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FEDERAL METEOROLOGICAL HANDBOOK No. 3

Radiosonde Observations

U.S. DEPARTMENT OF COMMERCE
U.S. DEPARTMENT OF DEFENSE

FEDERAL METEOROLOGICAL HANDBOOK No. 3

Radiosonde Observations

Supersedes Seventh Edition of WBAN
Circular P

Effective January 1, 1969

U.S. DEPARTMENT OF COMMERCE
U.S. DEPARTMENT OF DEFENSE
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RECORD OF CHANGES

Change no.	Date effective	Pages affected	Initials	Date entered

PREFACE

Parts A and B of this handbook have been prepared by personnel of the U. S. Weather Bureau in collaboration with representatives of the U. S. Air Force, U. S. Navy, Environmental Data Service and the Meteorological Service of Canada. Every effort has been made to standardize procedures where possible in order to provide compatible radiosonde observations. Where this is not possible, instructions pertaining to a particular service will be identified as follows: WB-Weather Bureau N-Navy, AF-Air Force. Part C of the handbook is prepared by the individual service and contains instructions which pertain only to that service.

Changes to the handbook and Part C will be issued as page changes except in the case of minor corrections which may be issued as pen and ink changes. It is essential that the handbook be kept up to date. When changes are received, the effective date, change number, pages affected, initials of the person making the change and date the change is entered will be recorded on the page entitled "Record of Changes."

History of Federal Meteorological Handbook #3

Instructions for Making Aerological Observations, WB 740, 1921.

Instructions for Making Aerological Observations, Circular P, First Edition, 1930.

Instructions for Making Aerological Observations by Means of Airplanes and Sounding Balloons, Circular P, Second Edition, 1938.

Instructions for Modulated Audio Frequency Radiosonde Observations, Circular P, Third Edition, 1941. Reprinted, June 1942. Fourth Edition, August 1943. Fifth Edition, January 1945.

Manual of Radiosonde Observations, Circular P, Sixth Edition, January 1950.

Manual of Radiosonde Observations, Circular P, Seventh Edition, June 1957.

INTRODUCTION

Radiosonde observations, or "RAOBS" as they are termed, are made to determine the pressure, temperature, and humidity from the surface to the point where the balloon bursts. The radiosonde consists of meteorological measuring elements coupled to a radio transmitter and assembled into a small lightweight box. The device is carried aloft by a balloon filled with hydrogen or helium gas. Included in the train is a small parachute to slow the descent of the instrument after the balloon bursts, thereby minimizing the danger of injury to life and property. As the balloon rises, measurements of pressure, temperature, and relative humidity are transmitted to a ground station where the data are recorded automatically. An observer then transcribes the information into a more commonly used form and plots it on various charts. Measurements of pressure are made in millibars, temperature in degrees Celsius, and moisture in percent of relative humidity. The Celsius temperature scale is the same as the centigrade scale and replaces that scale in all meteorological observations.

As the balloon rises, it is followed either visually by an observer at a theodolite, or electronically by radio-direction-finding equipment that tracks the transmitted signal. The balloon's drift away from the release point is plotted, and from this the direction and speed of the air movements are determined. The winds-aloft observation is termed a "RABAL" when the tracking is done visually, and a "RAWIN" when the tracking is done electronically. A combined rawin and raob is termed a "RAWINSONDE." Instructions for the rabal or rawin portion of the observation are contained in the Federal Meteorological Handbook #5 (Winds-Aloft Observations).

Raobs, rawins, and rawinsondes have many procedures in common. This handbook deals primarily with those procedures necessary in taking the raob. While effort was made in writing this handbook to list the procedures in the order that they would normally be performed, the various types of equipment in use will necessitate some variations in the actual sequence of operation. Cross reference is made throughout the handbook and an index is placed at the end to facilitate the finding of specific instructions. Tables and illustrations integral with the text are given a double number to indicate the chapter in which they appear, e.g., Table B2-1 indicates the first table in chapter two of Part B, and Figure B4-3 indicates the third illustration in chapter four of Part B.

When computations require the disposal of a decimal, the following procedure will be followed:

1. When the digit to be disposed is five or greater the preceding digit will be increased by one.

2. When the digit to be disposed is less than five the preceding digit will remain unchanged.

In disposing of digits the algebraic sign will be disregarded, e.g., +1.5 = 2, -1.5 = -2.

This is primarily a reference handbook. It is assumed that the user is familiar with the nomenclature and equipment pertaining to raobs.

PART A

CONTENTS

LIST OF ILLUSTRATIONS

CHAPTER A1

RAWINSONDE SYSTEMS

1. Rawinsonde System. The basic rawinsonde system consists of a balloon-borne radiosonde, a receiver and tracking unit, and a recorder. The most commonly used radiosonde transmits meteorological information consisting of pressure obtained from an aneroid cell, temperature, and relative humidity. The telemetered meteorological information from the radiosonde is detected, amplified, and shaped by a receiver and the processed information is printed in graphic form on a strip chart recorder. An antenna array, which is an integral part of the receiving equipment, is used to track the radiosonde. Tracking is accomplished either manually or automatically. The elevation and azimuth angle information so obtained, in conjunction with height information computed from the meteorological data, is used to compute winds aloft.

Figure A1 - 1. WBRT, Tracking Unit

2. Components Differing From the Basic Rawinsonde System. The following is a brief description of components differing from the basic rawinsonde system.

2.1 Hypsometer. The hypsometer-radiosonde is similar to that used in the basic system except that a more accurate pressure measurement device, a hypsometer, is included in the radiosonde. The hypsometer measures pressure at high altitude by employing the relationship between the temperature of the ebullient fluid and the atmospheric pressure. A small thermistor bead is used to measure the temperature of the ebullient fluid. Height data computations using the hypsometer are begun at some point of pressure less than 100 mb.

Figure A1 - 2. GMD-1( ), Tracking Unit

2.2 Transponder. The transponder-radiosonde is essentially the same as that used in the basic system except that a ranging capability is built into the radiosonde. The slant range between the transponder-radiosonde and the tracking unit is obtained by measuring the phase difference between the transmitted and received range signal generated in the ground-based transmitter. This signal is received and retransmitted by the radiosonde to the ground-based receiving equipment. The difference in phase between the transmitted and received range signal is a measure of slant range. The phase difference occurs because of the finite time required for the range signal to travel from the ground-based transmitter to the radiosonde and back again. A phase change of one complete cycle corresponds to a range change of 2000 meters. The cumulative phase shift is a measure of the total range change. Stations that use equipment with ranging capability compute winds using slant range and elevation angle or slant range and computed height to obtain distance from observation point. On some transponder-radiosondes, the conventional baroswitch commutator is replaced with a clock switch commutator.

2.3 Transponder-Hypsometer. This radiosonde combines the features of both the transponder and hypsometer type radiosondes.

2.4 Rabal. An optical theodolite is used to obtain the elevation and azimuth angles of the radiosonde for winds-aloft computations.

2.5 Automatic Wind and Height Systems. An analog-to-digital converter and a digital computer are added to the basic rawinsonde system. The meteorological data processor provides, on punched tape, azimuth and elevation tracking angles, slant range, temperature and humidity data, and elapsed time. Prelaunch calibration data, station identification, etc., may be entered manually.

2.6 Radar Wind. A target, suitably matched to the frequency of the radar in use, is attached to the train of the radiosonde balloon. The radar will provide the slant range to the target by measurement of the time interval between the transmitted and reflected radar pulse. The azimuth indicator of the radar set will indicate the azimuth angle of the target. Slant range is used in conjunction with height data, computed from the radiosondes' meteorological data, to compute distance from observation point.

2.7 Radiosonde System. A radiosonde system is basically the same as a rawinsonde system except that winds-aloft data are not provided.

3. Orientation of Ground Equipment. The Federal Meteorological Handbook No. 5 (Winds-Aloft Observations) provides instructions for orientation of the ground equipment.

4. Separate Instructions. Detailed instructions for reports, receiving and recording equipment, radiosondes, supplies, test equipment, evaluation equipment, special flights, checking of observations, mailing of forms etc., are contained in separate instructions issued by each service.

NOTE: Separate instructions, detailed instructions etc. mentioned in all chapters refer to instructions contained in Part C issued by the separate services.

CHAPTER A2

RADIOSONDE INSTRUMENTS

1. <u>Radiosonde Instruments</u>. The radiosonde is a balloon-borne, battery-powered instrument used together with the ground-receiving equipment to delineate the vertical profile of the atmosphere. Pressure is measured by means of a baroswitch which employs an expanding aneroid pressure cell to move a contact arm across a commutator bar as the pressure decreases. Temperature is measured by a thermistor; the electrical resistance of the thermistor being a function of temperature. Relative humidity is measured by a hygristor; the electrical resistance of the hygristor being a function of relative humidity and, to some extent, temperature. As the radiosonde ascends, the thermistor and hygristor are switched sequentially into the modulator circuit by the baroswitch. The frequency of the received signal, therefore, is alternately a function of temperature or humidity, and may be any value from 10 to 200 Hz. In addition, fixed resistors are connected periodically into the modulator circuit by the baroswitch so that the frequency transmitted, when these are connected, will show any change that may be occurring in the modulator characteristic due to variations of circuit parameters. Radiosondes

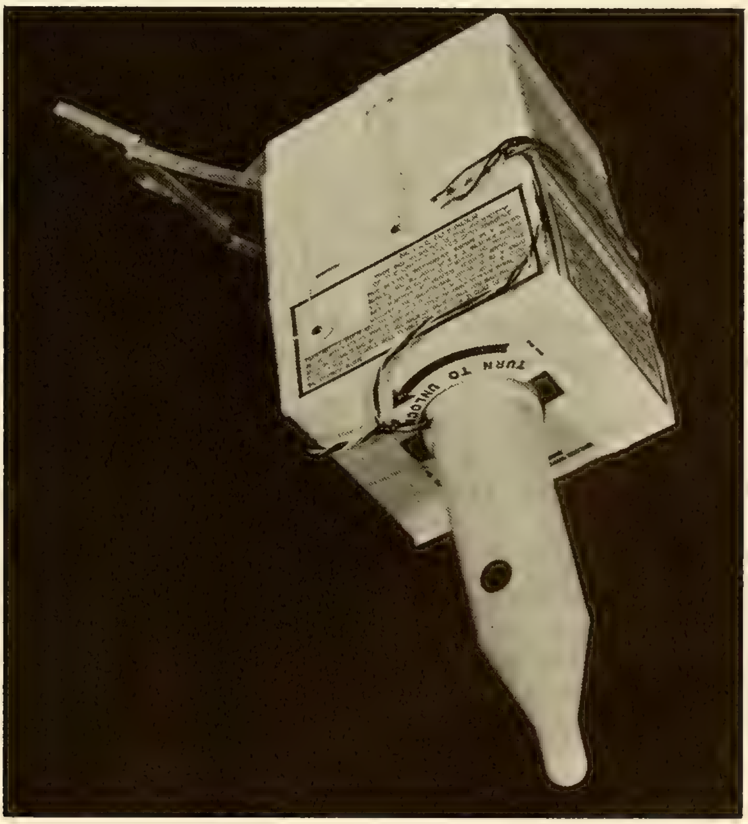


Figure A2 - 1. 1680 MHz Radiosonde

are provided with the thermistor mounted externally on an outrigger which exposes it at some distance from the radiosonde case. The hygristor is enclosed within an airduct to shield the element from direct exposure to precipitation. The radiosonde contains an aneroid baroswitch for measuring pressure, a white-coated thermistor for temperature, and a carbon hygristor for relative humidity. Radiosondes of this type will be considered the basic radiosonde and will usually be identified by a serial number containing no suffix.

1.1 Serial Numbers of Radiosondes Differing From the Basic Radiosonde. Serial numbers are used to identify radiosondes differing from the basic radiosonde. The following is a list of the suffixes used to identify these radiosondes.

a. Radiosondes for use with high-altitude balloons are equipped with hypsometers to provide more accurate measurements of pressure than that provided by the aneroid cell at very high altitudes. These radiosondes will usually be identified by the letter "H" appended as a suffix to the serial number.

b. Radiosondes for use with the transponder system are equipped with a receiver to intercept the ranging signal radiated from the transponder ground adjuncts. These radiosondes will usually be identified by the letter "R" appended as a suffix to the serial number.

c. Radiosondes equipped with both the hypsometer and the transponder capability will usually be identified by the letters "HR" appended as a suffix to the serial number.

d. (WB) Reconditioned radiosondes are identified similarly except an additional letter is placed ahead of the serial number.

2. Radiosonde Frequency. Radiosondes currently in use by U.S. Supported Upper-Air Stations and Ships operate on a nominal carrier frequency of 1680 or 403 MHz. These frequencies are used as follows:

a. The 1680 MHz radiosonde transmits a 100 percent amplitude modulated signal at a nominal frequency of 1680 MHz. The frequency modulated 403 MHz radiosonde transmits a signal at a nominal frequency of 403 MHz. The transmitted signals of these radiosondes provide meteorological data and serve as the direction-finding or tracking signal for the rawin receptor.

b. The pulse modulated 403 MHz radiosonde transmits a signal at a nominal frequency of 403 MHz. The transmitted signal provides meteorological data.

c. The transponder radiosonde is a receiver-transmitter type of instrument. The receiver operates on a frequency of 403 MHz, and the transmitter operates on a frequency of 1680 MHz. This instrument is designed to be used with rawinsonde systems equipped with ranging capability.

CHAPTER A3

RAWINSONDE BALLOONS

1. Rawinsonde Balloons. Rawinsonde balloons are spherically shaped films of natural or synthetic rubber (neoprene) which, when inflated with a lighter-than-air gas (hydrogen, natural gas, or helium), are used to transport radiosonde flight equipment into the upper atmosphere. The

Figure A3-1. Inflated Rawinsonde Balloon With Hydrogen Automatic Shut-Off Valve film thickness of these balloons is extremely thin, being from two-to four-thousandths (.002 - .004) of an inch thick when inflated for release and decreases to a thickness of one ten-thousandths (.0001) of an inch at bursting altitude. To state it more graphically, the film of the balloon at release is thinner than an ordinary piece of writing paper, and at bursting altitude, it would take 100 thicknesses of the film to equal the thickness of a punch-card. Additionally, the balloon expands in size from an approximate release diameter of 6 feet to an expanded diameter of 24-32 feet at bursting. It is not hard to see that the smallest cut, bruise, or scratch sustained during preflight preparation is almost sure to result in the balloon bursting at a lower altitude than it normally would have attained. The requirement for careful preflight handling of these balloons cannot be overemphasized.

CHAPTER A4

ADIABATIC CHART

1. Adiabatic Chart. The WBAN-31 is a combined form for computing, recording and graphing raob data. This form consists of three sections, the WBAN-31A or AA, B, and C. Data from the recorder record are entered in the forms under the heading "Data Block." After evaluation, they are transcribed to the adiabatic chart for additional computation. Data required for punched cards and transmission purposes are entered in the blocks printed to the right of the chart. Baseline-check readings and the surface-observation data are entered in the appropriate section provided on WBAN-31A and AA. Constant pressure level computations are entered on the back of WBAN-31A and AA, for levels below the surface of the station. NOTE: Instructions that refer to WBAN-31A are also applicable to WBAN-31AA. WBAN-31AA is used at stations where temperatures colder than -60°C may be encountered at pressures greater than 400 mb. The notation WBAN-31( ), means that instructions are applicable to all charts, i.e., WBAN-31A, AA, B, and C.

1.1 Use of the Adiabatic Chart. The adiabatic portions of WBAN-31( ) furnish a graphical means of computing many of the functions of pressure, temperature, and relative humidity. The horizontal lines represent pressure, and the vertical lines, temperature. Space is provided on the left side of WBAN-31A and B for plotting values of relative humidity. The sloping lines on the chart are dry adiabatic lines. Along the lower edge and below the temperature scale is an altitude scale expressed in kilometers above sea level. All altitudes are expressed in terms of the geopotential meter (gpm), which is approximately equal to the geometric meter. In this handbook it will be understood that meters are expressed in terms of the geopotential meter. Short vertical brown lines, or tabs, printed on WBAN-31A are used to obtain the virtual temperature increments for the strata in which they occur. Short vertical black tabs, printed on WBAN-31A, B, and C, are used to determine the thickness between adjacent standard isobaric surfaces. Since the thickness ticks are overprinted on the base chart, each chart must be checked for correct registration before the chart is used in an observation. Registration tabs are placed in each corner of the chart for this purpose. Altitude computations should not be made, using the thickness tick method, when the registration on the chart, at any corner, is in error by more than 0.3 of a printed division. If a chart is found in error by more than 0.3 of a printed division, Table 7 will be used to determine thickness between adjacent standard isobaric surfaces.

NOTE: Table 7 in ¶A4-1.1 refers to the Radiosonde Observation Computation Tables (WBAN), January 1966 edition. To determine which table a reference is referring to, note the digit after the word table. If a letter follows the word "table," it will be found in this Handbook, otherwise it will be found in the Radiosonde Observation Computation Tables (WBAN).

The following is a list of tables and titles of the Radiosonde Observation Computation Tables (WBAN).

PART B

CONTENTS

TABLES

ILLUSTRATIONS

ILLUSTRATIONS

CHAPTER B1. INSPECTING AND TESTING THE RADIOSONDE

CONTENTS

CHAPTER B1

INSPECTING AND TESTING THE RADIOSONDE

1. Visual Inspection of the Radiosonde. If possible, this inspection will be made upon receipt of the radiosonde; otherwise, it will be made at the time the radiosonde is tested for the observation. If the visual inspection of the radiosonde is made just before the observation, the oldest serviceable radiosonde on hand will be checked for the observation and the next oldest checked for the standby. Generally, the oldest radiosonde is the one having the lowest serial number. If radiosondes on hand are more than 36 months old, they should be set aside and their disposition will be determined by the appropriate headquarters. If all radiosondes on hand are over 36 months old, use those that show the least amount of corrosion, aging, etc., so that no special or scheduled flights will be missed. The visual inspection should be completed in the order specified below.

1. Calibration Chart (see ¶B1-1.1)
2. Temperature Section (see ¶B1-1.2)
3. Humidity Section (see ¶B1-1.3)
4. Baroswitch Section (see ¶B1-1.4)
5. Relay (see ¶B1-1.5)
6. Separate Transmitter Unit (see ¶B1-1.6)
7. Hypsometer Unit (see ¶B1-1.7)
8. (WB) Inspection Stamp (see ¶B1-1.8)

1.1 Calibration Charts. Check that the radiosonde serial numbers on the pressure calibration chart and radiosonde agree. Also check that the number on the baroswitch assembly agrees with the baroswitch serial number printed on the corresponding calibration chart. If the baroswitch serial numbers disagree, reject the radiosonde. If the baroswitch serial numbers agree but the radiosonde serial numbers do not, accept the radiosonde and change the radiosonde serial number on the calibration chart to agree with that on the radiosonde. If the radiosonde is a hypsometer type, check to see that the serial numbers on the hypsometer and its calibration chart agree. If they do not agree, reject the radiosonde, see also ¶B2-15.2. Check to ensure that the numbers on the strip charts to identify the pressure values pertaining to the 10 millibar markings are properly aligned. If the numbers and markings are improperly aligned to the extent that uncertainty exists about which value corresponds to a given set of markings, reject the radiosonde. Four types of pressure calibration charts are used. The following subsections describe these charts.

1.1.1 A long strip-chart containing two scales (see Fig. B1-1). The scale on the left shows the pressure in millibars and is marked in two-millibar increments. Each 10 mb increment is indicated by a wider mark. Numbers denoting 50 mb increments are printed to the left of every fifth ten-millibar mark. The scale on the right is the "contacts" scale. A calibration dash for the "make" of every metallic segment of the commutator is superimposed on the pressure scale. The contact number is printed every fifth contact. For evaluation purposes, the bottom edge of the dashed calibration line is used for reading the pressure value. For evaluation of partial contacts, linear interpolation is necessary between the bottom edges of the calibration dash preceding and succeeding the partial contact.

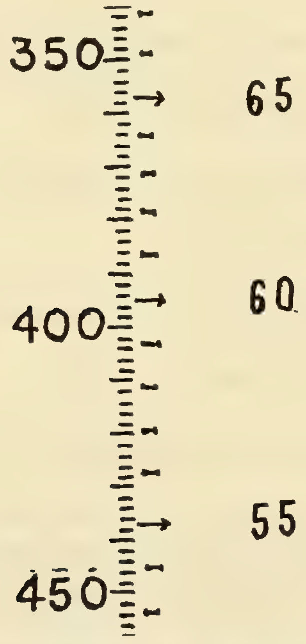


Figure B1-1. Strip-Type Calibration Chart (Two-Mb Increments)

1.1.2 A long strip-chart on which the calibration is automatically traced as a continuous inked line (see Fig. B1-2). The "make" and "break" of each commutator segment is indicated by a horizontal offset in the trace. The calibration contacts appear as a series of segments described by successive "makes" and "breaks." Superimposed on the contacts are horizontal offsets to the left, indicating increments of pressure of one millibar. The pressure scale is numbered at 10 mb increments, and the contact scale is numbered at 5-contact increments. For evaluation of partial contacts, linear interpolation is necessary between the "make" of the contact preceding and following the partial contact.

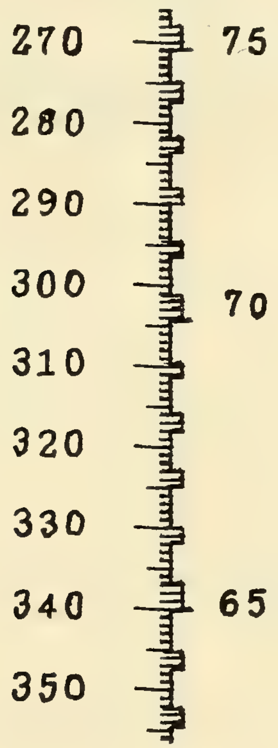


Figure B1-2. Strip-Type Calibration Chart (Continuous Inked Line)

1.1.3 The digital calibration chart is printed with the commutator contact number on the left side of the chart and the corresponding pressure value, to the nearest millibar, on the right side of the chart (see Fig. B1-3). To determine the pressure at a given contact value, use the following procedure:

a. If the contact value falls on a whole contact (5.0, 10.0, 13.0, etc.), use the pressure value corresponding to that contact.

b. If the contact value falls between two whole contacts (5.2, 10.1, 13.7, etc.), use the method of linear interpolation.

(1) Subtract the value of pressure corresponding to the higher contact from the corresponding pressure at the lower contact.

(2) Multiply the result obtained in step (1) by the tenths value of the pressure contact.

(3) Subtract the product obtained in step (2) from the pressure value at the lower contact. The result is the pressure at the desired contact.

0	6	1	-	0	4	2	6	.
0	6	0	+	0	4	3	5	.
0	5	9	-	0	4	4	3	.
0	5	8	-	0	4	5	1	.
0	5	7	-	0	4	5	8	.
0	5	6	-	0	4	6	6	.
0	5	5	-	0	4	7	5	.
0	5	4	-	0	4	8	4	.
0	5	3	-	0	4	9	2	.
0	5	2	-	0	5	0	0	.
0	5	1	-	0	5	0	8	.
0	5	0	-	0	5	1	8	.
0	4	9	-	0	5	2	7	.
0	4	8	-	0	5	3	5	.
0	4	7	-	0	5	4	4	.
0	4	6	-	0	5	5	3	.
0	4	5	+	0	5	6	3	.
0	4	4	-	0	5	7	3	.

Figure B1-3. Portion of Digital Calibration Chart

Example:

Pressure Contact 6.0 = 992 millibars
Pressure Contact 7.0 = 980 millibars
Find Pressure at Contact 6.2

(1) 992 - pressure at 6.0 (lower contact)
980 - pressure at 7.0 (higher contact)
12 - difference

(2) x .2 - tenths value of pressure contact
2.4 - product

(3) 992.0 - pressure at lower contact
-2.4 - product obtained in 2.

989.6 - result = 990 mb pressure at 6.2 contacts when pressure is rounded off to nearest whole millibar.

To determine the pressure contact value from the pressure value, use the following procedure:

a. If pressure value falls on a whole contact (5.0, 10.0, 12.0), use contact value corresponding to that pressure.

b. If pressure value falls between two whole pressure contacts:

(1) Determine the pressure difference between the two whole pressure contacts that bracket the desired pressure.

(2) Subtract pressure value for which contact value is desired from pressure value at next lower whole contact (higher pressure).

(3) Divide value obtained in (2) by value obtained in (1). Result is tenths value desired. Add this value to lower pressure contact.

Example:

Pressure value for which contact value is desired = 988 mbs (rounded off to nearest whole millibar).

(1) 992 - pressure at 6.0 (lower contact)
980 - pressure at 7.0 (higher contact)
12 - difference

(2) 992 - pressure value at 6.0 (lower contact)
988 - pressure value for which contact value is desired
4 - difference

(3) $\frac{4}{12} = 0.333 = 0.3$

Desired contact = 6.3

The dash between the whole contact and the corresponding pressure (see Fig. B1-3) is replaced by a plus at each high reference contact (30, 45, 60, etc.). If this plus is missing or is placed at some other contact, reject the radiosonde. The pressure value 0003, 0002, or 0001 will be printed at the top of the pressure scale without a corresponding contact. If this last number has a contact printed to its left or should some other number appear at the top of the pressure scale without a corresponding contact, reject the radiosonde.

1.1.4 Hypsometer radiosondes contain two calibration charts. In addition to the calibration chart provided with the baroswitch, a hypsometer calibration chart is also provided. The hypsometer calibration chart displays a curve showing the relationship between the temperature of the saturated vapor, expressed in ordinate value, and the ambient pressure. If this curve is missing, reject the radiosonde.

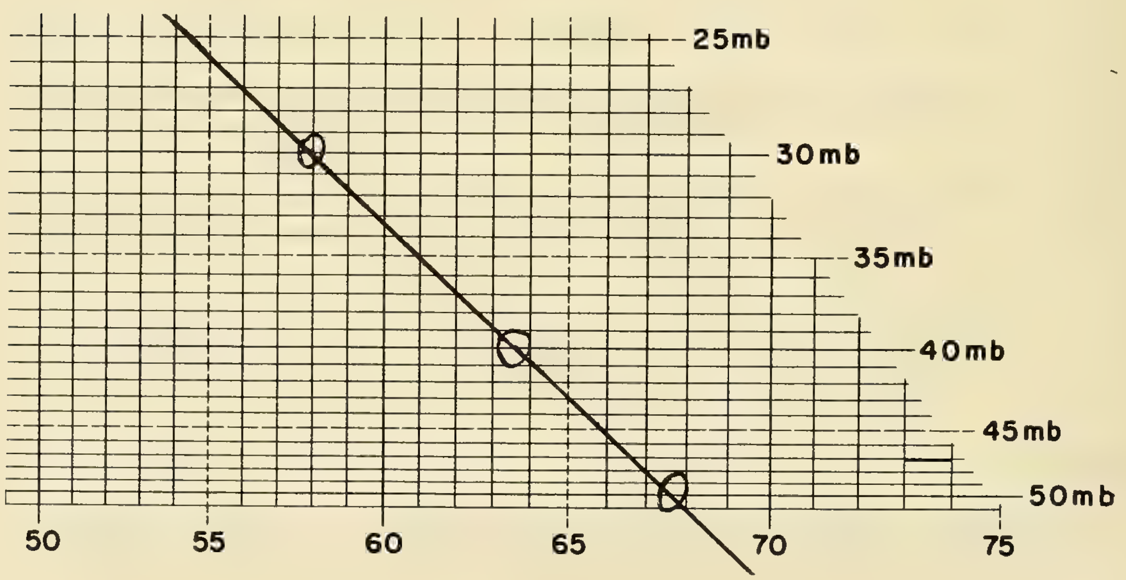


Figure B1-4. Portion of Hypsometer Calibration Chart

1.2 Temperature Section. Examine the temperature section of the radiosonde to make certain that:

a. The outrigger is not broken or pulled loose from the box and that the wiring is not broken or placed under undue strain. Reject any radiosonde with a broken or loose outrigger or with any broken wires.

b. The thermistor is not broken, that the leads are securely soldered to the terminals of the carrier frame (if the thermistor is already installed) and that the white coating is not chipped, cracked, or soiled (see ¶B2-2.5 and 2.5.1).

1.3 Humidity Section. Check the humidity section to make certain that:

a. The hygristor clips are bent inward so that they will not become loose and allow the hygristor to fall out or produce an intermittent connection in the circuit.

b. There are no broken, loose, or disconnected leads.

c. There is no oxidation at the points where the clamps contact the edges of the hygristor. The silver plated humidity clips may become discolored because of the action of sulfides in the air. Radiosondes with humidity clips so discolored will not be discarded.

1.4 Baroswitch Section. Check the baroswitch section as follows:

a. Check visually to make certain that the baroswitch is securely fixed to the radiosonde case, that the contact arm is not bent, and that the linkage is not disengaged. The tip of the pen arm of a reconditioned radiosonde is often intentionally bent during reconditioning so the contact point will travel over a new and unworn path. This is done before calibration and is no reason for a rejection.

b. Lower the contact arm and check that the contact point makes physical contact with the surface of the commutator.

c. Check that the contact point is within one contact of the pressure-contact setting (see ¶B2-15.5) corresponding to the station pressure corrected to the altitude of the radiosonde. If the contact point is more than three contacts to the right or left of the proper setting, reject the radiosonde. If the contact point is from one to three contacts to the right or left of the proper setting, adjust the point to the proper setting and recheck it after about one week. If at the end of this time the contact point is within one contact of the proper setting, accept the radiosonde or modulator; otherwise, reject it. The correct method of contact setting is explained in ¶B2-15.5.

d. With the contact point set in accordance with (c) above, turn the detent knob clockwise and counter-clockwise about one revolution and determine that there is relative motion between the contact point and commutator.

e. With the contact arm lifting lever in its lower position, check visually (by sighting along the lifting bar) to make sure that the pen arm will not touch the pen arm's lifting bar at any point along the commutator (do not move the arm manually). Invert the instrument and check that the contact point remains in contact with the commutator arm. Lift the contact arm after this inspection is completed. If the baroswitch fails to meet the above requirements, reject the radiosonde.

1.5 Relay. The radiosonde relay, mounted on the transmitter chasis or near the baroswitch, is protected from foreign particles by a plastic cover. The relay will not be cleaned, adjusted, or uncovered for any reason. If the radiosonde is received with the plastic cover off the relay, replace the cover carefully, and if the radiosonde passes all other checks, accept it for use. Radiosondes with relay defects will be rejected (see ¶B1-2.11).

1.6 Separate Transmitter Unit. Check for cracks or breaks in the case. If any damage is observed that would interfere with normal operation, reject the unit as defective. Reject transmitters that have broken plugs or cable leads, and those that cannot be securely attached to the radiosonde.

1.7 Radiosondes with Hypsometer Units. If the bead thermistor is visible or if there are broken leads or other visible damage, reject the radiosoned.

1.8 (WB) Inspection Stamp. Radiosondes received from the manufacturer must have a government inspection stamp; if no stamp is found, reject the radiosonde. The stamp may usually be located on the battery compartment door, in the transmitter holder or near the battery clamps. Reconditioned radiosondes need not have a government inspection stamp.

2. Testing the Radiosonde. If possible, the tests will be made upon receipt of the radiosonde; otherwise, they will be made at the time the radiosonde is being checked for the flight.

2.1 Power Supply. The testing of the radiosonde must be done with a power supply source other than the flight battery even if this testing is done just before taking the baseline-check. If a power supply source other than a flight battery is not available, a flight battery will be used to make the tests on as many radiosondes as possible before the battery voltage drops below minimum requirements (see Table B2-1).

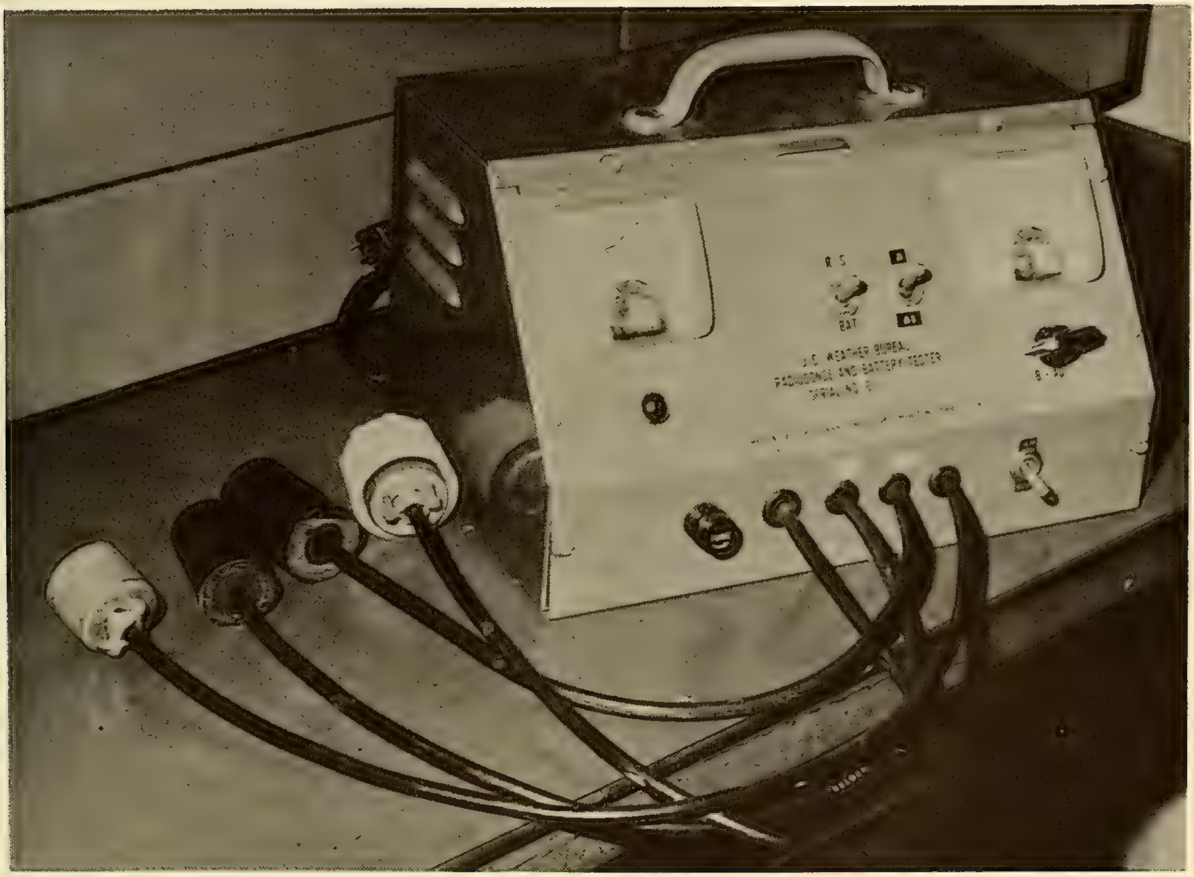


Figure B1-5. WB Radiosonde and Battery Tester

2.2 Preparation. Before testing the radiosonde, turn on the rawin set and the radiosonde recorder. After the appropriate warm-up, inspect all units of the receiving and recording equipment to make certain they are operating properly. Install the radiosonde antenna, if necessary, in accordance with instructions for the type of radiosonde in use. Use the Radiosonde and Battery Tester, test batteries, or baseline check set internal power supply to power the radiosonde. Turn on the radiosonde by connecting the black leads or by turning the "on-off" switch to "on" and make the following tests.

1. Radio-Frequency (see ¶B1-2.3)

2. Radiosonde Signal (see ¶B1-2.4)

3. Low Reference (see ¶B1-2.5)

4. Stability Check (see ¶B1-2.6)

5. High Reference (see ¶B1-2.7)

6. Temperature (see ¶B1-2.8)

7. Hypsometer (see ¶B1-2.9)

8. Humidity (see ¶B1-2.10)

9. Relay Defects (see ¶B1-2.11)

2.3 Radio-Frequency (r-f). Check and adjust the r-f of the 1680 MHz radiosonde to within ±2 MHz of 1680 MHz. Check and adjust the frequency of the 403 MHz radiosonde to within ±1 MHz (N, ±2 MHz) of 402.5 MHz. In order to preclude the possibility of erroneous bearings, and fading or unstable signals, the frequency of the radiosonde used for a second release should also be adjusted to the frequency specified whenever the wind speed and direction are such that interference will not result from the first radiosonde released. During a period of light or uniform winds, when there is a strong likelihood that the second radiosonde will be in a direct line with the first, thereby causing serious interference, the r-f of the second instrument should be adjusted to either 401.5 MHz, or 1675 MHz.

2.4 Radiosonde Signal. Tune in the radiosonde signal in accordance with instructions for the receiver used. Check to determine that the contact point is raised from the commutator. If a signal is not received, check that the receiver is operating and that all tuning controls and switches are properly adjusted. If the trouble is not found, test by connecting the red or blue test lead to the black test lead. If a signal is not now received, reject the radiosonde. If several successive radiosondes are rejected under these circumstances, suspect trouble with the ground equipment. If a radiosonde with a separate transmitter is used and a r-f signal is received but not an audio signal, replace the radiosonde transmitter and retest.

2.5 Low Reference. With the INPUT or SIGNAL SELECTOR switch in the 60 Hz position (if ground equipment has no 60 Hz position, use the 120

Hz position and value) adjust the ground equipment to the appropriate 60 Hz value. After the adjustment has been made, turn the INPUT or SIGNAL SELECTOR switch to X or SIGNAL and connect the blue to the black test lead. After the recorder corrections have been applied, the signal should be received at or above 89.0 ordinates but below 100.0 ordinates. If the radiosonde does not meet this requirement, check the test battery voltage or baseline check set internal power supply. If the voltage is at or below the lower limit, (see Table B2-1) set the radiosonde aside and repeat the test with the flight battery. If, with the flight battery, the radiosonde does not meet this requirement, reject the radiosonde. If the radiosonde is satisfactory, adjust the low reference to 95.0. At any station where the power line frequency is suspected of differing from 60 Hz, and power line frequency measuring equipment is available, e.g., reed-type power frequency meter, determine the power line frequency to the nearest one-half Hz. With the INPUT or SIGNAL SELECTOR switch in the 60 Hz position, adjust the ground equipment to the appropriate power line frequency. This will be the indicated power line frequency divided by 2.

2.6 Stability Check. While the low reference signal is being received, tap the radiosonde lightly. If a permanent shift of more than 0.2 ordinate in the low reference occurs, reject the radiosonde.

2.7 High Reference. On radiosondes equipped with high reference test leads, the red and black leads are shorted together to transmit a high reference signal. With the low reference adjusted to 95.0, the high reference signal should be received at 96.0 ordinates or above. If it is received below 96.0 ordinates, reject the radiosonde. There are, however, some radiosondes where the high reference signal is received at 93.0 ordinates; with this type of radiosonde, if the high reference signal has the same ordinate value as the low reference signal, reject the radiosonde. The primary purpose of the high reference is to facilitate rapid identification of contacts.

2.8 Temperature. If the thermistor is not already installed, install it in accordance with ¶B2-2.5 and 2.5.1. (If instructions for the radiosonde in use call for installation of the thermistor just prior to the baseline-check, the temperature check will not be done at this time; it will be done prior to the baseline-check.) The temperature circuit will be checked after the low reference has been adjusted to record at 95.0 ordinates. After all leads have been disconnected and the pen arm is raised from the commutator bar, the radiosonde should transmit a temperature signal. Using the temperature evaluator appropriate for the radiosonde and thermistor being tested, set the ordinate corresponding to the temperature signal opposite the temperature of the air at the radiosonde. The 25.0°C line on the evaluator should fall within the limits specified for the evaluator (see ¶B2-9.1). If it does not fall within the specified limits or if the thermistor is broken, set the radiosonde aside and replace the thermistor with another of the same type at some convenient time. If the replacement thermistor also indicates a value outside the limits, reject the radiosonde.

2.9 Hypsometer. If the radiosonde is equipped with a hypsometer make the following test. No liquid is needed in the hypsometer for this test. After adjusting the recorder to receive the low reference signal at 95.0 ordinates, join the black and green test leads to connect the hysometer thermistor to the transmitter. If a value greater than 94.8 or less than 90.0 is received reject the radiosonde. (AF, N) Radiosondes rejected because of defective hypsometers may be used for soundings for which high altitude data are not required.

2.10 Humidity. The humidity circuit will be checked without a humidity element installed. After adjusting the recorder to receive the low reference at 95.0 ordinates, connect the yellow and black test leads. A signal of less than 5.0 but more than 2.5 ordinates should be received, after recorder corrections (if any) have been applied. If a recorder signal outside these limits is received, reject the radiosonde. Short the humidity clamps and again connect the yellow and black test leads. A low reference signal (within $\pm$1.0 ordinates of 95.0 ordinates) should now be received; otherwise, reject the radiosonde.

2.11 Relay Defects. Proper power supply voltage is necessary for satisfactory relay operation. Before rejecting a radiosonde for defective relay, the power supply voltage should be rechecked to make sure that the minimum voltage requirements are met (see Table B2-1). A defective relay, or one out of adjustment, may be indicated as shown below, when a hygristor is not in the mounting clamps and the clamps are not short-circuited. Do not attempt to adjust the relay, instead reject the radiosonde.

a. Temperature ordinate is received for both temperature and humidity.

b. Less than 5.0 ordinates is received for both temperature and humidity.

c. Audible signal is not received for temperature or humidity, or both.

Touch the black and yellow wires at least ten times to determine that the relay is switching properly.

2.12 Completion of Tests. After completing the foregoing tests, disconnect the radiosonde from the power source. Disconnect the radiosonde's black battery leads if provided or turn the "on-off" switch to off.

CHAPTER B2 . PREPARATIONS FOR SOUNDING

CONTENTS

CHAPTER B2

PREPARATIONS FOR SOUNDING

1. General. Before beginning preparations for a raob, the observer will familiarize himself with the wind and weather conditions and the expected air traffic. He will consider the length of exposure time and warm-up time required for the various pieces of equipment, and he will determine the order in which the preliminary operations are to be performed. The order must be adapted to the arrangements and needs of the station and of the particular observation. Several of the operations can be carried on at the same time, and all must be started sufficiently early so that the release can be made on schedule. Check the recorder paper, data printer paper, and the ink supply to determine if there is enough to meet the needs of the current observation.

2. Preparation of Radiosonde for Baseline-Check. After the radiosonde has been inspected and accepted for use in accordance with the instructions in Chapter B1, it will be prepared for the baseline-check in accordance with the following instructions and those issued separately for the specific series of radiosondes. NOTE: If the radio-frequency check, specified in ¶B1-2.3, was made more than four days before the sounding, the radio-frequency check will be done again before the baseline-check.

2.1 Activation of Battery. Each can of batteries contains a copy of activation instructions. These instructions must be strictly adhered to so that the life of the activated battery will not be shortened nor damage be done to the battery. While wetting the battery, care should be taken to keep the battery socket away from the water.

2.2 Battery Voltage Check. It is of utmost importance that the battery voltage be checked and that it be up to minimum voltage before the baseline-check or prior to inserting into the radiosonde, if a baseline check set with internal power supply is used for the baseline-check.

2.2.1 Battery Under Load. After wetting, the battery must be placed under load for about five minutes in order for the battery voltage to build up. The battery may be placed under load by connecting it to the radiosonde or to the battery test set. Since the batteries from the various manufacturers differ in the speed with which their voltages build-up, a table should be kept to establish the minimum time needed for each type of battery to build up minimum voltage. Use the battery test set provided to check the battery voltage. Reject batteries that do not build up to minimum voltages in the established period of time. If a battery starts to

Table B2-1. Minimum Voltage Requirements

Radiosonde Type	A	A_1	B	C
WB, 1680 MHz conventional	5.5		90	
WB, 1680 MHz transponder	5.4	1.1	95	
WB, 1680 MHz hypsometer	5.5		90	
WB, 1680 MHz transponder-hypsometer	5.4	1.1	95	
WB, 403 MHz conventional	5.5		90	
WB, 403 MHz pulsed	5.5		90	3.0
AF, AN/AMT - 12A	5.5		90	
AF, 1680 MHz transponder	5.4	1.1	95	
AF, AN/AMQ - 9	5.5	1.1	95	
N, 1680 MHz	5.5	1.1	90	
N, 403 MHz	5.5		90	
N, 1680 MHz transponder	5.5	1.3	120	

smoke, steam or heats excessively, there is a short between the sections and it should be rejected.

2.3 Installation of Antenna or Transmitter. Install the antenna or transmitter in accordance with instructions issued for the type and series of radiosonde in use. The transmitting antenna or transmitter should be installed in the radiosonde before connecting the battery to avoid damaging the transmitter circuit. This does not apply to the wire flight antenna for transponder radiosondes, which is installed after the baseline-check and prior to making the pre-release range setting.

2.4 Installation of Battery. Install the battery in the radiosonde in accordance with instructions issued for the type and series of radiosonde in use. Extreme care should be taken when inserting the battery plug into the battery socket. The instrument may be damaged if a low voltage prong is accidentally pushed part way in a high voltage socket. If a filament switch is provided, it should be in the "off" position before the battery plug is inserted into the socket; if a twisted wire type filament switch is provided, these black wires should be separated. The radiosonde should be kept in an upright position once the battery is installed.

2.4.1 Battery Time. If the battery is used for the baseline-check, the filament circuit should normally be left closed after the radiosonde is placed in the baseline-check box. The exposure time in the baseline-check box should be kept to a minimum. The workload should be so arranged that the release can be made within a few minutes after the completion of the baseline-check. This will reduce the battery drain to a minimum. The drain on the battery from the time it is connected after activation until the time of release should not exceed 25 minutes. If this limit is expected to be exceeded, the battery should be disconnected. If a filament switch is provided, open the filament switch. The battery may be left disconnected for up to 15 minutes. If the battery has been disconnected more than 15 minutes, it will be checked to see if it still meets the minimum voltage requirements. When the battery is reconnected, allow a minimum of two minutes for the battery voltage to stabilize. On radiosondes equipped with twisted lead type of filament switch be sure that the leads are very tightly twisted.

2.5 Thermistor. (WB, AF). Normally the thermistor is factory installed. If not already installed or if a replacement is needed for any reason, the thermistor leads will be soldered to the leads on the outrigger of the radiosonde prior to the baseline-check. The thermistor should always be handled by its leads to avoid touching the white coating. A heat sink shall be placed on the thermistor leads when soldering to avoid damaging the temperature element. An alligator clip, attached to the lead between the thermistor and the end to be soldered, provides an acceptable heat sink. Use only thermistors which have clean, unbroken white coatings. Thermistors with chipped or soiled coatings should be replaced at some convenient time before the radiosonde is to be used.

2.5.1 Thermistor. (N). The thermistor will be installed in accordance with instructions for the type of radiosonde in use.

2.6 Installation of Hygristor. The hygristor element is packed in a closed air-tight container for shipment. If a humidity indicator is also enclosed with the hygristor, it will be inspected upon opening the container. The indicator should show blue; if it shows white or pinkish-white, reject the hygristor. The container should not be opened until just before preparation of the radiosonde for the baseline-check. Once the container is opened, the hygristor should be handled by its metal edges with considerable care to insure that contact is avoided between the film and the skin of the handler or with other foreign substances. If contact with the film should occur, reject the hygristor. Insert the hygristor between the clips. Place the edge of the hygristor in the groove of the back clip and turn the hygristor until the other edge snaps in place on the opposite clip. Move the hygristor back and forth lengthwise several times through a short distance to insure a good electrical contact and to test the clamp for sufficient tension. If the clamp does not hold the hygristor firmly in place, remove the hygristor and bend the two clips together slightly. Insert the hygristor and again test for sufficient tension. The hygristor should be centered in the space provided and should not touch the sides of the radiosonde case.

(WB) The hygristors are identified by a letter, or combination of letters, which is placed on the container in which the element is shipped. Enter this identification near the serial number on the calibration chart of the radiosonde in which the hygristor is to be used.

2.7 Installing Hypsometer. If a hypsometer radiosonde is to be used and the hypsometer is not an integral part of the radiosonde, install it by placing it under the elastic strap provided on the side of the instrument.

2.8 Return Bag. (WB) Whenever a station in the United States uses a parachute in the radiosonde train, a cloth mailing bag with shipping tag attached should be packed in the battery compartment. Enter the radiosonde serial number, name of station, date, and scheduled time of release (GMT) on the front of each tag. Make all entries with typewriter or permanent ink. Stations located outside the U.S. should not include a mailing bag or shipping label, regardless of whether or not a parachute is included in the train.

2.9 Securing the Battery Compartment. Secure the battery compartment with the strings or clamps provided after the return bag, if needed, and the battery along with the battery plug have been inserted into the battery compartment.

3. Pre Baseline-Check Tests. All pre-release checks will be made without applying manual pressure to the recorder pen. When a zero recording is to be obtained, the pen must go to zero without manual pressure and when the sensitivity and baseline-checks are being recorded the pen must not be forced, either upscale or downscale. If the recorder has been adjusted to the proper zero value, but does not return to this point from upscale, or when the pen is slow returning to proper recordings during the sensitivity or baseline-checks, the electronics technician

should be notified. During the zero and sensitivity check recordings, the recorder record must feed out normally and must not be fed out manually.

3.1 Zero Recordings. One-half inch zero recordings will be made before and after the sensitivity check. Zero recording of at least one-eighth of an inch in length will follow the low reference and baseline-checks. If a hypsometer radiosonde is used, the hypsometer check will be followed by a zero recording of at least one-eighth of an inch. These zero recordings will be made with the recorder record feeding out normally. If more paper is needed, it may be fed out manually.

3.2 Sensitivity Check. The recorder sensitivity check will be taken before the baseline-check and will be submitted as part of the recorder record pertaining to each radiosonde observation. Instruction for taking a satisfactory sensitivity check will be found in the ground equipment section of the instructions issued by the separate services.

3.3 Low Reference Check. After the sensitivity check has been completed, the recorder will have been adjusted to the correct 60 or 120 Hz value. After the appropriate amount of zero recording, connect the blue and black test leads. Turn the INPUT or SIGNAL SELECTOR recorder switch to the X or SIGNAL position. Record about 10 seconds of the unadjusted low reference signal. If the low reference signal, after recorder corrections have been applied, is received at or above 89.0 ordinates but below 100.0 ordinates, the radiosonde is acceptable. In this case adjust the low reference to record at 95.0 ordinates after the 10 seconds of the unadjusted trace have been obtained. If the signal is received outside these limits, recheck the battery voltage; if the battery voltage is within limits (see Table B2-1), reject the radiosonde. The low reference check will be submitted as part of the recorder record pertaining to each radiosonde observation.

3.4 Hypsometer Check. If a hypsometer radiosonde is used, a hypsometer check (see ¶B1-2.9) will be taken prior to the baseline-check (after the low reference check) and submitted as part of the recorder record pertaining to each radiosonde observation. If the radiosonde is equipped with a hypsometer (green) test lead, the bare portion will be cut off before the baseline-check (see ¶B2-14.1). An invalid baseline will result if this lead should accidentally be used instead of the low reference lead.

4. Radiosonde Baseline-Check Boxes. The baseline-check box provides a method of securing stable temperature and relative humidity conditions during the baseline-check. The box contains a radiosonde test switch, ventilation fan, psychrometer, humidity control tray and in some models an internal radiosonde instrument power supply.

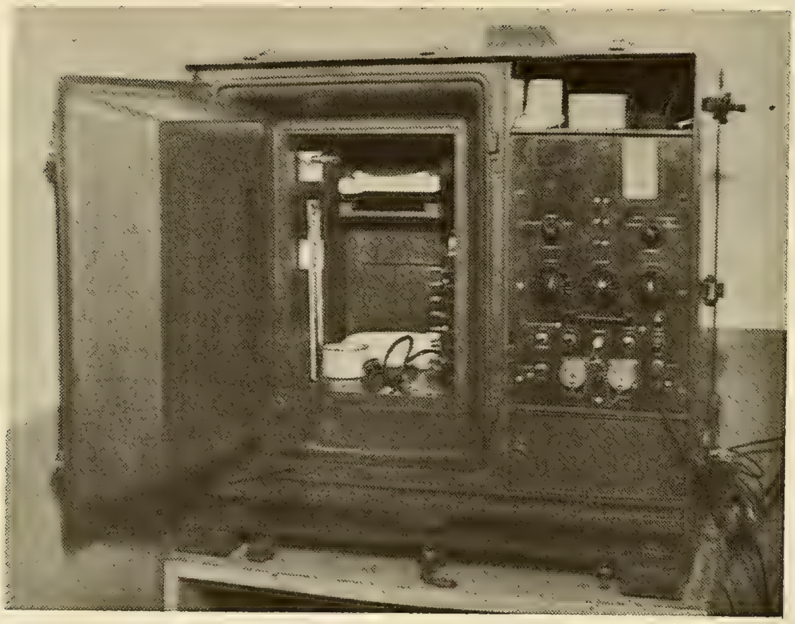


Figure B2-1. AF Baseline-Check Box With Internal Power Supply

4.1 Preparations for Baseline-Check. Make certain the contact arm is off the commutator of the radiosonde. Open the box and position the radiosonde on the supports provided in the check box. Be certain that the airflow over the temperature and humidity elements is unrestricted. Connect, in correct order, the radiosonde test leads to the leads from the test switch. Turn on the radiosonde and close the door.

5. The Baseline-Check. The baseline-check is required to establish a relationship between radiosonde transmitted values of temperature and humidity (recorded in terms of ordinate values by the radiosonde recorder) and observed values of temperature and humidity (read from the psychrometer upon completion of the baseline-check). This temperature-humidity ordinate relationship is necessary to convert the ordinate values of temperature and humidity, recorded during the sounding, to temperature in degrees Celsius and relative humidity in percent. The importance of obtaining accurate values in the baseline-check cannot be over-emphasized.

5.1 Adjustment of Equipment. The following adjustments will be made to the equipment before making the baseline-check. The radiosonde should be conditioned in the closed box before starting the baseline-check recordings. The amount of time required to produce stable temperature and humidity conditions will depend upon the climatic conditions occurring at the station. The blower should be operated only long enough to produce stable temperature and humidity conditions. If the

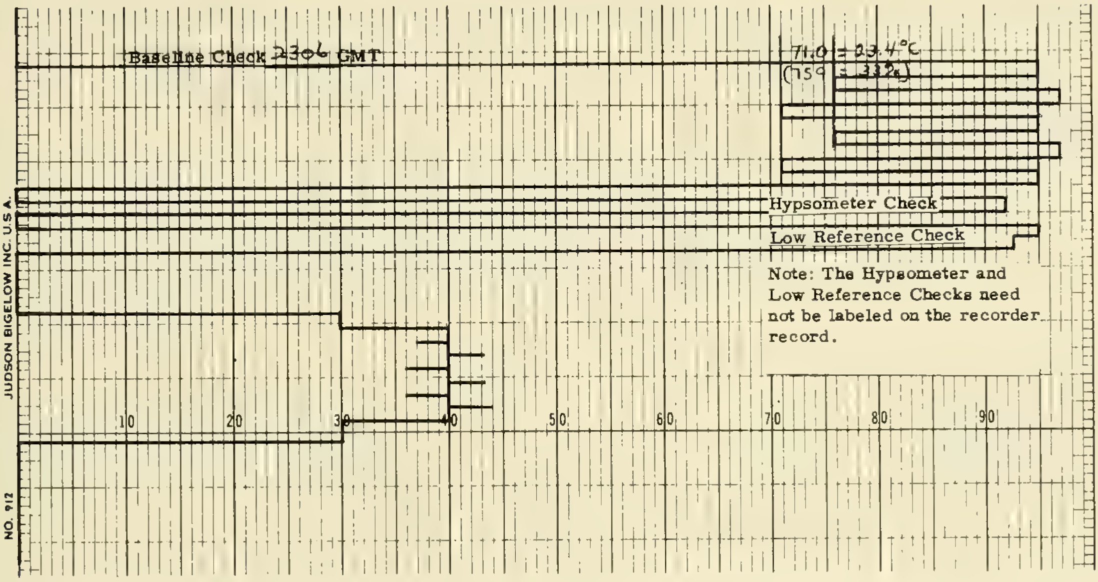


Figure B2-2. Baseline-Check (four lead) With Hypsometer Check

switching motor is on a separate switch, it will be turned on when the blower motor is turned on. The baseline-check should be completed as soon as possible after the battery voltages have reached their minimum values. When the temperature and humidity stabilize, tune the recorder-receiver to receive the radiosonde signal and adjust the controls for maximum signal strength and stability.

5.2 Relative Humidity in the Baseline-Check Box. The relative humidity in the baseline-check box should fall within the range of 30 to 40 percent when the carbon hygristor is used in the radiosonde. Should these limits be exceeded, the baseline-check humidity will be valid and used in the evaluation of that flight; however, as soon as the flight has been completed, the silica jel, magnesium chloride or the calcium chloride solution in the baseline-check box will be changed or renewed to bring the relative humidity in the box back within the 30 to 40 percent range. Silica jel is used as a drying agent to reduce the moisture in the box. The magnesium chloride solution absorbs moisture from the box when relative humidity is above 33 percent and evaporates moisture into the box when relative humidity is below 33 percent. When the calcium chloride solution is used as a humidity control solution, the addition of more calcium chloride lowers the relative humidity and the addition of water raises the relative humidity. The door of the box should remain closed except when inserting or removing the radiosonde, or when the humidity control agent is being changed.

(WB, N) Do not change the humidity controlling agent just before the baseline-check as several hours are required for conditions within the box to stabilize.

(AF) Change the solution just prior to placing the radiosonde into the baseline-check set.

5.3 The Baseline-Check Recorder Traces. The radiosonde is automatically or manually switched through the cycles of reference, temperature, and relative humidity. When the baseline-check cycle includes both the high and low reference, the order of switching is as follows: low reference, temperature, high reference and relative humidity. When the temperature and relative humidity traces are recording near the same ordinate value, the observer must remember that the temperature trace follows the low reference trace. An invalid flight would result if the ordinate readings were interchanged. When the baseline-check cycle has no high reference, the order of switching is as follows: low reference, temperature, low reference, relative humidity. When the temperature and relative humidity traces are recording near the same ordinate value, the observer must be careful not to interchange the ordinate readings. When the traces cannot be definitely identified the following method must be used:

a. take a valid baseline-check as defined in the following paragraphs, mark the level where a valid baseline-check was completed

b. continue to record the switching of the radiosonde

c. take the psychrometric reading

d. open the door of the baseline-check box

e. while the recorder is still recording the switching, change the relative humidity by blowing near the hygristor; an indication of rising relative humidity will now be recorded. In this way the relative humidity trace will definitely be identified

f. count back to the level where a valid baseline-check was completed and identify the relative humidity and temperature traces.

Since the traces could not be identified originally the criteria in ¶B2-5.3.4 need not be complied with. A note will be placed on the recorder record, above the baseline-check, stating that the continued switching was necessary to identify the recorder traces.

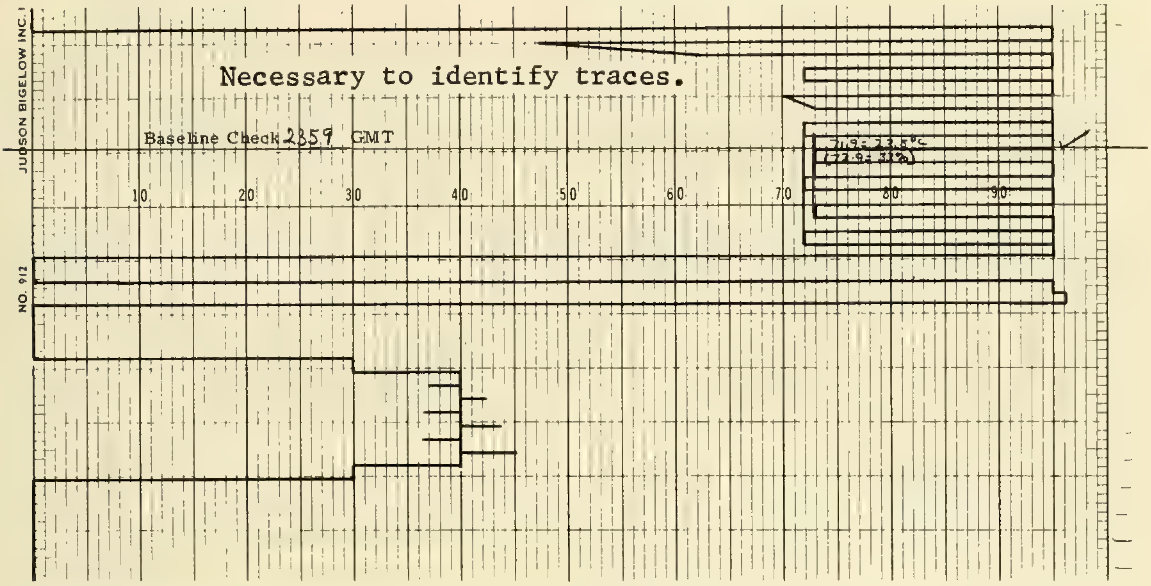


Figure B2-3. Baseline-Check (three lead) Showing Temperature and Relative Humidity Recording Near the Same Ordinate Value

While the first low reference signal is being received, adjust the controls so that the trace is recorded at 95.0. Check the value of each successive low reference trace and adjust to 95.0 whenever necessary. The recording of reference, temperature, and humidity signals are continued until the requirements listed below are satisfied in the same series of consecutive traces.

5.3.1 Low Reference. The upper left edge of all consecutive low reference traces in the baseline-check must be recorded at 95.0 without adjustment of the controls. When an adjustment is required, a new series of baseline cycles will be started.

5.3.2 Relative Humidity. The relative humidity traces must satisfy one of the following conditions:

a. Two consecutive traces must be so aligned that a line connecting the left top edge of both is parallel with the ordinate lines of the recorder paper.

b. Three consecutive traces must show a trend in the same direction, either rising or falling. The left top edges of the three traces must fall on a straight line and cover no more than 0.3 of an ordinate. Verify the indication that the humidity is changing by making additional test psychrometric readings.

c. If the baseline-check is made manually the humidity traces must satisfy (a) or (b) above, except that when (b) is used the left edges of the three traces must fall on a straight line covering not more than 1.0 ordinate.

5.3.3 Temperature. The temperature traces must satisfy one of the following conditions:

a. Two consecutive temperature traces must be aligned so that a line connecting the upper left edge of each will be parallel to the ordinates printed on the recorder paper.

b. If the baseline check is made manually (see ¶B2-13), two consecutive temperature traces must be aligned in accordance with (a) above, or three consecutive temperature traces must show a trend in the same direction, either rising or falling and not cover more than 0.5 of an ordinate. Whenever a trend is used, the left top edges of the traces must fall on a straight line, and the radiosonde indication that the temperature is changing must be verified by additional test thermometer readings.

5.3.4 Termination of a Baseline-Check. When the requirements for a satisfactory baseline-check recording have been met, terminate the recording upon the completion of the low reference following the last good humidity trace. The low reference must be unadjusted and the left edge of the trace recording at 95.0 ordinates.

6. Conservation of Recorder Paper. Continue the receiving and recording units in operation, but turn off the recorder paper-drive mechanism when it is expected that more than ten minutes will elapse before the release of the balloon. The paper-drive mechanism will be turned on again before releasing the balloon.

7. Baseline-Check Psychrometric Readings. Immediately after placing the radiosonde in the baseline-check box, wet the muslin on the wet bulb. (While wetting the muslin check to see if it is becoming dirty; if it is, replace the muslin before the next baseline-check). If the baseline check is not completed within five minutes, rewet the muslin of the wet bulb two to three minutes before readings are to be taken. Make the readings at the time of maximum depression of the wet bulb, which usually occurs about two to three minutes after wetting the muslin. Read the dry and wet bulb temperatures to the nearest 0.1 degree. If necessary, apply the thermometer corrections to the readings in accordance with Federal Meteorological Handbook No. 1 (Surface Observations) and enter

the corrected values under "Baseline-Check Readings" on WBAN-31A. The readings should be in degrees Celsius and will be entered in ink opposite the caption "°C." When the baseline-check temperature is entered in degrees Fahrenheit, this value should also be entered in ink. The dry and wet bulb temperatures will always be entered on WBAN-31A first, i.e., as soon as the readings are taken and before the ordinate values are evaluated. Once these data have been entered on WBAN-31A, no values will be erased. If corrections are necessary or if the chart is used for a second release, the new or correct value will be entered in red immediately above the incorrect value. The original entry will be lined out, in red pencil in a manner that will leave it legible.

7.1 Baseline-Check Box Relative Humidity. Values of baseline-check relative humidity data, derived from psychrometric data referred to in §B2-7, may be computed by means of a psychrometric calculator or tables if a psychrometric calculator is not available.

a. The psychrometric calculator will be used in accordance with appropriate instructions in the Federal Meteorological Handbook No. 1 (Surface Observations) and instructions printed on the device. If it is necessary to convert the psychrometric readings in order to use the calculator, the original and converted values will be entered on WBAN-31A opposite the appropriate caption (°F., °C.).

b. When a psychrometric calculator is not available, the relative-humidity data will be computed by means of Table 4, Radiosonde Observation Computation Tables (WBAN), using as arguments the temperature of the psychrometer dry bulb and the depression of the wet bulb in degrees and tenths Celsius. Interpolate as necessary.

c. The relative humidity, derived by either method will be entered to whole percent on WBAN-31A under the caption "Baseline Check Readings, Water."

8. Evaluation of Baseline-Check Data. Throughout this manual, the term ordinate is used as equivalent to the terms "Temperature Ordinate," "Chart Division," and "Frequency Division" that are found on the various types of evaluators and calibration charts used. The left edge of the recorder trace will be used for all evaluations. Evaluators will be used to convert temperature and relative humidity ordinate values from the recorder record to temperature in degrees Celsius and relative humidity in percent. Care must be exercised that the evaluators used are appropriate for the thermistor and hygristor used.

8.1 Baseline-Check Recorder Entries. Draw a horizontal line across the recorder record parallel to the horizontal lines printed on the recorder paper and at the top of the last baseline relative-humidity trace.

a. Draw straight lines connecting the top left edges of the temperature, humidity, and low reference traces that comprise the baseline-check. Extend the lines through the horizontal line drawn in accordance with the preceding paragraph.

b. At approximately the tenth ordinate and immediately above the horizontal line, enter the notation "Baseline-Check," followed by the time, to the nearest minute (GMT), that the baseline-check was completed.

c. When a manual baseline-check is made, enter "manual" just to the left of the baseline-check ordinate values.

d. Read the temperature ordinate to tenths and enter the value on the horizontal line immediately to the right of the line connecting the left edge of the temperature traces. Following the temperature ordinate, enter the proper recorder correction, an equal sign, and the corrected temperature ordinate value. Enter another equal sign followed by the baseline-check dry-bulb temperature value. Example: 71.5-0.1 = 71.4 = 23.6°C. Recorder corrections of 0 will not be entered.

e. Read the humidity ordinate value at the intersection of the horizontal line and the line connecting the left edges of the humidity traces. Enter this value just below the horizontal line, under the temperature ordinate value, followed by the applicable recorder correction, an equal sign, and the corrected ordinate. Enter another equal sign followed by the baseline-check psychrometric-humidity value. Recorder corrections of 0 will not be entered. Enter all values in parentheses as shown in the following example: (77.3-0.3 = 77.0 = 34%).

f. The entries of the baseline data will be spaced out to prevent obliteration of any part of the baseline record.

g. Normally, the person reading and recording the baseline data will be the same person that evaluates the flight portion of the recorder record.

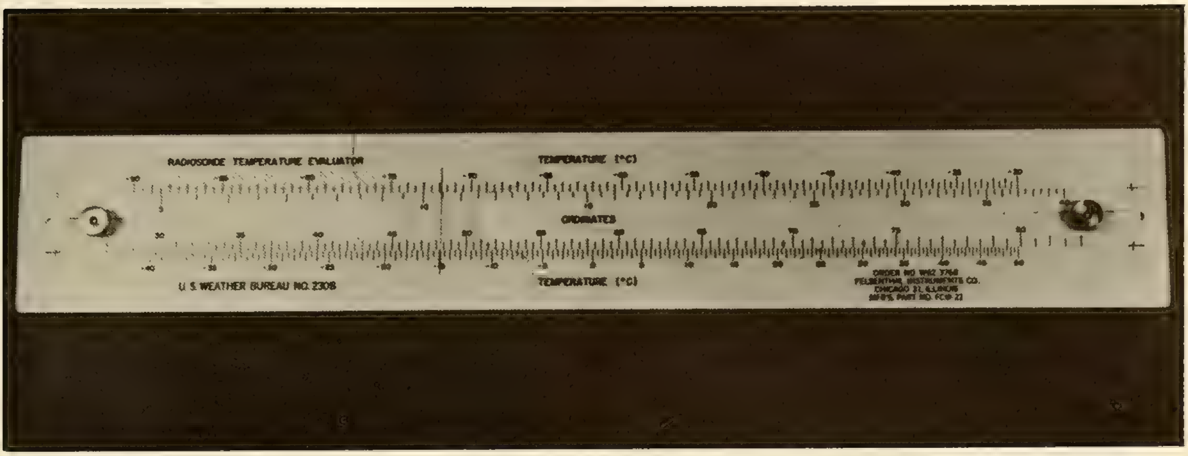


Figure B2-4. WB, 230B, Temperature Evaluator

9. Temperature Evaluator. Using the appropriate temperature evaluator for the radiosonde in use, set the recorded temperature ordinate to tenths opposite the corresponding dry-bulb temperature in degrees and tenths Celsius. The two scales of the evaluator are locked together to retain this setting which will not be altered during the subsequent raob. A short piece of tape may be used for locking together the scales if a locking device is not furnished with the evaluator. Opposite any temperature ordinate on the evaluator, read the corresponding temperature in degrees and tenths Celsius.

9.1 Temperature Limits. Certain limits on the ordinate scale of the evaluator have been established within which the 25°C. line must fall. The following ordinate ranges, for the 25°C. line shall apply to the evaluators listed:

Type Evaluator	Ordinate Range
USWB #230 and #230B	69.5 - 73.5
AMT - 7 and 11	69.5 - 73.5
CP - 223B/UM	66.5 - 68.9

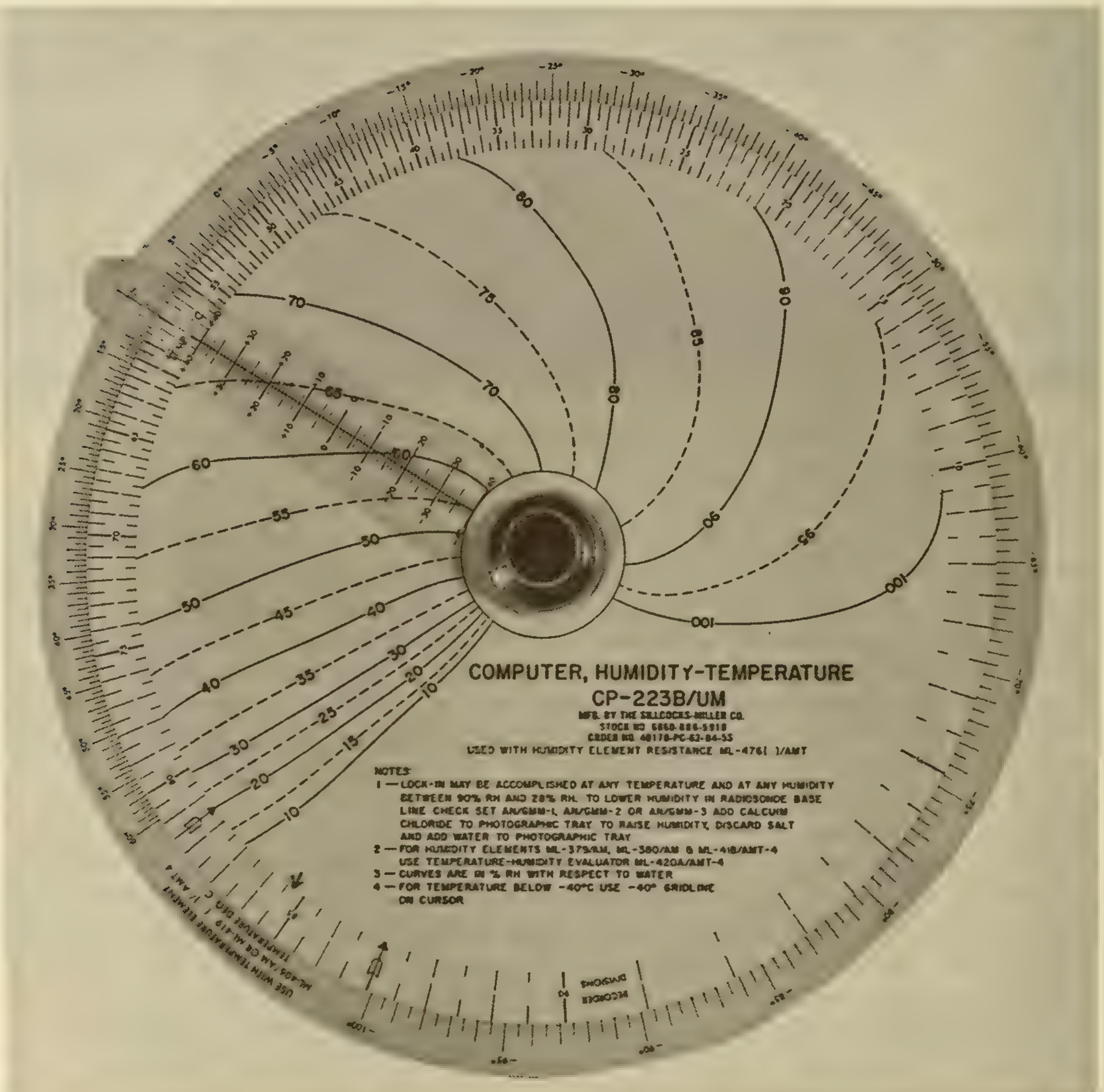


Figure B2-5. CP-223B/UM, Temperature and Relative Humidity Calculator

If the limits of the temperature evaluator are exceeded, the radiosonde will be set aside and another thermistor installed at a convenient time. Use the standby radiosonde and take another baseline-check. If a radiosonde is released that does not have its baseline-check temperature within limits, another release is required.

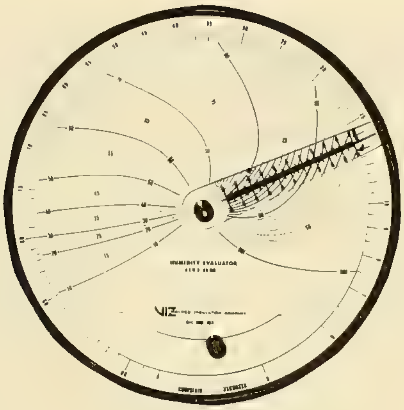


Figure B2-6. WB #500, Relative Humidity Evaluator

10. Humidity Evaluator. Using the appropriate humidity evaluator, set the cursor over the humidity ordinate value. Rotate the humidity disk until the baseline humidity value found on the family of curves lies under the cursor line and the baseline-check dry bulb reading. Lock the evaluator. For any humidity value, set the hair line on the cursor at the humidity-ordinate value and read the humidity to the nearest whole percent under the temperature value on the cursor, interpolating as necessary between the curved lines.

10.1 Humidity Limits. If limits have been established for the humidity evaluator, they will be indicated by two marks on the ordinate scale between which a mark on the humidity scale must fall. If limits have not been established for the humidity evaluator in use, these marks will not be present and the evaluator will simply be adjusted to the baseline humidity readings. The hygristor will be rejected and another baseline-check taken with a new hygristor if the humidity is out of limits for the evaluator in use. Reject the radiosonde if the humidity of the second baseline-check is also out of limits. If a radiosonde that does not have its baseline-check humidity within limits is released, the humidity aloft will be considered missing and a second release may be required. (see ¶B4-8.3).

11. WBAN-31 Entries. Under "Baseline-Check Readings", enter in the indicated spaces the time of the baseline-check (GMT), temperature and relative humidity ordinate values, and the baseline-check temperature and relative humidity. The latter two entries will be made in ink (see ¶B2-7.)

12. Unstable Baseline-Check. When an unstable record is received for any of the transmitted circuits, check the receiver tuning and the check

box connections. Also, check for electrical leakage. Use the standby radiosonde if the instability persists. If an unstable record is received from the standby radiosonde, remove the radiosonde from the check box and make the baseline-check manually (see ¶B2-13).

12.1 Electrical Leakage in the Baseline-Check Box. Moisture or some other foreign material in the radiosonde check box test plugs or switching unit may cause electrical leakage. When this condition exists, the baseline-check temperature ordinate value will be recorded at a higher value than should be indicated. The baseline-check temperature-ordinate relationship is then incorrect and will result in temperature evaluations aloft which are too cold, producing erroneous altitude data computations. The test for electrical leakage will be made in accordance with instructions issued by the separate services, for the baseline-check box in use.

13. Manual Baseline-Check. If a baseline-check box is not available, or is suspected of producing erroneous results, make the baseline-check manually.

13.1 Preparation for Manual Baseline-Check. Place the radiosonde on a desk in the office with exposed thermistor and the hygristor in line with the path of air blown by a nearby fan. Maintain as nearly stable conditions as possible during the baseline-check. Forced air heating and air conditioning units should be turned off during the manual baseline-check.

13.2 Making the Manual Baseline-Check. Use a short wire jumper with alligator clips or a dummy connector plug to connect the black test lead to each of the other leads. Make the test connection in the following order:

a. Black to blue (low reference)

b. Disconnect all test leads (temperature)

c. Black to red (high reference) or repeat low reference if the radiosonde does not have a high reference test lead.

d. Black to yellow (humidity)

Allow each circuit to transmit for about fifteen seconds. Repeat the sequence until a satisfactory (see ¶B2-5.3.1 thru B2-5.3.4) baseline record is received. To avoid affecting the radiosonde signal, stand at least six feet away from the radiosonde after each test connection. If a stable baseline-check is obtained manually, when one could not be obtained with the check box, the check box was probably at fault and should be checked for poor contacts, loose connections, and electrical leakage, before the next raob. Place the Celsius psychrometer to the side of and about one inch from the thermistor. Make the psychrometric readings according to ¶B2-7, as supplemented below.

a. Relative humidity of less than 10 percent may be encountered when taking a manual baseline-check. Enter the correct value on WBAN-31A, but set the relative humidity evaluator at 10 percent for baseline-check relative humidity of 10 percent or less.

14. Additional Preparation of Radiosonde. After the baseline-check psychrometric readings have been recorded and the recorder record baseline-check has been evaluated, open the door of the baseline-check box and disconnect the radiosonde test leads or plug from the test switch. Turn off the test switch and the blower, remove the radiosonde and close the door.

14.1 Cutting Test Leads. Cut off the bare portion of all test leads. Some observers may prefer to use a high (or low) reference to mark the release, in this case approximately 1/32 inch of the high (or low) bare reference lead may be left on. If a second baseline-check is required after the test leads have been cut, strip not more than 1/4 inch of the insulation from each of the test leads.

15. Pressure-Contact Setting. The pressure-contact setting is the position of the contact point on the commutator corresponding to station pressure corrected to the altitude of the radiosonde. Make the pressure-contact setting following the baseline-check. A contact on the commutator extends from the left edge of one conducting segment to the right edge of the next insulating segment to the right.

15.1 Baroswitch Setting Pressure. Determine the correct baroswitch pressure as follows:

a. Obtain the station pressure from the precision aneroid barometer, altimeter setting indicator, microbarograph, or mercurial barometer (listed in order of priority). Apply any necessary correction established in accordance with WBAN Manual of Barometry.

b. The station pressure must be corrected for the difference between the elevation of the radiosonde at the time the pressure setting is made and the Station Elevation. Use Table B2-2 to determine the correction corresponding to this difference.

This correction is the "pressure contact setting" correction and will not be entered on WBAN-31A. The pressure will not be corrected for a difference in altitude of less than 3 meters.

Table B2-2. Pressure Correction for Difference Between Station Elevation and Elevation of the Radiosonde

Difference in Altitude (meters)	Correction (millibars)
3	0.4
4	.5
5	.6
6	.7
7	.8
8	.9
9	1.1
10	1.2

The table is based on the relationship of 1 millibar per 8.5 meters difference in elevation. Add the correction to the station pressure when the elevation of the radiosonde is lower than the station elevation, and subtract it when the radiosonde is higher. In some cases, the station elevation differs from that of the actual altitude of the barometer. Under these circumstances, use the altitude upon which the pressure reduction tables are based to compute the difference referred to ¶B2-15.1. The pressure contact setting as determined in ¶B2-15.5 is the setting of the baroswitch before release and will not appear on WBAN-31A. if the elevation of the radiosonde at contact setting and the release elevation differ by 3 or more meters (see ¶B4-4.3).

15.2. Calibration Chart. A chart indicating the pressure calibration values is supplied with each radiosonde (see ¶B1-1.1). Check all calibration charts for uniformity; e.g., all contacts and millibar values must be reasonable. Reject the radiosonde when the calibration chart appears erroneous.

15.3 Cleaning the Baroswitch. Clean the baroswitch before making the contact setting. The printed commutator should not be polished with emery cloth or crocus cloth. All dust and foreign particles should be removed by brushing the contact surface of the commutator and the contact point thoroughly with a camel hair brush, after which the entire commutator surface should be wiped firmly with lens tissue, and finally brushed again to remove any remaining particles. The brush strokes should be parallel to the contacts. Care must be taken not to apply force either horizontally or vertically other than that exerted by the lifting lever. The camel hair brush should be rinsed in a good grade of denatured alcohol once a week, or oftener if contaminated. For protection, it should be stored in a glass vial with the brush handle inserted through a cork.

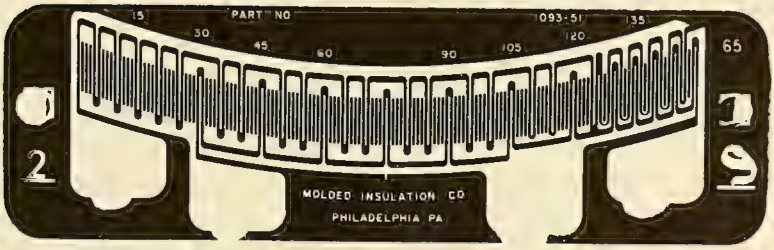


Figure B2-7. Radiosonde Commutator Bar

15.4 <u>The Detent</u>. All baroswitch-pressure-contact settings will be made by use of the detent. The proportional part of a millibar corresponding to one click of the detent is the "detent click." Most pressure-calibration charts will have the detent click value entered in the space provided.

15.5 <u>Pressure-Contact Setting</u>. Make pressure-contact setting immediately following the baseline-check and before disconnecting power. All baroswitch-pressure settings will be made by use of the detent screw. If a value has not been entered in the space, "one detent click equals ____MB," on the calibration chart, proceed as follows. If a value has been entered omit steps (d-j) below. To insure accurate settings, the radiosonde will be positioned so that a clear and uninterrupted signal is obtained. Lower the contact arm and proceed as follows:

a. Obtain the baroswitch setting pressure in accordance with ¶B2-15.1. Record this pressure on the calibration chart as pressure (1).

b. Determine from the calibration chart the pressure corresponding to the "make," or beginning, of the nearest contact in the direction of higher pressure than pressure (1). Read this value from the calibration chart as pressure (2).

c. Subtract pressure (1) from pressure (2) to obtain the difference in millibars between the beginning of the contact and the baroswitch setting pressure.

d. Determine from the calibration chart the pressure corresponding to the "make," or beginning, of the next contact towards lower pressure. Record this value on the calibration chart as pressure (3).

e. Subtract pressure (3) from pressure (2) to obtain the number of millibars per contact.

f. Turn the commutator adjustment screw (detent screw) until the contact point rests at least two contacts to the left (high pressure side) of pressure (2). Turn the screw gently counterclockwise and exert no force on the commutator frame.

g. Turn the detent screw slowly clockwise to the "make," or beginning, of the contact corresponding to pressure (2). This is the point at which the audio signal switches from temperature to humidity or reference.

h. As soon as the signal changes to indicate the "make," or beginning, of the contact, begin to count the clicks and continue to turn the detent screw until the "make," or beginning, of the succeeding contact is reached. The complete contact will encompass a humidity (or reference) signal and a temperature signal. Record the number of clicks per contact on the calibration chart.

i. Repeat steps (f), (g), and (h) above and take the average of the number of clicks per contact.

j. Multiply the average number of clicks per contact by the difference in millibars (pressure (2), minus pressure (1)) and divide by the number of millibars per contact (pressure (2) minus pressure (3)). This gives the number of clicks between the beginning of the contact (pressure (2)) and the baroswitch setting pressure (1).

k. On most calibration charts a detent click value will be given. In such cases, steps (d) through (j) may be omitted. The pressure difference (2) minus (1) divided by the detent click value gives the number of clicks between the beginning of the contact (pressure (2)) and the baroswitch setting pressure (1).

l. Repeat steps (f) and (g). At the "make," or beginning, of the contact representing pressure (2), begin counting clicks and turn the detent screw the number of clicks obtained in steps (j) or (k) (to the nearest whole number of clicks). If the baroswitch-setting pressure is very close to the end of the contact, do not continue the detent count beyond the "make" of the succeeding contact. Do not attempt to count in the direction of increasing pressure from the succeeding "make"; e.g., even though the baroswitch setting pressure is very near the end of the contact, the detent click setting must always be made in the direction of decreasing pressure from the "make," not in the direction of increasing pressure from the "break."

m. As a check for gross errors, compare the setting visually with the indicated position of the baroswitch-setting pressure on the calibration chart.

Example. Assume that the baroswitch-setting pressure (1) at the altitude of the radiosonde is 1001.6 mbs. Inspection of the calibration chart shows this pressure is between contacts 4.0 and 5.0. Pressure (2) corresponding to contact 4.0 is 1006 mbs. and pressure (3) corresponding to contact 5.0 is 990 mbs. Pressure (2) minus pressure (1) equals 4.4 mbs. The number of millibars per contact (pressure (2) minus pressure (3)) equals 16 mbs. Turn the detent screw until the contact point rests on approximately contact 1.8. Then turn the detent screw carefully until the contact point just touches contact 4.0. At contact 4.0 begin counting the clicks and continue to contact 5.0. Repeat and obtain the average number of clicks from contact 4.0 to 5.0; if this is 30 clicks, then the number of clicks corresponding to the difference between pressure (1) and pressure (2) is $30 \times \frac{4.4}{16} = 8.3$ clicks. After turning the detent screw until the contact point rests on contact 1.8 and returning to 4.0, turn the detent screw 8 clicks towards decreasing pressure from contact 4.0. This gives the correct pressure-contact setting corresponding to the baroswitch-setting pressure. If the detent click value is given on the calibration chart, for instance .55 mbs, then the number of clicks corresponding to the difference between pressure (1) and pressure (2) is $\frac{4.4}{.55}$ = 8 clicks.

After the setting has been made, the contact point will not be raised from the commutator before release.

15.6 Release Point Contact Setting. Estimate from the pressure calibration chart the pressure-contact setting to the nearest 0.1 contact corresponding to the pressure at release point (see ¶B4-4.3). Record the pressure-contact setting on WBAN-31A.

16. Battery Time. Do not install the battery or if it is installed, disconnect it when a delay of more than five minutes is expected before the balloon is released. If the radiosonde is equipped with a battery switch, open the switch instead of disconnecting the radiosonde from the battery. A minimum of two minutes should be allowed before release after the water-activated battery is again connected.

17. Hypsometer Fluid. Fluid will be placed in the flask of the hypsometer radiosonde in accordance with instructions for the type radiosonde in use.

18. Exposure Before Release. The sensing elements and the radiosonde box adjust to changes in temperature quite rapidly. The time needed to tie the instrument to the train and get ready for the release will normally be sufficient for the radiosonde to be conditioned to the change of temperature from a warm room to the outside air. However, if the temperature difference between the baseline-check and the outside air exceeds 30°C, an exposure time in the outside air of at least 10 minutes should be allowed. The radiosonde, which is ready for release, will be conditioned to the outside air in a sheltered, unheated place, protected from rain or blowing snow. It will be placed in an upright position and have ample space for free circulation of air around the radiosonde.

19. Baseline-Check if Release is Delayed. If the release is delayed for more than two hours after the radiosonde has been removed from the baseline-check box, a new baseline-check will be made with a new battery and a new hygristor before the radiosonde is released. A new baseline-check will also be made if it is necessary to change over to another set of ground equipment or if substitutions are made in the major components of the ground equipment - frequency converter or recorder - during the period between the baseline-check and release. The Electronics Technician will be consulted if a component has been changed, and there is a question whether a new baseline-check is needed.

CHAPTER B3 . BALLOON INFLATION AND ASSEMBLY OF TRAIN

CONTENTS

CHAPTER B3

BALLOON INFLATION AND ASSEMBLY OF TRAIN

1. Storage and Handling of Balloons. Balloons will be stored in their original sealed containers, and in a room isolated from large electric motors or generators. Motors and generators emit ozone which is detrimental to neoprene. Ideal temperature for storage would be in the range 50° to 85°F. Temperatures below 32°F and above 110°F should be avoided during storage. Balloons deteriorate with age; therefore, they should be used in the order of their production dates to avoid excessive aging. If by necessity balloons are stored at temperatures below 50°F., they should be removed to a room having temperatures of 70°F or higher for at least 48 hours before use to avoid any damage that would result if removed from the container and unfolded when cold. The balloons are extremely delicate, especially when softened by conditioning. No part of the balloon except the neck should be touched with bare hands. Soft rubber gloves, soft cotton gloves, or the plastic bag in which the balloon was received, used as a glove, should be used to handle any portion other than the neck of the balloon.

1.1 Balloon Conditioning. As a result of exposure to relatively low temperatures and of extended periods in storage, neoprene balloons suffer a partial loss of elasticity through crystallization. Neoprene balloons used in this state will burst prematurely. Therefore, to insure maximum elasticity possible, all neoprene balloons will be conditioned, or not conditioned, before release in accordance with instructions in the following paragraphs.

1.2 When to Condition Balloons. Balloons that are less than one year old and that have not been stored in sub-freezing temperatures may be used without conditioning. All balloons that are one year or more old, or that have been stored in sub-freezing temperatures, must be conditioned before they are inflated using either the hot water or electric conditioner method. The hot water method will be used only when the electric conditioner is inoperative or not available at the station. Some stations may prefer to condition balloons for night flight, even though they are less than a year old and have not been stored in sub-freezing temperatures.

1.3 Electric Conditioning Method. When the electric balloon conditioner is used, balloons will be conditioned for a minimum of 12 hours at temperatures ranging between 60° and 65°C (or 140° to 160°F) and at a relative humidity near 100 percent. Four balloons may be kept in the conditioner at one time. Balloons should be conditioned no more than 72 hours. The balloon should be removed from the polyethylene bag, unfolded, and placed in its cardboard box to permit uniform conditioning.

1.4 Hot-Water Conditioning Method. Hot-water balloon conditioning consists of immersing the balloon in water for at least five minutes as follows:

a. Prepare the balloon for hot-water conditioning as follows:

(1) Open the box and bag containing the balloon and lift out the balloon neck.

(2) Insert a small wooden plug in the neck of the balloon, or tie the neck of the balloon tightly with soft twine or a heavy rubber band. Closing the neck of the balloon which will be submerged in water will prevent the water from entering the balloon.

b. The container in which the balloon is to be conditioned should be made of smooth porcelain or non-corrosive metal. The walls of the container should be kept smooth and the top rim should be rolled, ground or filed smooth so that the balloon will not be scratched. The container should be of sufficient size so that the balloon may be completely immersed.

c. A metal pan or tray will be placed in the bottom of the container over the heat source to cover hot spots. When the water is brought to a boil, turn off the heat source.

d. Remove the balloon and bag from the box. Hold the neck of the balloon and ease the balloon out of the bag and into the conditioning tank, using a rod to keep the balloon submerged. The rod should be of either bakelite or hard rubber, not less than 1/2-inch in diameter, with a smooth, rounded edge. If it is necessary to use a wooden rod, the end used to submerge the balloon should be padded with cloth, rubber or other soft material. Keep the balloon moving in the water to insure that it is heated uniformly.

e. After 5 minutes, remove the balloon from the conditioning tank by raising the neck and folding the remainder onto a gloved hand or rod. Allow the balloon to drain as it is removed from the water, or if possible, place the balloon on a smooth tray and permit the water to drain off. Use the tray to carry the balloon to the inflation area. Do not open the neck until the inflation nozzle is to be inserted.

f. If the outside temperature is 40°F or above, the balloon is ready for inflation. If, however, the outside temperature is below 40°F, the balloon should be allowed to dry before inflating. Hang the balloon by the neck to facilitate drying.

1.5 Heat Conditioning Method. In an emergency, if neither the electric nor hot water conditioning method can be used, neoprene balloons may be conditioned by removing them from their polyethylene bag, and then placing them over a heater, radiator, or electric lamp, care being taken to insure uniform heating and to shield the balloon from direct contact with the heat sources. A conditioning period of 12 hours should be used with temperatures near 65°C and relative humidity near 100 percent. The length of the conditioning period should be decreased as the temperature is increased. The balloons should not be exposed to temperatures in excess of 100°C.

2. Inflation Lift Requirements. The amount of helium, hydrogen, or natural gas most favorable for producing optimum performance should be ascertained before actual inflation of the balloon. Optimum performance is usually defined as the highest possible bursting altitude, with an average ascent rate favorable for obtaining winds-aloft data. Lift is defined as follows:

a. Free Lift - Free lift is the number of grams of lift that are available over and above that required by a balloon to support the weight of a complete radiosonde train.

b. Nozzle Lift - Nozzle lift is free lift plus the grams of lift required by a balloon to support the weight of a complete radiosonde train.

c. Gross Lift - Gross lift is nozzle lift plus the grams of lift required to support the weight of the balloon.

2.1 Performance of the Balloon. The performance of a balloon (bursting altitude and ascent rate) is affected by the free lift, thickness of the neoprene film, current air mass and weather conditions, and the size and shape of the balloon envelope. Since most of these factors cannot be controlled, the free lift to produce optimum performance for any given sounding can best be determined by experience. The following paragraphs are included as a guide.

a. For fair-weather conditions, free lift ranging from 1000 to 1400 grams for 600 to 1200 gram balloons (including severe weather balloons) and 800 to 1000 grams free lift for 300 gram balloons, will normally produce optimum performance.

b. The performance obtained in the preceding flights may be considered in selecting a free-lift value to be used.

c. When precipitation, icing, or terrain turbulence is occurring or expected, an effort will be made to provide sufficient free lift to insure that the balloon will not descend or float. An increased free lift of 100 grams is normally sufficient to compensate for an increase in the weight of the train resulting from light precipitation. Under light or moderate icing conditions, moderate to heavy precipitation, or terrain turbulence, an increase in the free lift of from 200 to 300 grams will usually be sufficient. Under severe icing conditions, an increase of up to 500 grams may be required.

d. Whenever an observation is to be made during periods of strong winds aloft that will cause loss of wind data owing to limiting angles at nontransponder stations, or the loss of meteorological data at transponder stations the balloon should be inflated to obtain the highest possible ascensional rate. However, increasing the lift beyond 300 grams in excess of the values given will often decrease the ascension rate for the sounding from the surface to the level of maximum wind.

e. Attach the weights required to give the desired nozzle lift to the inflation nozzle, making allowance for part of the hose that will be supported by the balloon as well as the nozzle itself, hose clamps, cut-off valves, etc. (usually 200 to 400 grams).

3. Inflation of Balloons. After the weights have been placed on the inflation nozzle, inflation should be started as soon as the balloon is removed from the conditioner except when drying is required. When the electric balloon conditioner is used, any air should be forced out of the balloon before attaching the neck to the inflation nozzle. If the balloon is not conditioned, the inflation nozzle should be inserted into the neck before removing it from the plastic bag. In either case, the balloon should be handled as little as possible.

3.1 Inflating With Hydrogen or Natural Gas. If the balloon is to be filled with hydrogen or natural gas, posted safety instructions and safety instructions issued by the separate services will be followed and protective gear worn at all times during the inflation and tieing off of the balloon. If a partially full or completely filled balloon is discovered to be leaking, open one of the inflation doors, take the balloon outdoors and let the hydrogen or natural gas escape from the balloon. This may be done by rolling the balloon from the top to the neck. Reject the balloon and begin inflating a second balloon.

3.2 Positioning Balloon for Inflation. Place the balloon in a position where it will not come in contact with sharp objects or rough surfaces. If the dimensions of the inflation shelter permit, the balloon should be placed on a table for inflation. The table top should be very smooth, free from projections of any sort, with all edges rounded and the top covered with talc. The table top should be cleaned frequently and a new coat of talc applied. The table should be large enough so that the balloon can be fully extended before inflation is started to reduce abrasion during inflation. If it is not practicable to use a table, then the balloon should be placed on a clean sheet of paper large enough to keep the balloon off the floor. Remove any objects with sharp points from the immediate vicinity of the balloon and smooth all edges on the inflation weights and nozzle. Wrap the loops on the handles of the inflation nozzle clamps with tape. Place the inflation nozzle in the neck of the balloon and secure it with a clamp or soft cord.

3.3 Rate of Inflation. Inflate the balloon at a sufficiently slow rate to insure a uniform expansion of the film. If the gas regulator or outlet valve is equipped with a low-pressure gage, open the valve to a pressure not exceeding 20 pounds per square inch when using helium. When a low-pressure outlet gage is not available, adjust the flow of gas so that a period of 12-15 minutes is required to inflate the balloon completely. When hydrogen is used, open the valve to a pressure not exceeding 10 pounds per square inch. If the balloon is rapidly inflated with hydrogen gas, the likelihood of generation of static electricity is greatly increased and with it the hazard of fire or explosion.

3.4 Checking for Leaks. When the balloon is about one-half inflated, close the gas valve. Listen for gas leaks and examine the balloon for defects. Serious defects may result from foreign material in the rubber, a break in the balloon skin, or a deformity in a small area of rubber film. Discoloration should not be regarded as a defect unless experience indicates that certain types of discolorations result in premature bursting. If the balloon is defective, reject it and begin preparing a second balloon; otherwise, proceed with inflation. Close the outlet valve as soon as the inflation weights are raised from their support. Again listen momentarily for escaping gas from the balloon. If a leak is detected, reject the balloon.

3.5 Constant-Rate Inflation. When a balloon cannot be completely inflated with the inflation nozzle resting on a table because the balloon is likely to touch the ceiling, move the nozzle to the floor and continue the inflation. If the balloon is still likely to touch the ceiling before the desired lift has been reached, protect the balloon from damage by stretching a net below the ceiling, or by padding the ceiling with some soft material. Then proceed as follows:

a. Inflate the balloon to a nozzle lift of 1500 grams.

b. Increase the inflation weight by 300 grams.

c. Using a watch with a second hand, determine the time, in minutes and seconds, required to inflate the balloon the extra 300 grams referred to in (b).

d. Mark the position of the exhaust valve of the helium regulator or manifold system when it is in position (c).

e. Using the rate of flow determined in (c), compute the time required to inflate the balloon to the required nozzle lift. Once the rate of flow has been determined, the value may be used until the regulator, tubing or nozzle is replaced, at which time a new determination should be made. The rate of flow method should be checked with inflation weights, using a balloon which does not touch the ceiling. The required inflation weights should be installed even though the flow rate is used.

When the constant-rate inflation method is used, the cylinder should be replaced when the gas pressure drops to 100 psi, since the rate of flow then no longer remains constant. The partial cylinder of gas should be used at the beginning of the next inflation. If the ceiling of the inflation shelter is too low to determine the flow rate in accordance with the above instructions, the flow rate should be determined in a hangar or outdoors during a period with calm winds. The constant-rate inflation method must not be used unless the balloon is likely to touch the ceiling before the desired nozzle lift is reached.

4. Tying the Neck. Tie the neck of the balloon with a 6-foot length of double cord as soon as inflation has been completed. Make one turn of the doubled cord around the neck of the balloon near the center (close to the top of the inflation nozzle). Adjust the doubled cord so that a free end of about 5 feet and another of about 1 foot in length result. Pull the cord as tightly as possible and tie with a square knot. Make another turn around the neck and tie again. Remove from the nozzle, fold the neck upward and again tie the neck just above the first knot. Be sure that all cord is below the area where the neck starts to flare out to join the envelope of the balloon.

5. The Inflated Balloon. The balloon should be left in the inflation shelter until preparations for the release have been completed. If the release is not expected to occur within 15 minutes after the inflation is completed, the balloon should not be held down by weights attached to the

neck since the strain on the film will cause premature bursting. Rather, the balloon should be allowed to rest against the ceiling of the inflation room, provided the ceiling is smooth and free from projections or rough spots. If the ceiling is not smooth, then the balloon should be allowed to rest against the balloon cover. If no cover is available, then a sheet or some other suitable material may be used to protect the balloon. Do not use a balloon for a later observation if the observation for which the balloon was inflated was missed. The balloon should not be inflated more than one hour prior to the time of the expected release.

6. Launching Device and Flow Meter. If a launching device and flow meter are used, be careful when placing the balloon in the launching device to insure that the balloon is not twisted and that it is not tangled in the launching shroud. Instructions on the operation and use of the launcher and flow meter will be issued by the using service.

7. Assembly of Train. Use as long a train as the release conditions will permit, up to a maximum length of 120 feet. In order to avoid erroneous temperature readings, trains of less than 70 feet in length must never be used and the parachute must be tied not more than 5 feet below the balloon. When the release must be made in high winds, a train regulator may be used. When a train regulator (see ¶B3-9) is used, the train will be assembled as follows: Tie the end of the doubled 5-foot length of cord, which was used to tie the neck of the balloon to the upper end of the parachute. Tie the lower end of the parachute to the upper eye or spacer bar of the train regulator, and tie the free end of the cord from the train regulator to the ring on top of the radiosonde.

8. Parachutes. Parachutes will be used at all stations and on shipboard unless specific instructions to the contrary are issued.

9. Radiosonde Train Regulators. The radiosonde train regulator consists of a frame, reel, and braking mechanism. The regulator is furnished with approximately 60 feet of twine or nylon tape wound on the reel. The braking mechanism permits the weight of the radiosonde to unwind the twine at the nominal rate of 12 feet per minute. The regulator is designed to withstand the stresses placed on it in normal use. Care must be exercised to avoid unnecessary strains, which might ruin the gear train and braking mechanism. Before using, test the regulator by firmly pulling about 5 feet of cord from the reel. Should the reel feed out too rapidly, it may be adjusted by squeezing the metal braking pawls together with a pliers. If the braking pawls are too tight, the regulator will not feed out. To use, place the free end of the twine through the eye or over the spacer at the bottom of the regulator. Tie the twine to the supporting ring at the top of the radiosonde. Determine that the regulator

operates normally when supporting the weight of the radiosonde. Then rewind the twine by rotating the reel manually.

9.1 Shock Unit for Train Regulator. A shock unit may be used in the radiosonde train between the regulator and the radiosonde if the vibration caused by the regulator produces unstable signals. The shock unit may be formed by tying together in parallel four 1/8" wide rubber bands. Tie the bands to the cord of the train so that the cord is slack between the ends of the bands, permitting them to act as a shock absorber.

10. Balloon Covers or Shrouds. The radiosonde balloon cover or shroud is designed to protect the radiosonde balloon while it is being moved to the point of release, and to aid in releasing it under conditions of high winds. The cover or shroud consists of a hood and four flaps, each of which terminate in a hand hold.

10.1 Placing the Balloon in the Cover. To place the balloon in the cover, the bottom portion of the segments should be untied and the balloon lowered as near the floor as possible. Two of the segments should be pulled to one side and the balloon then allowed to rise under the cover. The cover supporting cord is then unsnapped and pulled free of the loops on the top of the cover.

10.2 Drying the Shroud. If the cover or shroud becomes wet, it should be suspended loosely until it is thoroughly dry.

10.3 Types of Balloon Covers. Two types of balloon covers are available. The antistatic treated balloon covers will be used at radiosonde stations using hydrogen. The untreated shroud will be used at stations using helium.

DANGER. Do not use the untreated shroud with hydrogen-filled balloons.

CHAPTER B4 . RELEASE AND RECORDER RECORD

CONTENTS

CHAPTER B4

RELEASE AND RECORDER RECORD

1. Observation Schedules. The standard times of observations are 0000, 0600, 1200, and 1800 GMT. Insofar as possible, the release times (actual times of observation) will be scheduled as close as conditions permit to 2330, 0530, 1130, and 1730 GMT. Except for earlier releases from moving vessels, as provided in special instructions, no other releases will be scheduled more than 15 minutes earlier nor more than 30 minutes later than 2330, 0530, 1130, and 1730 GMT. Delayed releases may be made after the standard times of observation, but in no case later than 0100, 0700, 1300, and 1900 GMT. Special observations may be made outside these specified release times when authorized.

1.1 Number of Observations Per Day. The number of observations per day will be specified in separate instructions.

1.2 Priority of Balloon Release. At stations where observing personnel are responsible for both upper air and surface weather observations, special, local, and scheduled surface weather observations will have priority over the release and computation of the radiosonde. If the release of the radiosonde conflicts with the time of a surface weather observation, the release will be delayed until the surface weather observation is completed. Insofar as possible, the exact time of the release should be scheduled so that it does not conflict with any scheduled surface observations.

2. Release Notices. Before making the release, appropriate agencies will be notified as indicated in the following paragraphs.

2.1 (WB) NOTAMS. At least thirty minutes before the radiosonde is released, all stations located at airports having FAA ATCS broadcast facilities will file a "Notice to Airmen" (NOTAM) with the communicator. This NOTAM will state the probable time of the balloon's release and the time it is expected to reach the altitudes of 10,000 and 25,000 feet,m.s.l. If it becomes apparent that the release will be delayed more than fifteen minutes, a correction to the first NOTAM will be filed at once. These NOTAMS will be broadcast. Whenever the upper-air station is adjacent to the FAA ATCS broadcast facility, the NOTAM will be filed on Form 610-5. Whenever, through previous arrangements, the NOTAM is filed via telautograph, teletypewriter, or voice communications, the upper-air station will keep a log showing the date and time of the expected release, the expected time at 10,000 and 25,000 feet, and the time the NOTAM was filed. A copy of the telautograph or teletypewriter message may be substituted for the log provided such copy is retained in the station files for one year. Regardless of the method used in filing the NOTAM, it will also be transmitted on available local interphone and teletypewriter circuits.

2.2 (WB) Release At or Near Controlled Airports. To reduce the possibility of the radiosonde, train, and balloon becoming a hazard to aircraft in flight, observers will inform the local control tower thirty minutes before the intended release. Arrangements will be made to obtain clearance from control tower personnel, by telephone or visual signal at the time of actual release.

2.3 (WB) Release at Non-Controlled Airports. Raob stations at airports not having an operative control tower will release the balloon after a visual survey indicates that the flight train will not present a hazard to aircraft operating in the vicinity of the airport.

2.4 (AF, N) Release at Military Establishments. The local communications commander will be advised of the schedule of observations currently in effect at the rawinsonde section, and the necessary arrangements will be made to obtain clearance from the tower by telephone or visual signal for each rawinsonde or rawin release. The procedures to be used in obtaining the clearance for release will be made a matter of record and filed in the permanent files of the rawinsonde section.

3. The Release. Release procedures must necessarily be varied with wind conditions at the site from which the release is made. The observer should be familiar with all obstructions around the area before attempting a release. Before the balloon is removed from the inflation shelter, the wind direction and speed will be determined and a point selected from which the radiosonde may be released without striking obstructions or encountering downdrafts.

3.1 Release Precautions. A continuing source of danger to personnel is associated with radiosondes which become entangled with high tension power lines and transmitting antennas. When entanglement occurs, it is usually at release - especially during periods of high wind and heavy precipitation. No attempt should be made to disentangle radiosondes, but the circumstances should be reported at once to the officials of the power company, broadcasting station, or communications agency involved.

3.2 Posting of the Location of All High-Tension Wires and Transmitting Antennas. The location of all high-tension wires and transmitting antennas in the vicinity of all of the points of release at the station will be charted by the official in charge, and posted in a conspicuous place in the station. This chart will be brought to the attention of all assistants, who will be informed that severe burns and even death, can result from coming in contact with these wires, or from allowing the radiosonde train to come in contact with the wires while still holding the radiosonde. It will become the duty of officials in charge at stations where raob work is inaugurated to inform all who might be involved of the dangers inherent in disentangling radiosondes from high-tension wires.

3.3 Release Procedures. Make a rapid visual check of the train and radiosonde. The battery should be connected for a minimum of two minutes before the release. Turn the recorder (selector) switch to receive the radiosonde signal. Check that the chart or paper drive switch is in the ON position. Tune the receiver if necessary and check that a steady trace of the circuit corresponding to the contact setting is being received. (AF) Place the AUTO-PRINT switch in the down position. When the observer at the recorder is satisfied with the operation of the radiosonde, he will request a clearance from the control tower. Then either the observer or the control tower operator will give the prearranged release signal to the observer with the radiosonde. If there is no control tower, the observer at the recorder will indicate that the release may be made.

3.4 Marking the Release. When there is an observer at the recorder, one of the following two methods will be used to mark the release.

a. The observer at the recorder will mark the recorder record by turning the recorder switch to record at zero momentarily just prior to release, and then back to the position of signal record at the exact moment of release. He will also turn the AUTO-PRINT switch to the ON position at the moment of release and will note the time the release was made.

b. The observer with the radiosonde may mark the point of release on the recorder record by grounding the reference lead until the moment of release. The observer at the recorder will turn the AUTO-PRINT switch to the ON position at the exact moment of release and will note the time release was made.

If only two observers are on duty at a station, and both are required to make the release, the recorder will be turned on to receive the signal, as indicated in ¶B4-3.3, before the observer leaves the recorder. The observer handling the balloon will note the exact time of release, and when he returns to the recorder, he will place the controls to their normal flight recording position. The surface level on the recorder record can be located by making use of the known rate of paper feed. The horizontal lines printed on the recorder chart are normally one minute apart when the recorder is operating on 60-Hertz after the radiosonde was released, and the elapsed time will be added to all printed times to obtain the correct time. Those stations that have been supplied with remote control units do not need a person at the recorder at release. All necessary switches are on the remote control unit to start the timer and track the radiosonde.

3.5 Release in Light Winds. In light winds, pay out the train until the radiosonde is reached. Hold the radiosonde by its ring or support strap, and release upon appropriate signal.

3.6 Release in High Winds. If a train regulator is used, it should be attached according to instructions in ¶B3-7 and 9. The balloon should be held in one hand and the train regulator and radiosonde in the other hand, if a one-man release is to be made. The train regulator should be held in such a way that the weight of the radiosonde or the weight of the regulator does not unwind any of the string until the moment of release. When the point of release is reached, the balloon is released and then the radiosonde almost simultaneously. Where space is available, the two-man overhead release may be preferable under certain conditions to the use of the train regulator during periods of moderate or high winds. During periods of high winds, the two-man overhead release may be combined with the use of the train regulator to make a successful release when it otherwise might not be possible. To be successful under any conditions, the two-man overhead release must be carefully planned in advance by the two observers making the release. Familiarity with local obstructions, current wind and weather conditions, local turbulence, and many other factors will assist in making a successful release. These plans must be complete, and all preliminary checks of the radiosonde should be made with the balloon still in the inflation shelter. Once the balloon is out of the shelter the release should proceed smoothly and rapidly with no delay. The first observer will place the radiosonde top side up in his left hand, grasp the cord with his right hand at a point about two feet above the top of the radiosonde, and extend the train until a slight tension is exerted on his right hand to avoid having the train become tangled. The second observer will then remove the balloon from the shelter; the balloon will be taken as rapidly as is practicable to the preselected site, with the first observer keeping the tension on the train. The first observer should position himself downwind from the balloon so that it will pass directly overhead when the weight of the radiosonde is assumed. Correct positioning is the responsibility of the observer with the radiosonde since under these conditions the observer with the balloon will find it more difficult to change his position. When the release area is reached, the second observer will release the balloon, and the instant the train slackens, the first observer will run downwind until the balloon takes up the slack. As this happens, he will raise the radiosonde with his left hand and bring the cord forward with his right hand. If the movement of his hands are coordinated, the radiosonde will follow the balloon with no noticeable jerk.

When obstructions prevent the observer with the radiosonde from running downwind, the observer holding the radiosonde will stand in a position from which he can observe the movement of the balloon. At the instant the balloon takes up the slack, he will follow through with the radiosonde to reduce the jolt and any possible damage to the radiosonde.

In cases of very high and gusty surface winds, or where the balloon must be carried through a space without sufficient clearance, the balloon cover or shroud can be used. It should be placed on the balloon in accordance with instructions in ¶B3-10.1. To take the balloon from the inflation shelter, grasp two adjacent segments of the shroud in each hand. The two held in each hand should both be on the same side of the cord of the radiosonde train. In case of very high wind the loops on the top of the cover may be used by another observer to assist in guiding the balloon out of the shelter and to the point of release. The hands should be placed so that one is slightly above the other, with the cord in the upper opening between the segments of the cover. To release, let go of the segments held by the upper hand so that the cover falls away from the cord. Pull slightly on the cover with the lower hand. The cover will drop away, without fouling the cord of the radiosonde train. The balloon will rise over the cover and gain altitude before picking up the weight of the radiosonde.

It is sometimes possible to guide the radiosonde train around a troublesome obstruction by means of an auxiliary cord attached to the neck of the balloon. With a train 70 to 100 feet long, the auxiliary cord should be about 60 feet long and should be attached to the doubled over portion of the balloon's neck to avoid damaging the film. At release, one observer would carry the radiosonde downwind from the balloon and slightly to one side of the obstruction. A second observer would carry the auxiliary cord downwind from the balloon and further to the same side of the obstruction so that auxiliary cord is taut and forms an angle of about 45° with the line from the balloon to the radiosonde. A third observer should hold the balloon. At the moment of release, force applied to the auxiliary cord will deflect the balloon and cause it to travel across the wind flow as well as downwind as it rises. When the lateral movement has been sufficient for the train to clear the obstruction, the auxiliary cord should be released to permit the train to continue its ascent.

4. Entries on Recorder Record, Calibration Chart or WBAN-31A.

4.1 Surface Observation at Release. Make a complete surface observation as close as possible to the time of the release and enter the data on WBAN-31A under the caption "Surface Observation at Release". This observation may be taken just before the release provided that doing so does not delay the release and provided that not more than 10 minutes elapse between the beginning of the surface observation and the actual release. Whenever the surface observation is not taken within 10 minutes before the release time, it will be taken as soon as possible after the release.

4.2 Time of Release. Enter the time of release to the nearest minute, GMT, on the recorder record, calibration chart and the WBAN-31( ).

4.3 Pressure. Enter the station pressure to hundredths of an inch and tenths of a millibar on WBAN-31A. However, stations equipped with a precision aneroid barometer calibrated in millibars will omit the entry in inches. (NOTE: All AF, N stations will read and record pressure in terms of millibars.). Use table B2-2 to correct the station pressure to the surface pressure. Enter the correction and the surface pressure to tenths of millibars on WBAN-31A. Surface pressure and surface altitude (gpm) refer to the value of the data at the following points listed in order of priority:

a. The floor of the instrument shelter if within three meters of the actual height of the release point and the shelter is used in the measurement of the surface temperature and relative humidity.

b. The intake of the official temperature measuring equipment (hygrothermometer, etc.) if within three meters of the actual height of the release point.

c. The height of the release point, as established for the station. This height will be considered to be four feet above the floor of the radiosonde balloon inflation shelter.

4.4 Temperature. Whenever a telepsychrometer or hygrothermometer is available and operative, it will be used in accordance with instructions in Federal Meteorological Handbook No. 1 (Surface Observations) to obtain data for the raob surface observations.

a. The telepsychrometer yields values for the dry-bulb and wet-bulb (via wet-bulb depression) temperatures. These values should be entered on Form WBAN-31A in the surface observation block, in terms of whole °F, and the equivalent °C will be entered to the nearest tenth of degree. Relative humidity and dewpoint temperature should be computed using the Fahrenheit readings.

b. The hygrothermometer yields values of temperature and dewpoint. The temperature should be entered on Form WBAN-31A in the surface observation block, in terms of whole °F, and the equivalent °C will be entered to the nearest tenth of degree. The relative humidity should be computed using the temperature and dewpoint readings (°F). Entry of a value for wet-bulb temperature may be omitted.

4.4.1 Ventilated or Sling Psychrometer. If a telepsychrometer or hygrothermometer is not available or is inoperative, the ventilated or sling psychrometer will be used to obtain the temperature at release. Enter the dry and wet bulb readings in degrees and tenths as indicated in the following paragraphs.

a. If the thermometers are calibrated in degrees Celsius and a psychrometric calculator is available to compute relative humidity using Celsius temperature, then the temperatures will be entered directly on WBAN-31A without conversions. If a psychrometric calculator is not available, table 4 in the Radiosonde Observation Computation Tables (WBAN) may be used to compute relative humidity.

b. If the thermometers are calibrated in degrees Fahrenheit, the relative humidity will be computed using those temperatures directly by means of a psychrometric calculator. The dry bulb temperature will be converted to °C. Entries on WBAN-31A will include both °C and °F for the dry bulb and °F for the wet bulb.

4.5 Relative Humidity. Compute the relative humidity in accordance with ¶B2-7.1. When the wet-bulb is covered with water and a depression cannot be obtained, the relative humidity will be regarded as 100 percent and the dewpoint the same as the wet-bulb. If the wet-bulb is covered with ice and a depression cannot be obtained, the relative humidity will be regarded as 100 percent with respect to ice and its water equivalent determined, as indicated on the psychrometric calculator, when the dry-bulb is less than 0°C, except that whenever liquid fog is present at the station and no depression is obtainable, it will also be regarded as 100 percent with respect to water. The surface relative humidity will not be calculated when the surface temperature is colder than -35°F or -37.2°C. Enter the relative humidity to the nearest whole percent, on WBAN-31A.

4.6 Surface Wind. Enter direction in digit form to the nearest 5 degrees (5, 30, 245) and speed to the nearest whole meter per second (4, 23, 109) on WBAN-31A. When the wind is calm, enter "0" for the direction and "0" for the speed.

4.7 Clouds and Weather. The clouds and weather will be entered on WBAN-31A.

4.7.1 Clouds. When clouds are not present, enter "Clear." When clouds are present, enter the amount, and type in accordance with instructions in the Federal Meteorological Handbook No. 1 (Surface Observations), e.g., 10 As. The total amount may exceed ten-tenths when pilots' reports or frequent observations indicate the extent or existence of cloud layers above lower layers.

4.7.2 Weather. Use the same symbols for recording weather as those employed in the Federal Meteorological Handbook No. 1 (Surface Observations) for similar entries.

4.7.3 Entry of Raob Balloon Into Base of Clouds. Whenever requested, observe the entry of the raob balloon into the base of any clouds that may be present. The observer at the recorder will mark on the recorder record the point of the balloon's entry into the cloud layer.

4.8 Identification Stamp. Enter the name of the station, the date and time of release GMT, the ascension number, the radiosonde serial number, the reason for termination of the observation, and the names of the computer and verifier. Place the stamp within the first seven inches of the recorder record so as not to interfere with the baseline-check. The left edge of the stamp should be at approximately the ten ordinate line.

5. The Recorder Record. The task of the observer at the recorder is to obtain an accurate and continuous recording of the signal transmitted by the radiosonde. As the radiosonde moves away from the earth's surface, the radiofrequency usually drifts slightly, making it necessary for the observer to retune occasionally. Ground equipment with automatic frequency control usually will not require manual retuning during a sounding. The observer at the recorder will evaluate as much of the recorder record as possible while the balloon is ascending. The remainder will be completed as soon as possible after the termination of the flight.

5.1 Setting Low Reference. As each low reference is recorded, first note that the receiver is properly tuned and that the trace is being recorded clearly. Then, if required, adjust the low reference to 95.0, making sure that this adjustment is completed and a portion of the adjusted trace is recorded before the signal switches to the temperature circuit. In no case will the low reference be adjusted before a portion of the trace needing adjustment is recorded. If the ascension rate is so high that the recorder low reference traces are too short to provide a readable record both before and after adjustment, an adjustment will not be made. Similarly, an adjustment will not be made when the low reference trace is so scattered or unsteady that there is doubt as to the actual value of the low reference ordinate. If the reference was adjusted to 95.0 ordinate, and the radiosonde switches to temperature before a portion of the adjusted trace could be recorded, a notation, (Adj.), will be placed at the point of adjustment.

5.2 Recorder Zero. It is necessary, during the observation, to occasionally examine the sprocket holes of the paper to see if the paper is creeping up on the pins. If it is, turn the proper switch momentarily to obtain a record of the recorder zero. If the drift appears to be uniform and 0.3 ordinates or more, paper drift corrections will be applied (see ¶B4-17). If the paper drift does not appear to be uniform, make the best possible estimate of the drift and apply the drift correction as required. Paper drift is a result of misalignment of the chart paper with respect to the sprockets on the chart drum, caused by the misalignment of the paper supply roll. Adjustment controls are provided to permit correct alignment of the supply roll with respect to the chart drum sprockets.

5.3 Recording Low Ordinate Values. On some types of recorders, it is difficult to obtain a trace at low ordinate values (below 5 ordinates). In this case, and in this case only, it will be permissible to draw the missing trace with a hand held pen. The trace will be drawn where the pen was observed to be at the time. A notation will be placed on the recorder record indicating the portion of the trace that was drawn by hand. In no case will the sensitivity of the recorder be reduced to obtain this trace.

6. Selection of Significant Levels. Significant levels are placed on the recorder record to mark the boundaries of strata having differing temperature lapse rates or vertical humidity gradients.

6.1 Identification of Significant Levels. Identify the significant level by drawing a line completely across the recorder record at that point.

6.2 Surface. The first significant level is the point of the balloon's release. Determine from the recorder record the contact value at release and enter it on the surface level slightly to the left of the ordinate equivalent of the surface temperature and in the appropriate block on WBAN-31A. Determine the recorder values of the observed surface temperature and humidity and enter circled dots on the first level of the recorder record and label them T and RH as appropriate.

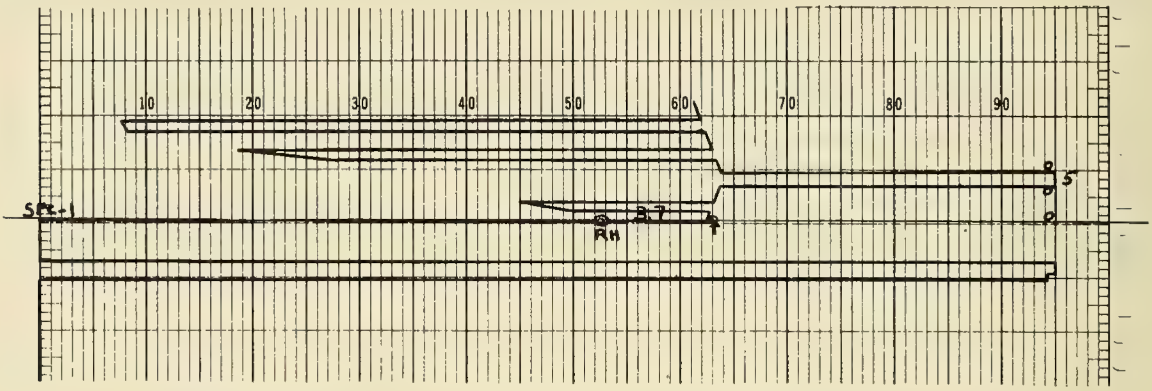


Figure B4 - 1. Significant Level (Surface)

6.3 Significant Level Above the Surface. No significant level will be placed within 10 mb of the surface level since this portion of the record may not be representative.

6.4 Priorities for Selection of Significant Levels. In selecting significant levels, the temperature departure levels are selected first, additional levels required by ¶B4-6.6 second, and relative humidity levels last. When selecting levels for temperature, however, the observer should be aware of the relative humidity trends so that, when necessary, a level may be selected advantageously to reflect changes in trend of both temperature and relative humidity. When the levels have been selected and the evaluated data plotted on the adiabatic chart, the resulting curves must closely reflect the profile of the recorded traces and agree everywhere with the traces within ± 1°C from the surface up to and including 100 mb and ± 2°C from 99 mb up to and including the termination, and within 10% in relative humidity for all humidity evaluated.

6.5 Selecting Significant Temperature Levels. In selecting levels for temperature, all points at which there is change in the slope of the traces on the recorder record must be examined for possible placement of significant levels. Find these points by using a straight-edge to identify successive segments having a uniform slope.

a. Align the lower portion of a straight-edge with the point where the recorded trace intersects the preceding significant level. If the preceding significant level is the surface, align the straight-edge with the ordinate equivalent of the observed surface temperature.

b. Maintaining the lower portion of the straight edge in position (a), move the upper portion to successive points of change until the departure between the trend indicated by the straight-edge and any point of change on the intervening record equals or exceeds $\pm 1°C$ from the surface up to and including 100 mb and $\pm 2°C$ from 99 mb up to and including the termination.

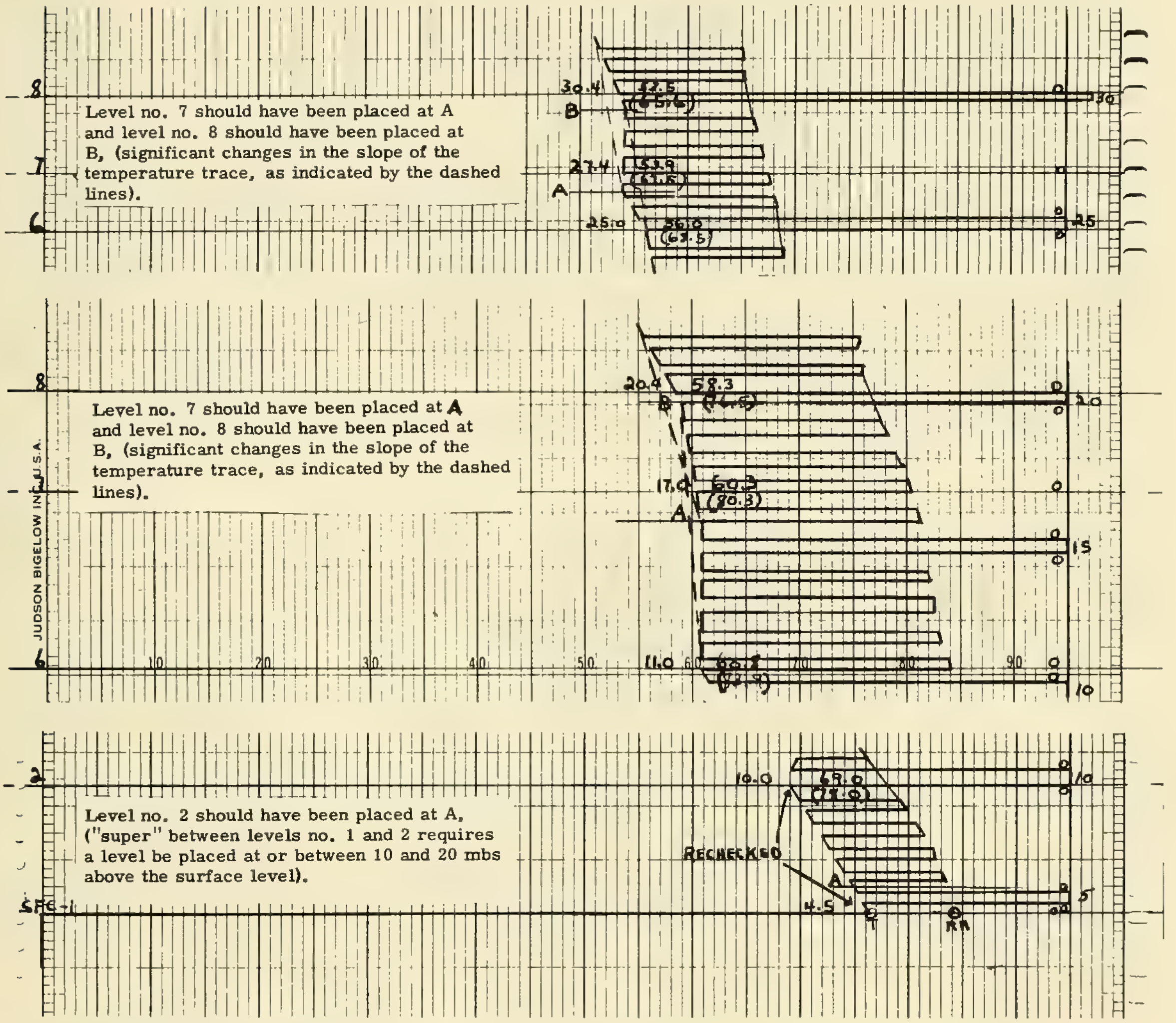


Figure B4-2. Incorrect Selection of Significant Levels

6.6 Additional Levels. Place additional levels as follows:

a. At the highest complete contact of the first ascent, and at the same contact of the second or last ascent, when the radiosonde descends owing to icing or turbulence, and then rescends.

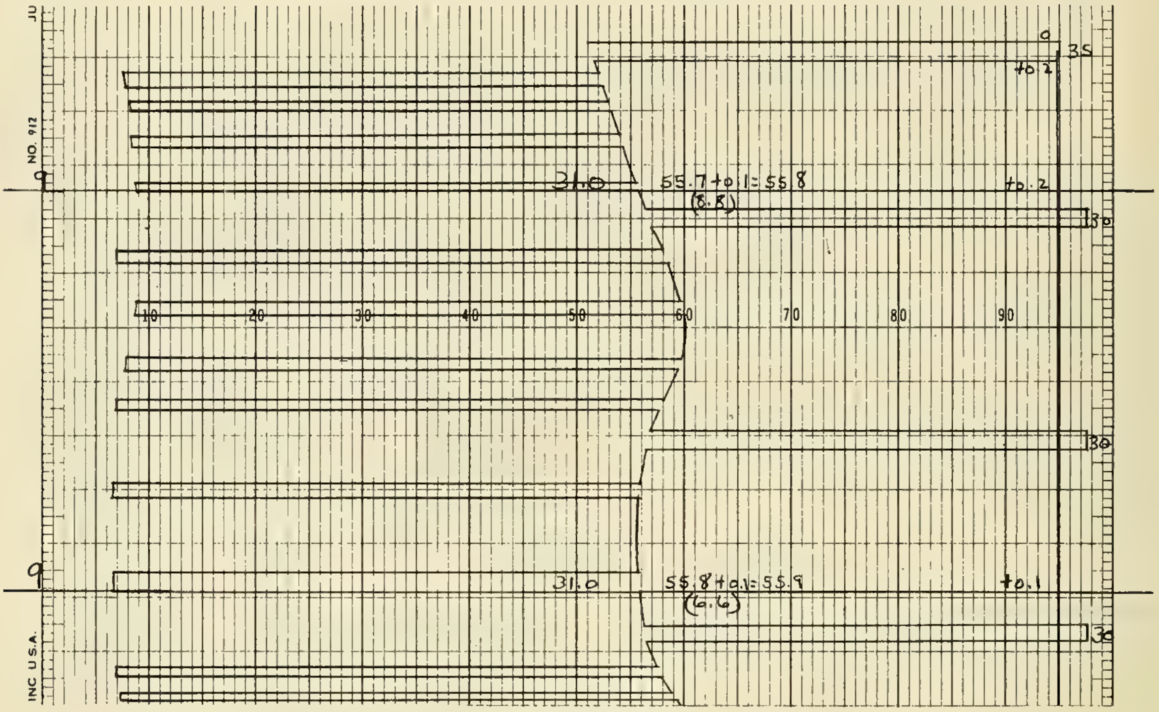


Figure B4 - 3. Balloon Forced Down by Ice

b. At the bursting point of the balloon or at the highest usable point of the record. When the bursting point occurs during a reference or a relative humidity contact, the evaluation of the flight will be terminated at the top of the last temperature contact. When all or part of the last temperature trace has a decidely rounded appearance and indicates a marked increase in

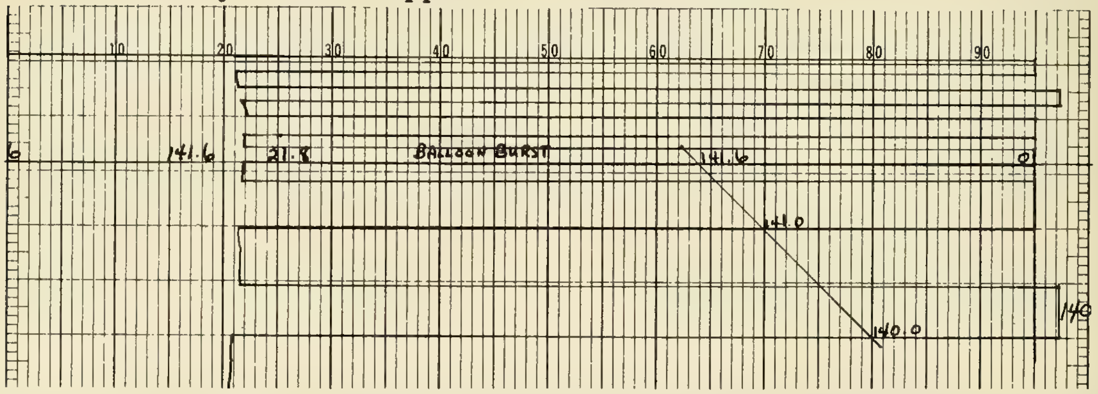


Figure B4-4. Balloon Burst. At balloon burst the contact point may be jarred to indicate slightly higher pressure. The true contact can be determined by extending a 10 ordinate per contact line through the last complete contact up to the level of balloon burst.

temperature that is not supported by the lapse rate of the trace immediately preceding, the terminating level will be placed at the point where the marked increase begins; this phenomenon should not be confused with explosive warming (see Fig. B4-9). When the radiosonde ascends beyond the last printed calibration contact, the sounding will be terminated at a pressure corresponding to this contact. This contact will be considered as the highest usable point of the calibration chart. "Chart Limitations" will be used as the reason for termination. Do not attempt to extrapolate the baroswitch or hypsometer calibration beyond the last printed contact.

c. (WB) At 5 millibars which will be the terminating level on the adiabatic chart when the pressure is derived from baroswitch data. When the flight continues to altitudes higher than 5 mb., continue the selection of levels in accordance with applicable requirements. Enter the evaluated data from these levels in the data block on WBAN-31C, but do not plot the data on the adiabatic chart or enter it in the CPD blocks.

d. At the beginnings and endings of strata:

1. whose temperature is classified as missing or doubtful.

2. whose humidity is classified as missing provided the strata of missing humidity extends over more than 50 mb (see ¶B4-7.5.2(c)).

3. a combination of (1) and (2).

On the levels bounding both missing humidity and temperature enter "Begin (or End) missing data." On the levels bounding doubtful temperature enter "Begin (or End) doubtful temp." On the levels bounding missing relative humidity only, enter "Begin (or End) missing RH." This notation will be made close to the evaluated data but in a position where it will not interfere with or obliterate any part of the record or the evaluations.

e. Within each stratum whose humidity and temperature are both classified as missing. Since it will not be possible to evaluate data pertaining to such levels, the exact points at which the levels are placed are unimportant, but it is necessary that they be assigned a level number to aid in constructing the adiabatic chart and coding the raob message. For these purposes, only one level will be placed within each stratum of data classified as missing. Enter "Missing Data" on these levels.

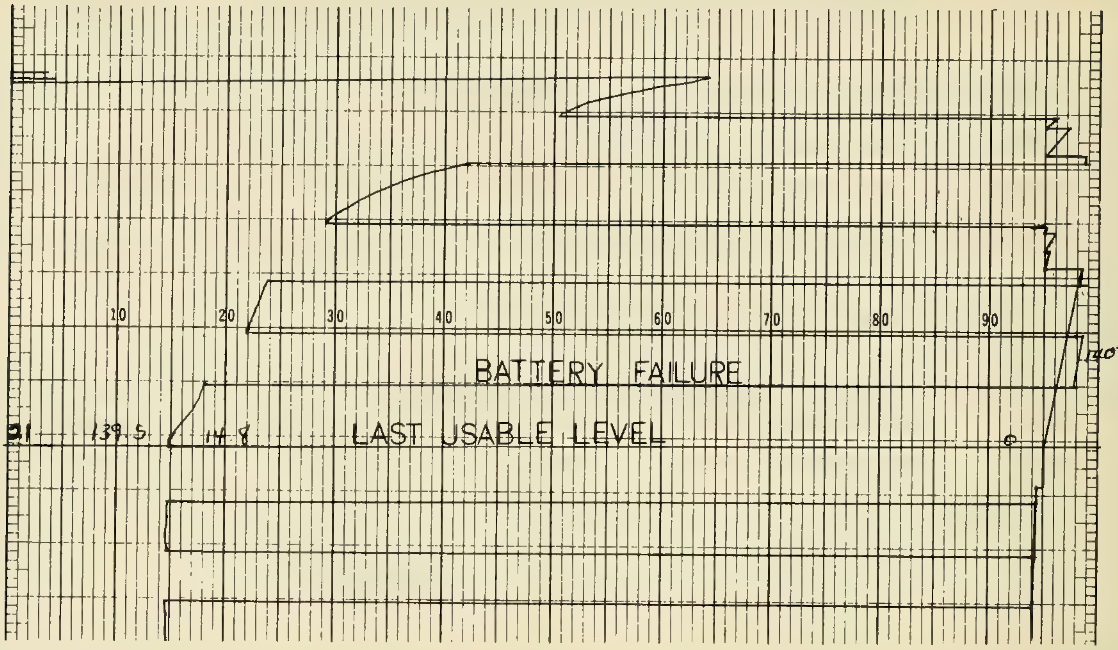


Figure B4-5. Battery Failure. Levels cannot be selected after the battery begins to fail because the usual drift corrections are not applicable. During battery failure temperature and references drift independently of one another.

f. At or between 10 and 20 mb above the surface, when a surface based superadiabatic lapse rate is encountered.

g. Between 400 and 500 mb, to provide a common level for WBAN-31A and 31B whenever a sounding extends to a pressure lower than 400 mb. A common level will be provided similarly at or between 125 and 100 mb and 12.5 and 10.0 mb.

h. At the base of a stratum within which icing occurs. The occurrence of icing under favorable conditions of temperature and relative humidity is usually indicated by a decrease in the ascension rate of the raob balloon and a consequent lengthening of the contacts on the recorder record. Since a decrease in the ascension rate can be caused by turbulence as well as icing, the temperature and relative humidity will be examined critically before assuming that the decrease is a result of icing. There should be a progressive increase in the length of the contacts to support the assumption that the accretion of ice is increasing. This increase cannot usually be exhibited in less than four contacts. Moreover, the temperature should be close to freezing or below, and the relative humidity high. The selection of a level at the base of a stratum within which icing occurs should be correlated with the selection of RAICG and RAFRZ data.

i. At a pressure corresponding to any mandatory level (mandatory levels are as specified in the Federal Meteorological Handbook No. 4 (Radiosonde Code)) unless for some other reason a level has already been selected within ± 100 mb. of the pressure at the mandatory level.

6.7 Selecting Significant Relative Humidity Levels. In selecting levels for relative humidity, any points where the relative humidity deviates 10 percent or more in linearity from the relative humidity curve is significant and a level is placed at this point. Departure from linearity is established by placing a straight-edge between relative humidity ordinate values of two consecutive levels previously selected. The horizontal distance of any trace on the curve from the straight-edge is the departure from linearity. The level selected in accordance with this procedure should be placed at the point of maximum departure from linearity, except that if an accompanying change in temperature lapse rate or a requirement for an additional level should make it desirable, the level may be placed within one contact above or below this point. The maximum humidity departure may be extended (vertically on the recorder record) to this level provided it is not 10 percent less or greater than the actual recorded relative humidity and that by doing so, no relative humidity trace, between the extended trace and the previous significant level, departs from linearity by 10 percent or more. When relative humidity level selection is continued above this level, the extended relative humidity trace will be considered rather than the actual trace.

Relative humidity will be evaluated on the recorder record only for levels with temperatures of -40°C or warmer and within the portion of the recorder record where relative humidity data are normally received. A significant level, based on either temperature or humidity must be placed within the -37°C to -40°C portion of the recorder record. This level for the final measurable humidity, however, must be placed at the highest point necessary to provide the maximum amount of relative humidity data for the CPD blocks.

Example: Pressure at -37°C is 312 mb. Pressure at -40°C is 289 mb. In this case a level would be selected at or between 289 and 300 mb, to provide relative humidity data for the 300 mb CPD block.

Whenever the surface temperature is colder than -37.2°C and whenever the evaluation of relative humidity has been discontinued because the temperature has fallen to colder than -40°C, and the temperature again rises, the evaluation of the relative humidity will not be resumed unless the temperature becomes warmer than -35°C. If, however, it is resumed, the first level after resumption will be placed within the -37 to -40°C. portion. The level for the beginning or the resumption of relative humidity must be placed at the lowest point necessary to provide the maximum data for the CPD blocks. When the surface temperature is -37.2°C or warmer and the temperature falls to colder than -40.0°C within the first ten millibars of the flight, a level will not be selected to show the last measurable humidity of that portion of the flight.

7. Evaluating the Recorder Record. Usable record will be obtained and evaluated to the highest altitudes possible. A second release will be required whenever the raob terminates at a pressure higher than (WB 225 mb) or (AF, N 60 mb) or fails to meet the other conditions of doubtful and missing data as prescribed in the following paragraphs.

7.1 Requirement for Satisfactory Flight. While evaluating the recorder record, the observer will be alert for evidences of conditions that will necessitate a second release. Whenever necessary, a second radiosonde will be released as promptly as possible in order to stay within the time limits of scheduled observation (see ¶B4-1 for instructions concerning delayed observations). However, if because of unfavorable atmospheric conditions or other reasons, it is apparent that a pressure equal to or less than 225 mb or 60 mb, as applicable (see ¶B4-7), cannot be attained in subsequent attempts, an additional release will not be made. If a second release is not made and the record from the first one is usable, even though it did not extend to a pressure equal to or less than 225 mb or 60 mb, as applicable, the record from the first release will be evaluated and used for summary and transmission purposes. When a second release is required but not made, the reasons for the omission will be stated fully in the remarks section of the adiabatic chart for the first release, if evaluated; otherwise, on the adiabatic chart for the next succeeding raob. If a second and succeeding release does not reach the required minimum altitude, the ascension providing the greatest amount of data will be evaluated and used as the official observation. In this case a note will be placed on the first fold of the recorder record of each flight giving a full explanation.

7.2 Left Edge of Traces Used for Evaluation. As in the baseline-check evaluation, the left edge of the recorded traces will be used for all evaluations during the flight.

7.3 Personal Bias. The observer will use no personal bias while evaluating the recorder record, super adiabatic lapse rates, "supers", will not be hidden by "re-evaluating" the recorder record. Assuming the outrigger was fully extended, the proper length of train was placed between the balloon and the radiosonde, and no obvious malfunctioning of the radiosonde and/or ground equipment is evident, the recorder record will be evaluated as accurate.

7.4 Labeling "Supers". All segments on the recorder record which are "super" will be labeled rechecked, with arrows pointing to the bounding levels which were rechecked.

7.5 Doubtful and Missing Data. When the radiosonde or ground equipment functions abnormally, the accuracy of the raob data will be classified in accordance with the following paragraphs. A precise determination of the accuracy of the data will often be difficult or impossible. Classification, therefore, will be based upon the possible error characteristic of common situations.

7.5.1 Temperature.

a. When the possible error is 1°C or less, the data will be regarded as accurate.

b. When the possible error is more than 1°C but not more than 3°C, the data will be regarded as doubtful.

c. When the possible error is more than 3°C, the data will be regarded as missing.

7.5.2 Relative Humidity.

a. When the possible error is 10 percent or less, the data will be regarded as accurate. (Note that the relative humidity may continue accurate within the ±10 percent range even though the temperature in the stratum is classified as doubtful.)

b. When the possible error is more than 10 percent, the data will be regarded as missing. Relative humidity data will not be classified as doubtful.

c. Relative humidity data will be classified as missing whenever the radiosonde fails to transmit humidity or whenever the humidity traces are unreadable and the temperature is -40°C or warmer. If, however, the missing stratum is shallow (50 mb or less in extent) the missing traces may be ignored and the humidity data will be regarded as accurate through the stratum, and evaluated by linear interpolation between the boundry points. When both temperature and relative humidity data of a stratum are classified as missing, the relative humidity will be regarded as missing through the stratum, even though it is 50 mb or less in extent.

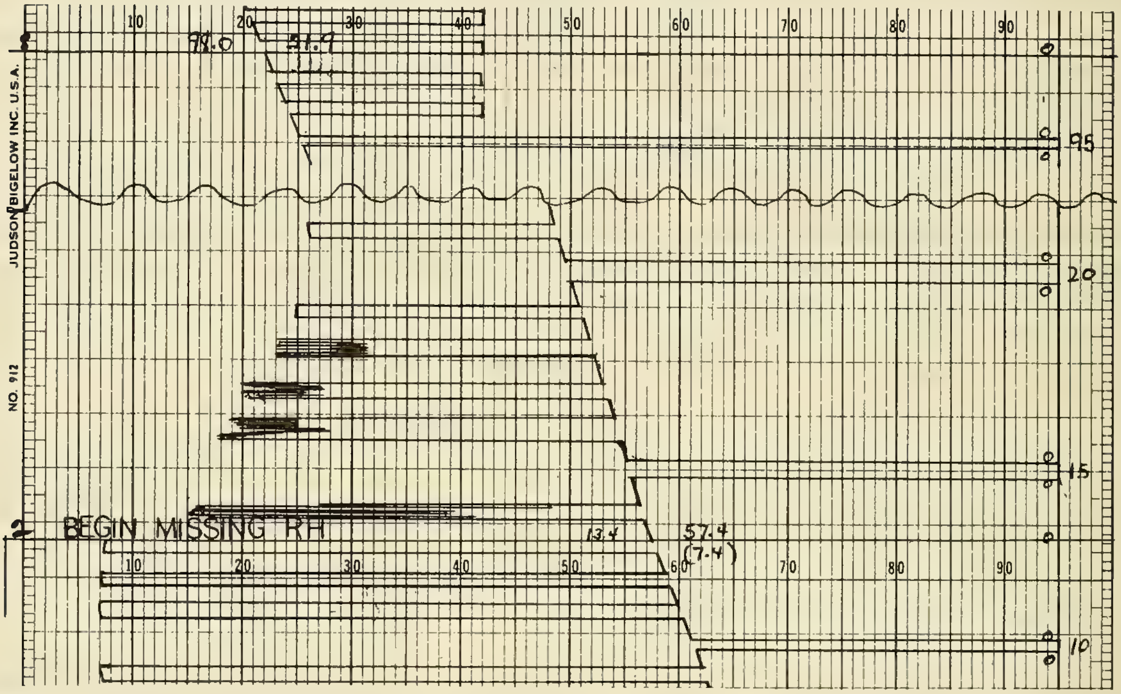


Figure B4-6. Abnormal Hygristor Action. During a flight thru precipitation the hygristor may fail. The failure would be indicated first as an unsteady humidity trace and then would record unusually high humidity throughout the remainder of the flight.

d. The lower limit of measurable relative humidity is approximately 10 percent throughout the temperature range of the carbon hygristor and the upper limit is 100 percent. When there is no obvious malfunctioning of the radiosonde and the indicated relative humidity exceeds 100 percent by three ordinates or less, the relative humidity will be regarded as 100 percent and used for all purposes as an accurate value.

Whenever 100 percent relative humidity is exceeded by more than three ordinates, a level will be selected at the point where 100 percent was first exceeded and relative humidity above that point will be considered missing for the remainder of the flight. Likewise, when the indicated relative humidity is less than 10 percent by three ordinates or less the relative humidity will be regarded as 10 percent and used for all purposes as an accurate value. Whenever the indicated relative humidity is more than three ordinates less than 10 percent, a level will be selected at the point where the relative humidity was first indicated to be more than three ordinates less than 10 percent and relative humidity above that point will be considered missing for the remainder of the flight.

7.5.3 Altitude. Those altitudes computed from doubtful or missing temperature data will be considered doubtful when the accumulated error in altitudes exceeds the limits in ¶B5-10.2. On the level where doubtful altitude begins, enter on the recorder record "Begin doubtful altitude."

7.6 Classification of Data Associated with either Malfunctioning of Equipment or Unusual Meteorological Conditions. Doubtful or missing temperature data are possible when:

a. The instrument and/or ground equipment is malfunctioning and there are obvious evidences on the recorder record that erroneous data are recorded.

b. The instrument and/or ground equipment is malfunctioning and there are no obvious evidences on the recorder record that erroneous data are recorded. If data for an observation are classified other than accurate and if the reason(s) are not apparent on the recorder record, notes to explain the reason(s) for this classification will be entered on WBAN-31A.

c. There is an intermediate stratum of entirely missing or scattered temperature traces.

7.7 Evidence of Malfunctioning. Some of the more obvious evidences of malfunctioning, the underlying causes, the general characteristics of these, and a guide for determining the possible error are:

a. Independent Temperature Shift. When the temperature frequency signal changes without a corresponding change in the low reference frequency signal, an abrupt shift will occur in the temperature trace without a change in the temperature before and after the shift. If the shift is more than 1°C but not more than 3°C, classify the data above the independent shift as doubtful; if more than 3°C, classify the data as missing; i.e., terminate the sounding at the point of the shift. (Do not mistake a "wet bulb" effect for an independent temperature shift.)

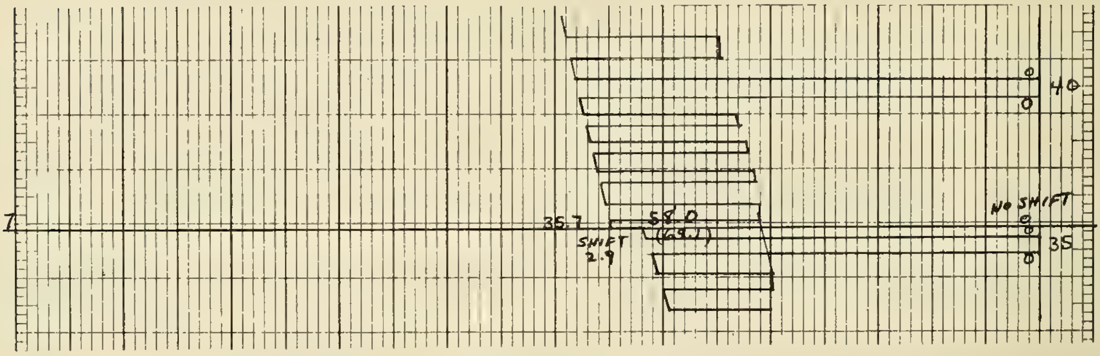


Figure B4 - 7. Independent Temperature Shift

b. Lack of Sensitivity. Sensitivity is the measure of the recorder's ability to return to the same ordinate value when this value is approached from upscale and downscale, or the recorder's ability to respond to small changes. A lack of sensitivity is indicated by failure of the recorder pen to return to the correct ordinate value. This failure results in "stepping of the traces" and is most noticeable when the radiosonde switches from reference to temperature or when the pen shifts abruptly in the middle of the temperature trace after having been recording nearly isothermally. When lack of sensitivity becomes apparent, action must be taken to have the ground equipment serviced before the next flight. Failure to do so may result in many non-representative "supers" aloft and data which are doubtful. When there is a lack of sensitivity, levels should be selected as near to the top of the temperature trace as possible. If the temperature traces show abrupt changes of more than 1°C, the data will be classified doubtful.

c. Fading or Weak Signals. Some factors which could cause this condition are very strong winds aloft which will carry the instrument out of the range of good reception, weak batteries, bad ground equipment, and failure to tune the ground equipment properly. If weak or fading signals persist, action must be taken to have the ground equipment serviced. The temperature trace may be entirely missing or scattered to such an extent that actual ordinate values cannot be determined. When such a stratum exceeds 100 mb. between the surface and 400 mb., 50 mb. between 400 and 100 mb., and 25 mb. between 100 mb. and the termination, the data within the stratum will be classified missing. When it does not exceed these limits, the possible error will be computed as follows: Project a line following the trend of the last good temperature trace to the level of the first good temperature trace above. Likewise, project a line following the trend of the first good temperature trace down to the level of the last good temperature trace below. If the difference between the temperature at the top or bottom (use the point of least difference) of the missing stratum and the projected line is 1°C or less, classify the data in the stratum as accurate. If the difference is more than 1°C but not more than 3°C, classify the stratum as doubtful. If the difference is more than 3°C, classify the stratum as missing.

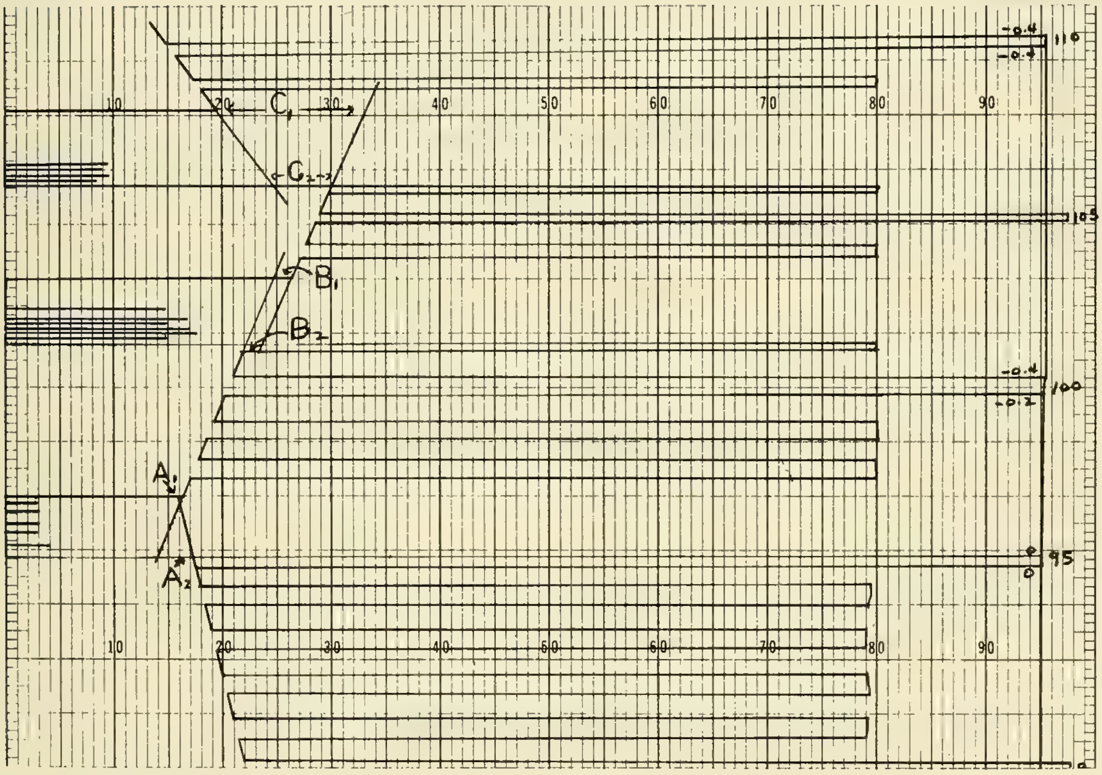


Figure B4-8. Classification of Shallow Strata of Missing Temperature. The stratum, A_1 to A_2, is classified as accurate, (less than 1°C at A_1). The stratum, B_2 to B_1, is classified as doubtful, (more than 1°C but not more than 3°C at B_2). The stratum, C_2 to C_1, is classified as missing, (more than 3°C at C_2).

Special Note: If the signal does not remain steady long enough to print a readable vertical line of the value in question, no value should be assigned. In no case should a line of pen reversal be considered sufficient evidence to assign values at this line.

d. Unstable Temperature Traces. Failure of a component in the radiosonde is the most likely source of unstable temperature traces. The resultant data are fluctuating traces with considerable change within and between most of the traces. Whenever changes within these traces or whenever abrupt changes in the trends of the traces exceed 1°C, the data will be classified doubtful. When, in general, these changes exceed 3°C the data will be classified as missing.

7.8 No Evidence of Malfunctioning. Some types of ground and flight equipment malfunctioning exhibit little or no evidence on the recorder record. These cases, however, do show certain patterns and a knowledge of these is very helpful in the classification of the data.

7.8.1 Leaking Pressure Cell. The inside of the radiosonde pressure cell, if constructed properly, is as near a vacuum as feasible. When the pressure cell is leaking, air enters the cell. The entrapped air then causes the cell to expand more rapidly than it should as the instrument is carried aloft and, in turn, causes the instrument to record higher contact values (lower pressures) than should be indicated. Therefore, as long as the lapse rate is positive (temperature cooling with an increase of altitude) and the pressure cell is leaking, the temperatures will be too warm. When this lapse rate reverses itself and becomes negative (temperature warming with an increase of altitude), a leaking pressure cell will cause the temperature data to be too cold. This temperature pattern is useful in determining approximately where in the flight the effects of a leaking pressure cell begins to show up. Another useful tool is the rate of ascent. If ascension rates for strata 1 or 2 km in extent are computed (the heights above the station for the minute readings on Forms 20 or 21 may be used) for the portion of the sounding which appears erroneous and a marked increase from one stratum to another occurs and an above normal ascensional rate continues thereafter, the pressure data are probably questionable. Another, and possibly the best indication that incorrect pressures are being received is the recording of data on the recorder above the limits of the commutator bar in the form of a continuous temperature trace. Whenever, in the best judgment of the observer, the pressure data are believed to be incorrect because of a leaking pressure cell, all data from the beginning of the suspect portion of the record will be classified as missing.

7.8.2 Sticking Contact Arm. A rough commutator bar, foreign matter on the commutator bar, and a rough point on the contact arm are some factors which may cause sticking or retarding of the contact arm. Many of the characteristics of this malfunction are completely opposite to those of a leaking pressure cell, i.e., lower contact values (higher pressures) will be recorded than should be indicated. If a contact arm "sticks", it usually remains in this position for a time and the contact becomes excessively long. If it becomes unstuck, it jumps to the ambient pressure and either misses or passes over the intervening contact very quickly. Thus, uneven or missing contacts usually result. These uneven contacts should not be confused with turbulence or possible vertical currents. Whenever, in the best judgment of the observer, the pressure data are believed to be incorrect because of a sticking contact arm, all data from the beginning of the suspect portion of the record will be classified as missing.

7.8.3 Electrical Leakage in the Baseline-Check Box. Moisture or some other foreign material in the radiosonde baseline-check box test plug and/or switch may cause electrical leakage. When this condition exists, the temperature ordinate value will be recorded at a higher value than should be indicated. The baseline-check temperature-ordinate relationship is then incorrect and will result in temperature evaluations aloft which are all too cold, and, as a result, there will be an increasing error in the computed altitude data. When the temperature ordinate equivalent of the actual surface temperature is consistently lower than the temperature ordinate value at release, the electrical leakage checks should be made.

7.8.4 Repeated Contacts. Repeated contacts are a result of a faulty baroswitch assembly. When the recorder record indicates a repeat of contacts which are not associated with the balloon descending and then reascending, data will be classified missing above the point where the repeat began. The data below this point will be considered accurate if the repeated portion was three contacts or less. All data of the flight will be classified as missing when the repeated portion is more than three contacts.

7.9 Classifications for Other Unusual Situations. Recorder records showing unusually steep lapse rates (either positive or negative) that must be evaluated as accurate are:

a. Wet Bulb "Supers". All "supers" which appear to be the result of a "wet bulb" effect will be evaluated as recorded on the recorder record and the data classified as accurate. A "wet bulb" effect may occur when the instrument goes from a moist environment into one which is relatively dry. The ideal situation for this type of moisture change often occurs at the top of a cloud. The stratum above a cloud, especially one caused by convection, is recognized as having a steep temperature gradient. While the instrument is in the cloud, the thermistor may pick up some moisture. Immediately, as entry into drier air takes place, some evaporation of the moisture from the thermistor occurs. Therefore, the cooling caused by evaporation, together with the increase of the lapse rate immediately above the cloud, undoubtedly produce this type of "super".

b. Explosive Warming. During the winter months at some stations between 25° and 70° north latitude excessive warming at approximately 20 mb and above is occasionally encountered. This phenomenon has been termed "explosive warming". Characteristics of this may show up at a station for about 36 hours. Changes of 20-30°C in a very shallow stratum can be expected when this condition exists. (Do not mistake this phenomenon for a battery failure, which affects both temperature and references, or some other instrumental malfunctioning.)

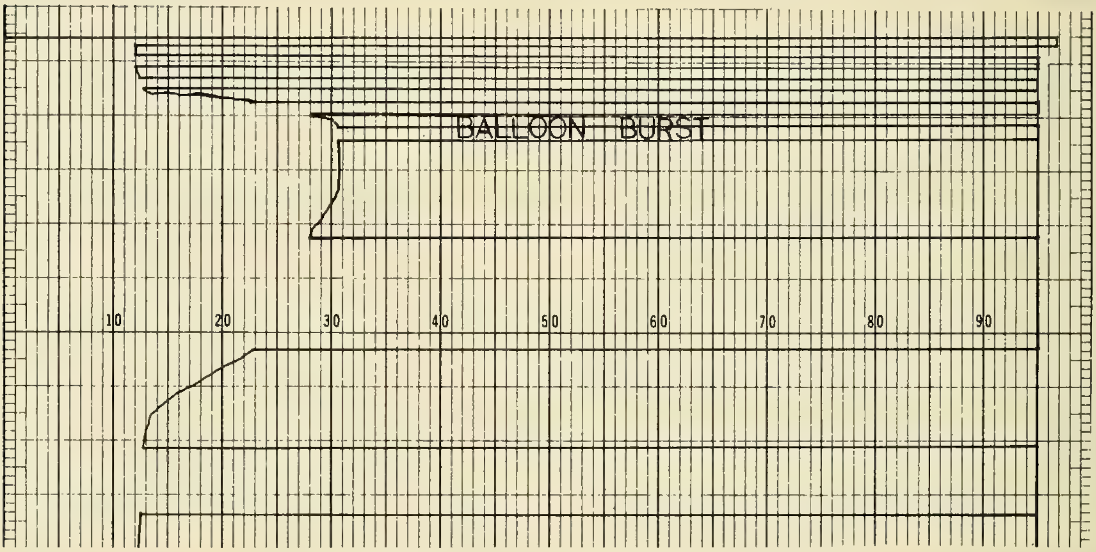


Figure B4 - 9. Explosive Warming

7.10 Continuous Temperature Trace. Whenever the radiosonde fails to switch from temperature so that the pressure-contact values cannot be determined, and then switches again, so that the pressure-contact values are again definitely identified, the pressure for significant temperature levels will be determined as indicated in (e) below. Whenever this occurs above the humidity portion of the record, the pressure contact values should be verified by recording the descent to the recurrence of the humidity traces. Classification of the data will be as follows:

a. If the continuous temperature trace is not more than 100 mbs in extent from the surface to 200 mbs and 50 mbs in extent from 200 mbs to termination, the stratum will be regarded as accurate.

b. When it exceeds the limits in (a) above and no level is required for temperature change, the stratum will be regarded as accurate.

c. When it exceeds the limits in (a) above and a level is required for temperature change, the stratum will be regarded as doubtful.

NOTE: After the radiosonde has ceased to switch for fifteen minutes and minimum height requirements have not been attained, another instrument should be prepared for baseline. If it appears that the radiosonde will continue to fail to switch and time allows for another release, the observation should be terminated at the last known contact and another release made.

d. If the radiosonde should cease to switch, and thereafter only a continuous temperature trace is recorded, the data will be regarded as missing and the computations terminated at the top of the last contact at which switching occurred.

e. If the radiosonde should cease to switch and commence again so that there are known contacts bounding the non-switching portion, data through the stratum will be evaluated as described in the following subparagraphs. Data within the stratum will be regarded as accurate or doubtful in accordance with (a), (b) and (c) above. The observation will be terminated whenever the doubtful stratum exceeds the limits of ¶B4-8.2.

   (1) Place levels on the recorder record at known contacts bounding the stratum of the continuous temperature trace. Determine the temperature and pressure of these levels. Enter the temperature and pressure in the normal manner on WBAN-31( ).

   (2) Draw straight dashed lines between the two levels on the recorder record and also on WBAN-31( ).

(3) Determine from the recorder record the point at which each significant level is required (see Fig. B4-10). Draw a horizontal line on the recorder record through the points representing the significant levels. Evaluate the temperature representing (A) the temperature ordinate and (B) the ordinate where the dashed line intersects the significant level.

(4) Plot the temperature (B) from the dashed-line ordinate of the recorder record on the dashed line of WBAN-31( ) and read the pressure. This is the pressure corresponding to the temperature ordinate of the significant level and should be used without respect to the pressure calibration chart.

(5) Plot the temperature (A) of the significant level at this pressure on WBAN-31( ) and enter both temperature and pressure in the appropriate data blocks.

(6) If the stratum is 50 mb or less consider the relative humidity accurate (see ¶B4-7.5.2). If the stratum is greater than 50 mb consider the relative humidity as missing.

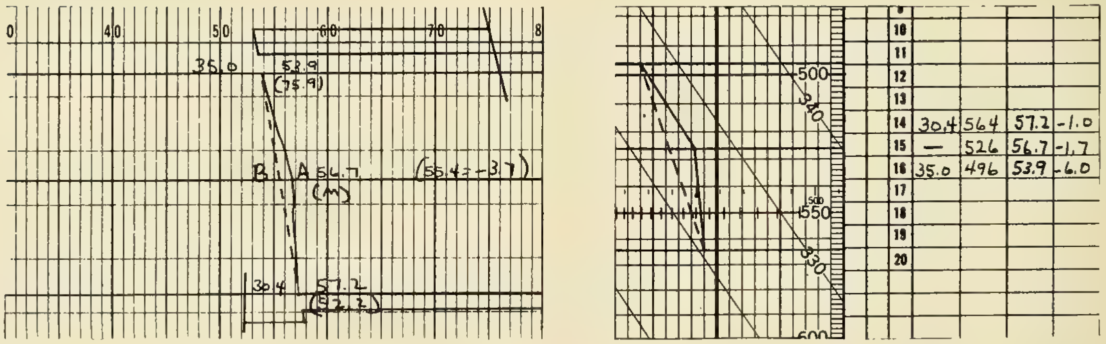


Figure B4 - 10. Evaluation of Recorder Record Thru Continuous Temperature Trace

NOTE: This does not take into consideration that the stratum could be isothermal. In that specific instance or if the lapse rate was shallow, the upper limit could be plotted ten ordinates (or any convenient value) colder or warmer than the lower limit.

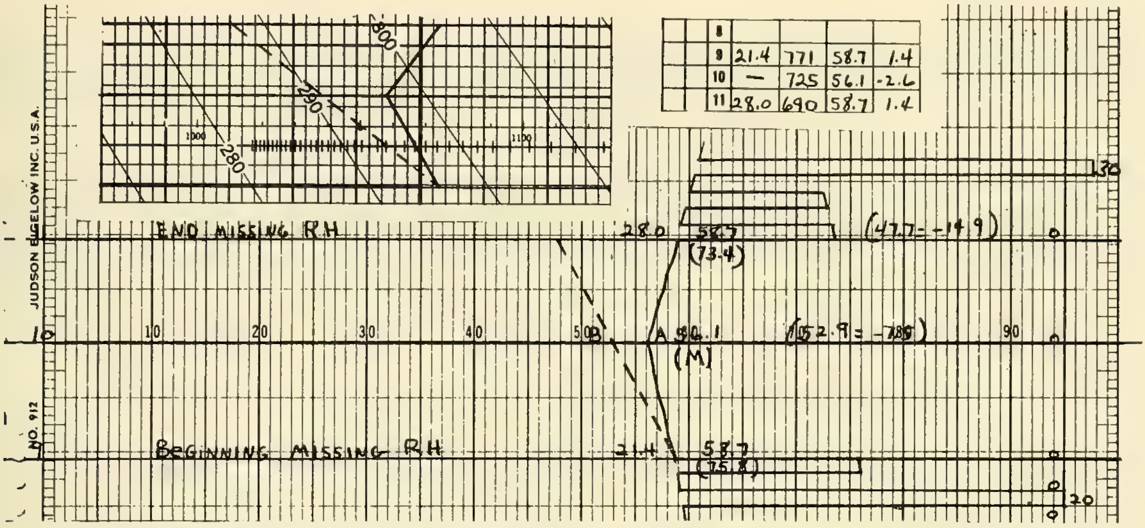


Figure B4 - 11. Displaced Temperature at Upper Limit of Continuous Temperature Trace

7.11 <u>Determining Chart Changeover Temperature in Continuous Temperature Trace</u>. If a continuous temperature trace commences before and extends through the 500-400 mb, 125-100 mb, or 12.5-10 mb, determine the chart changeover temperature, i.e., 400 mb, 100 mb, or 10 mb, as follows:

a. When the continuous temperature trace extends through the 500-400 mb stratum;

(1) Trim a blank WBAN-31B along its 400 mb isobar,

(2) Align this auxiliary chart with the 400 mb isobar of WBAN-31A,

(3) Plot the upper bounding level of the continuous temperature trace on the auxiliary WBAN-31B,

(4) Evaluate the temperature trace and select the 400 mb temperature,

(5) Discard the auxiliary WBAN-31B.

b. If the continuous temperature trace extends through the 125-100 mb stratum;

(1) On a blank WBAN-31B, relabel as many isobars as necessary at half their printed value, e.g., 400 becomes 200, 300 becomes 150, etc.,

(2) Plot the entire continuous temperature trace on this expanded scale of the auxiliary WBAN-31B,

(3) Evaluate the temperature and select the 100 mb temperature,

(4) Discard the auxiliary WBAN-31B.

c. If the continuous temperature trace extends through the 12.5-10 mb. stratum;

(1) On a blank WBAN-31C relabel as many isobars as necessary at half their printed value, e.g., 25 becomes 12.5, 20 becomes 10, etc.

(2) Plot the entire continuous temperature trace on this expanded scale of the auxiliary WBAN-31C,

(3) Evaluate the temperature and select the 10 mb temperature,

(4) Discard the auxiliary WBAN-31C.

7.12 Hypsometer Failure. When a hypsometer is out of fluid or otherwise fails, the pressure indicated by the hypsometer begins to differ from that indicated by the baroswitch trace by increasing amounts. If the provisions of ¶B4-13.1 are met, so that pressure derived from the hypsometer traces are used for radiosonde evaluation, and subsequently a difference of 5 mb or more between the pressure values indicated by the hypsometer and the baroswitch develops, then:

a. If the pressure-altitude data has already been computed from hypsometer data and recomputation of the data using the baroswitch pressure is not feasible (i.e., due to time limitations), the flight will be terminated at the level at which the difference becomes 5 mb.

b. If it is possible to recompute the pressure-altitude data using baroswitch data only, then the baroswitch pressure should be used and the flight evaluated to balloon burst or (WB) 5 mb.

8. Termination Owing to Doubtful or Missing Data. If the following limits are exceeded and the requirements of ¶B4-7 and 7.1 are not met, another release will be made.

8.1 Missing Temperature. Whenever a stratum of missing temperature data is followed by a satisfactory record, the computations will be continued, provided the stratum or strata of missing data do not exceed the following limits:

a. From the surface to 700 mb, 1 km.

b. From the surface to 400 mb, 2 km with (a) satisfied.

c. From the surface to 100 mb, 4 km with (a) and (b) satisfied.

d. From the surface to the termination of the flight, 5 km with (a), (b) and (c) satisfied.

e. When the tropopause occurs in a stratum of missing temperature data more than 3 km thick, the computations will be terminated.

Whenever the limits above are exceeded in one stratum of missing data, the computations will be terminated at the base of the stratum. Whenever the limits above are exceeded in the summation of several strata of missing data, the computations will be terminated at the base of the stratum in which the limits above are exceeded. Entries made in the data blocks for significant levels above the termination of the flight, because of missing data, will be erased.

8.2 Doubtful Temperature. Whenever any portion of the temperature record is classified as doubtful, the computations will be continued in the normal manner, except that more than 1 km of doubtful temperature data below 700 mb will necessitate another release.

8.3 Missing Relative Humidity. When relative humidity data are classified as missing, the computation of a sounding will be continued in the normal manner except as provided in the next paragraph.

If, because of prevailing weather conditions, the relative humidity is of decided importance, a stratum of missing relative humidity data exceeding the limits in ¶B4-8.1(a) and (b) will necessitate another release. Humidity will always be considered important when the station is located in an area for which severe weather warnings or watches have been issued. If time does not permit a second release, which would normally be required because of missing relative humidity on the first release, the first release will be evaluated and the reason for not making a second release will be entered in the remarks portion of WBAN-31A.

9. Drift and Shift Corrections. The following paragraphs explain the method of applying drift and shift corrections to the temperature, humidity, and hypsometer traces of the recorder record.

9.1 Contact Numbers and Drift Line. At each high and low-reference contact, write the contact number (5, 10, 15, 20, etc.) to the right of the reference trace, provided that the contact number is a multiple of 5. Connect each successive recorded low-reference contact with a straight line, termed the "drift line", drawn from the upper left edge of the lower low-reference contact to the lower left edge of the succeeding one, regardless of whether intervening low-reference contacts are missing. This procedure will be altered as explained in the following paragraphs if a shift has occurred between successive low-reference contacts (see ¶B4-9.4 and 9.5).

9.2 Entry of Low Reference Drift. At the bottom and top of each low-reference contact, and immediately to the left of it, enter to tenths of ordinates, with proper sign prefixed, the difference between the low-reference trace and the ninety-fifth ordinate. If the difference is zero enter 0. This difference is termed "low-reference drift correction." Entry of the low-reference drift correction at low-reference contacts may be omitted beginning with the point on the record where low reference replaces the humidity contacts. The low-reference drift correction will, however, continue to be entered at each significant level.

9.3 Low Reference Drift for Surface Level. Draw the drift line vertically, that is, parallel to the printed ordinate lines from the lower left edge of the first low reference after release to the surface level, unless there is evidence to indicate that there has been a shift between release and first low reference. This may be indicated by an abrupt shift in the temperature trace.

9.4 Shift of all Elements. If the record indicates that there has been an abrupt shift (proportional), draw the drift line accordingly. Inspect the record to determine that there has been a shift of all elements and that the shifts are proportional to their ordinate values. Determine carefully that there has not been an independent shift of the temperature trace. Note: A proportional shift in each direction may occur between successive low-reference traces such that the shift does not show up in examining the reference traces.

9.5 Drift and Shift. If there has been a drift as well as a shift, draw the drift line as follows (see Fig. B4-12):

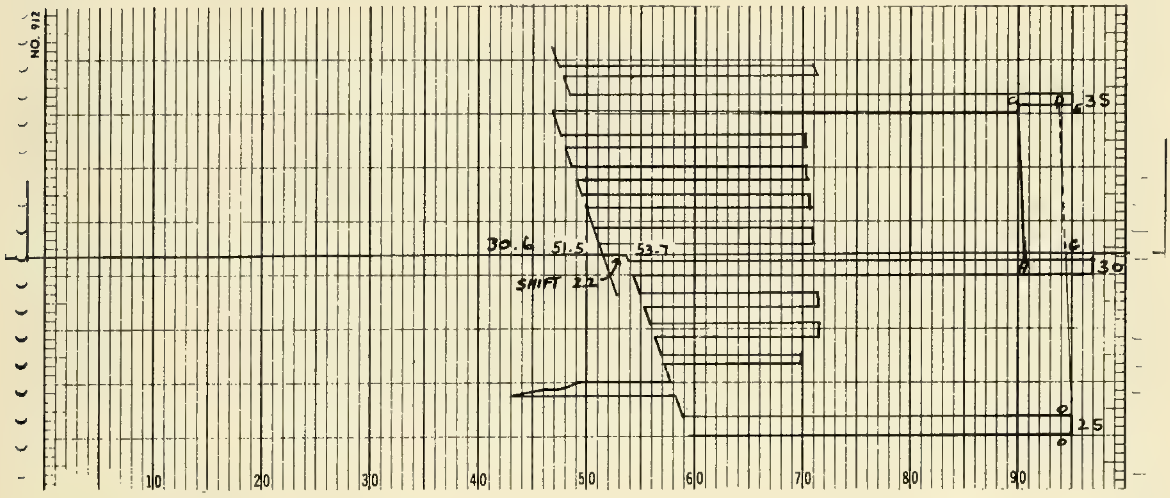


Figure B4 - 12. Shift and Drift

a. Multiply the amount of shift of the temperature ordinate by the ordinate of the low reference before the shift, and divide the product by the temperature ordinate before the shift, thus: $C = \frac{TR}{0}$ where C = Correction for shift to be applied to the following low-reference contact, T = shift of temperature ordinate, R = low-reference ordinate before shift, and 0 = temperature ordinate before shift.

b. At the following low reference, place a point an amount equal to and in a direction opposite from the computed low-reference shift. The difference between this point and the preceding low reference is the amount of drift which occurred in addition to the shift. Draw the drift line from the preceding low reference toward this point, but stop at the level of the shift. Then displace the drift line the same direction and amount as the computed low-reference shift. Continue the drift line to the left edge of the following low reference.

10. Missing Low-Reference Contacts. When one or more low-reference contacts are missing, draw the drift line between the first readable low-reference contact above and below them. If all the low-reference contacts become unreadable, but the high-reference contacts continue readable, determine the relationship between the low and high references

from a previous portion of the sounding, and, using this relationship at each high reference, determine a low-reference value. Draw the drift line through these points. If all reference contacts should become unreadable, but the temperature, relative-humidity, and hypsometer, if applicable, record continues readable, the drift line will be drawn vertically - that is, parallel to the printed ordinate lines from the last readable low (or high) reference contact to the termination of the sounding, provided that there has been little or no drifting and shifting and the temperature record indicates little possibility of a shift having occurred after the low (or high) reference contacts became unreadable. Under these circumstances, the data will be classified as accurate for 20 contacts, doubtful for the next 20 contacts, and missing thereafter. However, if the record indicates that an appreciable amount of shifting or drifting occurred without low or high references being recorded, the data will be classified as missing, since the possible error in such cases may be appreciably large.

11. Data at Significant Levels.

11.1 Numbering of Levels Selected. Number each level, making the surface level number 1, (labeled SFC-1). Write the appropriate number upon the level at the extreme left of the recorder record. In case of multiple ascents (see ¶B4-6.6(a)), the same level number will be given to the base of the last ascent which is equal in pressure to the top of the first ascent.

If it is necessary to place additional levels on the recorder record after the levels have been numbered, the additional levels may be numbered alphabetically as 1A, 2A, 2B, etc.

11.2 Drift Correction. On all levels enter to the left of the drift line the ordinate difference to tenths between the drift line and the ninety-fifth ordinate. If the difference is zero, enter 0. Place a plus sign before the difference if the drift line is to the left of the ninety-fifth ordinate, and a minus sign if it is to the right. Omit this entry if a correction for low-reference drift has already been entered at this point, i.e., the level intersects the bottom or top of a low reference trace.

11.3 Pressure-Contact Value. At each significant level, determine the pressure-contact value to the nearest one-tenth contact by counting the contacts from the preceding reference contact, numbered in accordance with ¶B4-9.1, to the given level. A contact begins at the base of the relative humidity or reference portion and ends at the top of the temperature portion. Except when turbulence is encountered, determine proportional parts of a contact with reference to the whole contact as it appears on the recorder record; that is, the relative-humidity portion of a contact will not necessarily be regarded as four-tenths of the whole contact. When turbulence, either on the surface or aloft, is encountered, make the best estimate possible by considering the length of the preceding and/or following contacts. Enter the values of the pressure-contacts immediately above the level and to the left of the temperature trace. If a hypsometer equipped radiosonde is used, the value of the hypsometer trace will be entered to the left of the temperature trace in place of the baroswitch value after the crossover point is reached (see ¶B4-13.2). On the surface level, enter the value of the pressure-contact at release as it appears on the recorder record (see ¶B4-6.2). The fractional value of the contact at release will be estimated by comparing it with the length of the following contact, except that when conditions of wind and precipitation make this impossible the most reasonable value will be assigned to the contact.

12. Discrepant Contact at Release. The contact value taken from the calibration chart (see ¶B2-15.6) will be compared with the contact value at release as shown on the recorder record.

a. If the difference between these two values is 0.2 contact or less, corrections will not be applied to pressure-contact values for the significant levels.

b. When the discrepant difference is more than 0.2 contact, but less than 3.0 contacts corrections to the indicated pressure-contact values will be determined according to the instructions issued for the particular series of radiosondes. If such instructions are not received for the particular series of radiosondes, the following instructions will be observed. If the release contact on the recorder record differs from the one determined from the calibration chart by more than 0.2 contacts, but less than 3.0 contacts, a correction will be applied to all levels where the aneroid pressure cell is used to determine pressure, that correction is the difference between the value found on the calibration chart and the value found on the recorder record. This value can be either positive or negative depending on whether the contact was set or jarred too high or too low. If, for example, the record shows that the radiosonde was released with the contact point set at 5.0 and the calibration chart indicates that the setting should have been 4.5, the pressure-contact at the surface level will be entered as 5.0 - 0.5 = 4.5. In the same manner, this correction of -0.5 contact will be applied to the pressure-contact values of all other significant levels.

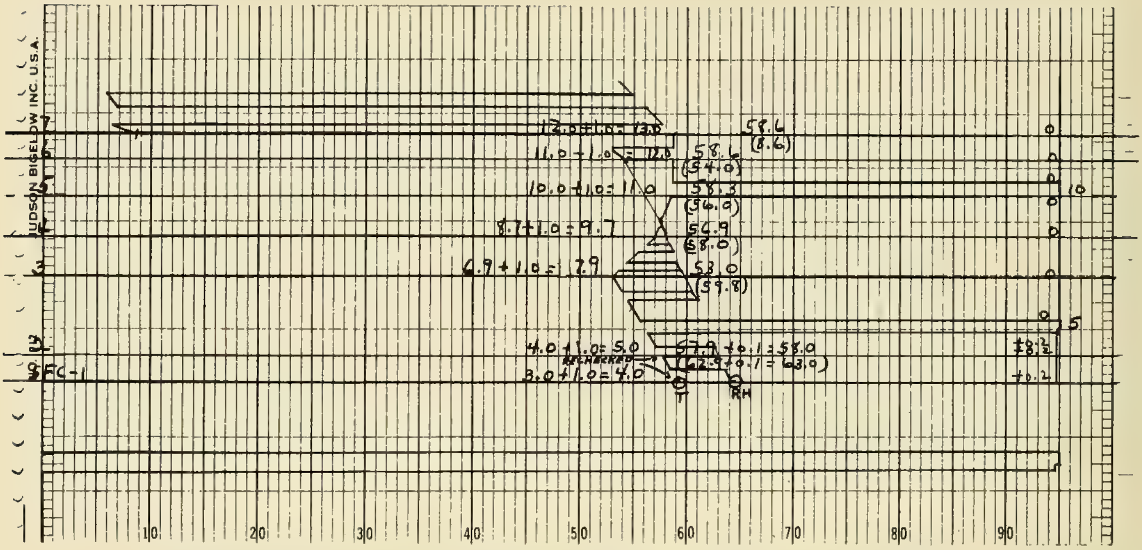


Figure B4 - 13. Discrepant Contact at Release

c. If the contact value at release is 3.0 or more contacts different from the release contact value taken from the calibration chart, all data aloft will be regarded as missing and a new release made.

d. The portion of the flight where the pressure is computed by use of the hypsometer trace will not be affected by a discrepant contact at release; however, when switching from baroswitch to hypsometer evaluation, the corrected baroswitch pressure in (b) above, must be used to compare pressure values.

13. Hypsometer Curve. Construct the hypsometer curve using the following procedures:

a. At the base and top of each hypsometer contact, read and enter the hypsometer ordinate value to the right of the trace. Apply recorder, drift and paper-drift corrections (zero corrections will not be entered). Example: 20.5 - 0.1 + 0.2 = 20.6; where 20.5 is the hypsometer ordinate, -0.1 is the recorder correction, +0.2 is the drift correction.

b. If a correction is needed, place a dot at the correct ordinate value.

c. Draw a straight line connecting the hypsometer traces. If a trace has a correction dot, draw to the dot.

d. If the sounding terminates on a temperature or reference trace, extend the hypsometer trend line to the terminating level.

e. The hypsometer ordinate for significant levels will be read from this constructed curve.

13.1 Evaluation of Hypsometer Data. During the flight no indication of the hypsometer trace will appear on the recorder record until the humidity circuit has terminated. Pressure values will be taken from the baroswitch traces from the release to the level in which hypsometer traces become usable. Criteria for using the hypsometer trace are as follows:

a. Beginning at an altitude where the pressure is close to or slightly less than 50 mb (or 100 mb when calibrated from 100 mb) compare the values indicated by the baroswitch and the hypsometer at successive portions of the hypsometer trace.

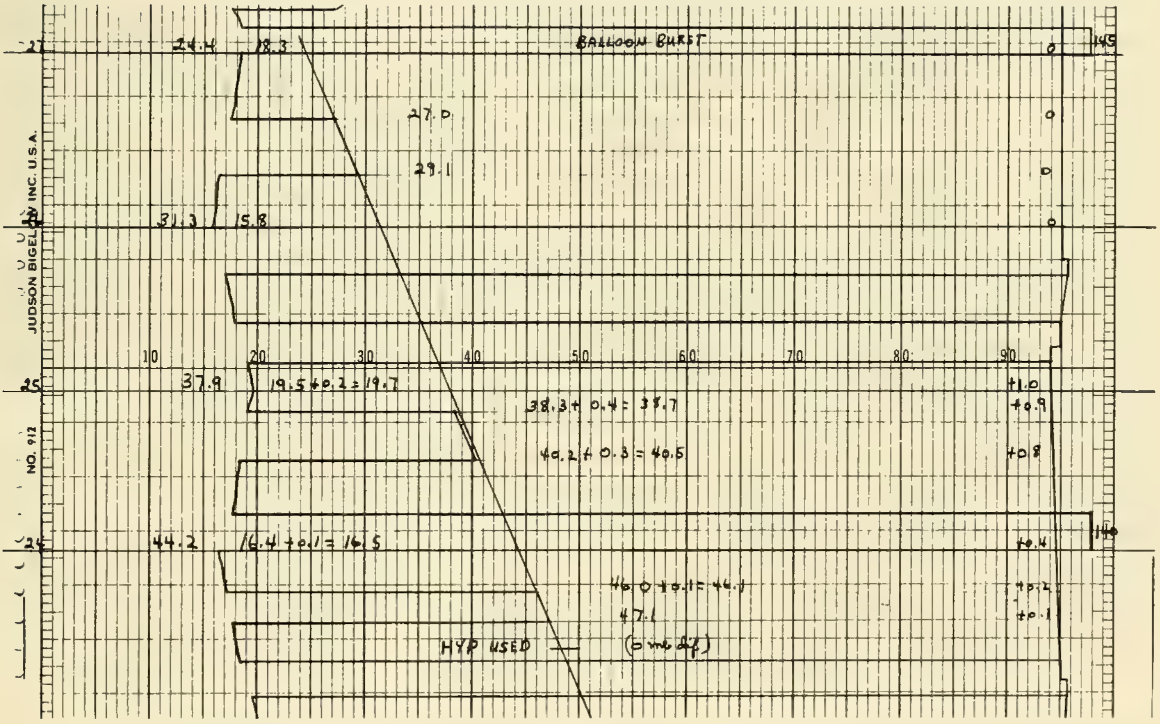


Figure B4 - 14. Evaluation of Hypsometer Data

b. Continue use of the baroswitch trace for pressure evaluation until the difference of this pressure value and the hypsometer is 0 mb. If, however, no point can be found where the difference is 0, prior to the point where the baroswitch trace indicates 15 mbs, use the point of least difference provided the difference is 3 mb or less. If the closest point of difference is greater than 3 mb, continue using the baroswitch traces for the remainder of the sounding.

c. When the above conditions are met, the hypsometer trace will be used to evaluate pressure data for the remainder of the flight except when the hypsometer fails (see ¶B4-7.12).

13.2 <u>The Crossover Point</u>. In order to minimize any pressure difference, and to facilitate the placement of levels in the crossover area, accomplish the crossover as follows:

a. Select the first point on the recorder record where the pressure difference between the calibration charts is the smallest (see ¶B4-13.1). Draw a short horizontal line through the hypsometer curve at this point and label it point "A".

b. Multiply the pressure difference by two (2). The resulting numerical value is the number of minutes below point "A" at which the crossover point is to be placed. At this point draw a short horizontal line through the hypsometer curve and enter "HYP USED". If no significant levels are to be placed between point "A" and "HYP USED", omit steps (c), (d), and (e) below.

c. Read the pressure from the aneroid calibration chart corresponding to the contact value at the point where "HYP USED" was entered. Find the hypsometer ordinate value corresponding to this pressure value from the hypsometer calibration chart.

d. Plot this hypsometer ordinate value on the hypsometer crossover line and label this point "B". Connect points "A" and "B" with a straight line.

e. Compute and use hypsometer pressure for all significant levels falling between points "A" and "B", using line "A-B" as the hypsometer pressure curve.

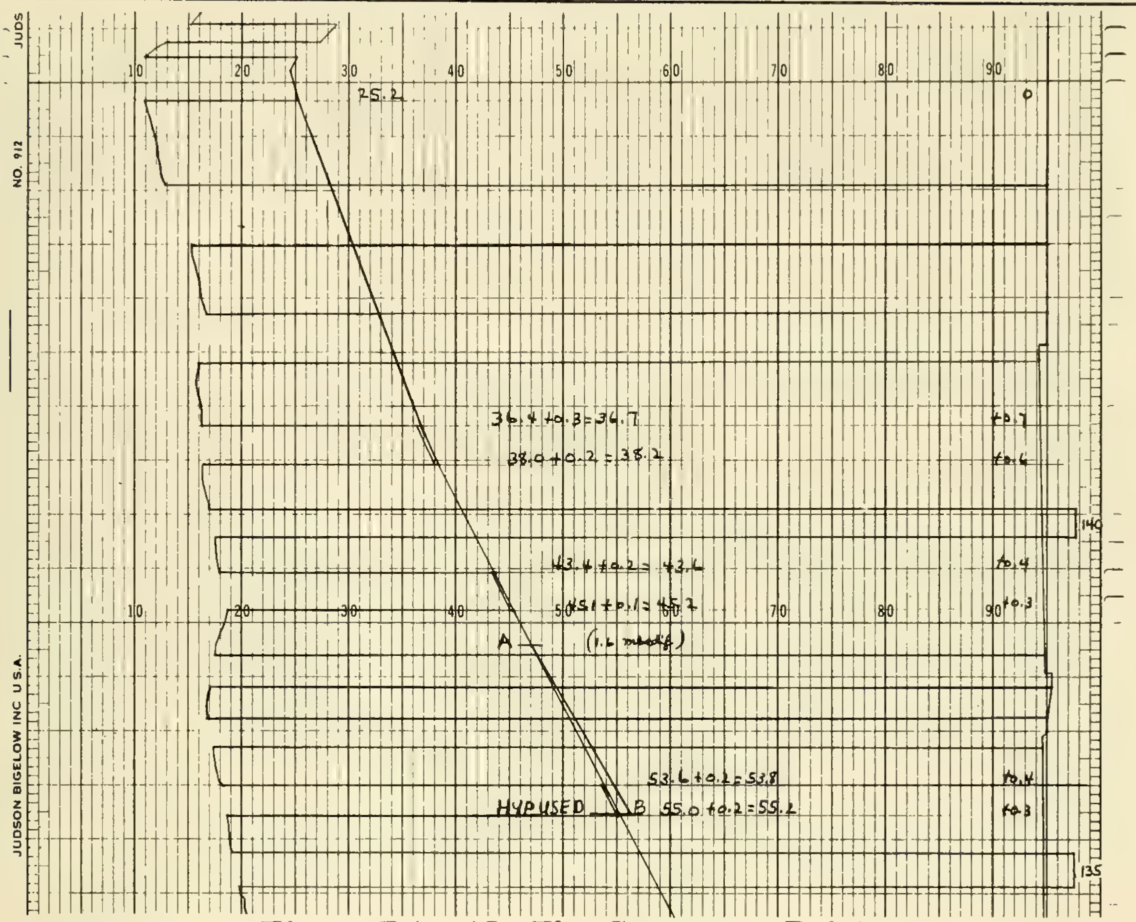


Figure B4 - 15. The Crossover Point

14. Temperature-Ordinate Value. Read the temperature ordinate value to the nearest one-tenth at the intersection of the left edge of the temperature trace and the horizontal lines drawn in accordance with ¶B4-6.1. When a level is drawn between two temperature contacts, draw a line between the top edge of the lower and bottom edge of the upper. At the intersection of this line with the horizontal line, read the temperature ordinate pertaining to the level. When the level is drawn in an adjusted low reference, correct the lower temperature-ordinate before connecting these temperature traces. When the lapse rate is not uniform (base and top of inversions, etc.), and a level must be placed between temperature traces because of relative humidity change or selecting a common level between charts, use the ordinate value of the top of the lower temperature contact as the temperature for the level. This type of selection of levels should be avoided where possible by using instructions in ¶B4-6.7.

Enter the temperature-ordinate values to tenths immediately above the level to the right of the temperature trace.

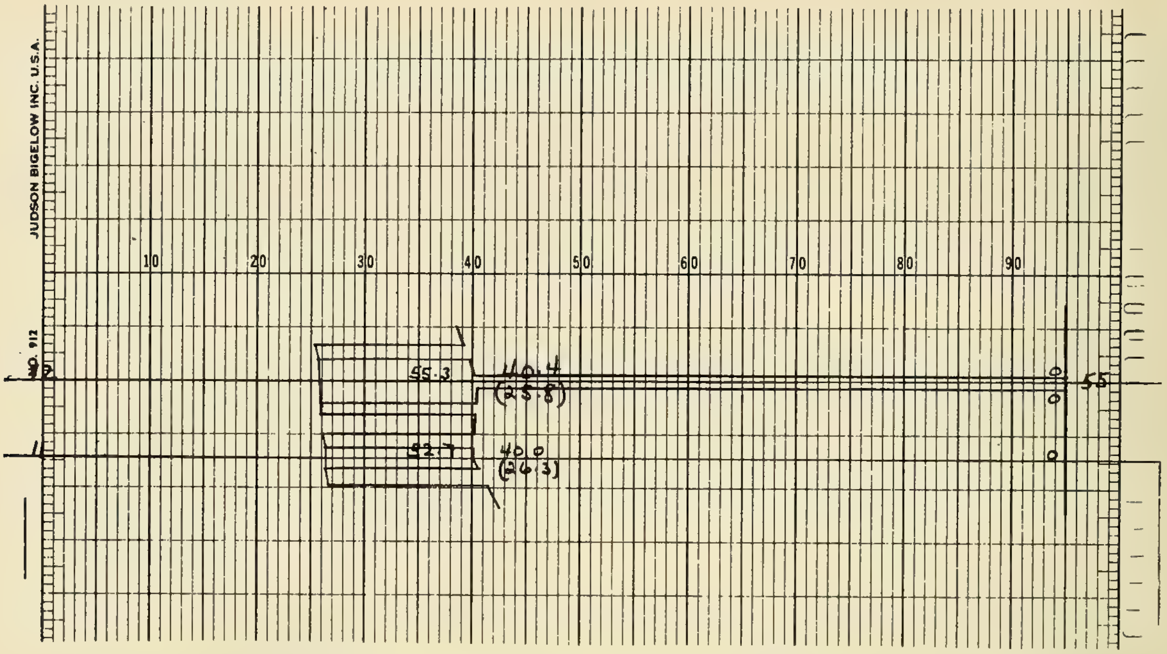


Figure B4 - 16. Level Selecting Between Temperature Traces (Non-uniform Lapse Rate)

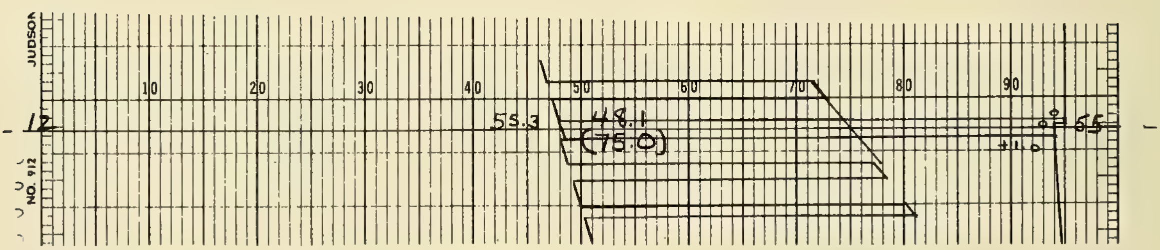


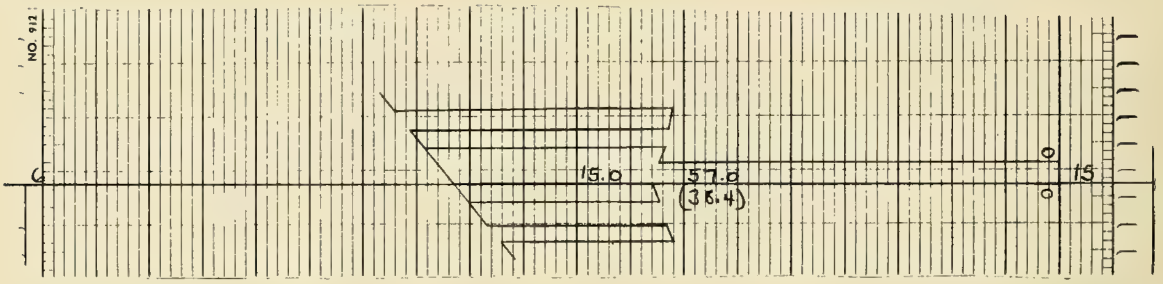
Figure B4 - 17. Level Selected in an Adjusted Low Reference

15. Relative-Humidity Ordinate Value. When a significant level intersects a relative-humidity contact, the relative humidity will be evaluated at the point where the significant level intersects it.

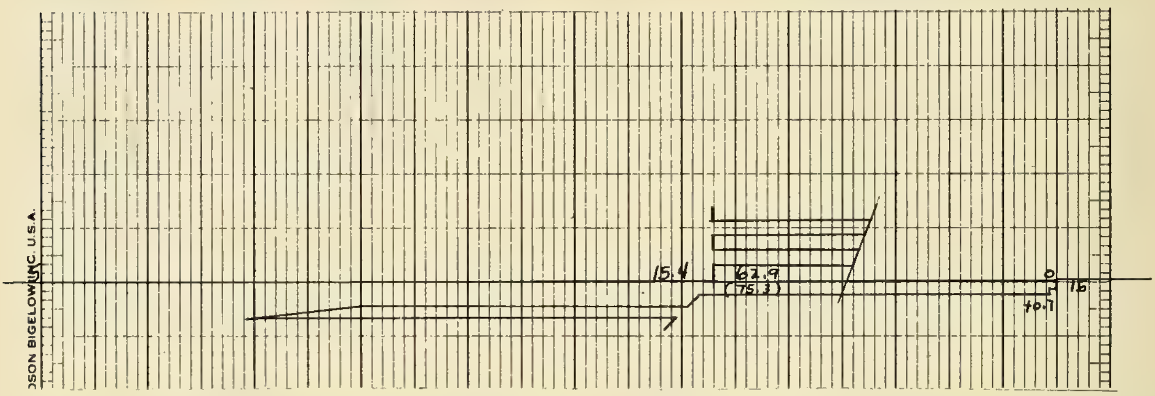
a. When a significant level does not intersect a relative-humidity contact, the contact will be evaluated in accordance with instructions in Table B4-1.

Table B4-1. Evaluation of Humidity Contacts

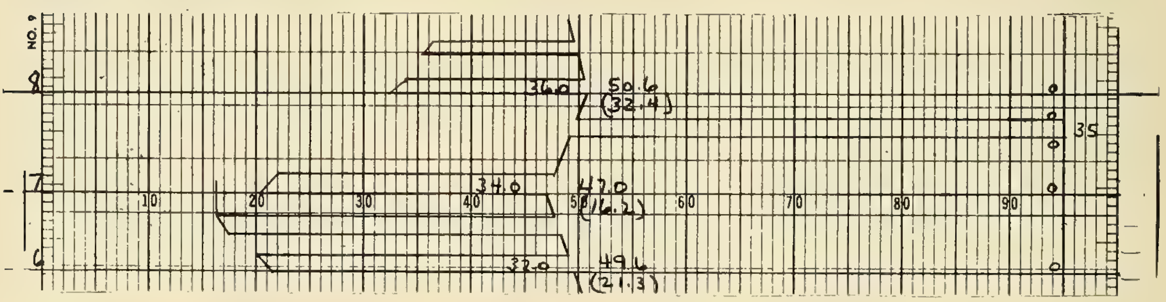
Humidity characteristics	Evaluation procedure
Humidity contacts immediately below and above the level are aligned in the same general direction; there is no abrupt change.	Evaluate at the intersection of the significant level and a straight line connecting humidity contacts below and above the level.
Significant level separates stratum of little or no change in humidity from stratum with abrupt change.	Extrapolate the trend of the humidity in the layer having little or no change in humidity.
Humidity contacts reverse direction or indicate displacement at level.	When the temperature lapse rate decreases at the level: Extrapolite vertically the portion of the adjacent humidity contact having the higher humidity (in percent).
	When the temperature lapse rate increases at the level: Extrapolate vertically the portion of the adjacent humidity contact having the lower humidity (in percent).



Humidity contacts immediately below and above the level are aligned in the same general direction.

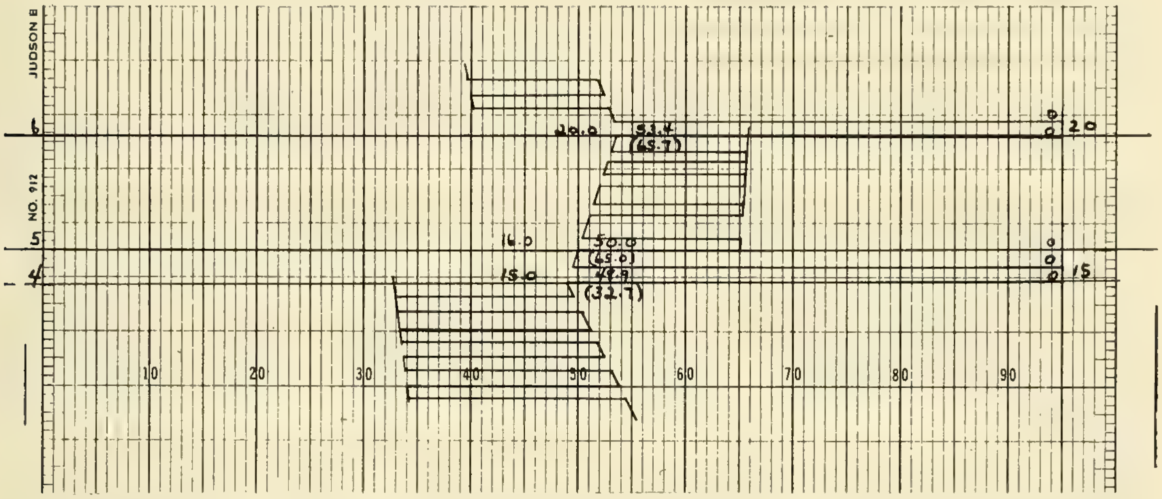


Significant level seperates stratum of little or no change in humidity from stratum with abrupt change.

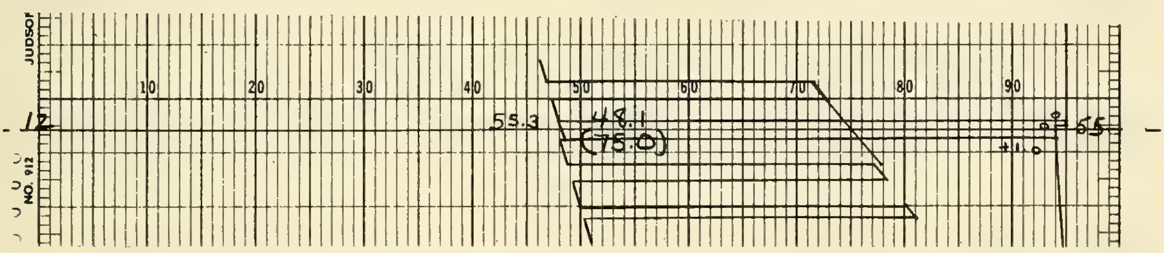


Extended humidity trace (see ¶B4-6.7).

Figure B4 - 18. Evaluation of Relative Humidity Trace



Humidity contacts reverse direction or indicate displacement at the level.



Evaluation of humidity in an adjusted low reference contact.

Figure B4 - 19. Evaluation of Relative Humidity Traces

b. Read the relative humidity ordinate values to the nearest one-tenth, and enter them immediately to the right of the temperature trace and below the levels. These values, their recorder and drift corrections, and the corrected values will be enclosed in parentheses. Enter "M" if a value is classified as missing.

16. <u>Application of Corrections to Temperature, Relative Humidity and Hypsometer</u>.

16.1 <u>Recorder Correction</u>. Enter the applicable recorder corrections, with proper sign prefixed, to the right of the temperature, relative-humidity, and hypsometer ordinate values. Zero corrections will not be entered.

16.1.1 <u>Recorder-Correction Changes</u>. When a new set of recorder corrections is issued by an electronics technician, a note will be entered to that effect on the first fold of the first recorder record obtained after the calibration, and a list of the recorder corrections will also be entered. The note should indicate whether the corrections are "Temporary" or "Final". A note should be entered on the recorder record for the first flight after each calibration showing that the recorder has been recalibrated, even though there is no change in the calibration. If no corrections are required, then the note should so state.

16.2 <u>Drift and Shift Corrections</u>. Corrections for shifts will be applied as though the shift had been a drift.

16.2.1 <u>Drift Corrections</u>. Drift corrections will be based on ordinate values after recorder corrections have been applied. The ordinate difference between the drift line and the ninety-fifth ordinate, at the point where each significant level intersects it, will be placed with proper sign prefixed, immediately to the left of the drift line and on the significant level.

16.2.2 <u>Computation of Drift Corrections</u>. Multiply the temperature, humidity, and hypsometer ordinate values (after application of recorder corrections) by the drift. Divide the product by the ordinate value of the low-reference drift line. The quotient is the drift correction. To correct humidity and temperature ordinate values at significant levels, place the quotient with the proper sign prefixed, immediately after the recorder correction applied to the ordinate values (zero drift corrections will not be applied). This will be followed by an equal (=) sign and the corrected ordinate, thus: 30.0 - 0.1 + 0.2 = 30.1, where the recorder correction is -0.1 and the drift correction is +0.2.

a. To facilitate the computation of drift corrections, 90 may be used as the divisor if the low-reference drift is to the left and is 3.0 or more but not more than 7.0 ordinates. If the drift is to the right, in the same amount, 100 may be used as the divisor.

b. When the drift exceeds seven ordinates, it is essential that the actual value of the low-reference drift line be used as the divisor.

c. If the reference drift is less than 3.0 ordinates, correction charts based on 95 as the divisor may be used.

17. Paper-Drift Corrections. A paper-drift line will be drawn and corrections will be computed if the check of the zero recording made in accordance with ¶B4-5.2 indicated a paper-drift of 0.3 ordinate or more at any level of the sounding.

17.1 Entering Paper-Drift Corrections. If paper-drift corrections are required, they will be placed, with proper sign prefixed, after the temperature and humidity ordinates to which recorder and drift corrections have been applied. An equal (=) sign will be placed after them, followed by the corrected temperature or humidity ordinate values, e.g., 30.0 - 0.1 + 0.2 = 30.1 - 0.3 = 29.8, where -0.1 is the recorder correction, +0.2 is the drift correction, and -0.3 is the correction for paper-drift. The paper-drift correction will be applied to the hypsometer ordinate before constructing the hypsometer curve.

17.2 Computation of Paper-Drift Corrections. If the paper-drift is believed to have been gradual, draw the paper-drift line from the left edge of the top of the zero trace before release to the bottom of the next zero trace. If the record indicates that abrupt changes in the paper alignment have occurred, draw the drift line accordingly. The sprocket holes should be examined closely to find where the paper began to climb on the pins. Continue this drift line from the top of each zero trace to the bottom of the next following zero trace through the termination of the sounding.

17.3 Unadjusted Paper-Drift. Enter the paper-drift correction of each level immediately to the right of the paper-drift line. If the low reference has not been adjusted during the paper-drift, the correction will be the ordinate difference between the drift line and the correct ordinate value of the zero setting. If the recorder at zero prints to the left of the true ordinate of the zero setting, a positive correction will be required. If it prints to right, a negative correction will be required.

17.4 Adjusted Paper-Drift. If the low-reference had been adjusted during or after the paper drift, use the following method. Subtract from 95.0 the ordinate value to be corrected. Multiply the remainder by the paper-drift correction at the given level and divide the product by 95. The quotient will be the required correction for the ordinate. For example, if the temperature ordinate (after application of recorder correction) at a given level is 40.3, and the paper-drift is 0.7 ordinate, the correction would be computed as follows: 95.0 - 40.3 = 54.7. Therefore, $\frac{54.7 \times 0.7}{95}$ = 0.4, the required paper-drift correction for an ordinate of 40.3.

18. Post-Sounding Zero Recording. After the termination of the observation, secure, if possible, a recording of the first high reference on the descent and then obtain a record of the recorder zero. One-half inch or more of the zero recording after the termination of the observation will be included as part of the record.

19. Reason for Termination. Enter the reason for the termination of the sounding slightly above the last ascent level evaluated (see Fig. B4-4), and in the station identification data stamped on the recorder record. A partial list of reasons follows:

1. Balloon burst
*2. Interference
3. Leaking or floating balloon
4. Weak or fading signal
5. Unstable signal
*6. Switching failure
*7. Excessive missing data
*8. Radiosonde failure
*9. Ground equipment failure
*10. Power failure
11. Military alert

*These should be explained by a note on the first fold of the recorder record.

12. Balloon forced down by precipitation or icing

13. Chart limitations

14. 5 mb (baroswitch, WB)

20. Ascension Rate. Whenever an observation reaches an indicated altitude considerably above the average attained at the station with similar balloons and radiosondes, or whenever the ascension rate near the top of the flight appears to be above normal, check the data for evidence of baroswitch failure. To accomplish this, critically examine the ascension rates of the balloon for several layers and compare the rate for each layer with the rates for the preceding and succeeding layers. For example, compute the ascension rates for layers bounded by constant pressure surfaces; i.e., 50-40 mb, 20 to 15, 10 to 8, 8 to 7, 7 to 6, 6 to 5, etc. A marked increase (50 percent or more) from one layer to another with a rapid ascension rate continuing thereafter is a good indication that pressure values are questionable. Whenever the pressure data are determined to be erroneous, all data from the beginning of the erroneous portion will be regarded as missing.

21. Notes and Comments. Notes and comments pertinent to the observation may be entered on the recorder record below the station identification data. Observers are encouraged and requested to make such entries on the record as will assist in clarifying, qualifying, or explaining any unusual aspects of the record. The provisions of this paragraph should not be construed as authorizing the solicitation of such instructions and opinions which should properly be made the subject of a letter or memorandum.

22. Folding the Recorder Record and Calibration Chart. The recorder record will be folded uniformly to facilitate inspection and filing. It will be folded evenly, accordion fashion, in 7-inch folds so that the entire record may be examined by turning over the folds. The first fold of the recorder record, upon which the identifying data are entered, should face outward.

Staple the bottom of the strip-type calibration chart to the bottom of the recorder record centered at the 50-ordinate line. Stretch the calibration chart along the 50-ordinate line and then fold the calibration chart and recorder record together, accordion fashion, in 7-inch folds so that the entire record may be examined by turning over the folds. The first fold of the strip-type calibration chart upon which the identifying data are entered should face outward. The identifying data consists of the station name, date, time of release (GMT), to the nearest minute, the ascension number, and (WB) type of hygristor used.

Whenever a hypsometer equipped radiosonde is used, fold the hypsometer calibration chart and insert it into the first fold of the recorder record.

When two or more releases are made, the pressure calibration charts and recorder records pertaining to the unused flights (see ¶B4-7.1) will be submitted with the rest of the station's forms. The charts and records will be properly labeled, i.e., second release, third release, etc., and will include the station identification data and the baseline-check. A complete explanation of the circumstances causing the unsuccessful flights will be entered under the identifying data on the recorder records.

CHAPTER B5. PREPARATION OF CHARTS

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CHAPTER B5

PREPARATION OF CHARTS

1. Entering Data on WBAN-31( ). The form WBAN-31( ) will be prepared in a clear, legible manner so that the forms may be microfilmed for use as a climatological record and data can be easily extracted for punched cards. The instructions contained in ¶B5-1.1 thru 1.3 prescribe the manner in which data are to be entered on the forms to insure satisfactory computations, reproduction, and punching.

1.1 Rubber Stamps. If available, rubber stamps will be used to enter identification data on WBAN-31A, B, C, recorder records and calibration charts. Rubber stamps may also be used for entering the date, the observer and verifier names, serial and ascension numbers, and other often used remarks such as "rechecked," "second release," "begin missing data," etc. Stamped data should have sharp contrast with the paper. The letters of the stamp should be at least 3/16 of an inch in height.

1.2 Type of Pencil to be Used. Raob charts will be prepared neatly and legibly, and should appear black rather than gray. Although a well-sharpened No. 2H pencil is recommended, individual observers may prefer a slightly harder or softer lead. However, make certain the record is clear and has sharp contrast.

1.3 Plotting and Entering Data in Red. The last level selected at or between 12.5 and 10 mb. will be replotted on WBAN-31C in red and all data from that point to 1 mb will be plotted in red. Changes made after transmission to the coded message and final rawin height and pressure will also be entered in red. (Weather Bureau stations will enter identifiers for significant punched card levels.) Use a red pencil that will provide a clear legible copy for microfilming and is capable of being erased, if necessary e.g., the carmine red Venus Unique pencil #1277 or its equivalent.

1.4 Date and Time. Enter the date and time of the raob release on the recorder record and the calibration chart in terms of GMT. The time entry will be expressed in terms of the 24-hour clock and made to the nearest minute. Midnight will be expressed as 0000 and regarded as the beginning of the day. On WBAN-31( ), entries in the Date and Release Time block will be as follows:

a. The first line will reflect the actual date and time of the raob release based upon local standard time. The time entry will be in terms of the 24-hour clock and made to the nearest minute. The meridian of the time zone will be entered in the space "_____ th Mer." In areas where a standard time zone has not been established, the meridian that is closest to the station and that is evenly divisible by 15 will be entered and the date and time entry will pertain to that meridian. The time difference between LST and GMT must always agree with the meridian time-zone entry, i.e., 75th is 5 hours, 150 is 10 hours, etc.

b. A "scheduled observation" is one released within the 45 minutes allotted by International agreement, i.e., between 2315 and 0000, 0515 and 0600, 1115 and 1200, and 1715 and 1800 GMT. For all "scheduled observations," the second line will show the time to whole hours, i.e., 00, 06, 12 or 18 as appropriate.

c. An observation not released within the 45 minutes allotted by international agreement is considered to be a "delayed scheduled," a "non-scheduled" or a "special" observation unless granted a waiver by a higher authority. The second line will show the time to the nearest whole hour, i.e., 0015 GMT will be entered 00, 0047 as 01, 1105 as 11, 1345 as 14, 2215 as 22, etc.

1.5 Radiosonde Serial Number. The radiosonde serial number can be found stamped on the outside of the case in the one-part instrument and is identical to the number on the modulator in the two-part instrument. Any prefix or suffix will be regarded as a part of the radiosonde number which will be entered in the appropriate space on WBAN-31( ).

1.6 Ascension Numbers. Ascension numbers required on the WBAN-31 ( ), the recorder record, and the calibration chart will be numbered consecutively throughout the year. No. 1 will be the first raob of each year GMT, (the 0000 GMT scheduled raob, or the first raob taken thereafter). Special raobs, and all raobs that have attained a pressure of 225 mb or less (AF, N, 60 mb or less), will be given an ascension number except that if more than one release is required, only the one which is evaluated and used as the official observation will be assigned an ascension number (see ¶B4-7 and 7.1). If a raob terminates before reaching 225 mb (AF, N, 60 mb) and because of unfavorable weather conditions or other reasons, a second release is not made, the first will be given an ascension number, evaluated, and the data transmitted. If conditions should later improve to such an extent that a second raob is taken, and this extends to a higher altitude than the first, which has already been transmitted, forms pertaining to both raobs will be forwarded in accordance with the following instructions.

Forms for the first raob will retain the ascension number already given them, and those for the second will be numbered one higher. The complete forms for both releases will be forwarded in accordance with instructions, regardless of the height attained. If an observation is omitted or is unsuccessful, an ascension number will not be assigned. Raobs taken for operational purposes and those taken for other agencies or services will be given ascension numbers.

(WB) Ascension numbers for shipboard raobs will begin with No. 1 for the first raob of each patrol or voyage and numbered consecutively until termination of the patrol or voyage.

1.7 Name of Station. Enter the name of the station on all forms, including the recorder record and calibration chart. Further identification may be entered in parentheses below the name of the station. At military establishments, the name of the city to which each is customarily considered to be attached will be entered and immediately below in parentheses the name of the field or base. If the raob is taken from a ship the name of the ship and the service that operates it will be entered. If the ship is an Ocean Station Vessel, the station it is manning or enroute to or from will be entered.

Examples: USC&GSS MT. MITCHELL

Valparaiso, Florida
(Eglin AFB)

Bismarck, N. Dakota
(Municipal Airport)

1.8 Latitude and Longitude of the Station. Enter the latitude and longitude of the station in degrees and minutes, indicating the appropriate direction by N or S in the case of latitude, and E or W in the case of longitude.

1.9 Unscheduled Raobs. All forms for unscheduled raobs will be so marked, giving the reason for the observation. This information will be entered in the "Remarks" block of WBAN-31A. Example: "Hurricane Special." Likewise, forms pertaining to observations in which multiple releases have been made will be so marked, on the first fold of the appropriate recorder record, example: "Second Release," "Third Release," etc. These notations should also be made in the "Remarks" block of WBAN-31A if the flight was evaluated.

2. Names of Computer and Verifier. Print clearly the initials and surname, and military rank or rating, if any, of the computer and verifier on all WBAN-31( ) and recorder records. The forms will be verified by an observer other than the computer, insofar as possible.

3. Data Block. A data block is printed on each of the three adiabatic charts. Enter only data in each block that pertain to the corresponding adiabatic chart. However, data pertaining to the levels common to WBAN-31A and B will be entered only in "Data Block A," and levels common to WBAN-31B and C will be entered only in "Data Block B." In the following instructions, surface pressure and surface altitude refer to the value of these data at the point determined in ¶B4-4.3.

3.1 Significant Levels. When the number of significant levels on WBAN-31( ) exceeds the number of available significant level blocks on that chart, divide a sufficient number of the blocks in half to provide for the extra levels. Care must be taken to insure that all entries in these blocks are legible.

3.2 Data to be Entered in Data Blocks. Appropriate surface data at release will be entered on the first line of Data Block A. The pressure contact or hypsometer ordinate, temperature ordinate, and relative humidity ordinate for each upper level evaluated on the recorder record will be entered opposite its corresponding level number. The surface is the first significant level. In the case of multiple ascents (see ¶B4-6.6 (a)), the significant level blocks will be divided in half and the last level of the first ascent will be entered in the top half and the first level of the last ascent will be entered in the bottom half, both will have the same level number. When a requirement for one or more additional levels is found after successive levels have already been entered in the Data Block, the new levels may be entered near the bottom of the Data Block and assigned subfigures (2A, 4A, 4B, etc.) to indicate their proper order among the levels already evaluated.

Level numbers pertaining to the first level entered on the first horizontal line of Data Block B will be numbered one higher than the last level entered in Data Block A.

Succeeding levels will be entered in Data Block B and numbered consecutively. Whenever the sounding extends to a pressure lower than 100 millibars, follow the same procedure when entering data in Data Block C.

3.2.1 Missing and Doubtful Data. Whenever a level is placed on a recorder record to indicate missing data, "Missing Data" will be entered in the data block at approximately the middle of the line corresponding to

		12	39.4		58.0		8.6				
		13	41.2		57.6		7.5				
		14	43.0 43.0		57.1 57.0		6.8 7.2				
		15	50.0		52.0		82.1				
		16	56.0		47.0		81.5				
		17	63.2		42.1		82.0				
		18									
		19									
		20									
		14A	45.0		55.6		8.5				
		14B	48.0		53.4		79.6				
		16A	58.4		45.2		73.6				

Figure B5 - 1. Entry of Additional and Multiple Ascent Levels.

the level, thereby furnishing a number for the level in the missing stratum. The beginning and ending of missing or doubtful data will be indicated in the column captioned "Altitude of Significant Levels, or "Remarks" of the appropriate level by using one of the following abbreviations:

BMD to denote Begin Missing Data

EMD to denote End Missing Data

BMRH to denote Begin Missing Relative Humidity

EMRH to denote End Missing Relative Humidity

BDTD to denote Begin Doubtful Temperature Data

EDTD to denote End Doubtful Temperature Data

BDAD to denote Begin Doubtful Altitude Data

These abbreviations will not be used elsewhere on Forms WBAN-31( ) or the recorder record.

3.3 Data to be Entered in Data Block Columns. Data will be entered in the columns headed Pressure, Temperature, Relative Humidity, and Dew Point in accordance with the following instructions.

3.3.1 Pressure. Two entries are required for pressure at all levels except the surface; these are under "contact" and "mb."

a. Contact. For those upper-levels for which the pressure is determined by the baroswitch, enter the contact value to the nearest tenth, as obtained from the recorder record. For those upper-levels for which the pressure is determined by the hypsometer, enter the hypsometer reading to the nearest tenth of an ordinate, as obtained from the recorder record.

b. Millibars. For the surface level enter the surface pressure to the nearest whole mb (see ¶B4-4.3). Obtain this value from the "Surface Observation at Release" block. For upper levels, enter the pressure values as follows:

(1) Whenever pressure data are derived from aneroid measurements, pressure values will be entered in whole millibars. If however, at high altitudes, the rounding of pressure to whole millibar values results in two or more significant levels having the same value, pressure for those levels only will be entered in Data Block C to the nearest 0.5 mb whenever the value is between 19.5 and 10.0 mb, and to the nearest 0.1 mb. whenever the value is less than 10 mb. In such instances, note in remarks that pressure value for level numbered __ is shown to tenths of a millibar. This does not imply that the aneroid baroswitch is capable of measurements to the indicated accuracy. For example, two pressures rounded off to the nearest mb both have a value of 6 mb. If both were read to the nearest tenth they would be 6.4 and 5.8. Select the one furtherest from the rounded value, and enter to tenths. The entries would then be 6.4 and 6. If both were selected for transmission 6.4 would be transmitted 064 and 6 would be transmitted as 060.

(2) Whenever pressure data are derived from hypsometer measurements pressure values will be entered in whole millibars whenever the value is 20 mb, or greater, to the nearest 0.5 mb, whenever the value is between 19.5 and 10.0 mb, and to the nearest 0.1 mb whenever the value is less than 10 mb. (WB,N) Insert in remarks "Hypsometer data begin with ___ level. Pressures less than 20 mb are shown to tenths of mbs."

3.3.2 <u>Temperature</u>. Two entries are required for temperatures at all levels except the surface; these are under "ordinate" and "ascent °C".

a. <u>Ordinate</u>. For each upper level enter the corrected ordinate reading to tenths as obtained from the recorder record.

b. <u>Ascent °C.</u> On the surface level, enter the dry-bulb temperature to degrees and tenths, as obtained from the "Surface Observation at Release" block. For each upper level, enter the temperature to degrees and tenths, corresponding to the temperature ordinate of the level, as obtained from the temperature evaluator. Prefix a minus sign to the entry on WBAN-31A whenever the temperature is colder than 0.0°C. Prefix a plus sign to the entry on WBAN-31B and C whenever the temperature is warmer than 0.0°C.

3.3.3 <u>Relative Humidity</u>. The two subdivisions under this column are "ordinate" and "ascent %."

a. <u>Ordinate</u>. For each upper level enter the corrected ordinate reading to tenths as obtained from the recorder record. Enter "M" if the relative humidity data are missing. No entry will be made when the temperature is colder than -40°C.

b. <u>Ascent %.</u> On the first line of the column enter the relative humidity at the time of release as recorded in "Surface Observation Release" block. The relative humidity at the surface will not be computed when the surface temperature is colder than -35°F (-37.2°C); a dash will be entered in this case. On the line pertaining to each upper level, enter the relative humidity as obtained from the evaluator. Enter a dash if the relative humidity is missing. No entry will be made when the temperature is colder than -40.0°C.

3.3.4 <u>Dewpoint</u>. The two subdivisions under this column are "ascent °C" and "depression."

a. <u>Ascent °C</u>. Use the dewpoint calculator to compute the data. Computation will be made from the relative humidity to whole percent and temperature to the nearest 0.1°C pertaining to each level. Dewpoint temperatures based on doubtful temperature and accurate relative humidity data will be classified as doubtful. Enter the dewpoint to the nearest 0.1°C on each level which will be transmitted and that has numerical values of temperature and relative humidity. Enter a dash to indicate that the relative humidity was missing. No entry will be made when the temperature is colder than -40.0°C.

b. Depression. For those levels selected for transmission, subtract algebraically the dewpoint from the temperature. Enter the difference, to the nearest tenth of a degree in the depression column. Enter a dash to indicate that the relative humidity was missing. No entry will be made when the temperature is colder than -40.0°C.

Examples:			
	14.6	1.2	-1.3
	10.6	-12.6	-6.5
	4.0	13.8	5.2

3.3.5 Type of Level Column. This column is used to identify significant levels for punching of climatological data. Those stations not required to select significant levels for punching will make no entries of any kind in the column labeled "type of level", since even though these data are not required to be entered on-station, it is very possible that this column will be used at some future time.

3.3.6 Rawin Termination Data. The altitude, m.s.l., and the corresponding nearest whole mb of pressure, for the last whole minute of ascent for which rawin data, direction and speed, are evaluated will be entered in red in the Data Block two or three spaces below the termination level of the sounding. If no rawin was taken enter three zeros for the pressure and five zeros for the altitude. The value for pressure, in whole mbs without the tenths figure, will be entered in the column headed "mb," and the value of altitude will be entered in the column headed "Altitude of Significant Levels or Remarks." Since altitude data for the rawin are obtained from the corresponding radiosonde observation, in no instance will the rawin pressure be less than, or the rawin altitude be greater than corresponding data for the raob terminating level. If a hypsometer radiosonde was used, the terminating rawin pressure will be no greater than the last whole mb of raob pressure. Example: Raob terminates at 4.1 mbs, last whole minute of wind corresponds to 4.4 mbs, 5 mbs will be entered as the rawin terminating pressure.

44		22	139.7	20	23.2	-49.9	
55	0	23	140.0	19	24.1	-48.5	26991
						-	
						-	
				20		-	26630

Figure B5 - 2. Rawin Termination Data

4. Plotting Data on Adiabatic Charts. After the required computations have been completed in the data blocks, the computed values are plotted on the adiabatic charts.

4.1 Pressure. Draw a level across the adiabatic chart, from the extreme left edge of the left margin to the extreme right vertical temperature line, at a point corresponding to the surface pressure entered on the first line of Data Block A under the caption "Pressure, mb." Label this level in the left margin "Sfc-1."

Draw levels across the adiabatic chart, from the extreme left edge of the left margin to the extreme right vertical temperature line, at the pressures of significant levels and number them in the left margin (note that the level at the surface has been numbered 1). Levels placed in strata of missing data (see ¶B4-6.6 (e)) will be drawn approximately midway between the upper and lower significant levels bounding the strata.

Whenever the observation extends to a pressure lower than 400 mb., the highest level on WBAN-31A must be plotted as the lowest level on WBAN-31B. Similarly, the highest level on WBAN-31B must be plotted as the lowest level on WBAN-31C. Whenever the observation extends to pressures less than 10 mb, data for the replotted level (at or between 12.5 and 10 mb) and up to 1 mb will be plotted on the same WBAN-31C used for the 125 to 10 mb range. The pressure lines pertaining to the replotted level and up to 1 mb will be drawn and numbered in red.

4.2 Temperature. On each significant level, plot the corresponding temperature to degrees and tenths and connect each successive point with a solid straight line. Whenever the observation extends to pressure less than 10 mb, data for the replotted level (at or between 12.5 and 10 mb) to 1 mb will be plotted on the same WBAN-31C used for the 125 to 10 mb range. The temperature curve pertaining to the replotted level to 1 mb range will be drawn in red. Curves through strata of doubtful data will be drawn as solid lines. Temperature curves will be drawn as dashed lines through strata whose data are classified as missing. For this purpose it will be assumed that the temperature lapse rate is represented by a straight line between the two known temperature values bounding the missing portion. If data on the recorder record make the selection of a level exactly at 400, 100 or 10 mb inconvenient or impossible, the temperature at 400 and 100 mb and humidity at 400 mb will be taken from the overlap portion of the following chart. The temperature at 10 mb will be taken from the overlap portion of WBAN-31C. A dot will be placed on the 400, 100 and 10 mb portion of the chart, as appropriate, to represent the data at those points. The respective curves on WBAN-31( ) will then be drawn to these points as though they were plotted on a significant level. The completed temperature curve will be labeled "T" at the top and bottom of each chart.

a. Whenever the temperature is colder than -60°C at a pressure greater than 400 millibars, and the WBAN-31AA is not available, displace the temperature curve ten degrees to the right through the standard stratum affected to permit the temperature trace to be plotted on the grid of the adiabatic chart. Relabel the temperature grid for the stratum accordingly. The thickness of the stratum will be obtained by means of Table 7.

b. The limits of doubtful temperature on the adiabatic chart will be indicated by entering "Begin (or End) doubtful temperature" close to the temperature curve and on the levels bounding the stratum of doubtful temperature, but so that no data will be obscured. Strata of missing data will be similarly indicated. "Missing Data" will be entered on the level placed in the missing strata.

c. The dry adiabatic lines drawn on the adiabatic charts represent a lapse rate of 9.76°C per km. Whenever the temperature lapse rate equals or exceeds 9.8°C per km, i.e., when the lapse rate is superadiabatic, all data pertaining to the level bounding the superadiabatic stratum will be rechecked on the recorder record, in the data block, and as plotted on the chart. If this recheck does not reveal an error, the word "rechecked," with arrows pointing to the beginning and ending of the superadiabatic portion of the curve will be placed to the left of the segment of the temperature curve on the adiabatic chart and recorder record.

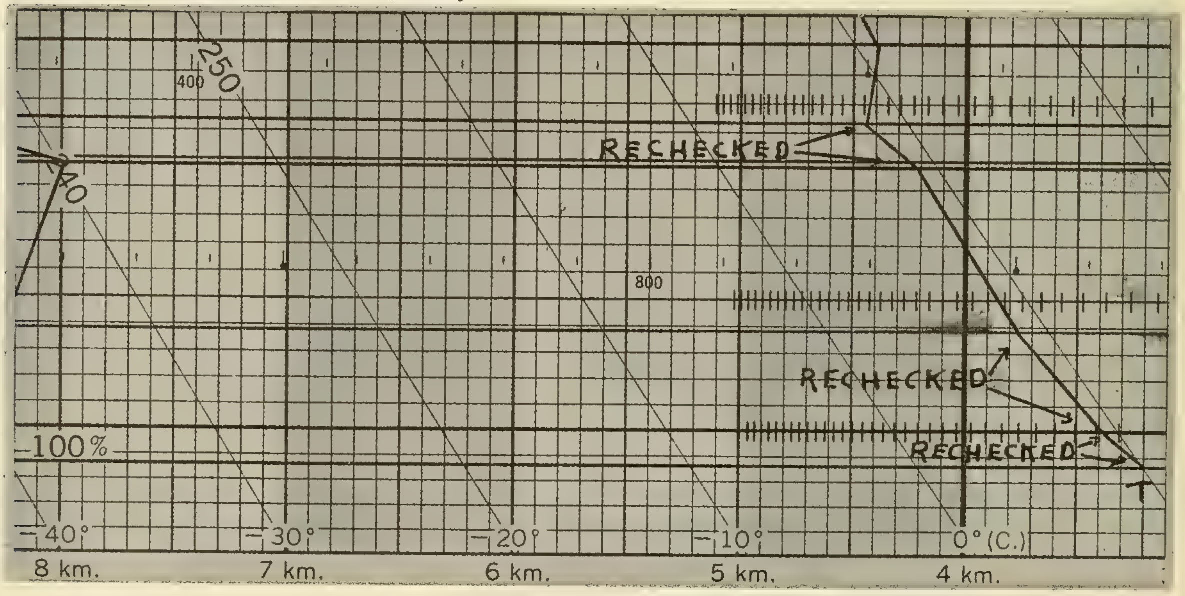

Figure B5 - 3. Superadiabatic Lapse Rate

d. Whenever two temperature values occur at the same pressure (as when the balloon is forced down and reascends), both values will be plotted on the adiabatic chart if the difference is 1°C or more. The temperature curve for the first ascent will end, and for the last ascent resume, at their corresponding temperatures. Use the colder temperature for purposes of transmission and tabulation. If the difference is less than 1°C, the colder temperature will be plotted and the warmer value ignored.

4.4 Relative Humidity. On each significant level plot the corresponding value of relative humidity, and connect each successive point with a straight line. Enter "M" on significant levels at the 50 percent line to indicate missing humidity. No entry will be made when the temperature is colder than -40.0°C.

a. Neither dashed nor solid lines will be drawn through strata more than 50 mb. in extent whose data are classified as missing. When the surface relative humidity is not evaluated because the dry-bulb temperature is colder than -35°F (-37.2°C), the relative humidity will be regarded as missing from the surface to the first usable humidity contact and a line will not be drawn regardless of the thickness of this stratum.

b. A solid line will be drawn through missing RH data 50 mb or less in extent whenever the missing portion is ignored (see ¶B4-7.5.2 (c)).

c. Whenever two values of relative humidity occur at the same pressure (as when the balloon is forced down and reascends), both values will be plotted on the adiabatic chart. The relative humidity curve for the first ascent will end, and for the last ascent resume, at their respect values. The value to be used in all computations, etc., pertaining to this level, will be the value corresponding to the temperature selected in accordance with ¶B5-4.3 (d).

d. When the relative humidity curve terminates at the highest level on WBAN-31A, this single value will not be replotted on WBAN-31B.

e. The completed relative humidity curve will be labeled "RH" at the top and bottom of the curve on each chart. Where the curves are broken because of missing data, the broken ends will not be labeled. When the humidity is missing for the portion of the flight where the humidity is to be terminated (see ¶B4-6.7) the top of the missing portion will be labeled, RH-M, where the temperature becomes -40.0°C. (see Fig. B5-4).

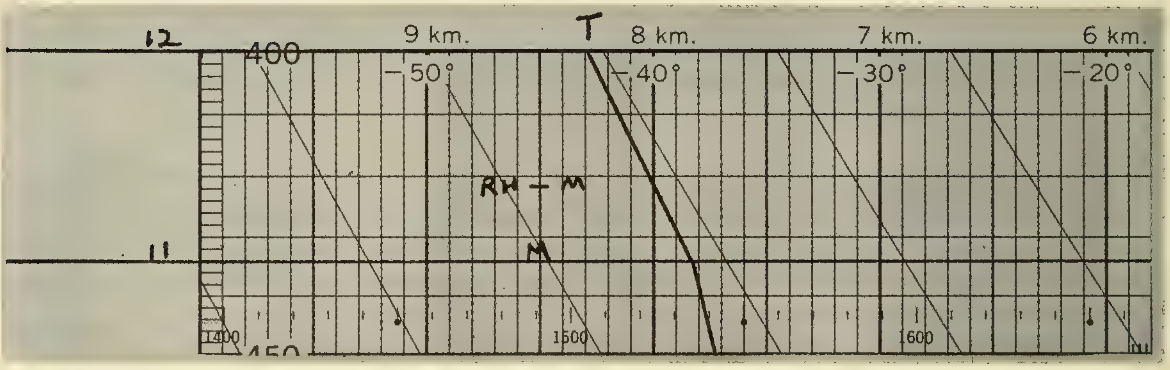

Figure B5 - 4. Labeling RH Curve at End of Missing RH

5. Mean Temperature of Stratum. A stratum, in this instance, is defined as that layer bounded by the standard isobaric surfaces listed in Table 7 and printed as heavy horizontal lines on WBAN-31( ), and as the layer bounded by the surface level and the first standard isobaric surface and the layer bounded by the last standard isobaric surface and the termination level. Estimate the mean temperature of each stratum by laying a transparent straight edge over the temperature curve on the adiabatic chart. The straight edge should be kept parallel to the vertical temperature lines and moved from left to right until the edge intersecting the temperature curve produces equal areas to the left and right of it. These areas will be bounded by the straight edge, segments of the temperature curve, and the isobaric surfaces bounding the stratum. When the straight edge has been adjusted to provide for equal areas, draw a 1/4 inch vertical dash along the side of the straight edge and near the middle of the stratum. The mean temperature of missing portions of the record will be estimated by assuming that the temperature lapse rate is represented by the dashed straight line between the two known temperature values bounding the missing portion.

In a stratum having a uniform lapse rate, the mean temperature would be indicated slightly above the midpoint of the stratum; that is, slightly above the middle pressure of the stratum. For example, uniform between 500 and 400 mb., the mean temperature would be at the point where the temperature curve crosses 447 mb.

6. Mean Virtual Temperature. The mean virtual temperature of each stratum is found by displacing to the right the dash representing the mean temperature of the stratum. Determine the amount of this displacement, which is based on the mean relative humidity and the mean temperature of the stratum, as follows:

a. Find the distance between the vertical brown tabs bounding the extension of the dash denoting the mean temperature. If there are no printed vertical brown tabs immediately above or below the dash and in the same stratum, or none embracing it, the mean virtual temperature will be considered the same as the mean temperature.

b. Estimate the mean percentage of relative humidity for the stratum. If the stratum contains missing humidity record, the mean will be based on the best possible estimate of the moisture content of the stratum.

c. Multiply the distance found in (a) by the mean percentage found in (b).

d. At the distance found in (c), draw a dash parallel to, and to the right of, the mean temperature dash of the stratum. The mean virtual temperature of the stratum will be read at the displaced dash.

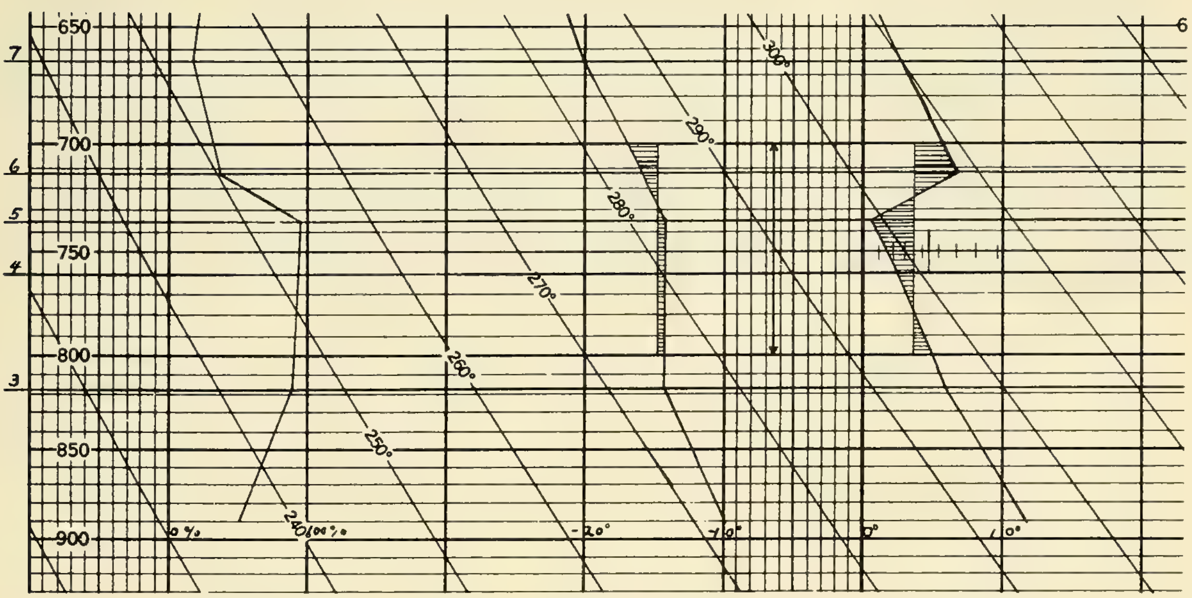

Figure B5 - 5. Mean Virtual Temperature Computation

For example, if the relative humidity is 100 percent, the mean temperature will be displaced to the right by an amount equal to the full distance between the vertical tabs to obtain the mean virtual temperature; if the relative humidity is 50 percent, the mean temperature will be displaced one-half the distance, etc. When the mean virtual temperature of a complete stratum is being determined - that is, one bounded by standard isobaric surfaces - the brown tabs to be used are those printed on the isobars between the standard isobaric surfaces. When the mean virtual temperature of an incomplete stratum is being determined - that is, a stratum bounded by only one standard isobaric surface - the brown tabs to be used are those nearest the midpoint of the stratum.

7. Determination of the Thickness and Altitude of the Strata. Find the thickness of the stratum between the surface and the next higher standard isobaric surface (and the altitude, meters m.s.l., on the latter) in accordance with the following instructions, except that whenever the surface level coincides with a standard isobaric surface, the scale method described above will be used.

a. Enter the surface altitude (see ¶B4-4.3) in meters above mean sea level immediately to the right of the 50°C vertical temperature line and opposite the 900 mb pressure of WBAN-31A.

b. Use the values found in Table 6 and 6A to find the value corresponding to the surface pressure to the nearest 0.1 mb. (Note that pressure is recorded to 0.1 mb. in "Surface Observation at Release" block.) Enter this value beneath the surface altitude entry. This value will be the thickness of the stratum, uncorrected for temperature, between the surface level and the next higher standard isobaric surface.

c. Find the temperature correction in Table 9 for the thickness in (b). The mean virtual temperature and the thickness of the stratum are the arguments for determining this correction.

d. Enter the correction found in (c) under the uncorrected thickness of the stratum found in (b), prefix a minus sign to it if the mean virtual temperature is below 0°C. If the correction is negative, subtract it from the uncorrected thickness; if it is positive, add it to the uncorrected thickness. Place the sum or remainder below the correction found in (c) and above the surface altitude entered in accordance with (a).

e. Enter the sum of the surface altitude and the corrected thickness of the stratum in the altitude section of the constant pressure data block corresponding to the next higher standard isobaric surface. This sum is the altitude of that standard isobaric surface above mean sea level.

7.1 Thickness of Layers Between Standard Isobaric Surfaces. The standard isobaric surfaces are listed in Table 7, and are printed as heavy horizontal lines on WBAN-31( ). The thickness of each layer will be computed either by means of height tabs printed on the charts, or by means of Table 7. Preference is given to the first of the two methods. A height tab scale is provided for most of the strata. Each division of the scale is equal to 10 geopotential meters, and the spacing between the tabs is sufficient for the scale to be read to the nearest whole meter with an accuracy of ±2 meters. To find the thickness of the stratum, use the point on the height tab scale corresponding to the mean virtual temperature. If the thickness tabs are omitted, or appear in error (see ¶A4-1.1),

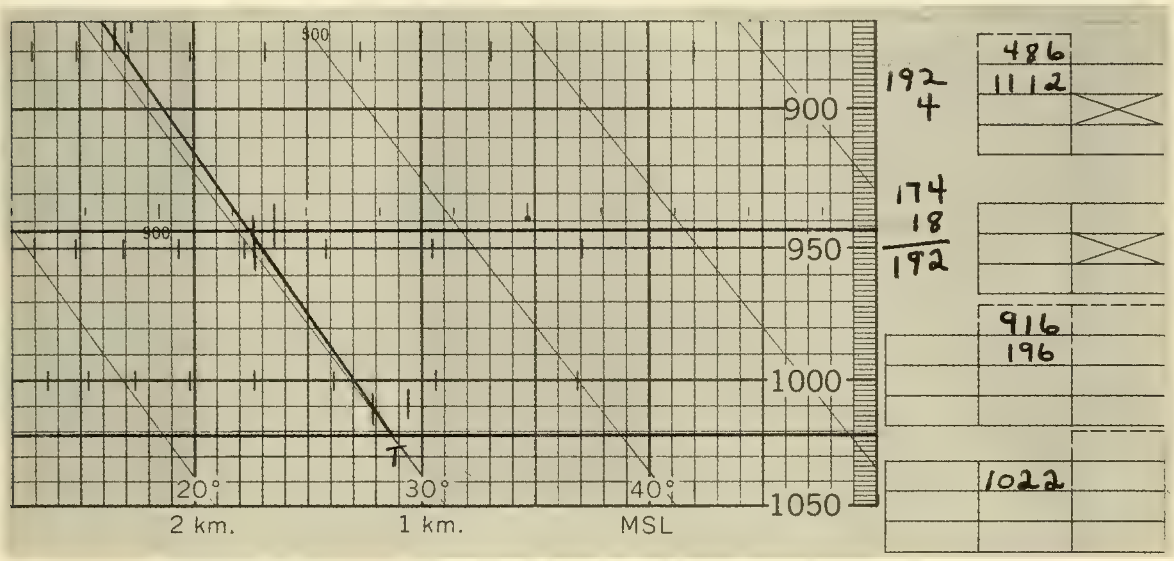

Figure B5 - 6. Determination of Thickness of Stratum find the thickness of the stratum in Table 7 using the mean virtual temperature and the section of the table lying between the pair of dashed lines corresponding to the pressures at the upper and lower limits of the stratum. Enter the thickness value in the dashed block just above the constant pressure block, if provided, pertaining to the base of the stratum. Thickness values for complete strata only will be obtained by either method. Whenever the observation extends to pressures less than 10 mb, thickness values for strata within the 12.5 to 1 mb range can be computed from the same thickness tabs used in computing the thickness values within the 125 to 10 mb range. In this case, however, the strata for which thickness values are computed will be: 12.5 - 10 - 8 - 7 - 6 - 5 - 4 - 3 - 2.5 - 2 - 1.5 - 1 mb.

7.2 Altitude of Standard Isobaric Surfaces. Compute the altitude of each of the standard isobaric surfaces by adding the thickness of each stratum to the altitude of the base of the stratum, progressing upward to the highest standard isobar reached in the sounding. Enter the altitude data thus found in the altitude section of the constant pressure data block corresponding to the appropriate standard isobaric surface.

8. Computation When Less Than Station Altitude. Whenever the surface pressure is less than 1000.0 or 850.0 millibars, the altitude of the corresponding constant-pressure level or levels relative to sea level will be computed on the back of WBAN-31A in accordance with the following instructions. The tables referred to in these instructions on the back of WBAN-31A are included in the Radiosonde Observation Computation Tables (WBAN).

8.1 Lines 1 Thru 5. On the lines 1 thru 5, enter the data to tenths as required by the legends. These lines are used to compute the station temperature argument (t), which is entered on line 6 and is expressed by the formula:

$t = 1/3\ (2t_0+t_{-6})$, degrees Celsius, where

t_0 = current station temperature (°C)

t_{-6} = station temperature 6 hours previously (°C)

8.2 Lines 6 Thru 14. On lines 6 thru 14, enter the required data as indicated by the legends on the respective lines. The entry required on line 9 is the surface altitude in meters m.s.l. (see ¶B4-4.3). When the value entered on line 13 is greater than the value entered on line 9, the value entered on line 14 will have a minus sign (-) prefixed to the value.

8.3 Tables 10 and 12. The pressure and temperature arguments used in deriving values from these tables are those entered on lines 1 and 6 respectively. The arguments in the tables nearest to the corresponding values of pressure and temperature entered on lines 1 and 6 will be used. Interpolation is not necessary; therefore, the entry on line 7 will always be to the nearest whole degree.

8.4 Tables 11 and 13. The temperature argument used in deriving values from these tables is that entered on line 8 pertaining to the level whose altitude is being sought. The pressure argument is the value entered on line 1, rounded to the next lower multiple of 10 millibars. For example, if the pressure is 978.9, for purposes of Table 11 it will be regarded as 970. Interpolation for the remainder, 8.9 will be made in table 14. With the rounded value of pressure and the temperature value taken from line 8 as arguments, find the corresponding tabular value in table 11 or 13 and enter it on line 10. The immediately adjacent value in the column captioned "dif" to the right of this tabular value will be entered on line 11.

8.5 Table 14. This is a table of proportional parts designed to facilitate interpolation of altitude differences found in tables 11 and 13 for various values. One argument is the difference in pressure between the value entered on line 1 and the next lower multiple of 10 millibars. The other argument is the altitude difference "dif" value entered on line 11 and referred to in ¶B5-8.4. The value taken from Table 14 corresponding to these arguments will be entered on line 12.

8.6 Maximum Altitude. Find the thickness of the stratum between the highest standard isobaric surface and the level at the maximum altitude of the raob (whenever this level does not coincide with a standard isobaric surface) in accordarce with the instructions in the following paragraphs. Computations will be made within the last 10° space on the right side of the adiabatic chart.

a. From Table 8, find the uncorrected thickness of this stratum, using as the sole argument the pressure at the maximum altitude of the raob. Enter the value from Table 8 about 1 inch above the terminating level.

b. By use of Table 9, the thickness found in (a) will be corrected for temperature in the same manner as the corresponding thickness in the stratum bounded by the surface and the next higher standard isobar. The arguments are the mean virtual temperature and the uncorrected thickness of the stratum.

c. Enter the correction found in (b), preceded by a minus sign whenever the mean virtual temperature is below 0°C, under the uncorrected thickness of the stratum. If the correction is negative, subtract it from the uncorrected thickness, if it is positive, add it to the uncorrected thickness. Enter the sum or difference immediately below the correction.

d. Enter the altitude for the highest standard isobaric surface on the printed isobar, within the last 10° space on the right side of the adiabatic chart, pertaining to that surface. Enter the corrected thickness obtained in (c) just above this altitude entry. Add the two entries and place the sum on the terminating level of the raob. This sum is the altitude of that level.

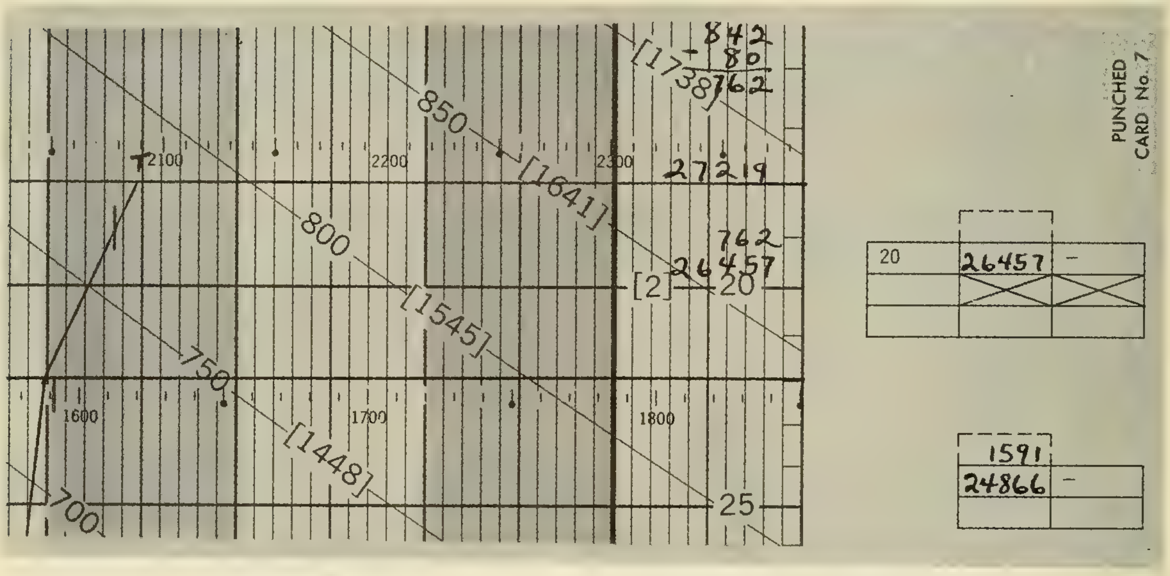

Figure B5 - 7. Entry of Maximum Altitude

9. Extrapolation of Altitude Data. Extrapolated altitude data will be computed from the terminating level of the ascent to the next higher (with respect to altitude) mandatory constant pressure surface when the difference between terminating level and the constant pressure surface is:

a. 25 mbs or less up to and including the 100 mb surface.

b. 1/4 (or less than 1/4) of the pressure value of the mandatory constant pressure surface for levels above the 100 mb level.

9.1 Procedure for Extrapolation of Altitude.

a. Determine the pressure difference between the terminating level and the next higher mandatory level (i.e., 12-10 = 2 mbs).

b. Add the pressure value determined in (a) to the pressure of the terminating level (i.e., 12+2 = 14 mbs).

c. Mark the point on the temperature curve corresponding to the value in (b) (i.e., point A, the terminating temperature is point B).

d. Place a straight edge between the point found in (c) and the terminating point (i.e., points A and B).

e. With the straight edge aligned with points A and B, extend the temperature curve linearly with a dashed line from the terminating point to the mandatory pressure level (i.e., dashed line B-C).

f. Note the mean virtual temperature in the stratum (or strata) bounded by the standard levels commencing with the standard level below the terminating level to the mandatory level above the terminating level. For this purpose use the actual temperature curve up to the terminating point and the extrapolated temperature curve from this point to the mandatory level (i.e., curve D-B-C).

g. Compute the altitude of the mandatory level in the usual way, using the thickness tab marks on the adiabatic chart and commencing with the altitude of the standard level below the terminating level.

9.2 Entry of Extrapolated Data on WBAN-31( ). Enter the extrapolated altitude in the constant pressure data block pertaining to that surface, and enclose the entry in parentheses. Enter "Extrapolated" above the constant pressure data block.

The pressure altitude curve will not be drawn to the extrapolated height. A circled dot, however, will be entered to indicate the altitude and will be used as a check on the accuracy of the calculations.

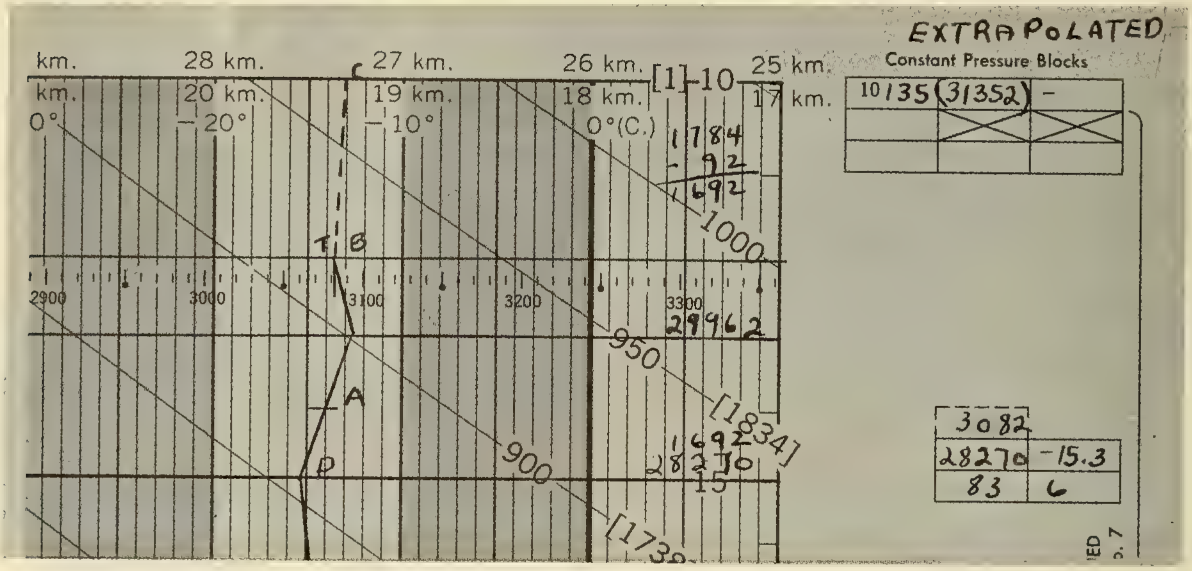

Figure B5 - 8. Extrapolation of Pressure Altitude Data.
NOTE: points A, B, C, and D are labled for illustration and need not be labeled on WBAN-31().

10. Pressure Altitude Curve. A pressure altitude curve, based on pressure, temperature, and relative humidity data, is computed for each raob and drawn on the adiabatic chart. It provides a means of determining the altitude of significant levels and of other data entered on the chart. The pressure altitude curve is also used as a sighting line for location of errors in altitude computations. These altitudes are in geopotential meters above mean sea level.

10.1 Plotting the Pressure Altitude Curve. Plot the surface altitude on the surface level against the altitude scale printed along the lower edge of the adiabatic chart. In the same manner, plot the altitude of each standard isobaric surface and the altitude of the level at the maximum altitude of the sounding. Connect the successive plotted points by straight lines and label the curve "PA" at top and bottom of each section of the adiabatic chart, Whenever the observation extends to pressures less than 10 mb data for the 10 to 1 mb range will be plotted on the same WBAN-31C used for the 100 to 10 mb range. The pressure altitude curve pertaining to the 10 to 1 mb range will be drawn in red.

a. To reduce the likelihood of a computation and/or plotting error when an observation terminates shortly after transferring from one adiabatic chart to another or when it is necessary to displace the pressure altitude curve, each portion of the pressure altitude curve should be based on at least three points. For example, if an observation terminates at 82 mb, the pressure-altitude curve on WBAN-31C could be based on the 125, 100, and 82 mb points; if it terminates at 12 mb, the pressure-altitude curve on WBAN-31C could be based on the 20, 15 and 12 mb points; if it terminates at 8 mb, the red pressure-altitude curve on WBAN-31C could be based on the 12.5 10, and 8 mb points.

b. Whenever the pressure altitude of a standard isobaric surface or maximum altitude exceeds or falls below the pressure altitude scale printed on a chart, displace the pressure altitude curve to the right or left, as appropriate, and renumber the scale accordingly.

c. Whenever the pressure altitude curve is based on estimated mean virtual temperature, the estimated portion of the curve will be drawn as a solid line through missing or doubtful portions of the record.

d. Whenever the station pressure is less than 1000.0 or 850.0 millibars, the altitude of the corresponding constant-pressure surface, as computed on the back of WBAN-31A, will be plotted, and the pressure altitude curve extended to the 1000 mb level.

10.2 Doubtful Pressure Altitude. Pressure altitude computation will be classified as doubtful when the mean virtual temperature is based on a doubtful or missing portion of the temperature curve and exceeds the following limits:

MISSING TEMPERATURE

a. From the surface to 400 mb., 1 km.

b. From the surface to 100 mb., 1.5 km with (a) satisfied.

c. From the surface to termination of flight 2 km with (a) and (b) satisfied.

d. When the tropopause occurs in a missing stratum 1.5 km thick.

DOUBTFUL TEMPERATURE

a. From the surface to 400 mb., 2 km.

b. From the surface to 100 mb., 3 km. with (a) satisfied.

c. From the surface to termination of flight 4 km with (a) and (b) satisfied.

COMBINATION MISSING AND DOUBTFUL TEMPERATURE

The limits set for missing temperature will be followed, and the doubtful temperature portion weighted 1/2 that of the missing temperature. Example:

> Missing temperature from 950 to 900 mb (500m), doubtful temperature from 620 to 580 mb (1/2 600m), missing temperature from 430 to 416 mb (280m); (500 + 300 + 280) m = 1.080 km. (Altitude data considered doubtful beginning at 430 mb.)

10.3 Beginning of Doubtful Altitude. The doubtful portion will begin at the base of the first stratum within which the limits indicated in ¶B5-10.2 are exceeded and continue through the remainder of the flight.

11. Completing Constant Pressure Data Blocks. Blocks for entering constant pressure level data are printed to the right of the adiabatic chart on WBAN-31( ). All stations will enter data in the blocks corresponding to the constant pressure levels that are printed on the WBAN-31( ). Data will be entered in the CPD blocks in accordance with the key printed on WBAN-31( ). Entry will be made at any level for which data are available regardless of whether data are available at other levels.

a. Entries in the CPD block for the surface level will consist of pressure in whole millibars, temperature, relative humidity, dewpoint depression, and wind direction and speed. A computation block is provided to enter the dewpoint. Additional blocks are provided to code the data for transmission.

b. When the surface pressure is less than 1000.0 or 850.0 millibars, the altitude of these levels will be computed on the back of WBAN-31A in accordance with ¶B5-8. The values to the nearest whole geopotential meter will be entered in appropriate spaces in the CPD blocks, and dashes will be entered in the spaces provided for temperature, relative humidity, dewpoint depression, and wind, direction and speed.

c. Altitude, temperature, relative humidity, and wind data at the corresponding constant-pressure levels will be taken from the adiabatic chart and the winds aloft graphing board and entered in the appropriate section of the constant pressure data block. This may be accomplished while the raob is still in progress.

11.1 Altitude. Altitude computations are made directly within the CPD blocks; therefore, altitude entries will be made to the nearest whole meter at all computed levels. Thickness between strata will also be entered in the blocks provided to the nearest whole meter. For example, 1,544 meters will be entered as 1544, and 21,456 meters as 21456. Altitudes pertaining to intermediate constant pressure levels are read from the plotted PA curve; therefore, altitude entries at the non-computed levels will be made to the nearest ten meters. Prefix a minus sign to entries pertaining to levels below sea level.

11.2 Temperature. Enter in degrees and tenths (see ¶B5-11.7). Enter a dash when data are missing.

11.3 Relative Humidity. Enter to the nearest whole percent, with 100 percent entered as 100 (see ¶B5-11.7). If the relative humidity data are missing enter a dash. Enter a dash for relative humidity when the temperature is colder than -40.0°C.

11.4 Dewpoint. Enter the dewpoint temperature in degrees and tenths (see ¶B5-11.7). Whenever the temperature or relative humidity is missing, and whenever the temperature is colder than -40.0°C, the dewpoint will be entered as a dash.

11.5 Dewpoint Depression. Enter dewpoint depression to degrees and tenths (see ¶B5-11.7). When either the temperature or the dewpoint is missing or both are missing, enter a dash.

11.6 Wind Data. Wind data will be taken from the wind curve at altitudes corresponding to the altitude of the constant pressure surfaces. Only rawin or rabal data secured with the raob balloon will be entered on this form. Wind directions will be entered to the nearest whole degree and wind speeds will be entered to the nearest whole meter per second (see ¶B5-11.7). A single zero will be entered in each space for direction and speed whenever the wind is calm. When data are missing, or when the level is below the surface, enter a dash.

11.7 Examples. Examples of data entries in the CPD blocks.

Altitude of 44 meters entered as 44. Altitude of 21,456 meters entered as 21456.

Temperature of 2.4°C entered as 2.4.

Temperature of -7.3°C entered as -7.3

Temperature of -57.3°C entered as -57.3

Relative Humidity 100 percent entered 100.

Relative Humidity 20 percent entered 20.

Dewpoint of 2.8°C entered as 2.8.

Dewpoint of -26.4°C entered as -26.4.

Dewpoint depression 14.4°C entered as 14.4.

Wind direction from 272 degrees entered as 272.

Wind direction from 62 degrees entered as 62.

Wind speed of 5 meters per second entered as 5.

Wind speed of 112 meters per second entered as 112.

11.8 Other Entries. Enter a dash in the spaces for temperature, relative humidity, dewpoint and wind data pertaining to constant-pressure levels below the level of the station.

11.9 Doubtful Data. Temperatures believed to be more than 1°C but less than 3°C in error, and altitudes computed from doubtful or missing temperature exceeding the limits specified in ¶B5-10.2, will be entered in the CPD blocks in parentheses. An altitude entry may be regarded as accurate even though the temperature entry for the same level is doubtful or missing. However, once altitudes are classified doubtful they will be regarded as doubtful for the remainder of the observation (see ¶B-10.3).

12. Checking Records. Where possible, an observer other than the computer will check the flight records in detail before transmission of the raob message. This check and other checks deemed necessary before mailing will be done in accordance with the instructions issued by the separate services.

13. Computation of Stability Index. The stability index for each raob will be computed at all radiosonde stations within the United States and the Pacific Region, except that Alaska stations will make these computations only during the period May 1 to September 30, inclusive. The index indicates the degree of stability of the layer of air extending from a level near the surface of the earth to the 500 mb surface. The computations consist of finding the temperature a particle of air at a selected level would have if it were moved upward along a moist pseudo-adiabatic

curve from its condensation level to the 500 mb surface, and then subtracting algebraically this temperature from the true temperature of the air at the 500 mb surface as indicated by the raob. The remainder, with appropriate algebraic sign, is the stability index. Positive values connote stable conditions, and negative values unstable. The degree of stability is indicated by the magnitude of the difference.

The thickness of the layer of air used in the computation varies from station to station, because of the difference in altitude. Computations will begin at a base level appropriate to the altitude of the station and selected from Table B5-1.

Table B5-1. Base Level Appropriate to Station Altitude

Station Altitude (for raob purposes)	Base Level
Less than 1000 gpm	850 mb
1000 to 1400 gpm	800 mb
1401 to 2000 gpm	750 mb

13.1 Computations. Computation of the stability index will be as follows:

a. Compute the dewpoint temperature (to the nearest tenth of degree) at the base level using the temperature and relative humidity values from the plotted curves vn WBAN-31A. Record the dewpoint temperature on the right side of the form between the 50° line and the constant-pressure data blocks opposite the level. Draw a circle around the value. When the base level is the 850 mb surface, use the dewpoint temperature recorded in the 850 mb constant pressure data block. An additional entry will not be required.

b. On a pseudo-adiabatic chart, at a pressure corresponding to that of the base level, locate the dewpoint temperature found in (a) and the temperature (to the nearest tenth of degree) of the sounding at the same pressure. Project the dewpoint temperature up the mixing ratio curve which passes through it and project the temperature of the sounding up the dry adiabatic curve. Find the point of intersection of the two curves. Which is the level of lifting condensation. If the lifting condensation pressure is less than 500 mb, do not compute a stability index but record it as "dry."

c. Project the lifting condensation point found in (b) up the moist pseudo-adiabatic curve which passes through it to the 500 mb level. Read the temperature (to the nearest tenth of degree) corresponding to that point on the curve.

d. Subtract algebraically the temperature found in (c) from the temperature of the sounding at the 500 mb level. The difference represents the stability index. Record this value to the nearest whole degree, with appropriate algebraic sign, to the right of Data Block "A" on WBAN-31A and just below the 500 mb constant pressure data block. Draw a circle around the value.

NOTE: When the temperature found in (c) is lower than the temperature the sounding at 500 mb., the index is positive; when it is higher the index is negative.

e. Code the index in accordance with separate instructions.

Examples:

a. If: station altitude 360 gpm

base level 850 mb.

dewpoint 6.8°

temperature 7.4°

raob temperature at 500 mb -15.4°

computed condensation temperature 6.6°

temperature on pseudo-adiabatic curve at 500 mb -19.6°

The stability index is then:

-15.4° - (-19.6°) = +4.2° or +4° to the nearest whole degree and entered +4

b. If: station altitude 1619 gpm

base level 750 mb

dewpoint 7.1°

temperature 20.4°

raob temperature at 500 mb. -7.5°

computed condensation temperature 4.2°

temperature on pseudo-adiabatic curve at 500 mb -4.8°

The stability index is then:

-7.5° - (-4.8°) = -2.7° or -3° to the nearest whole degree and entered -3

13.2 When not to Compute Stability Index. The stability index will not be computed when the relative humidity is missing at the base level, or when the temperature is missing or doubtful at the base level or at the 500 mb. level.

14. Determination of Tropopause Level for Transmission Purposes. The tropopause is defined in terms of temperature lapse rate change, pressure level, and thickness of strata as described below.

14.1 Criteria for Selecting Tropopause Level.

a. At pressures of 500 mb or less:

(1) The lowest level, with respect to altitude (at or between 500 and 30 mbs), at which the temperature lapse rate decreases to 2°C/km or less.

(2) The average lapse rate from this level to any point within the next higher two km does not exceed 2°C/km.

(3) The flight must extend at least two km above the tropopause level.

b. At pressures greater than 500 mb (only if no tropopause found at pressures of 500 mb or less).

(1) The highest level, with respect to altitude, at which the temperature lapse rate decreases to 2°C/km or less.

(2) The average lapse rate from this level to any point within the next higher two km does not exceed 2°C/km.

(3) The flight must extend to a pressure of 200 mb or less.

(4) The average lapse rate does not exceed 3°C/km over at least 1 km in any higher layer up to and including 100 mbs.

14.2 Procedure for Selecting Tropopause Level. To facilitate the selection of the tropopause level, a Tropopause Template WBAN-31B1 is provided. This template may be used only with WBAN-31B. The sloping curves on the template approximate lapse rates of 2°C/km. The barbs on the curves are approximately the boundaries of 2-km layers.

14.3 Tropopause Template WBAN-31B1. To use the Tropopause Template WBAN-31B1, superimpose it on WBAN-31B so that 500-mb isobar on the template coincides with the 500-mb isobar on the adiabatic chart, and so that the vertical border lines on the template are parallel to the isotherms on the adiabatic chart. Move the template to the right or left until the sloping curve, whose temperature is nearest that of the level tested, intersects the temperature curve at the level. If the lapse rate in the stratum immediately above the level tested is 2°C/km or less, and the temperature throughout the two-km layer above the level are everywhere as high as , (or higher than) a 2°C/km lapse rate, all temperatures will fall on or to the right of the sloping curve and the level tested may be regarded as the tropopause. This will be true regardless of the configuration of the temperature curve within the two-km stratum as long as no point within the stratum falls to the left of the sloping curve. If the level in question fails to qualify as the tropopause and another level must be tested, repeat the process until the tropopause is located, or until it is definitely established and no point within the range of the template meets the criteria for a tropopause.

Since the curve on the template is based on the Standard Atmosphere, the actual lapse rate should be computed when the temperature trace and the sloping curve on the template almost coincide, to ascertain that the criteria in ¶B5-14.1(a)(2) are met.

Whenever no tropopause is selected within the range of the Tropopause Template WBAN-31B1, the actual lapse rates must be computed. If the tropopause is selected at pressure greater than 500 mbs, the lapse rates above the tropopause must be tested for compliance with ¶B5-14.1(b)(4).

14.4 Transmitted Data. Tropopause data will be included in the appropriate "Coded Message for Transmission" block on WBAN-31A or B and will be transmitted in accordance with instruction in the Federal Meteorological Handbook No. 4 (Radiosonde Code). Wind data will be taken from the winds-aloft graph at the corresponding pressure.

15. Raob Messages. Raob messages will be coded and transmitted in accordance with the latest Federal Meteorological Handbook No. 4 (Radiosonde Code).

15.1 Entering Coded Message on WBAN-31( ). The coded message will be entered on WBAN-31( ) in the "Coded Message for Transmission" section. Data for the first transmission will be entered on WBAN-31A and data for the second transmission will be entered on WBAN-31B. Each group in the message will be entered on a segment of the broken lines provided for the entries. Corrections made after the data have been transmitted will be made in red without obliterating or erasing the data as they originally appeared in the transmitted message.

15.2 Selecting Levels for Transmission. Levels will be selected for transmission purposes in accordance with instructions in the Federal Meteorological Handbook No. 4 (Radiosonde Code).

15.3 Code Check. In the column headed "Code Check" on WBAN-31( ), number the transmitted significant levels as follows. The first significant level above the surface level and the first significant level above 100 mb will be numbered "11," the second "22." etc. Code checks 00 will be used for the surface level only. If additional significant levels for transmission are discovered after the message has already been transmitted, the "Code Check" for these levels may consist of letters, "AA," "BB," etc. A correction message will be filed in accordance with instructions contained in Federal Meteorological Handbook No. 4 (Radiosonde Code).

15.4 Special Raobs. Messages based on special raobs will not be transmitted unless specifically authorized.

15.5 Early Transmission of Specified Data. Data pertaining to designated constant-pressure surfaces, freezing and icing levels, mean winds and the stability index will be computed in accordance with instructions in the following paragraphs as soon as they become available. These data are required for transmission before the regular transmission of the coded radiosonde report.

15.6 Constant-Pressure Surfaces, Stability Index, and Mean Winds. These data will be coded for transmission as specified in the Federal Meteorological Handbook No. 4 (Radiosonde Code).

15.7 Freezing-Level Data. Whenever, during an observation the temperature profile crosses the 0°C isotherm, the altitude and the relative humidity pertaining to the first (lowest) crossing and the number of crossings will be determined. The method for determining the altitude is described in ¶B5-15.9. The relative humidity will be determined by noting on the radiosonde recorder record, the humidity ordinate opposite the point where the temperature trace reached 0°C; all appropriate corrections should be applied. Freezing-level data will be transmitted in accordance with instructions in the Federal Meteorological Handbook No. 1 (Surface Observations).

15.8 Icing-Level Data. Icing of the raob balloon will be assumed under the conditions described in ¶B4-6.6(h), and the altitude pertaining to the beginning of such conditions will be determined in accordance with instructions in ¶B5-15.9. Icing-level data will be transmitted in accordance with instructions in Federal Meteorological Handbook No. 1 (Surface Observations).

15.9 Determination of the Altitude of Freezing and Icing Levels. Table 16 will be used to determine the altitude above sea level of freezing and icing levels. The table is based upon the ICAO Standard Atmosphere, and altitudes of levels determined by means of it will, therefore, usually differ from altitudes of the same levels determined by means of the adiabatic chart. Since the altimeters used in most aircraft are calibrated to the standard atmosphere, altitudes indicated by an altimeter will generally be in much closer agreement with altitudes determined by the table than with those determined by an adiabatic chart. Determine from an inspection of the recorder record the contact corresponding to the icing or freezing level. In the former case, it will be the first lengthened contact; and in the latter, the first contact above the surface corresponding to a temperature of 0°C.

a. Find the pressure corresponding to this contact from the pressure calibration chart furnished with each radiosonde, and from Table 16, find the altitude to the nearest hundred feet corresponding to this pressure.

b. Use Table 16 in the same manner to find the altitude in hundreds of feet corresponding to the station pressure at the time of release of the radiosonde.

c. Subtract algebraically the altitude in (b) from the altitude found in (a). Add the station altitude in feet to the remainder. The resultant value will be the required altitude in feet, m.s.l. Note that this subtraction must be made algebraically, as shown in the following example.

Given: Station Altitude 60 feet

Station Pressure 1025 mb

Freezing level occurs at the 25th contact

(1) The calibration chart furnished with the radiosonde indicated that the 25th contact corresponds to a pressure of 740 mb.

(2) From Table 16 it is found that a pressure of 740 mb corresponds to an altitude of 8400 feet mean sea level (to the nearest hundred feet).

(3) In a similar manner, it is found that the station pressure of 1025 mb corresponds to an altitude of -300 feet mean sea level (to the nearest hundred feet).

(4) Subtract algebraically the value found in (3) from that found in (2): 8400 - (-300) = 8700

Plus station altitude of 60 feet (to the nearest hundred

feet = 100

Required altitude 8800 feet

It will be noted that the value found in (3) will always be negative for pressures of 1016 mb or greater.

16. Mailing of Forms.

16.1 General. The flight records and computation forms will be assembled and mailed in accordance with instructions issued by the separate services.

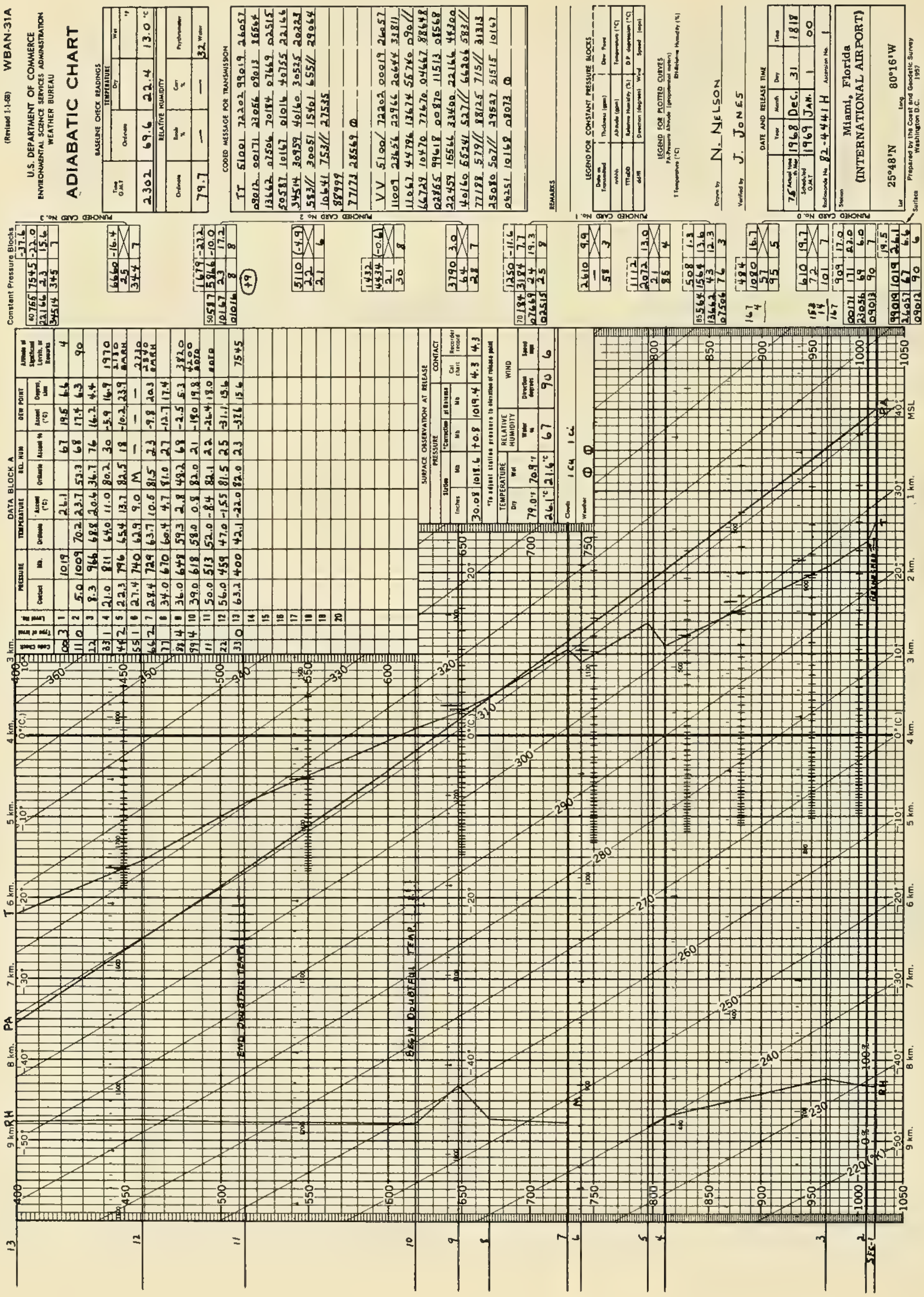

Figure B5 - 9a. Sample Form WBAN-31A

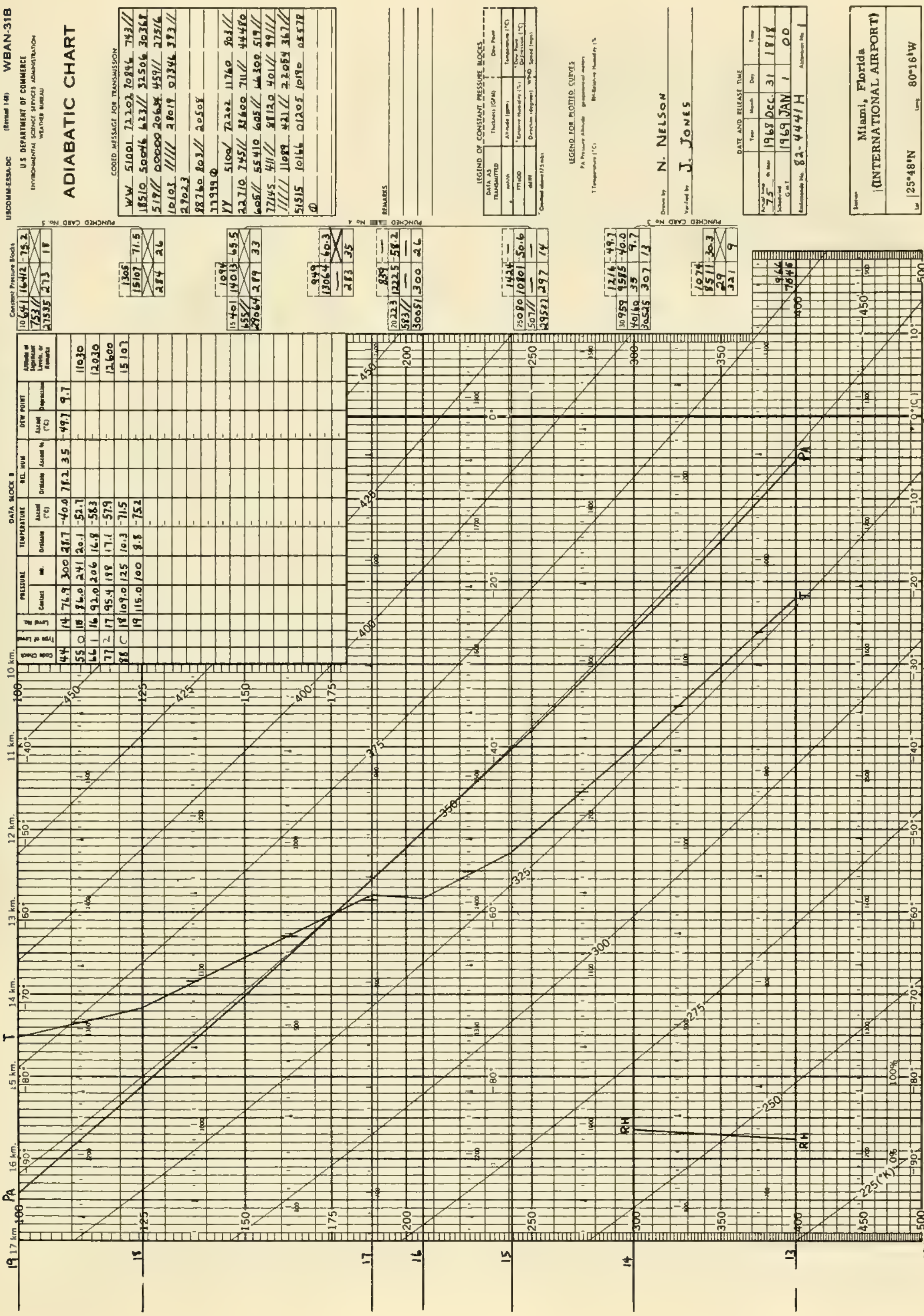

Figure B5 - 9b. Sample Form WBAN-31B

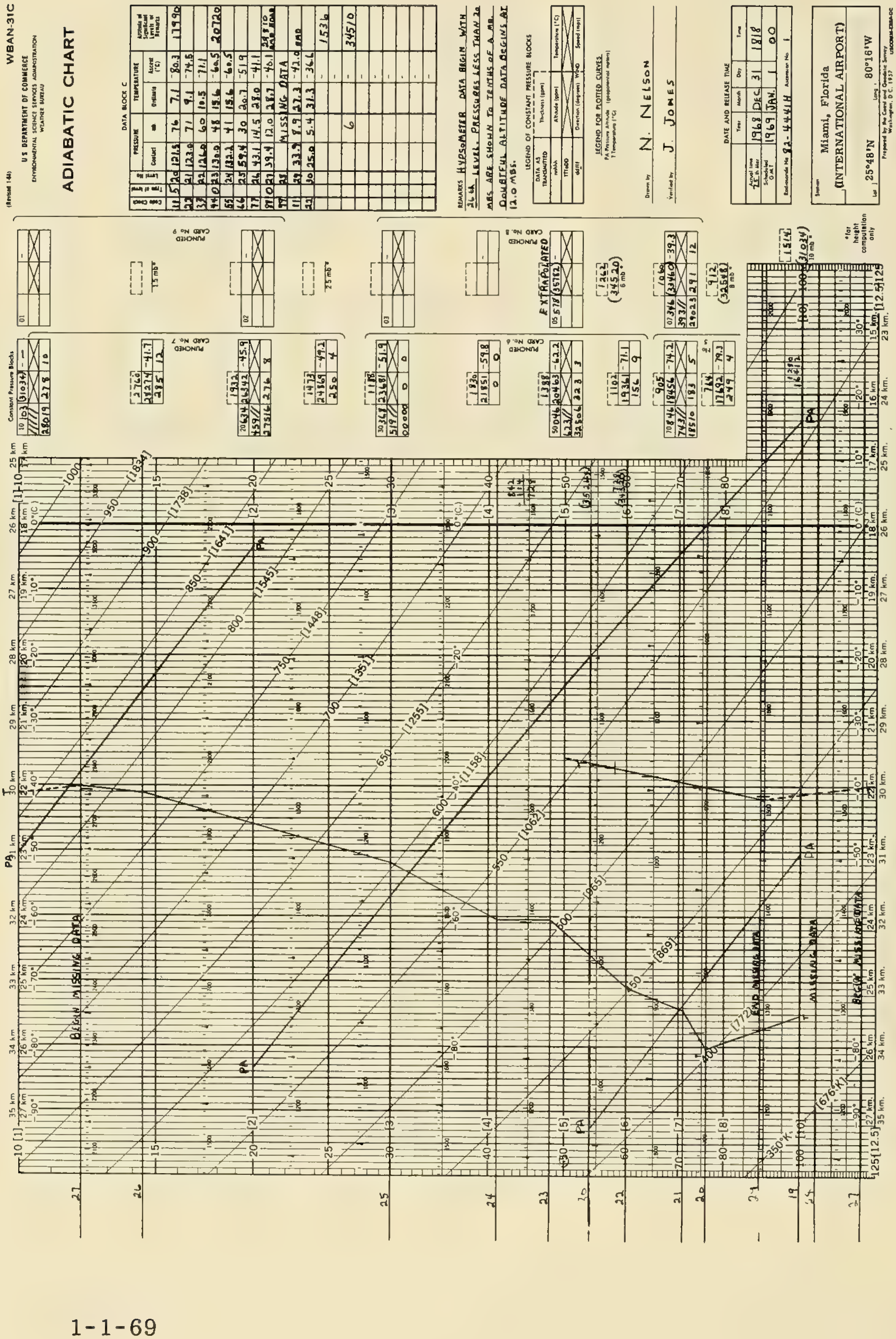

Figure B5 - 9c. Sample Form WBAN-31C