figure, 0 to 9, representing the total extent of sky covered by clouds, is entered immediately following the call letters for station names, in accordance with the following:

0 No clouds.
1 Less than 0.1.
2 0.1.
3 0.2 to 0.3.
4 0.4 to 0.6.
5 0.7 to 0.8.
6 0.9.
7 More than 0.9 but with breaks.
8 Overcast (solid).
9 Sky obscured.

Classification of report

The symbols C, N, or X are used immediately following, after 1 space, the station letters to classify weather conditions at airports specifically designated as controlled airports.

If no classification letter is used the station is not located at a controlled airport.

C: Satisfactory for contact flight.
N: Requiring observance of instrument flight rules.
X: Take-off and landing suspended.

Type of report

"SPL," meaning "special report," appears when crucial changes have occurred in weather conditions since the last report.

The absence of the observation-type letter group "SPL" indicates an observation where no crucial changes have occurred since the last transmitted observation.

"LCL," meaning "local extra observation," appears only on reports sent over local circuits. Such reports are made every 15 minutes during periods of low ceiling and/or visibility.

Time of report

Time groups are in figures based on the 24-hour clock, with following letters showing the standard of time used, e. g., "1440E" means 2:40 p. m., Eastern Standard Time; "0030C" means 12:30 a. m., Central Standard Time; "2359M" means 11:59 p. m., Mountain Standard Time; "2015P" means 8:15 p. m., Pacific Standard Time, etc.

"SPL" reports which are sent alone and all "LCL" reports bear the time of observation immediately following, after 1 space, the observation-type letter group "SPL" or "LCL."

"SPL" reports appearing in sequences do not show the time-of-report group and the time of observation is considered as the time of all other reports in the sequence as indicated in the sequence heading.

Ceiling

The absence of a "ceiling" group indicates an "unlimited" ceiling (above 9,750 feet).

Figures representing the number of *hundreds* of feet which apply are used to indicate the height of the ceiling between 51 and 9,750 feet, inclusive, above the station, e. g., "35" indicates 3,500 feet, "3" indicates 300 feet, etc.

The figure naught (0) is used when the ceiling is zero (below 51 feet).

When the height is estimated the letter "E" precedes the ceiling figures.

A plus sign (+) is used preceding the ceiling figures to indicate the ceiling balloon was blown from sight at the height represented by the figures and before reaching the clouds.

The letter "V" is used, immediately following the figures for ceiling, if the height of the ceiling is changeable and below 2,000 feet.

Sky

The absence of a symbol for sky indicates that precipitation or obstructions to vision are present and reduce the ceiling to zero and/or the visibility to one-fifth mile or less and make the sky unobservable.

The sky condition is indicated by the following symbols unless the condition given above is present:

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

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

Height of lower scattered clouds is indicated by the entry of a figure, representing the hundreds of feet applying, immediately preceding the scattered clouds symbol.

Visibility

The absence of a figure for visibility indicates that the visibility is 10 miles or more.

The value of the visibility below 10 miles is indicated by figures representing the number of miles and/or fractions of miles.

The letter "V" is used, immediately following the figure for visibility, if the visibility is fluctuating rapidly and is 2 miles or less.

Weather

The "weather" element of the report is indicated, when appropriate, by the following symbols:

R− Light rain.
R Moderate rain.
R+ Heavy rain.
S− Light snow.
S Moderate snow.
S+ Heavy snow.
ZR− Light freezing rain.
ZR Moderate freezing rain.
ZR+ Heavy freezing rain.
L− Light drizzle.
L Moderate drizzle.
L+ Heavy drizzle.
ZL− Light freezing drizzle.
ZL Moderate freezing drizzle.
ZL+ Heavy freezing drizzle.
E− Light sleet.
E Moderate sleet.
E+ Heavy sleet.
A− Light hail.
A Moderate hail.
A+ Heavy hail.
AP− Light small hail.
AP Moderate small hail.
AP+ Heavy small hail.
OP− Light snow pellets.
OP Moderate snow pellets.
OP+ Heavy snow pellets.
SQ− Mild snow squall.
SQ Moderate snow squall.
SQ+ Severe snow squall.
RQ− Mild rain squall.
RQ Moderate rain squall.
RQ+ Severe rain squall.
T− Mild thunderstorm.
T Moderate thunderstorm.
T+ Severe thunderstorm.
SW− Light snow showers.
SW Moderate snow showers.
SW+ Heavy snow showers.
RW− Light rain showers.
RW Moderate rain showers.
RW+ Heavy rain showers.
TORNADO (always written out in full).

Obstructions to vision

The "obstructions to vision" element of the report is indicated, when appropriate, by the following symbols:

F−− Damp haze.
F− Light fog.
F Moderate fog.
F+ Thick fog.
FF Dense fog.
GF− Light ground fog.
GF Moderate ground fog.
GF+ Thick ground fog.
GFF Dense ground fog.
IF− Light ice fog.
IF Moderate ice fog.
IF+ Thick ice fog.
IFF Dense ice fog.
H Hazy.
K− Light smoke.
K Moderate smoke.
K+ Thick smoke.
D− Light dust.
D Moderate dust.
D+ Thick dust.
BS− Light blowing snow.
BS Moderate blowing snow.
BS+ Thick blowing snow.
GS− Light drifting snow.
GS Moderate drifting snow.
GS+ Thick drifting snow.
BD− Light blowing dust.
BD Moderate blowing dust.
BD+ Thick blowing dust.
BN− Light blowing sand.
BN Moderate blowing sand.
BN+ Thick blowing sand.

Barometric pressure

The barometric pressure is indicated by a group of 3 figures; tens, units, and tenths of millibars involved. Thus a pressure of 1015.2 millibars would be written as "152"; 999.9 as "999"; 1025.7 as "257"; etc. Sent only by stations equipped with mercurial barometers.

Temperature

Temperature is indicated by figures giving its value to the nearest degree Fahrenheit.

Values below zero Fahrenheit are indicated by the entry of a minus sign (−) immediately preceding the figures for temperature. Zero is entered as "0."

Dew point

Dew point is indicated by figures giving its value to the nearest degree Fahrenheit.

Values below zero Fahrenheit are indicated by the entry of a minus sign (−) immediately preceding the figures for dew point.

Wind

The wind *direction* is indicated by arrows, as follows:

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

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 velocity figures.

The *character* of the wind is indicated, when appropriate, by entry, immediately following the velocity, of a minus sign (−) for "fresh gusts" and a plus sign (+) for "strong gusts." No indication of character means the wind is steady.

Wind shifts which have occurred at the reporting station are indicated, immediately following the other wind data, by an arrow showing the direction (to 8 points only) from which the wind was blowing prior to the shift, followed by the local time, on the 24-hour clock, at which the shift occurred, with following letter showing the standard of time used. The intensity of the shift is indicated by the minus sign (−) for "mild," the absence of a sign for "moderate," and the plus sign (+) for "severe," the signs being entered immediately following the standard-of-time letter.

Altimeter setting

Indicated by a group of 3 figures representing the inch and hundredths of an inch of pressure involved. Thus, 30.00 would be written as "000"; 29.98 as "998"; etc. Sent only by designated stations equipped with mercurial barometers.

Remarks

Remarks are transmitted in authorized English abbreviations and teletype symbols. Lists of the abbreviations are available for inspection at all Weather Bureau Airport Stations. The teletype symbols used are shown on this chart.

Special data

Special data comprising pressure change and characteristic, 5,000-foot pressure at selected stations, cloud, thunderstorm, and snow depth data, Great Lakes water temperature, etc., data from selected stations, etc., are entered in code at certain times by the stations designated to do this, as separate groups, immediately following the report proper. These data are intended primarily for the preparation of maps for forecasting.

Missing data

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

For example, the report given above would be deciphered as follows: Washington—sky more than nine-tenths covered but with breaks; satisfactory for contact flight; special report at 4:24 p. m., Eastern Standard Time; ceiling estimated at 3,000 feet; overcast, lower scattered clouds at 1,500 feet; visibility 2 miles, variable; mild thunderstorm; light rain; light blowing dust; barometric pressure 1015.2 millibars; temperature 68° F.; dew point 60° F.; wind west-northwest 18 miles per hour, fresh gusts; moderate wind shift from the south at 4:18 p. m., Eastern Standard Time; altimeter setting, 29.96 inches; dark to the northwest.

151480—39 (Face p. 155) No. 2

UNITED STATES DEPARTMENT OF AGRICULTURE

WEATHER BUREAU

Aerological Division

September 27, 1939

CORRECTIONS AND CHANGES IN "INSTRUCTIONS FOR AIRWAY METEOROLOGICAL SERVICE," CIRCULAR N, 1939

This list of errata in the new Circular N is issued to all concerned in order that corrections may be made in that Circular without the delay that would occur if it were necessary to wait for the printing of revised pages. It is expected that all corrections will be indicated, either by cutting the paragraphs from these errata sheets or by a correction in ink, depending on the amount of printing involved in each correction. Action is being taken to have revised pages, containing these corrections, printed for issue to all who have loose-leaf copies of Circular N, but those copies should also be corrected according to the foregoing, pending receipt of the revised pages.

The numbers refer to paragraphs.

203 Add at the end of the first sentence,- "except that circulars which remain in effect during the subsequent year will be kept together and filed separate from the bound file and in a convenient manner for ready reference."

304 (c) Delete "check" from the first sentence.

306 (e) "Special observations required in connection with fog. - Beginning or ending of fog, ground fog, or ice fog; beginning or ending of thick or dense fog, ground fog, or ice fog; or the change from one type or classification (not intensity) of fog to another type or classification e.g. ground fog to fog, ice fog to fog, fog to ground fog, etc."

306 (g) Change to read - "and when 3,000 feet or below rises to a height 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 to above 500 feet sufficiently to require the reporting of a value of 400 feet or less or 600 feet or more, a special observation will be filed. In this latter case, however, if the ceiling is fluctuating so rapidly between ceiling values of 400 and 600 feet that the filing of a "special" covering each individual change is impracticable, then the ceiling may be characterized as "variable" in the report as outlined in Paragraph 336 (h) hereinafter. When the sky condition goes from scattered below 10,000 feet ... etc."

306 (h) "The visibility when 7 miles or more at the last previous record or special observation, lowers to 3 miles or less or when originally less than 7 miles lowers one-half or more, or when less than 4 miles increases to a value two or more times the value in the previous

record or special observation, except that when the visibility lowers to 1 mile or below or rises above 1 mile sufficiently to require the reporting of a value of 1 1/4 mile or more, a special observation will be filed. In this latter case, however, if the visibility is fluctuating so rapidly between visibility values of 3/4 mile and 1 1/4 miles that the filing of a special for each individual change is impracticable, then the visibility may be characterized as 'variable' in the report as outlined in Paragraph 344 (e), hereinafter."

309 Delete from the second sentence - "in parentheses, and in the next column will be entered the proper letter for the Civil Air Regulation classification (if the station is located within a controlled zone) of the report."

Add following the next to last sentence - "The entry of individual elements on Form 1130-Aer. will be treated in Chapter II, Part VII of this Circular N."

309 (a) Delete "except that each element of the report will be entered in the column assigned to it".

Add in place thereof - "the groups being placed in the columns indicated by solid lines."

309 (b) Add - "each element being placed in the proper column as indicated by dotted and solid lines."

322 In the first example the gusts should be "strong", "(+)".

325 (d) In the "sent" example add "four" between "broken" and "light".

336 (f) In (1) delete "or thick".
In (3) substitute "is" for "in" between "present" and "50 feet".

Add the following as -

336 (i) Observers using ceiling light projectors installed on base lines of approximately 1,000 feet are cautioned that the spot of light frequently cannot be observed under conditions of low ceilings and poor visibility because of the distance between the observing point and the projector. In such cases, the observers should pace the distance towards the projector to a point where the spot can be observed and make observations of the ceiling computed on the basis of the shorter base line.

344 (b) Make the latter part of the first sentence read "..... over more than half of the horizon) no value will be included in the report as entered or transmitted."

347 (f) Add "1/5" as a visibility to be reported under "heavy snow".

359 (d) Substitute "10 to 15 minutes" for "5 to 10 minutes".

365 (II) (d) Substitute "mind" for "wind".

365 (II) (e) At the top of page 55 make the sentence read: "Upon receipt of advice that the aneroid is reading inaccurately as compared with station pressure readings of the mercurial barometer located at the station, the supervising Weather Bureau official - - - - - etc."

372 (b) Add "or commercial" between "transport" and "pilots" in the subheading and first sentence.

376 In the first example on page 58 substitute "visibility 10 miles or more" for "visibility over 10 miles"

In the first example on page 58 make the call letter "TL" and the classification "X" - "closed to landings and take-offs".

505 - Table 9 - Substitute "8,000" for "2,500" as the lower limit of the summer range in height of alto-cumulus and alto-cumulus-castellatus.

703 In the second sentence delete "placing data in the proper columns as indicated in the headings on the form" and substitute in place thereof "placing data as indicated in the instructions at the top of the form".

708 Delete from the first sentence - "in the ceiling column".

709 Delete from the last sentence "in the sky condition column".

710 Make the fifth sentence read "......if a separate copy of Form 1130-Aer. is prepared ..... etc."

711 Add -"When the wind velocity is estimated this should be indicated by entry of the letter "E" immediately following the velocity."

712 Make the first sentence read - "Remarks shall be entered according to instructions contained in Appendix IV of this Circular."

Delete the second sentence.

Delete at the end of the third sentence-"and set off by parentheses".

Page 71 - Figure 5 - Add "S" preceeding the "R" at "0230" and "0530". Add "302 60036" in the remarks column at "0430". Substitute "Ocnly E-K" for "Ocnly F" at "0500", "0510", and "0525".

946 Change "(3)" to "(5)", "(4)" to "(3)", "(5)" to "(4)".

969 Change the first word in fifth from last sentence from "above" to "below".

975 In the first sentence change "convex" to "concave".

1027 Substitute "mail" for "teletype" in the first sentence; also substitute "official in charge" for "airway observer". Add: "Where only ceiling balloon observations are made only single cylinders of gas will be furnished and the observer shall notify the supervising official when the gas pressure is down to 400 pounds."

1031 Substitute "drizzle" for "mist or sprinkle".

1057 Make the next to last sentence read "... and then re-oiling with an amount of light engine oil sufficient to bring the oil level to the upper bearing after the axis is replaced."

1088 - Add: "The time of changing the sheets should be entered at the point where the pen is lifted from the sheet."

UNITED STATES DEPARTMENT OF AGRICULTURE

Aerological Division

October 26, 1939

CHANGES IN CIRCULAR N, 1939.

The following changes should be indicated in Circular N, 1939. It is planned to issue these changes as revised pages for insertion in the loose-leaf copies of Circular N. However, pending receipt of these pages, the loose-leaf copies should also be corrected in accordance with the following:

Paragraphs 304 (a), 319 (b), 320 (b), 322, 325, 330, 374, 376, and the chart "Explanation of Symbol Weather Reports" - - Delete all references to the use of sky code figures. This change to be effective November 15, 1939.

Appendix I, Paragraph 9 (c), Page 128.

Change CONO to PICO
RANO to PIRA
SONO to PISO
FONO to PIFO
KONO to PIKO
IONO to PIIO
BANO to PIBA
DUNO to PIDU
HYNO to PIHE and "no hydrogen, -" to "no helium, - -"
FINO to PIFI

(These changes to be effective November 15, 1939)

The circular letter, Aerological Division, dated October 5, 1939, addressed to all raob stations and concerning the use of "DATA DBTF" for "Data doubtful", should be considered as an addition to Appendix II.

In the chart "Explanation of Symbol Weather Reports" the classification should be "N".

Paragraph 969. - In the sixth from the last line make "....bulb and ...." read ".... bulb end .....".

Effective Nov. 15, 1939

Paragraph 801. Add Albuquerque, N. Mex., and Billings, Mont., to the list of airway forecast centers.

Paragraphs 802, 804, 806. All references to periods covered by forecasts should be for 8-hour periods beginning at 5:30 and 11:30 a.m. and p.m., E.S.T., daily, instead of beginning at 4:30 and 10:30 a.m. and p.m., E.S.T., as at present.

APPENDIX V

(CIRCULAR N, 1939)

Revised Effective November 15, 1939.
(Temporary Copy - to be issued later in printed form).

INSTRUCTIONS FOR SIX-HOURLY AND THREE-HOURLY AIRWAY SERVICE

CHAPTER I

CANCELLATION OF PREVIOUS CIRCULARS

1. The following instructions, effective November 15, 1939, cancel those contained in the previous Appendix V to Circular N, 1939, which became effective July 1, 1939.

CHAPTER II

PURPOSE AND SCOPE OF INSTRUCTIONS

2. The instructions contained in this appendix to Circular N will govern the transmission and entry on forms of observations taken at 1:30, 4:30, 7:30 and 10:30 a.m. and p.m., E.S.T., at all stations named or included in the various categories as outlined hereinafter, except where specific exceptions to this general rule are stated, effective November 15, 1939.

SECTION I - 6-HOURLY SERVICE

CHAPTER III

TYPES OF REPORTS

3. In order to provide all data necessary for the preparation of complete weather maps at the 6-hourly periods upon which to base airway weather forecasts, a comprehensive collection and distribution of synoptic weather reports is required. To accomplish this, the following major groups of reports are to be transmitted on all teletype and radio circuits, beginning November 15, 1939:

(a) Code-Sequence Reports ("CS"): Complete synoptic meteorological reports, enciphered in the Weather Bureau figure code and transmitted from airway weather reporting stations on teletype and radio circuits authorized to do this and in the order of stations shown in CAA B-6 Manual of Operations. Sequences to run on individual teletype and radio circuits are then relayed to all other circuits in the country at times set by and in accordance with instructions governing this as issued by the Civil Aeronautics Authority. The elements included in such reports for each individual

6-hourly period, their order and method of enciphering in figure code are those prescribed in the Weather Code (Numeral System) 1939, except that the regular station letter designators will be used instead of figure designators. e.g. WA47 - - - - - - - - - -, etc.

(b) Map Reports ("M"): Complete meteorological surface reports to be made at designated stations not located on teletype or radio circuits at 1:30 and 7:30 a.m. and p.m., E.S.T., which reports are enciphered in the authorized numeral weather code, or, in the case of reports from foreign countries or from ships, in the code authorized for use by those countries or for ships. Their method of distribution differs from that of code-sequence reports in that they are collected by various methods (telegraph, SGL D&A, special message, etc.) and then transmitted in groups from designated distributing points.

(c) Special Data Added to Sequence Reports: Three-hour pressure change and characteristic groups are to be added to the 1:35 and 7:35 a.m. and p.m. sequence reports made at stations located on teletype and radio circuits which are not designated hereinafter to render code-sequence reports, and which are equipped with pressure-measuring instruments.

CHAPTER IV

GENERAL PLAN OF CODE-SEQUENCE TRANSMISSIONS

4. The transmission of code-sequence reports will be accomplished as follows:

(a) Each station listed in Chapter V following will prepare a code-sequence report as outlined in paragraph 3(a) above and have this ready for transmission at the beginning of the 30th minute past the hours of 0100, 0700, 1300, and 1900 E.S.T.; the observation on which this report is based to have been started not more than 20 minutes previous to that time. At stations where the Weather Bureau personnel turn the reports over to the Civil Aeronautics Authority station for transmission, the Weather Bureau personnel will file the report at least by 0128, 0728, 1328 and 1928, E.S.T., so that it may be punched up on the perforator prior to transmission on the long lines.

(b) The reports will then be entered on the individual long-line circuits beginning at approximately 0130, 0730, 1330 and 1930, E.S.T., in the order of stations as given in CAA B-6, "Manual of Operations."

(c) After this original transmission no relays of code-sequence reports will be made until after the completion of the hourly sequences which begin at 35 minutes past each hour. Then

relays will begin and will be continued during such periods and times as are prescribed by the National Communication Schedule and Bulletin B-6 of the Civil Aeronautics Authority until each code-sequence report has been transmitted to all circuits in the country in addition to the one on which it originated.

CHAPTER V

USE OF CODE-SEQUENCE DATA IN REGULAR SEQUENCE REPORTS

5. Since the code-sequence reports will be made only 5 minutes prior to the beginning of the regular hourly symbol sequence report collections and relays, it will not be necessary for the observer to take a new observation for this latter transmission unless conditions have changed to such a degree as would require the filing of a "special" airway report as outlined in Part III, Chapter V of Circular N, 1939. However, the conditions reported in the code-sequence report will be checked just prior to the filing of the regular sequence report so that conditions reported in the sequence report are strictly up-to-date.

CHAPTER VI

FORMS TO BE USED IN TAKING AND RECORDING CODE-SEQUENCE REPORTS

6. Since the making of proper code-sequence reports involves the taking of complete meteorological observations, including reductions of the marcurial barometer readings, such observations will be recorded on Form 1083. Necessary data for the regular airway sequence report (checked by the observer as required in Chapter V above) will then be extracted from this and entered on Form 1130 for transmission. Entries on Form 1083 are to conform with instructions for preparing that form, and these should be studied very carefully so that the proper entries, permitting the taking of data therefrom for entry in proper form on 1130, are made in all cases.

CHAPTER VII

STATIONS WHICH SHALL RENDER CODE-SEQUENCE REPORTS

7. The following stations shall take code-sequence observations and enter these reports on the teletype circuit indicated, and in the order shown in Civil Aeronautics Authority B-6 "Manual of Operations," copies of which will be furnished to all concerned; the first transmission on each circuit to begin at approximately 1:30 and 7:30 a.m. and p.m., E.S.T. All other hourly reporting stations equipped with pressure-measuring instruments shall add data for the code group "app" to their 1:35 and 7:35 a.m. and p.m., E.S.T., sequence reports irrespective of whether or not the station is authorized to report sea-level pressure.

CODE-SEQUENCE REPORTS (CS)

(Distributed nationally without regard to zones)

*	AN	Aberdeen, S. D.
	AP	Abilene, Tex.
	AF	Advance, Mo.
*	RN	Akron, Colo.
	AZ	Albany, N. Y.
	AB	Albuquerque, N. Mex.
	AE	Alexandria, Minn.
	AJ	Alma, Ga.
	AQ	Amarillo, Tex.
	AT	Ardmore, Okla.
**	FK	Ashfork, Ariz.
	AG	Atlanta, Ga.
	VD	Augusta, Ga.
	XN	Austin, Tex.
	BK	Baker, Oreg.
	BD	Bakersfield, Calif.
	BB	Bangor, Me.
	JJ	Bellingham, Wash.
	BZ	Big Springs, Tex.
	BI	Billings, Mont.
	BH	Birmingham, Ala.
	RK	Bismarck, N. Dak.
	UU	Blanding, Utah
	BC	Blue Canyon, Calif.
	YH	Blythe, Calif.
	BE	Boise, Ida.
	BW	Boston, Mass.
	JB	Bristol, Tenn.
	JI	Brownsville, Tex.
	BJ	Buffalo, N. Y.
	BU	Burbank, Calif.
	BX	Burley, Ida.
	JG	Burlington, Vt.
	BT	Butte, Mont.
	KM	Camden, N. J.
*	CW	Casper, Wyo.
	CZ	Chanute, Kans.
	NU	Chanute Field, Ill.
	CS	Charleston, S. C.
	KN	Charleston, W. Va.
	CB	Chattanooga, Tenn.
	CH	Chehalis, Wash.
	UW	Cherry Fork, O.
	CX	Cheyenne, Wyo.
	CG	Chicago, Ill.
	CC	Cincinnati, Ohio
	CV	Cleveland, Ohio
	CA	Columbia, Mo.
	CI	Columbia, S. C.
	CO	Columbus, Ohio
	CR	Corpus Christi, Tex.
	VZ	Delta, Utah
	DV	Denver, Colo.
	DM	Des Moines, Iowa
	DO	Detroit, Mich.
	DC	Dickinson, N. Dak.
	DZ	Dubois, Ida.
	EF	Effingham, Ill.
	EK	Elkins, W. Va.
	EI	Elko, Nev.
	EA	Elmira, N. Y.
	EB	Ellensburg, Wash.
	EM	El Morro, N. Mex.
	EO	El Paso, Tex.
**	NP	Enterprise, Utah
	ER	Erie, Pa.
	EU	Eugene, Ore.
	EN	Evergreen, Ala.
	FO	Fargo, N. Dak.
	FL	Florence, S. C.
	FV	Fort Worth, Tex.
	FW	Fort Wayne, Ind.
	FT	Fresno, Calif.
*	GS	Galveston, Tex.
	GJ	Gordonsville, Va.
	GF	Grand Forks, N. Dak.
	GI	Grand Island, Nebr.
	GR	Grand Rapids, Mich.
	GT	Great Falls, Mont.
	GW	Greensboro, N. C.
	GD	Greenwood, Miss.
	HX	Harrisburg, Pa.
	HT	Hartford, Conn.
	HU	Houston, Tex.

	HD	Humboldt, Nev.
*	HR	Huron, S. D.
	ID	Indianapolis, Ind.
	JA	Jackson, Miss.
	JX	Jacksonville, Fla.
	JM	Jamestown, N. Dak.
	KC	Kansas City, Mo.
	KW	Key West, Fla.
	KR	Kirksville, Mo.
	KT	Knight, Wyo.
	KX	Knoxville, Tenn.
	KY	Kylertown, Pa.
	LE	La Crosse, Wis.
*	LC	Lake Charles, La.
	LF	Lafayette, Ind.
	LQ	Las Vegas, Nev.
	LN	Lebo, Kans.
	LI	Little Rock, Ark.
	LT	Livingston, Mont.
	LV	Louisville, Ky.
	UN	Macon, Ga.
	MA	Madison, Wis.
	MF	Medford, Oreg.
	OU	Melbourne, Fla.
	PS	Memphis, Tenn.
	MC	Mercer, Pa.
	UM	Meridian, Miss.
	MM	Miami, Fla.
	MY	Miles City, Mont.
	MK	Milwaukee, Wis.
	MP	Minneapolis, Minn.
	MX	Missoula, Mont.
	MS	Mobile, Ala.
	MO	Moline, Ill.
	UG	Montgomery, Ala.
	UO	Monroe, La.
	SC	Mt. Shasta, Calif.
	MN	Mullan Pass, Ida.
	NA	Nashville, Tenn.
	NT	Navasota, Tex.
*	NJ	Needles, Calif.
	NK	Newark, N. J.
	NO	New Orleans, La.
	NQ	North Platte, Nebr.
	OA	Oakland, Calif.
	CL	Oklahoma City, Okla.
	CH	Omaha, Nebr.
*	UX	Palacios, Tex.
	XP	Parco, Wyo.
	PB	Pembina, N. Dak.
	PO	Pendleton, Oreg.
	PI	Peoria, Ill.
	PH	Phoenix, Ariz.
	PT	Pittsburgh, Pa.
	PW	Portland, Me.
	PQ	Pocatello, Ida.
	PD	Portland, Oreg.
	FQ	Port Townsend, Wash.
	PU	Pueblo, Colo.
	RA	Raleigh, N. C.
	RG	Redding, Calif.
	RP	Reno, Nev.
	RW	Richmond, Va.
	RO	Roanoke, Va.
	RT	Rock Springs, Wyo.
	RH	Rodeo, N. Mex.
	RJ	Rolla, Mo.
	RB	Roseburg, Oreg.
	SZ	Sacramento, Calif.
	ZJ	St. Joseph, Mo.
	ZO	Saltillo, Tex.
	SL	Salt Lake City, Utah
	ZN	San Antonio, Tex.
	ZB	Sandberg, Calif.
	SQ	San Diego, Calif.
	SH	Savannah, Ga.
	SA	Seattle, Wash.
	ZX	Sexton Summit, Oreg.
*	ZY	Sheridan, Wyo.
	ZH	Shreveport, La.
	SD	Sidney, Nebr.
	RL	Silver Lake, Calif.

YX Sioux City, Iowa
TL Sioux Falls, S. D.
SO Smiths Grove, Ky.
SU Spartanburg, S. C.
SM Spokane, Wash.
ZD Springfield, Ill.
ZF Springfield, Mo.
SR Syracuse, N. Y.

* TM Tampa, Fla.

TD Trinidad, Colo.
TZ Tucson, Ariz.
TC Tucumcari, N. Mex.
TS Tulsa, Okla.
TY Tylertown, Miss.

WC Waco, Tex.
WA Washington Airport, Va.
WU Watertown, S. D.
WY Waynoka, Okla.
WV Wendover, Utah
WZ West Palm Beach, Fla.
WD Wichita, Kans.
* WF Wichita Falls, Tex.
WI Wilkes-Barre, Pa.
WS Williams, Calif.
WP Wink, Tex.
WO Winslow, Ariz.

CANADIAN

624 Toronto, Ont. (YZ)
626 Kingston, Ont. (KKI)
627 Montreal, Que. (UL)
628 Ottawa, Ont. (OW)
629 Killaloe, Ont. (XI)
630 Muskoka, Ont. (QA)
731 North Bay, Ont. (YB)
736 Earlton, Ont. (XR)
739 Porquis Junction, Ont. (QJ)
799 Victoria, B. C. (VI)
831 Kapuskasing, Ont. (YU)
833 Pagwa, Ont. (XK)
840 Nakina, Ont. (QN)
841 Wagaming, Ont. (YW)
842 Sioux Lookout, Ont. (XL)
850 Kenora, Ont. (QK)
852 Winnipeg, Man. (WG)

860 Rivers, Man. (YI)
861 Broadview, Sask. (XB)
863 Regina, Sask. (QR)
870 Swift Current, Sask. (YN)
872 Medicine Hat, Alta (XH)
874 Lethbridge, Alta (QL)
875 Cowley, Alta (YM)
877 Calgary, Alta (YC)
878 Penhold, Alta (QF)
879 Edmonton, Alta (XD)
881 Cranbrook, B. C. (XC)
883 Grand Forks, B. C. (YF)
884 Crescent Valley, B. C. (QB)
885 Carmi, B. C. (XO)
886 Princeton, B. C. (QP)
892 Vancouver, B. C. (VR)

* To become "CS" station when and if teletype or radio installed.

** To be established as "CS" station (Now has teletype or radio)

CHAPTER VIII

STATIONS WHICH SHALL RENDER MAP REPORTS

8. The following lists indicate the group in which each station authorized to be included in the map report transmissions will be placed at the teletype distributing centers (Chicago, Newark or North Beach, Oakland). Proper headings as prescribed by the Civil Aeronautics Authority will be entered at beginning of transmission.

"A" GROUP-CHICAGO

(Transmitted at all 6-hourly periods unless otherwise specified)

45/	Ambrose Lightship, N. J.
099	Hamilton, Bermuda (1)
200	San Juan, P. R. (1)
210	Ft. Myers, Fla.
211	Tampa, Fla. (2)
212	Ocala, Fla. (4)
213	Thomasville, Ga.
216	Americus, Ga.
220	Apalachicola, Fla.
224	Dothan, Ala.
239	Monticello, Ark.
242	Galveston, Tex. (2)
245	Lufkin, Texas
246	Alexandria, La.
247	Palestine, Tex.
301	Wilmington, N. C.
302	Cape Lookout, N. C. (3)
304	Hatteras, N. C.
305	Greenville, N. C.
308	Norfolk, Va.
315	Asheville, N. C.
316	Mt. Mitchell, N. C.
322	Florence, Ala.
328	Stearns, Ky.
330	Tupelo, Miss.
335	Batesville, Ark.
337	Paris, Tenn.
342	McAlester, Okla.
344	Ft. Smith, Ark.
348	West Plains, Mo
400	Urbana, Va.
402	Snow Hill, Md.
404	Delaware Breakwater, Del.
407	Atlantic City, N. J.
412	Flat Top, West Va.
413	Pikeville, Ky.
415	Clarksburg, W. Va.
418	Frostburg, Md.
421	Winchester, Ky.
427	Parkersburg, W. Va.
432	Evansville, Ind.
433	Carbondale, Ill. (4)
435	Washington, Ind.
443	Clinton, Mo.
505	Block Island, R. I.
506	Nantucket, Mass.
5/2	Kane, Pa.
515	Binghamton, N. Y.
5/1	Delhi, N. Y. (4)
2/4	Arcadia, La.

Coast Guard Stations

52/	Ditch Plain, L.I., N.Y.
51/	Tiana, L.I., N.Y.
50/	Fire Island, L.I., N.Y.
44/	Barnegat, N. J.
43/	Cape May, N. J.
42/	Ocean City, Md.
41/	Assateague, Va.
40/	Hog Island, Va.
33/	Princess Anne, Va.
32/	Caffeys Inlet, N. C.
31/	Oregon Inlet, N. C.

6/1 Brattleboro, Vt. (4)
522 Alger, Ohio
527 Knapp Creek, N. Y.
542 Mount Ayr, Ia.
547 Dubuque, Ia.
548 Iowa Falls, Ia.
608 Eastport, Mo.
611 Lebanon, N. H.
613 Mt. Washington, N. H.
615 Whiteface Mountain, N. Y.
616 Lake Placid, N. Y.
618 Rumford, Me.
619 Greenville, Mo.
621 Watertown, N. Y. (4)
632 Canton, N. Y.
634 Harbor Beach, Mich.
637 Houghton Lake, Mich.
638 Frankfort, Mich.
639 Alpena, Mich.
642 Charles City, Ia.
644 Rochester, Minn.
645 Green Bay, Wisc.
646 Wausau, Wisc.
734 Sault Ste. Marie, Mich.
741 Park Falls, Wisc.
742 Hinckley, Minn.
743 Marquette, Mich. (3)
744 Houghton, Mich.
745 Duluth, Minn.
747 International Falls, Minn.

"B" GROUP-CHICAGO

(Transmitted at all 6-hourly periods unless otherwise specified)

252 Laredo, Tex.
257 Brady, Tex.
261 Del Rio, Tex.
262 Alpine, Tex.
263 Sonora, Tex. (4)
267 Lubbock, Tex.
268 Roswell, N. Mex.
269 Carrizozo, N. Mex.
275 Engle, N. Mex.
276 Mogollon, N. Mex.
280 Yuma, Ariz.
351 Wichita Falls, Tex. (2)
355 Elk City, Okla.
357 Ponca City, Okla.
367 Clayton, N. Mex.
368 Guymon, Okla. (4)
372 Prescott, Ariz.
377 Crownpoint, N. Mex.

378	Grand Canyon, Ariz.
451	Dodge City, Kans.
454	Genesseo, Kans.
455	Ellis, Kans.
456	Topeka, Kans.
458	Concordia, Kans.
459	Phillipsburg, Kans.
461	Monte Vista, Colo.
463	Lamar, Colo.
465	Goodland, Kans.
467	Leadville, Colo.
471	Durango, Colo.
476	Grand Junction, Colo.
477	Green River, Utah
555	Burwell, Nebr.
557	Sioux City, Iowa (2)
558	Tyndall, S. D. (4)
560	Akron, Colo. (2)
567	Valentine, Nebr.
568	Chadron, Nebr.
569	Casper, Wyo. (2)
570	Roosevelt, Utah
571	Craig, Colo.
576	Lander, Wyo.
577	Big Piney, Wyo.
651	Sioux Falls, S. Dak. (2)
653	Springfield, Minn.
654	Huron, S. Dak. (2)
656	Watertown, S. Dak. (2)
659	Aberdeen, S. Dak. (2)
667	Broadus, Mont. (4)
661	Newcastle, Wyo.
662	Rapid City, S. Dak.
664	Pierre, S. Dak.
666	Sheridan, Wyo. (2)
668	Mobridge, S. Dak.
669	Lemmon, S. Dak.
674	Cody, Wyo.
675	Yellowstone Park, Wyo. (3)
755	Bemidji, Minn.
757	Devil's Lake, N. Dak.
759	Roseau, Minn. (4)
762	Glendive, Mont.
765	Garrison, N. Dak.
766	Minot, N. Dak.
767	Williston, N. Dak.
768	Fort Peck, Mont.
771	Lewistown, Mont.
777	Havre, Mont.
778	Cutbank, Mont.
779	Kalispell, Mont.

"C" GROUP-OAKLAND

(Transmitted at all 6-hourly periods unless otherwise specified)

289 Mt. Wilson, Calif.
291 San Nicholas Island, Calif.
292 Buffalo Springs, Calif.
293 San Pedro, Calif.
380 Needles, Calif. (2)
388 Independence, Calif.
391 Goleta, Calif.
392 Point Arguello, Calif.
393 Taft, Calif.
394 Lost Hills, Calif.
395 Estero, Calif.
396 Pt. Piedras Blancas, Calif.
397 Coalinga, Calif.
398 King City, Calif.
399 Hollister, Calif.
484 Hawthorne, Nev.
485 Tonopah, Nev.
486 Ely, Nev.
487 Austin, Nev.
490 Mount Hamilton, Calif.
492 Tracy, Calif.
495 S. E. Farallon Island, Calif.
496 San Pablo, Calif.
497 San Rafael, Calif.
499 Point Arena, Calif.
583 Winnemucca, Nev.
584 Susanville, Calif.
587 Riddle, Idaho
589 Lakeview, Oreg.
590 Fort Bragg, Calif.
594 Eureka, Calif.
598 Brookings, Oreg.
683 Burns, Oreg.
686 Salmon, Idaho
687 Grangeville, Idaho
691 North Bend, Oreg.
692 Bend, Oreg.
695 Newport, Oreg.
697 Hood River, Oreg.
780 La Crosse, Wash.
781 Yakima, Wash. (1)
783 Wenatchee, Wash.
786 Bonner's Ferry, Idaho
787 Colville, Wash.
788 Oroville, Wash.
791 North Head, Wash.
794 Moclips, Wash.
798 Tatoosh Island, Wash.
999 Honolulu, T. H. (1)

"D" GROUP-CHICAGO

(Transmitted at all 6-hourly periods unless otherwise specified)

Note: Due to the fact that Canada is a belligerent in the current war, not all reports listed below will be available for general teletype distribution, particularly those in eastern and northeastern Canada. However, they are listed here for convenience, and transmission will undoubtedly be resumed when and if hostilities cease.

600 Sable Island, N. S.
601 Halifax, N. S.
603 Yarmouth, N. S. (1)
623 London, Ont. (3)
631 Parry Sound, Ont. (1)
632 Southampton, Ont. (1)
707 Sydney, N. S. (3)
709 Grindstone Island, Quebec
714 Quebec, Quebec (1)
715 Kedgewick, New Brunswick (3)
719 Father Point, Quebec (1)
727 San Maur, Quebec (1)
728 Doucet, Quebec (3)
729 St. Felicen, Quebec (1)
736 Haileybury, Ontario (1)
738 White River, Ontario (1)
749 Port Arthur, Ont.
800 Cape Race, N. F.
801 St. John's, N. F. (3)
802 Grand Bank, N. F. (3)
803 Newfoundland Airport, N. F.
805 St. Georges, N. F. (3)
806 Fogo, N. F.
810 Anticosti, S. W. Point, Quebec
812 Clarke City, Quebec (3)
814 Harrington, Quebec (3)
816 Northwest River, Labrador (3)
818 Cartwright, Labrador (3)
821 Lake Dore, Quebec (1)
827 Sandgirt Lake, Quebec (3)
830 Cochrane, Ontario (3)
836 Moosonee, Ont. (1)
853 Minnedosa, Manitoba (1)
854 Red Lake, Ont. (1)
858 Norway House, Manitoba (3)
859 God's Lake, Manitoba (3)
862 Qu'Appelle, Saskatchewan (1)
867 The Pas, Manitoba (1)
869 Prince Albert, Saskatchewan (1)
876 Battleford, Saskatchewan
887 Kamloops, B. C.
890 Hope, B. C. (1)

894 Estevan, B. C.
896 Prince George, B. C.
898 Prince Rupert, B. C.
899 Langara, B. C. (3)
903 Resolution, Hudson Strait
904 Hopes Advance, Hudson Strait (1)
907 Port Harrison, Quebec
908 Nottingham, Hudson Strait (3)
913 Churchill, Manitoba
916 Chesterfield, Dist. of Keewatin (3)
918 Arctic Bay, Dist. of Franklin (1)
932 McMurray, Alberta (3)
933 Keg River, Alberta (1)
934 Smith, Alberta (1)
938 Coppermine, Dist. of Mackenzie (1)
941 Beaver Lodge, Alberta (1)
942 Fairview, Alberta
944 Hudson Hope, B. C. (1)
945 Nelson (Fort), B. C. (3)
946 Fort Simpson, Dist. of Mackenzie (3)
952 Ketchikan, Alas. (1)
953 Watson Lake, B. C. (1)
956 Norman (Fort), Dist. of Mackenzie (3)
962 Juneau, Alas. (1)
964 Whitehorse, Yukon
965 Mayo, Yukon (1)
966 Dawson, Yukon (1)
968 Aklavik, Dist. of Mackenzie (3)
970 Kodiak, Alas. (1)
971 Cordova, Alas. (1)
974 Fairbanks, Alas. (1)
984 Bethel, Alas. (1)
987 Nome, Alas. (1)
989 Barrow, Alas. (1)
990 Dutch Harbor, Alas. (1)
991 Atka, Alas. (1)
993 St. Paul, Alas.

"E" GROUP-NEWARK OR NORTH BEACH

(Transmitted at all 6-hourly periods)

Atlantic and Gulf ship reports

"F" GROUP-OAKLAND

(Transmitted at 7:30 a.m. and p.m., E.S.T., periods, only)

Pacific ship reports and positions of highs and lows at sea.

"G" GROUP-SAN DIEGO

(Transmitted at 7:30 a.m. and p.m., E.S.T., periods, only)

Mexican reports

Notes:

(1) Transmitted at 7:30 a.m. and p.m., E.S.T., only.

(2) Will be included in code-sequence transmissions and dropped from above transmissions when teletype or radio installed and operating.

(3) Transmitted at the 7:30 a.m., 1:30 p.m. and 7:30 p.m., E.S.T., periods only.

(4) New Station. Will be included in transmissions at all periods after stations are established and operating.

SCHEDULE OF "M" TRANSMISSIONS

9. The general plan of transmission of map reports involves their concentration at Chicago, Oakland, Newark (or North Beach), and San Diego and distribution to teletype circuits from these points as outlined in the following plan.

SCHEDULE OF "I" TRANSMISSIONS

Time (E.S.T.) (All times inclusive)	Group A	Group B	Group C	Group D	Group E	Group F	Group G
8:11-8:21 a&p 2:11-2:21 a&p	Placed on Circuits 3 and 7 at Chicago; relayed to 1 and 2 by Newark, to 5 by Washington	Placed on Circuits 6 and 12 at Chicago, then relayed to 9 by Kansas City and to 10 by Fort Worth	Placed on Circuits 14 and 15 by Oakland then relayed to 13 and 23 by Seattle.				
8:24-8:34 a&p 2:24-2:34 a&p	Relayed by Chicago to Circuit 6, by Washington to 10	Relayed by Chicago to Circuits 3 & 7, by Salt Lake to 13 and 14, by Seattle to 15 and 23.	Relayed by Burbank to Circuit 9, by Salt Lake to 12.		Placed on Circuits 1 & 2 by Newark, relayed to 5 by Washington		
8:55-8:59 a&p 9:04-9:10 a&p 2:55-2:59 a&p 3:04-3:10 a&p	Relayed to Circuit 9 by Kansas City, to 12 by Chicago.	Relayed to Circuits 1 & 2 by Newark, to 5 by Washington.	Relayed to Circuit 6 by Billings, to 7 by Chicago.		Relayed to Circuits 3 and 10 by Washington.	Placed on Circuits 14 & 15 by Oakland, relayed to 13 & 23 by Seattle	
9:11-9:21 a&p 3:11-3:21 a&p			Relayed to Circuit 10 by Fort Worth.	Placed on Circuits 3, 6, 7 and 12 by Chicago, then relayed to 1 & 2 by Newark, 5 by Washington, 13 and 14 by Salt Lake, 15 and 23 by Seattle.		Relayed to Circuit 9 by Burbank	
10:04-10:14 a&p only	Relayed to Circuits 13 & 14 by Salt Lake, to 23 by Seattle		Relayed to Circuits 1, 2 and 3 by Newark, to Circuit 5 by Washington.			Relayed to Circuit 6 by Billings, to Circuit 12 by Salt Lake, to Circuit 7 by Kansas City	Placed on Circuit 15 by San Diego relayed to 9 by Burbank and 10 by Fort Worth.

NOTE: (1) Proper headings for each group will be entered by the transmitting station. (2) The end of any group transmission will be signified by writing "End Group ___" and ringing one bell at the transmitting station. (3) In the event that any transmission does not fill all the allotted time, then this time will be used for any miscellaneous short transmissions that may be available. (4) It is not expected that Pacific ship reports (Group F) will be available for the 1:30 a.m. and p.m., E.S.T., periods from Oakland until some time in 1940. Until these are available, this open time will be used as outlined under "3" above.

SECTION II - 3-HOURLY SERVICE

CHAPTER IX.

Three-Hourly-Reports

10. Stations on the airways teletype or radio circuits which are equipped with pressure measuring instruments shall add to the 4:30 and 10:30 a.m. and p.m., E.S.T., reports, the code group "app" for data representing three-hourly pressure change and characteristic. Such of these stations as have been specifically instructed to do so shall also add to these reports the code group "$C_LC_MC_HhD_C$", representing cloud data. These groups shall be added immediately following any remarks.

11. Stations off the airways which have been so designated and instructed and are listed in the last paragraph of this chapter shall telegraph reports at 4:30, and 10:30 a.m. and p.m., E.S.T., using only the data for the first five code groups as indicated in the Weather Code (Numeral System) 1939, except that the sixth ($6R_cR_tRR$) group will be included when precipitation or a thunderstorm has occurred since the last observation. The precipitation amount is not to be measured or coded, slants being used in the group in place of this value, unless a thunderstorm with no precipitation has occurred, in which case "00" would be enciphered for amount. A separate copy of Form 1083 will be prepared each day for these 4:30 and 10:30 a.m. and p.m., E.S.T. observations, the time headings in the observation columns and any other places they may appear being changed to agree with the time of the observations.

12. The following is a list of all off-airway stations included in the system of 3-hourly reporting stations:

220 Apalachicola, Fla.
240 Lake Charles, La.
257 Brady, Tex.
262 Alpine, Tex.
267 Lubbock, Tex.
304 Hatteras, N. C.
348 West Plains, Mo.
402 Snow Hill, Md.
421 Winchester, Ky.
451 Dodge City, Kans.
458 Concordia, Kans.
465 Goodland, Kans.
472 Blanding, Utah

476 Grand Junction, Colo.
499 Pt. Arena, Calif.
506 Nantucket, Mass.
587 Riddle, Idaho
594 Eureka, Calif.
598 Brookings, Oreg.
634 Harbor Beach, Mich.
653 Springfield, Minn.
654 Huron, S. D.
683 Burns, Oregon
691 North Bend, Oreg.
695 Newport, Oreg.
734 Sault Ste. Marie, Mich.
767 Williston, N. D.
777 Havre, Mont.
779 Kalispell, Mont.
788 Oroville, Wash.
791 North Head, Wash.
794 Moclips, Wash.
798 Tatoosh Island, Wash.

SECTION III - GENERAL INSTRUCTIONS

CHAPTER X

Instructions for Recording and Coding of Observations

13. Instructions which appear with Form 1083 are to be followed in the entering of observations on that form.

14. Observations at stations which render map reports ("M") will be taken and enciphered in accordance with instructions contained in the Weather Code (Numeral System) 1939.

15. Coded SGL D&A messages shall be entered on Form 3070-Tel. Coded reports sent by special messages shall be entered on Form 3024-Tel. (pink blank).

16. Present instructions to individual stations regarding the telegraphing of their six-hourly reports are not affected or changed in any way by this Appendix.

17. When a station now telegraphing reports is commissioned as a Civil Aeronautics Authority teletype or radio station, the general supervising official concerned will be responsible for taking the necessary proper action, viz., (1) notify all concerned regarding entry in the code sequences; (2) notify the Officials in Charge of the Chicago or Oakland Weather Bureau Office; (3) notify the Central Office. If airway observers are taking the observations and the work is transferred to a teletype or radio station, general supervising officials will make recommendations to the Central Office for approval of the discontinuance of the services of the observers and the closing of the station.

Appendix IV. - TRANSMISSION OF REMARKS IN AIRWAY SYMBOL WEATHER REPORTS

1. Use of Symbols and Abbreviations. - When it is necessary to include remarks in airway weather reports which are transmitted by teletype or radio, the information included in such remarks will be coded as one or more groups of symbols and abbreviations. Symbols to be used will be those authorized for use in transmission of weather reports by teletype. The abbreviations used will be those authorized by the Civil Aeronautics Authority and published in that Authority's "Manual of Operations", Chapter B, Part 4.

2. Position in Reports. - The remarks group will be separated from the last element of the report proper by one space.

3. When Used. - Remarks will be used to express only elements of phases of the weather which cannot be included in the body of the report. Such conditions prevailing at a distance from the observer will be included in remarks, e. g., "T NW" - thunderstorm NW; "K SE" - smoky SE, etc. Abbreviations will be used for directions from the station in which phenomena are observed. Intensities of weather and obstructions to vision phenomena will not be indicated except in cases where they are pertinent to the value of the remarks, i. e., "R+ ocnly" = "Rain occasionally heavy".

4. Only Necessary Remarks to be Included. - Observers should constantly endeavor to keep remarks as short as possible and include only those which are essential to a valuable report. Remarks which merely repeat some phase of the body of the report in another form are superfluous and should never be included, e. g., when -⊕/ is sent as the sky condition, it is unnecessary and inefficient to include "lunar halo" in remarks, since the lunar halo indicates a sheet of high thin clouds reported earlier in the message.

5. Examples of Remarks. - In order to illustrate the method of coding remarks in weather reports sent by teletype or radio, the following examples of some of the more important remarks are given:

A - CEILING

"+⊕ OBSCG MTNS"	Heavy clouds obscuring mountains
" ⊕ ALG MTNS"	Clouds along mountains
" ⊙ TPG MTNS"	Clouds topping mountains

NOTE: When it is desired to represent conditions similar to the foregoing, the same sky symbol should be employed as was used in the body of the report for the clouds to which reference is made.

"60⊕" Overcast estimated at 6,000 feet. (Used when ⊕⊕ appears in the body of the report and the height of the overcast must therefore be indicated in remarks.)

"3⊙" Lower scattered clouds at 300 feet. (Used when it is necessary to indicate a third layer of clouds.)

B - SKY

"+⊕ NW" Clouds dark northwest. (The same sky symbol should be employed as was used in the body of the report for the clouds to which reference is made.)

"⊕ TURBT" Clouds turbulent.

C - VISIBILITY

"2F NW" Fog bank to northwest, visibility 2 miles.

"3K NE" Smoky to the northeast, visibility 3 miles. (Used to indicate visibility lower in some direction than that indicated in the body of the report.)

D - WEATHER

"T APCHG SW" Thunderstorm approaching from the southwest.

"RQ W" Rain squall to west.

"SW TO SW" Snow shower to southwest

NOTE: If there is a possibility of confusing the direction with the element, insert "to" preceding the direction abbreviation.

"CM OVHD" Mammato-cumulus clouds overhead.

"ACC INCRG" Alto cumulus-castellatus clouds increasing.

"R+ OCNLY" Rain occasionally heavy.

"RE OCNLY" Sleet occasionally mixed with rain (when rain is indicated in the body of the report) OR -

Occasional sleet and rain mixed (when neither sleet nor rain is indicated in the body of the report)

E - OBSTRUCTIONS TO VISION

"STARS VSB THRU GF" Stars visible through ground fog.

"FK OCNLY" Smoke occasionally mixed with fog.

6. Methods to be Used When Other Conditions are Present. - The foregoing examples do not cover every condition but merely illustrate the method of coding. Observers should use their best judgment in placing other remarks in the report in such a manner that they can be easily translated. Any remarks which are considered necessary, but which cannot be indicated in symbol form, will be entered by means of authorized English abbreviations.

UNITED STATES DEPARTMENT OF AGRICULTURE

WEATHER BUREAU
Washington

March 21, 1940

PREPARATION OF FORMS

FORM 1083

1. Form 1083 is the record of the four daily original surface observations at six-hour intervals. The placing of only two observations on one Form 1083 for the last day of one month and another two on the form for the first day of the following month is not authorized. The form containing the last two observations of one month and two of the following month will be kept with the forms for the first month. Checking stations may where necessary make a memorandum copy of such data as are necessary to carry from one to another succeeding month for any station checked.

2. Whenever hail falls within twenty-five miles of the station, this fact, if known, should be recorded under "Miscellaneous Notes", with other pertinent information, such as size of hailstones, damage, etc.

3. Whenever a tornado occurs in the vicinity of a station, the observer should gather and record under "Miscellaneous Notes" as complete information as possible concerning the path and size of the storm, its appearance, direction of movement, damage, etc.

4. The times of beginnings and endings of precipitation and of changes in the kind of precipitation will be entered to the nearest minute on Form 1083 under "Precipitation Notes". If this time is unknown, it will be estimated as closely as possible and will be followed by the small letter "e" to indicate "estimated". If it is known that the estimated time of beginning or ending could be over one hour in error, the time will nevertheless be estimated under "Precipitation Notes", but in such cases "Unknown" will be entered in line 22 to facilitate coding. When the time is estimated, appropriate remarks may be added under "Miscellaneous Notes" to explain the estimate.

5. The time of beginning and ending of each intensity of fog should be recorded on Form 1083 as completely as observed. It frequently occurs that one intensity ends or begins when another intensity begins or ends, respectively. Estimates will be recorded, as necessary, by adding the small letter "e" to the entry of the time.

6. Times of beginnings and endings of haze, smoke, dust, and sand will be entered under "Miscellaneous Notes" on Form 1083 whenever known. The outer limit of visibility for haze, smoke, dust, and sand is defined as six miles in Circular N and these phenomena need be

recorded only when the visibility is six miles or less. It is desired that as complete entries as possible for these be made.

7. Abbreviations authorized for use on Form 1083 are listed in Civil Aeronautics Authority Manual of Operations, Chapter B, Part 4, Section 1, Abbreviations and Phrase Contractions.

8. If the sky is "overcast with breaks", record 9+ on line 2, if "less than one-tenth covered" record 1-.

9. When thunder is heard and it is estimated to be two miles or more from the station, this should be indicated by the word "distant" in the character column under "Thunderstorm Notes". Reference is made to Page 29 of "Definitions of Hydrometeors and Other Atmospheric Phenomena, November 18, 1938".

10. In disposing of decimals, if the last figure is greater than 5 (or is 5 with a remainder) the preceding figure will be increased by 1. If the figure is 5 exactly, the preceding figure will be increased by 1 when odd, and when even it will remain unchanged (in this case the result will always be an even number). If the last figure is less than 5, retain the preceding figure unchanged.

The above instructions are additions to and revisions of those contained in the covers for Form 1083 and Division of Climate and Crop Weather Circular of November 28, 1939 and "Instructions for Preparing Form 1083, Revision" dated January 17, 1940. The circular "Condensed Instructions for Preparation of Meteorological Forms for Stations Making Six-Hourly Observations and Manned by Airway Observer or Civil Aeronautics Personnel", as effective January 1, 1940, is hereby cancelled in its entirety.

FORM 1083 USED FOR RECORDING THREE-HOURLY OBSERVATIONS MID-WAY BETWEEN THE STANDARD SIX-HOURLY OBSERVATIONS.

1. No entries will be made in lines 23 to 40 inclusive and 53 to 68 inclusive, nor under "Precipitation Notes", "Thunderstorm Notes", and "Miscellaneous Notes".

2. Stations using Form 1083 for recording three-hourly observations mid-way between the standard six-hourly observations will forward these forms at the end of each month in the same manner and to the same station as Form 1083 used for six-hourly observations.

(A new Form 1082 will be available for use in recording original observations at the three-hourly periods midway between the standard six-hourly observations, in about six months. This form will supplant the use of Form 1083 for recording three-hourly observations. Only a quantity of Forms 1083, used for three hourly observations, sufficient to make up a six months' supply should be ordered.)

The above instructions on Form 1083, used for three hourly observations only, are in addition to the ones contained in Appendix V, Circular N.

FORM 1083-A

A scratch form in pads, for recording elements taken outdoors. This form is now available and may be obtained on requisitions. It may be carried outdoors instead of the regular Form 1083. This is particularly advantageous during rainy weather. Entries will be transferred immediately to Form 1083 and checked for accuracy in transferring, before proceeding with the observation. Form 1083-A is not required, but is provided for the convenience of the observer and to facilitate neatness on Form 1083. This form, when prepared, will be kept on file at the preparing station for at least three months, after which it may be disposed of.

FORM 1135

717. PURPOSE AND INSTRUCTIONS FOR USE OF FORM 1135.- 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. EXCEPT FOR THOSE STATIONS WHICH RENDER CODED SIX-HOURLY REPORTS, this form shall be used at all stations having mercurial barometers for the recording of the data called for thereon at observations taken at 1:35 and 7:35 a.m. and p.m., E. S. T. Stations rendering both Form 1135 and Form 1146 (see instructions for Form 1146 below) will prepare Form 1135 for both sea-level and 5,000-foot pressure. 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 be checked by checking stations unless the station using this form is manned by Weather Bureau commissioned personnel. In the later event computations on the form will invariably be checked by some person on the station other than the one taking the observation.

719. ENTRY OF DATA.- Data will be entered in pencil. Entries on the lines "SEA-LEVEL PRESSURE" and "TOTAL = 5,000 FT. PRESSURE" will be made in millibars and tenths of a millibar. No entries will be made in columns for "CLOUDS" or "THUNDERSTORMS". "THREE-HOUR STATION PRESSURE CHANGE AND CHARACTERISTIC" should be deleted on each form and the sea-level pressure in inches and hundredths of an inch be entered on this line. The observer taking the observation will sign his initials in the space formerly used for upper cloud entries. The omission of three-hour pressure change and characteristic data on Form 1135 in no way affects the addition of this data on Form 1130 for the 1:35 and 7:35 a.m. and p.m., E. S. T. sequence observations.

720. FILING AND DISPOSITION OF FORMS 1135.- At stations manned by Weather Bureau commissioned personnel the forms will be filed in chronological order at the station making the observations. Forms 1135 from second-order stations manned by Weather Bureau observers or Civil Aeronautics Authority personnel will be mailed from the checking station to the General Supervising Station for permanent filing. In

the event the first-order station is discontinued, the forms will be forwarded to the General Supervising Station for permanent filing.

Paragraphs 717, 719, and 720 of Circular N are hereby amended to conform with the above. A revised page for Circular N containing these amemded paragraphs will be issued in the future.

FORM 1146

Effective with the forms for March 1940 these will be prepared for stations reporting 5000-foot pressure and for that pressure only, and under the supervision and instructions of the Weather Bureau Airport Station, Oakland, California..

Chapter VI, paragraphs 723 to 727 inclusive of Circular N are hereby cancelled.

D. M. Little,
Chief, Aerological Division.