NATIONAL WEATHER SERVICE
OBSERVING HANDBOOK NO. 8

AVIATION WEATHER OBSERVATIONS
for Supplementary Aviation Weather Reporting Stations (SAWRS)

MANUAL OBSERVATIONS

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PREFACE

This handbook was prepared by the the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, to complement the instructions in Federal Meteorological Handbook No. 1 (FMH-1), *Surface Weather Observations and Reports*. This handbook is intended for use at Supplementary Aviation Weather Reporting Stations (SAWRS). No other stations are authorized to use this handbook.

RECORD OF CHANGES

Change No.	Effective Date	Initials	Date Entered	Remarks

When you enter a change in this handbook, make a notation on this page. Changes are indicated by a vertical line (▌) in the outside margin adjacent to the data affected. See the example to the right of this paragraph.

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CHAPTER 1 INTRODUCTION

1.1 Purpose

National Weather Service Observing Handbook No. 8 (WSOH #8) prescribes aviation weather observing, reporting, coding standards, and procedures applicable to Supplementary Aviation Weather Reporting Stations (SAWRS) engaged in taking and reporting manual surface observations. It provides a framework within which meteorological phenomena can be identified and reported in a standardized and understandable format.

1.2 Observational Procedures

Procedures assume that Aviation Routine Weather Reports (METAR) are made hourly and that special observations (SPECI) are made whenever significant changes or occurrences are observed. Weather observations recorded on the Meteorological Form MF1M-10C will reflect only those conditions seen from the usual point of observation and, unless otherwise specified, must have occurred within 15 minutes prior to the times recorded on the MF1M-10C.

1.3 Designated Stations

"Designated stations" refers to weather observing stations that have been instructed by the National Weather Service Headquarters or Regional Headquarters to perform a specified task that is not required to be performed at all stations.

1.4 Applicability of Standards

Procedures and practices described in this handbook are applicable only if a station has the capability to comply.

Throughout this handbook, the following definitions apply:

a. "shall" indicates that a procedure or practice is mandatory;

b. "should" indicates that a procedure or practice is recommended;

c. "may" indicates that a procedure or practice is optional;

d. "will" indicates futurity; it is not a requirement to be applied to practices.

1.5 Format of Manual Observations

Chapter 1 presents an introduction to manual observations.

Chapter 2 describes manual observations, types, and special criteria.

Chapters 3 through 8 focus on specific elements and their associated parameters that appear in the weather observation.

Chapter 3 - Wind

Chapter 4 - Visibility

Chapter 5 - Present Weather

Chapter 6 - Sky Condition

Chapter 7 - Temperature and Dew Point

Chapter 8 - Pressure

Chapter 9 describes the coding and dissemination of the manual observation (body and remarks).

Chapter 10 describes the entries on Meteorological Form MF1M-10C.

Appendix A is a list of abbreviations and acronyms used in WSOH #8.

Appendix B is a glossary of terms used in WSOH #8.

Appendix C consists of various tables from Chapters 2 through 9 and some additional tables. These tables may be removed from the handbook and used at the observing desk as an observing aid or quick reference.

1.6 Changes to Manual Observations Handbook

Changes, additions, deletions, and corrections will be issued under the titles Change No. 1, 2, 3, etc., by the Office of Systems Operations, Observing Systems Branch.

1.7 Maintaining Manual Observations Handbook

Any portion of WSOH #8 may be removed that is not applicable to the user/observer's particular mission which will create a working handbook for quick reference. An unmarked copy of WSOH #8, complete with changes and supplements, shall be maintained at each observing station for reference purposes. When making changes to WSOH #8, be sure to make a notation on page iii.

1.8 Unforeseen Requirements

No set of instructions can cover all possibilities in weather observing. Observers must use their own judgment, adhering as closely as possible to WSOH #8, to describe phenomena not adequately covered by specific instructions. Recommendations for changes or clarification should be forwarded via normal administrative channels to Regional headquarters. If a change is deemed appropriate, Regional headquarters shall forward suggestions to the Office of Systems Operations, Observing Systems Branch.

1.9 Certification of Observers

Observers shall be certified in accordance with instructions in Weather Service Operations Manual, Chapter B-61.

CHAPTER 2 GENERAL PROCEDURES

2.1 Introduction

This chapter explains the types of surface weather observations and prescribes general practices for observing and reporting them.

2.2 Surface Aviation Weather Observing Stations

For meteorological observations, the location of the station is defined as the point or points at which the various elements of the observation are evaluated. In cases where all measurements are taken at approximately the same point, a station will be regarded as having a single location. In cases where various sensors are in different locations to obtain acceptable exposure, the station location will be regarded as varying with the individual elements in an observation. For example, at an airport the aviation weather reporting station may be at the following points.

a. For visually observed elements such as clouds, prevailing visibility, weather, and obscurations, the station location might be immediately adjacent to the weather station office.

b. For temperature, dew point, and wind, the station location might be the center of the runway complex.

c. For cloud height and ceiling, the station location might be a point near the approach end of a runway.

Normally, multiple locations will be confined to an area within about 2 miles of the station. Weather reports may also contain information on phenomena occurring at other than the location of the station, such as clouds over mountains NW, lightning SE, showers W, etc. In such instances, the concept of multiple locations will not be extended to include points where the distant phenomena are occurring.

2.3 The Weather Observer

2.3.1 Certification of Observers

An observer must be certified by the National Weather Service (NWS) to take official surface weather observations. Observer certificates shall be available, on station, for review.

2.3.2 Observer Responsibility

In addition to taking and disseminating accurate, scheduled observations, the observer must report significant changes in weather conditions that could have an adverse effect on safe and efficient aviation operations. Observations should be taken and disseminated as rapidly and accurately as feasible to report these changes when they are observed.

The observer shall disseminate corrected reports immediately upon discovering an error, in accordance with paragraph 9.5.3. and 9.5.4.

2.4 Observation Form

Use the MF1M-10C to record the various elements of an observation. After all required data is entered, the completed form is archived as the record of surface observations for the station. Stations using the MF1M-10C shall prepare an original and at least one carbon copy. Copies must be legible and suitable for retention and duplication.

2.4.1 Disposition of MF1M-10C Originals

Unless otherwise directed by the NWS Regional Headquarters, mail by the second working day of each month the original copies of the previous month's MF1M-10C to the office designated by the NWS Regional Headquarters for verification and archiving.

2.4.2 Retention of MF1M-10C Carbon Copies

The corrected carbon copies of the MF1M-10Cs will be retained on station for 90 days. A longer on station retention of these copies may extend beyond the 90 day requirement if directed by the Regional Headquarters.

2.5 Definitions

2.5.1 Coordinated Universal Time (UTC)

The time in the zero degree meridian time zone. The acronym "**UTC**" is derived from the French Universal Temps Coordonné.

2.5.2 Local Standard Time (LST)

A time based on the geographic location of the station in one of the legally established time zones of the globe. This time shall not change during daylight savings time. Table 2-2 gives examples of converting LST to UTC.

2.5.3 Standard Time of Observation

The hour to which a record observation applies.

2.5.4 Actual Time of Observation

For METARs, the time (UTC) the last element of the report was observed or evaluated. For SPECI reports, the time (UTC) the criteria for the SPECI was met or noted.

2.5.5 Aircraft Mishap

An inclusive term to denote the occurrence of an aircraft accident or incident.

2.5.6 Surface Observation

A measurement or evaluation of one or more meteorological elements that describe the state of the atmosphere at the location(s) where the observation is taken.

2.5.7 Unofficial Weather Reports

A report of one or more weather elements from individuals who are not certified to take weather observations; e.g., a pilot on the ground and/or a law enforcement official. These unofficial reports provide additional and supplemental information that may be of interest to the public and to aviation. However, these unofficial observations are not to be put in a surface observation collective or encoded into a surface observation type format.

2.6 Time

All times refer to the 24-hour clock; e.g., 1:47 a.m. shall be referred to as 0147 and 1:47 p.m. as 1347. The times 0000 and 2359 indicate the beginning and ending of the day, respectively.

2.6.1 Time Standards

Times used in aviation weather observations are reported in UTC. On the MF1M-10C form, UTC is used to record time of observation, time checks, and other entries made in Column 65 that require a time notation. UTC is used on all transmitted data.

2.6.2 Accuracy of Time in Observations

The accuracy of the actual time of observation is of utmost importance in aviation safety investigations. One clock shall be designated as the station standard, and checked daily at part-time stations or on each shift at full-time stations. Log time check(s) in Column 65 of MF1M-10C. The clock used shall be within ± 1 minute of the U. S. Naval Observatory time. The format for the time is given in paragraph 10.5.20.

2.7 Observing Practices

2.7.1 Order of Observing

Elements having the greatest rate of change are evaluated last. When conditions are relatively unchanging, evaluate the elements in the following order:

a. Elements evaluated outdoors.

b. Elements evaluated indoors, with pressure last.

2.7.2 Recency of Observed Elements

Individual elements entered in an observation shall, as closely as possible, reflect conditions existing at the actual time of observation. Elements entered shall have been observed within 15 minutes of the actual time of observation. Gusts and squalls shall be reported if observed within 10 minutes of the actual time of observation. Routine observations shall be made as close to the scheduled time of the observation as possible to meet filing deadlines, but in no case shall these observations be started more than 15 minutes before the scheduled time.

2.7.3 Brightness Adaption

Allow enough time for your eyes to become adjusted to the ambient light conditions.

2.7.4 Rounding Figures

Except where otherwise designated, the rounding of numbers shall be accomplished as follows: If the fractional part of a positive number to be dropped is equal to or greater than one-half (1/2), the preceding digit shall be increased by one. If the fractional part of a negative number to be dropped is greater than one-half (1/2), the preceding digit shall be decreased algebraically by one. In all other cases, the preceding digit shall remained unchanged. For example, 1.5 becomes 2 (02), −1.5 becomes −1 (M01), 1.3 becomes 1 (01), −2.6 becomes −3 (M03).

An exception to this procedure is in reporting cloud heights and visibility. When the actual cloud height or visibility falls midway between two reportable values, report the lower of the two values.

Another exception to this procedure is in altimeter readings. The number shall be rounded down to the next reportable value. For example, an altimeter reading of 29.248 inches becomes 29.24 (truncate to the hundredth digit).

2.8 Aviation Weather Observations

These observations are taken by certified weather observers to report meteorological conditions. These observations are classified according to their purpose as designated in the following paragraphs.

2.8.1 Aviation Routine Weather Reports

The METAR is the primary observation code used in the United States to satisfy requirements for reporting surface meteorological data. The data are reported primarily in an alphanumeric code formatted for aviation users. A METAR for SAWRS contains a report of wind, visibility, weather phenomena, sky condition, temperature, dew point, and altimeter setting, collectively referred to as "the body of the report." In addition, significant information elaborating on data reported in the body of the report may be appended to the report in a section referred to as "remarks."

METARs are transmitted (disseminated) every hour between H+50 to H+55 with unscheduled observations (SPECI) transmitted (disseminated) when any of the criteria in paragraph 2.8.3 occur. SAWRS 135 observers who do not take routine hourly observations will use the SPECI classification, but the content will be the same as a METAR.

2.8.2 Routine (METAR) Weather Observations

METARs are taken on an hourly basis, 15 minutes prior to the hour. The contents of routine scheduled observations are given in Table 2-1.

2.8.3 Special Observations

SPECIs are taken whenever mandatory criteria are met, and at the discretion of the observer, to report significant weather changes. Unscheduled, non-hourly observations taken for SAWRS 135 operations will use this classification, but their content will be the same as a METAR. SPECIs are also taken when an aircraft accident or mishap occurs, and for any weather situation that in the opinion of the observer is critical to local operations. The contents of a special observation are given in Table 2-1. Take, record, and disseminate a SPECI observation when

any of the following is observed to occur:

a. WIND SHIFT. Wind direction changes by 45 degrees or more in less than 15 minutes and the wind speed is 10 knots or more throughout the wind shift.

b. VISIBILITY. Surface visibility as reported in the body of the report decreases to less than or, if below, increases to equal or exceed:

(1) 3 miles.

(2) 2 miles.

(3) 1 mile.

(4) Lowest standard instrument approach procedure minimum as published in the National Oceanic Service (NOS) U. S. Terminal Procedures. If none is published, use 1/2 mile.

c. TORNADO, FUNNEL CLOUD, OR WATERSPOUT.

(1) Is observed.

(2) Disappears from sight or ends.

d. THUNDERSTORM.

(1) Begins (a SPECI is not required to report the beginning of a new thunderstorm if one is currently being reported).

(2) Ends.

e. PRECIPITATION.

(1) Hail begins or ends.

(2) Freezing precipitation begins, ends, or changes intensity.

(3) Ice pellets begin, end, or change intensity.

f. SQUALLS. When squalls occur.

g. CEILING. The ceiling (rounded off to reportable values) forms or dissipates below, decreases to less than, or, if below, increases to equal or exceed:

(1) 3,000 feet.

(2) 1,500 feet.

(3) 1,000 feet.

(4) 500 feet.

(5) Lowest standard instrument approach procedure minimum as published in the National Oceanic Service (NOS) U. S. Terminal Procedures. If none is published, use 200 feet.

h. SKY CONDITION. A layer of clouds or obscurations aloft is present below 1,000 feet and no layer aloft was reported below 1,000 feet in the preceding METAR or SPECI observation.

i. VOLCANIC ERUPTION. Eruption first noted.

j. AIRCRAFT MISHAP. Upon notification of an aircraft mishap unless there has been an intervening observation.

k. MISCELLANEOUS. Any other meteorological situation which in the observer's opinion is critical to aviation safety.

2.8.3.1 SPECI Observations upon Resumption of Observing Function

A SPECI observation shall be taken within 15 minutes after the observer returns to duty following a break in observing coverage at the station unless a record observation is filed during that 15-minute period.

2.8.3.2 Single-element SPECI Observations

Single-element SPECI observations are authorized to be taken for tornadic activity and volcanic eruptions.

Body of Report - Consists of 10 Groups				
Group	Reference	Brief Description	METAR	SPECI
Type of Report	9.5.1	Indicates type of report.	X	X
Station Identifier	9.5.2	A four-character group used to identify the observing location.	X	X
Date and Time of Report	9.5.3	Date and time of the report or when criteria for a SPECI are met.	X	X
Report Modifier	9.5.4	A report modifier (COR) identifying the report as a correction.	X	X
Wind	9.5.5	Indicates wind direction and speed. Gusts are appended if required.	X	X
Visibility	9.5.6	Provides prevailing visibility from the usual point of observation.	X	X
Present Weather	9.5.7	Any weather occurring at the station or obstructions (obscurations) to vision.	X	X
Sky Condition	9.5.8	State of the sky in terms of sky cover, layers and heights, ceilings, and obscurations.	X	X
Temperature and Dew Point	9.5.9	Measure of hotness/coldness of ambient air. Dew point measures saturation point temperature. (Dew point reported at designated stations).	X	X/D
Altimeter	9.5.10	Indicates altitude above Mean Sea-level of an aircraft on the ground.	X	X

X - Indicates element is included at all stations.
D - Designated stations.

Table 2-1. Content of Manual Surface Observations

Remarks Section of Report - Consists of 1 Category				
Manual and Plain Language Remarks				
Element	Reference	Brief Description	METAR	SPECI
Volcanic Eruptions	9.6.1a	Name of volcano, LAT/LON, DTG (date/time group), and other data reported.	X	X
Funnel Cloud (Tornadic Activity)	9.6.1b	Report whenever tornados, funnel clouds, or waterspouts begin/end and direction.	X	X
Wind Shift	9.6.1c	Wind direction change ≥ 45° and speed ≥ 10 kts. FROPA included if associated with frontal passage.	X	X
Variable Prevailing Visibility	9.6.1d	If prevailing visibility <3 miles and it increases/decreases by 1/2 SM.	X	X
Sector Visibility	9.6.1e	Visibility covers 45° of horizon circle. Reported when it differs from surface visibility by one or more reportable values when either the prevailing or sector visibility is <3 miles.	X	X
Lightning	9.6.1f	If observed, report type and location.	X	X
Thunderstorm Location	9.6.1g	Report location and movement, if known.	X	X
Hailstone Size	9.6.1h	Report diameter of hailstones. No remark required if GS is coded in body of report.	X	X
Virga	9.6.1i	Precipitation not reaching ground. Direction from station is optional.	X	X
Variable Ceiling Height	9.6.1j	When height is variable and ceiling layer is below 3000 feet.	X	X
Obscuration	9.6.1k	Include weather causing obscuration, applicable sky cover amount, and applicable height.	X	X
Variable Sky Condition	9.6.1l	Sky cover layer varies by one or more reportable values during evaluation period of sky.	X	X
Significant Cloud Types	9.6.1m	Provides type of clouds, location from station, and direction of movement.	X	X
Aircraft Mishap	9.6.1n	SPECI taken upon notification.	X	X
Other Significant Information	9.6.1o	Reports information not otherwise reported in the observation.	X	X
X - Indicates element included at all stations.				

Table 2-1 (Continued). Content of Manual Surface Observations

STANDARD TIME ZONE	To Convert LST to UTC (+) Add	1200 LST Equals
Atlantic Standard Time	4 HOURS	1200 + 4 = 1600 UTC
Eastern Standard Time	5 HOURS	1200 + 5 = 1700 UTC
Central Standard Time	6 HOURS	1200 + 6 = 1800 UTC
Mountain Standard Time	7 HOURS	1200 + 7 = 1900 UTC
Pacific Standard Time	8 HOURS	1200 + 8 = 2000 UTC
Alaska Standard Time	9 HOURS	1200 + 9 = 2100 UTC
Hawaii Standard Time	10 HOURS	1200 + 10 = 2200 UTC

Table 2-2. Converting Local Standard Time (LST) to Coordinated Universal Time (UTC)

CHAPTER 3 WIND

3.1 Introduction

Wind is measured in terms of velocity, a vector that includes direction and speed. The absence of apparent motion of the air is termed "CALM." The direction and speed of the wind should be measured in an unsheltered area. This will avoid, to a large degree, the measuring of wind directions and speeds that have been disturbed by local obstructions and will result in the reporting of winds more representative for aircraft operations.

3.2 Definitions

3.2.1 Wind Direction

The direction from which the wind is blowing.

3.2.2 Wind Speed

The horizontal speed of air past a given point.

3.2.3 Gusts

Rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls.

3.2.4 Variable Wind Direction.

A fluctuation of 60 degrees or more that takes place during the period of observation.

3.2.5 Wind Shift

A change in wind direction of 45 degrees or more that takes place in less than 15 minutes and has sustained winds of 10 knots or more throughout the wind shift.

3.3 Observing, Determining, and Reporting Procedures

Wind direction, speed, gusts, and shifts shall be determined at all stations.

3.3.1 Wind Direction

The wind direction shall be determined by averaging the observed direction over a 2-minute interval when direct-reading dials or recorders are used.

Wind direction shall be reported in all observations (except single-element SPECIs). Direction shall be reported in tens of degrees with reference to true north or may be reported as VRB (variable) if the speed is 6 knots or less. The format for reporting wind direction is given in paragraph 9.5.5.

3.3.2 Variable Wind Direction

The wind direction may be considered variable if, during the 2-minute evaluation period, the wind speed is 6 knots or less. Also, the wind direction shall be considered variable if, during the

2-minute evaluation period, it varies by 60 degrees or more when the average wind speed is greater than 6 knots. The format for reporting variable wind direction when wind speeds are 6 knots or less is given in paragraph 9.5.5b, and in paragraph 9.5.5c for wind speeds greater than 6 knots.

3.3.3 Estimating Wind Direction

If the wind direction indicator is inoperable, estimate the direction by observing the wind cone or tee, movement of twigs, leaves, smoke, etc., or by facing into the wind in an unsheltered area. When estimating wind direction, note that even small obstacles may cause variations in the wind direction. Do not use the movement of clouds, regardless of how low the clouds are, in estimating the surface wind direction.

3.3.4 Wind Speed

If possible, the average wind speed should not be determined during a peak or a lull in gusty winds or squalls. The wind speed shall be determined by averaging the speed to the nearest knot over a 2-minute period. Where direct-reading dials or recorders are used, determine the speed by averaging the observed values.

Wind speed shall be reported in all observations (except single-element SPECIs). Wind speed is always reported in surface observations in knots. The format for reporting speed is given in paragraph 9.5.5.

3.3.5 Estimating Wind Speed

Use the Beaufort scale, Table 3-1, to estimate wind speeds if instruments are out of service or if the wind speed is below the starting speed of the anemometer in use. Gusts and squalls are not to be estimated.

WIND EQUIVALENT -- BEAUFORT SCALE				
Beaufort #	MPH	KTS	International Description	Specifications
0	<1	<1	Calm	Calm; smoke rises vertically.
1	1-3	1-3	Light Air	Direction of wind shown by smoke drift, not by wind vanes.
2	4-7	4-6	Light Breeze	Wind felt on face; leaves rustle; vanes moved by wind.
3	8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	11-16	Moderate	Raises dust, loose paper; small branches moved.
5	19-24	17-21	Fresh	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	22-27	Strong	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Whole trees in motion; inconvenience felt walking against the wind.
8	39-46	34-40	Gale	Breaks twigs off trees; impedes progress.
9	47-54	41-47	Strong Gale	Slight structural damage occurs.
10	55-63	48-55	Storm	Trees uprooted; considerable damage occurs.
11	64-72	56-63	Violent Storm	Widespread damage.
12	73-82	64-71	Hurricane	

Table 3-1. Estimating Wind Speed

3.3.6 Wind Gust

The existence of gusts is indicated on direct-reading wind speed indicators by fluctuation and sudden increases and decreases of wind speed. If the criteria given in paragraph 3.2.3 are met, the speed of the gust is the maximum instantaneous speed observed.

When a gust is detected within 10 minutes prior to an observation that includes wind, the gust shall be reported in the body of the observation. The format for reporting wind gust is given in paragraph 9.5.5a.

3.3.7 Wind Shifts

A wind shift is indicated by a change in wind direction of 45 degrees or more over a less than 15-minute period with sustained wind speeds of 10 knots or more. Wind shifts are normally associated with some or all of the following phenomena:

a. Gusty winds shifting in a clockwise manner in the Northern Hemisphere;

b. Rapid drop in dew-point;

c. Rapid drop in temperature;

d. Rapid rise in pressure;

e. In summer: Lightning, thunder, heavy rain, and hail;

f. In winter: Frequent rain or snow showers.

A wind shift shall always be reported when it occurs. A special (SPECI) observation shall be taken immediately after a wind shift occurrence, and a remark, reporting the wind shift and the time it occurred, shall be included. When the shift is believed to be associated with a frontal passage, report "FROPA" in remarks immediately after the time the shift began. When a SPECI containing a wind shift is not given long-line dissemination, include the wind shift data in the remarks of the next transmitted report. The format for the remark is given in paragraph 9.6.1c.

3.3.8 Calm Wind

When no motion of the air is detected, the wind shall be reported as calm. The format is given in paragraph 9.5.5d.

3.4 Conversion of True and Magnetic Winds

Obtain the local variation from an aeronautical chart and proceed as follows:

a. To convert from true to magnetic wind:

   (1) Add westerly variation to true direction.

   (2) Subtract easterly variation from true direction.

b. To convert from magnetic to true direction:

   (1) Add easterly variation to magnetic direction.

   (2) Subtract westerly variation from magnetic direction.

3.5 Priority of Instruments

At stations having several types of equipment, the following priority shall be followed in selecting the wind equipment to be used:

a. Direct-reading recorders,

b. Direct-reading dials (2-minute wind only),

c. Other equipment.

CONVERSION OF MILES PER HOUR TO KNOTS										
MPH	0	1	2	3	4	5	6	7	8	9
	KTS	KTS	KTS	KTS	KTS	KTS	KTS	KTS	KTS	KTS
0	0	1	2	3	3	4	5	6	7	8
10	9	10	10	11	12	13	14	15	16	17
20	17	18	19	20	21	22	23	23	24	25
30	26	27	28	29	30	30	31	32	33	34
40	35	36	36	37	38	39	40	41	42	43
50	43	44	45	46	47	48	49	50	50	51
60	52	53	54	55	56	56	57	58	59	60
70	61	62	63	63	64	65	66	67	68	69
80	70	70	71	72	73	74	75	76	76	77
90	78	79	80	81	82	83	83	84	85	86
Note: This table is not reversible. Use Table 3-3 to convert knots to miles per hour.										

Table 3-2. Conversion of Miles Per Hour to Knots

CONVERSION OF KNOTS TO MILES PER HOUR										
KTS	0	1	2	3	4	5	6	7	8	9
	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH
0	0	1	2	3	5	6	7	8	9	10
10	12	13	14	15	16	17	18	20	21	22
20	23	24	25	26	28	29	30	31	32	33
30	35	36	37	38	39	40	41	43	44	45
40	46	47	48	49	51	52	53	54	55	56
50	58	59	60	61	62	63	64	66	67	68
60	69	70	71	72	74	75	76	77	78	79
70	81	82	83	84	85	86	87	89	90	91
80	92	93	94	96	97	98	99	100	101	102
90	104	105	106	107	108	109	110	112	113	114
Note: This table is not reversible. Use Table 3-2 to convert miles per hour to knots.										

Table 3-3. Conversion of Knots to Miles Per Hour

CHAPTER 4 VISIBILITY

4.1 Introduction

Visibility is a measure of the opacity of the atmosphere and is expressed in terms of the horizontal distance at which specified objects can be seen and identified. All visibilities referred to in this chapter are horizontal visibilities.

4.2 Definitions

4.2.1 Prevailing Visibility

The visibility considered to be representative of the visibility conditions at the station. This is the greatest visibility equaled or exceeded throughout at least half the horizon circle, which need not necessarily be continuous.

4.2.2 Sector Visibility

The visibility in a specified direction that represents at least a 45 degree arc (sector) of the horizon circle.

4.2.3 Surface Visibility

The prevailing visibility determined from the usual point of observation.

4.2.4 Variable Prevailing Visibility

A condition when the prevailing visibility is less than 3 statute miles and rapidly increases and decreases by 1/2 mile or more during the period of observation.

4.2.5 Visibility

The greatest horizontal distance at which selected objects can be seen and identified. Since suitable selected objects (visibility markers) are not present at all reportable values, the visibility in a specified direction must be estimated based on the appearance of available markers.

4.2.6 Visibility Markers

Dark or nearly dark objects viewed against the horizon sky during the day, or unfocused lights of moderate intensity (about 25 candela) during the night.

4.3 Observing, Determining, and Reporting Procedures

4.3.1 Unit of Measure

Visibility shall be reported in statute miles.

4.3.2 Observing Aids for Visibility

Charts, lists, or other positive means of identifying visibility markers shall be posted near the observer's position. Separate lists or charts can be used for daytime and nighttime markers. In

any case, the markers must be clearly identified as daytime and/or nighttime markers.

4.3.3 Observation Sites

Visibility observations shall be taken from as many locations as necessary to view as much of the horizon as practicable. In this respect, natural obstructions, such as trees, hills, etc., are not obstructions to the horizon but define the horizon.

4.3.4 Selection of Visibility Markers

Insofar as possible, use markers of the type described in paragraph 4.2.6 for determining visibility. The red obstruction lights on TV and radio towers or buildings, unfocused street lamps, neon signs of moderate intensity, etc., may be used as nighttime visibility markers. Because of their intensity, focused lights such as airway beacons may not be used as markers, but their degree of brilliance may be used as an aid to estimating whether the visibility is greater or less than the distance to the light source..

4.3.5 Dark Adaptation

Before taking visibility observations at night, observers shall spend as much time as practicable in the darkness to allow their eyes to become accustomed to the limited light.

4.3.6 Determining Visibility

Visibility shall be evaluated as frequently as practicable. All available visibility markers shall be used to determine the greatest distances that can be seen in all directions around the horizon circle. When the visibility is greater than the distance to the farthest markers visible, estimate the greatest distance seen in each direction. Base this estimate on the appearance of all visibility markers. If they are visible with sharp outlines and little blurring of color, the visibility is much greater than the distance to them. If a marker can barely be seen and identified, the visibility is about the same as the distance to it.

4.3.7 Determining Prevailing Visibility

After visibilities have been determined around the entire horizon circle, resolve them into a single value for reporting purposes (see Table 4-1). The prevailing visibility is the greatest reportable distance that can be seen throughout at least half the horizon circle. If the prevailing visibility varies rapidly during the time of observation, use the average of all observed values. For example, during the period of observation you determine that the prevailing visibility at H+52 = 1 1/2, H+54 = 1/2, H+56 = 0, and H+58 = 1. Using the average of these observed values, the prevailing visibility is 3/4 statute miles and the range of variability is from 0 to 1 1/2 statute miles. See Figure 4-1 for other examples in determining prevailing visibility. Report the prevailing visibility in all observations, except single-element specials.

4.3.8 Variable Prevailing Visibility

If the prevailing visibility rapidly increases and decreases by 1/2 mile or more during the time of the observation and the average prevailing visibility is less than 3 miles, the visibility is considered to be variable and the minimum and maximum visibility values observed shall be reported in remarks. The format for the remark is given in paragraph 9.6.1d.

4.3.9 Sector Visibility

When the visibility is not uniform in all directions, divide the horizon circle into arcs (sectors) that have approximately the same visibility and represent at least one eighth of the horizon circle (45 degrees). The visibility that is evaluated in each sector is sector visibility.

Sector visibility shall be reported in remarks of weather observations when it differs from the prevailing visibility by one or more reportable values and either the prevailing or sector visibility is less than 3 miles. The format for the remark is given in paragraph 9.6.1e.

4.3.10 Reportable Visibility Values

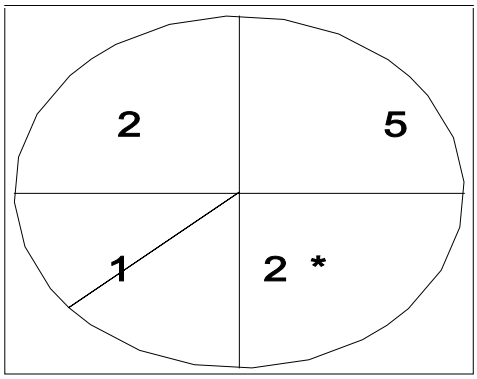
The reportable values for visibility are listed in Table 4-1. If the visibility falls halfway between two values, the lower value shall be reported.

REPORTABLE VISIBILITY VALUES				
0	5/8	1 5/8	4	12
1/16	3/4	1 3/4	5	13
1/8	7/8	1 7/8	6	14
3/16	1	2	7	15
1/4	1 1/8	2 1/4	8	20
5/16	1 1/4	2 1/2	9	25
3/8	1 3/8	2 3/4	10	30
1/2	1 1/2	3	11	35[a]

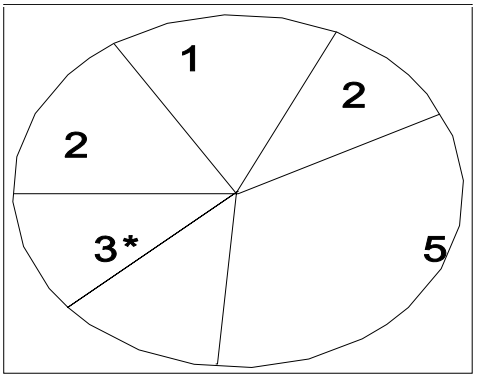
a. Further values in increments of 5 statute miles may be reported, e.g., 40, 45, 50, etc..

Table 4-1. Reportable Visibility Values

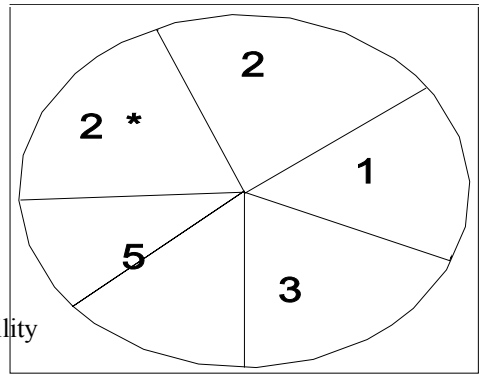
Four Sectors	
Visibility	Approximate Degrees Azimuth
5	90
2 ½*	90
	180
2	90
1 ½	90



Five Sectors	
Visibility	Approximate Degrees Azimuth
5	100
3*	90
	190
2 ½	60
2	50
1 ½	60



Five Sectors	
Visibility	Approximate Degrees Azimuth
5	72
3	72
2 ½*	72
	216
2	72
1 ½	72



*Indicates prevailing visibility

Figure 4-1. Examples - Determination of Prevailing Visibility

CHAPTER 5 PRESENT WEATHER

5.1 Introduction

This chapter provides information concerning the identifying, recording, and reporting of present weather conditions. Present weather includes precipitation, obscurations (obstructions to visibility), well-developed dust/sand whirls, squalls, tornadic activity, sandstorms, and dust storms. Methods of evaluating present weather include Instrumentally and/or manual methods are used to evaluate present weather.

5.2 Definitions

5.2.1 Precipitation

Precipitation is any form of water particles, whether in liquid or solid state, that fall from the atmosphere and reach the ground. Precipitation that reaches the ground can be an obscuration or obstruction to horizontal visibility. The various types are:

a. Drizzle. Drizzle is a fairly uniform type of precipitation that is composed of fine drops with diameters of less than 0.02 inch (0.5 mm) that are very close together. Drizzle appears to float while following air currents. Unlike fog droplets, drizzle does fall to the ground.

b. Rain. Rain comes in two forms. The first is in the form of drops larger than 0.02 inch (0.5 mm). The second can have smaller drops, but unlike drizzle, they are widely separated. It does not fall to the ground like drizzle.

c. Snow. This type of precipitation contains crystals, most of which are branched in the form of six-pointed stars.

d. Snow Grains. This is precipitation containing very small, white, and opaque grains of ice. It is the solid equivalent of drizzle. When the grains hit the ground, they do not bounce or shatter. They usually fall in small quantities, never as showers.

e. Ice Crystals (Diamond Dust). Ice crystals are often so tiny that they seem to be suspended in the air. They may fall from a cloud or from clear air. Ice crystals are visible mainly when they glitter in the sunshine or other bright light. They are rarely more than the lightest precipitation, which occurs only at very low temperatures in stable air masses and are in the form of needles, columns, or plates.

f. Ice Pellets. Ice pellets is a form of precipitation containing transparent or translucent pellets of ice which are round or irregular in shape, rarely conical, and have a diameter of 0.2 inch (5 mm) or less. There are two types. The first is hard grains of ice consisting of frozen raindrops or largely melted and refrozen snowflakes. The second type consists of pellets of snow encased in a thin layer of ice which have formed from the freezing of droplets intercepted by pellets or of water resulting from the partial melting of pellets. The pellets usually rebound when striking hard ground and make a sound on impact.

g. Hail. Hail is small balls or other pieces of ice falling separately or frozen together in irregular shapes.

h. Small Hail and/or Snow Pellets. This type of precipitation consists of white, opaque grains of ice which are round or sometimes conical. Their diameters range from 0.08 to 0.2 inch (2 to 5 mm). They are brittle and easily crushed. When they fall on hard ground they bounce and often break up.

5.2.2 Obscurations

Obscurations or obstructions to visibility can be any phenomenon in the atmosphere that reduce horizontal visibility. The various kinds are: (not including precipitation)

a. Mist. A visible aggregate of minute water particles suspended in the atmosphere that reduces visibility to less than 7 statute miles but greater than or equal to 5/8 statute miles.

b. Fog. A visible aggregate of minute water particles (droplets) which are based at the earth's surface and reduce the horizontal visibility to less than 5/8 statute miles. Fog does not fall to the ground like drizzle. Fog with a "qualifier" (see paragraph 5.4.2) can be reported if the visibility is 5/8 mile or more.

c. Smoke. Small particles produced by combustion that are suspended in the air. A transition to haze may occur when smoke particles have traveled great distances (25 miles or more) and, when the larger particles have settled out, the remaining particles have become widely scattered through the atmosphere.

d. Volcanic Ash. Fine particles of rock powder that have erupted from a volcano and remain suspended in the atmosphere for long periods of time.

e. Widespread Dust. Fine particles of earth or other matter raised or suspended in the air by the wind that may have occurred at or away from the station.

f. Sand. Particles of sand raised to a sufficient height that reduces visibility.

g. Haze. A suspension in the air of extremely small, dry particles invisible to the naked eye but sufficiently numerous to give it an opalescent appearance.

h. Spray. An ensemble of water droplets torn by the wind from the surface of a large body of water, generally from the crest of waves, and carried a short distance into the air.

5.2.3 Other Weather Phenomena

a. Well-developed Dust/Sand Whirl. An ensemble of particles of dust or sand, sometimes accompanied by small pieces of litter, that is raised from the ground and takes the form of a whirling column with varying height, small diameter, and an approximate vertical axis.

b. Squall. The sudden onset of strong winds with speeds increasing to at least 16 knots and sustained at 22 or more knots for at least one minute.

c. Funnel Cloud. A violent, rotating column of air which does not touch the ground. It is one aspect of tornadic activity.

d. Tornado. A funnel cloud that touches the ground. It is one aspect of tornadic activity.

e. Waterspout. A funnel cloud that forms over a body of water and touches the water's surface. It is one aspect of tornadic activity.

f. Sandstorm. Particles of sand carried aloft by strong winds. For the most part, the particles are found at the lowest ten feet. Rarely do they rise to more than 50 feet above the ground.

g. Duststorm. A severe weather condition characterized by strong winds and dust-filled air over a large area.

5.3 Weather Observing Standards

Weather shall be defined by qualifiers. These qualifiers fall into two categories: intensity or proximity and descriptors. Qualifiers may be used in various combinations to describe present weather phenomena. More refined definitions are as follows:

a. Intensity. Intensity qualifiers are the terms light, moderate and heavy. These terms vary in their meaning depending on the type of precipitation they are describing. The following tables establish criteria for these qualifiers:

Intensity	Criteria
Light	Up to 0.10 inch per hour; maximum 0.01 inch in 6 minutes.
Moderate	0.11 inch to 0.30 inch per hour; more than 0.01 inch to 0.03 inch in 6 minutes.
Heavy	More than 0.30 inch per hour; more than 0.03 inch in 6 minutes.

Table 5-1. Intensity of Rain or Ice Pellets Based on Rate-of-Fall

Intensity	Criteria
Light	From scattered drops that, regardless of duration, do not completely wet an exposed surface up to a condition where individual drops are easily seen.
Moderate	Individual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces.
Heavy	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

Table 5-2. Estimating Intensity of Rain

Intensity	Criteria
Light	Scattered pellets that do not completely cover an exposed surface regardless of duration. Visibility is not affected.
Moderate	Slow accumulation on ground. Visibility reduced by ice pellets to less than 7 statute miles.
Heavy	Rapid accumulation on ground. Visibility reduced by ice pellets to less than 3 statute miles.

Table 5-3. Estimating Intensity of Ice Pellets

Intensity	Criteria
Light	Visibility > 1/2 mile.
Moderate	Visibility > 1/4 mile but ≤ 1/2 mile.
Heavy	Visibility ≤ 1/4 mile.

Table 5-4. Intensity of Snow or Drizzle Based on Visibility

b. Proximity. The proximity qualifier is vicinity. Weather phenomena not occurring at the point of observation but between 5 to 10 statute miles from the point of observation shall be reported as "in the vicinity of the station." The exception: any type of precipitation not occurring at the point of observation, but within 10 statute miles, is reported as "showers in the vicinity," i.e., VCSH.

c. Descriptors. These are qualifiers that further describe weather phenomena and are used with certain types of precipitation and obscurations. The terms used are shallow, partial, patches, low drifting, blowing, shower(s), thunderstorm, and freezing; they are defined below:

(1) Shallow, Partial, AND Patches: Used to describe fog that has little vertical extent (normally greater than 6 but less than 20 feet) and reduces horizontal visibility. Stars and the sun may be seen.

(2) Low Drifting: Used to further describe the weather phenomenon when dust, sand, or snow is raised by the wind to less than 6 feet.

(3) Blowing: Used to further describe the weather phenomenon when dust, sand, snow, and/or spray is raised by the wind to heights of 6 feet or greater.

(4) Shower(s): Precipitation characterized by its sudden starting/stopping, rapid change in intensity, and accompanied by rapid changes in the appearance of the sky.

(5) Thunderstorm: A local storm produced by a cumulonimbus cloud that is accompanied by lighting and/or thunder.

(6) Freezing: Used to further describe the precipitation when drizzle and rain freeze upon impact and/or form a glaze on the ground or other exposed surfaces. When fog occurs and the temperature is below 0^{o}C, freezing fog (FZFG) shall be used to

describe the phenomena.

5.4 Present Weather Reporting Procedures

As noted above, weather phenomena fall into three categories: precipitation, obscurations, and other phenomena. The categories shall be combined with the qualifiers to identify the present weather that is reported when it is occurring at, or in the vicinity of, the station and at the time of observation. With the exception of volcanic ash (which is always reported when observed) and low-drifting dust, sand, and snow, obscurations are reported only when the prevailing visibility is less than 7 statute miles or considered operationally significant.

When more than one type of present weather is reported at the same time, the following precedence listing shall be followed:

Tornadic Activity - Tornado, Funnel Cloud, or Waterspout
Thunderstorm(s) with/without associated precipitation
Present weather in order of decreasing predominance[1] (most dominant reported first)
Left-to-right in Table 5-5 (Columns 1-5)

Precipitation shall be reported when it is occurring at the point of observation. The location of other weather phenomena shall be reported as "occurring at the station" if within 5 statute miles of the point of observation. Any type of precipitation (SN, RA, SHSN, SHRA, -SHRA, etc.) not occurring at the point of observation but within 10 statute miles shall be reported as "showers in the vicinity" (VCSH). Other weather phenomena, not occurring at the point of observation, shall be reported as "in the vicinity of the station" when between 5 to 10 statute miles of the point of observation. Weather phenomena beyond 10 statute miles of the point of observation shall be reported as "distant from the station."

[1]Precipitation will always be reported before obscurations.

Table 5-5, provides reporting notations to be used in the METAR/SPECI.

QUALIFIER		WEATHER PHENOMENA		
INTENSITY OR PROXIMITY 1	**DESCRIPTOR** 2	**PRECIPITATION** 3	**OBSCURATION** 4	**OTHER** 5
- Light	**MI** Shallow	**DZ** Drizzle	**BR** Mist	**PO** Well-Developed Dust/Sand Whirls
Moderate[2]	**PR** Partial	**RA** Rain	**FG** Fog	
+ Heavy	**BC** Patches	**SN** Snow	**FU** Smoke	**SQ** Squalls
VC In the Vicinity[3]	**DR** Low Drifting	**SG** Snow Grains	**VA** Volcanic Ash	**FC**[4] Funnel Cloud(s) (Tornado or Waterspout)
	BL Blowing	**IC** Ice Crystals	**DU** Widespread Dust	
	SH Shower(s)	**PE** Ice Pellets		**SS** Sandstorm
	TS Thunderstorm	**GR** Hail	**SA** Sand	**DS** Duststorm
	FZ Freezing	**GS** Small Hail and/or Snow Pellets	**HZ** Haze	
			PY Spray	

1. The weather groups shall be constructed by considering columns 1 to 5 in the table above in sequence, i.e., intensity, followed by description, followed by weather phenomena; e.g., a heavy rain shower is coded as +SHRA.
2. To denote moderate intensity, no entry or symbol is used.
3. See paragraphs 5.3.b and 5.4 for vicinity definitions.
4. Tornados and Waterspouts shall be coded as +FC.

Table 5-5. Notations for Reporting Present Weather[1]

5.4.1 Precipitation

Precipitation of any form shall be reported in the body of the weather report whenever it is observed to be occurring at the point of observation. Precipitation not occurring at the point of observation, but within 10 statute miles, shall likewise be reported in the body of the report as "showers in the vicinity." Precipitation observed at a distance from the point of observation (beyond 10 statute miles) shall be reported as "distant from the station" in "Remarks."

5.4.1.1 Determining and Reporting Precipitation

Determine the type of precipitation occurring at the point of observation in accordance with the definitions in paragraph 5.2.1. Report precipitation using symbols found in Table 5-5. A SPECI observation is required whenever freezing precipitation (FZRA, FZDZ) or Ice Pellets (PE) begin, end, or change intensity. A SPECI observation is also required when Hail (GR) begins or ends.

5.4.1.2 Determining the Character of Precipitation

The character of precipitation can be determined by using the follow definitions:

a. Continuous. Intensity changes gradually, if at all.

b. Intermittent. Intensity changes gradually, if at all, but precipitation stops and starts at least once within an hour.

c. Showery (a descriptor). Precipitation changes intensity, or starts and stops abruptly.

5.4.1.3 Determining and Reporting the Intensity of Precipitation

Use the tables in this chapter to determine the intensity of precipitation. Report the intensity of precipitation using the symbols in Table 5-5.

No intensity symbol is used with Hail (GR), Small Hail (GS), or Ice Pellets (PE).

5.4.2 Obscurations

Obscurations should be reported in the body of the report only if prevailing visibility is reduced to less than 7 statute miles, with the exception of fog. If a descriptor qualifier is used to describe fog (MIFG, PRFG, BCFG), prevailing visibility can be greater than 6 statute miles. A proximity qualifier (in the vicinity, VCFG) is used to report any type of fog observed between 5 and 10 statute miles from the point of observation. Fog, without the use of any qualifier, shall be reported when the horizontal visibility is less than 5/8 statute mile.

5.4.3 Other Weather Phenomena

Other weather phenomena will be reported in the body of the report when they are occurring at the time of the observation.

5.4.4 Thunderstorm

A SPECI observation is required when a thunderstorm, with or without precipitation, begins or ends.
The report should include:

a. Type (TS).

b. Location of each storm center with respect to the station.

c. Direction toward which the storm is moving. Omit if unknown.

The previous elements (a and c) should also appear in the remarks of the next METAR if not previously reported in a routine report.

The beginning of a thunderstorm is the earliest time thunder is heard or lightning is observed at the station when the local noise level is sufficient to prevent hearing thunder. The ending of a thunderstorm shall be reported 15 minutes after the last occurrence of any of the criteria listed above.

5.4.5 Tornadic Activity

A SPECI observation is required whenever these phenomena are observed to begin or disappear. This report may be a single-element SPECI. The report shall contain the following items, if they are known:

a. Type (+FC or FC) in Column 9 and spelled out in Column 14 (TORNADO, WATERSPOUT, or FUNNEL CLOUD).

b. Location with respect to the station.

c. Direction toward which the phenomenon is moving. If this is unknown, enter "MOV UNKN" in Column 14.

These elements should also appear in the remarks of the next METAR if not previously reported in a routine report.

5.5 Other Significant Weather Phenomena

Observers shall be alert to weather phenomena that are visible from the station, but not occurring at the station. Examples are fog banks, localized rain, snow blowing over runways, etc. They shall be reported when they are considered to be operationally significant. Volcanic eruptions shall also be reported in the remarks section of a report.

CHAPTER 6 SKY CONDITION

6.1 Introduction

This chapter provides information on sky condition which is a description of the appearance of the sky. It also prescribes the standards and procedures for observing and reporting sky condition in METAR/SPECI reports.

6.2 Definitions

6.2.1 Sky Cover

The amount of the celestial dome that is hidden by clouds and/or obscurations.

6.2.2 Summation Layer Amount

A categorization of the amount of sky cover at and below each reported layer of clouds and/or obscurations.

6.2.3 Layer Height

The height of the bases of each reported layer of clouds and/or obscurations. It can also be the vertical visibility into an indefinite ceiling.

6.2.4 Ceiling

The height above the earth's surface (field or ground elevation) of the lowest layer that is reported as broken or overcast. It can also be the vertical visibility into an indefinite ceiling.

6.2.5 Type of Clouds

The variety of clouds present.

6.3 Observing Standards

Sky condition shall be evaluated at all stations. Observations of layers, amount, direction of movement, height of bases, and the effect of obscurations on vertical visibility shall be taken from as many locations as necessary and practical to view the entire sky.

6.3.1 Layer Opacity

All cloud layers and obscurations aloft shall be considered opaque.

6.3.2 Surface

The surface shall be the assigned field elevation of the station. Where the field elevation has not been established, the surface shall be the ground elevation at the observation site.

6.3.3 Sky Cover

Sky cover shall include any clouds or obscurations (partial and indefinite ceilings) detected from

the observing location. It shall be evaluated with reference to the surface.

6.3.3.1 Clear Skies

Skies are clear when no clouds or obscurations are observed or detected from the point of observation.

6.3.3.2 Layer Amounts

The amount of sky cover for each layer shall be the eighths (or oktas) of sky cover attributable to clouds or obscurations (i.e, smoke, haze, fog, etc.) in the layer being evaluated.

6.3.3.3 Summation Layer Amount

The summation amount for any given layer is equal to the sum of the sky cover for the layer being evaluated plus the sky cover of all lower layers including partial obscurations. Portions of layers aloft detected through lower layers aloft shall not increase the summation amount of the higher layer. A summation amount for a layer can not exceed 8/8ths.

6.3.3.4 Variable Amounts of Sky Cover

The sky cover shall be considered variable if it varies by one or more reportable values (FEW, SCT, BKN, or OVC) during the period of evaluation.

6.3.4 Stratification of Sky Cover

Sky cover shall be separated into layers with each layer containing clouds and/or obscurations (i.e., smoke, haze, fog, etc.), with bases at about the same height.

6.3.5 Evaluation of Multiple Layers

Frequent observations are necessary to evaluate layers. A series of observations will often show the existence of upper layers above a lower layer. Through thin lower layers, it may be possible to observe higher layers. Differences in the directions of cloud movements are often a valuable aid in observing and differentiating between cloud layer, particularly when the presence of haze, smoke, etc., increases the difficulty of evaluation. Ceiling light indications may be used as a guide in determining the presence of multiple layers at night.

6.3.6 Evaluation of Interconnected Layers

Clouds formed by the horizontal extension of swelling cumulus or cumulonimbus, which are attached to a parent cloud, shall be regarded as a separate layer only if their bases appear horizontal and at a different level from the parent cloud. Otherwise, the entire cloud system shall be regarded as a single layer at a height corresponding to the base of the parent cloud.

Angle of Advancing or Receding Layer Edge	Eighths of Sky Cover	Angular Elevation of Layer Surrounding Station
>0 to 50 degrees	1	>0 to 10 degrees
51 to 68 degrees	2	11 to 17 degrees
69 to 82 degrees	3	18 to 24 degrees
83 to 98 degrees	4	25 to 32 degrees
99 to 112 degrees	5	33 to 41 degrees
113 to 129 degrees	6	42 to 53 degrees
130 to ≤179 degrees	7	54 to 89 degrees
180 degrees	8	90 degrees

Table 6-1. Sky Cover Evaluation

6.3.7 Obscuration

The portion of sky (including higher clouds, the moon, or stars) hidden by weather phenomena either surface-based or aloft. An obscuration is reported in both the sky condition and remarks.

6.3.8 Vertical Visibility

Vertical visibility shall be one of the following:

a. The distance an observer can see vertically into an indefinite ceiling.

b. The height corresponding to the top of a ceiling light projector beam.

c. The height at which a ceiling balloon disappears during the presence of an indefinite ceiling.

6.3.9 Ceiling

The lowest layer aloft that is reported as broken or overcast shall be the ceiling. If the sky is totally obscured, the height of the vertical visibility shall be the ceiling.

6.3.10 Significant Clouds and Cloud Types

Significant clouds include cumulonimbus, cumulonimbus mammatus, towering cumulus, altocumulus castellanus, standing lenticular, or rotor clouds. Cloud types shall be identified in accordance with WMO International Cloud Atlas - Volumes I and II, the WMO *Abridged International Cloud Atlas,* or NWS aids for cloud identification.

6.3.11 Height of Sky Cover

A ceilometer, ceiling light, or known heights of unobscured portions of abrupt, isolated objects within 1-1/2 statute miles of a runway shall be used to measure the height of layers aloft. Alternative methods for estimating ceiling height such as ceiling balloon, pilot report or other agency guidelines, or observer experience may be used.

a. Indefinite Ceiling Height (Vertical Visibility). The height into an indefinite ceiling shall be the

vertical visibility. It is measured in hundreds of feet.

b. Height of Layers. The height of a layer shall be the average height of the cloud bases or obscurations for the evaluated layer. Layers of clouds 50 feet or less shall be regarded as layers aloft and have a height of 000. During the period of evaluation, when the ceiling layer's height changes rapidly by amounts given in Table 6-2, it shall be considered variable and the ascribed height shall be an average of all the varying values.

Ceiling (feet)	Variation (feet)
≤ 1,000	≥200
>1,000 and ≤2,000	≥400
>2,000 and <3,000	≥500

Table 6-2. Criteria for Variable Ceiling

c. Use of alternative methods to estimate ceiling height. When using an alternative method to estimate ceiling height, the following procedures shall be used:

(1) Use of height reported by a pilot shall be converted from height above mean sea level to height above surface.

(2) Choose and inflate the appropriate colored balloon; red balloons are usually preferred with thin clouds and blue or black balloons under other conditions.

(a) Release and watch the balloon continuously to determine, with a watch, the length of time that elapses between release of the balloon and its entry into the base of the layer. The point of entry, for layers aloft, will be considered as midway between the time the balloon begins to fade until the time the balloon completely disappears.

(b) Determine the height above the surface corresponding to the elapsed ascent time, using Table 6-3 or Table 6-4. The accuracy of the height obtained by the balloon will be decreased when the balloon:

- does not enter a representative portion of the cloud base, or
- is used at night with a light attached, or
- is used during the occurrence of hail, ice pellets, any intensity of freezing rain, or moderate to heavy rain or snow.

10-Gram Balloon Ascension Rates* Nozzle Lift 45-Grams Helium							
Time Minutes and Seconds			Reportable Height	Time Minutes and Seconds			Reportable Height
0:00	-	0:06	0	5:36	-	5:50	2600
0:07	-	0:17	100	5:51	-	6:04	2700
0:18	-	0:30	200	6:05	-	6:18	2800
0:31	-	0:42	300	6:19	-	6:32	2900
0:43	-	0:53	400	6:33	-	6:47	3000
0:54	-	1:06	500	6:48	-	7:01	3100
1:07	-	1:20	600	7:02	-	7:15	3200
1:21	-	1:32	700	7:16	-	7:30	3300
1:33	-	1:45	800	7:31	-	7:44	3400
1:46	-	1:58	900	7:45	-	7:58	3500
1:59	-	2:11	1000	7:59	-	8:12	3600
2:12	-	2:24	1100	8:13	-	8:27	3700
2:25	-	2:37	1200	8:28	-	8:41	3800
2:38	-	2:51	1300	8:42	-	8:55	3900
2:52	-	3:04	1400	8:56	-	9:10	4000
3:05	-	3:17	1500	9:11	-	9:24	4100
3:18	-	3:30	1600	9:25	-	9:38	4200
3:31	-	3:43	1700	9:39	-	9:52	4300
3:44	-	3:56	1800	9:53	-	10:07	4400
3:57	-	4:10	1900	10:08	-	10:21	4500
4:11	-	4:24	2000	10:22	-	10:35	4600
4:25	-	4:38	2100	10:36	-	10:50	4700
4:39	-	4:52	2200	10:51	-	11:04	4800
4:53	-	5:07	2300	11:05	-	11:18	4900
5:08	-	5:21	2400	11:19	-	12:01	5000
5:22	-	5:35	2500	12:02	-	12:02+70sec	**5500
				13:13	-	13:13+70sec	**6000
				etc.			

* Daytime Use Only
** Ascension rate above 5,000 feet is 500 feet per 70 seconds

Table 6-3. 10-Gram Balloon Ascension Rate

30-Gram Balloon Ascension Rates* Nozzle Lift 139-Grams Helium							
Time Minutes and Seconds			Reportable Height	Time Minutes and Seconds			Reportable Height
0:00	-	0:04	0	3:53	-	4:01	2600
0:05	-	0:12	100	4:02	-	4:11	2700
0:13	-	0:20	200	4:12	-	4:21	2800
0:21	-	0:30	300	4:22	-	4:31	2900
0:31	-	0:38	400	4:32	-	4:40	3000
0:39	-	0:46	500	4:41	-	4:50	3100
0:47	-	0:55	600	4:51	-	5:00	3200
0:56	-	1:03	700	5:01	-	5:10	3300
1:04	-	1:12	800	5:11	-	5:20	3400
1:13	-	1:22	900	5:21	-	5:31	3500
1:23	-	1:31	1000	5:32	-	5:41	3600
1:32	-	1:40	1100	5:42	-	5:51	3700
1:41	-	1:50	1200	5:52	-	6:01	3800
1:51	-	1:59	1300	6:02	-	6:11	3900
2:00	-	2:08	1400	6:12	-	6:21	4000
2:09	-	2:17	1500	6:22	-	6:32	4100
2:18	-	2:27	1600	6:33	-	6:42	4200
2:28	-	2:36	1700	6:43	-	6:52	4300
2:37	-	2:45	1800	6:53	-	7:02	4400
2:46	-	2:54	1900	7:03	-	7:12	4500
2:55	-	3:03	2000	7:13	-	7:22	4600
3:04	-	3:13	2100	7:23	-	7:33	4700
3:14	-	3:23	2200	7:34	-	7:43	4800
3:24	-	3:32	2300	7:44	-	7:53	4900
3:33	-	3:42	2400	7:54	-	8:24	5000
3:43	-	3:52	2500	8:25	-	8:25+51sec	**5500
				9:17	-	9:17+51sec	**6000
				etc.			
* Daytime Use Only ** Ascension rate above 5,000 feet is 500 feet per 51 seconds							

Table 6-4. 30-Gram Balloon Ascension Rate

(3) Use of Convective Cloud-Base Height Diagram (WS TA B-0-8). Use this diagram only to estimate the height of cumulus clouds formed in the vicinity of your station. It cannot be used at stations in mountainous or hilly terrain, or to determine the height of other than cumulus clouds. This diagram is most accurate when used to determine the height of cloud bases below 5,000 feet. Use the dry-bulb temperature and dew point to obtain the height of cloud bases above the point of observation.

6.4 Reporting Standards

Sky cover shall be included in all METAR and SPECI reports.

6.4.1 Layer Amount

The amount of sky cover reported for each layer shall be based on the summation layer amount for that layer. Table 6-5, below, provides the reportable contractions to be used in a report.

Reportable Contraction	Meaning	Summation Amount of Layer
VV	Vertical Visibility	8/8
SKC	Clear	0
FEW[1]	Few	1/8 - 2/8
SCT	Scattered	3/8 - 4/8
BKN	Broken	5/8 - 7/8
OVC	Overcast	8/8
[1] Any layer amount less than 1/8 is reported as **FEW**.		

Table 6-5. Reportable Contractions for Sky Cover

Layers composed of cumulonimbus or towering cumulus shall be identified by appending the contraction CB or TCU, respectively. If a layer consists of both TCU and CB, report CB. No more than 6 layers shall be reported.

Sky condition shall be reported in ascending order to the first overcast layer. At mountain stations, if the cloud layer is below station level, the height of the layer shall be reported as ///.

6.4.2 Units of Measure for Heights

Sky cover heights shall be reported in hundreds of feet above the surface. See Table 6-6, below, for value increments.

Range of Height Values (feet)	Reportable Increment (feet)
≤5,000	To nearest 100
>5,000 but ≤10,000	To nearest 500
>10,000	To nearest 1,000

Table 6-6. Increments of Reportable Values of Sky Cover Height

6.4.3 Layer Heights

Heights of layers shall be reported in hundreds of feet and rounded to the nearest reportable increment. When a value falls halfway between two reportable increments, the lower value shall be reported. When a layer is 50 feet or less above the surface, the height reported is 000.

6.4.4 Obscuration

A surface-based obscuration is reported using the sky cover amount of the obscuration (FEW, SCT, BKN) and the height of "000" in the body of the report. It shall also be reported in remarks. The remark shall consist of the phenomenon causing the obscuration (i.e., fog, smoke, haze, etc.), a space, then the layer amount and height (e.g., FG FEW000, FU SCT000, HZ BKN000).

An obscuration aloft is reported when the obscuration is above the surface of the ground using

the sky cover amount of the obscuration (FEW, SCT, BKN, OVC) and the height of the obscuration. It shall also be reported in remarks. The remark shall consist of the phenomenon causing the obscuration (i.e., smoke, volcanic ash, etc.), a space, then the layer amount and height (e.g., FU BKN040, VA OVC015).

6.4.5 Variable Ceiling

A remark shall be included in a report giving the range of variability when the height of the ceiling layer is variable and below 3000 feet.

6.4.6 Variable Sky Condition

Variable sky conditions shall be provided in the remarks portion of the report.

6.4.7 Significant Cloud Types

Significant cloud types shall be provided in the remarks portion of the report.

CHAPTER 7 TEMPERATURE AND DEW POINT

7.1 Introduction

This chapter describes observing, determining, and reporting the temperature and dew point temperature in a surface observation. The temperature data obtained using the instruments in this chapter are in terms of the Celsius scale. Dew points are calculated with respect to water at all temperatures. Dew point temperature is required only if terminal forecasts are prepared for the station.

7.2 Definitions

7.2.1 Temperatures

a. Dew Point. The temperature at which a parcel of air becomes saturated when cooled at constant pressure and constant water-vapor content.

b. Dry-bulb. Technically, the ambient temperature registered by the dry-bulb thermometer of a psychrometer. However, it is identical to the temperature of the air and may also be used in that sense.

c. Wet-bulb. The lowest temperature attained by evaporating water from a saturated wick covering the bulb of a thermometer at the point of observation.

7.2.2 Hygrothermometer

An instrument system using remote sensors to obtain ambient air and dew-point temperatures. Digital or dial readouts show temperatures.

7.2.3 Instrument Shelter

A boxlike structure designed to protect thermometers from exposure to direct sunshine, precipitation, and condensation, while at the same time providing adequate ventilation.

7.2.4 Psychrometer

An instrument used for measuring the water-vapor content of the air. It consists of two ordinary glass thermometers. The bulb of one thermometer (wet-bulb) is covered with a clean muslin wick, which is saturated with water prior to an observation. When the bulbs are properly ventilated, they indicate the wet- and dry-bulb temperatures of the atmosphere.

7.2.5 Psychrometric Calculator

A circular slide rule used to compute the temperature of the dew point from known values of dry- and wet-bulb temperatures at the station's normal atmospheric pressure. Instructions for the use of this calculator are printed on it.

7.2.6 Psychrometric Tables

Tables prepared from a psychrometric formula and used to obtain the temperature of the dew point from known values of dry- and wet-bulb temperatures.

7.2.7 Sling Psychrometer

A psychrometer that is ventilated by whirling the thermometers with a handle and a swivel link until the coldest wet-bulb temperature has been obtained.

7.2.8 Wet-bulb Depression

The difference between the dry- and wet-bulb temperatures. Example:

Dry-bulb	Wet-bulb	Wet-bulb Depression
33.8	23.5	10.3
–6.7	–7.4	0.7

7.3 Temperature and Dew Point Observing Standards

The method of obtaining temperature and dew point varies according to the system in use at the station. The data may be read directly from digital or dial readouts, or calculated from other measured values.

Use the first operable system of the following for obtaining temperature and/or psychrometric data:

a. Hygrothermometer or Equivalent Systems

b. Psychrometer.

7.3.1 Hygrothermometer

The operating range for a hygrothermometer shall be the following:

a. Temperature: −46°C (−50°F) to 49°C (120°F)

b. Dew Point: −29°C (−20°F) to 27°C (80°F)

7.3.2 Psychrometer

Thermometers (dry- and wet-bulb) used for obtaining psychrometric data shall be the following:

a. Dry-bulb temperatures above −37°C (−35°F): Mercury Thermometers

b. Dry-bulb temperatures −37°C (−35°F) or less: Spirit Thermometers, in the range of −46°C (−50°F) to 43°C (110°F).

7.4 Obtaining Psychrometric Data

The method of obtaining temperature and dew point values varies with the system in use at your station.

When the dew point temperature from the system in use equals or exceeds the dry-bulb temperature and the system is within operational limits:

a. Assume the wet-bulb and dew-point temperatures with respect to water to be the same as the dry-bulb temperature if the wick of the wet bulb is not frozen or liquid fog is present, or

b. Assume the wet-bulb and dew-point temperatures with respect to ice to be the same as the dry-bulb and convert them to their water equivalent if the wet-bulb wick is frozen or ice fog is present.

7.4.1 Hygrothermometer Readings

If temperature readings are within the operating range of the hygrothermometer, obtain data in accordance with the following:

a. If readings are obtained from dial indicators, face each indicator on as direct a line of sight as possible to minimize parallax errors.

b. Observe temperatures to the nearest degree Celsius. If readouts are in Fahrenheit, use Fahrenheit-to-Celsius conversion chart.

c. If the temperature is −4.4°C (−30°F) or lower, disregard the dew point indicated on the instrument and assume the temperature of the dew point to be the same as the temperature (dry-bulb) with respect to ice. Convert it to the corresponding dew point with respect to water using a psychrometric calculator.

7.4.2 Hygrothermometer to Station's Standby Equipment

Obtain psychrometric data from your station's standby equipment whenever the following occur in relation to your station's hygrothermometer:

a. If readings exceed the operating range of the hygrothermometer.

b. If the difference between the ambient air temperature and the hygrothermometer exceeds 2°F.

c. If the dew point is higher than the dry-bulb temperature or if the comparison checks indicate that the sensor is out of calibration. Discontinue use of the sensor until it has been serviced and calibrated.

7.4.3 Psychrometer Operating Procedures

Obtain readings from dry-bulb and wet-bulb thermometers using the following instructions.

7.4.3.1 Dry-bulb Thermometer

When driving rain or snow is occurring, dry the bulb and shield it from the precipitation as long as necessary to permit dissipation of extraneous heat before reading it again. Use this reading for psychrometric purposes rather than the reading normally made when the lowest wet-bulb reading is taken. When frost forms on the thermometer, remove it with a warm cloth and allow sufficient time for the dissipation of extraneous heat before reading the thermometer.

7.4.3.2 Wet-bulb Thermometer

The procedure used in moistening the wet-bulb varies according to whether the dry-bulb temperature is above, near, or below freezing, and whether the relative humidity is high or low, as described below.

7.4.3.3 Temperature Above Freezing

Moisten the wet-bulb with clean water just prior to ventilating the psychrometer (even if the humidity is high or the wick already appears wet). If, however, the temperature is high and the relative humidity is low, or it is expected that the final temperature of the wet-bulb will be 32 degrees or less, moisten the wet-bulb thoroughly several minutes before taking a reading so that a drop of water will have formed on the end of the bulb. This procedure will reduce the temperature of the wet-bulb without danger of the wick drying out before the temperature reaches its lowest point.

7.4.3.4 High Temperature and Low Humidity

In areas where the temperature is high and the relative humidity low, use pre-cooled water for moistening the wet-bulb to avert premature drying of the wick. Water can be pre-cooled for this purpose by storing it in a porous jug. To avoid altering moisture conditions in the shelter, do not keep this jug in the shelter. If this method should not be effective, extend the wick from the wet-bulb to an open container of water and keep the end of the wick immersed in water between observations. When the psychrometer is ventilated, remove the wick from the water until the wet-bulb thermometer has been read. Regardless of the method used, ventilate the psychrometer in accordance with 7.4.3.7 before determining the wet-bulb temperature.

7.4.3.5 Temperatures Below Freezing

At wet-bulb temperatures below 32°F, if the wick is not frozen, touch it with clean ice, snow, or another cold object to induce freezing. If the observer is unable to induce freezing of the wick, use the low temperature range of the psychrometric calculator for the computation of psychrometric data.

7.4.3.6 Dry-bulb Temperature Below 37 Degrees Fahrenheit

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

7.4.3.7 Psychrometric Ventilation

Ventilate the psychrometer for about 10 seconds. The minimum speed of air passing over the psychrometer bulbs should be 15 feet per second. This is approximately one revolution per second of the geared (2-to-1 ratio) whirling psychrometer crank, two revolutions per second of the sling psychrometer, and three and one-half revolutions per second of the crank of the psychrometer fan or motor (direct-drive) whirling psychrometer.

7.4.3.8 Sling Psychrometer Ventilation

Ventilate the sling psychrometer as follows:

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

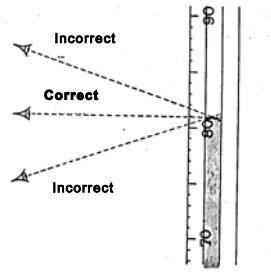
b. Face into the wind.

c. Hold the handle at arm's length while whirling the psychrometer.

7.4.3.8.1 Reading Liquid-in-Glass Thermometers

Observe the temperature from mercury- or alcohol-in-glass thermometers as follows:

The observer shall stand as far from the thermometer as possible to prevent body heat from affecting the readings. To minimize errors of parallax, make sure that the line of sight from your eye to the top if the liquid column is level. Read the dry- and wet- bulb temperatures to the nearest tenth (0.1) of a degree.



7.4.3.8.2 Psychrometric Evaluations

a. Near Freezing Temperature. At wet-bulb temperatures near freezing, determine visually that the wet-bulb is unfrozen before using wet-bulb depression data.

b. Unobtainable Depression. When the wet-bulb is covered with water and a depression cannot be obtained, the relative humidity shall be regarded as 100% and the temperature of the dew point the same as that of the wet-bulb. If the wet-bulb is covered with ice and a depression cannot be obtained, use the dew-point converted to the equivalent value with respect to water, unless liquid fog is present at the station. In this latter instance, the dew point will be regarded as the same as the wet-bulb temperature.

7.4.3.9 Obtaining Readings

After proper ventilation has been achieved, quickly read both thermometers, wet-bulb first. Repeat until two successive wet-bulb readings are the same, indicating that the wet-bulb temperature has reached its proper point. If the wet-bulb temperature rises between successive readings, pre-moisten the wick and reventilate. Accurate readings are especially important at low temperatures, where a given wet-bulb depression has a greater effect on the accuracy of psychrometric computations.

7.4.3.10 Psychrometric Computations

Use the dry-bulb and wet-bulb temperatures to calculate the dew point with psychrometric calculators or psychrometric tables based on atmospheric pressures of 23, 25, 27, 28, 29, or 30 inches of mercury. Use a psychrometric calculator with the appropriate range, if one is available, in preference to tables.

Use the appropriate psychrometric calculator to convert dew-point values with respect to ice to a corresponding value over water. On the low-temperature face of the calculator, equivalent values of dew point appear opposite each other on the "**DP**" (or "**t_w, DP**") and "**T_i**" scale, e.g., a dew point of 20°F with respect to ice is equivalent to 18.5°F with respect to water.

7.5 MF1M-10C Reporting Procedures

If temperature data were obtained with the use of Fahrenheit instruments, conversion to Celsius shall be made before temperature data are recorded on MF1M-10C. Determine and report dry-bulb and dew-point temperatures for each METAR/SPECI report. Dew point may be omitted if terminal forecasts are not required.

7.5.1 Temperature

Record temperature to the nearest whole degree Celsius. Prefix sub-zero Celsius temperatures with a minus sign (−). Transmitted sub-zero temperatures are preceded with the letter "M" instead of a minus sign.

7.5.2 Dew-Point Temperature

Record the dew-point temperature to the nearest whole degree Celsius. Prefix sub-zero Celsius temperatures with a minus sign (−). Transmitted sub-zero temperatures are preceded with the letter "M" instead of a minus sign. The dew-point entry is included if needed for terminal forecasts.

7.5.3 Dry-Bulb and Wet-Bulb Temperatures (Columns 19 and 20)

These columns are completed only if they are used to compute dew point; i.e., when a psychrometer is used. Enter data in degrees and tenths Celsius.

7.6 Coding Procedures

Temperature and dew point are coded in the body of the report in accordance with paragraph 9.5.9.

CHAPTER 8 PRESSURE

8.1 Introduction

This chapter contains instructions on identifying, recording, and reporting pressure. It also describes the operation of pressure-measuring equipment. Refer to Chapter 10 for recording pressure information on the MF1M-10C.

8.2 Definitions

8.2.1 Altimeter Setting (ALSTG)

The pressure value to which an aircraft altimeter scale is set so it will indicate the altitude above mean-sea-level (MSL) of the aircraft on the ground at the location for which the pressure value was determined.

8.2.2 Field Elevation, H_a

The officially designated field elevation (H_a) of an airport above MSL. It is the elevation of the highest point on any of the runways of the airport.

8.2.3 Barometer Elevation, H_Z

The height of the pressure instrument above MSL surveyed accurately within one foot. This height is posted on or immediately adjacent to the instrument.

8.2.4 Posted Pressure Correction

The value added algebraically to the reading obtained from the station's altimeter setting indicator (ASI, not aircraft-type altimeter) to correct it to a comparison standard.

8.2.5 Posted Height Correction

The correction, in feet, which must be added algebraically to the posted height (MSL) of an aircraft-type altimeter. This correction is indicated on the altimeter correction card furnished by the calibration station.

8.3 Observing, Determining, and Reporting Procedures

8.3.1 General

An ASI, digital altimeter setting indicator (DASI), or aircraft-type altimeter, used to obtain altimeter settings, must be routinely compared and corrected as described in this chapter. The latest correction for each instrument used to determine altimeter setting shall be displayed on the instrument. The posted correction shall be added algebraically to the instrument's reading before reporting the altimeter setting.

8.3.2 Barometers Used

Common pressure-measuring instruments are: ASI, DASI, and Aircraft-type altimeter.

8.3.3 Altimeter Setting from ASI

a. Tap the face of the instrument lightly with the finger to reduce the effect of friction on the pointer mechanism.

b. Read the scale of the indicator at the pointer, to the nearest 0.005 inch, estimating values between the graduations.

c. Record the altimeter setting determined by adding algebraically the posted correction, which has been determined from a comparison standard, to the reading and rounding the sum down to the next reportable value; i.e., 29.249 inches becomes 29.24.

8.3.4 Altimeter Setting from DASI

Record the altimeter setting determined from the digital display by algebraically adding the posted correction, which has been determined from a comparison standard, to the reading and rounding the sum down to the next reportable value; i.e., 30.019 inches becomes 30.01.

8.3.5 Aircraft-Type Altimeters

When used for the purpose of determining an altimeter setting, these altimeters must be installed and calibrated in accordance with the current FAA Advisory Circular 91-14. Use the following procedures to obtain the altimeter setting from an aircraft-type altimeter:

a. Turn the knob of the altimeter until the hands indicate the actual height of the instrument (MSL). Apply any correction required by the correction card.

b. Tap or vibrate the altimeter while resetting it to eliminate any lag due to friction in the mechanism.

c. Recheck the setting after vibration, and reset if necessary.

d. Read the altimeter setting to the nearest 0.01 inch from the pressure scale in the small window in the face of the altimeter.

e. When two aircraft-type altimeters are used, read both instruments at the same time and use the lower reading as the altimeter setting.

8.4 Comparison for Determining Altimeter Reliability

Verify the reliability of each altimeter device using the following procedures.

8.4.1 Comparison of Two Aneroid Instruments at Station

At locations having two altimeter-setting instruments, ASI, DASI, aircraft-types, or combination, daily compare the altimeter settings obtained from the instruments. If the difference does not exceed .05, the instruments are considered reliable. If the difference exceeds .05 and the procedures in paragraph 8.4.2.1 or 8.4.2.2 cannot be used to determine the accurate instrument, the altimeter setting will not be reported. When both instruments are reliable, use the lower reading as the reported altimeter setting. Once every day on which observations are made, record the comparison between the two instruments in Column 65 of MF1M-10C (see paragraph 8.5.1).

8.4.2 Comparison if Only One Altimeter is Available on Station

If only one instrument is available, it must be compared with:

a. The altimeters in an aircraft parked on a ramp adjacent to the weather observing station, (procedures are outlined in paragraph 8.4.2.1) or

b. The altimeter at a NWS, FSS, AFSS, Contract, or LAWRS facility having a mercury barometer or an ASOS pressure transducer meeting distance, elevation, wind, and temperature criteria. Criteria are given in paragraph 8.4.2.2.

8.4.2.1 Comparison between Altimeter in the Station and Altimeter in an Aircraft

With this type of comparison, the aircraft must be maintained under the provisions of FAR (Federal Aviation Regulation) Part 121 or Part 135 and be equipped with two altimeters (captain's and first officer's). Make comparisons at least three different days each week, or daily if an aircraft is available. Use the following procedures:

a. Determine the altimeter setting in the station using the procedure outlined in paragraph 8.3.3 for ASI, or paragraph 8.3.4 for DASI, or paragraph 8.3.5 for aircraft-type altimeters.

b. With the aircraft's altimeters set to indicate their actual elevation (MSL), obtain the pressure scale reading of both the captain's and first-officer's altimeters to the nearest 0.01 inch. Determine the mean of these two readings.

c. Compare the aircraft's mean altimeter setting with the reading of the station's altimeter.

d. Log the difference between the station's altimeter and the mean of the aircraft's in Column 65 of MF1M-10C each time the comparison is made.

If the difference between the mean aircraft reading and the station reading exceeds 0.04 inch, do not report the altimeter setting until a future comparison shows the difference to be 0.04 inch or less. If the difference exceeds 0.04 inch on two successive comparisons, the altimeter must be recalibrated before further use.

8.4.2.2 Comparisons with an Adjacent Station

Locations with only one altimeter instrument may compare their altimeter device against values obtained from an adjacent Weather Service Office (including WSCMO), Flight Service Station (including AFSS, Contract, FCWOS), or a LAWRS having a mercury barometer (Digiquartz may also be used), provided:

a. At locations where precision approaches are conducted, the weather station is not more than 10 nautical miles away and, at both locations, the wind speed is 12 knots or less with no gusts above 15 knots.

b. At all other locations, the distance must not exceed 25 nautical miles and, at both locations, wind speed must be 15 knots or less with no gusts above 20 knots.

c. The difference in elevation does not exceed 100 feet at precision approach locations and

200 feet at all other locations.

d. The station's temperature, at both locations, must be within 30°F of the Standard Atmosphere Temperature for the station's elevation.

Do not use altimeter-setting values from aneroid instruments when the difference exceeds .02 at precision approach locations or .05 at all other locations.

SAWRS, SAWRS II, and BSAWRS may compare with a commissioned ASOS or AWOS III if the criteria in 8.4.2.2 is met

8.5 Recording Comparisons

Depending on the method used to compare aneroid devices, make entries in Column 65 as described in the following paragraphs.

8.5.1 Comparison of Altimeter Setting from Two Instruments

At stations determining altimeter-setting values from the lower pressure reading of two aneroid devices, neither located in an aircraft, enter in Column 65 of the MF1M-10C each day on which observations are taken: the reading of each instrument, the difference between the readings, and the date and time of readings; e.g., **ALSTG: INST #1 29.32 INST #2 29.33 DIFF .01, 25/1330**.

8.5.2 Comparison of Altimeter in Station with Aircraft's Altimeters

When an altimeter is compared with altimeters in an aircraft, enter in Column 65, MF1M-10C, the reading of the station's altimeter, the mean of the altimeters (pilot's and co-pilot's) in the aircraft, the difference between the station's and mean aircraft altimeter setting, and the date and time of the comparison (UTC); e.g., **ALSTG: STN 29.95 ACFT MEAN 29.94 DIFF .01 25/1200**.

8.5.3 Comparison of Station Altimeter with Adjacent Station

Enter in Column 65, MF1M-10C, the reading of your station's altimeter, the reading obtained from adjacent NWS, FSS, AFSS, Contract, or LAWRS, the difference between the readings, and the date and time of the comparison; e.g., **ALSTG: STN 29.96 KBOS 29.94 DIFF .01 24/1500**.

8.6 Reporting Procedures

Altimeter setting is recorded in the body of the report in accordance with paragraph 9.5.10.

Instrument Compared	Differences Must Not Exceed	Determining the Altimeter Setting
Two altimeter-setting instruments, ASI, DASI, or aircraft-type altimeters, or combination, located in office. Compare Instruments #1 and #2 (paragraph 8.4.1). Make daily comparisons.	.05 inches	If the difference is within limits, use the instrument with the lower reading for the altimeter setting. If the difference exceeds limits, do not report the altimeter setting if the accuracy of the instrument cannot be determined (paragraph 8.4.2.1 and 8.4.2.2).
One altimeter-setting instrument, ASI, DASI, or aircraft-type altimeter compared with the altimeter setting from an adjacent NWS, AFSS/FSS, LAWRS or Contract office meeting the criteria in paragraph 8.4.2.2. Make daily comparisons.	.02 inch at precision approach locations, or .05 inch at all other locations.	If the difference exceeds limits, do not report the altimeter setting.
One altimeter-setting instrument, ASI, DASI, or aircraft-type altimeter compared with mean value of the two altimeters (pilot's and co-pilot's) in an aircraft parked on the ramp adjacent to the weather station (paragraph 8.4.2.1). Make comparisons daily if an aircraft is available, otherwise at least three times a week.	.04 inches	If the difference exceeds limits, do not report the altimeter setting.

Table 8-2. Comparison of Aneroid Devices

CHAPTER 9 CODING AND DISSEMINATION

9.1 Introduction

This chapter prescribes the standards and procedures for coding an Aviation Weather observation in routine weather report (METAR) or selected special weather report (SPECI) format. The format does not include Runway Visual Range (RVR) information within the body of the report as SAWRS observers as a rule do not report RVR information. The format used by SAWRS observers is slightly different than the complete METAR report as there is no RVR information and no additive data.

9.2 METAR/SPECI Code

METAR or SPECI_CCCC_YYGGggZ_COR_dddff(f)G$f_m f_m(f_m)$KT_$d_n d_n d_n V d_x d_x d_x$_
VVVVVSM_w'w'_[$N_s N_s N_s h_s h_s h_s$ or VV$h_s h_s h_s$ or SKC]_T'T'/T'$_d$T'$_d$_A$P_H P_H P_H P_H$_RMK_
(Manual and Plain Language)

METAR/SPECI has two major sections: the Body (consisting of a maximum of 10 groups) and the Remarks (consisting of a maximum of 1 category). Together, the body and remarks make up the complete METAR/SPECI. In general, the remarks are coded in the order depicted above and as established in this chapter.

9.3 Format and Content of the METAR/SPECI

a. Body of report.

(1) Type of Report - **METAR/SPECI**
(2) Station Identifier **- CCCC**
(3) Date and Time of Report - **YYGGggZ**
(4) Report Modifier - **COR**
(5) Wind - **dddff(f)G$f_m f_m(f_m)$KT_$d_n d_n d_n V d_x d_x d_x$**
(6) Visibility - **VVVVVSM**
(7) Present Weather - **w'w'**
(8) Sky Condition - **$N_s N_s N_s h_s h_s h_s$ or VV$h_s h_s h_s$ or SKC**
(9) Temperature and Dew Point - **T'T'/T'$_d$T'$_d$**
(10) Altimeter - **A$P_H P_H P_H P_H$**

b. Remarks section of report--RMK

- Manual and Plain Language

The underline character "_" indicates a required space between the groups. If a group is not reported, the preceding space is also not reported. The only place a solidus "/" is used to separate data in the report is in the Temperature/Dew Point group.

9.4 Coding Missing Data in METAR and SPECI

When an element does not occur, or cannot be observed, the corresponding group and preceding space are omitted from that particular report.

9.5 Coding the Body of the METAR/SPECI

9.5.1 Type of Report (METAR or SPECI)

The type, **METAR** or **SPECI**, shall be included in all reports. The type of report shall be separated from elements following it by a space. Whenever SPECI criteria are met at the time of the routine METAR, the type of report shall be METAR.

9.5.2 Station Identifier (CCCC)

The station identifier, **CCCC**, shall be included in all reports to identify the station to which the coded report applies. The station identifier shall consist of four alphabetic-only characters if the METAR/SPECI is transmitted long-line. The agency with operational control when the station is first established shall be responsible for coordinating the location identifier with the FAA. A list of approved identifiers can be found in the FAA Manual 7350 Series, *Location Identifiers*.

9.5.3 Date and Time of Report (YYGGggZ)

The date, **YY, and time, GGgg**, shall be included in all reports. The time shall be the actual time of the report or when the criteria for a SPECI is met or noted. If the report is a correction to a previously disseminated report, the time of the corrected report shall be the same time used in the report being corrected. The date and time group always ends with a **Z** indicating Zulu time (or UTC). For example, METAR KDCA 210855Z would be the 0900 scheduled report from station KDCA taken at 0855 UTC on the 21st of the month.

9.5.4 Report Modifier (COR)

The report modifier, **COR,** identifies the METAR/SPECI as a corrected report.

Corrections shall be disseminated, as soon as possible, whenever an error is detected in a transmitted report. However, if the erroneous data has been superseded by a later report (with the same or more complete dissemination), it shall not be necessary to transmit the corrected report. Corrections transmitted shall consist of the entire corrected report. The original date and time of the report shall be used as the date and time in the corrected report.

9.5.5 Wind Group (dddff(f)G$f_m f_m$(f_m)KT_$d_n d_n d_n$V$d_x d_x d_x$)

The standards and procedures for observing and reporting wind are described in Chapter 3.

The wind direction, **ddd,** shall be coded in tens of degrees using three figures. Directions less than 100 degrees shall be preceded with a "0". For example, a wind direction of 90° is coded as "090." The wind speed, ff(f), shall be coded in two or three digits immediately following the wind direction.

The wind speed shall be coded, in whole knots, using the units and tens digits and, if required, the hundreds digit. Speeds of less than 10 knots shall be coded using a leading zero. The wind group shall always end with **KT** to indicate that wind speeds are reported in knots. For example, a wind speed of 8 knots shall be coded "08KT," a wind speed of 112 knots would be coded "112KT."

a. **Gust**. Wind gusts shall be coded in the format, **G$f_m f_m$(f_m)**. The wind gust shall be coded in two or three digits immediately following the wind speed. The wind gust shall

be coded, in whole knots, using the units and tens digits and, if required, the hundreds digit. For example, a wind from due west at 20 knots with gusts to 35 knots would be coded "27020G35KT."

b. **Variable Wind Direction (Speeds 6 knots or less)**. Variable wind direction with wind speed 6 knots or less may be coded as **VRB** in place of the **ddd**. For example, if the wind is variable at three knots, it would be coded "VRB03KT."

c. **Variable Wind Direction (Speeds Greater than 6 knots**). Variable wind direction with wind speed greater than 6 knots shall be coded in the format, $\mathbf{d_n d_n d_n V d_x d_x d_x}$. The variable wind direction group shall immediately follow the wind group. The directional variability shall be coded in a clockwise direction. For example, if the wind is variable from 180° to 240° at 10 knots, it would be coded "21010KT 180V240."

d. **Calm Wind**. Calm wind would be coded as "00000KT."

9.5.6 Visibility Group (VVVVVSM)

The standards and procedures for observing and reporting visibility are described in Chapter 4.

The surface visibility, **VVVVVSM**, shall be coded in statute miles using the values listed in Table 9-1. A space shall be coded between whole numbers and fractions of reportable visibility values. The visibility group shall always end with **SM** to indicate that visibilities are in statute miles. For example, a visibility of one and a half statute miles would be coded "1 1/2SM."

REPORTABLE VISIBILITY VALUES				
0	5/8	1 5/8	4	12
1/16	3/4	1 3/4	5	13
1/8	7/8	1 7/8	6	14
3/16	1	2	7	15
1/4	1 1/8	2 1/4	8	20
5/16	1 1/4	2 1/2	9	25
3/8	1 3/8	2 3/4	10	30
1/2	1 1/2	3	11	35[a]
a. Further values in increments of 5 statute miles may be reported; e.g. 40, 45, 50, etc.				

Table 9-1. Reportable Visibility Values

9.5.7 Present Weather Group (w'w')

The standards and procedures for observing and reporting present weather are described in Chapter 5. The appropriate notations found in Table 9-2 shall be used to code present weather.

QUALIFIER		WEATHER PHENOMENA		
INTENSITY OR PROXIMITY 1	**DESCRIPTOR** 2	**PRECIPITATION** 3	**OBSCURATION** 4	**OTHER** 5
- Light	**MI** Shallow	**DZ** Drizzle	**BR** Mist	**PO** Well-Developed Dust/Sand Whirls
Moderate[2]	**PR** Partial	**RA** Rain	**FG** Fog	
+ Heavy	**BC** Patches	**SN** Snow	**FU** Smoke	
VC In the Vicinity[3]	**DR** Low Drifting	**SG** Snow Grains	**VA** Volcanic Ash	**SQ** Squalls
	BL Blowing	**IC** Ice Crystals	**DU** Widespread Dust	**FC** Funnel Cloud(s) Tornado, or Waterspout[4]
	SH Shower(s)	**PE** Ice Pellets	**SA** Sand	
	TS Thunderstorm	**GR** Hail	**HZ** Haze	
	FZ Freezing	**GS** Small Hail and/or Snow Pellets	**PY** Spray	**SS** Sandstorm
				DS Duststorm

1 The weather groups shall be constructed by considering columns 1 to 5 in the table above in sequence, i.e., intensity, followed by description, followed by weather phenomena; e.g., a heavy rain shower is coded as +SHRA
2. To denote moderate intensity, no entry or symbol is used.
3 See paragraph 5.3b and 5.4 for vicinity definitions.
4 Tornado and Waterspout shall be coded +FC

Table 9-2. Notations for Reporting Present Weather[1]

The following general rules apply when coding present weather for a METAR or SPECI:

- Weather occurring at the point of observation (at the station) or in the vicinity of the station shall be coded in the body of the report; weather observed, but not occurring at the point of observation (at the station) or in the vicinity of the station shall be coded in Remarks.

- With the exception of volcanic ash and low-drifting dust, sand, and snow, shallow fog, partial fog, and patches (of) fog, an obscuration shall be coded in the body of the report if the surface visibility is less than 7 miles or considered operationally significant. Volcanic ash shall always be coded when observed.

- Separate groups shall be used for each type of present weather. Each group shall be separated from the other by a space. A METAR/SPECI shall contain no more than three present weather groups.

- The weather groups shall be constructed by considering columns 1 to 5 in Table 9-2 in sequence, i.e., intensity, followed by descriptor, followed by weather phenomena; e.g., a

heavy rain shower is coded as +SHRA.

a. Intensity or Proximity Qualifier.

(1) Intensity shall be coded with precipitation types, except ice pellets and hail, including those associated with a thunderstorm (**TS**) and those of a showery nature (**SH**). Tornados, well-developed funnel clouds, and waterspouts shall be coded as **+FC**. No intensity shall be ascribed to the obscurations of blowing dust (**BLDU**), blowing sand **(BLSA**), or blowing snow (**BLSN**). Only moderate or heavy intensity shall be ascribed to a sandstorm (**SS**), or dust storm (**DS**).

(2) The proximity qualifier for vicinity, **VC** (weather phenomena observed in the vicinity of but not at the point(s) of observation), shall be coded in combination with fog (**FG**), shower (**SH**), well-developed dust/sand whirls (**PO**), blowing dust (**BLDU**), blowing sand (**BLSA**), blowing snow (**BLSN**), sandstorm (**SS**), or dust storm (**DS**). Intensity qualifiers shall not be coded with **VC**.

VCFG shall be coded to report any type of fog in the vicinity of the point(s) of observation.

Precipitation not occurring at the point of observation, but within 10 statute miles, shall be coded as showers in the vicinity (**VCSH**).

b. Descriptor Qualifier. Only one descriptor shall be coded for each weather phenomena group, e.g., "−FZDZ." Mist (**BR**) shall not be coded with any descriptor.

(1) The descriptors shallow (**MI**), partial (**PR**), and patches (**BC**) shall be coded only with **FG**; e.g., "MIFG."

(2) The descriptors low drifting (**DR**) and blowing (**BL**) shall be coded only with dust (**DU**), sand (**SA**), and snow (**SN**); e.g., "BLSN" or "DRSN." **DR** shall be coded for **DU**, **SA**, or **SN** raised by the wind to less than 6 feet above the ground.

When blowing snow is observed with snow falling from clouds, both phenomena are reported, e.g., "SN BLSN." If there is blowing snow and the observer cannot determine whether or not snow is also falling, **BLSN** shall be reported. **PY** shall be coded only with blowing (**BL**).

(3) The descriptor shower (**SH**) shall be coded only with one or more of the precipitation types of rain (**RA**), snow (**SN**), ice pellets (**PE**), small hail and/or snow pellets (**GS**), or hail (**GR**). The **SH** descriptor indicates showery-type precipitation. When any type of precipitation is coded with **VC**, the intensity and type of precipitation shall not be coded.

(4) The descriptor thunderstorm (**TS**) may be coded by itself, i.e., a thunderstorm without associated precipitation, or it may be coded with the precipitation types of rain (**RA)**, snow (**SN**), ice pellets (**PE**), small hail and/or snow pellets (**GS**), or hail (**GR**). For example, a thunderstorm with snow and small hail and/or snow pellets would be coded as "TSSNGS." **TS** shall not be coded with **SH**.

(5) The descriptor freezing (**FZ**) shall be coded only in combination with fog (**FG)**, drizzle (**DZ**), or rain (**RA**), e.g., "FZRA." **FZ** shall not be coded with **SH**.

c. Precipitation. Up to three types of precipitation may be coded in a single present weather group. They shall be coded in order of decreasing dominance. Use the following codes: drizzle (**DZ**), rain (**RA**), snow (**SN**), snow grains (**SG**), ice crystals (**IC**), ice pellets (**PE**), hail (**GR**), small hail and/or snow pellets (**GS**).

d. Obscuration. Use the following codes:

(1) Mist (**BR**), fog (**FG**), smoke (**FU**), volcanic ash (**VA**), widespread dust (**DU**), sand (**SA**), and haze (**HZ**).

(2) Shallow fog (**MIFG**), patches of fog (**BCFG**), and partial fog (**PRFG**) may be coded with prevailing visibility of 7 statute miles or greater.

(3) Spray shall be coded only as **BLPY**.

e. Other Weather Phenomena. Use the following codes:

(1) Well-developed dust/sand whirls (**PO**), squalls (**SQ**), sandstorm (**SS**), and duststorm (**DS**).

(2) Tornados and waterspouts shall be coded as +**FC.** Funnel clouds shall be coded as **FC**.

9.5.8 Sky Condition Group ($N_sN_sN_sh_sh_sh_s$ or $VVh_sh_sh_s$ or SKC)

The standards and procedures for observing and reporting sky condition are described in Chapter 6.

a. Sky condition shall be coded in the format, $\mathbf{N_sN_sN_sh_sh_sh_s}$, where $\mathbf{N_sN_sN_s}$ is the amount of sky cover and $\mathbf{h_sh_sh_s}$ is the height of the layer. There shall be no space between the amount of sky cover and the height of the layer. Sky condition shall be coded in ascending order up to the first overcast layer. At mountain stations, if the cloud layer is below station level, the height of the layer shall be coded as ///.

b. Vertical visibility shall be coded in the format, $\mathbf{VVh_sh_sh_s}$, where **VV** identifies an indefinite ceiling and $\mathbf{h_sh_sh_s}$ is the vertical visibility into the indefinite ceiling. There shall be no space between the group identifier and the vertical visibility.

c. Clear skies shall be coded in the format, **SKC**, where **SKC** is the abbreviation used by manual stations to indicate no clouds are present.

Each layer shall be separated from other layers by a space. The sky cover for each layer reported shall be coded by using the appropriate reportable contraction from Table 9-3. The report of clear skies, **SKC**, is a complete layer report. The abbreviations **FEW**, **SCT**, **BKN**, and **OVC** shall be followed, without a space, by the height of the cloud layer.

Reportable Contraction	Meaning	Summation Amount of Layer
VV	Vertical Visibility	8/8
SKC	Clear	0
FEW	Few	>0 - 2/8
SCT	Scattered	3/8 - 4/8
BKN	Broken	5/8 - 7/8
OVC	Overcast	8/8

Table 9-3. Contractions for Sky Cover

The height of the base of each layer, $\mathbf{h_s h_s h_s}$, shall be coded in hundreds of feet above the surface using three digits in accordance with Table 9-4.

Range of Height Values (feet)	Reportable Increment (feet)
≤5,000	To nearest 100
>5,000 but ≤10,000	To nearest 500
>10,000	To nearest 1,000

Table 9-4. Increments of Reportable Values of Sky Cover Height

Cumulonimbus (**CB**) or towering cumulus (**TCU**) shall be appended to the layer. For example, a scattered layer of towering cumulus at 1,500 feet would be coded "SCT015TCU" and would be followed by a space if there were additional higher layers to code.

9.5.9 Temperature/Dew Point Group ($T'T'/T'_dT'_d$)

The standards and procedures for observing and reporting temperature and dew point are given in Chapter 7. The temperature shall be separated from the dew point with a solidus "/."

The temperature and dew point shall be coded as two digits rounded to the nearest whole degree Celsius. Sub-zero temperatures and dew points shall be prefixed with an M. For example, a temperature of 4°C with a dew point of −2°C is coded as "04/M02." A temperature of −0.5°C shall be coded as "M00."

If the temperature is not available, the entire temperature/dew point group shall not be coded. If the dew point is not available, the temperature shall be coded followed by a solidus "/" and no entry made for dew point. For example, a temperature of 1.5°C and a missing dew point would be coded as "02/."

9.5.10 Altimeter ($AP_HP_HP_HP_H$)

The standards and procedures for observing and reporting altimeter are described in Chapter 8. The altimeter group always starts with an A (the international indicator for altimeter in inches of mercury). The altimeter shall be coded as a four-digit group immediately following the A using

the tens, units, tenths, and hundredths of inches of mercury. The decimal point is not coded.

9.6 Remarks (RMK)

Remarks shall be included in all METAR and SPECI reports, if appropriate.

Remarks shall be separated from the body of the report by a space and the contraction **RMK**. If there are no remarks, the contraction **RMK** is not required.

Remarks shall be made in accordance with the following:

a. Where plain language is called for, authorized contractions, abbreviations, and symbols should be used to conserve time and space. However, in no case should an essential remark, of which the observer is aware, be omitted for the lack of readily available contractions. In such cases, the only requirement is that the remark be clear. For a detailed list of authorized contractions, see FAA Order 7340 Series, *Contractions*.

b. Time entries shall be made in minutes past the hour if the time reported occurs during the same hour the observation is taken. Hours and minutes shall be used if the hour is different, or this Handbook prescribes the use of the hour and minutes.

c. Present weather coded in the body of the report as **VC** may be further described, i.e., direction from the station, if known. Weather phenomena beyond 10 statute miles of the point(s) of observation shall be coded as distant (**DSNT**) followed by the direction from the station. For example, precipitation of unknown intensity within 10 statute miles east of the station would be coded as "VCSH E"; lightning 25 statute miles west of the station would be coded as "LTG DSNT W." All distance remarks shall be in statute miles.

d. Movement of clouds or weather, if known, shall be coded with respect to the direction toward which the phenomenon is moving. For example, a thunderstorm moving toward the northeast would be coded as "TS MOV NE".

e. Directions shall use the eight points of the compass coded in a clockwise order.

f. Insofar as possible, remarks shall be entered in the order they are presented in the following paragraphs.

9.6.1 Manual and Plain Language Remarks

This group of remarks may be generated by a manual station and generally elaborate on parameters reported in the body of the report.

a. **Volcanic Eruptions.** Volcanic eruptions shall be coded. The remark shall be plain language and contain the following, if known:

   (1) **Name** of volcano.

   (2) **Latitude** and **longitude** or the direction and the approximate distance from the station.

(3) **Date/Time** (UTC) of the eruption.

(4) Size **description**, approximate height, and direction of movement **of the ash cloud**.

(5) Any **other pertinent data** about the eruption.

For example, a remark on a volcanic eruption would look like the following:

MT. AUGUSTINE VOLCANO 70 MILES SW ERUPTED 231505 LARGE ASH CLOUD EXTENDING TO APRX 30000 FEET MOVING NE.

Pre-eruption volcanic activity shall not be coded. Pre-eruption refers to unusual and/or increasing volcanic activity which could presage a volcanic eruption.

b. **Funnel Cloud (Tornadic activity_LOC/DIR_(MOV)**. Tornados, funnel clouds, or waterspouts shall be coded in the format, **Tornadic activity_LOC/DIR_(MOV)**, where **TORNADO, FUNNEL CLOUD,** or **WATERSPOUT** identifies the specific tornadic activity; **LOC/DIR** is the location and/or direction of the phenomena from the station; and **MOV** is the movement, if known. Tornadic activity shall be coded as the first remark after the "RMK" entry. For example, "TORNADO 6 NE" would indicate that a tornado was 6 statute miles northeast of the station.

c. **Wind Shift (WSHFT_(hh)mm)**. A wind shift shall be coded in the format, **WSHFT**_(hh)mm, where **WSHFT** is the remark identifier and **(hh)mm** is the time the wind shift began (only the minutes are required if the hour can be inferred from the report time). The contraction **FROPA** may be entered following the time if it is reasonably certain that the wind shift was the result of a frontal passage. There shall be a space between the remark identifier and the time and, if applicable, between the time and the frontal passage contraction. For example, a remark reporting a wind shift accompanied by a frontal passage that began at 30 minutes after the hour would be coded as "WSHFT 30 FROPA."

d. **Variable Prevailing Visibility (VIS_$v_nv_nv_nv_nv_nVv_xv_xv_xv_xv_x$)**. Variable prevailing visibility shall be coded in the format **VIS_**$v_nv_nv_nv_nv_nVv_xv_xv_xv_xv_x$, where **VIS** is the remark identifier, $v_nv_nv_nv_nv_n$ is the lowest visibility evaluated, **V** denotes variability between two values, and $v_xv_xv_xv_xv_x$ is the highest visibility evaluated. There shall be one space following the remark identifier; no spaces between the letter **V** and the lowest/highest values. For example, a visibility that was varying between 1/2 and 2 statute miles would be coded "VIS 1/2V2."

e. **Sector Visibility (VIS_[DIR]_vvvvv)**. The sector visibility shall be coded in the format, **VIS_[DIR]_vvvvv,** where **VIS** is the remark identifier, [**DIR]** defines the sector to 8 points of the compass, and **vvvvv** is the sector visibility in statute miles, using the appropriate set of values in Table 9-1. For example, "VIS NE 2 1/2" would indicate that the visibility in the northeastern octant was 2 1/2 statute miles.

f. **Lightning (Frequency LTG(type)_[LOC]).** When lightning is observed at a manual station, the frequency, type of lightning, and location shall be reported. The remark shall be coded in the format **Frequency_LTG(type)_[LOC]**. The contractions for the type and frequency of lightning shall be based on Table 9-5. The location and direction shall be coded in accordance with paragraph 9.6.c; e.g., OCNL LTG, FRQ LTGCG VC,

or LTG DSNT W.

Type of Lightning		
Type	**Contraction**	**Definition**
Cloud-ground	CG	Lightning occurring between cloud and ground.
In-cloud	IC	Lightning which takes place within the thunder cloud.
Cloud-cloud	CC	Streaks of lightning reaching from one cloud to another.
Cloud-air	CA	Streaks of lightning which pass from a cloud to the air, but do not strike the ground.
Frequency of Lightning		
Frequency	**Contraction**	**Definition**
Occasional	OCNL	Less than 1 flash/minute.
Frequent	FRQ	About 1 to 6 flashes/minute.
Continuous	CONS	More than 6 flashes/minute.

Table 9-5. Type and Frequency of Lightning

g. **Thunderstorm Location (TS_LOC_(MOV_DIR)).** A thunderstorm shall be coded in the format, **TS_LOC_(MOV_DIR)**, where **TS** identifies the thunderstorm activity, **LOC** is the location of the thunderstorm(s) from the station, and **MOV_DIR** is the movement with direction, if known. For example, a thunderstorm southeast of the station and moving toward the northeast would be coded "TS SE MOV NE."

h. **Hailstone Size (GR_[size]).** Hailstone size shall be coded in the format, **GR_[size]**, where **GR** is the remark identifier and **[size]** is the diameter of the largest hailstone. The hailstone size shall be coded in 1/4 inch increments. For example, "GR 1 3/4" would indicate that the largest hailstones were 1 3/4 inches in diameter. If **GS** is coded in the body of the report, no hailstone size remark is required.

i. **Virga (VIRGA_(DIR)).** Virga shall be coded in the format, **VIRGA_(DIR)**, where **VIRGA** is the remark identifier and **DIR** is the direction from the station. The direction of the phenomena from the station is optional; e.g., "VIRGA" or "VIRGA SW."

j. **Variable Ceiling Height (CIG_$h_nh_nh_n$V$h_xh_xh_x$).** The variable ceiling height shall be coded in the format, **CIG_$h_nh_nh_n$V$h_xh_xh_x$**, where **CIG** is the remark identifier, $h_nh_nh_n$ is the lowest ceiling height evaluated, **V** denotes variability between two values, and $h_xh_xh_x$ is the highest ceiling height evaluated. There shall be one space following the remark identifier; no spaces between the letter **V** and the lowest/highest ceiling values. "CIG 005V010" would indicate a ceiling that was varying between 500 and 1,000 feet.

k. **Obscurations (w'w'_[$N_sN_sN_s$]$h_sh_sh_s$).** (Plain Language) Obscurations surface-based or aloft shall be coded in the format, **w'w'_[$N_sN_sN_s$]$h_sh_sh_s$**, where **w'w'** is the weather causing obscuration, $N_sN_sN_s$ is the applicable sky cover amount of the obscuration aloft (FEW, SCT, BKN, OVC) or at the surface (FEW, SCT, BKN), and $h_sh_sh_s$ is the applicable height. Surface-based obscurations shall have a height of "000." There shall be a space separating the weather causing the obscuration and, the sky cover amount;

there shall be no space between the sky cover amount and height. For example, fog hiding 3-4 oktas of the sky would be coded "FG SCT000." A 2,000-foot broken layer composed of smoke (that is reported in the sky condition) would be coded "FU BKN020."

l. **Variable Sky Condition ($N_sN_sN_s(h_sh_sh_s)$_V_$N_sN_sN_s$).** The variable sky condition remark shall be coded in the format, $N_sN_sN_s(h_sh_sh_s)$_V_$N_sN_sN_s$, where $N_sN_sN_s(h_sh_sh_s)$ and $N_sN_sN_s$ identify the two operationally significant sky conditions and **V** denotes the variability between the two ranges. If there are several layers with the same sky condition amount, the layer height **($h_sh_sh_s$)** of the variable layer shall be coded. For example, a cloud layer at 1,400 feet that is varying between broken and overcast would be coded "BKN014 V OVC."

m. **Significant Cloud Types.** (Plain Language) The significant cloud type remark shall be coded in all reports in the following manner:

(1) **Cumulonimbus or Cumulonimbus Mammatus (CB or CBMAM_LOC_(MOV_DIR)).** Cumulonimbus or cumulonimbus mammatus, as appropriate (for which no thunderstorm is being reported), shall be coded in the format, **CB** or **CBMAM_LOC_(MOV_DIR)**, where **CB** or **CBMAM** is the cloud type, **LOC** is the direction from the station, and **MOV_DIR** is the movement with direction (if known). The cloud type, location, movement, and direction entries shall be separated from each other with a space. For example, a CB up to 10 statute miles west of the station moving toward the east would be coded "CB VC W MOV E." A CB more than 10 statute miles to the west would be coded "CB DSNT W."

(2) **Towering Cumulus (TCU_[DIR])**. Towering cumulus clouds shall be coded in the format, **TCU_[DIR]**, where **TCU** is the cloud type and **DIR** is the direction from the station. The cloud type and direction entries shall be separated by a space. For example, a towering cumulus cloud 15 statute miles west of the station would be coded "TCU DSNT W."

(3) **Altocumulus Castellanus (ACC_[DIR])**. Altocumulus castellanus shall be coded in the format, **ACC_[DIR]**, where **ACC** is the cloud type and **DIR** is the direction from the station. The cloud type and direction entries shall be separated by a space. For example, an altocumulus cloud 5 to 10 statute miles northwest of the station would be coded "ACC VC NW."

(4) **Standing Lenticular or Rotor Clouds (CLD_[DIR]).** Stratocumulus (SCSL), altocumulus (ACSL), cirrocumulus (CCSL), or rotor clouds shall be coded in the format, **CLD_[DIR]**, where **CLD** is the cloud type and **DIR** is the direction from the station. The cloud type and direction entries shall be separated by a space. For example, altocumulus standing lenticular clouds observed southwest through west of the station would be coded "ACSL SW-W"; an apparent rotor cloud 5 to 10 statute miles northeast of the station would be coded "APRNT ROTOR CLD VC NE"; and cirrocumulus clouds over the station would be coded "CCSL OHD."

n. **Aircraft Mishap (ACFT_MSHP).** If a report was taken to document weather conditions when notified of an aircraft mishap, the remark **ACFT_MSHP** shall be coded in the report but not transmitted. The act of non-transmission shall be indicated by enclosing the remark in parentheses in the record, i.e., "(ACFT MSHP)."

o. **Other Significant Information.** At part-time stations, identify the last observation of the day by entering and reporting the remark **LAST** after the last element reported in Remarks.

9.7 Dissemination

9.7.1 Dissemination Requirements

All reports should be given local dissemination. Sites which receive a terminal forecast from the NWS must also provide long-line dissemination of the report as coordinated with either the NWS or the FAA. When reports are corrected, the corrected reports are given the same dissemination as the report being corrected.

9.7.2 Dissemination Priority

Reports should be given first to the positions which control local air traffic. Priorities for further dissemination may be estabilished by observers and their supervisors in any order consistent with local and national requirements.

Reports that are not required to be transmitted, shall be posted and available for all other users within 10 minutes after the observation is taken, i.e., if the time appearing in the report is 0435Z, it shall be posted and available for all other users no later than 0445Z.

9.7.3 Report Filing Time

SPECIs are completed and transmitted as soon as possible. METARs shall not be transmitted more than 10 minutes (H+50) before their scheduled time.

9.7.4 Verification of Transmitted Data

Care should be taken to avoid the dissemination of incorrect data. Check your observation before dissemination and, where possible, immediately after transmission, compare the original observation with that disseminated, both locally and long-line.

9.8 Examples of Transmitted Weather Reports

The following examples of coded weather reports are taken from "Exhibit 10-2. Examples of Entries on
MF1M-10C (Part-time Station)". The underline character (_) represents a required space.

```
05 SEP 1996

SPECI_KARA_051148Z_32010KT_7SM_SKC_18/16_A2983

SPECI_KARA_051255Z_29015KT_7SM_BKN050_BKN090_OVC120_22/15_A2983

SPECI_KARA_051530Z_24010KT_10SM_VCSH_FEW030_BKN100_24/16_A2986_RM
K_ VCSH_N

SPECI_KARA_051630Z_21010KT_12SM_FEW030TCU_SCT080_BKN250_28/23_A29
```

87_RMK_TCU_SW

SPECI_KARA_051950Z_22015G25KT_3/4SM_+TSRA_OVC015CB_28/24_A2992_RMK_FRQ_LTGCG_ALQDS_TS_OHD_MOV_E

SPECI_KARA_052025Z_25008KT_7SM_FEW025CB_26/17_A2990_RMK_TS_MOV_E_CB_E_LAST

06 SEP 1996

SPECI_KARA_061130Z_VRB03KT_2SM_BR_HZ_SCT000_BKN250_24/23_A2987_RMK_BR_HZ_SCT000

SPECI_KARA_061205Z_06007KT_1/4SM_-DZ_FG_VV003_25/24_A2987

SPECI_KARA_061245Z_03029G49KT_1_1/2SM_TSRAGR_OVC010CB_25/24_A2990_RMK_OCNL_LTGICCG_TS_OHD_MOV_NE_GR_3/4

SPECI_KARA_061345Z_05003KT_8SM_SCT025_BKN070_23/18_A2992_RMK_TS_MOV_NE_FU_SCT025

SPECI_KARA_061950Z_14012KT_110V170_10SM_-SHRA_SCT030_BKN040_OVC080CB_30/26_A2985_RMK_FRQ_LTGCG_VC_N_CB_OHD_MOV_E

SPECI_KARA_062025Z_17006KT_7SM_BKN040_BKN090_33/23_A2985_RMK_LAST

07 SEP 1996

SPECI_KARA_071145Z_VRB02KT_2SM_BR_BKN000_BKN060_33/31_A2985_RMK_VIS_SW_1/2_BR_BKN000

SPECI_KARA_071245Z_00000KT_0SM_FG_VV000_33/33_A2986

SPECI_KARA_071530Z_10010KT_15SM_FEW030_BKN045_30/22_A2987_RMK_BKN045_V_OVC

SPECI_KARA_071645Z_11015KT_10SM_SCT006_BKN015_30/26_A2988_RMK_CIG_ 014V018

SPECI_KARA_071745Z_04025KT_7SM_FEW005_OVC020_30/22_A2987_RMK_WSHFT_ 45_LAST

08 SEP 1996

SPECI_KARA_081151Z_06007KT_10SM_VCFG_OVC015_30/26_A2986_RMK_VCFG_NE-E

SPECI_KARA_081630Z_19014G20KT_160V220_6SM_TSRA_FEW008_SCT018TCU_BKN050CB_31/28_A2983_RMK_WSHFT_25_TS_SW_TCU_OHD_MOV_NE

SPECI_KARA_081830Z_20004KT_0SM_FG_VV000_30/28_A2983

SPECI_KARA_082100Z_05015G20_020V080_1_1/4SM_-RA_BR_FEW000_BKN020_

BKN080_26/24_A2984_RMK_VIS_1/2V2_CIG_017V023_BR_FEW000_BKN020_V_S
CT_LAST

CHAPTER 10 ENTRIES ON METEOROLOGICAL FORM 1M-10C

10.1 Introduction

This chapter contains instructions for making entries on the Meteorological Form 1M-10C (MF1M-10C). Many of the instructions in this chapter are duplicated from Chapter 9. To avoid rewriting some of the instructions, a reference is made to previous paragraphs.

10.2 Entries on Meteorological Form 1M-10C

Certified observers shall normally complete all entries on MF1M-10C. Non-certified trainees/observers may make entries on the form under the immediate supervision of a certified observer who assumes responsibility for the validity of the entries by initialing in Column 15. Non-certified observers may initial the observation, but the certified observer shall initial first. Initials shall be separated by a solidus (/).

10.2.1 Preparing MF1M-10C

Prepare an original and at least one carbon copy of MF1M-10C. Data for more than 1 day may be entered on the same sheet, separating data for different days by a line containing the day, month, and year of the data which follow it. All dates and times on this form are UTC.

10.2.2 Writing Instrument

The same type of writing instrument shall be used throughout the form. To ensure legible copies and ample contrast for reproduction, use a black-inked fine ballpoint pen.

10.2.3 Missing Data

Explain briefly the reasons for any missing data in Column 65, Remarks, Notes, and Miscellaneous Phenomena. See paragraph 9.4.

10.2.4 Late Observations

When a record observation is taken late, but within 15 minutes of the standard time of observation, and no appreciable changes have occurred since the standard time, enter the observation in black and transmit it using the actual time of observation. If conditions have changed appreciably or the observation is more than 15 minutes late, skip a line and record and transmit a SPECI containing all the elements in a record observation. After transmitting the special, using the actual time of observation, estimate the conditions probable at the standard time using recording instruments whenever possible. Record the data on the skipped line using the standard time in Column 2. Do not transmit the observation. Make a note in Column 65 and reference the actual time of observation.

10.3 Corrections

Draw a single black line (paper forms) through the erroneous entry. Do not erase or otherwise obliterate entries. Record corrected data in the appropriate blocks on the same or next line, appropriately identified.

10.4 Heading

The header portion of the MF1M-10 consists of nine blocks across the top of the form. The procedures for completing these blocks are as follows:

(a) In the blocks labeled "**LATITUDE**" and "**LONGITUDE**," enter the station's latitude and longitude to the nearest minute of a degree;

(b) in the block labeled "**STATION ELEVATION**," enter the station's elevation (H_p) to the nearest foot;

(c) in the block labeled "**TIME CONVERSION**," enter the number of whole hours to convert the station's local standard time to UTC. Circle the appropriate mathematical sign;

(d) in the block labeled "**DAY**," enter the current day using the appropriate numeric digit/s;

(e) in the block labeled "**MONTH**," enter the current month's three-letter abbreviation;

(f) in the block labeled "**YEAR**," enter the current year using four digits;

(g) in the block labeled "**SID**," enter the station's four-letter identifier;

(h) in the block labeled "**STATION**," enter the type (SAWRS), the official station name and state abbreviation.

.

10.5 Entries on MF1M-10C by Columns

In this section (10.5), the number after the second decimal does not always correspond to the column number on the form.

10.5.1 Type of Observation (Column 1)

"**M**" shall be recorded to designate a record (METAR) observation, and "**S**" is indicated for a special (SPECI) report.

10.5.2 Time of Observation (Column 2)

Record the actual time of observation in UTC.

10.5.3 Wind Direction (Column 3)

Record the true wind direction from which the wind is blowing in tens of degrees using three figures. Directions less than 100 degrees shall be preceded with a "0." When the wind is calm, enter 000 for direction. Wind direction can be coded VRB for variable wind direction when the wind speed is equal to or less than 6 knots.

10.5.4 Wind Speed (Column 4)

Record the wind speed in whole knots using two or three digits. Speeds of less than 10 knots will have a lead zero; i.e., 5 knots is logged as 05. Calm wind speed is recorded as 00.

10.5.5 Wind Gust (Column 5)

Record wind gusts in whole knots using two or three digits. A wind speed of 105 knots is logged 105.

10.5.6 Wind Variability (Column 6)

When the wind speed is greater than 6 knots, the variable wind direction will be coded in a clockwise direction. For example, if the wind is variable from 180^{o} to 240^{o}, the log entry would read 180V240.

10.5.7 Surface Visibility (Column 7a) and Tower Visibility (Column 7b)

Record the surface prevailing visibility determined from the SAWRS usual point(s) of observation using the reportable values listed in Table 4-1. Tower visibility (Column 7b) is not reported by SAWRS.

10.5.8 Runway Visual Range (Column 8)

RVR is not reported by SAWRS.

10.5.9 Present Weather (Column 9)

Record weather occurring at the station using the codes listed in Table 5-5. No more than three present weather groups can be reported. Entries will consist of an applicable qualifier, precipitation type, obscuration type, and/or other type of phenomenon.

10.5.10 Sky Condition (Column 10)

The procedures for reporting sky condition are given in Chapter 6. Record the sky cover that is visible from the station using the appropriate contractions or combination of contractions from Table 6-5. Height of Sky Cover will be reported from Table 6-6. Vertical visibility is coded using "VV," which indicates an indefinite ceiling followed by a value for the vertical visibility height into the indefinite ceiling. Clear skies will be noted by the acronym SKC.

10.5.11 Temperature (Column 11)

Record the dry-bulb temperature to the nearest whole degrees Celsius. Sub-zero temperatures shall be prefixed with a minus sign (–). Add a leading zero to single digit temperatures. An "M" shall be prefixed to sub-zero temperatures in the transmitted observation.

10.5.12 Dew Point (Column 12)

Record the dew point temperature to the nearest whole degree Celsius. Sub-zero dew points shall be prefixed with a minus sign (–). Add a leading zero to single digit dew points. Dew point temperature is reported at designated SAWRS locations. An "M" shall be prefixed to sub-zero dew point temperatures in the transmitted observation.

10.5.13 Altimeter Setting (Column 13)

The altimeter setting is a four-digit group using tens, units, tenths, and hundreds of inches of mercury. The decimal point is not included. Record 29.94 as 2994.

10.5.14 Remarks (Column 14)

Record all remarks in Column 14 according to the procedures and order given in paragraphs 9.6 through 9.6.1o.

10.5.15 Observer's Initials (Column 15)

The certified observer responsible for the observation will initial this column.

10.5.16 Total Sky Cover (Column 17)

For each hourly observation, record the eighths of sky hidden by all clouds and obscuring phenomena aloft that are visible from the station. Do not record total sky cover for hours when station personnel are not on duty. Stations that do not take hourly observations must complete Column 17 for all SPECI reports.

10.5.17 Dry-bulb Temperature (Column 19)

Record the dry-bulb temperature in degrees and tenths of degrees Celsius if psychometric data are obtained from other than a hygrothermometer or an equivalent system. Prefix sub-zero temperatures with a minus sign (−).

10.5.18 Wet-bulb Temperature (Column 20)

Record the wet-bulb temperature in degrees and tenths of degrees Celsius if psychometric data are obtained from other than a hygrothermometer or an equivalent system. Prefix sub-zero temperatures with a minus sign (−).

10.5.19 Remarks, Notes, and Miscellaneous Phenomena (Column 65)

Use this block to record data considered significant, but not recorded elsewhere, and the information described in the following paragraphs.

a. Record the UTC of occurrence of all entries unless otherwise specified.

b. Make entries to report:

(1) Outages, changes in instruments, reasons for change, and times of change or outage.

(2) Reasons for omission of mandatory data.

(3) Time checks of station clock that was designated as the station standard.

(4) Altimeter setting comparisons. See paragraphs 8.5.1 through 8.5.3.

(5) Changes in hours of station operation, with effective dates if temporary or date if permanent.

(6) Estimated data.

(7) Miscellaneous items; e.g., approximate date/time and location of an aircraft mishap; when notified by the FAA (FSS/TWR) of an aircraft mishap.

(8) Separate individual remarks by a single solidus (/); e.g., ALSTG: INST #1 29.32, INST #2 29.33, DIFF .01, 25/1330/WIND EQUIP. INOP. 1155-1405/STATION CLOSED DUE TO EMT DUTIES 1700-2000.

10.5.20 Time Check Entries in Column 65

The clock designated as the station standard must be checked at intervals stated in paragraph 2.6.2. The station standard clock must be compared with a standard and adjusted if an error exceeds 29 seconds. Record the time, in hours and minutes when the clock is correct, or has been corrected, to the nearest whole minute. All times entered are determined from the standard used to check the station clock.

Examples:

At 0345 the station clock when compared against a standard was 20 seconds slow. No adjustment needed, enter 0345.

At 1050 the station clock when compared against a standard was 35 seconds fast. Adjust the station clock and enter 1050.

TIME CHECK-CLOCK CORRECT TO THE NEAREST MINUTE AT:0345/1050/1647/

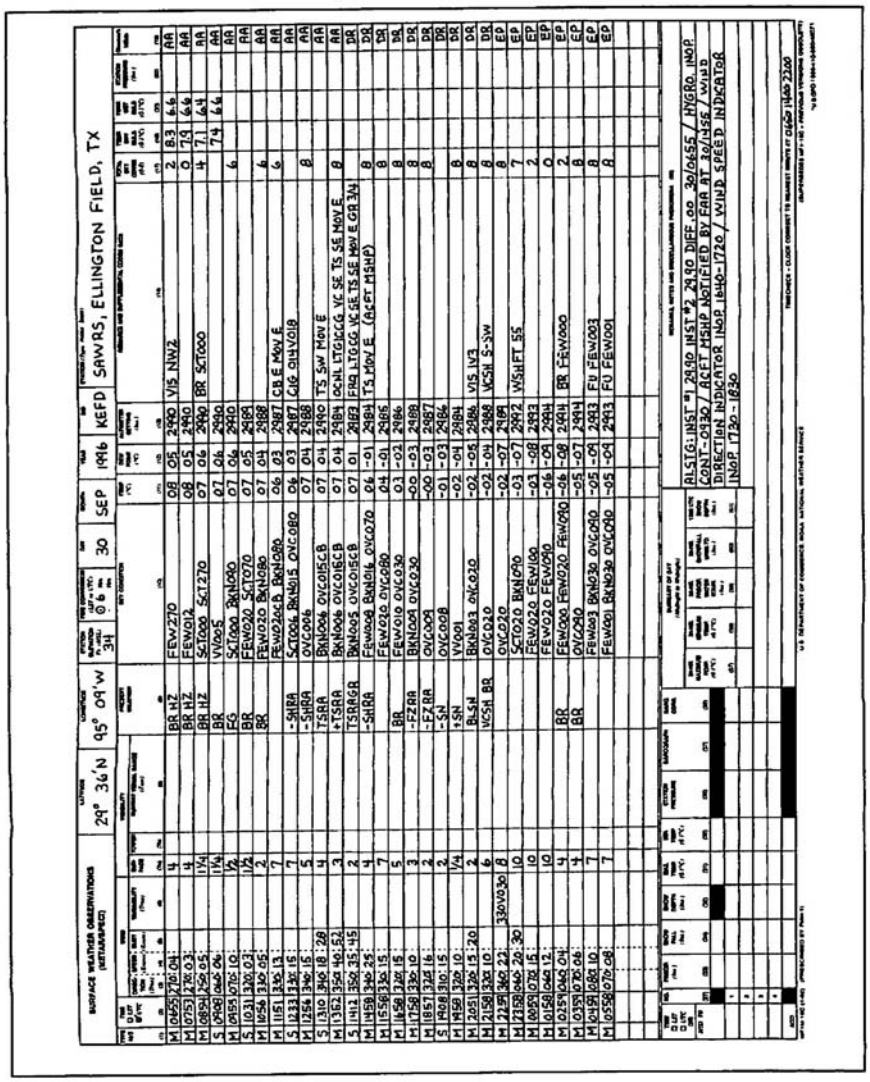


Exhibit 10-1. Example of Entries on MF1M-10C

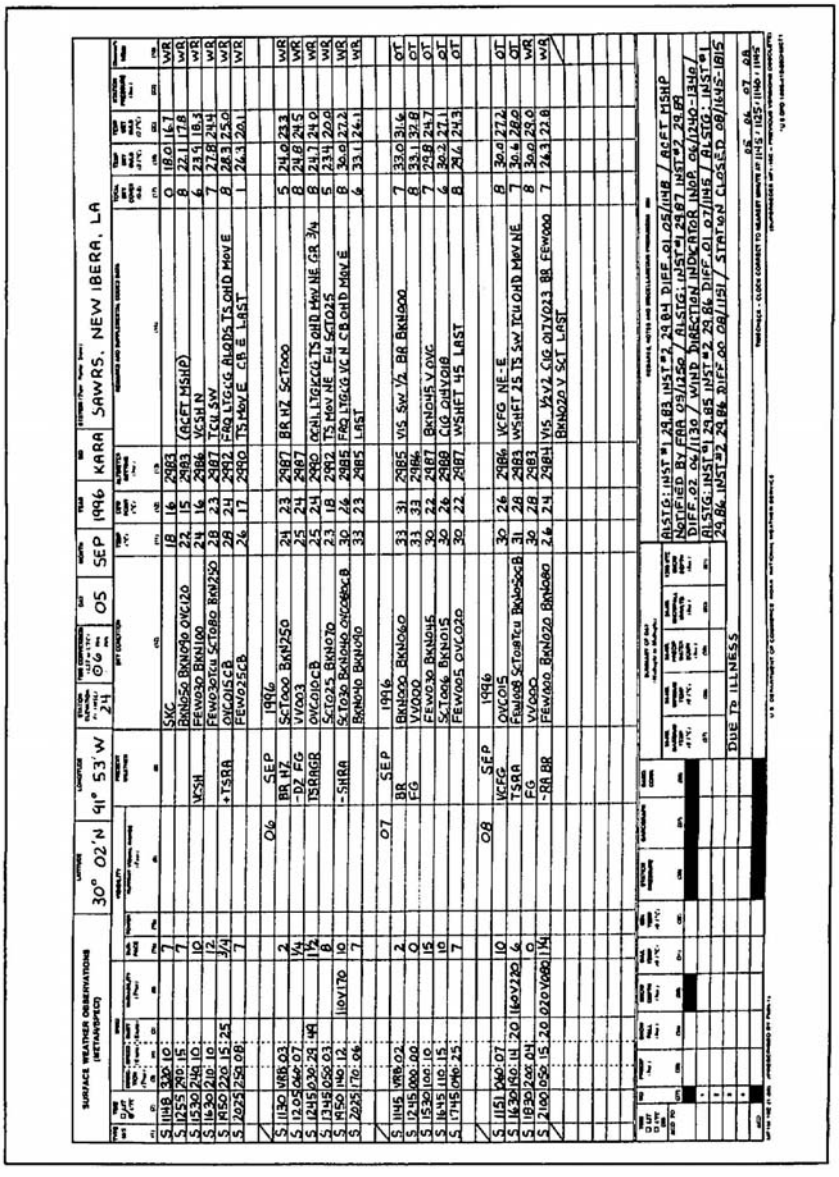


Exhibit 10-2. Example of Entries on MF1M-10C (Part-Time Station)

APPENDIX A - LIST OF ABBREVIATIONS AND ACRONYMS

This appendix includes abbreviations, acronyms, contractions, code groups, and symbols; they are defined in accordance with their usage in WSOH #8.

─ (minus sign)..... Light, Sub-zero Temperature
+ ..... Heavy
/ ..... Separation of Data within a Group
_ (underline)..... Required Space
°C ..... Degrees Celsius
°F..... Degrees Fahrenheit
ACC ..... Altocumulus Castellanus
ACFT ..... Aircraft
ACFT MSHP ..... Aircraft Mishap
ACSL ..... Altocumulus Standing Lenticularis
ALP ..... Airport Location Point
ALSTG..... Altimeter Setting
APRNT ..... Apparent
APRX..... Approximately
ASI ..... Altimeter Setting Indicator
BC ..... Patches
BCFG ..... Patches of Fog
BKN ..... Broken
BL ..... Blowing
BLDU..... Blowing Dust
BLPY ..... Blowing Spray
BLSA ..... Blowing Sand
BLSN ..... Blowing Snow
BR ..... Mist
CA ..... Cloud to Air (lightning)
CB ..... Cumulonimbus
CBMAM ..... Cumulonimbus Mamma (Mammatocumulus)
CC ..... Cloud to Cloud (lightning), Cirrocumulus
CCCC..... Station Identifier
CCSL..... Cirrocumulus Standing Lenticularis
CG..... Cloud to Ground (lightning)
CIG..... Ceiling
CLD..... Cloud
CONS..... Continuous

COR ..... Correction
CST ..... Central Standard Time
DASI ..... Digital Altimeter Setting Indicator
DIFF ..... Difference
DIR/ddd ..... Direction
DP ..... Dew Point
DR ..... Low Drifting
DRDU ..... Low Drifting Dust
DRSA ..... Low Drifting Sand
DRSN ..... Low Drifting Snow
DS ..... Duststorm
DSNT ..... Distant
DSPTG ..... Dissipating
DTG ..... Date, Time Group
DU ..... Widespread Dust
DZ ..... Drizzle
E ..... East
FAA ..... Federal Aviation Administration
FAR ..... Federal Aviation Regulation
FC ..... Funnel Cloud
FC+ ..... Tornado or Waterspout
FCWOS ..... FAA Contract Weather Observing Station
FEW ..... Few Clouds
FG ..... Fog
FMH -1 ..... Federal Meteorological Handbook No. 1, Surface Aviation Observations
FROPA ..... Frontal Passage
FRQ ..... Frequent
FSS ..... Flight Service Station
FT ..... Feet
FU ..... Smoke
FZ ..... Freezing
FZDZ ..... Freezing Dirzzle
FZFG ..... Freezing Fog
FZRA ..... Freezing Rain
G ..... Gust
GR ..... Hail
GS ..... Small Hail and/or Snow Pellets
H_a ..... Field Elevation
H_g ..... Inches of Mercury

H_Z ..... Barometer Elevation
HZ ..... Haze
IC ..... Ice Crystals, In-cloud Lightning
ICAO ..... International Civil Aviation Organization
INOP ..... Inoperative
INTMT ..... Intermittent
KT or KTS ..... Knots
LAST ..... Last Observation of the Normal Work Day
LAT ..... Lattitude
LAWRS ..... Limited Aviation Weather Reporting Station
LOC ..... Location
LON ..... Longitude
LST ..... Local Standard Time
LTG ..... Lightning
M ..... Minus
METAR ..... Aviation Routine Weather Report
MF1M-10C ..... Meteorological Form 1M-10C (METAR)
MI ..... Shallow
MIFG ..... Shallow Fog
MOV ..... Moved/Moving/Movement
MPH ..... Miles Per Hour
MSL ..... Mean Sea Level
N ..... North
NE ..... Northeast
NOS ..... National Ocean Service
NWS ..... National Weather Service
OCNL ..... Occasional
OHD ..... Overhead
OVC ..... Overcast
PE ..... Ice Pellets
PR ..... Partial
PRFG ..... Partial Fog
PO ..... Dust/Sand Whirls (dust devils)
PY ..... Spray
RA ..... Rain
RMK ..... Remark
RVR ..... Runway Visual Range
S ..... South

SA ..... Sand
SAWRS ..... Supplementary Aviation Weather Reporting Station
SCSL ..... Stratocumulus Standing Lenticular
SCT ..... Scattered
SE ..... Southeast
SG ..... Snow Grains
SH ..... Shower(s)
SHGR ..... Showers of Hail
SHGS ..... Showers of Small/or Snow Pellets
SHPE ..... Ice Pellet Shower
SHRA ..... Rain Shower
SHSN ..... Snow Shower
SKC ..... Sky Clear
SM ..... Statute Miles
SN ..... Snow
SPECI ..... Aviation Selected Special Weather Report
SQ ..... Squalls
SS ..... Sandstorm
STN ..... Station
SW ..... Southwest
TCU ..... Towering Cumulus
TS ..... Thunderstorm
TSGR ..... Thunderstorm with Hail
TSGS ..... Thunderstorm with Small Hail/or Snow Pellets
TSPE ..... Thunderstorm with Ice Pellets
TSRA ..... Thunderstorm with Rain
TSSN ..... Thunderstorm with Snow
UTC ..... Coordinated Universal Time
V ..... Variable
VA ..... Volcanic Ash
VC ..... In the Vicinity
VCDS ..... Duststorm in the Vicinity
VCFG ..... Fog in the Vicinity
VCPO ..... Dust/Sand Whirls (dust devils) in the Vicinity
VCSH ..... Showers in the Vicinity
VCSS ..... Sandstorm in the Vicinity
VIS ..... Visibility
VRB ..... Variable
VV ..... Vertical Visibility

W ..... West
WMO ..... World Meteorological Organization
WS ..... Weather Service
WSCMO ..... Weather Service Contract Meteorological Observatory
WSHFT ..... Wind Shift
WSOH #8 ..... Weather Service Observing Handbook No. 8
Z ..... Zulu, i.e., Coordinated Universal Time

APPENDIX B - GLOSSARY

actual time of observation. For METAR reports, it is the time the last element of the report is observed or evaluated. For SPECI reports, it is the time that the criteria for a SPECI were met or noted.

aircraft mishap. An inclusive term to denote the occurrence of an aircraft accident or incident.

airport location point. The permanent airport reference point defined by the latitude and longitude published in the Airport Facility Directory.

altimeter setting. The pressure value to which an aircraft altimeter scale is set so that it will indicate the altitude above mean sea level of an aircraft on the ground at the location for which the value was determined.

archive. A permanent record of surface weather reports and related data used to establish a climatological record for the United States.

atmospheric pressure. The pressure exerted by the atmosphere at a given point (see altimeter setting, pressure).

barometer. An instrument that measures atmospheric pressure.

blowing. A descriptor used to amplify observed weather phenomena whenever the phenomena are raised to a height of 6 feet or more above the ground.

blowing dust. Dust picked up locally from the surface of the earth and blown about in clouds or sheets, reducing the horizontal visibility to less than 7 statute miles.

blowing sand. Sand particles picked up from the surface of the earth by the wind to moderate heights above the ground, reducing the reported horizontal visibility to less than 7 statute miles.

blowing snow. Snow lifted from the surface of the earth by the wind to a height of 6 feet or more above the ground and blown about in such quantities that horizontal visibility is restricted at and above that height, reducing the reported horizontal visibility to less than 7 statute miles.

blowing spray. Water droplets torn by the wind from a body of water, generally from the crests of waves, and carried up into the air in such quantities that they reduce the reported horizontal visibility to less than 7 statute miles.

body of report. That portion of a METAR or SPECI report beginning with the type of report and ending with the altimeter setting.

broken layer. A cloud layer covering whose summation amount of sky cover is 5/8ths through 7/8ths.

calm. A condition when no motion of the air is detected.

candela. A unit of luminous intensity, equal to 1/60 of the luminous intensity of a square centimeter of a black body heated to 1773.5 degrees Celsius.

ceiling. The height above the earth's surface of the lowest layer that is reported as broken or overcast, or the vertical visibility into an indefinite ceiling.

ceiling light. A type of cloud-height indicator that uses a focused light to project vertically a narrow beam of light onto a cloud base.

ceilometer. A device used to evaluate the height of clouds or the vertical visibility into a

surface-based obscuration.

certified observer. An individual approved by designated Federal agencies to take surface observations approved for use in aircraft operations.

clear sky. The absence of sky cover.

cloud. A visible aggregate of minute water droplets or ice particles in the atmosphere above the Earth's surface.

cloud-air lightning (CA). Streaks of lightning which pass from a cloud to the air, but do not strike the ground.

cloud-cloud lightning (CC). Streaks of lightning reaching from one cloud to another.

cloud-ground lightning (CG). Lightning occurring between cloud and ground.

cloud height. The height of the base of a cloud or cloud layer above the surface of the earth.

cloud layer. An array of clouds whose bases are at approximately the same level.

cloud movement. The direction toward which a cloud is moving.

cloud type. A cloud form which is identified according to the WMO International Cloud Atlas.

contraction. A shortened form of a word, title, or phrase used for brevity.

Coordinated Universal Time (UTC). The time in the zero degree meridian time zone.

cumulonimbus. An exceptionally dense and vertically developed cloud, occurring either isolated or as a line or wall of clouds with separated upper portions. These clouds appear as mountains or huge towers, at least a part of the upper portions of which are usually smooth, fibrous, or striated, and almost flattened.

dew point. The temperature to which a given parcel of air must be cooled at constant pressure and constant water-vapor content in order for saturation to occur.

diamond dust. See ice crystals.

dissemination. The act of delivering a completed weather report to users.

drizzle. Fairly uniform precipitation composed exclusively of fine drops (diameter less than 0.02 inch or 0.5 mm) very close together. Drizzle appears to float while following air current, although unlike fog droplets, it falls to the ground.

dust. (see widespread dust).

duststorm. Severe weather condition characterized by strong winds and dust-filled air over an extensive area.

element. One of the basic conditions of the atmosphere discussed in this observing handbook (wind, visibility, runway visual range, weather, obscuration, sky condition, temperature and dewpoint, and pressure). See parameter.

few. A layer whose summation amount of sky cover is 1/8th through 2/8ths.

field elevation. The elevation above sea level of the highest point on any of the runways of the airport.

fog. A visible aggregate of minute water particles (droplets) which are based at the Earth's surface and reduce horizontal visibility to less than 5/8 statute mile and, unlike drizzle, it does not fall to the ground.

freezing. A descriptor, FZ, used to describe drizzle and/or rain that freezes on contact with the ground or exposed objects, and used also to describe fog that is composed of minute ice crystals.

freezing drizzle. Drizzle that freezes upon impact with the ground or exposed objects.

freezing fog. A suspension of numerous minute ice crystals in the air, or water droplets at temperatures below 0° Celsius, based at the Earth's surface, which reduces horizontal visibility; also called ice fog.

freezing precipitation. Any form of precipitation that freezes upon impact and forms a glaze on the ground or exposed objects.

freezing rain. Rain that freezes upon impact and forms a glaze on the ground or exposed objects.

frozen precipitation. Any form of precipitation that reaches the ground in solid form (snow, small hail and/or snow pellets, snow grains, hail, ice pellets, and ice crystals).

funnel cloud. A violent, rotating column of air which does not touch the surface, usually appended to a cumulonimbus cloud.

ground elevation. The official height of a weather station with reference to sea level when a field elevation has not been established. It is the height of the ground at the base of the ceilometer.

ground fog. See shallow fog.

gust. Rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls.

hail. Precipitation in the form of small balls or other pieces of ice falling separately or frozen together in irregular lumps.

haze. A suspension in the air of extremely small, dry particles invisible to the naked eye and sufficiently numerous to give the air an opalescent appearance.

horizon. The actual lower boundary of the observed sky or the upper outline of terrestrial objects, including nearby natural obstructions. It is the distant line along which the earth, or the water surface at sea, and the sky appear to meet.

ice crystals (diamond dust). A fall of unbranched ice crystals (snow crystals are branched) in the form of needles, columns, or plates.

ice fog. See freezing fog.

ice pellets. Precipitation of transparent or translucent pellets of ice, which are round or irregular, rarely conical, and have a diameter of 0.2 inch (5 mm) or less. There are two main types:

a. Hard grains of ice consisting of frozen raindrops, or largely melted and refrozen snowflakes.

b. Pellets of snow encased in a thin layer of ice which have formed from the freezing, either of droplets intercepted by the pellets or of water resulting from the partial melting of the pellets.

in-cloud lightning (IC). Lightning which takes place within the thunder cloud.

indefinite ceiling. The ceiling classification applied when the reported ceiling value represents the vertical visibility upward into surface-based obscuration.

intensity qualifier. Intensity qualifiers are used to describe whether a phenomenon is light (-), moderate (no symbol used), or heavy (+).

layer. An array of clouds aloft whose bases are at approximately the same level.
layer amount. The amount of sky covered by clouds at a given level above the Earth's surface.

layer height. The height of the bases of each reported layer above the surface or field elevation, or the vertical visibility into an indefinite ceiling.

lightning. The luminous phenomenon accompanying a sudden electrical discharge (see cloud-air lightning, cloud-cloud lightning, cloud-ground lightning, and in-cloud lightning).

liquid precipitation. Any form of precipitation that does not fall as frozen precipitation and does not freeze upon impact.

local dissemination. The transmission or delivery of a weather report to individuals or groups of users near the weather station.

Local Standard Time (LST). A time based on the geographic location of the station in one of the legally established time zones of the globe.

long-line dissemination (also long-line transmission). The transmission of a weather report by communication media to a group of users on a regional or national scale.

low drifting. A descriptor, DR, used to describe snow, sand, or dust raised to a height of less than 6 feet above the ground.

low drifting dust. Dust that is raised by the wind to less than 6 feet above the ground; visibility is not reduced below 7 statute miles at eye level although objects below this level may be veiled or hidden by the particles moving nearly horizontal to the ground.

low drifting sand. Sand that is raised by the wind to less than 6 feet above the ground; visibility is not reduced below 7 statute miles at eye level although objects below this level may be veiled or hidden by the particles moving nearly horizontal to the ground.

low drifting snow. Snow that is raised by the wind to less than 6 feet above the ground; visibility is not reduced below 7 statute miles at eye level although objects below this level may be veiled or hidden by the particles moving nearly horizontal to the ground.

may. A term used to indicate that a procedure or standard is optional.

METAR/SPECI. An evaluation of select weather elements from a point or points on or near the ground according to a set of procedures. It may include type of report, station identifier, date and time of report, a report modifier, wind, visibility, runway visual range, weather and obstructions to vision, sky condition, temperature, dew point, altimeter setting, and Remarks.

METAR/SPECI code. WMO code forms (FM 15-IX Ext. METAR and FM 16-IX Ext. SPECI, respectively) consisting of abbreviations, contractions, numbers, plain language, and symbols to provide a uniform means of disseminating surface weather reports.

mist. A hydrometer consisting of an aggregate of microscopic and more-or-less hygroscopic water droplets or ice crystals suspended in the atmosphere that reduces visibility to less than 7 statute miles but greater than or equal to 5/8 statute mile.

non-uniform sky condition. A localized sky condition which varies from that reported in the body of the report.

non-uniform visibility. A localized visibility which varies from that reported in the body of the report.

obscured sky. The condition when the entire sky is hidden by surface-based obscuration.

obscuration. Any aggregate of particles in contact with the earth's surface dense enough to be detected from the surface of the earth. Also, any phenomenon that reduces the horizontal visibility in the atmosphere.

observing location. The point or points from which an element is evaluated.

observing station. The point or points from which the various elements of the report are evaluated.

overcast. A layer of clouds whose summation amount of sky cover is 8/8ths.

parameter. A subset of the group of evaluations that constitute each element of an observation; e.g., sky condition is an element, sky cover and ceiling are parameters.

partial. A descriptor, PR, used only to report fog that covers part of the airport.

partial fog. Fog covering part of the station and which extends to at least 6 feet above the ground and apparent visibility in the fog is less than 5/8 statute miles. Visibility over parts of the station are less than or equal to 5/8 statute miles.

partial obscuration. The portion of the sky cover (including higher clouds, the moon, or stars) hidden by weather phenomena in contact with the surface.

patches. A descriptor, BC, used only to report fog that occurs in patches at the airport.

patches of fog. Fog covering part of the station.

precipitation. Any of the forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the ground.

precipitation discriminator. A sensor, or array of sensors, that differentiates between different types of precipitation (liquid, freezing, or frozen).

precipitation intensity. An indication of the rate at which precipitation is falling at the time of observation.

precipitation rate. The amount of water, liquid or solid, that reaches the ground in a specified period of time.

pressure. The force exerted by a column of air above the point of measurement.

prevailing visibility. The visibility that is considered representative of conditions at the station; the greatest distance that can be seen throughout at least half the horizon circle, not necessarily continuous.

rain. Rain comes in two forms. The first is in the form of drops larger than 0.02 inch (0.5mm). The second can have smaller drops, but unlike drizzle, they are widely separated.

remarks. Plain language added to the METAR/SPECI report, to include significant information not provided for in the body of the report.

rotor cloud. A turbulent cloud formation found in the lee of some large mountain barriers. The air in the cloud rotates around an axis parallel to the mountain range.

Runway Visual Range (RVR). An instrumentally derived value, based on standard calibrations, that represents the horizontal distance a pilot can see down the runway from the approach end.

sand. Loose particles of granular material.

sandstorm. Particles of sand ranging in diameter from 0.008 to 1 mm that are carried aloft by a strong wind. The sand particles are mostly confined to the lowest ten feet, and rarely rise more than fifty feet above the ground.

scattered. A layer whose summation amount of sky cover is 3/8ths through 4/8ths.

scheduled time of report. The time a scheduled report is required to be available for transmission.

sector visibility. The visibility in a specified direction that represents at least a 45 degree arc of the horizon circle.

shall. A term used to indicate that a procedure or practice is mandatory.

shallow. A descriptor, MI, used only to describe fog when the visibility at 6 feet above the ground is 5/8ths statute mile or more and the apparent visibility in the fog layer is less than 5/8ths statute mile.

should. A term used to indicate a procedure or practice is recommended.

shower. A descriptor, SH, used to qualify precipitation characterized by the suddenness with which it starts and stops, by the rapid changes of intensity, and usually by rapid changes in the appearance of the sky.

significant clouds. Cumulonimbus, cumulonimbus mammatus, towering cumulus, altocumulus castellanus, and standing lenticular or rotor clouds.

sky condition. The state of the sky in terms of such parameters as sky cover, layers and associated heights, ceiling, and cloud types.

sky cover. The amount of the sky that is covered by clouds or partial obscuration in contact with the surface.

small hail. See snow pellets.

smoke. A suspension in the air of small particles produced by combustion. A transition to haze may occur when smoke particles have traveled great distances (25 to 100 statute miles or more), the larger particles have settled out, and the remaining particles have become widely scattered through the atmosphere.

snow. Precipitation of snow crystals, mostly branched in the form of six-pointed stars.

snow grains. Precipitation of very small, white, opaque grains of ice; the solid equivalent of drizzle.

snow pellets. Precipitation of white, opaque grains of ice. The grains are round or sometimes conical. Diameters range from about 0.08 to 0.2 inch (2 to 5 mm).

spray. An ensemble of water droplets torn by the wind from an extensive body of water, generally from the crests of waves, and carried up into the air in such quantities that it reduces the horizontal visibility.

SPECI. A surface weather report taken to record a change in weather conditions that meets specified criteria or is otherwise considered to be significant. Also, an unscheduled, non-hourly observation taken for SAWRS 135 operations, having the same content as a METAR.

squall. A strong wind characterized by a sudden onset in which wind speed increases to at least 16 knots and is sustained at 22 knots or more for at least one minute.

APPENDIX C - TABLES

CONVERSION OF MILES PER HOUR TO KNOTS										
MPH	0	1	2	3	4	5	6	7	8	9
	KTS	KTS	KTS	KTS	KTS	KTS	KTS	KTS	KTS	KTS
0	0	1	2	3	3	4	5	6	7	8
10	9	10	10	11	12	13	14	15	16	17
20	17	18	19	20	21	22	23	23	24	25
30	26	27	28	29	30	30	31	32	33	34
40	35	36	36	37	38	39	40	41	42	43
50	43	44	45	46	47	48	49	50	50	51
60	52	53	54	55	56	56	57	58	59	60
70	61	62	63	63	64	65	66	67	68	69
80	70	70	71	72	73	74	75	76	76	77
90	78	79	80	81	82	83	83	84	85	86

CONVERSION OF KNOTS TO MILES PER HOUR										
KTS	0	1	2	3	4	5	6	7	8	9
	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH	MPH
0	0	1	2	3	5	6	7	8	9	10
10	12	13	14	15	16	17	18	20	21	22
20	23	24	25	26	28	29	30	31	32	33
30	35	36	37	38	39	40	41	43	44	45
40	46	47	48	49	51	52	53	54	55	56
50	58	59	60	61	62	63	64	66	67	68
60	69	70	71	72	74	75	76	77	78	79
70	81	82	83	84	85	86	87	89	90	91
80	92	93	94	96	97	98	99	100	101	102
90	104	105	106	107	108	109	110	112	113	114

REPORTABLE VISIBILITY VALUES				
0	5/8	1 5/8	4	12
1/16	3/4	1 3/4	5	13
1/8	7/8	1 7/8	6	14
3/16	1	2	7	15
1/4	1 1/8	2 1/4	8	20
5/16	1 1/4	2 1/2	9	25
3/8	1 3/8	2 3/4	10	30
1/2	1 1/2	3	11	35[a]

a. Further values in increments of 5 statute miles may be reported, e.g., 40, 45, 50, etc..

INTENSITY OF RAIN OR ICE PELLETS BASED ON RATE-OF-FALL	
Intensity	**Criteria**
Light	Up to 0.10 inch per hour; maximum 0.01 inch in 6 minutes.
Moderate	0.11 inch to 0.30 inch per hour; more than 0.01 inch to 0.03 inch in 6 minutes.
Heavy	More than 0.30 inch per hour; more than 0.03 inch in 6 minutes.

ESTIMATING INTENSITY OF RAIN	
Intensity	**Criteria**
Light	From scattered drops that, regardless of duration, do not completely wet an exposed surface up to a condition where individual drops are easily seen.
Moderate	Individual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces.
Heavy	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

ESTIMATING INTENSITY OF ICE PELLETS	
Intensity	**Criteria**
Light	Scattered pellets that do not completely cover an exposed surface regardless of duration. Visibility is not affected.
Moderate	Slow accumulation on ground. Visibility reduced by ice pellets to less than 7 statute miles.
Heavy	Rapid accumulation on ground. Visibility reduced by ice pellets to less than 3 statute miles.

INTENSITY OF SNOW OR DRIZZLE BASED ON VISIBILITY	
Intensity	**Criteria**
Light	Visibility > 1/2 mile.
Moderate	Visibility > 1/4 mile but ≤ 1/2 mile.
Heavy	Visibility ≤ 1/4 mile.

NOTATIONS FOR REPORTING PRESENT WEATHER				
QUALIFIER		**WEATHER PHENOMENA**		
INTENSITY OR PROXIMITY 1	**DESCRIPTOR 2**	**PRECIPITATION 3**	**OBSCURATION 4**	**OTHER 5**
− Light	**MI** Shallow	**DZ** Drizzle	**BR** Mist	**PO** Well-Developed Dust/Sand Whirls
Moderate[2]	**PR** Partial	**RA** Rain	**FG** Fog	
+ Heavy	**BC** Patches	**SN** Snow	**FU** Smoke	**SQ** Squalls
VC In the Vicinity[3]	**DR** Low Drifting	**SG** Snow Grains	**VA** Volcanic Ash	**FC**[4] Funnel Cloud(s) (Tornado, or Waterspout)
	BL Blowing	**IC** Ice Crystals	**DU** Widespread Dust	
	SH Shower(s)	**PE** Ice Pellets		**SS** Sandstorm
	TS Thunderstorm	**GR** Hail	**SA** Sand	**DS** Duststorm
	FZ Freezing	**GS** Small Hail and/or Snow Pellets	**HZ** Haze	
			PY Spray	

1. The weather groups shall be constructed by considering columns 1 to 5 in the table above in sequence, i.e., intensity, followed by description, followed by weather phenomena, e.g., heavy rain shower(s) is coded as +SHRA
2. To denote moderate intensity no entry or symbol is used.
3. See paragraphs 5.3.b and 5.4 for vicinity definitions.
4. Tornados and Waterspouts shall be coded as +FC.

SKY COVER EVALUATION		
Angle of Advancing or Receding Layer Edge	**Eighths of Sky Cover**	**Angular Elevation of Layer Surrounding Station**
0> to 50 degrees	1	0> to 10 degrees
51 to 68 degrees	2	11 to 17 degrees
69 to 82 degrees	3	18 to 24 degrees
83 to 98 degrees	4	25 to 32 degrees
99 to 112 degrees	5	33 to 41 degrees
113 to 129 degrees	6	42 to 53 degrees
130 to <179 degrees	7	54 to 89 degrees
180 degrees	8	90 degrees

CRITERIA FOR VARIABLE CEILING	
Ceiling (feet)	**Variation (feet)**
≤ 1,000	≥200
>1,000 and ≤2,000	≥400
>2,000 and <3,000	≥500

10-Gram Balloon Ascension Rates*
Nozzle Lift 45-Grams Helium

Time Minutes and Seconds	Reportable Height	Time Minutes and Seconds	Reportable Height
0:00 - 0:06	0	5:36 - 5:50	2600
0:07 - 0:17	100	5:51 - 6:04	2700
0:18 - 0:30	200	6:05 - 6:18	2800
0:31 - 0:42	300	6:19 - 6:32	2900
0:43 - 0:53	400	6:33 - 6:47	3000
0:54 - 1:06	500	6:48 - 7:01	3100
1:07 - 1:20	600	7:02 - 7:15	3200
1:21 - 1:32	700	7:16 - 7:30	3300
1:33 - 1:45	800	7:31 - 7:44	3400
1:46 - 1:58	900	7:45 - 7:58	3500
1:59 - 2:11	1000	7:59 - 8:12	3600
2:12 - 2:24	1100	8:13 - 8:27	3700
2:25 - 2:37	1200	8:28 - 8:41	3800
2:38 - 2:51	1300	8:42 - 8:55	3900
2:52 - 3:04	1400	8:56 - 9:10	4000
3:05 - 3:17	1500	9:11 - 9:24	4100
3:18 - 3:30	1600	9:25 - 9:38	4200
3:31 - 3:43	1700	9:39 - 9:52	4300
3:44 - 3:56	1800	9:53 - 10:07	4400
3:57 - 4:10	1900	10:08 - 10:21	4500
4:11 - 4:24	2000	10:22 - 10:35	4600
4:25 - 4:38	2100	10:36 - 10:50	4700
4:39 - 4:52	2200	10:51 - 11:04	4800
4:53 - 5:07	2300	11:05 - 11:18	4900
5:08 - 5:21	2400	11:19 - 12:01	5000
5:22 - 5:35	2500	12:02 - 12:02+70sec	**5500
		13:13 - 13:13+70sec	**6000
		etc.	

* Daytime Use Only
** Ascension rate above 5,000 feet is 500 feet per 70 seconds

30-Gram Balloon Ascension Rates* Nozzle Lift 139-Grams Helium					
Time Minutes and Seconds			Reportable Height	Time Minutes and Seconds	Reportable Height
0:00	-	0:04	0	3:53 - 4:01	2600
0:05	-	0:12	100	4:02 - 4:11	2700
0:13	-	0:20	200	4:12 - 4:21	2800
0:21	-	0:30	300	4:22 - 4:31	2900
0:31	-	0:38	400	4:32 - 4:40	3000
0:39	-	0:46	500	4:41 - 4:50	3100
0:47	-	0:55	600	4:51 - 5:00	3200
0:56	-	1:03	700	5:01 - 5:10	3300
1:04	-	1:12	800	5:11 - 5:20	3400
1:13	-	1:22	900	5:21 - 5:31	3500
1:23	-	1:31	1000	5:32 - 5:41	3600
1:32	-	1:40	1100	5:42 - 5:51	3700
1:41	-	1:50	1200	5:52 - 6:01	3800
1:51	-	1:59	1300	6:02 - 6:11	3900
2:00	-	2:08	1400	6:12 - 6:21	4000
2:09	-	2:17	1500	6:22 - 6:32	4100
2:18	-	2:27	1600	6:33 - 6:42	4200
2:28	-	2:36	1700	6:43 - 6:52	4300
2:37	-	2:45	1800	6:53 - 7:02	4400
2:46	-	2:54	1900	7:03 - 7:12	4500
2:55	-	3:03	2000	7:13 - 7:22	4600
3:04	-	3:13	2100	7:23 - 7:33	4700
3:14	-	3:23	2200	7:34 - 7:43	4800
3:24	-	3:32	2300	7:44 - 7:53	4900
3:33	-	3:42	2400	7:54 - 8:24	5000
3:43	-	3:52	2500	8:25 - 8:25+51sec	**5500
				9:17 - 9:17+51sec	**6000
				etc.	

* Daytime Use Only
** Ascension rate above 5,000 feet is 500 feet per 51 seconds

REPORTABLE CONTRACTIONS FOR SKY COVER		
Reportable Contraction	**Meaning**	**Summation Amount of Layer**
VV	Vertical Visibility	8/8
SKC	Clear	0
FEW[1]	Few	1/8 - 2/8
SCT	Scattered	3/8 - 4/8
BKN	Broken	5/8 - 7/8
OVC	Overcast	8/8

[1] Any layer amount less than 1/8 is reported as **FEW**.

INCREMENTS OF REPORTABLE VALUES OF SKY COVER HEIGHT	
Range of Height Values (feet)	**Reportable Increment (feet)**
≤5,000	To nearest 100
>5,000 but ≤10,000	To nearest 500
>10,000	To nearest 1,000

TYPE AND FREQUENCY OF LIGHTNING		
Type of Lightning		
Type	**Contraction**	**Definition**
Cloud-ground	CG	Lightning occurring between cloud and ground.
In-cloud	IC	Lightning which takes place within the thunder cloud.
Cloud-cloud	CC	Streaks of lightning reaching from one cloud to another.
Cloud-air	CA	Streaks of lightning which pass from a cloud to the air, but do not strike the ground.
Frequency of Lightning		
Frequency	**Contraction**	**Definition**
Occasional	OCNL	Less than 1 flash/minute.
Frequent	FRQ	About 1 to 6 flashes/minute.
Continuous	CONS	More than 6 flashes/minute.

WIND EQUIVALENT -- BEAUFORT SCALE				
Beaufort #	MPH	KTS	International Description	Specifications
0	<1	<1	Calm	Calm; smoke rises vertically.
1	1-3	1-3	Light Air	Direction of wind shown by smoke drift not by wind vanes.
2	4-7	4-6	Light Breeze	Wind felt on face; leaves rustle; vanes moved by wind.
3	8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag.
4	13-18	11-16	Moderate	Raises dust, loose paper; small branches moved.
5	19-24	17-21	Fresh	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	22-27	Strong	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Whole trees in motion; inconvenience felt walking against the wind.
8	39-46	34-40	Gale	Breaks twigs off trees; impedes progress.
9	47-54	41-47	Strong Gale	Slight structural damage occurs.
10	55-63	48-55	Storm	Trees uprooted; considerable damage occurs.
11	64-72	56-63	Violent Storm	Widespread damage.
12	73-82	64-71	Hurricane	

U.S. METAR/SPECI CODE FORMAT WITH REMARKS (SAWRS ONLY)	
METAR/SPECI_ CCCC_ YYGGggZ_COR_dddff(f)G$f_m f_m(f_m)$KT_$d_n d_n d_n V d_x d_x d_x$_ VVVVVSM_[$RD_R D_R/V_R V_R V_R V_R$FT or $RD_R D_R/V_n V_n V_n \overline{V}_n VV_x V_x \overline{V}_x V_x V_x$FT]_w'w'_[$N_s N_s N_s h_s h_s h_s$ or $VVh_s h_s h_s$ or SKC/CLR]_T'T'/T'dT'd_$AP_H P_H P_H P_H$_RMK_Manual and Plain Language	
Body of Report: PARAMETER	DESCRIPTION
Type of Report (METAR/SPECI)	METAR is the routine (scheduled) report. SPECI is the non-routine (unscheduled) weather report.
Station Identifier (CCCC)	ICAO station identifier. Consists of four alphabetic characters, e.g., KABC.
Date/Time (YYGGggZ)	Day of the month, followed by the actual time of the report or when the criteria for a SPECI is met or noted. Group ends with Z to indicate use of UTC. For example, 251456Z.
Report Modifier (COR)	COR indicates a correction to a previously disseminated report.
Wind (dddff(f)G$f_m f_m(f_m)$KT) ($d_n d_n d_n V d_x d_x d_x$)	True wind direction in tens of degrees using three digits. Speed is reported in whole knots (two or three digits). Gusts (G) are appended to the speed if required. Group ends with KT to indicate knots. For example, 23018G26KT. If wind direction varies by 60° or more and speed is > 6 knots a variable wind group is also reported, e.g., 180V250. Direction may be reported VRB (variable) if speed is ≤ 6 knots, e.g., VRB05KT. Calm winds are reported 00000KT.
Visibility (VVVVVSM)	Surface visibility reported in statute miles. A space divides whole miles and fractions. Group ends with SM to indicate statute miles. For example, 1 1/2SM.
Present Weather (w'w')	Present weather (other than obscurations) occurring at the station are reported in the body of the METAR/SPECI. Obscurations are reported if visibility < 7 miles. VA may be reported with any visibility. BCFG and PRFG may also be reported if visibility ≥ 7SM. Some present weather and qualifiers may be reported if In-the-Vicinity (not at point-of-observation), e.g., TS, FG, SH, PO, BLDU, BLSA, BLSN, SS and DS. Weather is reported in order of decreasing dominance. Maximum of three groups reported (precipitation included in one group; separate groups for other weather).
Sky Condition ($N_s N_s N_s h_s h_s h_s$ or $VVh_s h_s h_s$ or SKC)	Up to six layers can be reported; if no layers observed SKC is reported. Each layer contains the amount (FEW, SCT, BKN, OVC) immediately followed by the height using three digits, e.g., FEW015 BKN030. Any layer containing CB or TCU the contraction is appended to the layer height, e.g., FEW015TCU. All layers are considered opaque. Vertical visibility (VV) is reported in hundreds of feet for an indefinite ceiling, e.g., VV002. Surface obscuration reported using amount (FEW, SCT, BKN), followed by "000," e.g., SCT000; remark required.
Temperature/Dew Point (T'T'/$T'_d T'_d$)	Temperature and dew point are reported to the nearest whole degree Celsius using two digits, e.g., 17/13. Sub-zero values are prefixed with an M, e.g., 03/M02.
Altimeter ($AP_H P_H P_H P_H$)	Altimeter is prefixed with an A indicating altimeter in inches of mercury. Reported using four digits; tens, units, tenths, and hundredths of inches of mercury, e.g., A2990.
Remarks (RMK) -- Divided into Manual and Plain Language remarks. The following describes the order in which remarks are reported.	
Manual and Plain Language	Volcanic Eruption, Tornadic Activity (LOC/DIR_(MOV)), Wind Shift (WSHFT_(hh)mm_FROPA), Variable Prevailing Visibility (VIS_$v_n v_n v_n v_n v_n$V$v_x v_x v_x v_x v_x$), Sector Visibility (VIS_[DIR]_vvvvv), Lightning ([FREQ]_LTG[type]_[LOC]), Thunderstorm Location (TS_LOC_(MOV_DIR)), Hailstone Size (GR_[size]), Virga (VIRGA_(DIR)), Variable Ceiling Height (CIG_$h_n h_n \overline{h}_n V h_x h_x h_x$), Obscurations (w'w'_[$N_s N_s N_s$]($h_s h_s h_s$), Variable Sky Condition ($N_s N_s N_s (h_s h_s \overline{h}_s)$_V_Nubs$N_s N_s$), Significant Cloud Types, Aircraft Mishap (ACFT MSHP), Other Significant Information (LAST)
If an element or phenomena does not occur, is missing, or cannot be observed, the corresponding group and space are omitted (body and/or remarks) from that particular report.	

WIND CHILL CHART

MPH	TEMPERATURE (°F)																
Calm	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
	EQUIVALENT CHILL TEMPERATURE																
5	32	27	22	16	11	6	0	-5	-10	-15	-21	-26	-31	-36	-42	-47	-52
10	22	16	10	3	-3	-9	-15	-22	-27	-34	-40	-46	-52	-58	-64	-71	-77
15	16	9	2	-5	-11	-18	-25	-31	-38	-45	-51	-58	-65	-72	-78	-85	-92
20	12	4	-3	-10	-17	-24	-31	-39	-46	-53	-60	-67	-74	-81	-88	-95	-103
25	8	1	-7	-15	-22	-29	-36	-44	-51	-59	-66	-74	-81	-88	-96	-103	-110
30	6	-2	-10	-18	-25	-33	-41	-49	-56	-64	-71	-79	-86	-93	-101	-109	-116
35	4	-4	-12	-20	-27	-35	-43	-52	-58	-67	-74	-82	-89	-97	-105	-113	-120
40	3	-5	-13	-21	-29	-37	-45	-53	-60	-69	-76	-84	-92	-100	-107	-115	-123
45	2	-6	-14	-22	-30	-38	-46	-54	-62	-70	-78	-85	-93	-102	-109	-117	-125
	LITTLE DANGER				INCREASING DANGER (Flesh may freeze within 1 min.)						GREAT DANGER (Flesh may freeze within 30 seconds)						

To determine wind chill, find the outside air temperature on the top line, then read down the column to the measured wind speed (MPH - Miles Per Hour). For example: When the outside air temperature is 0°F, and the wind speed is 20 MPH, the rate of heat loss is equivalent to -39°F under calm* conditions. * - "Calm" as used in wind-chill determinations actually refers to the condition created by a person walking briskly (at 4 MPH) under calm wind conditions. Winds above 40 MPH have little additional effect.

HEAT INDEX CHART

Air Temperature (°F) and Relative Humidity (%) versus Apparent Temperature

	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
140°F	125																				
135°F	120	128																			
130°F	117	122	131																		
125°F	111	116	123	131	141																
120°F	107	111	116	123	130	139	148														
115°F	103	107	111	115	120	127	135	143	151												
110°F	99	102	105	108	112	117	123	130	137	143	150										
105°F	95	97	100	102	105	109	113	118	123	129	135	142	149								
100°F	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144						
95°F	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136				
90°F	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122		
85°F	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80°F	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86	87	88	89	91
75°F	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80
70°F	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

Precipitation		Intensity or Proximity: Light −	Moderate	Heavy +	Vicinity VC[2]	Descriptor[1]: Shallow MI	Partial PR	Patches BC	Low Drifting DR[3]	Blowing BL	Shower(s) SH	Thunder-storm TS[4]	Freezing FZ
Drizzle	**DZ**	−DZ	DZ	+DZ	-	-	-	-	-	-	-	-	FZDZ
Rain	**RA**	−RA	RA	+RA	-	-	-	-	-	-	SHRA	TSRA	FZRA
Snow	**SN**	−SN	SN	+SN	-	-	-	-	DRSN	BLSN	SHSN	TSSN	-
Snow Grains	**SG**	−SG	SG	+SG	-	-	-	-	-	-	-	-	-
Ice Crystals[5]	**IC**	-	IC	-	-	-	-	-	-	-	-	-	-
Ice Pellets	**PE**	−PE	PE	+PE	-	-	-	-	-	-	SHPE	TSPE	-

WEATHER PHENOMENA MATRIX

WX PHENOMENA		QUALIFIER											
Hail[5,6]	**GR**	-	GR	-	-	-	-	-	-	-	SHGR	TSGR	-
Small Hail[5,7]	**GS**	-	GS	-	-	-	-	-	-	-	SHGS	TSGS	-
Unknown	**UP**	Automated Stations Only - No				-	-	-	-	-	-	-	-
Thunderstorms, Showers, Freezing, and their Intensity or Proximity						-	-	-	-	-	-	-	-
TS	-	-	TS	-	VCTS[8]	-	-	-	-	-	-	-	-
TSRA	-	−TSRA	TSRA	+TSRA	-	-	-	-	-	-	-	-	-
TSSN	-	−TSSN	TSSN	+TSSN	-	-	-	-	-	-	-	-	-
TSPE	-	−TSPE	TSPE	+TSPE	-	-	-	-	-	-	-	-	-
TSGS	-	-	TSGS	-	-	-	-	-	-	-	-	-	-
TSGR	-	-	TSGR	-	-	-	-	-	-	-	-	-	-
SH	-	-	-	-	VCSH[9]	-	-	-	-	-	-	-	-
SHRA	-	−SHRA	SHRA	+SHRA	-	-	-	-	-	-	-	-	-
SHSN	-	−SHSN	SHSN	+SHSN	-	-	-	-	-	-	-	-	-
SHPE	-	−SHPE	SHPE	+SHPE	-	-	-	-	-	-	-	-	-
SHGR	-	-	SHGR	-	-	-	-	-	-	-	-	-	-
SHGS	-	-	SHGS	-	-	-	-	-	-	-	-	-	-
FZDZ	-	−FZDZ	FZDZ	+FZDZ	-	-	-	-	-	-	-	-	-
FZRA	-	−FZRA	FZRA	+FZRA	-	-	-	-	-	-	-	-	-
FZFG	-	-	FZFG	-	-	-	-	-	-	-	-	-	-
Obscurations		-	-	-	-	-	-	-	-	-	-	-	-
Mist[10]	**BR**	-	BR[10]	-	-	-	-	-	-	-	-	-	-
Fog[11]	**FG**	-	FG[11]	-	VCFG[12]	MIFG[13]	PRFG[14]	BCFG[15]	-	-	-	-	FZFG[16]
Smoke	**FU**	-	FU	-	-	-	-	-	-	-	-	-	-
Volcanic Ash[17]	**VA**	-	VA[17]	-	-	-	-	-	-	-	-	-	-
Widespread Dust	**DU**	-	DU	-	-	-	-	-	DRDU	BLDU	-	-	-
Sand	**SA**	-	SA	-	-	-	-	-	DRSA	BLSA	-	-	-
Haze	**HZ**	-	HZ	-	-	-	-	-	-	-	-	-	-
Spray	**PY**	-	-	-	-	-	-	-	-	BLPY	-	-	-
Blowing Phenomena		-	-	-	-	-	-	-	-	-	-	-	-
BLSN[18]	-	-	BLSN	-	VCBLS	-	-	-	-	BLSN	-	-	-
BLSA	-	-	BLSA	-	VCBLS	-	-	-	-	BLSA	-	-	-
BLDU	-	-	BLDU	-	VCBLD	-	-	-	-	BLDU	-	-	-
Other		-	-	-	-	-	-	-	-	-	-	-	-

Sand/Dust Whirls	**PO**	-	PO	-	VCPO	-	-	-	-	-	-	-	-
Squalls[19]	**SQ**	-	SQ	-	-	-	-	-	-	-	-	-	-
Funnel Cloud	**FC**	-	FC	-	-	-	-	-	-	-	-	-	-
Tornado/Waterspout[20]	**+FC**	-	-	+FC	-	-	-	-	-	-	-	-	-
Sandstorm[21]	**SS**	-	SS	+SS	VCSS	-	-	-	-	-	-	-	-
Duststorm[22]	**DS**	-	DS	+DS	VCDS	-	-	-	-	-	-	-	-

FOOTNOTES ON REVERSE SIDE

Footnotes for Weather Phenomena Matrix

1 - Only 1 descriptor shall be included for each weather phenomena group, e.g., BCFG. Only 2 exceptions exist to this rule: VCSH and VCTS.

2 - Vicinity is defined as >0SM to 10SM of the point of observation for precipitation. Other than precipitation (VCFG, VCBLSN, VCBLSA, VCBLDU, VCPO, VCSS, VCDS), vicinity is 5SM to 10SM.

3 - Raised by wind to less than 6 feet above the ground.

4 - TS may be reported by itself if no precipitation is associated with the thunderstorm.

5 - No intensity is ever given to hail (GR/GS[snow pellets]) or ice crystals (IC).

6 - Largest hailstone observed has a diameter of 1/4 inch or more.

7 - Hailstone diameter is less than 1/4 inch. No remark is entered for hailstone size.

8 - VCTS shall only be used by automated stations. If thunder is heard, TS shall be reported.

9 - Showers (SH), when associated with the indicator VC, the type and intensity of the showery precipitation shall not be specified, i.e., +VCSHRA is not allowed; only VCSH would be reported. VCSH shall be used to report any type of precipitation not at point of observation, but >0 to 10SM.

10 - BR (mist) shall only be used when the visibility is at least 5/8SM, but not more than 6SM.

11 - For FG (fog) to be reported <u>without</u> the qualifiers VC[12], MI[13], PR[14], or BC[15] the visibility shall be less than 5/8 SM.

12 - VC is used to report any type of fog observed in the vicinity (5-10SM) of the station.

13 - MIFG (shallow fog) to be reported, the visibility at 6 feet above ground level shall be 5/8SM or more and the apparent visibility in the fog layer shall be less than 5/8SM.

14 - PRFG (partial fog) indicates that a substantial part of the station is covered by fog while the remainder is clear of fog.

15 - BCFG (patches fog) indicates that patches of fog randomly cover the station.

16 - FZFG is <u>any</u> fog consisting predominately of water droplets at temperatures below 0°C,

whether it is depositing rime or not.

17 - Volcanic Ash is always reported in the body of the METAR/SPECI when present. Visibility is not a factor.

18 - SN BLSN indicates snow falling from clouds with blowing snow occurring. If the observer cannot determine whether or not snow is also falling from clouds, then only BLSN shall be reported.

19 - SQ (squall) is a sudden increase in wind speed of at least 16 knots, the speed rising to 22 knots or more and lasting for at least one minute.

20 - Tornadoes and Waterspouts shall be reported using the indicator "+", i.e., +FC.

21 - SS (sandstorm) reported if the visibility is ≥ 5/16SM and ≤ 5/8SM. Report +SS if the visibility is < 5/16SM.

22 - DS (duststorm) reported if the visibility is ≥ 5/16SM and ≤ 5/8SM. Report +DS if the visibility is < 5/16SM.

No more than three weather groups shall be used to report weather phenomena at or near the station. If more than one significant weather phenomena is observed, separate weather phenomena groups shall be included in the report. If more than one form of precipitation is observed, the appropriate abbreviations shall be combined in a single group with the predominant type of precipitation being reported first. In such a single group, the intensity shall refer to the total precipitation and be reported with one or no indicator as appropriate, e.g., −RASN FG HZ.

FAHRENHEIT TO CELSIUS

°F	.0 °C	.1 °C	.2 °C	.3 °C	.4 °C	.5 °C	.6 °C	.7 °C	.8 °C	.9 °C
+130	+54.4	+54.5	+54.6	+54.6	+54.7	+54.7	+54.8	+54.8	+54.9	+54.9
129	53.9	53.9	54.0	54.1	54.1	54.2	54.2	54.3	54.3	54.4
128	53.3	53.4	53.4	53.5	53.6	53.6	53.7	53.7	53.8	53.8
127	52.8	52.8	52.9	52.9	53.0	53.1	53.1	53.2	53.2	53.3
126	52.2	52.3	52.3	52.4	52.4	52.5	52.6	52.6	52.7	52.7
+125	+51.7	+51.7	+51.8	+51.8	+51.9	+51.9	+52.0	+52.1	+52.1	+52.2
124	51.1	51.2	51.2	51.3	51.3	51.4	51.4	51.5	51.6	51.6
123	50.6	50.6	50.7	50.7	50.8	50.8	50.9	50.9	51.0	51.1
122	50.0	50.1	50.1	50.2	50.2	50.3	50.3	50.4	50.4	50.5
121	49.4	49.5	49.6	49.6	49.7	49.7	49.8	49.8	49.9	49.9
+120	+48.9	+48.9	+49.0	-49.1	-49.1	+49.2	+49.2	-49.3	+49.3	+49.4
119	48.3	48.4	48.4	48.5	48.6	48.6	48.7	48.7	48.8	48.8
118	47.8	47.8	47.9	47.9	48.0	48.1	48.1	48.2	48.2	48.3
117	47.2	47.3	47.3	47.4	47.4	47.5	47.6	47.6	47.7	47.7
116	46.7	46.7	46.8	46.8	46.9	46.9	47.0	47.1	47.1	47.2
+115	+46.1	+46.2	+46.2	-46.3	+46.3	+46.4	+46.4	+46.5	+46.6	+46.6
114	45.6	45.6	45.7	45.7	45.8	45.8	45.9	45.9	46.0	46.1
113	45.0	45.1	45.1	45.2	45.2	45.3	45.3	45.4	45.4	45.5
112	44.4	44.5	44.6	44.6	44.7	44.7	44.8	44.8	44.9	44.9
111	43.9	43.9	44.0	44.1	44.1	44.2	44.2	44.3	44.3	44.4
+110	+43.3	+43.4	+43.4	+43.5	+43.6	+43.6	+43.7	+43.7	+43.8	+43.8
109	42.8	42.8	42.9	42.9	43.0	43.1	43.1	43.2	43.2	43.3
108	42.2	42.3	42.3	42.4	42.4	42.5	42.6	42.6	42.7	42.7
107	41.7	41.7	41.8	41.8	41.9	41.9	42.0	42.1	42.1	42.2
106	41.1	41.2	41.2	41.3	41.3	41.4	41.4	41.5	41.6	41.6
+105	+40.6	+40.6	+40.7	+40.7	+40.8	+40.8	+40.9	+40.9	+41.0	+41.1
104	40.0	40.1	40.1	40.2	40.2	40.3	40.3	40.4	40.4	40.5
103	39.4	39.5	39.6	39.6	39.7	39.7	39.8	39.8	39.9	39.9
102	38.9	38.9	39.0	39.1	39.1	39.2	39.2	39.3	39.3	39.4
101	38.3	38.4	38.4	38.5	38.6	38.6	38.7	38.7	38.8	38.8
+100	+37.8	+37.8	+37.9	+37.9	+38.0	+38.1	+38.1	+38.2	+38.2	+38.3
99	37.2	37.3	37.3	37.4	37.4	37.5	37.6	37.6	37.7	37.7
98	36.7	36.7	36.8	36.8	36.9	36.9	37.0	37.1	37.1	37.2
97	36.1	36.2	36.2	36.3	36.3	36.4	36.4	36.5	36.6	36.6
96	35.6	35.6	35.7	35.7	35.8	35.8	35.9	35.9	36.0	36.1
+95	+35.0	+35.1	+35.1	+35.2	+35.2	+35.3	+35.3	+35.4	+35.4	+35.5
94	34.4	34.5	34.6	34.6	34.7	34.7	34.8	34.8	34.9	34.9
93	33.9	33.9	34.0	34.1	34.1	34.2	34.2	34.3	34.3	34.4
92	33.3	33.4	33.4	33.5	33.6	33.6	33.7	33.7	33.8	33.8
91	32.8	32.8	32.9	32.9	33.0	33.1	33.1	33.2	33.2	33.3
+90	+32.2	+32.3	+32.3	+32.4	32.4	+32.5	+32.6	+32.6	+32.7	+32.7
89	31.7	31.7	31.8	31.8	31.9	31.9	32.0	32.1	32.1	32.2
88	31.1	31.2	31.2	31.3	31.3	31.4	31.4	31.5	31.6	31.6
87	30.6	30.6	30.7	30.7	30.8	30.8	30.9	30.9	31.0	31.1
86	30.0	30.1	30.1	30.2	30.2	30.3	30.3	30.4	30.4	30.5
+85	+29.4	+29.5	+29.6	+29.6	+29.7	+29.7	+29.8	+29.8	+29.9	+29.9
84	28.9	28.9	29.0	29.1	29.1	29.2	29.2	29.3	29.3	29.4
83	28.3	28.4	28.4	28.5	28.6	28.6	28.7	28.7	28.8	28.8
82	27.8	27.8	27.9	27.9	28.0	28.1	28.1	28.2	28.2	28.3
81	27.2	27.3	27.3	27.4	27.4	27.5	27.6	27.6	27.7	27.7

°F	.0 °C	.1 °C	.2 °C	.3 °C	.4 °C	.5 °C	.6 °C	.7 °C	.8 °C	.9 °C
+80	+26.7	+26.7	+26.8	+26.8	+26.9	+26.9	-27.0	+27.1	+27.1	+27.2
79	26.1	26.2	26.2	26.3	26.3	26.4	26.4	26.5	26.6	26.6
78	25.6	25.6	25.7	25.7	25.8	25.8	25.9	25.9	26.0	26.1
77	25.0	25.1	25.1	25.2	25.2	25.3	25.3	25.4	25.4	25.5
76	24.4	24.5	24.6	24.6	24.7	24.7	24.8	24.8	24.9	24.9
+75	+23.9	+23.9	+24.0	+24.1	+24.1	+24.2	-24.2	+24.3	+24.3	+24.4
74	23.3	23.4	23.4	23.5	23.6	23.6	23.7	23.7	23.8	23.8
73	22.8	22.8	22.9	22.9	23.0	23.1	23.1	23.2	23.2	23.3
72	22.2	22.3	22.3	22.4	22.4	22.5	22.6	22.6	22.7	22.7
71	21.7	21.7	21.8	21.8	21.9	21.9	22.0	22.1	22.1	22.2
+70	+21.1	+21.2	+21.2	+21.3	+21.3	+21.4	+21.4	+21.5	+21.6	+21.6
69	20.6	20.6	20.7	20.7	20.8	20.8	20.9	20.9	21.0	21.1
68	20.0	20.1	20.1	20.2	20.2	20.3	20.3	20.4	20.4	20.5
67	19.4	19.5	19.6	19.6	19.7	19.7	19.8	19.8	19.9	19.9
66	18.9	18.9	19.0	19.1	19.1	19.2	19.2	19.3	19.3	19.4
+65	+18.3	+18.4	+18.4	+18.5	+18.6	+18.6	+18.7	+18.7	+18.8	+18.8
64	17.8	17.8	17.9	17.9	18.0	18.1	18.1	18.2	18.2	18.3
63	17.2	17.3	17.3	17.4	17.4	17.5	17.6	17.6	17.7	17.7
62	16.7	16.7	16.8	16.8	16.9	16.9	17.0	17.1	17.1	17.2
61	16.1	16.2	16.2	16.3	16.3	16.4	16.4	16.5	16.6	16.6
+60	+15.6	+15.6	+15.7	+15.7	+15.8	+15.8	+15.9	+15.9	+16.0	+16.1
59	15.0	15.1	15.1	15.2	15.2	15.3	15.3	15.4	15.4	15.5
58	14.4	14.5	14.6	14.6	14.7	14.7	14.8	14.8	14.9	14.9
57	13.9	13.9	14.0	14.1	14.1	14.2	14.2	14.3	14.3	14.4
56	13.3	13.4	13.4	13.5	13.6	13.6	13.7	13.7	13.8	13.8
+55	+12.8	+12.8	+12.9	+12.9	+13.0	+13.1	+13.1	+13.2	+13.2	+13.3
54	12.2	12.3	12.3	12.4	12.4	12.5	12.6	12.6	12.7	12.7
53	11.7	11.7	11.8	11.8	11.9	11.9	12.0	12.1	12.1	12.2
52	11.1	11.2	11.2	11.3	11.3	11.4	11.4	11.5	11.6	11.6
51	10.6	10.6	10.7	10.7	10.8	10.8	10.9	10.9	11.0	11.1
+50	+10.0	+10.1	+10.1	+10.2	+10.2	+10.3	+10.3	+10.4	+10.4	+10.5
49	9.4	9.5	9.6	9.6	9.7	9.7	9.8	9.8	9.9	9.9
48	8.9	8.9	9.0	9.1	9.1	9.2	9.2	9.3	9.3	9.4
47	8.3	8.4	8.4	8.5	8.6	8.6	8.7	8.7	8.8	8.8
46	7.8	7.8	7.9	7.9	8.0	8.1	8.1	8.2	8.2	8.3
+45	+7.2	+7.3	+7.3	+7.4	+7.4	+7.5	+7.6	+7.6	+7.7	+7.7
44	6.7	6.7	6.8	6.8	6.9	6.9	7.0	7.1	7.1	7.2
43	6.1	6.2	6.2	6.3	6.3	6.4	6.4	6.5	6.6	6.6
42	5.6	5.6	5.7	5.7	5.8	5.8	5.9	5.9	6.0	6.1
41	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.4	5.4	5.5
+40	+4.4	+4.5	+4.6	+4.6	+4.7	+4.7	+4.8	+4.8	+4.9	+4.9
39	3.9	3.9	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.4
38	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.7	3.8	3.8
37	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3
36	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.7
+35	+1.7	+1.7	+1.8	+1.8	+1.9	+1.9	+2.0	+2.1	+2.1	+2.2
34	+1.1	+1.2	+1.2	+1.3	+1.3	+1.4	+1.4	+1.5	+1.6	+1.6
33	+0.6	+0.6	+0.7	+0.7	+0.8	+0.8	+0.9	+0.9	+1.0	+1.1
32	0.0	+0.1	+0.1	+0.2	+0.2	+0.3	+0.3	+0.4	+0.4	+0.5
31	-0.6	-0.5	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.1	-0.1

FAHRENHEIT TO CELSIUS

°F	.0 °C	.1 °C	.2 °C	.3 °C	.4 °C	.5 °C	.6 °C	.7 °C	.8 °C	.9 °C
+30	-1.1	-1.1	-1.0	-0.9	-0.9	-0.8	-0.8	-0.7	-0.7	-0.6
29	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.2	1.2
28	2.2	2.2	2.1	2.1	2.0	1.9	1.9	1.8	1.8	1.7
27	2.8	2.7	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.3
26	3.3	3.3	3.2	3.2	3.1	3.1	3.0	2.9	2.9	2.8
+25	-3.9	-3.8	-3.8	-3.7	-3.7	-3.6	-3.6	-3.5	-3.4	-3.4
24	4.4	4.4	4.3	4.3	4.2	4.2	4.1	4.1	4.0	3.9
23	5.0	4.9	4.9	4.8	4.8	4.7	4.7	4.6	4.6	4.5
22	5.6	5.5	5.4	5.4	5.3	5.3	5.2	5.2	5.1	5.1
21	6.1	6.1	6.0	5.9	5.9	5.8	5.8	5.7	5.7	5.6
+20	-6.7	-6.6	-6.6	-6.5	-6.4	-6.4	-6.3	-6.3	-6.2	-6.2
19	7.2	7.2	7.1	7.1	7.0	6.9	6.9	6.8	6.8	6.7
18	7.8	7.7	7.7	7.6	7.6	7.5	7.4	7.4	7.3	7.3
17	8.3	8.3	8.2	8.2	8.1	8.1	8.0	7.9	7.9	7.8
16	8.9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4
+15	-9.4	-9.4	-9.3	-9.3	-9.2	-9.2	-9.1	-9.1	-9.0	-8.9
14	10.0	9.9	9.9	9.8	9.8	9.7	9.7	9.6	9.6	9.5
13	10.6	10.5	10.4	10.4	10.3	10.3	10.2	10.2	10.1	10.1
12	11.1	11.1	11.0	10.9	10.9	10.8	10.8	10.7	10.7	10.6
11	11.7	11.6	11.6	11.5	11.4	11.4	11.3	11.3	11.2	11.2
+10	-12.2	-12.2	-12.1	-12.1	-12.0	-11.9	-11.9	-11.8	-11.8	-11.7
9	12.8	12.7	12.7	12.6	12.6	12.5	12.4	12.4	12.3	12.3
8	13.3	13.3	13.2	13.2	13.1	13.1	13.0	12.9	12.9	12.8
7	13.9	13.8	13.8	13.7	13.7	13.6	13.6	13.5	13.4	13.4
6	14.4	14.4	14.3	14.3	14.2	14.2	14.1	14.1	14.0	13.9
+5	-15.0	-14.9	-14.9	-14.8	-14.8	-14.7	-14.7	-14.6	-14.6	-14.5
4	15.6	15.5	15.4	15.4	15.3	15.3	15.2	15.2	15.1	15.1
3	16.1	16.1	16.0	15.9	15.9	15.8	15.8	15.7	15.7	15.6
2	16.7	16.6	16.6	16.5	16.4	16.4	16.3	16.3	16.2	16.2
1	17.2	17.2	17.1	17.1	17.0	16.9	16.9	16.8	16.8	16.7
+0	17.8	17.7	17.7	17.6	17.6	17.5	17.4	17.4	17.3	17.3
-0	-17.8	-17.8	-17.9	-17.9	-18.0	-18.1	-18.1	-18.2	-18.2	-18.3
1	18.3	18.4	18.4	18.5	18.6	18.6	18.7	18.7	18.8	18.8
2	18.9	18.9	19.0	19.1	19.1	19.2	19.2	19.3	19.3	19.4
3	19.4	19.5	19.6	19.6	19.7	19.7	19.8	19.8	19.9	19.9
4	20.0	20.1	20.1	20.2	20.2	20.3	20.3	20.4	20.4	20.5
-5	-20.6	-20.6	-20.7	-20.7	-20.8	-20.8	-20.9	-20.9	-21.0	-21.1
6	21.1	21.2	21.2	21.3	21.3	21.4	21.4	21.5	21.6	21.6
7	21.7	21.7	21.8	21.8	21.9	21.9	22.0	22.1	22.1	22.2
8	22.2	22.3	22.3	22.4	22.4	22.5	22.6	22.6	22.7	22.7
9	22.8	22.8	22.9	22.9	23.0	23.1	23.1	23.2	23.2	23.3
-10	-23.3	-23.4	-23.4	-23.5	-23.6	-23.6	-23.7	-23.7	-23.8	-23.8
11	23.9	23.9	24.0	24.1	24.1	24.2	24.2	24.3	24.3	24.4
12	24.4	24.5	24.6	24.6	24.7	24.7	24.8	24.8	24.9	24.9
13	25.0	25.1	25.1	25.2	25.2	25.3	25.3	25.4	25.4	25.5
14	25.6	25.6	25.7	25.7	25.8	25.8	25.9	25.9	26.0	26.1
-15	-26.1	-26.2	-26.2	-26.3	-26.3	-26.4	-26.4	-26.5	-26.6	-26.6
16	26.7	26.7	26.8	26.8	26.9	26.9	27.0	27.1	27.1	27.2
17	27.2	27.3	27.3	27.4	27.4	27.5	27.6	27.6	27.7	27.7
18	27.8	27.8	27.9	27.9	28.0	28.1	28.1	28.2	28.2	28.3
19	28.3	28.4	28.4	28.5	28.6	28.6	28.7	28.7	28.8	28.8
-20	-28.9	-28.9	-29.0	-29.1	-29.1	-29.2	-29.2	-29.3	-29.3	-29.4
21	29.4	29.5	29.6	29.6	29.7	29.7	29.8	29.8	29.9	29.9
22	30.0	30.1	30.1	30.2	30.2	30.3	30.3	30.4	30.4	30.5
23	30.6	30.6	30.7	30.7	30.8	30.8	30.9	30.9	31.0	31.1
24	31.1	31.2	31.2	31.3	31.3	31.4	31.4	31.5	31.6	31.6

°F	.0 °C	.1 °C	.2 °C	.3 °C	.4 °C	.5 °C	.6 °C	.7 °C	.8 °C	.9 °C
-25	-31.7	-31.7	-31.8	-31.8	-31.9	-31.9	-32.0	-32.1	-32.1	-32.2
26	32.2	32.3	32.3	32.4	32.4	32.5	32.6	32.6	32.7	32.7
27	32.8	32.8	32.9	32.9	33.0	33.1	33.1	33.2	33.2	33.3
28	33.3	33.4	33.4	33.5	33.6	33.6	33.7	33.7	33.8	33.8
29	33.9	33.9	34.0	34.1	34.1	34.2	34.2	34.3	34.3	34.4
-30	-34.4	-34.5	-34.6	-34.6	-34.7	-34.7	-34.8	-34.8	-34.9	-34.9
31	35.0	35.1	35.1	35.2	35.2	35.3	35.3	35.4	35.4	35.5
32	35.6	35.6	35.7	35.7	35.8	35.8	35.9	35.9	36.0	36.1
33	36.1	36.2	36.2	36.3	36.3	36.4	36.4	36.5	36.6	36.6
34	36.7	36.7	36.8	36.8	36.9	36.9	37.0	37.1	37.1	37.2
-35	-37.2	-37.3	-37.3	-37.4	-37.4	-37.5	-37.6	-37.1	-37.7	-37.7
36	37.8	37.8	37.9	37.9	38.0	38.1	38.1	38.2	38.2	38.3
37	38.3	38.4	38.4	38.5	38.6	38.6	38.7	38.7	38.8	38.8
38	38.9	38.9	39.0	39.1	39.1	39.2	39.2	39.3	39.3	39.4
39	39.4	39.5	39.6	39.6	39.7	39.7	39.8	39.8	39.9	39.9
-40	-40.0	-40.1	-40.1	-40.2	-40.2	-40.3	-40.3	-40.4	-40.4	-40.5
41	40.6	40.6	40.7	40.7	40.8	40.8	40.9	40.9	41.0	41.1
42	41.1	41.2	41.2	41.3	41.3	41.4	41.4	41.5	41.6	41.6
43	41.7	41.7	41.8	41.8	41.9	41.9	42.0	42.1	42.1	42.2
44	42.2	42.3	42.3	42.4	42.4	42.5	42.6	42.6	42.7	42.7
-45	-42.8	-42.8	-42.9	-42.9	-43.0	-43.1	-43.1	-43.2	-43.2	-43.3
46	43.3	43.4	43.4	43.5	43.6	43.6	43.7	43.7	43.8	43.8
47	43.9	43.9	44.0	44.1	44.1	44.2	44.2	44.3	44.3	44.4
48	44.4	44.5	44.6	44.6	44.7	44.7	44.8	44.8	44.9	44.9
49	45.0	45.1	45.1	45.2	45.2	45.3	45.3	45.4	45.4	45.5
-50	-45.6	-45.6	-45.7	-45.7	-45.8	-45.8	-45.9	-45.9	-46.0	-46.1
51	46.1	46.2	46.2	46.3	46.3	46.4	46.4	46.5	46.6	46.6
52	46.7	46.7	46.8	46.8	46.9	46.9	47.0	47.1	47.1	47.2
53	47.2	47.3	47.3	47.4	47.4	47.5	47.6	47.6	47.7	47.7
54	47.8	47.8	47.9	47.9	48.0	48.1	48.1	48.2	48.2	48.3
-55	-48.3	-48.4	-48.4	-48.5	-48.6	-48.6	-48.7	-48.7	-48.8	-48.8
56	48.9	48.9	49.0	49.1	49.1	49.2	49.2	49.3	49.3	49.4
57	49.4	49.5	49.6	49.6	49.7	49.7	49.8	49.8	49.9	49.9
58	50.0	50.1	50.1	50.2	50.2	50.3	50.3	50.4	50.4	50.5
59	50.6	50.6	50.7	50.7	50.8	50.8	50.9	50.9	51.0	51.1
-60	-51.1	-51.2	-51.2	-51.3	-51.3	-51.4	-51.4	-51.5	-51.6	-51.6
61	51.7	51.7	51.8	51.8	51.9	51.9	52.0	52.1	52.1	52.2
62	52.2	52.3	52.3	52.4	52.4	52.5	52.6	52.6	52.7	52.7
63	52.8	52.8	52.9	52.9	53.0	53.1	53.1	53.2	53.2	53.3
64	53.3	53.4	53.4	53.5	53.6	53.6	53.7	53.7	53.8	53.8
-65	-53.9	-53.9	-54.0	-54.1	-54.1	-54.2	-54.2	-54.3	-54.3	-54.4
66	54.4	54.5	54.6	54.6	54.7	54.7	54.8	54.8	54.9	54.9
67	55.0	55.1	55.1	55.2	55.2	55.3	55.3	55.4	55.4	55.5
68	55.6	55.6	55.7	55.7	55.8	55.8	55.9	55.9	56.0	56.1
69	56.1	56.2	56.2	56.3	56.3	56.4	56.4	56.5	56.6	56.6
-70	-56.7	-56.7	-56.8	-56.8	-56.9	-56.9	-57.0	-57.1	-57.1	-57.2
71	57.2	57.3	57.3	57.4	57.4	57.5	57.6	57.6	57.7	57.7
72	57.8	57.8	57.9	57.9	58.0	58.1	58.1	58.2	58.2	58.3
73	58.3	58.4	58.4	58.5	58.6	58.6	58.7	58.7	58.8	58.8
74	58.9	58.9	59.0	59.1	59.1	59.2	59.2	59.3	59.3	59.4
-75	-59.4	-59.5	-59.6	-59.6	-59.7	-59.7	-59.8	-59.8	-59.9	-59.9
76	60.0	60.1	60.1	60.2	60.2	60.3	60.3	60.4	60.4	60.5
77	60.6	60.6	60.7	60.7	60.8	60.8	60.9	60.9	61.0	61.1
78	61.1	61.2	61.2	61.3	61.3	61.4	61.4	61.5	61.6	61.6
79	61.7	61.7	61.8	61.8	61.9	61.9	62.0	62.1	62.1	62.2

TENTH OF DEGREES CELSIUS TO WHOLE DEGREES FAHRENHEIT

°C	.0 °F	.1 °F	.2 °F	.3 °F	.4 °F	.5 °F	.6 °F	.7 °F	.8 °F	.9 °F
+55	+131	+131	+131	+132	+132	+132	+132	+132	+132	+133
54	129	129	130	130	130	130	130	130	131	131
53	127	128	128	128	128	128	128	129	129	129
52	125	126	126	126	126	127	127	127	127	127
51	123	124	124	124	125	125	125	125	125	125
+50	+122	+122	+122	+123	+123	+123	+123	+123	+123	+124
49	120	120	121	121	121	121	121	121	122	122
48	118	119	119	119	119	119	119	120	120	120
47	117	117	117	117	117	118	118	118	118	118
46	115	115	115	115	116	116	116	116	116	116
+45	+113	+113	+113	+114	+114	+114	+114	+114	+114	+115
44	111	111	112	112	112	112	112	112	113	113
43	109	110	110	110	110	110	110	111	111	111
42	108	108	108	108	108	109	109	109	109	109
41	106	106	106	106	107	107	107	107	107	107
+40	+104	+104	+104	+105	+105	+105	+105	+105	+105	+106
39	102	102	103	103	103	103	103	103	104	104
38	100	101	101	101	101	101	101	102	102	102
37	99	99	99	99	99	100	100	100	100	100
36	97	97	97	97	98	98	98	98	98	98
+35	+95	+95	+95	+96	+96	+96	+96	+96	+96	+97
34	93	93	94	94	94	94	94	94	95	95
33	91	92	92	92	92	92	92	93	93	93
32	90	90	90	90	90	91	91	91	91	91
31	88	88	88	88	89	89	89	89	89	89
+30	+86	+86	+86	+87	+87	+87	+87	+87	+87	+88
29	84	84	85	85	85	85	85	85	86	86
28	82	83	83	83	83	83	83	84	84	84
27	81	81	81	81	81	82	82	82	82	82
26	79	79	79	79	80	80	80	80	80	80
+25	+77	+77	+77	+78	+78	+78	+78	+78	+78	+79
24	75	75	76	76	76	76	76	76	77	77
23	73	74	74	74	74	74	74	75	75	75
22	72	72	72	72	72	73	73	73	73	73
21	70	70	70	70	71	71	71	71	71	71
+20	+68	+68	+68	+69	+69	+69	+69	+69	+69	+70
19	66	66	67	67	67	67	67	67	68	68
18	64	65	65	65	65	65	65	66	66	66
17	63	63	63	63	63	64	64	64	64	64
16	61	61	61	61	62	62	62	62	62	62
+15	+59	+59	+59	+60	60	+60	+60	+60	+60	+61
14	57	57	58	58	58	58	58	58	59	59
13	55	56	56	56	56	56	56	57	57	57
12	54	54	54	54	54	55	55	55	55	55
11	52	52	52	52	53	53	53	53	53	53
+10	+50	+50	+50	+51	+51	+51	+51	+51	+51	+52
9	48	48	49	49	49	49	49	50	50	50
8	46	47	47	47	47	47	47	48	48	48
7	45	45	45	45	45	46	46	46	46	46
6	43	43	43	43	44	44	44	44	44	44
+5	+41	+41	+41	+42	+42	+42	+42	+42	+42	+43
4	39	39	40	40	40	40	40	40	41	41
3	37	38	38	38	38	38	38	39	39	39
2	36	36	36	36	36	37	37	37	37	37
1	34	34	34	34	35	35	35	35	35	35
+0	+32	+32	+32	+33	+33	+33	+33	+33	+33	+34
-0	+32	+32	+32	+31	+31	+31	+31	+31	+31	+30

°C	.0 °F	.1 °F	.2 °F	.3 °F	.4 °F	.5 °F	.6 °F	.7 °F	.8 °F	.9 °F
-0	+32	+32	+32	+31	+31	+31	+31	+31	+31	+30
1	30	30	30	30	29	29	29	29	29	29
2	28	28	28	28	28	28	27	27	27	27
3	27	26	26	26	26	26	26	25	25	25
4	25	25	24	24	24	24	24	24	23	23
-5	+23	+23	+23	+22	+22	+22	+22	+22	+22	+21
6	21	21	21	21	20	20	20	20	20	20
7	19	19	19	19	19	19	18	18	18	18
8	18	17	17	17	17	17	17	16	16	16
9	16	16	15	15	15	15	15	15	14	14
-10	+14	+14	+14	+13	+13	+13	+13	+13	+13	+12
11	12	12	12	12	11	11	11	11	11	11
12	10	10	10	10	10	10	9	9	9	9
13	9	8	8	8	8	8	8	7	7	7
14	7	7	6	6	6	6	6	6	5	5
-15	+5	+5	+5	+4	+4	+4	+4	+4	+4	+3
16	+3	+3	+3	+3	+2	+2	+2	+2	+2	+2
17	+1	+1	+1	+1	+1	+1	0	0	0	0
18	0	-1	-1	-1	-1	-1	-1	-2	-2	-2
19	-2	-2	-3	-3	-3	-3	-3	-4	-4	-4
-20	-4	-4	-4	-5	-5	-5	-5	-5	-5	-6
21	6	6	6	6	7	7	7	7	7	7
22	8	8	8	8	8	8	9	9	9	9
23	9	10	10	10	10	10	10	11	11	11
24	11	11	12	12	12	12	12	12	13	13
-25	-13	-13	-13	-14	-14	-14	-14	-14	-14	-15
26	15	15	15	15	16	16	16	16	16	16
27	17	17	17	17	17	17	18	18	18	18
28	18	19	19	19	19	19	19	20	20	20
29	20	20	21	21	21	21	21	21	22	22
-30	-22	-22	-22	-23	-23	-23	-23	-23	-23	-24
31	24	24	24	24	25	25	25	25	25	25
32	26	26	26	26	26	26	27	27	27	27
33	27	28	28	28	28	28	28	29	29	29
34	29	29	30	30	30	30	30	30	31	31
-35	-31	-31	-31	-32	-32	-32	-32	-32	-32	-33
36	33	33	33	33	34	34	34	34	34	34
37	35	35	35	35	35	35	36	36	36	36
38	36	37	37	37	37	37	37	38	38	38
39	38	38	39	39	39	39	39	39	40	40
-40	-40	-40	-40	-41	-41	-41	-41	-41	-41	-42
41	42	42	42	42	43	43	43	43	43	43
42	44	44	44	44	44	44	45	45	45	45
43	45	46	46	46	46	46	46	47	47	47
44	47	47	48	48	48	48	48	48	49	49
-45	-49	-49	-49	-50	-50	-50	-50	-50	-50	-51
46	51	51	51	51	52	52	52	52	52	52
47	53	53	53	53	53	53	54	54	54	54
48	54	55	55	55	55	55	55	56	56	56
49	56	56	57	57	57	57	57	57	58	58
-50	-58	-58	-58	-59	-59	-59	-59	-59	-59	-60
51	60	60	60	60	61	61	61	61	61	61
52	62	62	62	62	62	62	63	63	63	63
53	63	64	64	64	64	64	64	65	65	65
54	65	65	66	66	66	66	66	66	67	67
-55	-67	-67	-67	-68	-68	-68	-68	-68	-68	-69

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