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Flying Training

WEATHER FOR AIRCREWS

This revision serves as a text for undergraduate pilot and navigator training, all Air Force instrument refresher training and flight instruction programs, and various individual flying training programs. It also helps to familiarize Air Force, United States Air Force Reserve, and Air National Guard aircrews with weather codes, charts, services, and aviation weather hazards. It is issued to each flying unit, instructor, and student involved in such training.

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Chapter 1

STANDARD PILOT BRIEFING DISPLAY

This chapter acquaints aircrews with the Standard Pilot Briefing Display. Aircrews must become familiar with the weather charts displayed in the base weather station, and learn how to read and use these charts.

Base Weather Stations

Many base weather stations do not maintain a continuous forecaster service. Aircrews flying into and out of these locations must call a station with a 24-hour weather briefing capability (A Regional Briefing Station ((RBS)). The Flight Information Handbook lists these 24-hour stations.

Base weather stations maintain a Standard Pilot Briefing Display providing the following conditions are met:

—The forecaster section is not manned 24-hrs.

—An observer is on duty in the weather station.

—Aircrews receive flight weather briefings in the weather station during times when forecasters are not on duty.

When possible, the display conforms to the example in figure 1-1.

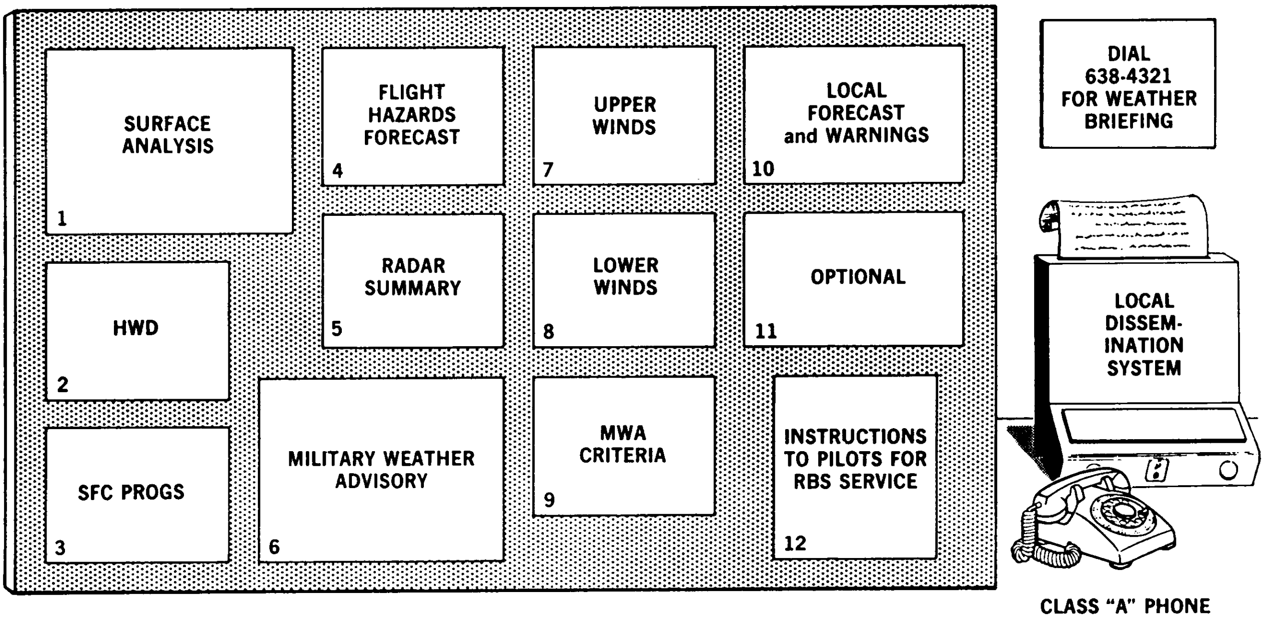


Figure 1-1. Standard Pilot Briefing Display.

Briefing Display Charts

Aircrews, before calling an RBS for a weather briefing, familiarize yourselves with all the information posted on the Standard Pilot Briefing Display. To obtain a mental picture of the current weather situation, read the latest aviation weather observations, radar observations, and pilot reports applicable to the planned route. Study the terminal forecasts for your destination and at least one alternate, if conditions indicate one is required.

The Standard Pilot Briefing Display (figure 1-1) consists of:

1. Surface analysis.
2. Horizontal weather depiction (HWD).
3. Surface forecasts (Sfc Progs).
4. En route flight hazards forecasts.
5. Radar summary.
6. Military weather advisory (MWA).

7. and 8. Winds aloft charts (high- and low-level wind panels).

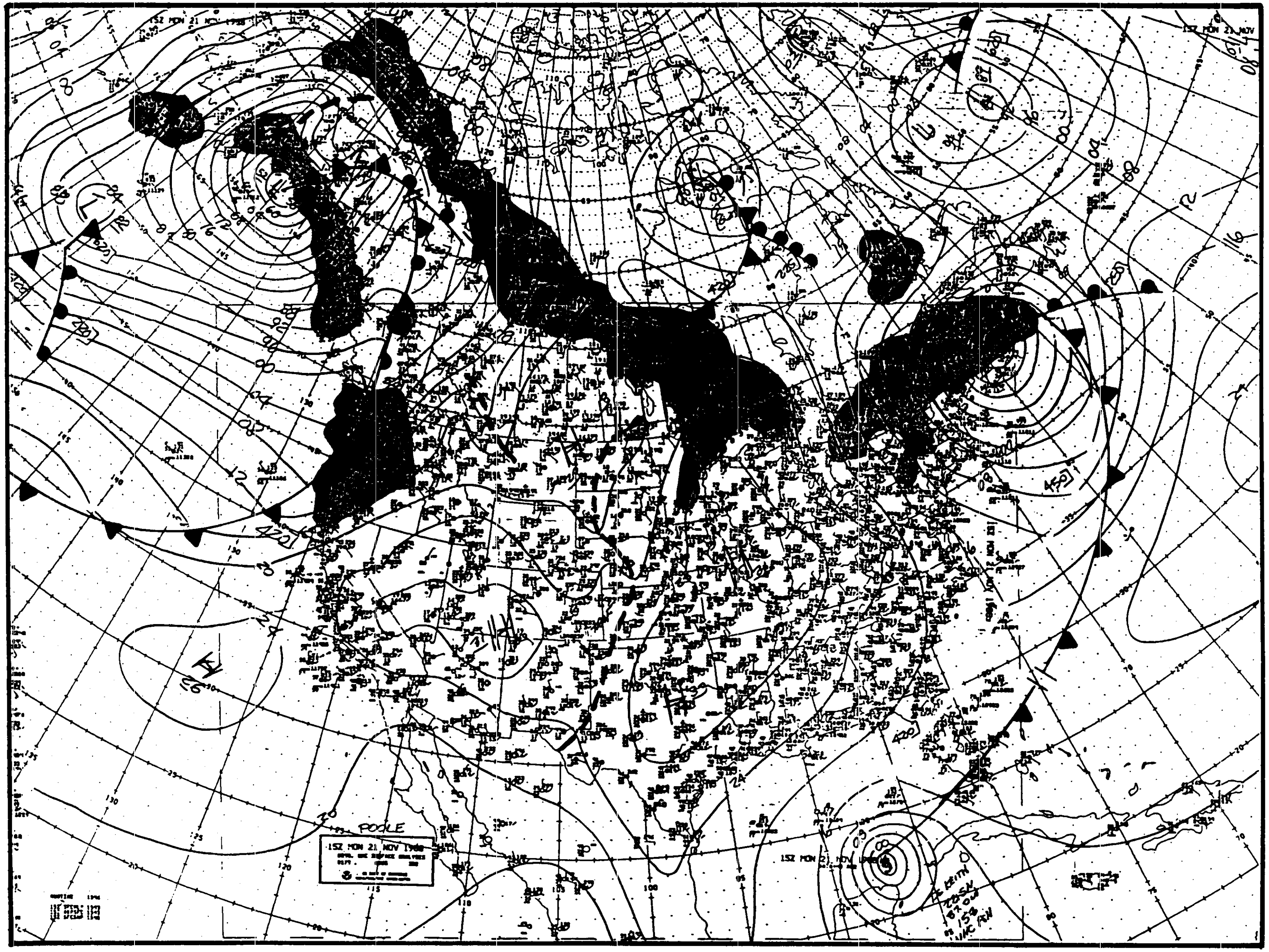


Figure 1-2. Chart 1—Surface Analysis.

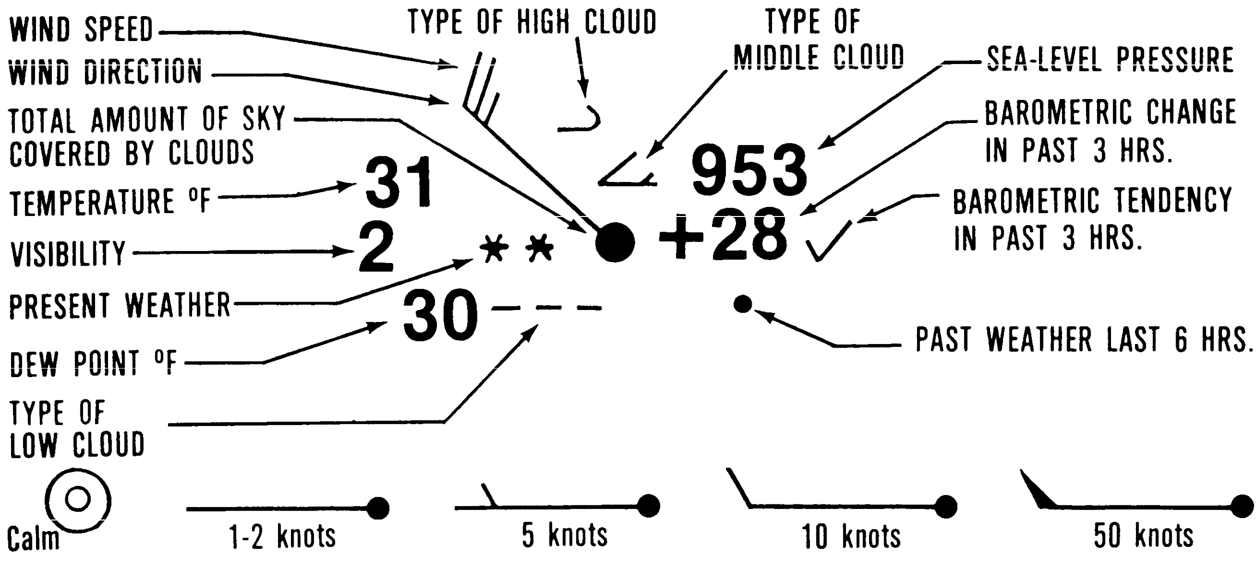


Figure 1-3. Station Model.

9. Military weather advisory criteria.
10. Local area forecast and any weather warnings for the local area.
11. Optional chart.
12. Instructions to aircrews for RBS service.

NOTE: All charts may not be available overseas.

Chart 1—Surface Analysis

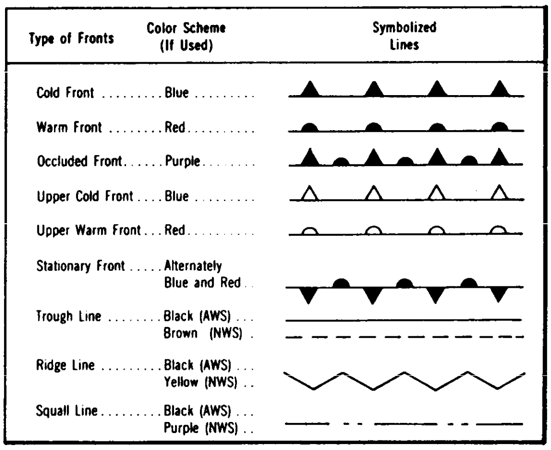
A surface analysis chart (figure 1-2) gives a view of past weather conditions. In the contiguous 48 States, a map, transmitted every 3 hours, covers this region and adjacent areas. Other areas with facsimile receive surface weather maps appropriate to their areas at regularly scheduled intervals. Most of the information plotted is for the forecaster. We will discuss only the portion that is valuable to aircrews. Figure 1-3 explains most of the information found on the station model.

Analysis of Surface Chart Symbols:

Isobars (lines connecting points of equal barometric pressure) are normally drawn at 4-millibar intervals. When the pressure gradient is weak, dashed isobars are sometimes inserted at 2-millibar intervals to more closely define the pressure pattern. Isobars are labeled by two numbers representing their numerical value. For example, 32 means 1032 mb; 00 is 1000 mb; and 92 is 992 mb.

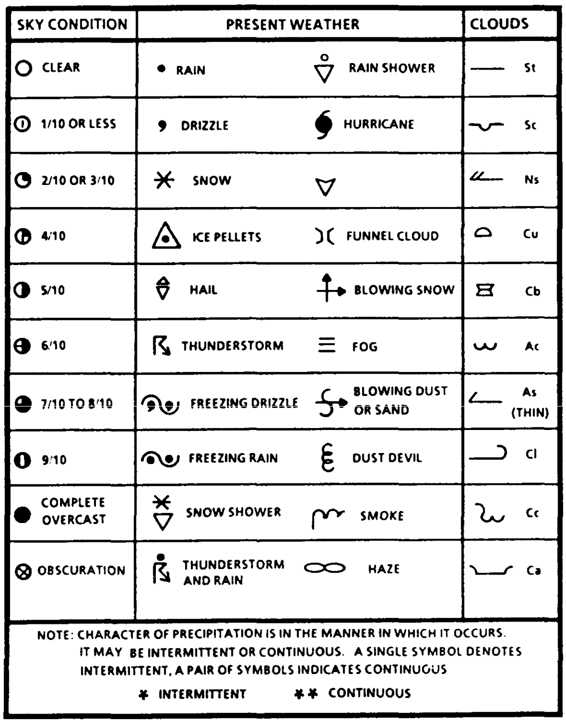
An "L" for a low and an "H" for a high designate pressure centers. Interpreted the same as the isobar label, a two-digit number indicates the pressure at each center.

Figure 1-4 depicts frontal analysis symbols. Notice the minor differences in color schemes and symbols between the Air Weather Service (AWS) and the National Weather Service (NWS). The "pips" on the frontal symbols indicate the type of front and point in the direction of frontal movement. Pips on both sides of a frontal symbol identify a stationary front and suggest little or no movement. Weather personnel color code the fronts only as time permits.



Type of Fronts	Color Scheme (If Used)	Symbolized Lines
Cold Front	Blue	
Warm Front	Red	
Occluded Front	Purple	
Upper Cold Front	Blue	
Upper Warm Front	Red	
Stationary Front	Alternately Blue and Red	
Trough Line	Black (AWS) Brown (NWS)	
Ridge Line	Black (AWS) Yellow (NWS)	
Squall Line	Black (AWS) Purple (NWS)	

Figure 1-4. Symbols for Indicating Fronts.



SKY CONDITION	PRESENT WEATHER		CLOUDS
○ CLEAR	● RAIN	RAIN SHOWER	St
1/10 OR LESS	DRIZZLE	HURRICANE	Sc
2/10 OR 3/10	SNOW	▽	Ns
4/10	ICE PELLETS	FUNNEL CLOUD	Cu
5/10	HAIL	BLOWING SNOW	Cb
6/10	THUNDERSTORM	≡ FOG	Ac
7/10 TO 8/10	FREEZING DRIZZLE	BLOWING DUST OR SAND	As (THIN)
9/10	FREEZING RAIN	DUST DEVIL	Cl
● COMPLETE OVERCAST	SNOW SHOWER	SMOKE	Cc
⊗ OBSCURATION	THUNDERSTORM AND RAIN	HAZE	Ca

NOTE: CHARACTER OF PRECIPITATION IS IN THE MANNER IN WHICH IT OCCURS. IT MAY BE INTERMITTENT OR CONTINUOUS. A SINGLE SYMBOL DENOTES INTERMITTENT, A PAIR OF SYMBOLS INDICATES CONTINUOUS

* INTERMITTENT   ** CONTINUOUS

Figure 1-5. Standard Weather Symbols.

Wind directions, plotted to the nearest 10 degrees relative to true north, blow *from* the barb or pennant *to* the station circle. Basic weather symbols plotted on the chart appear in figure 1-5.

Using the Surface Analysis Chart:

When using the surface analysis chart, concentrate on pressure patterns and fronts more than on plotted data. Keep in mind that weather systems move and conditions change. Since the chart is more than 2 hours old when received, use it as a guide to other briefing charts and teletype information. To obtain a more complete weather picture, use the surface chart with the weather depiction, radar summary, upper air, and prognostic (prog) charts.

Chart 2—Horizontal Weather Depiction (HWD) Chart

One of the most valuable graphic displays of weather is the HWD chart (figure 1-6). Prepared from surface aviation observations and hourly weather reports, this chart is a graphic presentation of visibility, total sky cover, and cloud height or ceiling. The station plotting model below is an abbreviated version of the station model given in figure 1-3.

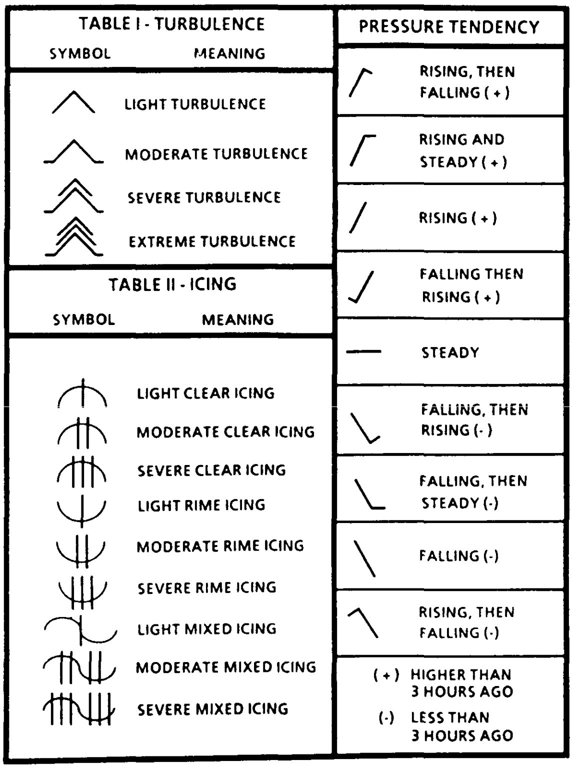


TABLE I - TURBULENCE

SYMBOL MEANING

LIGHT TURBULENCE

MODERATE TURBULENCE

SEVERE TURBULENCE

EXTREME TURBULENCE

TABLE II - ICING

SYMBOL MEANING

LIGHT CLEAR ICING

MODERATE CLEAR ICING

SEVERE CLEAR ICING

LIGHT RIME ICING

MODERATE RIME ICING

SEVERE RIME ICING

LIGHT MIXED ICING

MODERATE MIXED ICING

SEVERE MIXED ICING

PRESSURE TENDENCY

RISING, THEN FALLING (+)

RISING AND STEADY (+)

RISING (+)

FALLING THEN RISING (+)

STEADY

FALLING, THEN RISING (-)

FALLING, THEN STEADY (-)

FALLING (-)

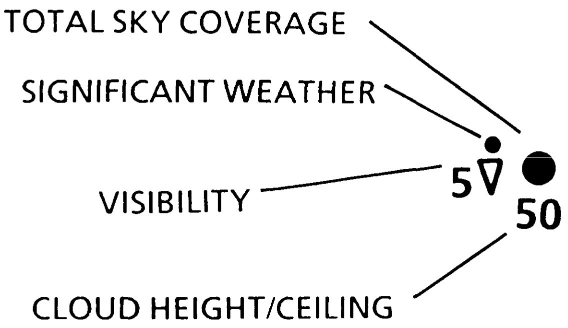
RISING, THEN FALLING (-)

(+) HIGHER THAN 3 HOURS AGO

(-) LESS THAN 3 HOURS AGO

Figure 1-5. Continued.

STATION MODEL



Total Sky Cover:

Total sky cover is shown by a shaded station circle, as in figure 1-7.

Cloud Height or Ceiling:

Under the station circle are cloud heights in hundreds of feet. If total sky cover is scattered or less, the height is the base of the lowest layer. If total sky cover is broken or greater, the height is the ceiling. A partially

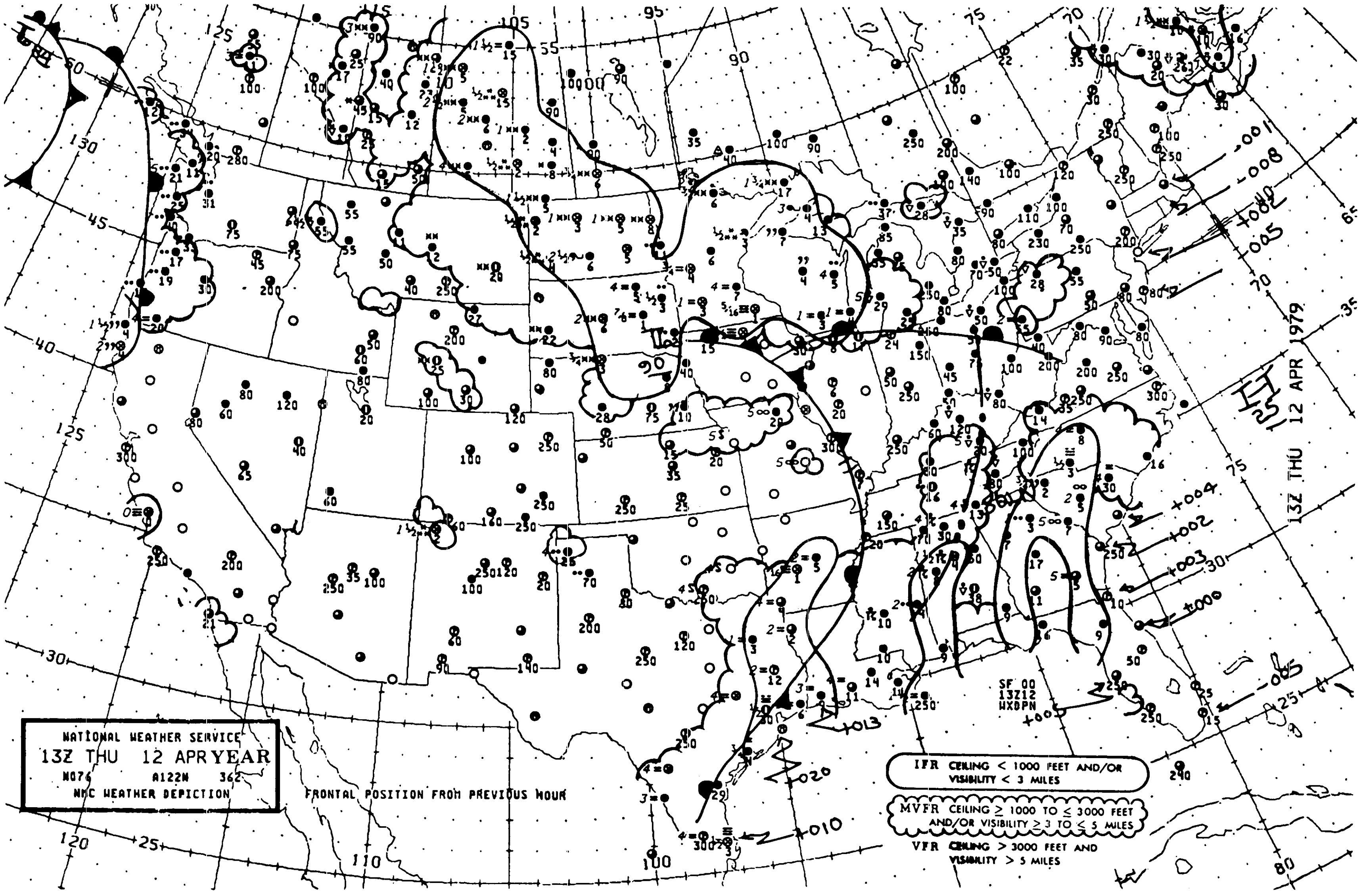


Figure 1-6. Chart 2—Horizontal Weather Depiction (HWD) Chart.

Symbol	Meaning
○	Clear
⌽ ◔	Scattered
◕	Broken
⦶	Overcast with breaks (BINOVC)
●	Overcast
⊗	Sky obscured or partially obscured

Figure 1-7. Total Sky Cover.

or totally obscured sky is shown by the same sky cover symbol. Partial obscuration is denoted by the absence of a height entry. Total obscuration has a height entry denoting the indefinite ceiling (vertical visibility into the obscuration).

Weather and Obstructions to Vision:

To the left of the station circle are weather and obstructions to vision, using the same symbols as on the surface analysis. Precipitation intensity is not entered. When several types of weather and or obstructions are reported at a station, only the most significant one or two types are entered.

Visibility:

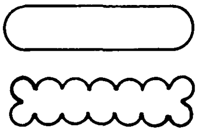
When visibility is less than 7 miles, it is entered in statute miles and fractions, to the left of weather and obstructions to vision. Figure 1-8 shows some examples of plotted data.

Plotted	Interpreted
◔$_8$	Scattered clouds, base 800 feet, visibility more than 6 miles
$\dot{\nabla}$ ◕$_{12}$	Broken sky cover, ceiling 1,200 feet, rain shower, visibility more than 6 miles
2 ≡○	Sky clear, visibility 2 miles, fog
¼✱⊗$_5$	Sky obscured, ceiling 500 feet, visibility ¼ mile, snow
1⛈●$_{12}$	Overcast, ceiling 1,200 feet, thunderstorm, visibility 1 mile

Figure 1-8. Examples of Plotting on the Horizontal Weather Depiction Chart.

Analysis of the HWD Chart:

Continuous lines (either solid or scalloped) outline areas where observed conditions at terminals have specified ceilings and or visibility conditions. Normally, isolated conditions over small geographic areas are not portrayed on this chart.



Instrument Flight Rules (IFR)—Ceiling less than 1,000 feet and or visibility less than 3 miles, outlined by a *smooth* line.

Marginal Visual Flight Rules (MVFR)—Ceiling 1,000 to 3,000 feet and or visibility 3 to 5 miles inclusive, outlined by a *scalloped* line.

The preceding surface analysis chart (earlier in the day) depicts frontal positions along with the major high and low pressure centers. These features are depicted the same as on the surface chart.

Using the HWD Chart:

The HWD chart gives information directly affecting flight plan decision-making. From it, you can determine general weather conditions more readily than from any other source. It shows areas of favorable and adverse weather, and pictures frontal and pressure systems associated with the weather. This chart does not eliminate the need for reading selected hourly aviation weather reports, but does highlight areas needing detailed study.

This chart may not completely represent en route conditions because of variations in terrain and weather between stations. Compare previous charts to obtain an idea of cloud changes and frontal movement. Areas enclosed by the 1,000 feet and or less than 3 mile smooth line, are helpful in determining bases below alternate minimums. After initially evaluating the general picture, final flight planning must consider forecasts, progs, and the latest pilot, radar, and surface weather reports.

Chart 3—Low-Level (Surface—400mb) Prog

Surface prognostic charts provide forecasts of significant weather at the surface and of cloud, turbulence, and precipitation through the lower layers. This layer normally extends up to 400 millibars (approximately 24,000 feet).

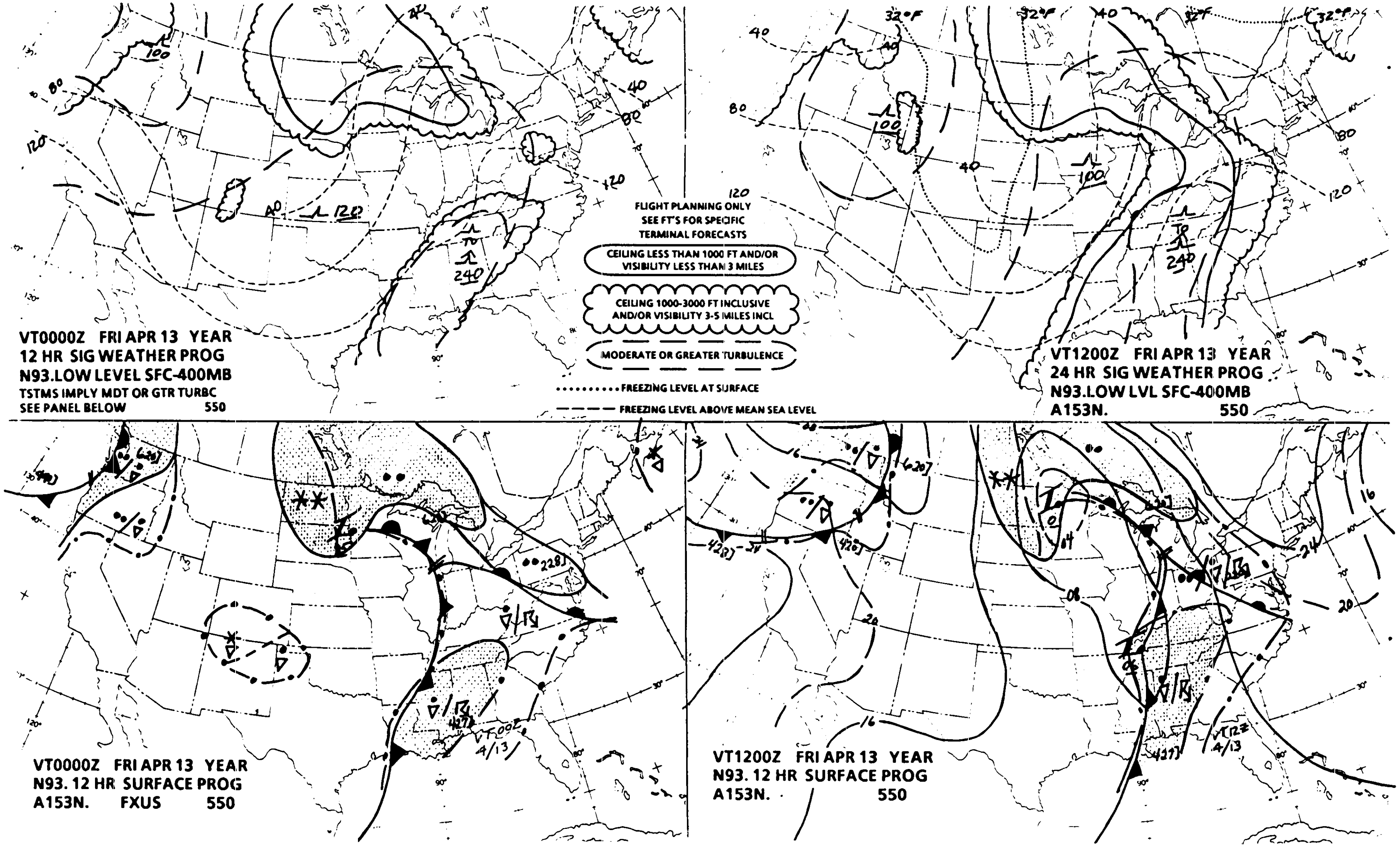


Figure 1-9. Chart 3–Low-Level and Surface Prog.

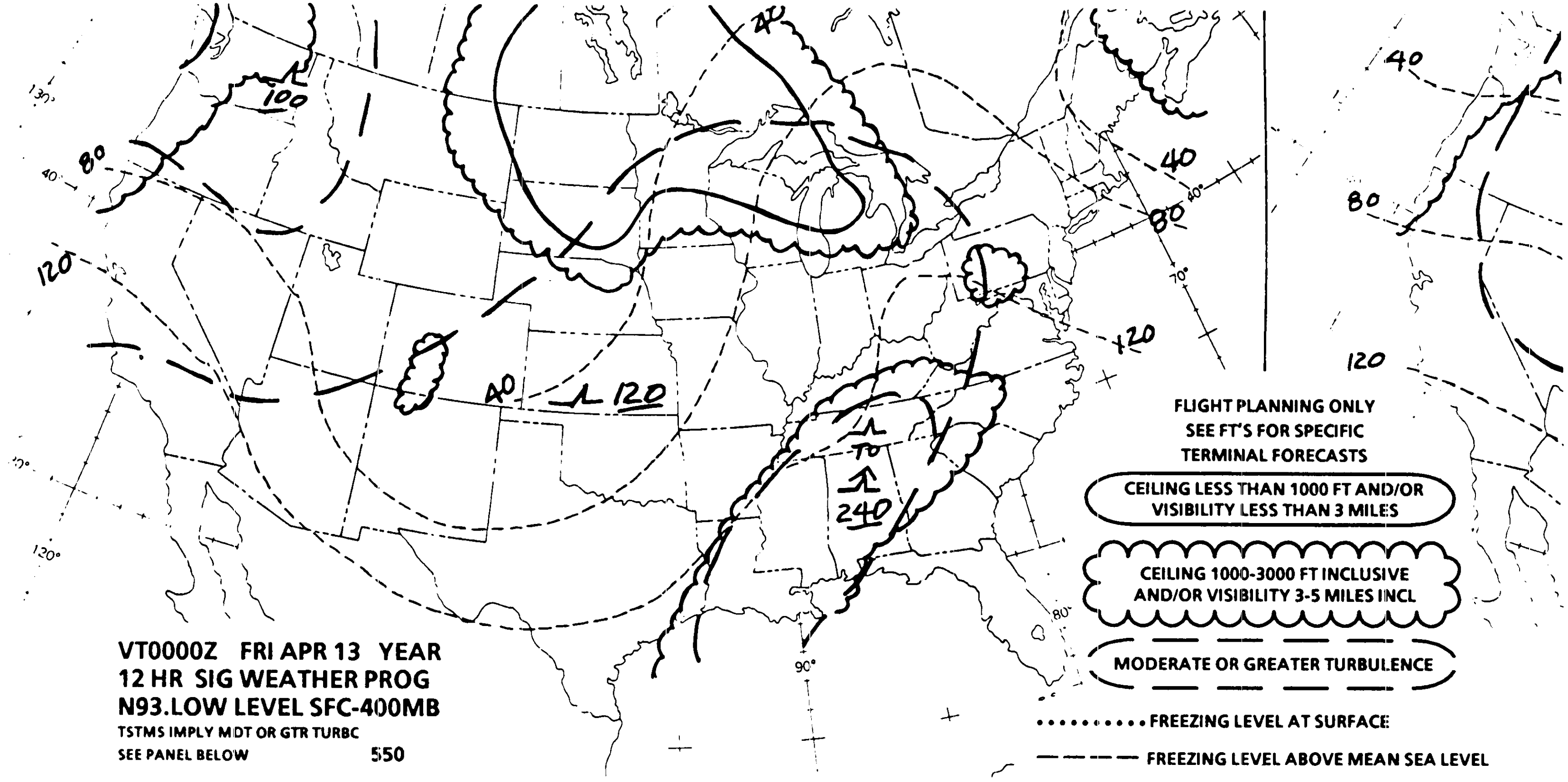


Figure 1-10. Chart 3–Upper Panel.

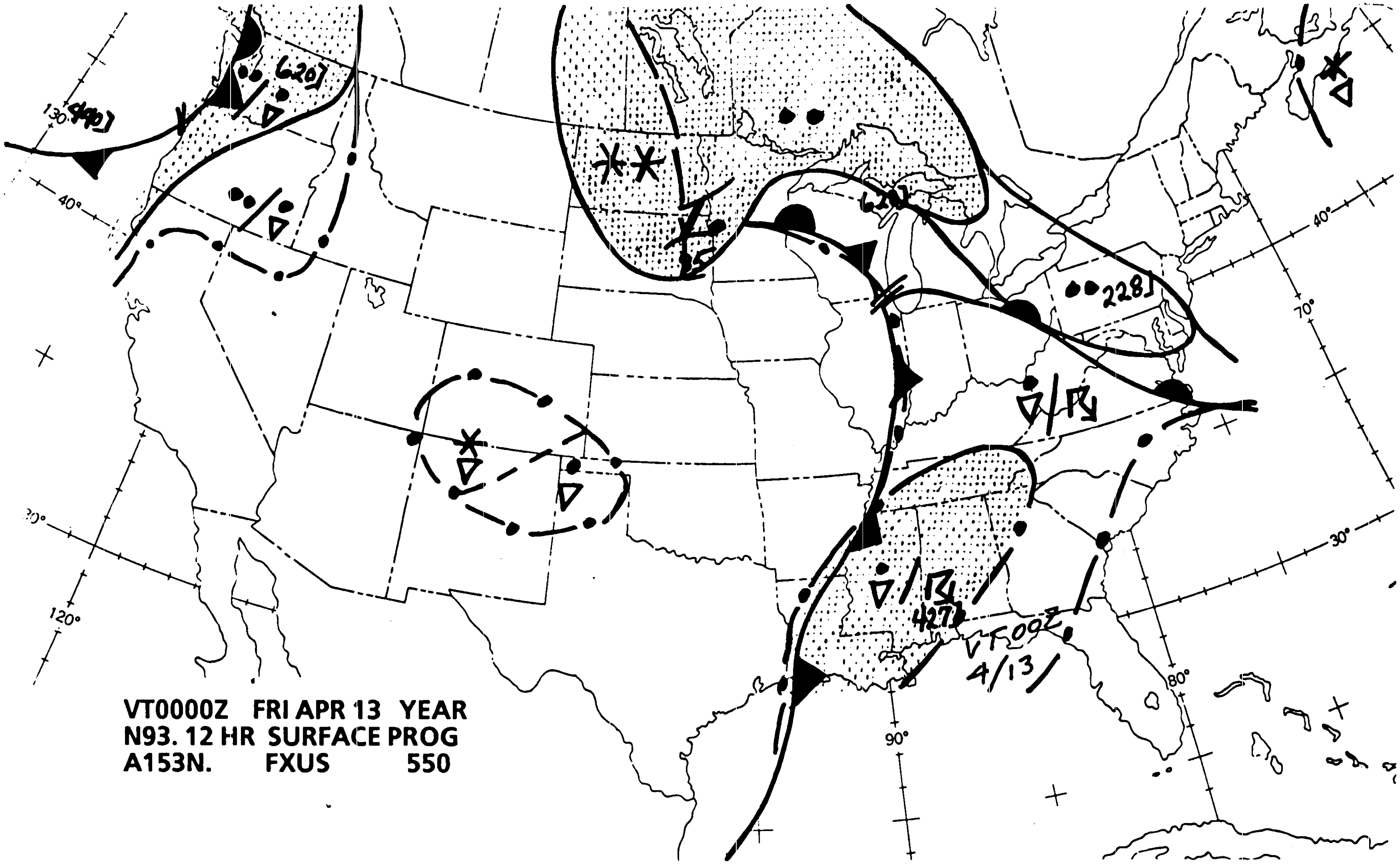


Figure 1-11. Chart 3–Lower Panel.

The US low-level prog is a four-panel chart, shown in figures 1-9, 1-10, and 1-11. The two lower panels are 12- and 24-hour surface progs. The two upper panels are 12- and 24-hour progs of significant weather from the surface to 400 millibars. The charts show conditions forecast for the valid time of the chart.

Analysis of the Low-Level Prognostic Chart

The two surface prog panels use standard symbols for fronts and pressure centers explained in the previous section. Some 24-hour surface progs include isobars depicting forecast pressure patterns.

The surface prog outlines areas of forecast precipitation and thunderstorms. Smooth lines enclose areas of expected continuous or intermittent precipitation; dash-dot lines enclose areas of expected showers or thunderstorms. Symbols indicating precipitation type, are the same as on the surface analysis (figure 1-5). Precipitation affecting half or more of an area is shaded; absence of shading denotes less than half the area is expected to receive precipitation.

The upper panels of figure 1-9 depict ceiling, visibility, turbulence, and freezing level. The legend, near the center of the chart, explains methods of depiction.

Smooth lines enclose areas of forecast IFR weather; scalloped lines enclose areas of MVFR weather; visual flight rule (VFR) areas are not outlined. Remember, the HWD chart uses the same manner to portray ceiling and visibility.

Long dashed lines enclose general areas of forecast moderate or greater turbulence. However, thunderstorms forecast on a surface prog *always* imply moderate or greater turbulence in the storms, even though the associated significant weather panel may not outline a general area of turbulence.

A symbol entered within a general area of forecast turbulence denotes intensity (figure 1-5). Figures below and above a short line show expected base and top of the turbulent layer in hundreds of feet. Absence of a figure below the line indicates turbulence from the surface upward. In figure 1-10, for example, the annotation appearing over the Pacific Northwest denotes moderate turbulence from the surface to 10,000 feet.

Freezing level height contours for the uppermost freezing level are drawn at 4,000 foot intervals beginning with 4,000 feet mean sea level (MSL). The 4,000 foot contour terminates at the 4,000 foot terrain level along the Rocky Mountains. Contours are labeled in hundreds of feet MSL. The freezing level line at the surface is labeled "32F."

The low-level significant weather prog does not specifically outline areas of icing. However, *icing is always implied in clouds and precipitation above the freezing level.*

Using the Low-Level Prog Chart:

Low-level prog charts provide an overall forecast of weather conditions below 24,000 feet for fixed times. These charts do not replace forecasts for specific terminals, but supplement them with general area forecast conditions. Obtain specifics, such as ceiling and visibility, from teletype and electrically transmitted station forecasts. To determine expected movement and changes in weather patterns, compare progs with analyses.

Significant weather progs for oversea locations normally cover large geographical areas. The symbols in figure 1-5 are used, but the legend may be somewhat different. It is best to consult a weather forecaster if you have any questions about the presentation of these details.

Chart 4—Flight Hazards Forecast

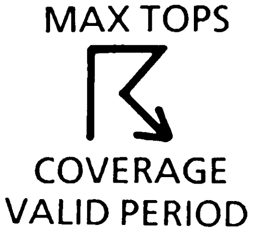
This display shows forecast areas of icing, clear air turbulence (CAT), and thunderstorms above 10,000 feet MSL (figure 1-12). The forecast areas of icing and CAT depict the worst conditions *(not associated with thunderstorm activity)* expected within the period noted.

Analysis of the Flight Hazard Forecast Chart:

The Flight Hazard Forecast Chart contains:

1. Icing. Areas of light or greater intensity icing.
2. Turbulence. Areas of moderate or greater CAT. If forecast, mountain wave turbulence is spelled out or annotated as "MTN WV."
3. Thunderstorms. Areas of thunderstorms when the maximum instantaneous cover (MIC) is 2 percent or greater. Thunderstorms forecast on this chart are more generalized than the Military Weather Advisory MWA chart, the official severe weather guidance chart for the continental United States (CONUS).

The following format displays thunderstorm symbols:



MIC is the percentage of the area covered by thunderstorms during the time of maximum activity. Values are:

ISOLD—Isolated: 1 to 2 percent
FEW—Few: 3 to 15 percent
SCTD—Scattered: 16 to 45 percent

NUMRS—Numerous: more than 45 percent

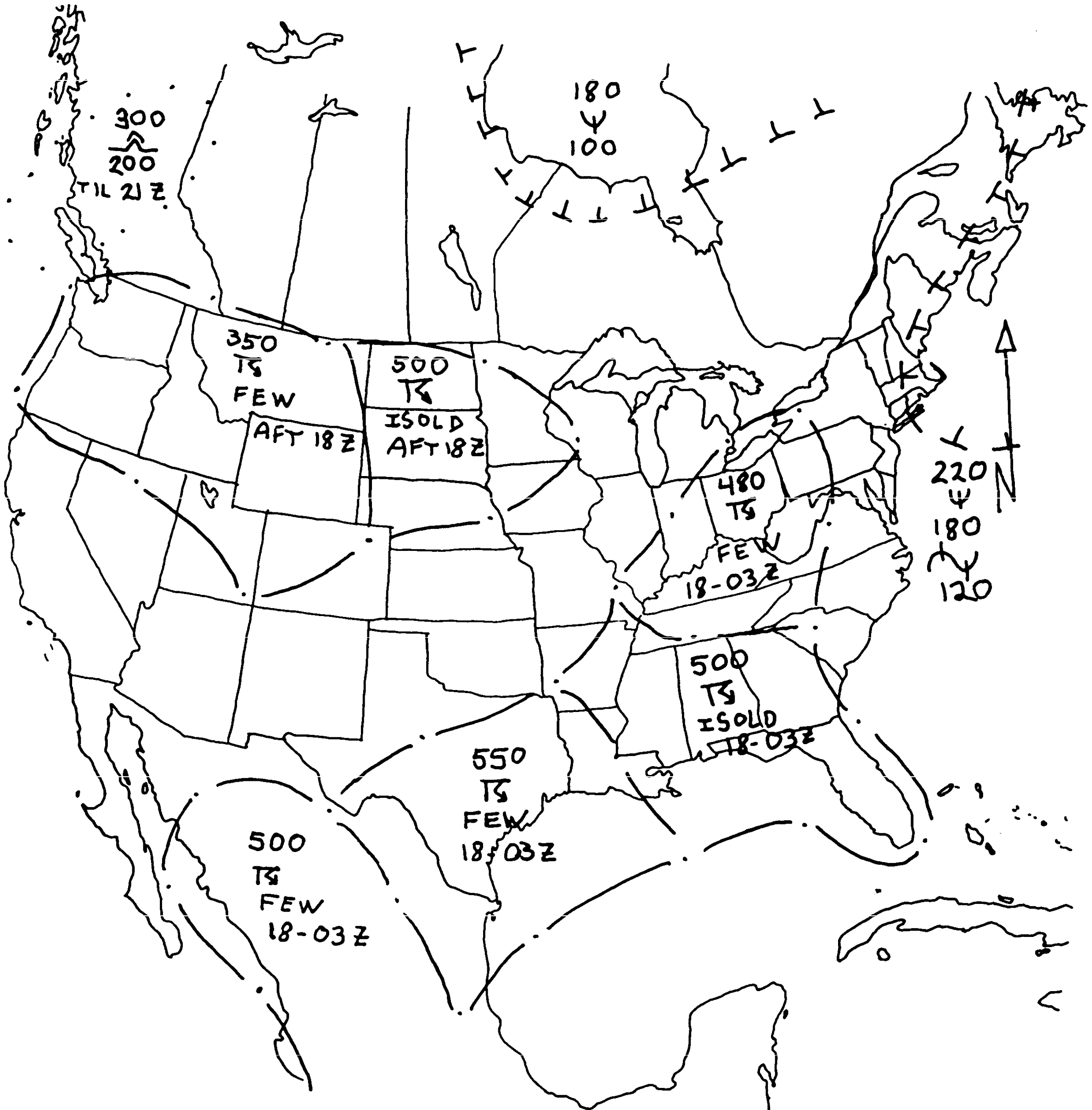


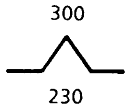
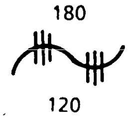
Figure 1-12. Chart 4—Flight Hazards Forecast.

Example:

Symbol	*Meaning*
	Thunderstorms forecast from 18Z to 3Z. Coverage during maximum activity will be from 3 to 15 percent. Maximum thunderstorm tops are forecast to be 48,000 feet.

Symbols for icing and turbulence are the same as in figure 1-5.

Examples:

Symbol	*Meaning*
	Moderate turbulence from 23,000 to 30,000 feet.
	Severe mixed icing from 12,000 to 18,000 feet.

Hazards associated with a moving weather system move with the system. An area on a Flight Hazards Forecast Chart will represent the movement of the hazard during the period. For example, in figure 1-12, thunderstorms forming over the Dakotas after 18Z could move into Minnesota later in the period. That could mean that a flight through the Dakotas at 02Z could safely avoid the thunderstorms despite being in a depicted thunderstorm area. The best policy is to consult your forecaster to determine expected movement.

Using the Flight Hazards Forecast Chart:

The Flight Hazards Forecast Chart is the official Air Force forecast of CAT and icing, and serves as the official forecast guidance for thunderstorms in the Pacific. The Air Force Global Weather Central (AFGWC) MWA normally covers thunderstorms in the CONUS, while the European Forecast Unit (EFU) Weather Warning Advisory cover them in Europe.

Use this chart in planning your flight to avoid areas and altitudes of probable significant icing and turbulence. You may also use this chart with the AFGWC MWA or EFU Weather Warning to plan your flight to remain clear of possible thunderstorms. By comparing progs with analyses, determine expected movement and changes in weather patterns.

NOTE: All thunderstorm activity indicates the potential for hail, severe icing, severe turbulence, and low-level wind shear.

Chart 5—Radar Summary Chart

The Automated Radar Summary Chart (figure 1-13) graphically displays collected radar weather reports. It is produced by computer, using coded surface radar observations. It shows precipitation echoes and indicates their location, coverage, movement, and tops, with other pertinent information associated with the echoes.

Analysis of the Radar Summary Chart:

A legend appears in the lower left-hand corner of the automated radar summary chart (figure 1-14). Refer to it for explanations of radar echoes appearing on the chart.

The legend does not include the following symbols which may appear on the chart, but aircrews should be familiar with them:

1. Precipitation Type Symbols Associated With Echoes:

Symbol	*Precipitation Type*
R	Rain
RW	Rain Shower
TRW	Thunder Shower
ZR	Freezing Rain
ZRW	Freezing Rain Showers
S	Snow
SW	Snow Shower
L	Drizzle
ZL	Freezing Drizzle
A	Hail

2. Change of Intensity of Radar Return:

Symbol	*Echo Intensity*
+	New or increasing
–	Decreasing

Contours drawn on the chart indicate relative intensity. Less intense echoes correspond to level 1 and the most intense echoes correspond to level 5.

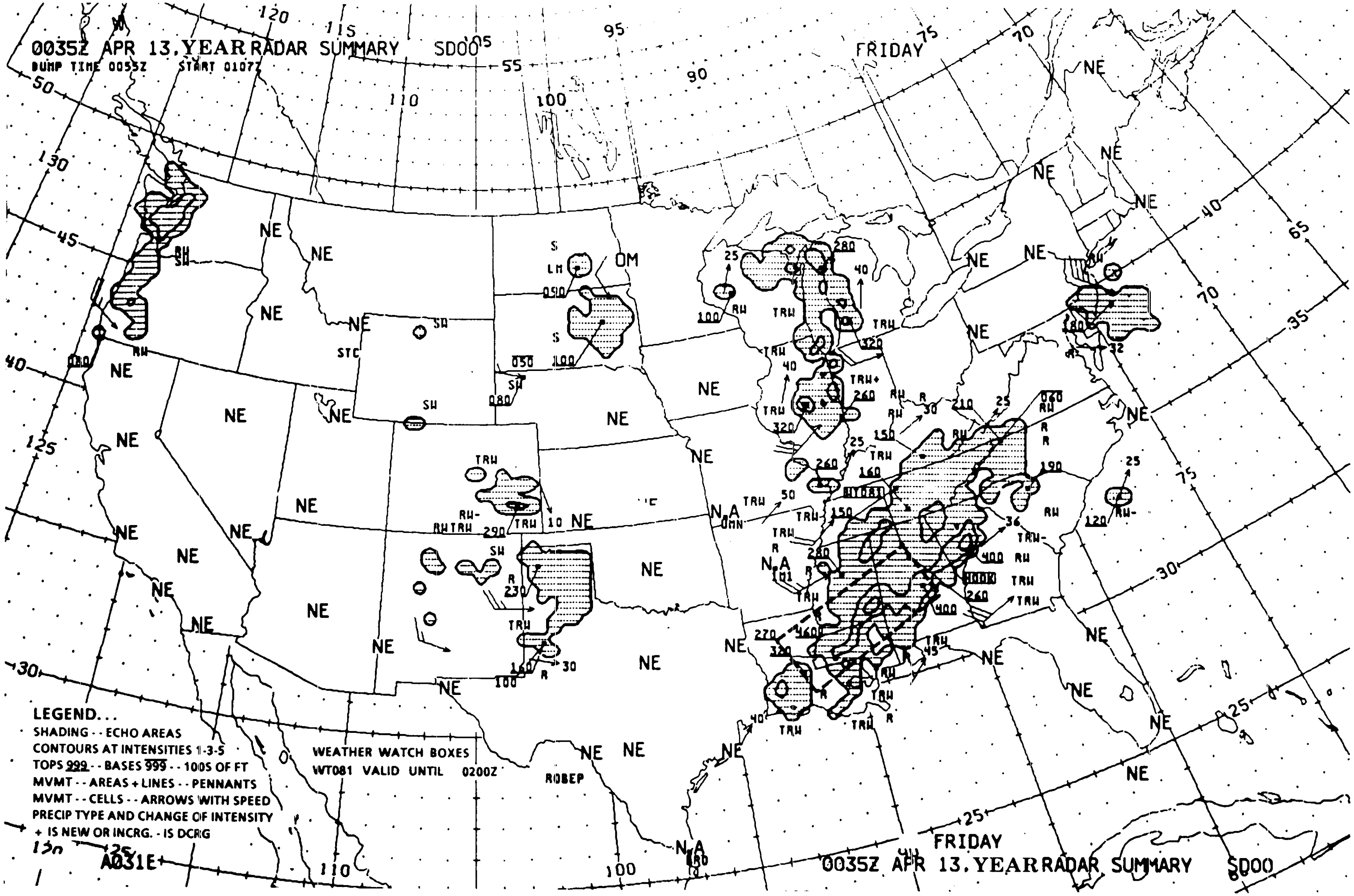


Figure 1-13. Chart 5–Radar Summary Chart.

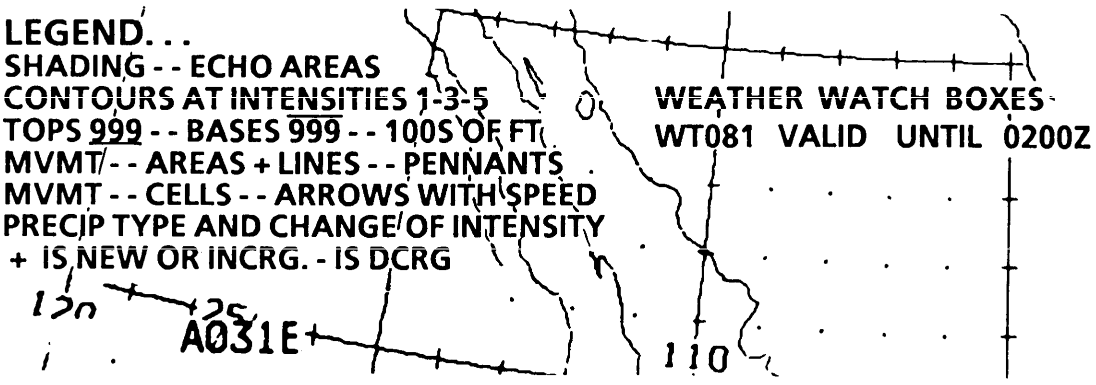


Figure 1-14. Chart 5–Radar Summary Legend.

3. Severe Weather Watch Boxes:

Dashed lines enclose severe weather watch areas issued by the National Weather Service. A label area at the bottom of the chart indicates the valid time of the severe weather box.

4. Status of Radar Equipment:

Symbol	*Meaning*
NE	Equipment operating, but no echoes observed
NA	Observations not available
OM	Equipment out for maintenance

Using the Radar Summary Chart:

The radar summary chart aids in preflight planning by identifying general areas and movement of precipitation and thunderstorms. Remember, radar detects only water droplets or ice particles of precipitation size; it does not detect clouds or fog. So, the absence of echoes does not guarantee clear weather. Also, actual cloud tops may be higher than precipitation tops detected by radar. The chart gives general movement and intensity changes which helps in forecasting. Use this chart with other charts, reports, and forecasts.

Review both current and previous radar summary charts. Carefully examine chart annotations. Always determine location and movement of echoes. Take special note of intensity and movement of echoes forecast near your planned route. Keep in mind that thunderstorms and rain showers shown on the chart may change intensity in a matter of minutes.

Chart 6—Military Weather Advisory (MWA)

The MWA is a forecast of possible severe weather prepared and transmitted every 12 hours by AFGWC. Two versions are produced: one a facsimile presentation (figure 1-15), the other a geographical teletype product.

Analysis of the MWA Chart:

MWA Codes (shown on Chart 9). The forecast is coded as follows:

Red—Tornadoes, waterspouts, or funnel clouds.

Blue—Severe thunderstorms (maximum wind gusts of 50 knots or greater, and or hail, 3/4 inch in diameter) and locally damaging wind storms.

Green—Moderate thunderstorms (maximum wind gusts of 35 knots or greater, but less than 50 knots, and or hail, 1/2 inch or greater in diameter, but less than 3/4 inch in diameter.

Orange—Thunderstorms (maximum wind gusts less than 35 knots and or hail, less than 1/2 inch in diameter).

Black—Strong surface winds (35 knots or more and not associated with thunderstorms).

Purple—Heavy rain (two inches or more in 12 hours or less).

Hatched Purple—Heavy snow (two or more inches in 12 hours or less).

Brown—Freezing precipitation (rain or drizzle).

Other abbreviations used are:

MIC (Maximum Instantaneous Coverage). Percentage of the area covered by thunderstorm cells during maximum activity. Percentage will appear like 3/25,

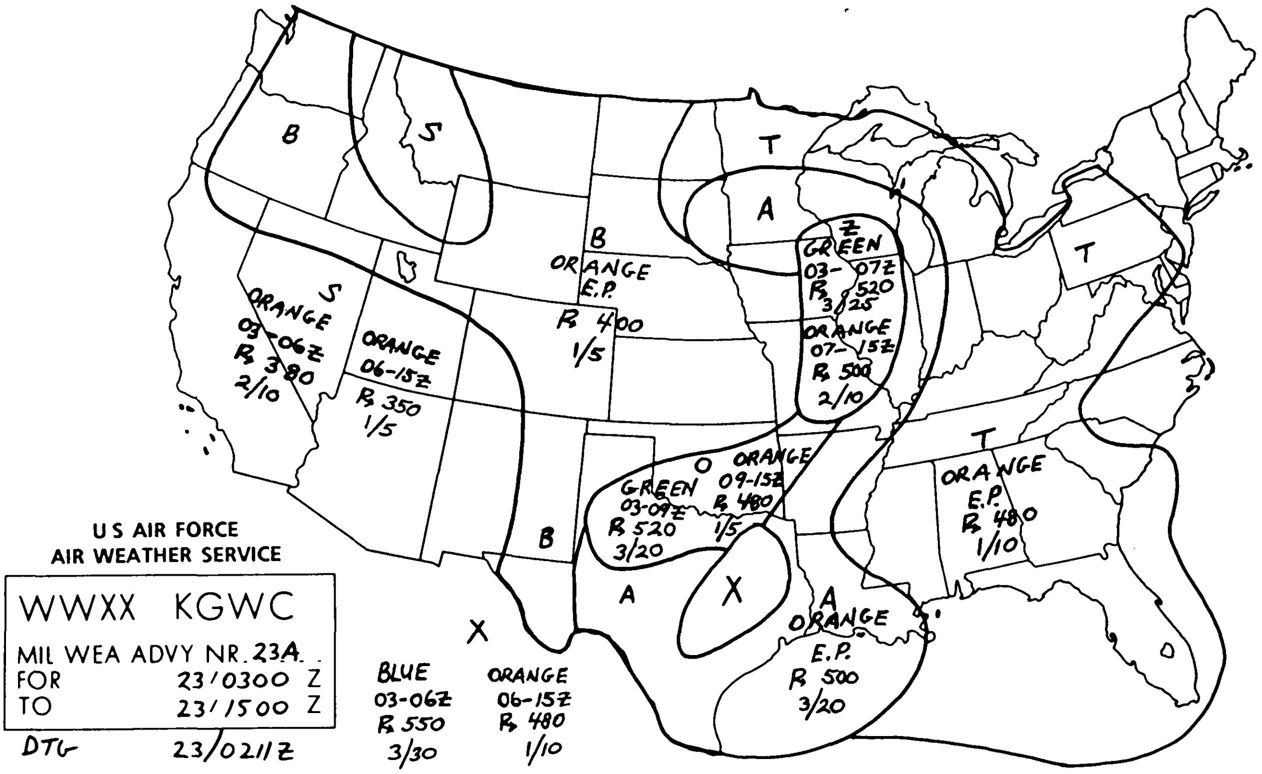


Figure 1-15. Chart 6–Military Weather Advisory (MWA).

indicating that three percent will be the MIC and 25 percent will be the total area affected (TAA).

TAA. Percentage of the area experiencing one or more thunderstorms during the valid period. (See example in the MIC explanation).

E.P. (Entire Period). Used when the expected phenomena is for the entire valid time of the chart instead of a portion thereof.

Maximum thunderstorm tops are displayed, i.e., 450, meaning 45,000 feet. The advisory areas, enclosed by solid lines, have a letter designator within the area. Forecast areas depict the worst conditions expected during the period noted.

The teletype bulletin contains information identical to the facsimile product. It also serves to amend and correct both the facsimile and teletype product.

Using the MWA Chart:

Use the contents of this advisory as a preflight aid to help plan your route of flight to avoid possible severe weather. Compare the MWA forecast with the latest weather available on the charts and teletype reports. Request clarification and updates via the telephone briefing.

Charts 7 and 8—Winds Aloft Charts

Forecast Winds and Temperatures Aloft:

Forecast winds and temperatures aloft charts cover eight levels in eight separate panels. A legend on each panel shows the valid time and level of the chart. Levels below 18,000 feet are true altitudes mean sea level (MSL) while levels 18,000 feet and above are pressure altitudes or flight levels. Figures 1-16 and 1-17 are panels of a wind and temperature aloft forecast.

Above the station circle, in one or two digits, are temperatures in degrees Celsius for each forecast point. Arrows with pennants and barbs similar to those on surface maps show true wind direction and speed. Wind direction is drawn to the nearest 10 degrees. The second digit of the coded direction is entered at the outer end of the arrow to assist in wind direction interpretation. A calm or light and variable wind is shown by "LV" entered at the lower right side of the station circle. Following are examples of plotted temperatures and winds in their interpretations:

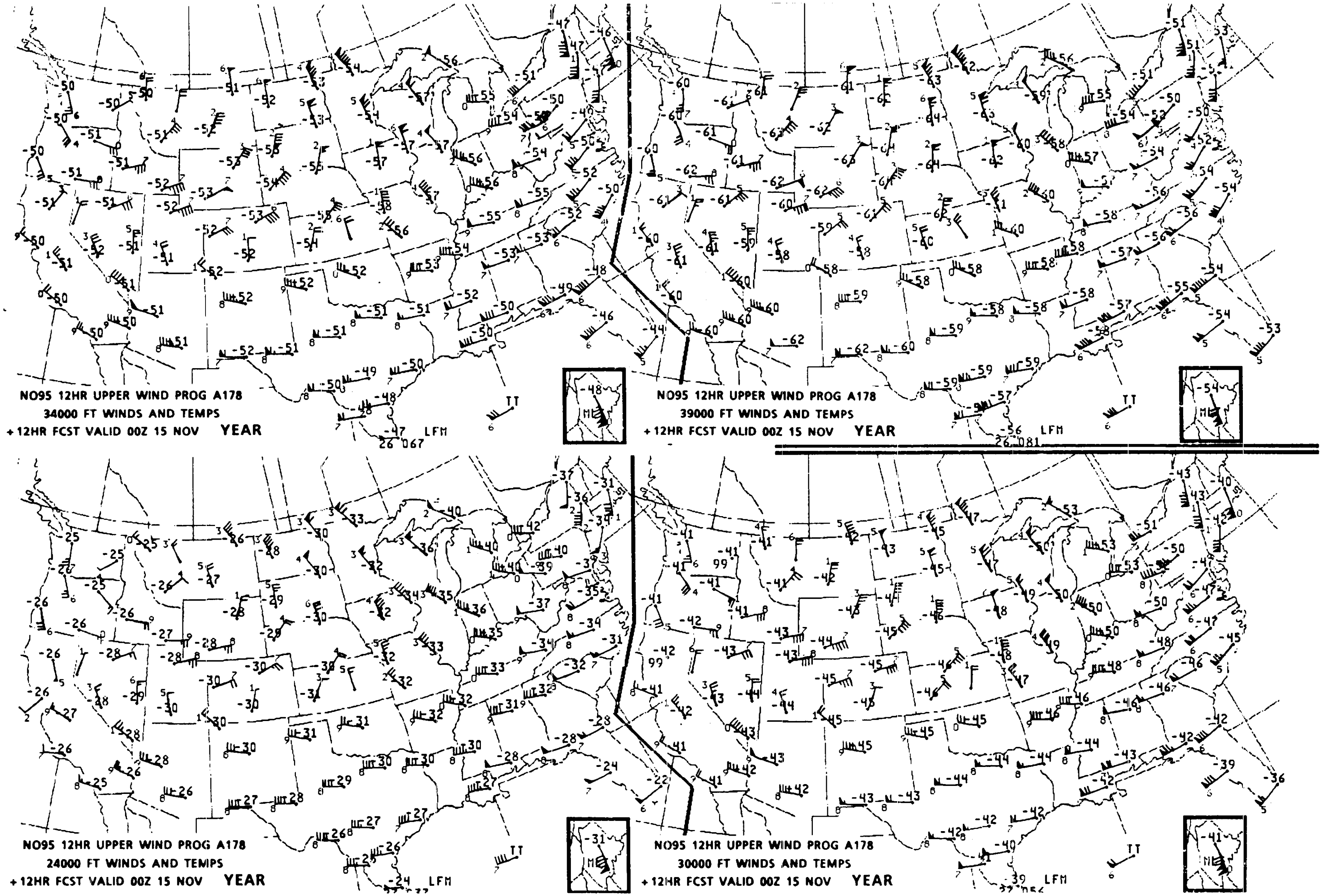


Figure 1-16. Chart 7–Upper Level Forecast Winds.

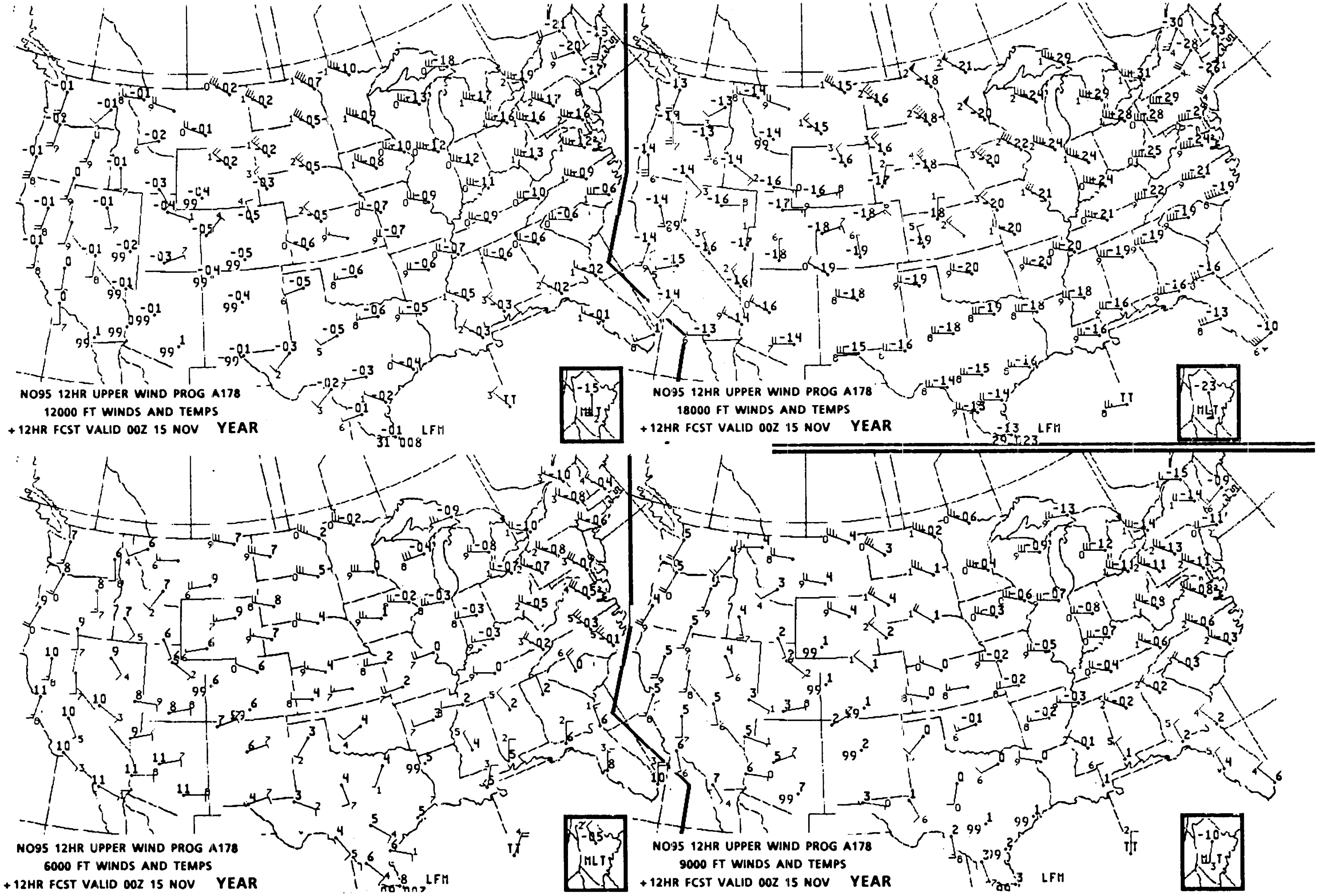


Figure 1-17. Chart 8–Lower Level Forecast Winds.

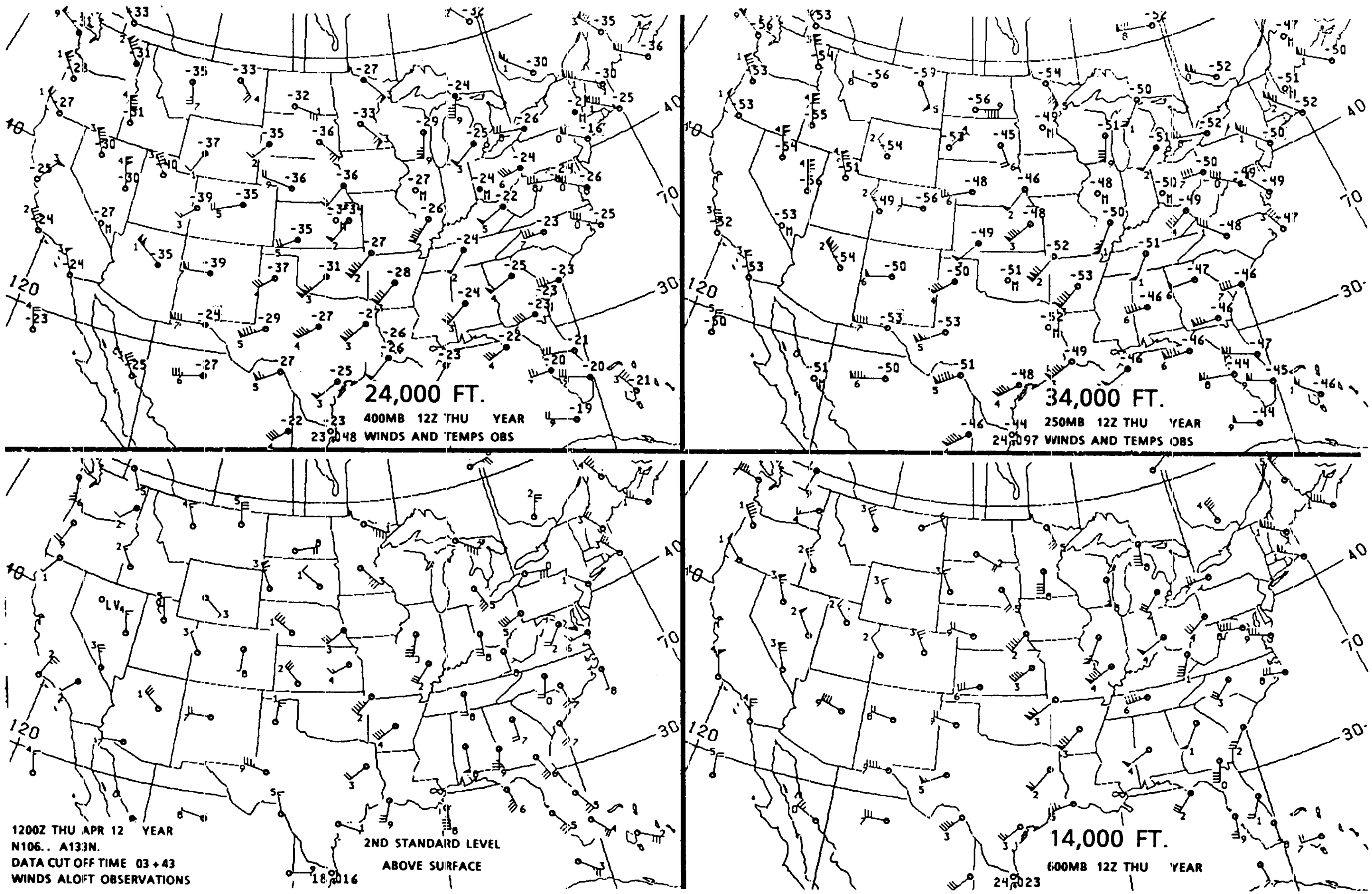
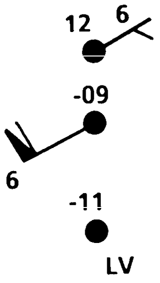


Figure 1-18. Observed Winds Aloft Chart.

PLOTTED



12°C, wind 060° at 5 knots

-09°C, wind 260° at 60 knots

-11°C, wind calm (light variable)

Observed Winds Aloft:

Charts of observed winds for selected levels are sent twice daily on a four-panel chart. Wind direction and speed at each observing station are shown by arrows as on the forecast charts. Figure 1-18 is a panel of the observed wind aloft chart. The upper two panels (24,000 feet and 34,000 feet) include observed temperatures.

Using the Winds Aloft Charts:

To determine flight level winds or to select the best altitude for a proposed flight, use the winds aloft chart. The information is useful to compute correct headings, ground speed, and temperature at an altitude. To determine winds and temperature at an altitude between charted levels, interpolate between the charted levels. Estimate flight-level temperature by using the latest prog for levels nearest your desired altitude. Adjust the temperature 2° C for each 1,000 feet of altitude according to your planned flight level. Remember, forecast winds are generally preferable to observed winds since they are more relevant to flight time. Observed winds are 5 to 8 hours old when received by facsimile, and their reliability diminishes with time.

Chart 9—Military Weather Advisory Criteria

Chart 9 in the Standard Pilot Briefing Display is a permanent display of the color codes and includes a discussion of MIC and TAA found on Chart 6, the Military Weather Advisory.

Chart 10—Local Scheduled Forecasts and Point Warnings

This chart contains local forecasts and weather warnings.

Chart 11—Optional Chart

Some examples of optional charts you may see:
- Constant Pressure Chart
- Satellite Imagery
- Freezing Level Chart
- Astronomical and Climatological Tables
- Regional Briefing Station and Pilot to Metro Service Facilities
- Low-Level Bombing Route Forecasts
- Primary and Alternate Forecasts
- Range and Drop Zone Forecasts

Constant Pressure Charts

Forecasters use constant pressure charts with surface pressure charts to examine past conditions in the atmosphere. Constant pressure charts, together with surface pressure charts and other charts and diagrams, present a three-dimensional picture of the atmosphere. These charts are prepared and transmitted by facsimile. Listed below are the standard pressure surfaces with their corresponding approximate altitude.

Standard Pressure Surface	**Approximate Height Above Mean Sea Level**	
Millibars	**Meters**	**Feet**
1000	120	400
850	1,500	5,000
700	3,000	10,000
500	5,500	18,000
300	9,000	30,000
250	10,000	34,000
200	12,000	39,000

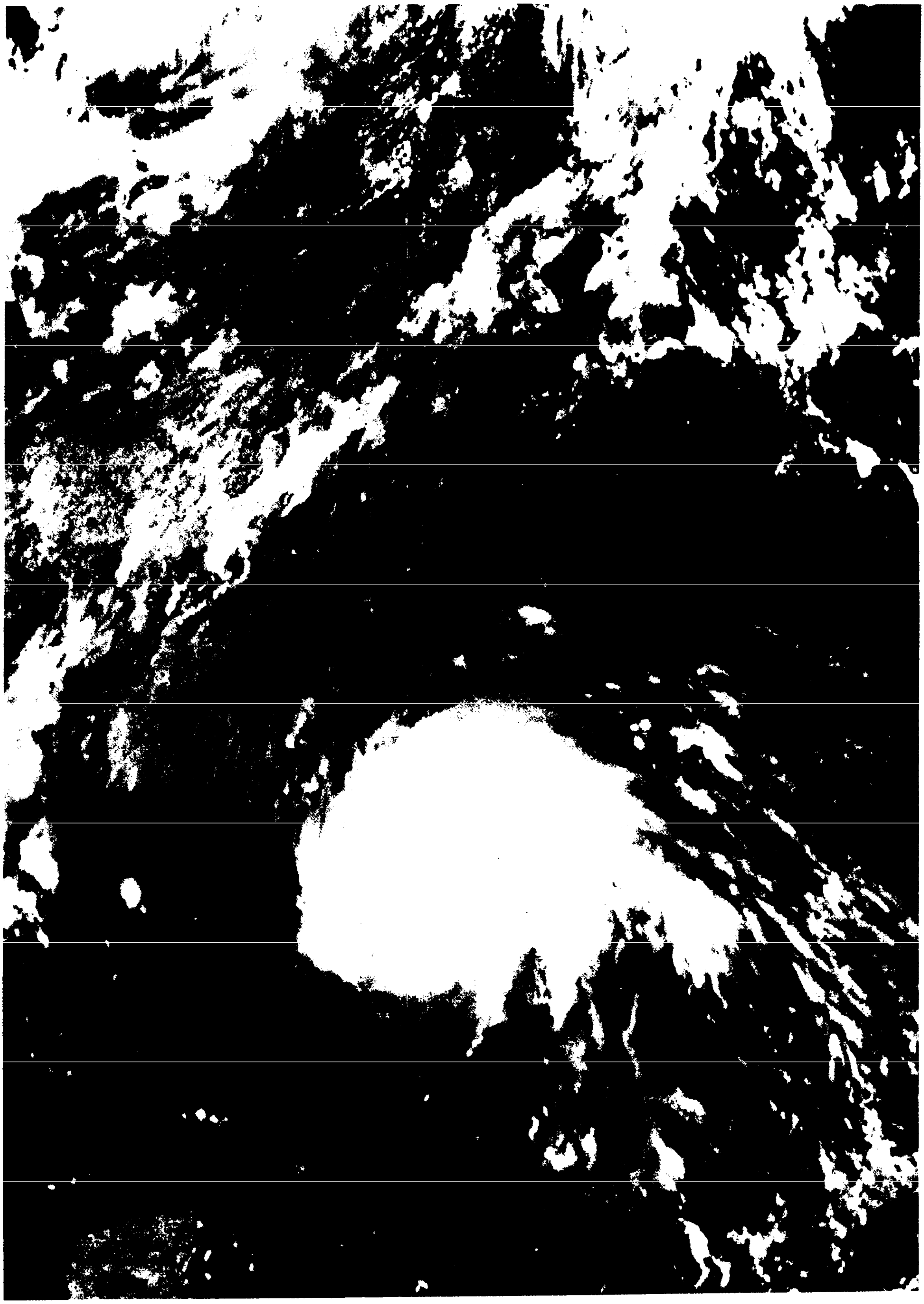


Figure 1-19. Daytime Visual DMSP Satellite Imagery (Resolution 1/3 Nautical Mile) of Hurricane David Over the Florida Coast.

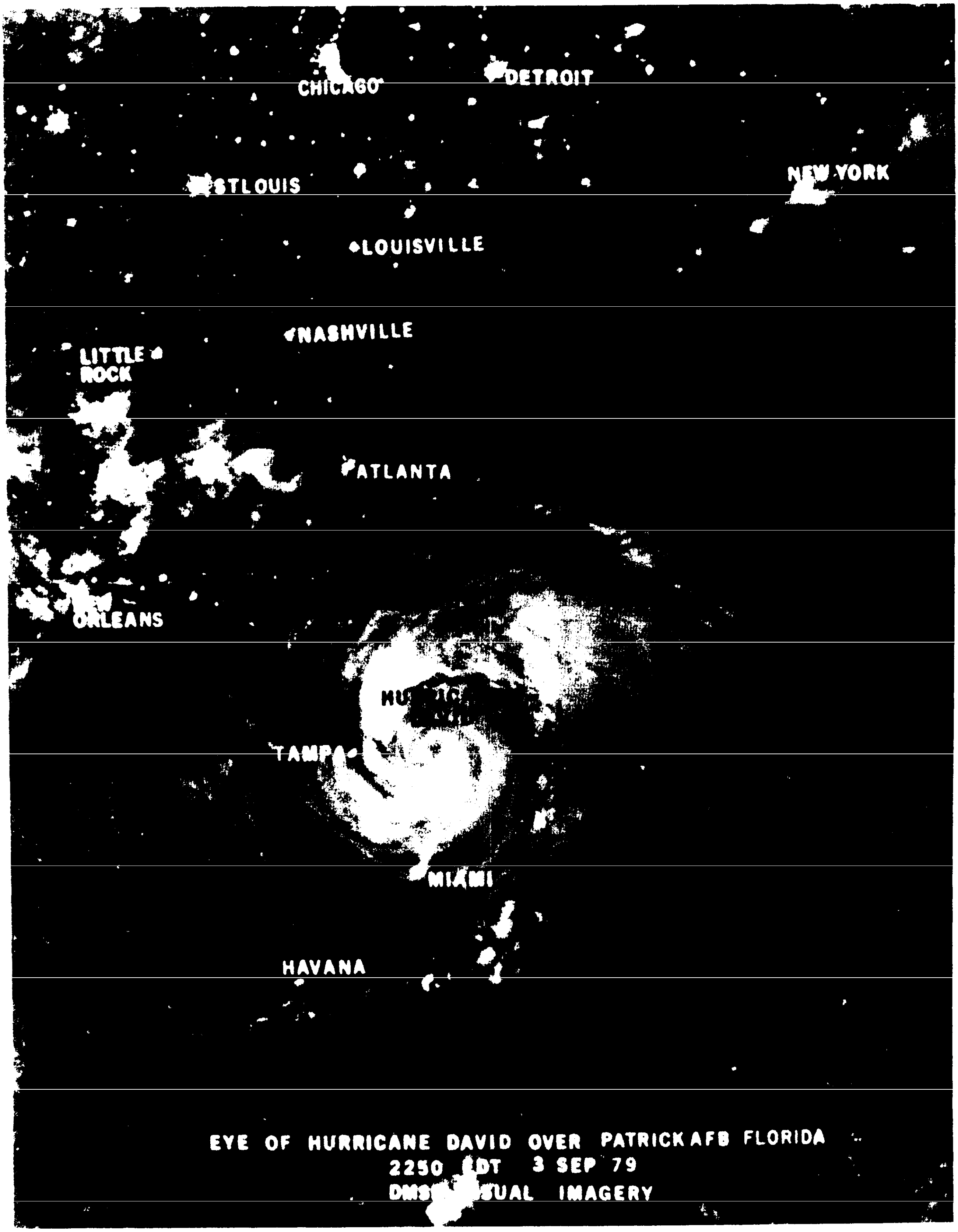


Figure 1-20. DMSP Visual Satellite Imagery of Hurricane David Over Inland Florida Taken at Night (Resolution 1.5 Nautical Miles) With the Aid of Reflected Moonlight 3 Days Before a Full Moon.

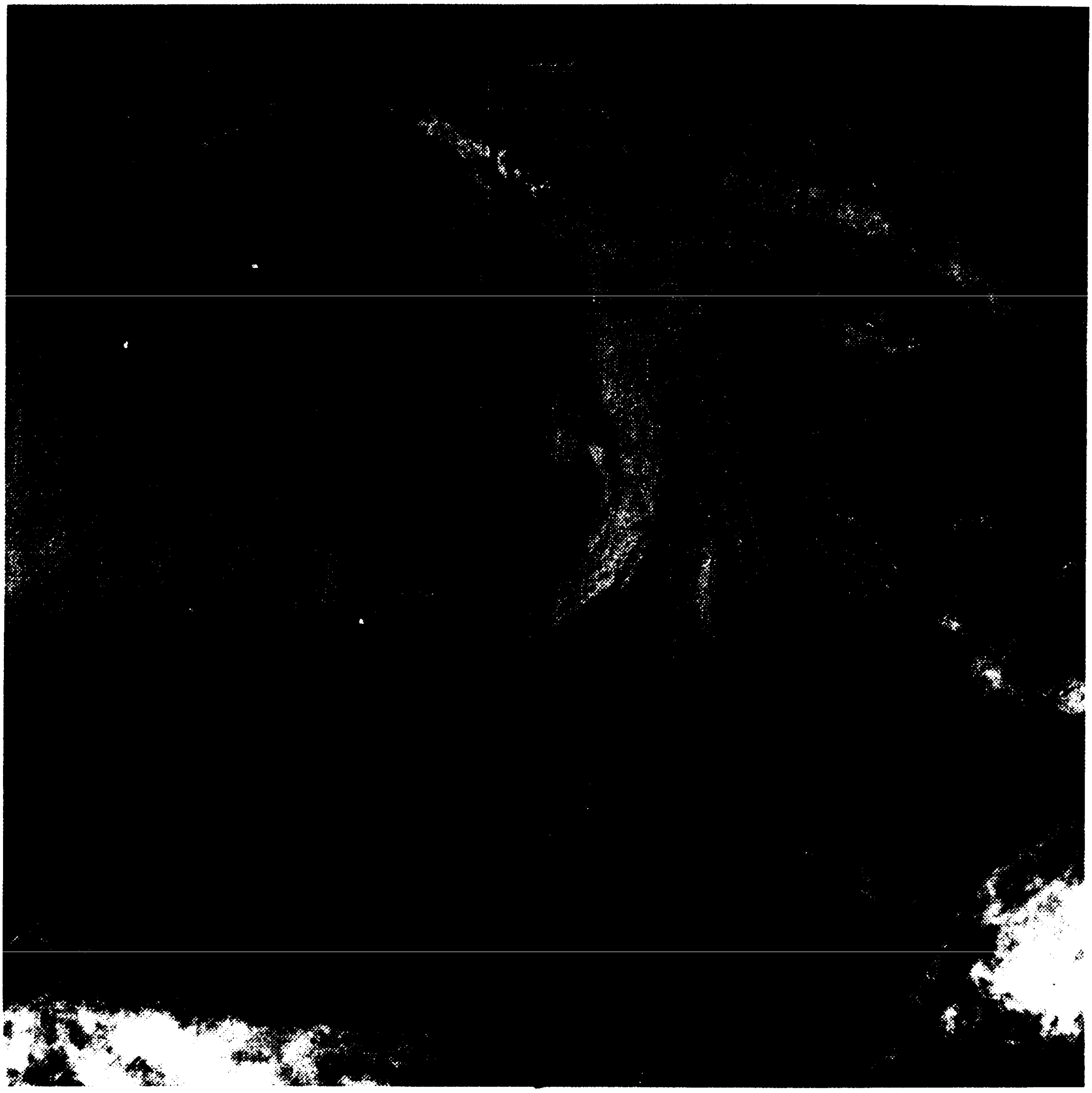


Figure 1-21. GOES Visual Satellite Imagery (Resolution 2 Nautical Miles) Showing a Storm System Along the Pacific Northwest Coast.

Satellite Charts

Satellite imagery (figures 1-19 through 1-21) allows us to see weather systems and prominent land features in near real time from a vantage point high above the earth. This ability leads to a tremendous increase in confidence in the forecast for the aircrew member and forecaster alike. Ironically, it also leads to a special trap called "nowcasting." It's very tempting for a person to look at a satellite photo that is 30 minutes old and believe nothing will change during the period of the proposed flight.

Using the Satellite Chart:

Use satellite imagery the same as any other weather chart. For broad areas of interest, compare the satellite chart to the horizontal weather depiction chart. To see forecast system movement and intensity changes, refer to the low-level prog chart.

Remember, satellite pictures should NOT be used to forecast. They give an overall view of past cloud patterns. Only qualified weather forecasters should interpret satellite imagery.

Chapter 2

TELETYPE INFORMATION

The amount of teletype information available to assist the crewmember is huge. This volume decreased in the CONUS and Hawaii due to COMEDS (CONUS Meteorological Data System), a computer system featuring the video display of alphanumeric weather data. However, since many aircrews fly overseas or into locations with limited forecaster service, they must be familiar with the teletype data necessary to supplement the charts they will use. This data includes weather observations and forecasts.

Weather Observations

Observed weather is reported in a number of ways. The three most pertinent to the aircrew member are:

1. The Aviation Weather Report (weather observation). This report indicates the current weather at a specific geographic location.
2. The Radar Report (RAREP). This gives information from individual radar reporting stations.
3. The Pilot Report (PIREP). Reported via teletype, it describes the weather other aircrews actually encounter. PIREPs assist your understanding of the total weather picture. Examples are given later in this chapter.

Aviation Weather Report:

Since aircrews need up-to-date weather information, routine surface weather observations are disseminated hourly. These hourly reports, are called record observations (SA). In addition, special (SP) and local (L) observations are taken when special weather conditions warrant. "SP" observations are transmitted longline (worldwide) and "L" observations (reflecting changing conditions significant to airfield operations) are passed only to local agencies.

Surface Observation Codes:

Aviation weather observations are encoded and reported in either Airways or Aviation Routine Weather Report (METAR) code (discussed later in this chapter), depending upon the geographical location of the weather station. Figure 2-1, the Airways code, is used mainly in North America, Hawaii, Puerto Rico, and Guam. It is explained in reference to general observation procedures and their relation to the crewmember.

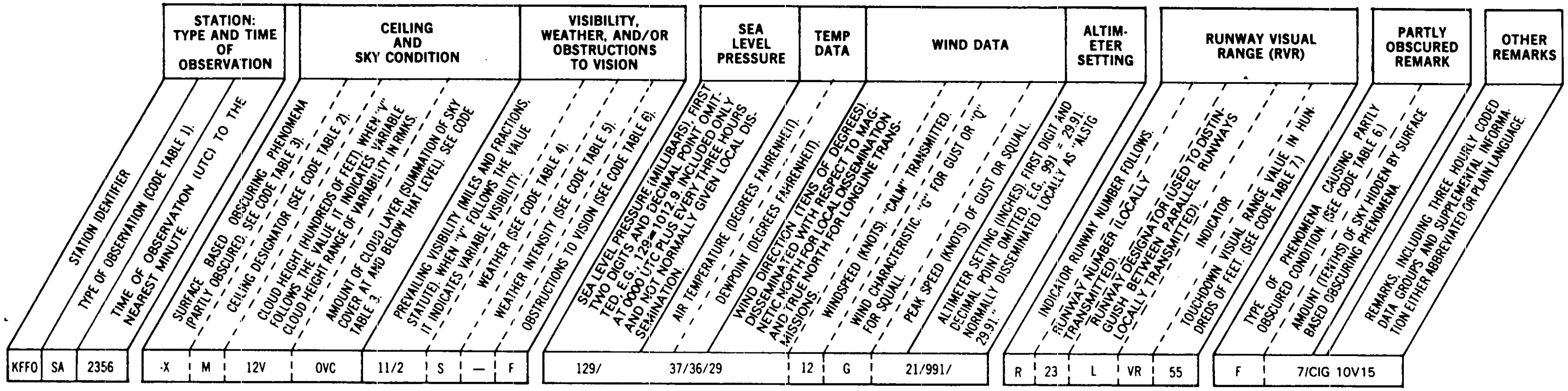
Sky Cover and Ceiling:

The weather observer estimates the amount (in tenths) of the total sky covered by clouds or by obscuring phenomena (either surface-based or aloft). In figure 2-2, examples A and B show two different conditions in which the observer would report the sky cover as scattered, *that is,* half covered (or less) by clouds. To classify the sky as broken or overcast, the cloud layer must cover six-tenths or more of the sky.

When the sides and tops of cumuliform clouds are visible, they produce a "packing effect" causing individual cloud elements to appear closer to, or without spaces between, the clouds toward the horizon. The observer estimates the cloud cover based on the amount of sky that is observable and appears covered. In some cases there are buildings or other obstructions which limit the amount of sky that the observer can see. In this case, the observer attempts to make as accurate an assessment of total sky cover as possible. In part C of figure 2-2, the base and sides of the clouds cover the entire sky. This condition is reported as overcast at 2,000 feet, despite the "clear" areas between the clouds.

Apply the summation principle when two or more cloud layers are present (figure 2-3, A and B). It is especially important for aircrews to understand that reports of broken or overcast clouds at a particular height above the ground does not necessarily mean the cloud layer *at that altitude* actually covers more than half of the sky. Often, the surface-based observer doesn't see the actual extent of higher cloud layers since lower clouds block the view. The observer uses the summation principle to report the amount of sky covered by clouds at each level. This involves adding the amount covered at lower levels to the apparent amount of sky cover at higher levels. Thus, an upper layer, considered scattered by itself, is reported as broken if the total summation of clouds at and below that level is six-tenths or more.

The cumulative amount of sky cover reported determines whether a layer is described as scattered, broken, overcast, partly obscured, or totally obscured (figure 2-1, table 3). The ceiling is the lowest layer reported as broken, overcast, or totally obscured, *and not classified as thin, or partly obscured.* If the sky is



Code Table 1

TYPE OF OBSERVATION	
Indicator	**Meaning**
SA	RECORD
RS	RECORD-SPECIAL
SP	SPECIAL
L	LOCAL
USP	URGENT SPECIAL

Code Table 2

CEILING DESIGNATORS	
E	ESTIMATED
M	MEASURED
W	INDEFINITE

Code Table 3

SKY COVER CONTRACTIONS	
Contraction	Amount of Sky Cover (Tenths)
CLR	NO CLOUDS.
SCT	TRACE TO 0.5
BKN	0.6 TO 0.9
OVC	1.0
A MINUS SIGN "-" PREFIXED TO SCT, BKN, OR OVC INDICATES ONE HALF OR MORE OF SKY COVER IS THIN (DOES NOT CONSTITUTE A CEILING).	
X	OBSCURED. INDICATES THAT SKY IS TOTALLY HIDDEN BY SURFACE BASED OBSCURING PHENOMENA.
—X	PARTLY OBSCURED. INDICATES THAT 0.1 TO 0.9 OF THE SKY IS HIDDEN BY SURFACE BASED OBSCURING PHENOMENA.

Code Table 4

WEATHER SYMBOLS	
Symbol	Meaning
in Plain Language	TORNADO WATERSPOUT FUNNEL CLOUD
T+	SEVERE THUNDERSTORM
T	THUNDERSTORM
R	RAIN
RW	RAIN SHOWERS
L	DRIZZLE
ZR	FREEZING RAIN
ZL	FREEZING DRIZZLE
A	HAIL
IC	ICE CRYSTALS
S	SNOW
SW	SNOW SHOWERS
SG	SNOW GRAINS
SP	SNOW PELLETS
IP	ICE PELLETS
IPW	ICE PELLET SHOWERS

Code Table 5

WEATHER INTENSITIES	
Symbol	**Intensity**
—	LIGHT
No Symbol	MODERATE
+	HEAVY
INTENSITY SYMBOLS ARE NEVER ASSIGNED TO "A" OR "IC"	

Code Table 6

OBSTRUCTIONS TO VISION	
D	DUST
F	FOG
GF	GROUND FOG
IF	ICE FOG
H	HAZE
K	SMOKE
BD	BLOWING DUST
BN	BLOWING SAND
BS	BLOWING SNOW
BY	BLOWING SPRAY

Code Table 7

RUNWAY VISUAL RANGE	
Symbol	Meaning
+	VALUE GREATER THAN HIGHEST REPORTED INCREMENT.
—	VALUE BELOW LOWEST REPORTED INCREMENT.
RVRNO	DATA FOR IN-USE RUNWAY NOT AVAILABLE.

Figure 2-1. Airways Code

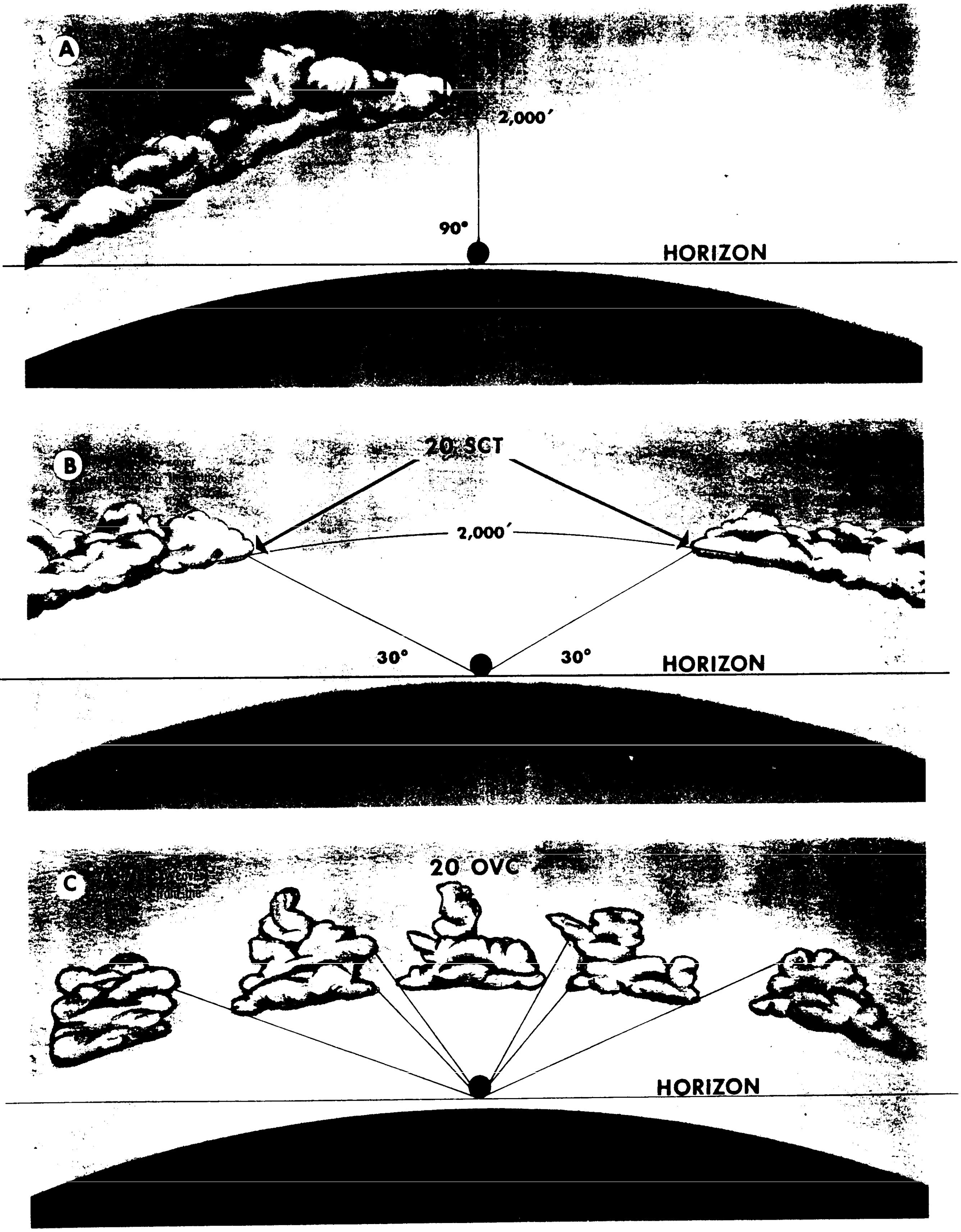
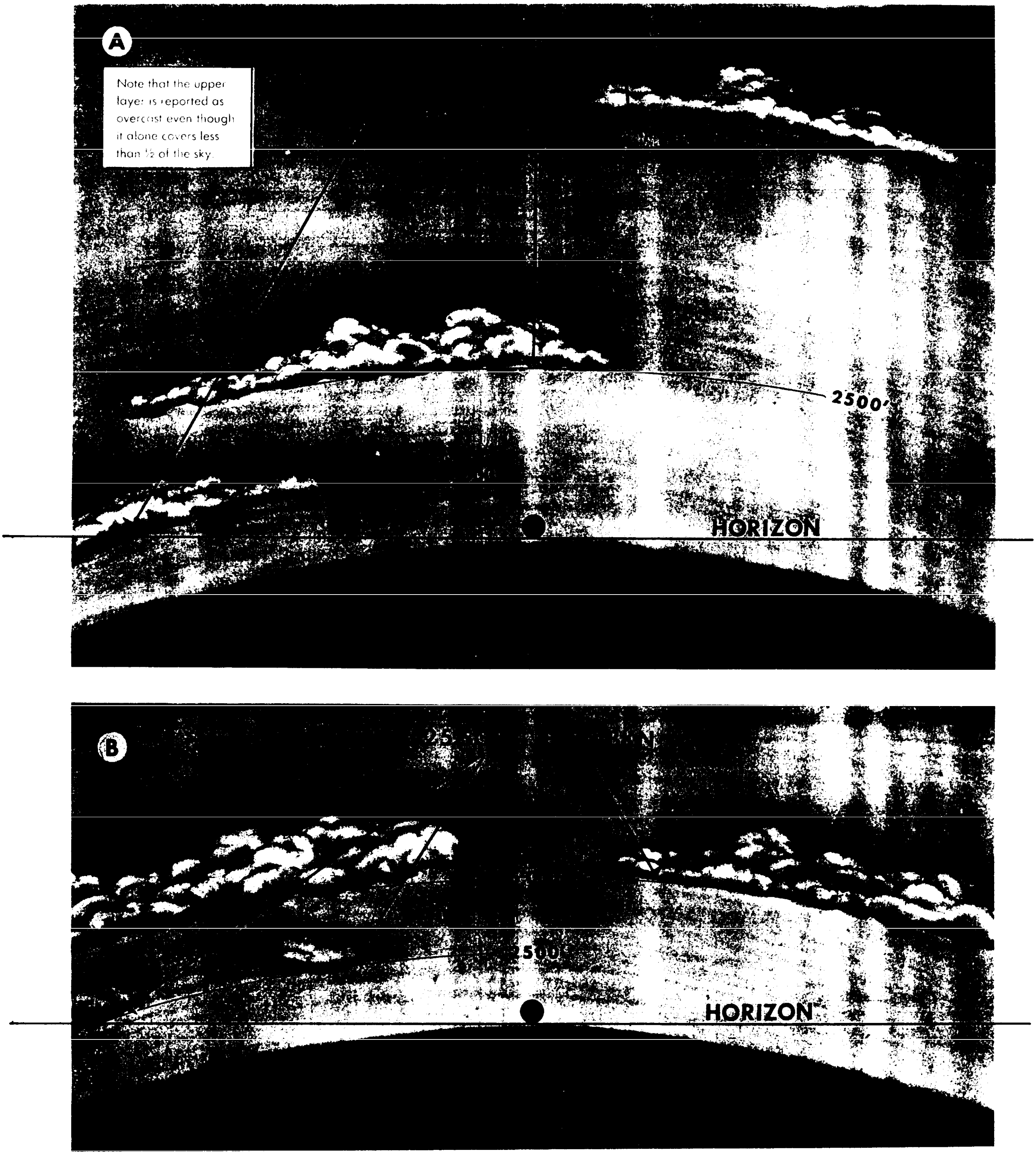


Figure 2-2. Sky Cover Determination (Single Cloud Layer).



Note that the upper layer is reported as overcast even though it alone covers less than ½ of the sky.

Figure 2-3. Summation of Cloud Cover.

totally obscured, the ceiling is the vertical visibility from the ground upward into the obscuration. A ceiling designator from figure 2-1, table 2, describes how the ceiling was determined.

Visibility:

Visibility is the greatest horizontal distance at which selected objects are seen and identified. This distance is not always the same in all directions. For this reason, aviation weather reports include the "prevailing" value.

Prevailing Visibility:

Prevailing visibility is the greatest horizontal visibility observed throughout at least half of the horizon circle. The segments making up this half of the horizon circle need not be adjacent to one another. Figure 2-4 shows how prevailing visibility is determined. Figure 2-5 shows how prevailing visibility varies at different levels and how it would be explained in the remarks section of the aviation weather report (weather observation).

Precipitation and Obstruction to Vision:

Precipitation types are visually determined and classified according to size and state (figure 2-1, table 4). Intensity is determined by rate-of-fall, or according to its effect on the prevailing visibility (figure 2-1, table 5).

Types of visual obstruction (figure 2-1, table 6) are determined by eye. Distinguishing one form of

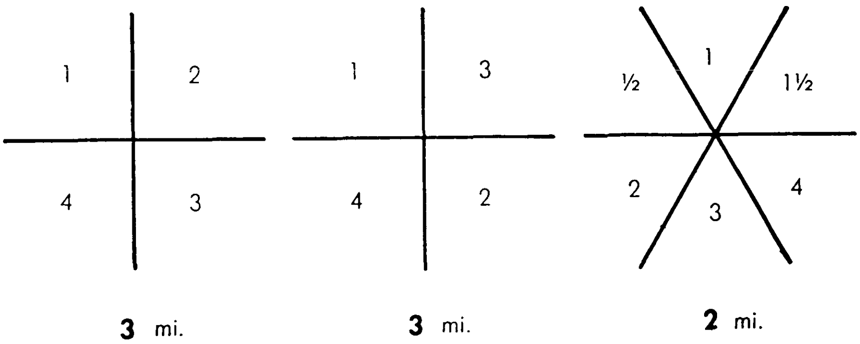


Figure 2-4. Determination of Prevailing Visibility.

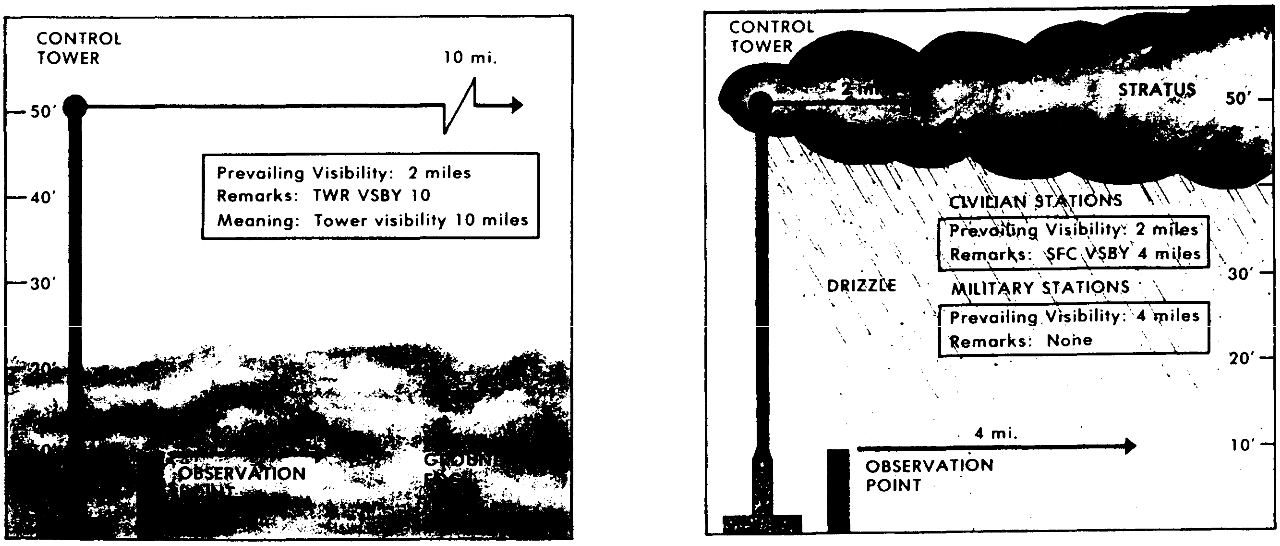


Figure 2-5. Visibility at Different Levels.

obstruction from another is sometimes difficult. *For example,* haze and smoke often look very much alike, and observers must use their knowledge of local effects to make this determination. Additionally, visual obstructions are reported only if they restrict prevailing visibility to six statute miles (9 km) or less.

Atmospheric Pressure and Altimeter Settings:

The atmospheric pressure reported in an aviation weather observation is the pressure at the observing station reduced to MSL. Every hour, observers at Air Force and Army airfields compute, record, and transmit sea level pressure. Aircrews are more interested in the altimeter setting than in the pressure at sea level. Information on altimeters is in AFM 51-12, volume I.

Temperature and Dew Point:

Temperature and moisture content (dew point) directly determine the density of the atmosphere. These two factors greatly influence the length of runway required for aircraft takeoff and landing, as well as power settings for helicopter operations.

Wind:

Most weather stations measure wind direction, speed, character (gusts or squalls), and shifts. Wind reports are estimated at stations without instrumentation, or where wind instrumentation is temporarily inoperative. In these uncommon situations, the aviation weather report signifies that the wind direction and speed are estimated and the direction is prefixed by an "E."

Gustiness is a sudden, brief increase in wind speed. For example, "20G30" means that the average wind speed is 20 knots and that peak speeds during gusts are 30 knots. A squall condition is reported if the wind speed suddenly increases by at least 15 knots, maintains a mean speed of 20 knots or more for 1 or more minutes, and then decreases. Squalls are often accompanied by a rain shower, virga, or thunderstorm and indicate turbulence near the surface.

The reported wind direction is the direction from which the wind is blowing in reference to true north. Normally, it is the prevalent direction over a 2-minute interval. For aviation routine weather report (METAR) observations, however, it is the prevalent direction over the 10-minute interval immediately preceding the time of observation.

A pilot preparing to takeoff or land needs to know the wind direction in reference to magnetic north because runways are oriented on this basis. Air traffic control (ATC) personnel give the magnetic north wind direction at local airports in air-ground communications with pilots. Wind directions for other locations are given in reference to true north. Therefore, all local surface winds are given in reference to magnetic north and all teletype, forecast, and en route winds are given in reference to true north.

Remarks:

The remarks portion of an aviation weather observation often contains information of considerable importance to the aircrew. Remarks, added at the end cover unusual aspects of the weather and pertinent information for pilots, ATC personnel, and weather forecasters. Many remarks are mandatory, while others are added if considered operationally significant. The observer reports additional information in the remarks section of the hourly and special observation as warranted.

As information is available, it's appended to the remarks section of aviation weather reports in the following order:

1. Runway Visual Range (RVR). Direct measuring devices (transmissometers) calculate RVR readings along the runway. At airfields where minima are published in feet, RVR is reported in hundreds of feet during periods in which the transmissometer reading is 6,000 feet or less. In METAR, RVR is reported in meters during periods in which the transmissometer reading is 1,830 meters or less. RVR is transmitted as a remark on longline weather communications circuits; however, in local observations RVR immediately follows the prevailing visibility in the body of the aviation observation.
2. Surface-Based Obscuring Phenomena. *for example,* "F4" means "fog obscuring 4/10 of the sky."
3. Coded Elements. Additional comments pertaining to coded elements reported in preceding sections, such as extreme variability of ceiling, visibility or wind, beginning or end of a thunderstorm or rain, and peak winds may be included in the remarks section.
4. Runway conditions. The base operations officer, or airfield manager provides this information for transmittal on longline weather circuits.

Conditions Reported	*Encoded*
Wet runway	WR
Slush on runway	SLR
Loose snow on runway	LSR
Packed snow on runway	PSR
Ice on runway	IR

Runway condition reading (RCR) is a two-digit decelerometer number from 02 to 25 (or "/ /" when a reading is not available). When applicable, "P" (patchy) and "SANDED" are appended. When conditions are patchy, the appropriate term "WET" or "DRY" follows the encoded runway condition.

An RCR value is not transmitted in weather reports when base operations is closed or data is not available, and the runway is not completely dry. During such periods, the remark "RCRNR" (no report) is appended to hourly weather observations. However, this remark may be omitted if the runway is known to be completely dry.

Examples:

PSR15 *(packed snow on the runway, decelerometer reading 15)*

IR08P dry *(ice on runway, decelerometer reading 08, patchy; remainder of runway is dry)*

WR/ / *(wet runway, decelerometer reading not determined)*

IR05 sanded *(ice on runway, decelerometer reading 5, runway as been sanded)*

RCRNR *(base operations closed, runway is not completely dry)*

Special Observations

Major changes in weather conditions significant to aviation safety and efficiency require prompt transmission. These special reports usually contain the elements of sky and ceiling, weather, obstructions to vision, wind, and appropriate remarks.

As ceiling and visibility deteriorate and begin restricting aircraft operations, only slight changes in these elements may require the transmission of special reports. Tornadoes, thunderstorms, hail, freezing precipitation, ice pellets, and sudden wind changes also require special observations.

Aviation Routine Weather Reports (METAR)

Aircrews flying in oversea areas, must be familiar with the METAR report (figure 2-6). This code is issued by all AWS units outside North America, Hawaii, Puerto Rico, and Guam. Figure 2-7 includes tables explaining each of the METAR code groups.

The METAR code has two formats similar to the standard format approved by the World Meteorological Organization. The first is for longline teletype dissemination of weather observations to other bases. The second, relayed to pilots by controlling agencies, is for local dissemination.

Radar Report (RAREP)

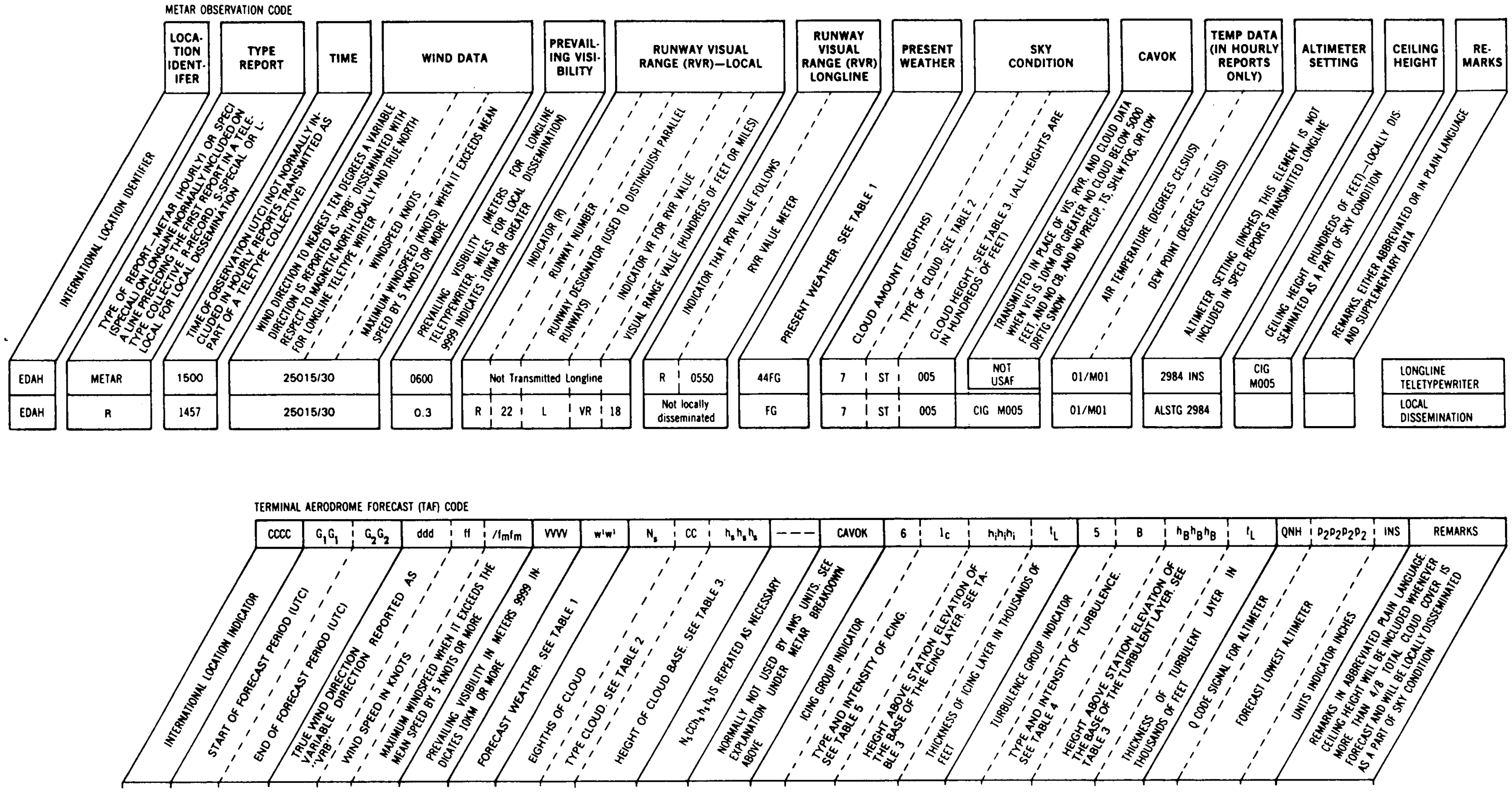
A network composed of NWS and AWS radar is designed to observe precipitation patterns and provide area coverage, height, intensity, and precipitation movement information. Radar observations are normally transmitted at 35 minutes past each hour. Storm detection (SD) is the radar report identifier. The radar code is made up of two major sections, the SD and a digital. The SD section gives radar data in an azimuth-range format *relative to true north,* based on the reporting station being the center of the radar. The digital section, not discussed here, is used as coded input to the automated radar summary, and as a quick-referenced plotting code for the weather forecaster and observer. The RAREP is explained in figure 2-8.

As mentioned earlier, radar observations are used in preparing the radar summary chart. Current radar observations should be used to update old charts. It is wise not to rely entirely on the chart, especially if your route of flight is planned through an area of bad weather. Remember, convective cells can change their character and intensity very rapidly.

Pilot Weather Report (PIREP)

Weather observations contain precise information most valuable for takeoffs, landings, approaches, and departures; but, they do not fully meet the need for information on weather conditions at flight altitude. Aircrews have a distinct advantage over ground observers in making weather observations. Not only do the aircrews usually have a broader horizon, but if they are flying above a cloud layer, they may see higher clouds or other phenomena which are probably unseen by the ground observer. Heights of upper cloud layers, turbulence, and icing are frequently evident only to airborne pilots, and their reports of these conditions are valuable to other aircrews, controllers, and weather forecasters.

ATC (towers and centers) makes wide use of PIREPs to expedite the flow of air traffic both into the terminal



EXAMPLE OF TAF FORMAT FOR LONGLINE TELETYPE TRANSMISSIONS

EDAH	1212	23015/25	9999		4CU 030	4CI250				QNH 29.96 INS	CIG 250
GRADU	1618	23020/30	8000	80 RASH	5CB020	4CI250		650504	550208	QNH 29.93 INS	CIG 020

EXAMPLE OF MODIFIED TAF FORMAT USED FOR LOCAL DISSEMINATION
(Visibility in miles, heights in hundreds of feet and wind direction in degrees magnetic.)

FORECAST VALID EDAH 12Z TO 12Z	23015/25	7		4CU030	4CI250CIG250				QNH 29.96 INS	
GRADU 16-17Z	25020/30	4.3	RASH	5CB020CIG020	4CI250		MOD ICING 050-090	MOD TURB 020-100	QNH 29.93 INS	

Figure 2-6. Key to METAR and TAF Codes.

METAR AND TAF CODE TABLES

TABLE 1

w' w' SIGNIFICANT PRESENT AND FORECAST WEATHER

Code	Decode	
04 FU	Smoke	
05 HZ	Haze	
06 HZ	Dust	
07 SA	Blowing dust or sand	
08 PO	Dust devils	
10 BR	Mist (fog)	
11 MIFG	Shallow fog or ice fog	
12 MIFG		
17 TS	Thunderstorm (no precipitation)	
18 SQ	Squall	
19 FC	Tornadic activity	
20 REDZ	Recent drizzle	
21 RERA	Recent rain	
22 RESN	Recent snow	
23 RERASN	Recent rain and snow	
24 RAFZRA	Recent freezing rain	
25 RESH	Recent showers	
26 RESNSH	Recent snow showers	
27 REGR	Recent hail*	
29 RETS	Recent thunderstorms	
30 SA	Duststorm or sandstorm	
31 SA		
32 SA		
33 XXSA	Heavy duststorm or sandstorm	
34 XXSA		
35 XXSA		
36 DRSN	Drifting snow	
37 DRSN		
38 BLSN	Blowing snow	
39 BLSN		
40 BCFG	Fog patches	
41 BCFG		
42 FG	Fog or ice fog	
43 FG		
44 FG		
45 FG		
46 FG		
47 FG		
48 FZFG	Freezing fog	
49 FZFG		
50 DZ	Light drizzle	
51 DZ		
52 DZ	Moderate drizzle	
53 DZ		
54 XXDZ	Heavy drizzle	
55 XXDZ		
56 FZDZ	Light freezing drizzle	
57 XXFZDZ	Moderate or heavy freezing drizzle	
58 RA	Light drizzle and rain	
59 RA	Moderate drizzle and rain	
60 RA	Light rain	
61 RA		
62 RA	Moderate rain	
63 RA		
64 XXRA	Heavy rain	
65 XXRA		
66 FZRA	Light freezing rain	
67 XXFZRA	Moderate or heavy freezing rain	
68 RASN	Light rain and snow	
69 XXRASN	Moderate or heavy rain and snow	
70 SN	Light snow	
71 SN		
72 SN	Moderate snow	
73 SN		
74 XXSN	Heavy snow	
75 XXSN		
76 IC	Ice crystals	
77 SG	Snow grains	
79 PE	Ice pellets	
80 RASH	Light rainshowers	
81 XXSH	Moderate rainshowers	
82 XXSH	Heavy rainshowers	
83 RASN	Light rain and snowshowers	
84 XXRASN	Moderate or heavy rain and snowshowers	
85 SNSH	Light snowshowers	
86 XXSNSH	Moderate or heavy snowshowers	
87 GR	Light ice or snow pellet showers	
88 GR	Moderate or heavy ice or snow pellet showers	
89 GR	Hail	
90 XXGR		
91 RA	Rain	With recent thunderstorms
92 XXRA	Heavy rain	
93 GR	Hail*	
94 XXGR		
95 TS	Thunderstorm with rain/snow	
96 TSGR	Thunderstorm with hail*	
97 XXTS	Servere thunderstorm with rain/snow	
98 TSSA	Thunderstorm with duststorm or sandstorm	
99 XXTSGR	Severe thunderstorm with hail*	

NOTE: The asterisk (*) refers to snow pellets, ice pellets (type 6) and hail.

TABLE 2

CC-CLOUD TYPE

Code	Decode	Code	Decode
CI	Cirrus	NS	Nimbostratus
CC	Cirrocumulus	SC	Stratocumulus
CS	Cirrostratus	ST	Stratus
AC	Altacumulus	CU	Cumulus
AS	Altostratus	CB	Cumulonimbus

TABLE 3

$h_Bh_Bh_B - h_fh_fh_f - h_ih_ih_i - h_sh_sh_s - h_th_th_t - h_xh_xh_x$

Code Figure	Meters	Feet	Code Figure	Meters	Feet
000	30	100	045	1350	4500
001	30	100	046	1380	4600
002	60	200	047	1410	4700
003	90	300	048	1440	4800
004	120	400	049	1470	4900
005	150	500	050	1500	5000
006	180	600	060	1800	6000
007	210	700	070	2100	7000
008	240	800	080	2400	8000
009	270	900	090	2700	9000
010	300	1000	100	3000	10000
011	330	1100	110	3300	11000
012	360	1200	120	3600	12000
013	390	1300	130	3900	13000
014	420	1400	140	4200	14000
015	450	1500	150	4500	15000
016	480	1600	160	4800	16000
017	510	1700	170	5100	17000
018	540	1800	180	5400	18000
019	570	1900	190	5700	19000
020	600	2000	200	6000	20000
021	630	2100	210	6300	21000
022	660	2200	220	6600	22000
023	690	2300	230	6900	23000
024	720	2400	240	7200	24000
025	750	2500	250	7500	25000
026	780	2600	260	7800	26000
027	810	2700	270	8100	27000
028	840	2800	280	8400	28000
029	870	2900	290	8700	29000
030	900	3000	300	9000	30000
031	930	3100	350	10500	35000
032	960	3200	400	12000	40000
033	990	3300	450	13500	45000
034	1020	3400	500	15000	50000
035	1050	3500	550	16500	55000
036	1080	3600	600	18000	60000
037	1110	3700	650	19500	65000
038	1140	3800	700	21000	70000
039	1170	3900	(etc)	(etc)	(etc)
040	1200	4000	990	29700	99000
041	1230	4100	999	30000	100000
042	1260	4200		or more	or more
043	1290	4300			
044	1320	4400			

TABLE 4

B-TURBULENCE

Code	Decode
0	None
1	Light turbulence
2	Light OCNL moderate turbulence in clear air
3	Moderate turbulence in clear air
4	Light OCNL moderate in cloud
5	Moderate turbulence in cloud
6	Light OCNL severe turbulence in clear air
7	Severe turbulence in clear air
8	Light OCNL severe turbulence in cloud
9	Severe turbulence in cloud

NOTES

1. AWS units will encode extreme turbulence by use of Code Figure 6, 7, 8, or 9 and adding "EXTRM TURB $h_Bh_Bh_B$—$h_th_th_t$ in REMARKS.
2. OCNL is defined as occuring less than 1/3 of the time.

TABLE 5

k - ICING

Code	Decode
* 0	None or trace
1	Light icing (light mixed)
2	Light icing in cloud (light rime)
3	Light icing in precipitation (light clear)
4	Moderate icing (moderate mixed)
5	Moderate icing in cloud (moderate rime)
6	Moderate icing in precipitation (moderate clear)
7	Severe icing (severe mixed)
8	Severe icing in cloud (severe rime)
9	Severe icing in precipitation (severe clear)

*WMO code figure 0 is no icing. AWS units will use 0 to indicate a trace of icing.

TABLE 6

FORECAST CHANGE GROUPS

The form GRADU GGG_eG_e is used if changes are expected to take place at an approximately constant rate throughout the period beginning at GG and ending at G_eG_e, e.g., "GRADU 0203" indicates a gradual change between 0200 and 0300 GMT. RAPID is used instead of GRADU when the changes are expected to take place during a period lasting less than half an hour.

The form INTER GGG_eG_e is used if the changes are expected to occur frequently for short periods and fluctuate almost constantly, throughout the period beginning at GG and ending at G_eG_e, e.g., "INTER 0913" indicates intermittent changes between 0900 and 1300 GMT. The intermittent condition will not cover in the aggregate more than one half of the forecast period, or more than 30 minutes of any hour (45 minutes for thunderstorms).

Figure 2-7. METAR and TAF Code Tables.

LOCATION IDENTIFIER	TIME OF REPORT	CHARACTER OF ECHOES	WEATHER AND INTENSITY	INTENSITY TENDENCY	LOCATION AND DIMENSIONS OF ECHOES	MOVEMENT	ECHO TOPS	REMARKS
EVV	**1635 Z**	**AREA 6**	**TRW + A**	/ +	**4/125 221/115 100W**	**A2715 CELLS 2325**	**MT 550 at 310/45**	**3/4 INCH HAIL 310/45**

DECODED REPORT

Evansville Indiana hourly Radar Report (RAREP) taken AT 1635Z. An area 6 tenths covered with echoes, containing thunderstorms producing heavy rainshowers and occasional hail at the surface. These echoes are increasing in intensity. Area extends from 4° 125 nautical miles to 221° 115 nautical miles, is 100 nautical miles wide.The area is moving from 270° at 15 knots, the cells within the area from 230° at 25 knots. Maximum top of the detectable moisture is 55,000 feet MSL at 310° 45 nautical miles. Hail 3/4 inch in diameter was reported with this echo.

The above report is for the echo area in the radarscope picture. The slash mark (/) is used to separate the intensity of the echo from the intensity tendency.

TIME OF REPORT

Time of observation (24-hour clock) in Universal Coordinated Time. Observations are normally taken at 35 minutes past each hour. When a special observation is taken, the contraction SPL is placed between the Time of Report and Character of Echoes.

CHARACTER OF ECHOES

CHARACTER	DEFINITION	CONTRACTION
Isolated echo	Independent convective echoes	CELLS
Area	A grouping of related or similar echoes	AREA
Line	Related or similar echoes forming a line at least 30 miles long with a length-to-width ratio of at least 5 to 1	LN
Stratified elevated echo	Precipitation aloft	LYR
Spiral band area	Curved lines of echoes including wall cloud, which occur in connection with hurricanes, tropical storms, and typhoons	SPRL BAND AREA
Fine line	Narrow, nonprecipitation echo associated with a meteorological discontinuity	FNLN

NOTE: Echo coverage in tenths within an area, line or elevated echo is given by the number which immediately follows the word or contraction describing the character of the echoes. For example, AREA 6 means that echoes cover 6 tenths of the outlined area.

PRECIPITATION SYMBOLS

IP	ICE PELLETS	SW	SNOW SHOWERS	ZR	FREEZING RAIN
L	DRIZZLE	T	THUNDERSTORMS	ZL	FREEZING DRIZZLE
RW	RAIN SHOWERS	S	SNOW	ZRW	FREEZING RAIN SHOWER
R	RAIN	A	HAIL	IPW	ICE PELLET SHOWER

INTENSITY

LIGHT	–	VERY HEAVY	++	UNKNOWN	U
MODERATE	NO SIGN	INTENSE	X		
HEAVY	+	EXTREME	XX		

INTENSITY TREND

TREND	CONTRACTION
Increasing	+
Unchanging	NC
Decreasing	—
Newly Developed	NEW

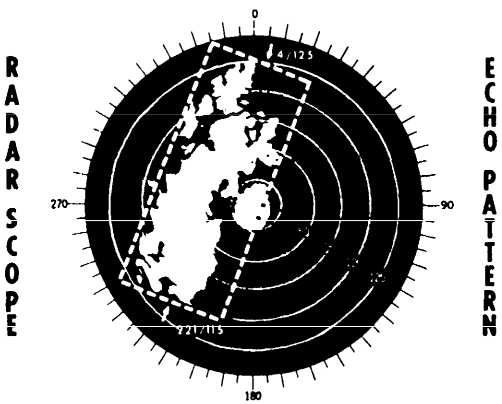
The intensity trend is evaluated in terms of a net change in the characteristic intensity equal to approximately one intensity category (light to moderate) during a specified time period, which is one hour for lines and areas and fifteen minutes for cells.

DIMENSIONS OF ECHOES

Width (W) or diameter (D) are reported in nautical miles. The average width of lines and rectangular areas, and the average diameter of cells and roughly circular areas, are reported.

MOVEMENT

Both direction and speed of movement are reported. Direction is reported in tens of degrees relative to true north. Speed is in knots. Movements are encoded in groups of five characters. The first character is the letter "A", "C" or "L" representing area, cell, or line movement. The next two characters are direction of movement in tens of degrees. The last two characters are the speed.



LOCATION OF ECHOES

1. Locations of echoes are relative to the radar position. The azimuth in degrees true, and the distance in nautical miles, to salient points of the echoes are given.
2. If the echoes are arranged in a line, the azimuth and distance will be given to as many points along the axis of the line as are necessary to establish its shape.
3. If an irregularly shaped area is covered by echoes, the azimuth and range to salient points on the perimeter of the area will be reported as necessary to reconstruct the shape and size of the echo area.
4. If an area of echoes of roughly circular shape is observed, or if a single echo such as a thunderstorm cell is observed, the azimuth and range to the center of the area or cell will be reported.

ECHO TOPS

Maximum height of detectable moisture, in hundreds of feet above mean sea level. Tops are not reported beyond 125 nautical mile range.

UNUSUAL ECHO FORMATIONS

Certain types of severe storms produce distinctive patterns on the radar scope. For example, the hook-shaped echo associated with tornadoes and the spiral bands with hurricanes. The bright band is a narrow horizontal layer of intensified radar signal a short distance below the 0°C isotherm (Melting level). Unusual echo formations will be reported in remarks.

OPERATIONAL STATUS

STATUS	CONTRACTION
(1) Equipment performance normal on PPI scan; echoes not observed	PPINE
(2) Equipment out of service for preventive maintenance resulting in loss of PPI presentation (The contraction is followed by a date time group to indicate the estimated time when operation will be resumed)	PPIOM
(3) Observation omitted for a reason other than those above, or not available.	PPINA
(4) Radar not operating on RHI mode; echo altitude measure— ments not available.	RHINO
(5) A-scope or A/R indicator not operating	ARNO
(6) Radar operating below performance standards	ROBEPS

A contraction pertaining to the operational status of the equipment is sent as required by the table above. In the above list, "PPI" refers to the radar-scope (Plan Position Indicator); the additional letters refer to "no echo" (NE).

GENERAL NOTES

SD (Storm Detection)-Radar Report (RAREP) identifier. Identifies the message as a RAREP.

Intensity of precipitation at distances exceeding 125 nautical miles from a WSR-57 or other radar of similar sensitivity, or 75 miles from other radars, will be reported as unknown (U). Intensities of snow, hail, drizzle, and ice pellets are not reported.

One rainfall intensity category is selected to characterize each reported echo system. For convective systems, it is the maximum intensity in the system. For other systems, it is the intensity predominant in horizontal extent.

Persisting echoes are indicated in remarks.

Figure 2-8. Radar Report (RAREP).

and in en route areas. *For example,* PIREPs of turbulence are considered when assigning a departure route or flight altitude. Weather forecasters use pilot weather reports as a forecasting aid to provide preflight briefing and inflight services to aircrews. The reports, broadcasted regularly over selected navigational aids for aircrews, are transmitted on weather communication circuits to benefit other facilities.

AFR 60-16 advises pilots to make reports of all weather elements when possible. Report hazardous weather immediately to the most appropriate facility (Air Route Traffic Control Center (ARTCC), approach control, tower or base weather). Consult the Flight Information Handbook for procedures and requirements for making PIREPs.

PIREP Format:

The PIREP format includes a "message type" (UUA, severe; UA, regular) and a "text element indicator" preceding each element of the PIREP to tell the computer that data follows. Each "indicator" consists of a slash (/), two letters, and a space (except for "FL" which is not followed by a space.)

1. /OV–Indicates that aircraft position, time of observation, and altitude follows. Aircraft position is relative to an omnirange transmitter (TACAN, VORTAC, VOR) with a six-digit group giving the relative bearing (first three digits) and distance (last three digits) from the omnirange. "DURGC" (during climb) or "DURGD" (during descent) indicates PIREPs received by aircraft taking off or landing.
2. /TM–Time of observation (Z).
3. /FL–Altitude (flight level).
4. /TP–Type of aircraft.
5. /SK–Sky cover.
6. /WX–Visibility and weather (visibility to nearest mile).
7. /TA–Temperature (in whole degrees C).
8. /WV–Wind direction and speed encoded in six digits; e.g. 030045 means winds from 030 degrees true at 45 knots.
9. /TB–Turbulence (includes intensity, type, and altitude).
10. /IC–Icing (includes intensity, type, and altitude).
11. /RM–Remarks. Clarifies coded elements and adds significant data.

Examples:

1. BLV UA/OV BLV 315045/TM 2224/FL UNKN/TP C9/RM BKN LN TSTMS N-S OCNL LTGCCCG 030 UNKN 345. A pilot at 315 degrees and 45 miles from Scott AFB was flying at 2224Z at an unknown flight level. The type aircraft is a C-9 and the pilot was flying in or near a broken line of thunderstorms aligned north to south with occasional lightning from cloud to cloud and from cloud to ground. Bases of the clouds are at 3,000 feet, total sky cover is unknown, and the tops of the clouds are at 34,500 feet.
2. FWH UA/OV DAL 050040/TM 2312/FL390/TP B52/TB MDT CAT 350-390. A pilot at 050 degrees and 40 miles from Carswell AFB was flying at 2312Z at 39,000 feet. The type of aircraft is a B-52 which encountered moderate clear air turbulence from 35,000 feet to 39,000 feet.

Aviation Weather Forecasts

Aircrews planning flights are concerned with the forecast surface weather conditions along the proposed route and at the destination and alternate bases. These forecasts advise the aircrew of the development of potentially hazardous weather and help determine the fuel requirements to complete the mission.

Aviation weather forecasts have two formats, Terminal Aerodrome Forecasts (TAF), and US Terminal Forecast Code. The AWS and International TAF codes are virtually the same.

Terminal Aerodrome Forecast (figure 2-6):

The TAF code, in the same format as the METAR observation code (figures 2-6, 2-7), is a forecast for a particular terminal for a period up to 24 hours covering the following weather data:

1. Wind direction, speed, and maximum wind expected.
2. Prevailing visibility in meters; 9999 indicates visibility is 10 km (7 statute miles) or more.
3. Weather phenomena, including forms of precipitation and restrictions to visibility. Forecast weather is encoded in both numbers and alphabetical designator from figure 2-7, table 1. For example, 61RA indicates light rain is forecast.
4. Eighths of sky coverage of each cloud layer expected over the station, with AGL cloud-bases and types of clouds. When no clouds are forecast, "SKC" is entered for clear sky. If clouds at or below a layer cover more than 4/8 of the sky, that layer is the ceiling, and is identified in the remarks section as "CIG" with the expected height; e.g., CIG 050. No ceiling (some of the clouds are thin even when covering more than

4/8 of the sky), is reported as "CIG NO." The format 9//hshshs means the sky is forecast obscured where hshshs is the vertical visibility in hundreds of feet; e.g., 9//002. CAVOK is a code (not used by AWS) replacing visibility, weather, and cloud layers when the following conditions are forecast simultaneously:

(a) Visibility 10 km or more.

(b) No clouds below 5,000 feet and no CB.

(c) No precipitation, thunderstorm, or shallow fog.

5. Height and thickness of icing and turbulence layers (not associated with thunderstorms). These entries are omitted when no icing or turbulence is forecast.

6. Minimum altimeter setting expected.

7. Pertinent plain language remarks.

Below are TAF code contractions and their meanings:

GRADU	Used when a change is to take place at a constant rate during the period (not to exceed 2 hours) of the GRADU (gradual) times.
RAPID	Indicates fast changing weather taking place over a period of less than 30 minutes.
INTER	Intermittent conditions occurring for less than 30 minutes (45 minutes for thunderstorms) of any hour, and less than one-half of the forecast period.

The International Terminal Aerodrome Forecast code also includes the following contractions:

TEMPO	Indicates temporary changes to occur for a period of less than 1 hour.
FRONT	Frontal passage indicator. "FRONT" is followed by 4 digits giving hours and minutes (time) of passage.
PROB	Indicates probability in percent of conditions occurring, i.e., "PROB20" means a 20 percent probability of conditions occurring.

US Terminal Forecast:

Terminal forecasts in the US FT code (sometimes called "Domestic" code) are valid for 24 hours. The FT format is essentially the same as for airways code; it uses most of the same symbols, abbreviations, and reportable values. Coded elements include terminal identification, date-time group, height and amount of sky cover, visibility, weather and obstruction to vision, surface wind, remarks, and a 6-hour categorical outlook.

Following is an example of FT, with explanation:

Example:

STL 251010 C5 X 1/2S-BS 3325G35 OCNL C0 X OS + BS 16Z C30 BKN 3BS 3320 BRF SW-. 22Z 30 SCT 3315. 00Z CLR. 04Z VFR WIND..

1. Station Identifier "STL." Forecast is for St. Louis, Missouri.

2. Date-Time Group "251010." Forecast valid on the 25th day of the month at 1000Z until 1000Z the following day.

3. Sky and Ceiling. Sky and Ceiling "C5 X" means ceiling 500 feet, sky obscured.

4. Visibility. Visibility "1/2" means visibility 1/2 statute mile. Absence of a visibility entry specifically implies visibility more than 6 miles.

5. Weather Obstructions. "S-BS" means light snow and blowing snow. These elements are in symbols identical to those used in airways reports (figure 2-1, tables 4 and 6).

6. Wind. Wind "3325G35" means wind from 330 degrees true at 25 knots gusting to 35 knots. Omission of a wind entry specifically implies wind less than 10 knots.

7. Remarks. Remarks "OCNL C0 X 0S + BS" means occasional ceiling zero, sky obscured, visibility zero, heavy snow and blowing snow.

8. Expected Changes. When changes are expected, preceding conditions are followed by a period and the time and conditions of the expected change. For example, "16Z C30 BKN 3BS 3320 BRF SW-. 22Z 30 SCT 3315. 00Z CLR," means by 1600Z, broken ceiling 3,000 feet, visibility 3 miles, blowing snow, wind 330 degrees at 20 knots, brief light snow showers. By 2200Z, 3,000 scattered (no ceiling), visibility more than 6 miles (implied), wind 330 degrees at 15 knots. By 0000Z sky clear, visibility more than 6 miles, wind less than 10 knots (implied).

9. Six-hour Categorical Outlook. The last 6 hours of the forecast is a categorical outlook using the following code:

LIFR (low IFR)	Ceiling less than 500 ft and or visibility less than 1 mi.
IFR	Ceiling 500 ft to <1,000 ft and or visibility 1 to less than 3 mi.
MVFR (marginal VFR)	Ceiling 1,000 to 3,000 ft and or visibility 3 to 5 miles inclusively.
VFR	Ceiling >3,000 ft and visibility >5 miles (includes clear sky).

10. "04Z VFR WIND.." means that from 0400Z until 1000Z, the end of the forecast period, the forecast calls for a ceiling >3,000 feet and visibility >5 miles (VFR). The word "WIND" indicates wind or gusts at 25 knots or greater for the outlook period. The double period (..) signifies the end of the FT.

Chapter 3

PREFLIGHT WEATHER BRIEFING

Weather briefing facilities established by the AWS provide tailored weather service for all military aircrews regardless of their departure point. These facilities are listed in the Flight Information Handbook. If a forecaster is not available at the departure base, call the designated regional briefing station (RBS). Review all available weather information, then make your call (figure 3-1).

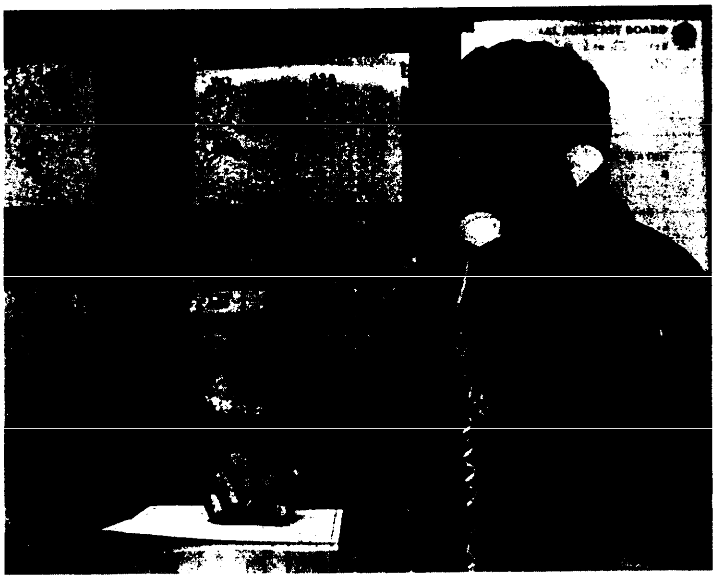


Figure 3-1. Telephone Weather Briefing.

Requesting the Weather Briefing

Aircrew action, with regard to obtaining a weather briefing, depends upon the availability of weather briefing services. The normal pattern for most flight planning is to call the weather station and obtain a general picture of weather conditions before making any detailed route and altitude selection. This allows a portion of the detailed planning to be done early. When ready for the weather briefing, give the forecaster or briefer your:

1. Name (If by phone, identify yourself as a crewmember).
2. Aircraft identification and type.
3. Departure point, destination and alternate bases.
4. Type of flight.
5. Estimated time of departure (ETD) and estimated time en route to destination and alternate.
6. Intended route.
7. En route stops, if applicable, with estimated time of arrival (ETA) and ETD.
8. Locations and times of refueling tracks, low-level flights, and ranges or targets being used.

Aircrews, prebrief yourselves (figure 3-2) when obtaining a weather briefing by phone and when a standardized pilot briefing display or similar weather data presentation is available.

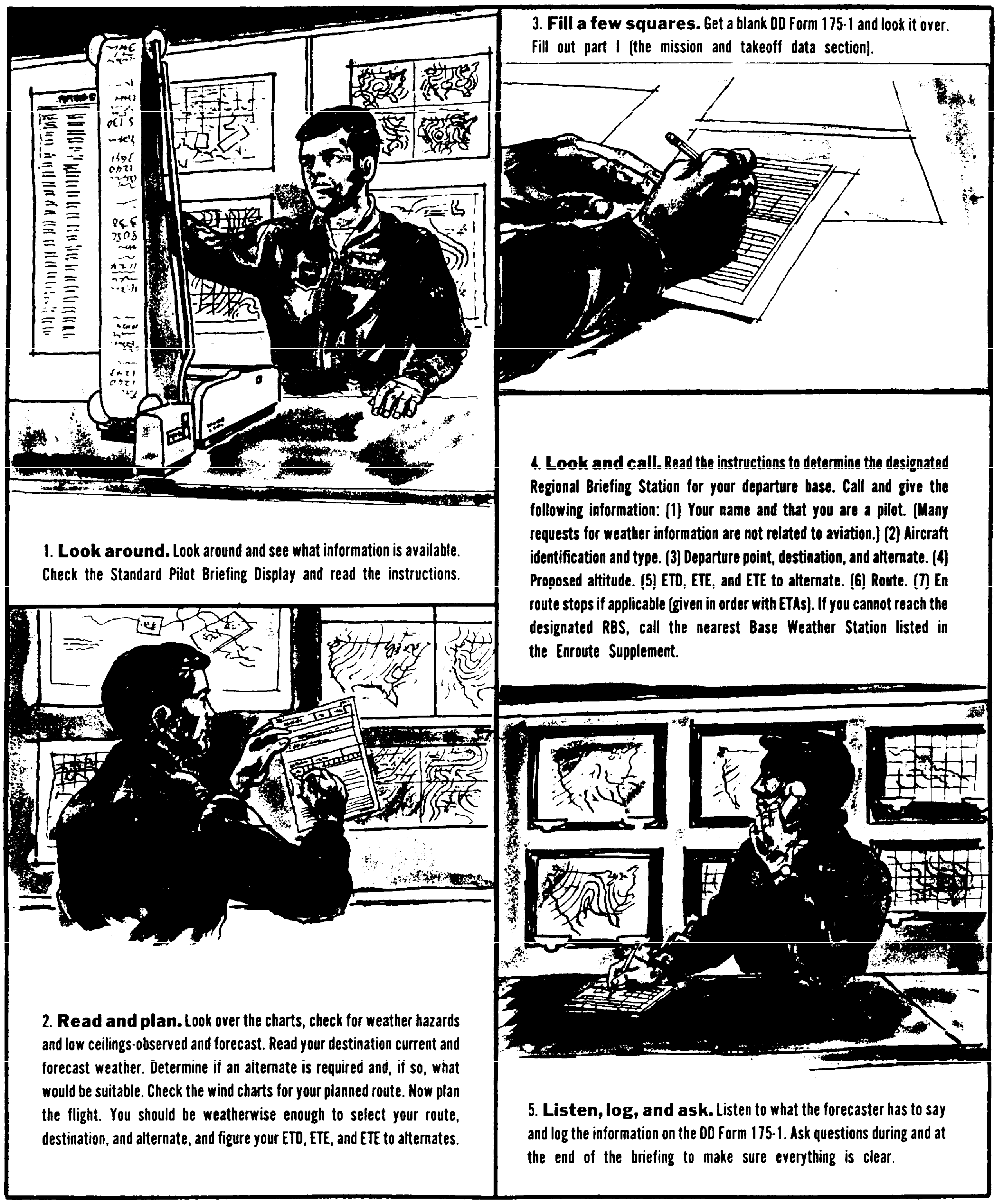
Content of the Weather Briefing:

Do not hesitate to ask the briefer about any particular item.
Check the following list of key items:

Weather at Takeoff:

1. Bases and tops of cloud layers.
2. Visibility and obstructions to vision.
3. Type and intensity of precipitation.
4. Freezing level.
5. Temperature and climb winds up to flight altitude.
6. Runway temperature, wind, pressure and density altitude.
7. Condition of runway (if affected by weather).

This checklist is designed as an aid if no forecaster is available at the departure base, but current charts and teletype are displayed. The aircrew member should:



1. **Look around.** Look around and see what information is available. Check the Standard Pilot Briefing Display and read the instructions.

2. **Read and plan.** Look over the charts, check for weather hazards and low ceilings-observed and forecast. Read your destination current and forecast weather. Determine if an alternate is required and, if so, what would be suitable. Check the wind charts for your planned route. Now plan the flight. You should be weatherwise enough to select your route, destination, and alternate, and figure your ETD, ETE, and ETE to alternates.

3. **Fill a few squares.** Get a blank DD Form 175-1 and look it over. Fill out part I (the mission and takeoff data section).

4. **Look and call.** Read the instructions to determine the designated Regional Briefing Station for your departure base. Call and give the following information: (1) Your name and that you are a pilot. (Many requests for weather information are not related to aviation.) (2) Aircraft identification and type. (3) Departure point, destination, and alternate. (4) Proposed altitude. (5) ETD, ETE, and ETE to alternate. (6) Route. (7) En route stops if applicable (given in order with ETAs). If you cannot reach the designated RBS, call the nearest Base Weather Station listed in the Enroute Supplement.

5. **Listen, log, and ask.** Listen to what the forecaster has to say and log the information on the DD Form 175-1. Ask questions during and at the end of the briefing to make sure everything is clear.

Figure 3-2. Self Weather Prebrief.

Weather En Route:

1. Bases, tops, types, and amount of each cloud layer.
2. Visibility at the surface and aloft.
3. Type, location, intensity, direction and speed of fronts.
4. Freezing level.
5. Temperature and winds.
6. Areas of severe weather (thunderstorms, icing, turbulence).
7. Areas of good weather.

Weather at Destination and Alternate Bases:

1. Bases, tops, types and amount of each cloud layer.
2. Visibility and obstructions to vision.
3. Type and intensity of precipitation.
4. Freezing level.
5. Turbulence.
6. Surface wind velocity.
7. Condition of runways (if affected by weather).

Additional Weather Considerations:

The weather at the departure station is often neglected during flight planning. Knowledge of this weather may be a deciding factor if you need to make an immediate decision because of an emergency soon after takeoff. A thorough knowledge of ceilings, visibilities, clouds, and weather hazards, not only en route but for adjacent areas, will provide valuable if an emergency forces deviation from the planned mission. Knowledge of the type and intensity of precipitation at the destination and alternate will aid you in estimating the runway braking action (if applicable).

Proper flight planning includes obtaining all the pertinent weather information available. An important factor in completing a successful mission is the extra time spent in the weather station forming a mental picture of the weather conditions.

DD Form 175-1, Flight Weather Briefing

During the preflight weather briefing, a DD Form 175-1, Flight Weather Briefing, is issued to ensure a complete briefing (figure 3-3). The DD Form 175-1 indicates the forecast departure, en route, and arrival weather conditions. During closed circuit television weather briefings, the forecaster may show completed portions of the form.

As a supplement to, or instead of DD Form 175-1, Flight Weather Briefing, folders made up of pictorial weather data, such as wind, temperature, horizontal weather depiction, cross-section charts, flimsies, and or computer flight plans, may be used. At some locations, forecasters provide a "verbal brief" instead of DD Form 175-1. When issued, flight weather briefing folders and verbal briefs contain the data included in the DD Form 175-1, in a format acceptable to the MAJCOM supported.

Guide For Completing DD Form 175-1

As an aircrew member, you may receive a telephone weather briefing and complete a DD Form 175-1. This section discusses completion of this form and may be used as a guide.

General Instructions. Entries in individual blocks are based on aircrew requirements and the weather. Make all time entries "Z." Enter all heights in *hundreds of feet.* Enter all winds in tens of degrees, speed in knots.

PART I, MISSION TAKEOFF DATA

1. Date. Enter UTC departure date.

2. Acft Type and Number. Enter aircraft type (F-4, B-52) and radio call sign, mission number, or last three digits of tail number.

3. Dep Pt and ETD. Enter departure airfield location identifier and estimated time of departure.

4., 5., and 6. Runway Temp, Dewpoint, Temp Dev. Enter in degrees Celsius (unless requested in Fahrenheit). Enter "temp dev" as the difference between the forecast temperature for climb and the standard atmosphere temperature.

7. and 8. Pressure Alt, Density Alt. Enter in feet with algebraic sign.

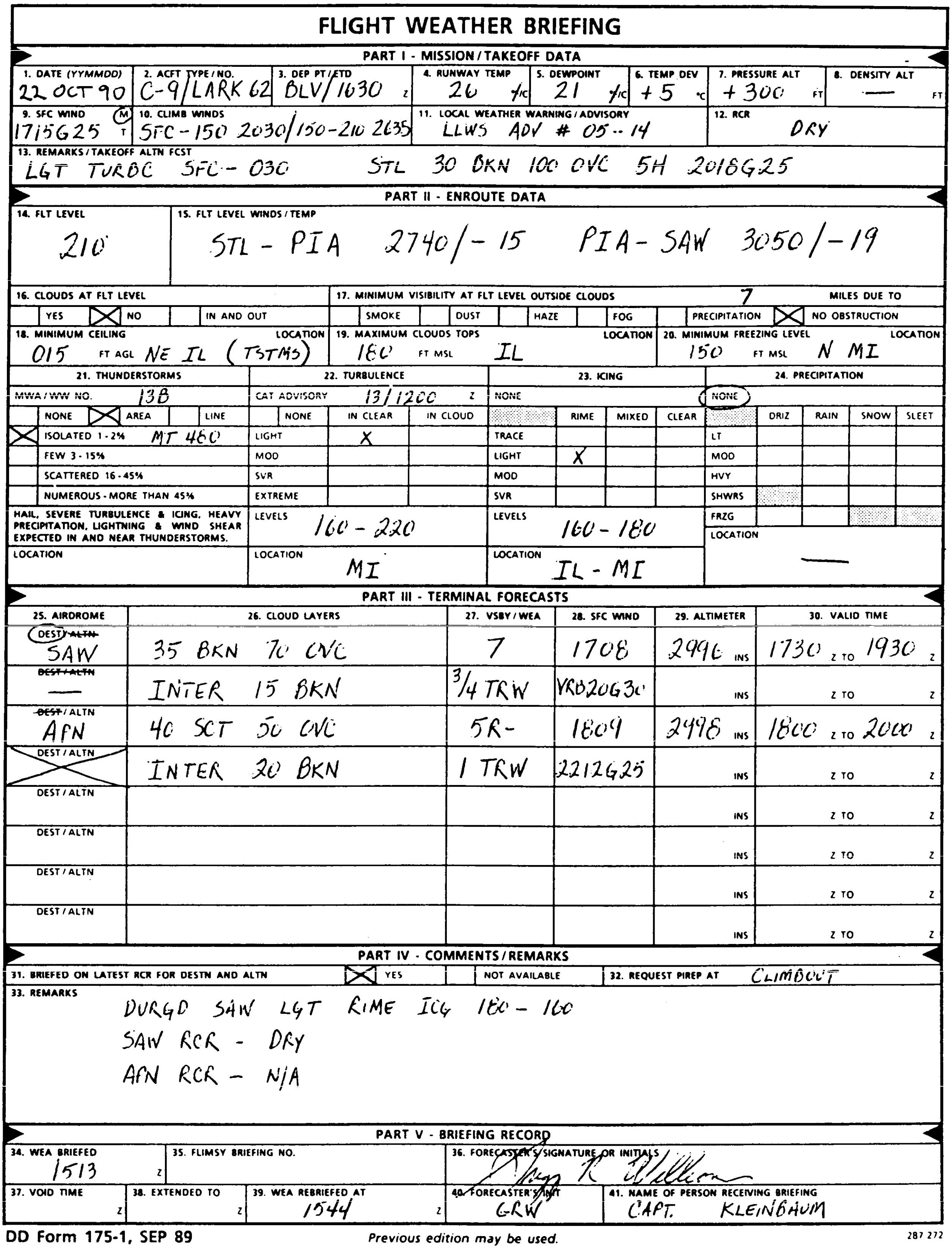
9. Sfc Wind. Enter magnetic direction. True directions are given by the forecaster during remote telephone briefings. In either case, forecasters specify "magnetic" or "true" during the briefing. Suffix magnetic entries with "M."

10. Climb Winds. Enter true direction.

11. Local Wea Wrng and Met Watch Adv. Enter local weather warnings and met watch advisories valid for ETD plus or minus one hour.

12. RCR. Enter latest reported runway condition for departure airfield, if available.

13. Remarks and Takeoff Altn Fcst. Enter remarks on weather affecting takeoff and climb. If required, enter a terminal forecast for the takeoff alternate.



FLIGHT WEATHER BRIEFING

PART I - MISSION/TAKEOFF DATA

1. DATE (YYMMDD)	2. ACFT TYPE/NO.	3. DEP PT/ETD	4. RUNWAY TEMP	5. DEWPOINT	6. TEMP DEV	7. PRESSURE ALT	8. DENSITY ALT
22 OCT 90	C-9/LARK 62	BLV/1630 Z	26 F/C	21 F/C	+5 °C	+300 FT	— FT

9. SFC WIND [✓ M] T	10. CLIMB WINDS	11. LOCAL WEATHER WARNING/ADVISORY	12. RCR
1715G25	SFC-150 2030/150-210 2635	LLWS ADV # 05--14	DRY

13. REMARKS/TAKEOFF ALTN FCST: LGT TURBC SFC-030 STL 30 BKN 100 OVC 5H 2016G25

PART II - ENROUTE DATA

14. FLT LEVEL: 210

15. FLT LEVEL WINDS/TEMP: STL - PIA 2740/-15 PIA-SAW 3050/-19

16. CLOUDS AT FLT LEVEL: ☐ YES ☒ NO ☐ IN AND OUT

17. MINIMUM VISIBILITY AT FLT LEVEL OUTSIDE CLOUDS 7 MILES DUE TO ☐ SMOKE ☐ DUST ☐ HAZE ☐ FOG ☐ PRECIPITATION ☒ NO OBSTRUCTION

18. MINIMUM CEILING 015 FT AGL LOCATION NE IL (TSTMS)

19. MAXIMUM CLOUDS TOPS 180 FT MSL LOCATION IL

20. MINIMUM FREEZING LEVEL 150 FT MSL LOCATION N MI

21. THUNDERSTORMS

MWA/WW NO. 13B

☐ NONE ☒ AREA ☐ LINE

☒ ISOLATED 1-2% MT 460
☐ FEW 3-15%
☐ SCATTERED 16-45%
☐ NUMEROUS-MORE THAN 45%

HAIL, SEVERE TURBULENCE & ICING, HEAVY PRECIPITATION, LIGHTNING & WIND SHEAR EXPECTED IN AND NEAR THUNDERSTORMS.

LOCATION

22. TURBULENCE

CAT ADVISORY 13/1200 Z

☐ NONE	IN CLEAR	IN CLOUD
LIGHT	X	
MOD		
SVR		
EXTREME		

LEVELS 160-220

LOCATION MI

23. ICING

NONE

	RIME	MIXED	CLEAR
TRACE			
LIGHT	X		
MOD			
SVR			

LEVELS 160-180

LOCATION IL-MI

24. PRECIPITATION

[✓ NONE]

	DRIZ	RAIN	SNOW	SLEET
LT				
MOD				
HVY				
SHWRS	▨			
FRZG			▨	▨

LOCATION —

PART III - TERMINAL FORECASTS

25. AIRDROME	26. CLOUD LAYERS	27. VSBY/WEA	28. SFC WIND	29. ALTIMETER	30. VALID TIME
[✓ DEST]/~~ALTN~~ SAW	35 BKN 70 OVC	7	1708	2996 INS	1730 Z TO 1930 Z
~~DEST/ALTN~~ —	INTER 15 BKN	3/4 TRW	VRB20G30	INS	Z TO Z
~~DEST~~/ALTN APN	40 SCT 50 OVC	5R-	1809	2998 INS	1800 Z TO 2000 Z
~~DEST/ALTN~~	INTER 20 BKN	1 TRW	2212G25	INS	Z TO Z
DEST/ALTN				INS	Z TO Z
DEST/ALTN				INS	Z TO Z
DEST/ALTN				INS	Z TO Z
DEST/ALTN				INS	Z TO Z

PART IV - COMMENTS/REMARKS

31. BRIEFED ON LATEST RCR FOR DESTN AND ALTN ☒ YES ☐ NOT AVAILABLE

32. REQUEST PIREP AT CLIMBOUT

33. REMARKS
DURGD SAW LGT RIME ICG 180-160
SAW RCR - DRY
APN RCR - N/A

PART V - BRIEFING RECORD

34. WEA BRIEFED	35. FLIMSY BRIEFING NO.	36. FORECASTER'S SIGNATURE OR INITIALS	
1513 Z			
37. VOID TIME	**38. EXTENDED TO**	**39. WEA REBRIEFED AT**	**40. FORECASTER'S INIT** / **41. NAME OF PERSON RECEIVING BRIEFING**
Z	Z	1544 Z	GRW / CAPT. KLEINBAUM

DD Form 175-1, SEP 89 *Previous edition may be used.* 287 272

Figure 3-3. Sample DD Form 175-1.

PART II, EN ROUTE DATA

Enter data for the entire route, exclusive of climb and descent.

14. Flt Level. Enter planned flight level in hundreds of feet, with three digits; e.g. "280" for 28,000 feet, "080" for 8,000 feet.

15. Flt Level Winds and Temp. Enter true wind direction at flight level in tens of degrees, speed to the nearest five knots. Enter temperature in degrees Celsius. If there are signficant differences, enter winds and temperatures in legs; e.g., "STL-ORD 2745-45." If one wind and temperature is representative of the entire route, identifiers are not necessary; e.g., "3240-38."

16. Clouds at Flt Level. Check appropriate block. "In and out" means that the flight will be in clouds between 1 and 45 percent of the time.

17. Minimum Visibility at Flt Level Outside Clouds. Enter minimum horizontal visibility en route outside of clouds; check appropriate blocks to indicate obstruction(s) to vision.

18. Minimum Ceiling and Location. Enter minimum ceiling en route (AGL) and the geographical location; e.g., "060 Ft AGL STL-PIA." (This means that the minimum ceiling is 6,000 feet AGL between St Louis and Peoria. Indicate if the minimum ceiling is over hilly or mountainous terrain, or in thunderstorms; e.g., "010 Ft MSL BOSTON AGL," or "020 Ft. AGL SW KY TSTMS."

19. Maximum Cloud Tops and Location. Enter maximum tops (exclusive of thunderstorm tops) and location of cloud layers in hundreds of feet MSL.

20. Minimum Freezing Level and Location. Enter height of lowest freezing level en route in hundreds of feet MSL, and geographical location. If lowest freezing level is at the surface, enter "SFC" and geographical location.

21. Thunderstorms. Enter applicable Military Weather Advisory number or date time group of product used and check applicable blocks. Enter geographical location and maximum tops of thunderstorms that may affect the flight.

22. Turbulence. Enter date time group of the turbulence forecast used (FAXN, SIGMET, AIRMET). If forecast is based on SIGMETs or AIRMETs, strike out "CAT" and substitute "SIGMET" or "AIRMET" as appropriate. Check applicable blocks. Enter levels and locations of turbulence affecting the flight.

23. Icing. Check applicable blocks and enter levels and geographical location of icing affecting the flight.

24. Precipitation. Check applicable blocks and enter geographical location of precipitation areas affecting the flight.

PART III, TERMINAL FORECASTS

If required, enter a forecast for the first stop and alternate. Enter forecasts for subsequent stops and alternates if desired, but you must update these forecasts when able.

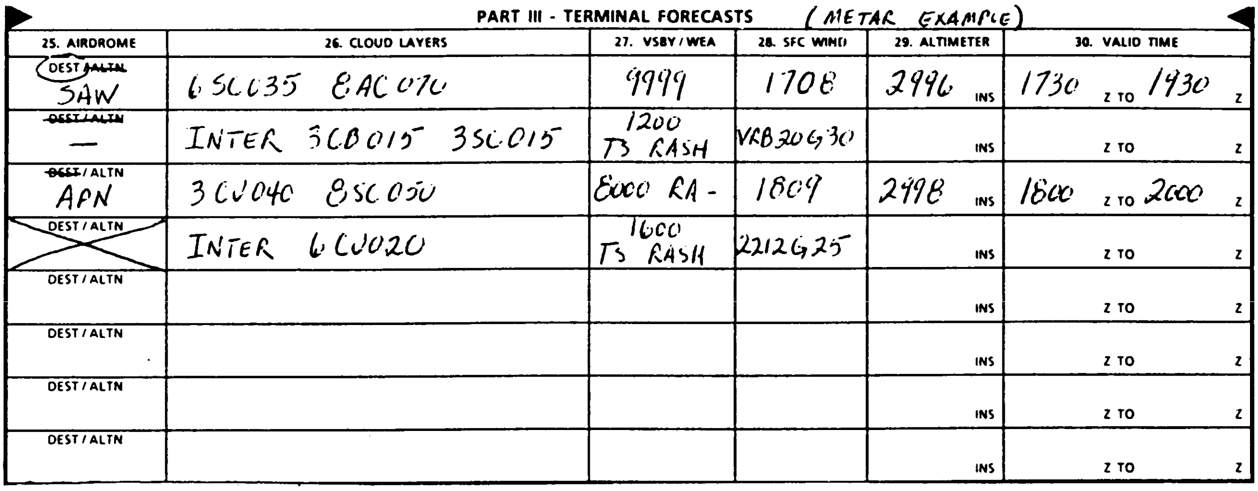
25. Dest and Altn. Line out inappropriate designator and enter station identifier.

26 and 27. Cloud Layers, Vsby and Wea. Enter

PART III - TERMINAL FORECASTS (TAF EXAMPLE)

25. AIRDROME	26. CLOUD LAYERS	27. VSBY / WEA	28. SFC WIND	29. ALTIMETER	30. VALID TIME
[✓ DEST] / ALTN SAW	35 BKN 70 OVC	7	1708	2996 INS	1730 Z TO 1930 Z
~~DEST / ALTN~~ —	INTER 15 BKN	3/4 TRW	VRB 20G30	INS	Z TO Z
~~DEST~~ / ALTN APN	40 SCT 50 OVC	5R-	1809	2998 INS	1800 Z TO 2000 Z
~~DEST / ALTN~~	INTER 20 BKN	1 TRW	2212G25	INS	Z TO Z
DEST / ALTN				INS	Z TO Z
DEST / ALTN				INS	Z TO Z
DEST / ALTN				INS	Z TO Z
DEST / ALTN				INS	Z TO Z

Figure 3-3. Continued.



PART III - TERMINAL FORECASTS (METAR EXAMPLE)

25. AIRDROME	26. CLOUD LAYERS	27. VSBY / WEA	28. SFC WIND	29. ALTIMETER	30. VALID TIME
DEST ~~ALTN~~ SAW	6SC035 8AC070	9999	1708	2996 INS	1730 Z TO 1930 Z
~~DEST / ALTN~~ —	INTER 3CB015 3SC015	1200 TS RASH	VRB20G30	INS	Z TO Z
~~DEST~~ / ALTN APN	3CU040 8SC050	8000 RA-	1809	2998 INS	1800 Z TO 2000 Z
~~DEST / ALTN~~	INTER 6CU020	1600 TS RASH	2212G25	INS	Z TO Z
DEST / ALTN				INS	Z TO Z
DEST / ALTN				INS	Z TO Z
DEST / ALTN				INS	Z TO Z
DEST / ALTN				INS	Z TO Z

Figure 3-3. Continued.

the lowest prevailing condition expected during the valid period. Enter conditions described by a change group (such as "INTER") on the next line, preceded by the change group. Enter visibility in the units used at destination; e.g., meters for European destinations, statute miles for CONUS.

28. Sfc Wind. Enter true direction if the destination is an airfield other than your own; if the flight is a "round-robin" that will terminate at your own airfield with no intermediate stops, enter the direction magnetic. In either case, specify "magnetic" or "true" during the briefing and suffix magnetic entries with "M."

29. Altimeter. Enter the lowest altimeter setting expected during the valid period.

30. Valid Time. Enter valid time as one hour either side of ETA. For flights of less than one hour, make the first entry the same as ETD.

PART IV, COMMENTS/REMARKS

31. Briefed on latest RCR for Destn and Altn. Check appropriate block.

32. Request PIREP at. If PIREPs are requested for specific areas, enter the areas.

33. Remarks. Enter any other significant data; for example:

a. Data for which there was insufficient space in other blocks.

b. Comments and remarks on terminal forecasts.

c. Icing and turbulence on approach to destination (enter location, type, intensity, and level).

d. Specialized remarks, such as low-level mission areas, air refueling, or gunnery and bombing ranges.

PART V, BRIEFING RECORD

34. Weather Briefed. Enter the briefing completion time.

35. Flimsy or Briefing No. If used, enter the flight weather briefing folder, flimsy, or computer flight plan (CFP) identification.

36. Forecaster's Signature or Initials. Enter the name or initials of the forecaster providing the briefing.

37 and 38. "Void Time" and "Extended To" not used by the USAF.

39. Wea Rebriefed At. If weather is rebriefed, make changes to original weather entries and enter the completion time.

40. Forecaster's Init. Enter initials of the forecaster providing the rebriefing or update.

41. Name of Person Receiving Briefing. Enter your name and grade.

Chapter 4

AVIATION WEATHER SERVICES

Weather service to aviation is a joint effort of the military weather services and several civilian agencies. Because of oversea flights and the need for worldwide weather, foreign weather services also have a vital input into the weather support available to the aircrew. In addition to surface observations and terminals forecasts, many others services are available to the aircrew. This chapter summarizes some of the weather services available to Air Force aircrews and discusses sources of weather information.

Telephone Weather and NOTAM Briefing

Crews departing from a location where weather service is not locally available must obtain weather information from the nearest military facility. The Flight Information Handbook lists military weather briefing facilities with their DSN and commercial telephone numbers.

Automatic Terminal Information Service (ATIS)

Selected high density military and civil airfields broadcast recorded weather for takeoff, approach, and landing. Listen to ATIS broadcasts to obtain the latest weather observation. Terminal Instrument Approach Procedures, en route charts, and aerodrome listings in the En Route Supplement list radio frequencies for ATIS-equipped aerodromes.

Pilot-to-Metro Service (PMSV)

The military operates PMSV at selected military bases (figure 4-1). This service provides aircrews the latest weather observations and forecasts for military and some civil airfields. PMSV facilities manned by forecasters are listed as "full service," while those manned by observers are listed as "limited service."

When observers respond to calls, they state when no forecaster is available and relay only surface observations, radar observations, terminal forecasts, and military weather advisories. If forecast

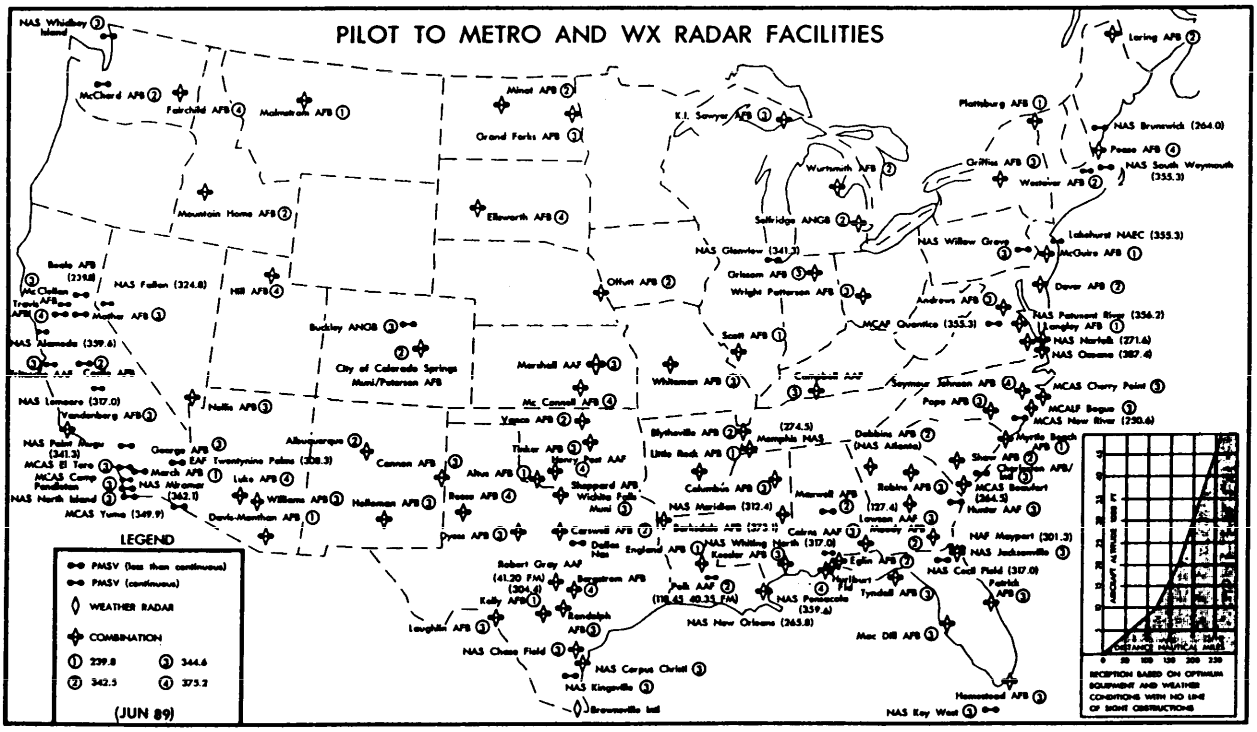


Figure 4-1. CONUS Pilot to Metro and Weather Radar Facilities.

interpretation is necessary, the observer will refer the aircrew to a full service PMSV where a forecaster is on duty.

Use PMSV to the maximum to update forecasts and obtain latest weather observations. The Flight Information Handbook publishes worldwide PMSV facility locations, frequencies, and instructions.

Weather Radar Observations

Echoes on the radar scope are radar signals reflecting precipitation. Two major sources, military weather stations and FAA flight service stations, provide weather radar information to aircrews.

Many military weather stations located worldwide are equipped with weather radar. The Flight Information Handbook lists these stations. Figure 4-1 shows the listing from the Flight Information Handbook. Military weather radar displays precipitation targets within 200 NM of the station and detects heights of weather returns to about 125 NM. When PMSV and radar equipment are collocated, forecasters in contact with aircrews, provide realtime radar reports. The weather forecaster can advise the aircrew of the location, movement, and tops of the *precipitation* (not necessarily the tops of the clouds). The forecaster can estimate the intensity of the weather returns, but CANNOT vector the aircraft!

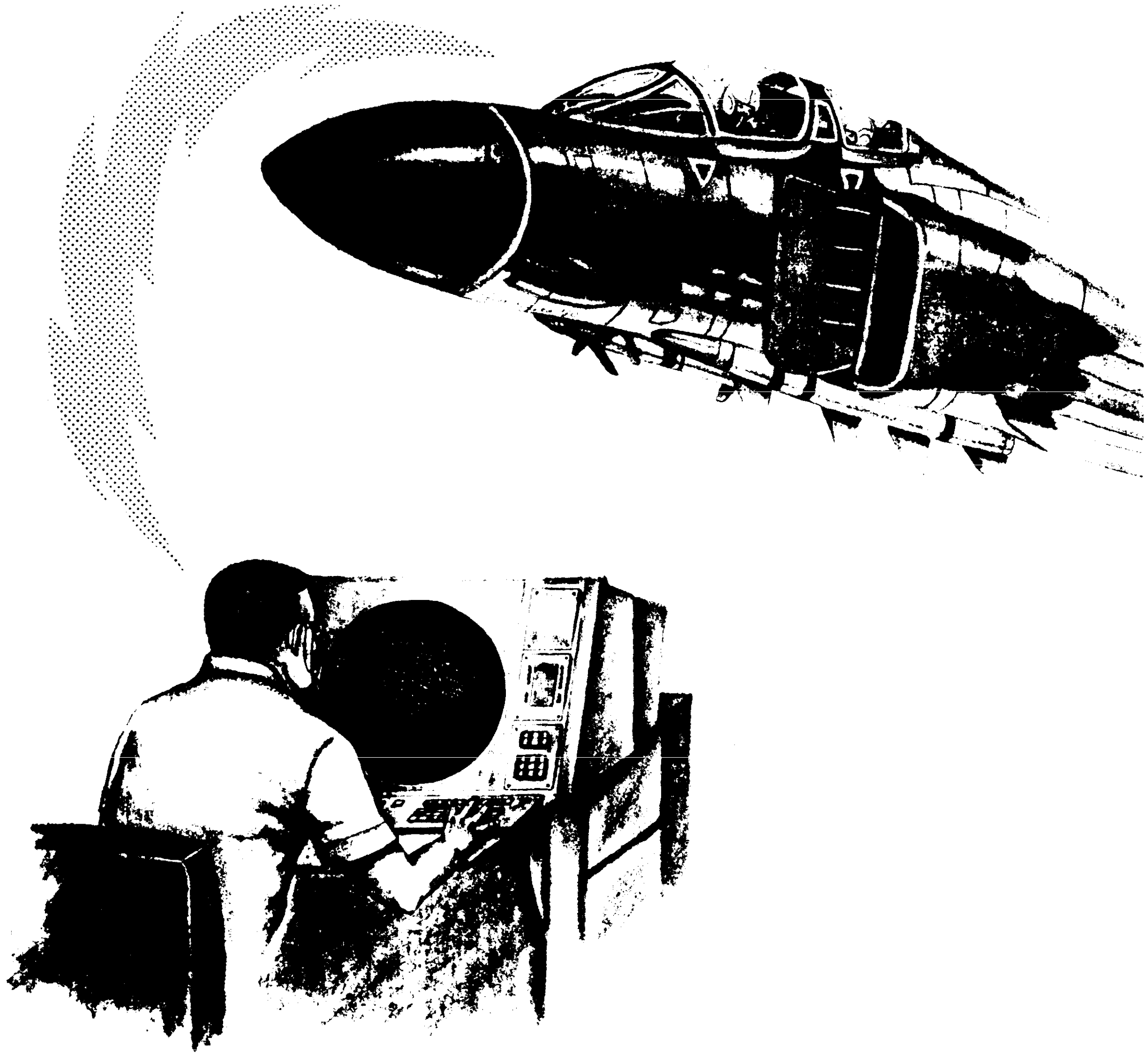


Figure 4-2. ARTCC Controllers Relay Weather Advisories and PIREPs to Aircrews Only as Time Permits.

Some FAA flight service stations (FSS) located near radar-equipped National Weather Service (NWS) stations have weather repeater scopes. At these locations, FSS specialists are certified to make interpretations of weather displayed on these scopes. They can brief the airborne crew on displayed weather patterns, area coverage, and movement. However, NWS forecasters analyze precipitation intensity, then forward this information to the FSS. The Flight Information Handbook lists FSS providing this service.

Air Route Traffic Control Center (ARTCC)

The FAA operates ARTCCs. ARTCC controllers, like controllers at all ATC facilities, can provide weather avoidance assistance. However, providing safe separation between aircraft is the ATC controller's primary purpose. Controllers provide weather avoidance assistance when work situations permit and when this service does not conflict with higher priority duties. The center controllers are a primary source for PIREPs regarding turbulence and severe weather en route.

ARTCCs in the United States have meteorologists assigned to provide tailored hazardous en route weather advisories within the ARTCC's area of responsibility. The controller relays en route advisories to aircrews (figure 4-2). Meteorologists provide additional details on hazardous weather to aircrews, including interpretation of weather returns on ARTCC radar and NWS weather radar. Again, aircrews request information through controllers, since meteorologists cannot communicate directly with the crews. The Flight Information Handbook lists ARTCCs providing these services. These forecaster services are available from approximately 0600 to 2200 local.

ARTCC Radar:

Aircrews must understand the capabilities and limitations of the ARTCC radar. Although weather returns are visible, when compared to either the military or NWS weather radars, the ARTCC radar has serious limitations.

Limitations of the ARTCC Radar:

1. Inability To Measure Storm Tops. FAA radars have a fan-shaped beam rotating at *a fixed elevation angle.* Weather radars employ an elevation adjustable pencil beam to measure tops of cells. Figure 4-3 compares the size of the FAA radar beam width (6.2°) and the FPS-77 weather radar beam (1.6°). A typical FAA radar has its beam axis set at a 5-degree elevation angle as shown. Beyond 60 NM in range, it will detect less and less return echoes of large storms and may miss smaller storms completely. Due to its fan shape it can still detect aircraft at most altitudes. In contrast, the weather radar beam can move vertically to detect the vertical extent of storms anywhere between 5 NM and 120 NM.

2. Inability To Obtain Accurate Reflected Energy Measurements. As shown in figure 4-3, most

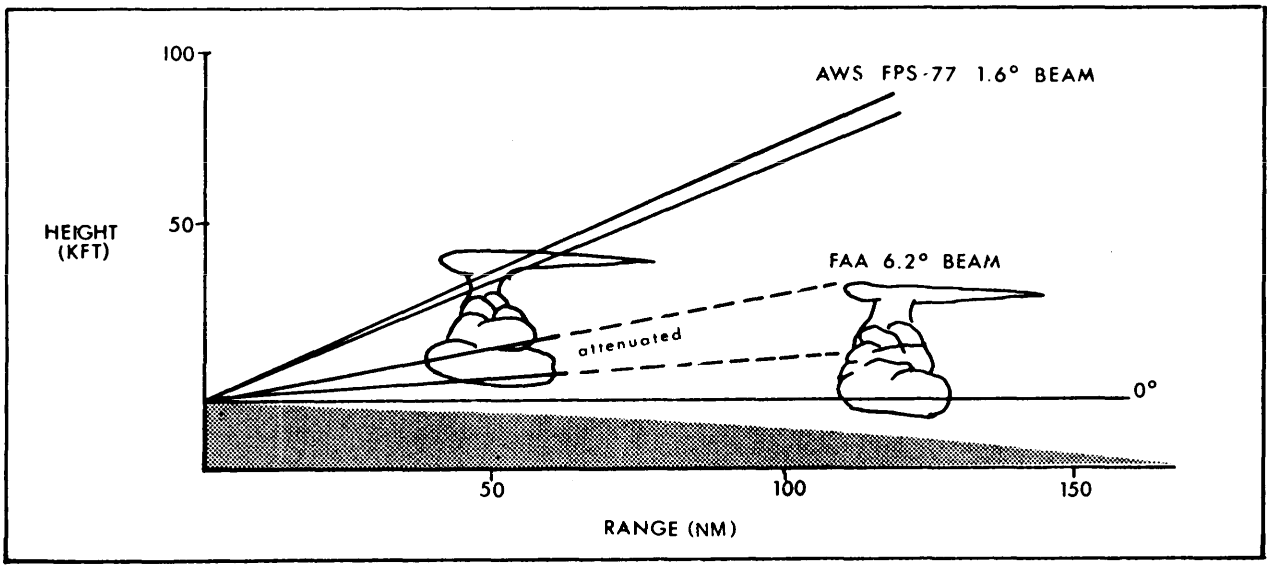


Figure 4-3. Comparison of the ARTCC and AWS Radars.

thunderstorms fill only part of the FAA beam beyond the 50 NM range. Within that range, the beam is so wide in the vertical, storm features integrate into one echo. This causes reflectivity losses 3 times greater at 120 NM than at 60 NM.

3. Non-Standard Normalization Factors. Echoes at different ranges from the antenna are displayed so that echoes near the antenna are no stronger than strong echoes further away. Therefore, a normalization factor is applied. The FAA uses a normalization factor for aircraft and non-weather targets which are not standard for all ARTCC radars. Controllers also change these settings from radar site to radar site. When used to detect weather echoes, losses in weather echo intensity may occur.

All ARTCCs use a computer-generated digital radar display (figure 4-4). This system provides the controller with two distinct levels of weather intensity by assigning radar intensity symbols for specific precipitation densities. Data consist of two echo intensity levels. Radial lines correspond to the weaker echo, while "Hs" represent moderate or greater echoes.

Center meteorologists use the same scope as ARTCC controllers, but the meteorologist normally uses the "unprocessed" weather display (figure 4-5). The meteorologist supplements this with radar reports from NWS radar sites in the area as well as PIREPs. At some centers, the meteorologist receives facsimile reproduction of NWS radar scope presentations. With the limitations of facsimile clarity and the unknown factors involving the elevation of the NWS radar, the center scope facsimile capability is used primarily as a backup to the ATC radar display.

In summary, ATC radars are designed and used primarily to separate aircraft traffic. When used to display and interpret weather information, they have several shortcomings. Hence, aircrews should not rely totally on thunderstorm avoidance information from the ATC controller. Total reliance on the controller may cause aircrews to penetrate storms the controller cannot see on the ATC radar scope.

Inflight Weather Advisories

Significant Meteorological Reports (SIGMET) and Airman's Meteorological Information (AIRMET) are inflight weather advisories issued by the NWS.

These advisories, individually issued, are broadcast by FSS at very high frequency omnidirectional range (VOR) facilities. ARTCC centers may not give the details of the SIGMET, but alert affected IFR traffic of a SIGMET being broadcast. Upon hearing the alert, aircrews should contact the nearest FSS and determine whether the advisory is pertinent to their flight.

The advisories notify aircrews of the possibility of encountering hazardous flying conditions not previously briefed. The aircrew must evaluate the potential hazard of the condition, based upon their experience and the operational limits of their aircraft.

SIGMETs are issued for weather phenomena potentially hazardous to all categories of aircraft, specifically:

—Tornadoes.
—Lines of thunderstorms (squall lines).
—Embedded thunderstorms.
—Hail (3/4 inch or larger).
—Severe or extreme turbulence.
—Severe icing.
—Widespread duststorms or sandstorms that lower visibility to below 3 nm.
—Thunderstorm areas greater than or equal to thunderstorm intensity level of four, or with an area coverage of 4/10 (40 percent) or more.

AIRMETs are issued for weather phenomena potentially hazardous to aircraft, including:

—Moderate icing.
—Moderate turbulence.
—Sustained winds of 30 knots or more at the surface.
—Windspread areas of ceilings less than 1,000 feet and or visibility less than three miles.
—Extensive mountain obscuration.

Flight Service Station (FSS)

The FAA operates FSSs. They provide aircrews with available inflight weather data similar to a preflight weather briefing, including weather forecasts for selected civil airports and some local military facilities. Direct pilot-to-weather briefer service is available by radio with any FSS. Although FSS specialists give briefings, they may NOT make original forecasts.

Inflight Weather Advisories:

FAA FSSs broadcast SIGMETs and AIRMETs during their valid period when they pertain to an area within 150 NM of the FSS. During the first hour, convective

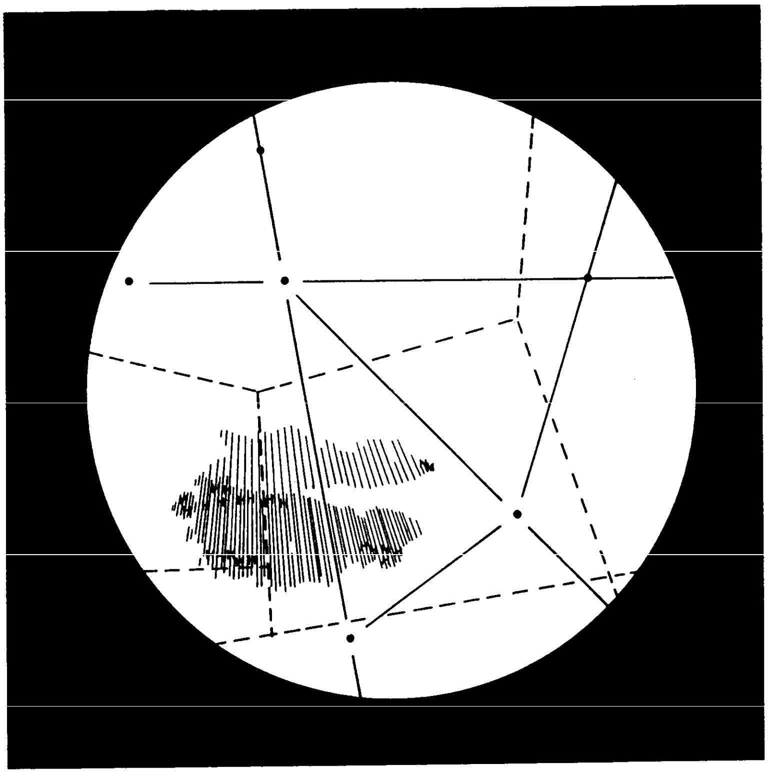


Figure 4-4. Weather Returns on the ARTCC Controller's Scope Utilizing the Computer "Processed" Display.

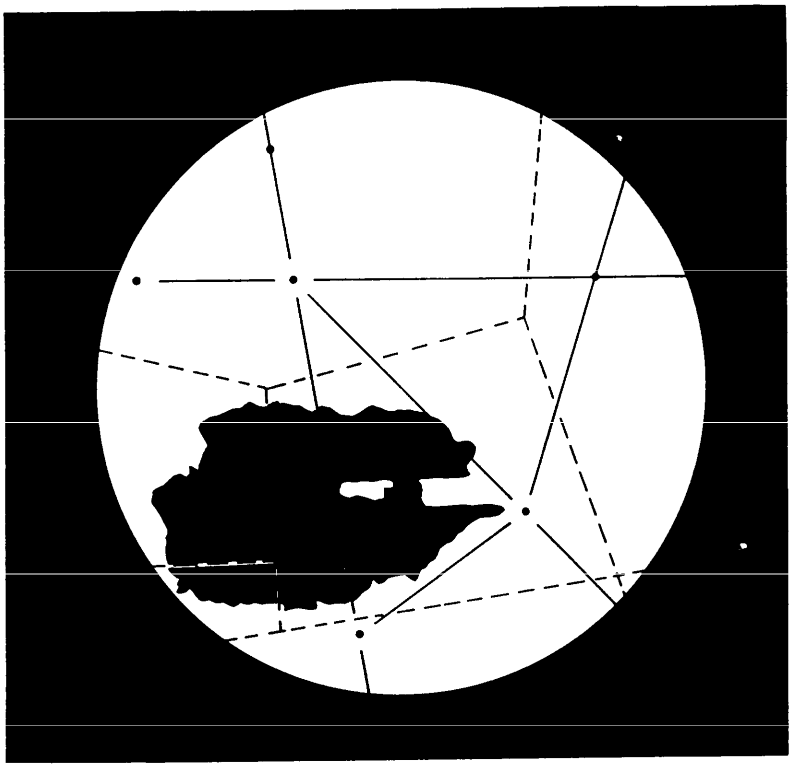


Figure 4-5. The Same Weather Picture on the Controller's Scope Without Computer Processing.

```
DAA PAED PASY1BA18P0308
RTD J,0ZZ,D
LEV 200,350                                                                 0       M.74      CFPO-1531214.8
MAC COMPUTER FLIGHT PLAN                                  H                        C-141B     *GB*  02/14Z-22Z
              PAED PASY
OPTIMIZED FUEL PLAN
                         OPNLWT 150000        PAYLOAD       30000
                     ARR FUEL/TIME BIAS         02500        /      0015

WP LOCID       ID     TC        MC        ALT        GS        ZD          ZT        DO        ETA     ATA
   LAT        CHNL              MH        ID         TAS                   TT       FLRM
   LON        FREQ             WIND                            TDR         TTR                          OW

---------------------------------------------------------------------------------------------------------------
1  ELMENDORF AF +                                                                              ____    ____
   N61152                                                                            1007
   W149475                                                     1275        0310
---------------------------------------------------------------------------------------------------------------
0  TOC/ LEVEL  OFF   260        236       350        ***        139          22        91      ____    ____
                                231       +04        ***                     22      0916
                            180/025                            1136        0248
---------------------------------------------------------------------------------------------------------------
2  MALOS             260        236       350        404         15           2         5      ____    ____
   N60490                       231       +04        430                     24      0911
   W155000                  200/045                            1121        0246
---------------------------------------------------------------------------------------------------------------
3  MOUSY             265        243       350        416         59           9        18      ____    ____
   N60440                       238       +03        429                     33      0093
   W157000                  190/038                            1062        0237
---------------------------------------------------------------------------------------------------------------
4  OZZIE             247        228       340        415        196          28        62      ____    ____
   N59270                       224       +01        429                    101      0831
   W163000                  180/030                             866        0209
---------------------------------------------------------------------------------------------------------------
0  BEGIN  DESCENT    227        222       340        408        210          31        63      ____    ____
                                221       -01        428                    252      0604
                            200/022                              99        0018
---------------------------------------------------------------------------------------------------------------
5  SHEMYA AB +       227        222       ***        ***         99          *8        45      ____    ____
   N52430                       221       ***        ***                    310      0559
   E174054                                             0       0000
---------------------------------------------------------------------------------------------------------------
FIRS   ADIZ/0101
CFP   ALT FWF -12    WF1 -12    WF2 -11           ENDURANCE 0750                              TOGW 281      00
A1 PAED               ALT TDEV     WIND         TAS        GS        ZD       AD                  ZT        TOGW
ELMENDORF             302  -02    289/006       412       416      1275     1263                 304         281
N61152 W149475
1 -ENROUTE             0252 040271                  8 -SUBTOTAL                                0802   100656
2 -RESERVE             0019 003838                  9 -TAXI                                           002000
3 -ENROUTE+RESERVE     0311 044109                  10 -REQ'D RAMP                                    102656
4 -ALTERNATE           0304 040888                  11 -ACTUAL RAMP                                   ______
5 -HOLDING             0115 011159                  12 -UNIDENTIFIED EXTRA                            ______
6 -APP&LANDING         0033 004500                  13 -REQ'D O/H DEST                                056547
7A -IDENTIFIED EXTRA        000000                  14 -V/O                                           048609
7B -STORED FUEL             000000
   FL    350/LO             340/0ZZ
           ** LOCKHEED FLIGHT PLANNING SYSTEM REL 7.12 **
```

Figure 4-6. Example of a Computer Flight Plan.

SIGMETs are broadcast at 15-minute intervals (H + 00, H + 15, H + 30, and H + 45), while AIRMETs and SIGMETs are broadcast at 30 minute intervals (H + 15 and H + 45). Thereafter, a summarized alert notice is broadcast at H + 15 and H + 45 during the valid period of the advisories.

Inflight Weather Radar Service:

Some FSSs have repeater scopes off NWS weather radars. FSS specialists at these locations can brief airborne crews on area coverage, movement and intensity of weather echoes. The Flight Information Handbook lists FSSs providing this service.

En Route Flight Advisory Service (EFAS):

Selected FSSs provide advisory service similar to the military PMSV. Staffed by controllers with special weather training, EFAS specialists maintain continuous weather watches to provide aircrews with realtime weather information, plus current reports on the location of hazardous weather as reported by pilots or observed on weather radar. Tied into a network of receiver and transmitter sites, aircrews can contact an EFAS station from anywhere in the contiguous United States when flying above 5,000 feet AGL. The US high and low en route charts identify EFAS stations providing this service. Contact them on VHF common frequency 122.0 MHz using the station name followed by the phrase, "FLIGHT WATCH" and the name of the nearest VOR to your position. The FAA requested that we append this remark to eliminate confusion of ground controllers.

Radio Navigation Aids

VHF Omnidirectional Range (VOR):

Certain VORs transmit area observations, weather advisories, PIREPs, RAREPs, and NOTAMs. Radio class code "AB" indicates FAA-operated VORs providing continuous automatic recorded weather broadcasts. You may also request weather service from a FSS on VHF common frequency 122.1 (receive only). FSS personnel will broadcast information over the VOR you are monitoring.

Nondirectional Beacon (NDB):

NDBs with radio class code "SABH" or "H-SAB" transmit transcribed continuous weather broadcasts containing route forecasts and observations for selected civilian airports.

Computer Flight Plans (CFP)

AFGWC provides specific weather support for established operations and any one-time mission with a CFP. Forecasts of winds, temperatures, and pressures are computed on a global basis and stored in the AFGWC computer data base. Aircrews must specify the essential data elements such as time of departure, flight altitude, and true airspeed. Given these data sources, the computer actually "flies" the route and records winds, temperatures, and pressures encountered. The computer determines the aircraft's ground speed, heading, wind factor, remaining fuel load, and many other factors for any specified point along the route. The computer also formats this data to the user's requirements (figure 4-6).

To obtain a computer flight plan, follow your command directives or consult your local weather forecaster.

Chapter 5

AVIATION WEATHER HAZARDS

Weather hazards affect the safety of all flights. Weather may cause loss of control, structural damage, or failure of the aircraft. This chapter contains a brief synopsis of weather hazards aircrews may encounter. Characteristics and probable locations of hazards are briefly discussed. To minimize the effects of hazardous weather, general procedures for aircrews are included. These general procedures supplement the specific guidance found in aircraft technical manuals. **For a complete discussion of hazards associated with the main topics in this chapter, see AFM 51-12, volume I.**

Clear Air Turbulence (CAT)

CAT implies turbulence devoid of clouds. However, the term is commonly used to refer to high-level wind shear turbulence even when it occurs in cirrus clouds or haze layers. The effect ranges from a few annoying bumps to severe jolts capable of causing structural damage to airframes and injury to passengers. While severe CAT is a rare event, light and moderate CAT occurs frequently during all seasons.

Most Likely Locations:

—Vicinity of jet stream.
—In or near sharp trough aloft.
—Circulation around a closed low aloft.
—Areas where large temperature gradient exists.

To Avoid or Minimize Effects:

—Change altitude or course.
—Fly recommended turbulence penetration airspeed.
—Tighten seat belt and shoulder harness.

When Jet Stream Turbulence Is Encountered in a Crosswind:

—If outside air temperature is rising - CLIMB.
—If outside air temperature is falling - DESCEND

Aircraft Icing

Aircraft icing is one of the major weather hazards to aviation. Ice on the airframe decreases lift and increases weight, drag, and stall speed. Also, water can freeze around control surfaces and restrict their movement. If ice breaks off the aircraft surface and is ingested into the aircraft engine, foreign object damage (FOD) may result.

Ice forming in the air intake of an engine will rob the engine of air to support combustion. Known as induction icing, it occurs with both reciprocating and turbine engines under a wide range of weather conditions.

Conditions Necessary for Structural Icing:

—Aircraft surface temperature colder than 0° C.
—Supercooled water droplets must be present:
  —Normal range 0° C to -20° C.
  —In thunderstorms to -40° C.

Conditions Conducive for Induction Icing:

—Small temperature dewpoint spread.
—Wide temperature range 22° C (72° F) to -10° C (14° F).

Procedures To Avoid or Minimize Effects:

—Remove ice and snow from aircraft before takeoff.
—Avoid flying in clouds when outside air temperature 0° C to -20° C.
—Use all necessary anti-ice and de-ice equipment.
—If ice is encountered, climb or descend to altitude where temperature is warmer than 0° C or colder than -20° C.
—Fly above 400 kts true air speed.
—Send a pilot report (PIREP) if icing is encountered or if it is forecast and not encountered.

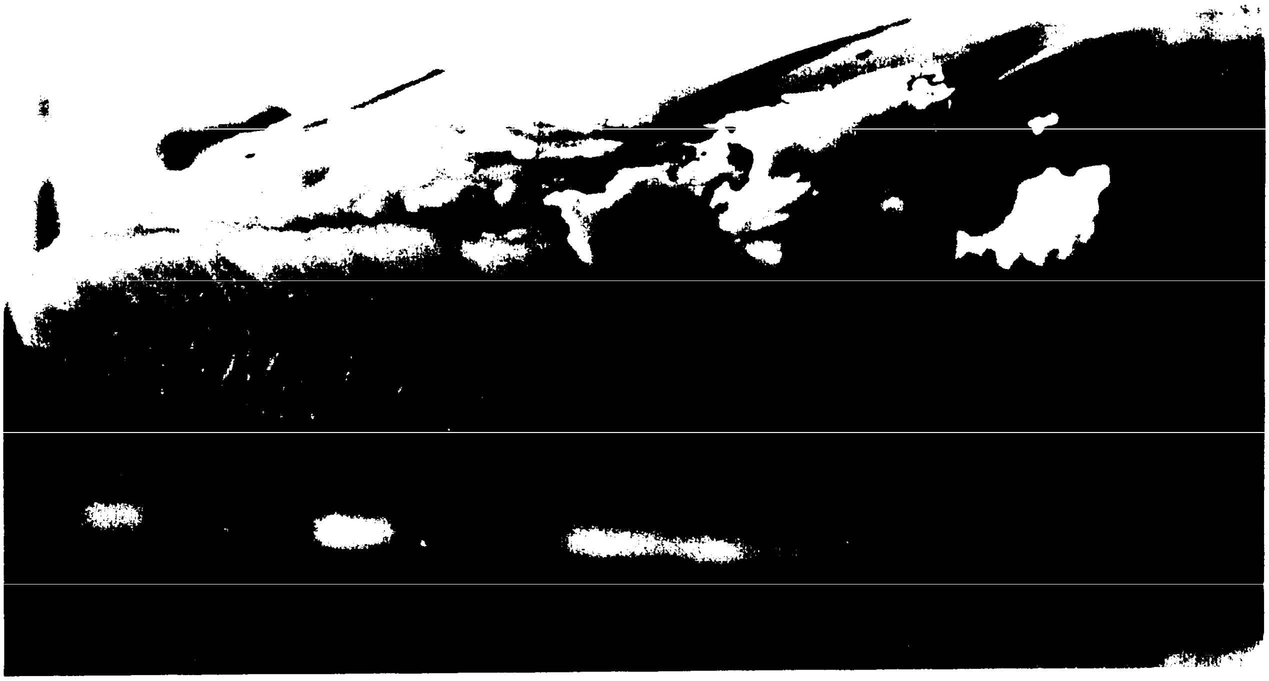


Figure 5-1. Rime Icing on Wing Leading Edge.

Figure 5-2. Rime Icing Inside An Engine.

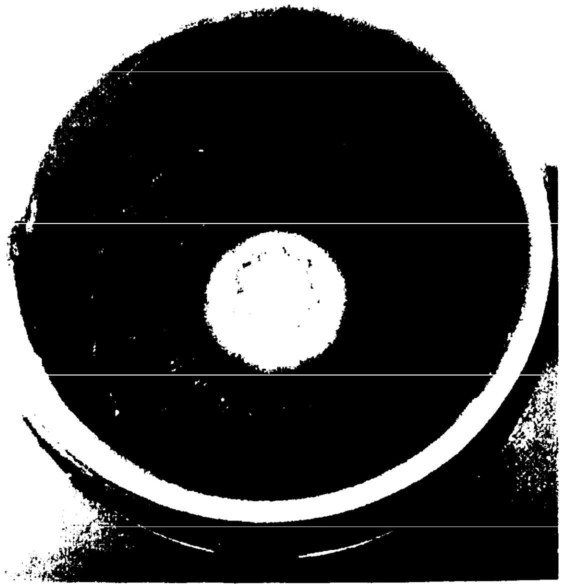


Figure 5-3. Engine Inlet Icing.

Thermal and Mechanical Turbulence

Localized vertical air movements, both ascending and descending cause thermal turbulence. These convective currents are most active on warm summer afternoons when winds are light. The currents may vary considerably within short distances because of uneven surface heating. Convection increases in strength and rises to greater heights as surface heating increases.

Mechanical turbulence results when obstructions such as buildings, trees, and rough terrain disrupt smooth wind flow. The degree of mechanical turbulence depends on wind speed and roughness of the obstructions. The higher the wind speed and or the rougher the surface, the greater the turbulence.

Aircraft reaction to turbulence varies not only with the intensity of the irregular motions, but also with aircraft characteristics such as airspeed, aircraft design, wing loading, and pilot technique.

Most Likely Location:

—In or near cumulus or cumulonimbus clouds.
—Areas with drastic change in topography.
—Areas where winds blow over structures or uneven ground.
—In valleys or canyons.

To Avoid or Minimize Effects:

—Fly above or around turbulent layer.
—Fly recommended turbulence penetration airspeed.
—Tighten seat belt and shoulder harness.

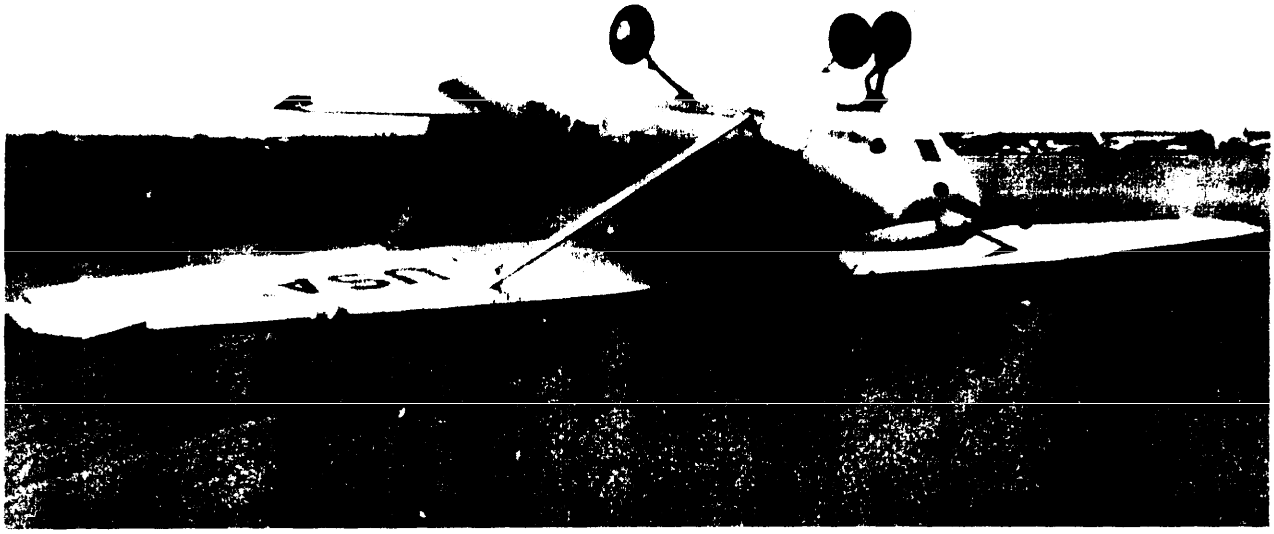


Figure 5-4. T-41 Upended by Thermal Convective Currents (Turbulence).

Figure 5-5. HH-53 Helicopter—Victim of Mechanical Turbulence.

Mountain Wave Turbulence

Areas of steady updrafts and downdrafts associated with the mountain wave may extend to 70,000 feet and as far as 300 miles downstream from a mountain range. Moderate to severe turbulence has been encountered in these waves. While clouds are often present to forewarn the presence of mountain wave activity, it is possible for wave action to take place when the air is too dry to form clouds.

Indicators of Mountain Wave Turbulence:

—Wind greater than 25 kts blowing perpendicular across top of mountain range.

—Blowing dust downwind of high terrain.

—Possible fluctuations of the airspeed indicator and the vertical velocity indicator.

—Appearance of:
  —Lenticular cloud.
  —Rotor (Roll) cloud.
  —Cap cloud.

To Avoid or Minimize Effects:

—Avoid lenticular, rotor or cap clouds.

—As a minimum, fly at a level 50 percent higher than the height of the highest terrain.

—Approach ridgelines at a 45 degree angle.

—Suspect pressure altimeter errors (as great as 2,500 ft).

Figure 5-6. B-52H Tail Section After Mountain Wave Turbulence.

Figure 5-7. B-52H Steers Home With Main Landing Gear After Losing Tail.

Vortex Wake Turbulence

Every aircraft in flight generates a pair of counter-rotating vortices at it's wing tips. The weight, speed, and shape of the generating aircraft's wing governs vortex strength. The greatest vortex strength occurs when the generating aircraft is HEAVY-CLEAN-SLOW.

A serious vortex wake encounter could result in structural damage to the aircraft. The primary hazard is loss of aircraft control due to induced roll. Aircrews must anticipate and avoid areas of possible vortex wake turbulence.

Characteristics:

—Begins at rotation; ends when nosewheel touches down.

—Moves outward laterally over ground at 5 kts (no wind).

—Sinks 400-500 feet/minute; levels off 800-900 feet below flight path.

Avoidance procedures:

—Fly at or above large aircraft's flight path.

—Land beyond heavy aircraft's touchdown point.

—Land and rotate prior to heavy aircraft's rotation point.

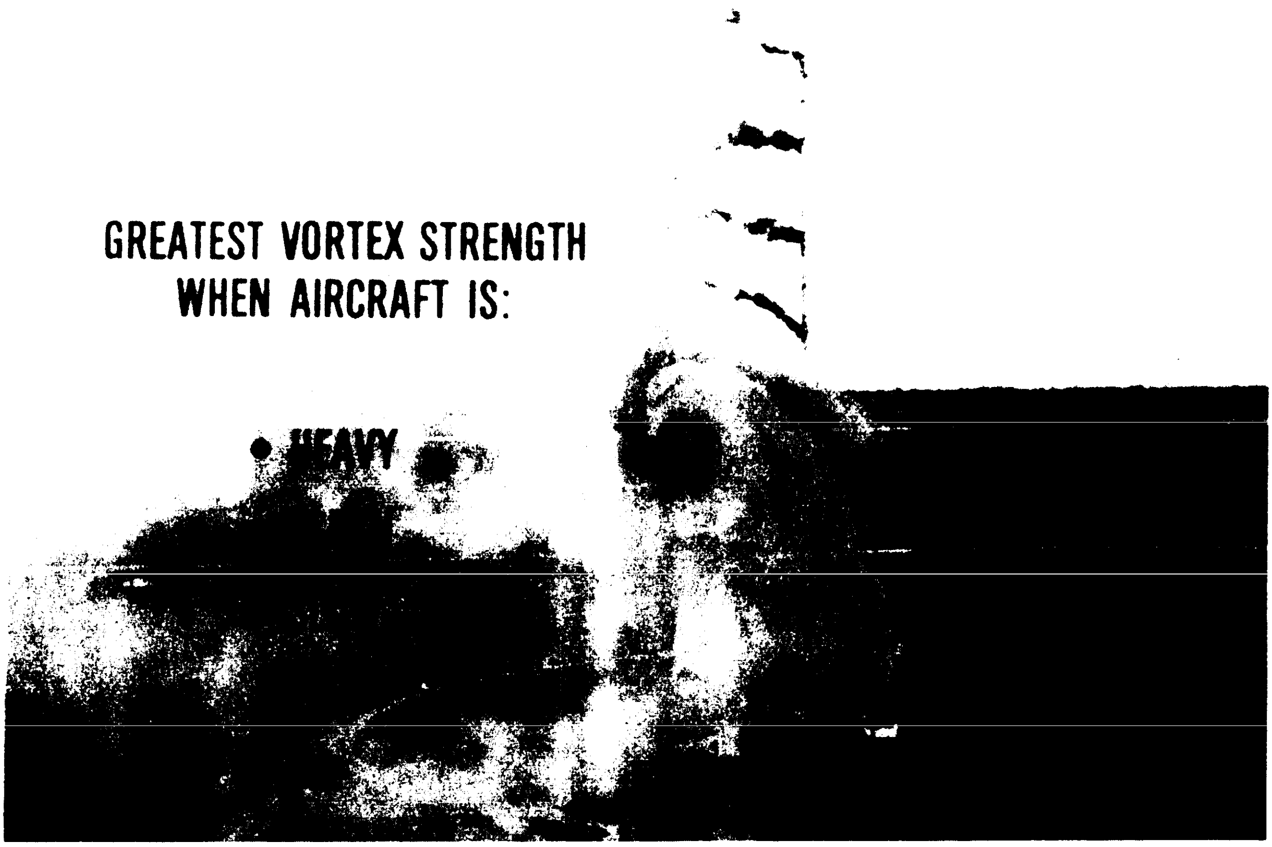


Figure 5-8. Wind Shear Created by Vortex Wake.

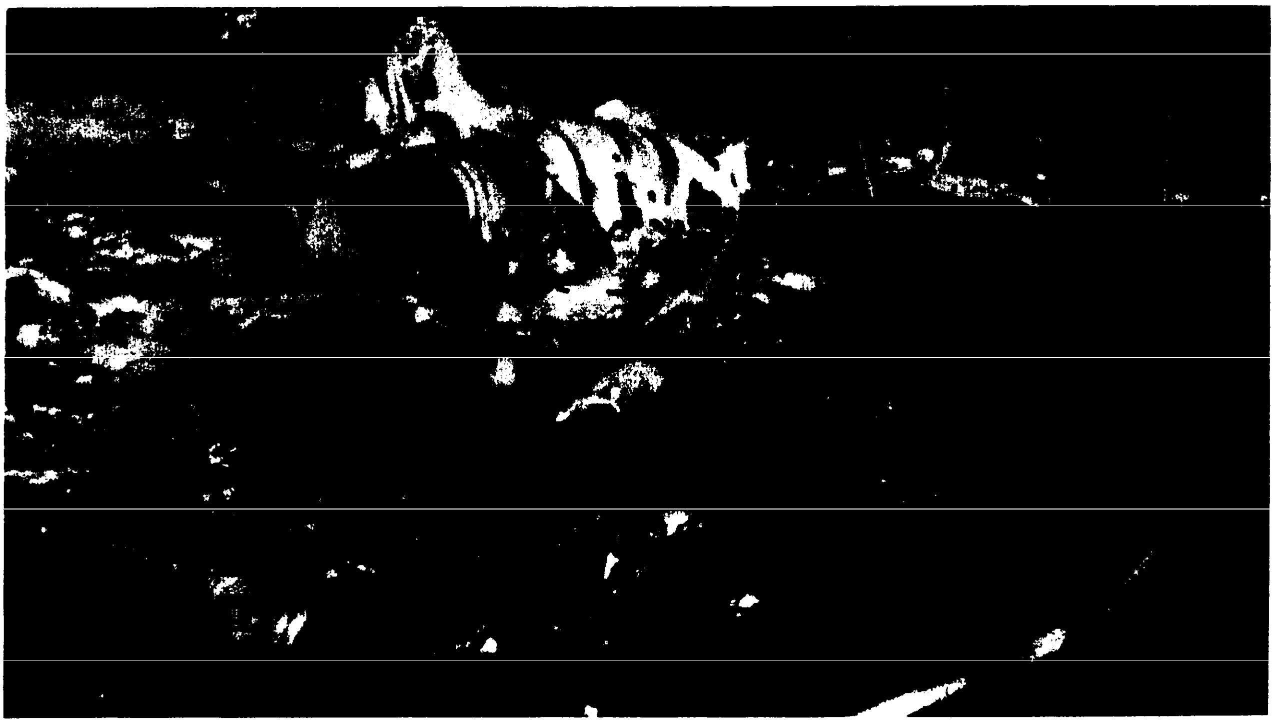


Figure 5-9. T-38 Victim of Wake Turbulence.

Low-Level Wind Shear

Low-level wind shear is the primary or probable cause of several aircraft incidents and accidents worldwide. It is particularly dangerous during takeoff or landing when an aircraft is within 2,000 feet of the ground. During this phase of flight the aircraft operates close to stall speed and may not have sufficient altitude available for recovery. Low-level wind shear is especially hazardous for jet aircraft since turbine engines respond slowly to increased power settings.

When weather or pilot reports indicate the likelihood of excessive shear, consider delaying your takeoff or approach.

Where To Expect Low-Level Wind Shear:

—During microbursts.
—During thunderstorm gust front and downdraft.
—At the top of a radiation inversion.
—Near a frontal boundary.
—Where surface winds are at least 30 kts.
—Near mountains, along straits and channels.

Low-Level Wind Shear Indicators:

—Abnormal power setting and rate of descent required to maintain glidepath.

—Fluctuations in indicated air speed (IAS) and vertical velocity indicator.

—Large difference between IAS and ground speed.

—Significant difference between approach wind and reported surface wind.

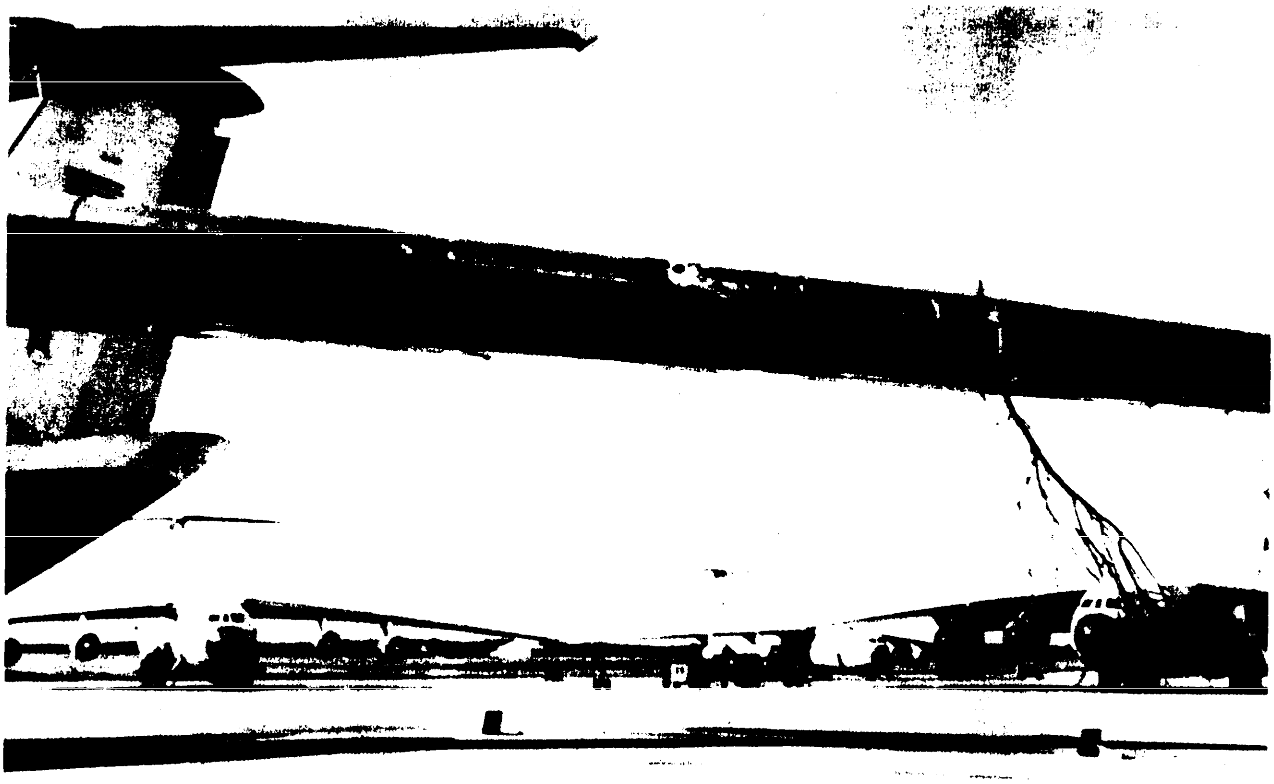


Figure 5-10. Low-Level Wind Shear Put This C-141 "In the Trees."

Lightning and Electrostatic Discharge

Lightning and electrostatic discharges are the leading causes of reportable weather-related aircraft accidents and incidents in the Air Force. Lightning occurs at all levels in a thunderstorm and in the clear air surrounding the top and beneath the storm. Electrostatic discharges are similar to natural lightning but are triggered by the aircraft itself. Aircraft can be struck or will trigger strikes in two types of weather conditions: electrically active (thunderstorms) and nonelectrically active (nonstormy) clouds. Major structural damage to aircraft can result from lightning strikes and electrostatic discharges; however, electrostatic discharges ususally cause only minor physical damage and indirect effects, such as electrical circuit upsets. Since every aircraft is susceptible to a lightning strike or electrostatic discharge, be familiar with the most probable areas of occurrence and avoidance procedures.

Where Most Strikes Occur:

—In the upper reaches of thunderstorms, (-40° C or colder).

—Within 8° C or 5,000 ft of the freezing level.

—Within thick cirrus deck from decayed thunderstorm.

How To Avoid or Reduce Probability of a Strike:

—Comply with thunderstorm avoidance rules.

—Do not loiter in clouds near the freezing level.

—Avoid prolonged flight in precipitation and clouds.

—Fly single ship/radar trail in weather.

—Use airborne radar and PMSV.

—Avoid cirrus clouds in the vicinity of thunderstorms.

Figure 5-11. "Serious Damage" to a KC-135.

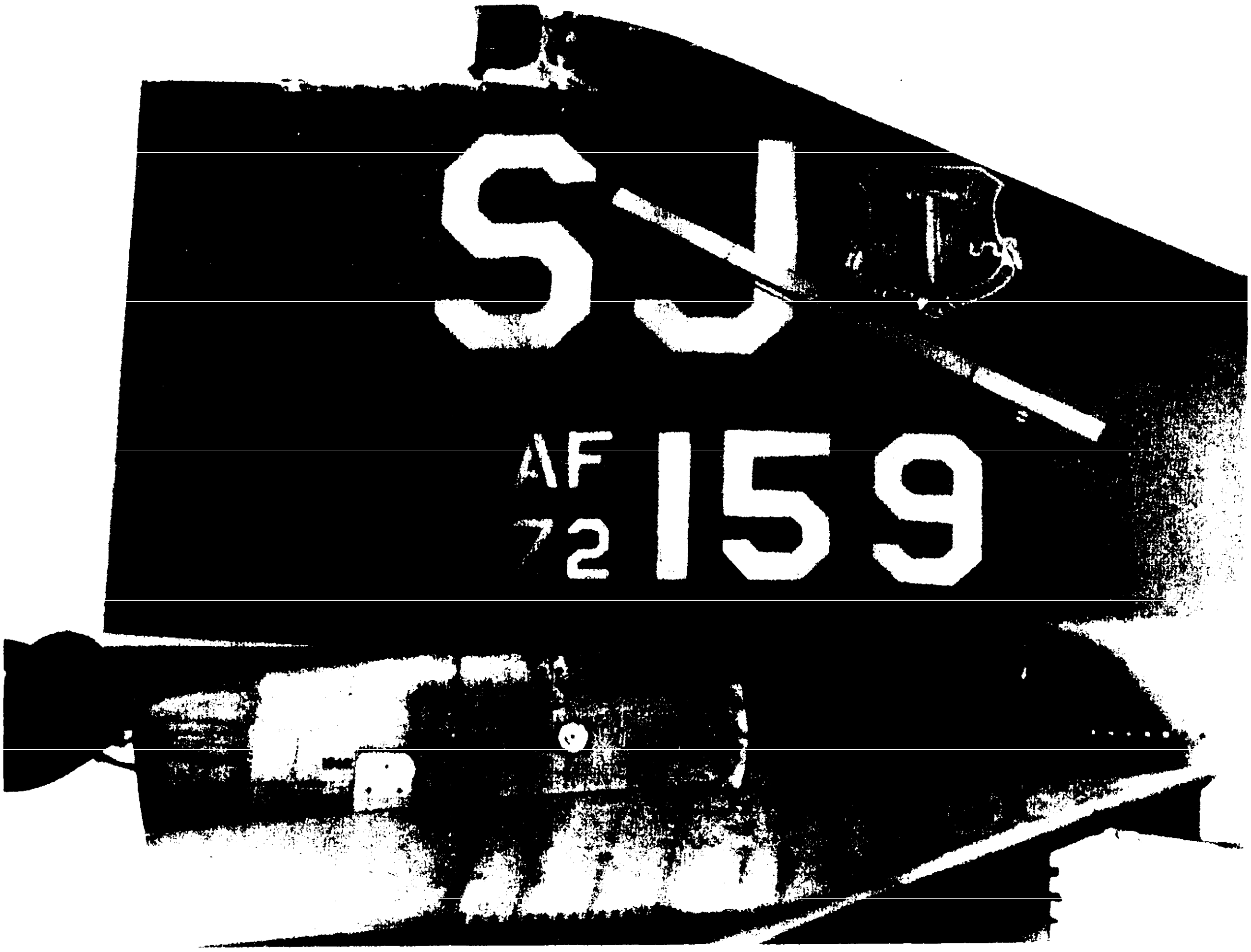


Figure 5-12. "Minor Damage" From a Lightning Strike.

Thunderstorms

Thunderstorms contain many of the most severe weather hazards to flight. These usually include strong gusty winds, severe turbulence, lightning, icing, heavy rain showers, and hazardous wind shear. Also, hail is frequently present and microbursts and tornadoes are possible. Almost every aircrew can expect to encounter a thunderstorm. Knowledge of thunderstorm hazards and the application of tested procedures will minimize the effect thunderstorms have upon the aircraft and crew.

Remember: The terms thunderstorm, cb, and cumulonimbus are synonymous! The only difference is the sound of thunder.

Hazards Associated with Thunderstorms:

—Turbulence.
—Downdrafts and surface gusts.
—Precipitation and icing.
—Hail.
—Lightning.
—Low-level wind shear.
—Microbursts.

Procedures:

—Best policy: AVOID THUNDERSTORMS! If you must penetrate a thunderstorm area:
—Use PMSV and aircraft radar.

NOTE: PMSV operators CANNOT give radar vectors.

—Avoid penetration near freezing level.
—Establish turbulence penetration airspeed.
—Maintain constant attitude: DO NOT chase altitude.
—Do not fly into or under the cirrus anvil.
—Avoid unnecessary maneuvering.
—DO NOT turn around.

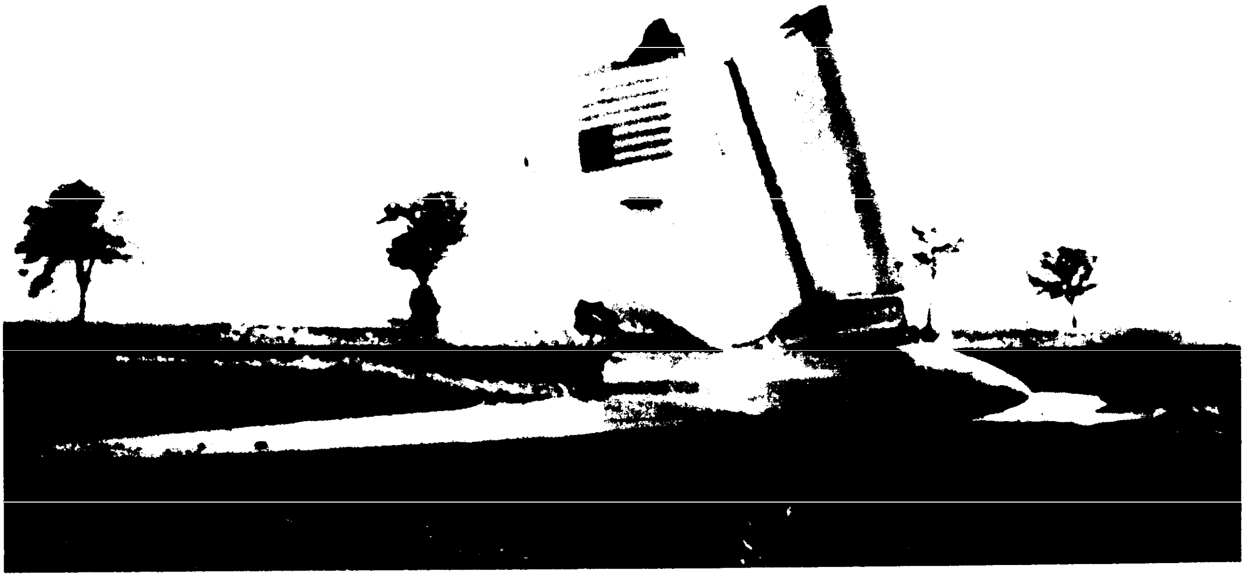


Figure 5-13. C-141 Tail Section After Flying Between Two Thunderstorms.

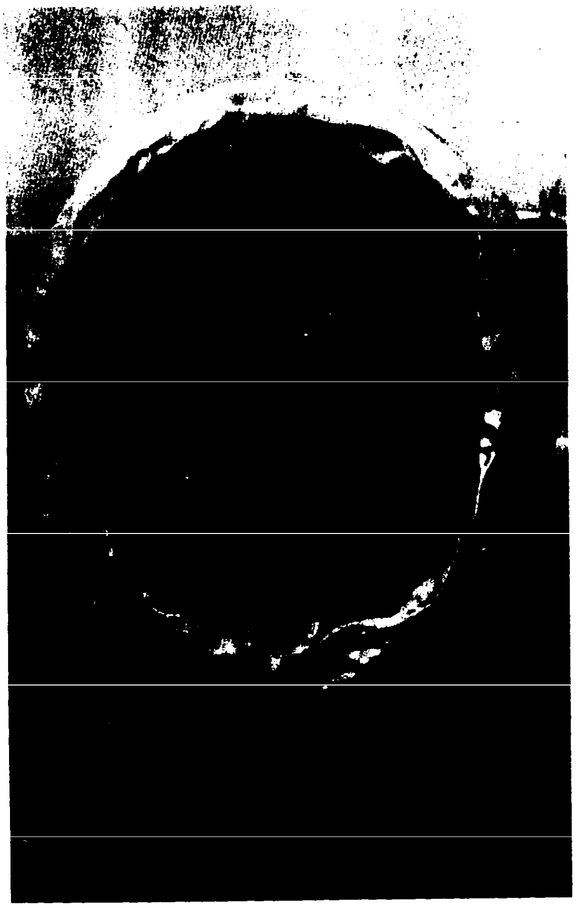


Figure 5-14. T-39 Hail Damage.

Figure 5-15. T-38 Tail Section Hail Damage.

BY ORDER OF THE SECRETARY OF THE AIR FORCE

OFFICIAL

MERRILL A. McPEAK, General, USAF
Chief of Staff

EDWARD A. PARDINI, Colonel, USAF
Director of Information Management

SUMMARY OF CHANGES

This revision expands information on thunderstorms; changes figure 1-2; expands figure 1-3; incorporates figure 1-7 into figure 1-6 which was also expanded; updates figure 1-13 and changes the corresponding text to reflect the update; makes several changes to the PIREP code; replaces figure 2-6 with an updated version; adds a new DD Form 175-1 (figure 3-3); updates figure 4-21; replaces figure 4-3 with a corrected version; adds information to the section on SIGMETs and AIRMETs; deletes figure 4-7; adds new information to chapter 5 on icing, mountain wave turbulence, low-level wind shear, lightning, electrostatic discharge, and thunderstorms; and adds captions to figures in chapter 5.

Ceiling and Visibility Equivalents

RUNWAY VISIBILITY

RVR Values Published in Hundreds of Feet	Statute Mile Equivalent	Nautical Mile Equivalent	Meter Equivalent	Kilometer Equivalent
16	1/4	2/10	490	.5
20	3/8	3/10	610	.6
24	1/2	4/10	730	.7
32	5/8	6/10	970	1.0
40	3/4	7/10	1220	1.2
45	7/8	8/10	1370	1.4
50	1	9/10	1520	1.5
60	1-1/4	1-1/10	1830	.1.8

CEILING

Published Minima Feet	Required Equivalent Meters
100	30
200	60
300	90
400	120
500	150
600	180
700	210
800	240
900	270
1000	300
1100	330
1200	360
1300	390
1400	420
1500	450

PREVAILING VISIBILITY

Statute Miles	Nautical Miles	Meters	Kilo-meters
1/8	1/10	200	.2
1/4	2/10	400	.4
3/8	3/10	600	.6
	4/10	700	.7
1/2		800	.8
	5/10	900	.9
5/8		1000	1.0
	6/10	1100	1.1
3/4		1200	1.2
	7/10	1300	1.3
7/8		1400	1.4
	8/10	1500	1.5
		1600	1.6
1			
	9/10	1700	1.7
1-1/4	1-1/10	2800	1.8
1-3/8	1-2/10	2200	2.2
1-1/2	1-3/10	2400	2.4
1-5/8	1-4/10	2600	2.6
1-3/4	1-5/10	2800	2.8
1-7/8	1-6/10	3000	3.0
2	1-7/10	3200	3.2
	1-8/10	3400	3.4
2-1/4	1-9/10	3600	3.6
	2	3700	3.7
	2-1/10	3900	3.9
2-1/2	2-2/10	4000	4.0
2-5/8		4200	4.2
	2-3/10	4300	4.3
2-3/4		4400	4.4
	2-4/10	4500	4.5
2-7/8		4600	4.6
	2-5/10	4700	4.7
3	2-6/10	4800	4.8
	2-7/10	5000	5.0
	2-8/10	5200	5.2
	3	6000	6.0

GLOSSARY OF ABBREVIATIONS

A

A—Hail
AFGWC—Air Force Global Weather Central
AGL—Above Ground Level
AIRMET—Airman's Meteorological Information
ALSTG—Altimeter Setting
ALT—Altitude
ALTN—Alternate Base or Destination
ARTCC—Air Route Traffic Control Center
ATC—Air Traffic Control
ATIS—Automatic Terminal Information Service
AWS—Air Weather Service

B

BKN—Broken (Sky Condition)
BWS—Base Weather Station

C

C—Centrigrade or Celsius
CAT—Clear Air Turbulence
CFP—Computer Flight Plan
CIG—Ceiling
CLR—Clear
COMEDS—CONUS Meteorological Data System
CONUS—Continental United States

D

Dep Pt—Departure Point
DMSP—Defense Meteorological Satellite Program
DP—Dew Point
DSN—Defense Switched Network
DURGC—During Climb
DURGD—During Descent

E

EFAS—En Route Flight Advisory Service
E.P.—Entire Period
ETA—Estimated Time of Arrival
ETD—Estimated Time of Departure

F

F—Fahrenheit
FAA—Federal Aviation Administration
FIH—Flight Information Handbook
FOD—Foreign Object Damage
FSS—Flight Service Station

G

GMT—Greenwich Mean Time
GOES—Geostationary Operational Environmental Satellite

H

HWD—Horizontal Weather Depiction

I

IFR—Instrument Flight Rules
IMC—Instrument Meteorological Conditions
INS—Inches
INTER—Intermittent

L

L—Local (Weather Observation)
LGT—Light
LIFR—Low Instrument Flight Rules
LLWS—Low-Level Wind Shear
LSR—Loose Snow on Runway
LV—Light and Variable Wind

M

M—Magnetic
mb—Millibar
MDT—Moderate
METAR—Aviation Routine Weather Report
MIC—Maximum Instantaneous Coverage
MSL—Mean Sea Level
MTN WV—Mountain Wave (Turbulence)
MVFR—Marginal Visual Flight Rules
MWA—Military Weather Advisory

N

NDB—Nondirectional Beacon
NE—No Echo
NOTAM—Notice(s) to Airmen
NUMRS—Numerous
NWS—National Weather Service

O

OCNL—Occasional
OM—(Radar) Out for Maintenance
OVC—Overcast

P

PIREP—Pilot Report
PMSV—Pilot-to-Metro Service
PROG—Prognosis
PSR—Packed Snow on Runway

Q

QNH—Altimeter

R
RAREP—Radar Report
RBS—Regional Briefing Station
RCR—Runway Condition Reading
RCRNR—Runway Condition Reading No Report
RVR—Runway Visual Range

S
SA—Hourly Weather Observation
SCT—Scattered
SD—Radar Report Identifier (Storm Detection)
SFC—Surface
SKC—Sky Clear
SIGMET—Significant Meteorological Information
SLP—Sea Level Pressure
SLR—Slush on Runway
SP—Special Weather Observation

T
TAA—Total Area Affected
TAF—Terminal Aerodrome Forecast
TURBC—Turbulence

U
UA—Routine Pilot Report (PIREP)
USAF—United States Air Force
UTC—Coordinated Universal Time
UUA—Severe Pilot Report (PIREP)

V
VFR—Visual Flight Rules
VHF—Very High Frequency
VIS (or VSBY)—Visibility
VMC—Visual Meteorological Conditions
VOR—VHF Omnidirectional Range
VRB—Variable

W
WMO—World Meteorological Organization
WND—Wind
WR—Wet Runway

Z
Z—Zulu