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Manual of Aeronautical Meteorological Practice

Approved by the Secretary General
and published under his authority

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AMENDMENTS

Amendments are announced in the supplements to the *Catalogue of ICAO Publications;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA		
No.	Date	Entered by

FOREWORD

1. The first edition of the *Manual of Aeronautical Meteorological Practice*, published in response to recommendations made by the Meteorology and Operations Divisional Meeting[1] (Paris, 1964), was intended as a guide for use by pilots and other aeronautical personnel on meteorological procedures, codes, symbols and abbreviations. It also contained a multilingual list of terms and phrases commonly used in meteorological briefings.

2. A second edition was prepared in 1977 to reflect, in particular, the many changes in procedures and terminology recommended by the Eighth Air Navigation Conference and the Meteorology Divisional Meeting[2] (1974).

3. As demand for the manual continued to grow and because further important changes to meteorological procedures had taken place, particularly in connection with the recommendations for the establishment of a world area forecast system (WAFS) made by the Communications/Meteorology Divisional Meeting[3] (Montréal, 1982), a third edition was prepared. That edition was rewritten aiming to meet the needs of operational aeronautical meteorologists, particularly those at the working level, as well as the needs of pilots and other aeronautical personnel.

4. As a consequence of an extensive amendment proposal to Annex 3 — *Meteorological Service for International Air Navigation* developed by the Communications/Meteorology/Operations (COM/MET/OPS) Divisional Meeting[4] (1990) including, in particular, provisions regarding the transition to the final phase of the WAFS, aerodrome observations, reports and forecasts, SIGMET information, etc., a fourth edition of the manual was published. In order to continue to meet users' requirements, however, the structure of the manual was not changed.

5. The fifth edition was the direct result of Amendment 70 to Annex 3, applicable from 1 January 1996, which constituted a comprehensive update of the provisions, in particular, those related to air-reporting and the observation and reporting of wind shear. In addition, new provisions concerning information on weather phenomena hazardous to low-level flights (AIRMET and GAMET messages) were introduced. However, the basic structure of the manual was maintained.

6. The sixth edition reflected the substantial changes made to Annex 3 in Amendments 71 and 72.

7. The seventh edition took account of the substantial changes which were introduced in Annex 3 through Amendment 73, which was developed by the Meteorological Divisional Meeting (2002)[5] and became applicable in November 2004. In view of the fact that all of the technical specifications and templates had been regrouped in Part II of Annex 3 by subject matter, it was no longer considered necessary to reproduce these templates in this manual. Furthermore, material related to coordination between aeronautical meteorological services and ATS, SAR and AIS units was eliminated since these issues were extensively covered in the *Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services* (Doc 9377).

8. The eighth edition incorporated all the changes included in Amendment 74 to Annex 3. Furthermore, explanations of the terms "MET authority", "MET inspectorate", "MET regulator" and "MET service provider" were

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1. Held conjointly with the Third Session of the Commission for Aeronautical Meteorology (CAeM) of the WMO.
2. Held, in part, conjointly with the Extraordinary Session (1974) of the body mentioned in Note 1.
3. Held conjointly with the Seventh Session of the body mentioned in Note 1.
4. Held conjointly with the Ninth Session of the body mentioned in Note 1.
5. Held conjointly with the Twelfth Session of the body mentioned in Note 1.

introduced; guidance related to issuance of SIGMET was expanded; and the chapter related to meteorological service for operators and flight crew members was re-organized and clarified.

9. This ninth edition reflects the substantial changes made to Annex 3 in Amendment 75.

10. The body of the manual is based primarily on Annex 3, summarized and enlarged upon, where necessary. The appendices provide information on other subjects such as location of instruments at aerodromes and use of meteorological information by flight operations officers.

11. It should be stressed that the material in this manual is intended for guidance only. It is not intended to replace relevant national instructions or explanatory material, nor is it intended to cover the many non-aeronautical uses of meteorological information. Nothing in this manual should be taken as contradicting or conflicting with Annex 3 provisions or any other Standards, Recommended Practices, procedures or guidance material published by ICAO or WMO. It should also be noted that in this manual the words “shall” or “should” are **not** used in a regulatory sense as in ICAO or WMO regulatory documents.

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Chapter 1

METEOROLOGICAL SERVICE FOR INTERNATIONAL AVIATION

1.1 GENERAL

1.1.1 Meteorological service for international aviation is provided by meteorological authorities designated by States. Details of the meteorological service to be provided for international aviation are determined by each State in accordance with the provisions of Annex 3 and with due regard for regional air navigation (RAN) agreements, which apply to specific areas designated as air navigation regions by ICAO. Each State also establishes a suitable number of meteorological offices, i.e. aerodrome meteorological offices, meteorological watch offices (MWOs) and aeronautical meteorological stations. Meteorological offices and aeronautical meteorological stations provide information required for operational planning, flight operations, the protection of aeronautical equipment on the ground, and for various other aeronautical uses. The information provided includes observations and reports of actual weather conditions at aerodromes and forecasts; it is made available at aerodrome meteorological offices and is disseminated as appropriate to aeronautical users, including operators, flight crew members, air traffic services (ATS) units, search and rescue (SAR) units, airport management and others concerned with the conduct or development of international air navigation.

1.1.2 Forecasts of en-route conditions, except forecasts for low-level flights issued by meteorological offices, are prepared by world area forecast centres (WAFCs) (see 1.5). This ensures the provision of high-quality and uniform forecasts for flight planning and flight operations. It also permits MWOs to concentrate on keeping watch on weather conditions in their flight information regions (FIRs) and permits meteorological offices at aerodromes to concentrate on local aerodrome forecasting, to keep watch over local (aerodrome) conditions and to issue warnings of weather conditions that could adversely affect operations and facilities at the aerodrome (e.g. aerodrome and wind shear warnings).

1.1.3 SIGMET and AIRMET information concerning the occurrence of specified en-route phenomena which may affect the safety of aircraft operations are issued by MWOs (see 1.3). In the specific case of tropical cyclones and volcanic ash, in addition to SIGMET, advisory information is issued by designated tropical cyclone advisory centres (TCACs) and volcanic ash advisory centres (VAACs) (see 1.6 and 1.7).

1.1.4 The responsibility for the provision of meteorological service for international air navigation mentioned in 1.1.1 rests with **the meteorological authority** designated by each State in accordance with Annex 3, 2.1.4. The meteorological (MET) authority may wish to provide the service or may arrange for the provision of the service by other providers on its behalf.

1.1.5 Terms additional to the "MET authority" are being used in the context of safety oversight audits related to institutional arrangements in States. In particular, use of the terms "meteorological (MET) inspectorate", "meteorological (MET) regulator" and "meteorological (MET) service provider" has raised questions. The following list attempts to clarify these terms which are neither specified nor used in Annex 3:

a) the "MET inspectorate" refers to the entity that is responsible for conducting safety oversight for the "MET authority" over the "MET service provider" in the State concerned;

b) the "MET regulator" can be considered to be simply another term for the "MET authority", i.e. the body responsible for the facilities and services to be provided in accordance with Annex 3. This term is used to highlight the regulatory aspects of its functions; and

c) the "MET service provider" is the entity that is providing the MET facilities and services as required in ICAO provisions. In the context of safety oversight audits, the term "entity providing the MET service" is sometimes used to designate the "MET service provider".

There are no provisions currently in place that would prevent the "MET inspectorate" to be part of the same organization as the "MET authority". Furthermore, in accordance with Annex 3, the "MET service provider" could be either within the "MET authority" or, alternatively, within an independent organization. However, in some States or regions (e.g. under the European Single Sky), the legislation stipulates that the "MET regulator" (i.e. "MET authority") and the "MET service provider" have to be separated, at least functionally. In cases where the "MET service provider" is part of the same organization as the "MET authority", it would be preferable that the oversight function be carried out by an outside, independent "MET inspectorate". In such cases, the inspectorate could be an independent MET expert involved in the International Organization for Standardization (ISO) certification audit of the "MET service provider", or be part of the ministry overseeing the "MET authority" or part of the civil aviation authority (CAA), provided that such a CAA-based inspectorate is a third-party, independent body with qualified MET personnel. Such arrangements would avoid any conflict of interest between inspection and service provision. Irrespective of the administrative arrangements, it is considered important that the "MET inspectorate" have close coordination with the entity responsible for the more general safety oversight (located in most cases within the CAA).

1.1.6 In order to meet the objectives of meteorological service for international air navigation and provide users with the assurance that the service, including the meteorological information provided, complies with the aeronautical requirements, the MET authority must establish and implement a properly organized quality system in accordance with the ISO 9000 series of quality assurance standards. The system is to be certified by an approved organization.

Note.— Specific guidance on this subject is contained in the Manual on the Quality Management System for the Provision of Meteorological Service to International Air Navigation (Doc 9873), published jointly with World Meteorological Organization (WMO).

1.1.7 Properly educated and trained personnel should be employed in the provision of meteorological service for international air navigation. It is, therefore, an important responsibility of the MET authority to ensure that widely recognized standards are applied to the qualifications, education and training of all of the personnel involved in the provision of meteorological service for international air navigation. With respect to meteorological personnel, the requirements of the WMO should be applied.

Note 1.— The requirements are given in WMO Publication No. 49, Technical Regulations, *Volume I* — General Meteorological Standards and Recommended Practices, *Chapter B.4* — Education and Training. *Detailed guidance is provided in the WMO* Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology, *Volume I (WMO-No. 258) which relates to the training and qualification requirements for aeronautical meteorological personnel.*

Note 2.— Education and training in aeronautical meteorology of aeronautical personnel (e.g. pilots, ATC personnel, flight dispatch officers), required by the aeronautical authorities concerned, must comply with the relevant ICAO documents (i.e. Training Manual, *Part F-1* — Meteorology for Air Traffic Controllers and Pilots *(Doc 7192)).*

1.2 METEOROLOGICAL OFFICES

Meteorological offices serving aviation are often located at aerodromes, in which case they are called aerodrome meteorological offices. The meteorological offices issue aerodrome forecasts as TAF and trend forecasts on the basis of RAN agreement. In addition to maintaining a continuous survey of meteorological conditions over the aerodrome(s) under their responsibility, preparing forecasts of local meteorological conditions, aerodrome warnings and wind shear warnings, these offices also provide briefing, consultation and flight documentation or other meteorological information, and display weather charts, reports, forecasts, meteorological satellite images and information derived from ground-based weather radar or a radar network. Much of the information is obtained from WAFCs or from other meteorological offices (which may be located in a different country). Furthermore, meteorological offices supply operational meteorological (OPMET) information to aeronautical users and exchange such information with other meteorological offices. This also includes the exchange of OPMET information required by RAN agreement. In addition, where necessary, meteorological offices supply information regarding pre-eruption activity, volcanic ash eruptions or the presence of volcanic ash in the atmosphere to their associated ATS units, the aeronautical information services (AIS) units and the MWO concerned, as agreed between the ATS, AIS and meteorological authorities concerned. However, not all international aerodromes have a meteorological office, and for such aerodromes the relevant air navigation plans (ANPs)/facilities and services implementation documents (FASIDs) indicate the name and location of the meteorological office designated to supply OPMET information concerning the aerodrome to operators, ATS units and others concerned.

1.3 MWOs

1.3.1 States accepting responsibility for an FIR have to either designate an MWO to serve that FIR or arrange for another State to designate a MWO on its behalf. The MWOs designated in accordance with RAN agreement are listed in the relevant ANP/FASID to indicate the overall plan for providing meteorological service for the FIR within each ICAO region. They maintain a continuous watch over meteorological conditions affecting flight operations within their areas of responsibility, issue information on the occurrence or expected occurrence of specified hazardous en-route weather conditions which may affect the safety of aircraft and low-level aircraft operations (SIGMET and AIRMET information, respectively) and supply this and other weather information to their associated ATS units, usually an area control centre (ACC) or a flight information centre (FIC). In addition, MWOs exchange SIGMET information issued by other MWOs as required by RAN agreement. The AIRMET information issued is transmitted to MWOs and meteorological offices in adjacent FIRs (for details see Chapter 4). In preparing SIGMET and AIRMET information, MWOs normally make use of special air-reports, and satellite and radar data.

1.3.2 MWOs also supply the information received on pre-eruption volcanic activity, volcanic eruptions and volcanic ash clouds, for which SIGMET information has not already been issued, to their associated ACC(s)/FIC(s), and in accordance with RAN agreement, to the VAACs concerned. It is also the responsibility of MWOs to supply information received concerning an accidental release of radioactive materials into the atmosphere within the area of their responsibility to their associated ACC(s)/FIC(s) and to the relevant AIS units, as agreed by the ATS, AIS and MET authorities concerned. This information is usually obtained from the WMO regional specialized meteorological centre (RSMC) which specializes in the provision of computer-generated dispersion model products for radiological environmental emergency response.

1.4 METEOROLOGICAL STATIONS

1.4.1 The actual weather observations at aerodromes and offshore structures are made by aeronautical meteorological stations. The specific types of observations and related reports are disseminated either locally, or to other aerodromes, as required, in accordance with RAN agreement.

1.4.2 In the areas prone to volcanic eruptions, aeronautical meteorological stations make observations regarding volcanic activity and volcanic eruptions. These observations form the basis for the issuance of volcanic activity reports. Details on the content and dissemination of such reports are given in 2.5.

1.5 WAFCs

The two WAFCs are components of the world area forecast system (WAFS), which is designed to supply MET authorities and other users with forecasts of global upper winds, upper-air temperatures, tropopause heights and temperatures, maximum winds, humidity, cumulonimbus (CB) clouds, icing, and in-cloud and clear air turbulence in the binary GRIB code form for direct input into meteorological and/or flight planning computers. The WAFS also supplies global forecasts of significant weather (SIGWX) in the binary BUFR code form.

Note.— Further information on the WAFS is given in Appendix 1.

1.6 TCACs

TCACs are meteorological centres designated by RAN agreement on advice from WMO. They monitor the development of tropical cyclones in their areas of responsibility, using geostationary and polar-orbiting satellite data and other meteorological information sources (e.g. numerical weather prediction models). TCACs provide MWOs, providers of international OPMET databanks established by RAN agreement, providers of the aeronautical fixed service (AFS) satellite distribution systems and, as necessary, other TCACs with advisory information regarding the position of the centre of the tropical cyclone, its forecast direction and speed of movement, central pressure and maximum surface wind near the centre of the cyclone. The advisory information is to be used by MWOs in support of the issuance of SIGMET information for tropical cyclones. The information is also made available to aeronautical users through the AFS satellite distribution systems.

1.7 VAACs

1.7.1 VAACs are meteorological centres designated by RAN agreement on advice from WMO. They monitor relevant satellite data to detect volcanic ash in the atmosphere. Subsequently, VAACs run volcanic ash numerical dispersion models to forecast the movement of a volcanic ash cloud. VAACs maintain contact with State volcano agencies in their respective areas of responsibility in order to obtain expert and timely information on significant pre-eruption volcanic activity and volcanic eruptions of concern to international air navigation. As a result, the VAACs provide, as required, MWOs, ACCs, FICs, NOTAM offices, WAFCs, international OPMET databanks established by RAN agreement, AFS satellite distribution systems and other VAACs, with advisory information regarding the lateral and vertical extent and forecast movement of volcanic ash in the atmosphere following volcanic eruptions. The advisory information is to be used by MWOs in support of the issuance of SIGMET information on volcanic ash clouds. The information is also made available to aeronautical users through the AFS satellite distribution systems.

1.7.2 VAACs form part of the ICAO International airways volcano watch (IAVW). The international arrangements set up within the IAVW are aimed at monitoring volcanic ash in the atmosphere and providing warnings to aircraft of volcanic ash and associated volcanic activity.

Note.— Detailed information on the IAVW can be found in the Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds *(Doc 9691) and in the* Handbook on the International Airways Volcano Watch (IAVW) — Operational Procedures and Contact List *(Doc 9766) (available in electronic format at http://www.icao.int/anb/iavwopsg)*.

1.8 STATE VOLCANO OBSERVATORIES

A number of States that have active volcanoes in their territories maintain a network of volcano observatories to monitor selected volcanoes. The selected volcano observatories that are required to provide information on significant pre-eruption volcanic activity and volcanic eruptions to the IAVW (see 1.7.2) are designated by RAN agreement and listed in the FASID for the ICAO regions concerned.

Chapter 2

METEOROLOGICAL OBSERVATIONS AND REPORTS

2.1 GENERAL

2.1.1 Observations of meteorological conditions are made by means of instruments and visual estimation and are used for landing and take-off, en-route navigation and flight performance, and as a basis for forecasting. Those observations used primarily for aircraft operations are called “OPMET information” while those used primarily for forecasting purposes are considered to be “basic meteorological data”. OPMET information includes aerodrome reports, landing forecasts, aerodrome forecasts, special aircraft observations, SIGMET and AIRMET information, tropical cyclone and volcanic ash advisories and WAFS forecasts. Basic meteorological data include synoptic surface and upper-air observations, satellite images, weather radar data and routine aircraft observations. OPMET information is described in detail below.

Note.— The total costs related to the provision of OPMET information can be recovered from international civil aviation through air navigation charges, while the costs related to the provision of basic meteorological data are to be allocated between aeronautical and non-aeronautical users. Detailed guidance related to cost allocation is given in the Manual on Air Navigation Services Economics (Doc 9161).

2.1.2 At many locations, observations are made by use of fully automatic observing equipment. The equipment normally forms part of an integrated automatic system, with displays at local aeronautical meteorological station(s), meteorological office(s), briefing facilities and ATS units. Semi-automatic observing equipment provides for the manual insertion of meteorological elements which the equipment is not capable of observing.

Note.— It should be noted that Human Factors principles should be observed in the design of these systems as well as of other systems and equipment used in the provision of meteorological service to international air navigation. Guidance material on the matter is given in the Human Factors Training Manual (Doc 9683).

2.1.3 High-quality and timely meteorological observations and reports for international air navigation are the foundation upon which an effective aeronautical meteorological service is based and of direct consequence to aviation safety. In view of this, the provision of meteorological observations and reports must form an integral part of the quality system established by the meteorological authority.

2.1.4 To the extent practicable, aerodrome observations are made at locations considered to be suitable for representative measurements of elements affecting aircraft during take-off and landing operations. Details in respect of these locations are given in Appendix 2, and the aeronautical requirements for the operationally desirable accuracy of meteorological observations are given in Annex 3, Attachment A.

2.2 AERODROME OBSERVATIONS AND REPORTS

2.2.1 At aerodromes, routine observations are made and reported at hourly or half-hourly intervals depending on RAN agreement. When required as a result of specified operationally significant changes in the meteorological conditions, special observations and reports are made whenever such changes occur between routine observations (see 2.4).

2.2.2 Observational data are combined into a report for dissemination at the local aerodrome or beyond (see Examples 2-1 and 2-2). Depending on their use, the reports are presented in two forms, i.e. as local routine and special reports in abbreviated plain language intended for dissemination and use at the aerodrome of origin or as an aerodrome routine meteorological report (METAR) and aerodrome special meteorological report (SPECI) intended for dissemination and use beyond the aerodrome of origin.

2.2.3 The issuance of SPECI is not necessary if METAR are issued at half-hour intervals.

2.2.4 The need to provide aeronautical users with two reports, one for local aerodrome use and one for use beyond the aerodrome, is to meet operational requirements as follows:

a) local routine and special reports for aircraft about to land or take off including requirements for ATIS (voice-ATIS and D-ATIS); and

b) METAR/SPECI for flight planning and en-route flight information service purposes, including requirements for OPMET information for aircraft in flight (VOLMET) broadcasts and D-VOLMET.

The information in both reports, therefore, differs slightly to fully reflect the respective operational requirements. Technical specifications for local routine reports, local special reports and METAR and SPECI are in a set of detailed templates relating to individual portions and groups in the reports contained in Annex 3, Appendix 3, Tables A3-1 and A3-2. The appendix also contains technical specifications concerning trend forecasts, which are attached to local routine and special reports, and METAR/SPECI, as required. These forecasts are dealt with in 3.5.

2.2.5 Local routine and special reports, and METAR and SPECI from fully automatic systems can be used without human intervention as depicted in Table 2-1. It only concerns States that are in a position to use automatic systems. Caution should be exercised in using reports from fully automatic systems in areas with rugged topography or with complex climatological regimes.

Table 2-1. Use of reports from fully automatic systems, without human intervention

	Type of report		
Hours of aerodrome	*Local routine and special reports*	*METAR/SPECI*	*Remarks*
Operational hours	As determined by the MET authority in consultation with users		Decision to be based on the availability and efficient use of personnel
Non-operational hours	Not applicable	Acceptable	No local reports issued during non-operational hours of the aerodrome

2.2.6 Local routine and special reports are supplied to ATS units which use them, together with any information obtained from their own duplicate displays (e.g. wind, height of cloud base, or runway visual range (RVR) displays of automatic meteorological observing systems) or supplementary visual observations taken by ATS personnel, in order to provide the required OPMET information to aircraft taking off or landing. These reports are supplied to aircraft by ATS units by air-ground data link, by directed transmissions and/or through broadcasts. Further details on coordination between meteorological offices/stations and ATS units in this and other respects are given in the *Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services* (Doc 9377).

Example 2-1. Routine reports

a) *Local routine report (same location and weather conditions as METAR):*

MET REPORT YUDO* 221630Z WIND 240/5MPS VIS 600M RVR RWY 12 TDZ 1000M MOD DZ FG CLD SCT 300M OVC 600M T17 DP16 QNH 1018HPA

b) *METAR for YUDO:*

METAR YUDO* 221630Z 24004MPS 0800 R12/1000U DZ FG SCT010 OVC020 17/16 Q1018

Meaning of both reports:

Local routine report or METAR for Donlon/International* issued on the 22nd of the month at 1630 UTC; surface wind direction 240 degrees; wind speed 5 or 4 metres per second (averaged over 2 or 10 minutes, respectively); visibility (along the runway(s) in the local routine report; prevailing visibility in METAR) 600 and 800 metres; runway visual range representative of the touchdown zone for runway 12 is 1 000 metres (averaged over 1 or 10 minutes, respectively), and the runway visual range values have shown an upward tendency during the previous 10 minutes (RVR tendency to be included in METAR only); moderate drizzle and fog; scattered cloud at 300 metres (1 000 ft); overcast at 600 metres (2 000 ft); air temperature 17 degrees Celsius; dew-point temperature 16 degrees Celsius; QNH 1 018 hectopascals.

* Fictitious location

Example 2-2. Special reports

a) *Local special report (same location and weather conditions as SPECI):*

SPECIAL YUDO* 151115Z WIND 050/26KT MAX37 MNM10 VIS 1000M RVR RWY 12 1200M HVY TSRA CLD BKN CB 500FT T25 DP22 QNH 1008HPA

b) *SPECI for YUDO:*

SPECI YUDO* 151115Z 05025G37KT 2000 1000S R12/1200N +TSRA BKN005CB 25/22 Q1008

Meaning of both reports:

Local special report or SPECI for Donlon/International* issued on the 15th of the month at 1115 UTC; surface wind direction 050 degrees; wind speed 26 or 25 knots (averaged over 2 or 10 minutes, respectively) gusting between 10 and 37 knots (for SPECI: “gusting to 37 knots”); visibility 1 000 metres (along the runway(s) in the local special report); prevailing visibility 2 000 metres (in SPECI) with minimum visibility 1 000 metres to south (directional variations to be included in SPECI only); runway visual range representative for the touchdown zone for runway 12, 1 200 metres (averaged over 1 and 10 minutes, respectively), (for SPECI: “no distinct tendency detected” in runway visual range values during previous 10 minutes); thunderstorm with heavy rain; broken cumulonimbus cloud at 500 feet; air temperature 25 degrees Celsius; dew-point temperature 22 degrees Celsius; QNH 1 008 hectopascals.

* Fictitious location

2.3 ROUTINE REPORTS

2.3.1 Paragraphs 2.3.3 to 2.3.15 deal with the content and format of routine reports; both those in abbreviated plain language disseminated locally (referred to below as local routine reports or MET REPORTs) and those disseminated beyond the aerodrome of origin (referred to as METAR). Local special reports (also referred to as SPECIALs) and special reports disseminated beyond the aerodrome of their origin (referred to as SPECI) are dealt with in 2.4. Practices relating to the transmission of local reports by local ATS units to aircraft taking off and landing are given in Doc 9377.

2.3.2 The METAR and SPECI code forms were developed by WMO on the basis of aeronautical requirements established by ICAO. These codes and local reports use the approved ICAO abbreviations contained in the *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC, Doc 8400). In view of this, METAR and SPECI are easily readable.

Note 1.— All details relating to the METAR and SPECI code forms are contained in WMO Publication No. 306, Manual on Codes — International Codes, *Volume I.1, Part A* — Alphanumeric Codes.

Note 2.— Units of measurement differ in some States depending on national practices. In this manual, all units used are those prescribed by Annex 5 — Units of Measurement to be Used in Air and Ground Operations *as primary or alternative units. As regards elements for which two units are permitted, numerical criteria are given for both units, and examples of reports are given in one or the other unit.*

Note 3.— Details concerning requirements for the exchange of these reports between meteorological offices can be found in the ANPs/FASIDs for the various ICAO regions.

Note 4.— Selected criteria applicable to meteorological information referred to in 2.3.6 to 2.3.15 for inclusion in aerodrome reports are given in Annex 3, Attachment C.

2.3.3 Identification of the type of report

(MET REPORT) — Local routine report
(METAR) — METAR

In the event of an error being disseminated in METAR, a corrected METAR should be issued using the entry METAR COR, in place of METAR.

2.3.4 Location indicator

(YUDO) in both reports

ICAO four-letter location indicator for the aerodrome for which the report is made. (The full name of the aerodrome is used in the transmission to aircraft.)

Note.— The indicators are prescribed in Doc 7910 — Location Indicators.

2.3.5 Time of the observation

(221630Z) in both reports

Day and actual time of observation: day of the month and time in hours and minutes, in Coordinated Universal Time (UTC).

2.3.6 Identification of an automated or a missing report

(AUTO *or* NIL) — NIL in METAR only

In the case of local routine reports and METAR from automatic observing systems with no human intervention, the report is to be identified with “AUTO”. In the event of missing METAR, the abbreviation “NIL” should be used.

2.3.7 Surface wind

(WIND RWY 18 TDZ 240/5MPS) — Local routine report
(2404MPS) — METAR

Note.— Anemometers are to be installed at a standard height of approximately 10 m (30 ft). Guidance is given in WMO Publication No. 8, Guide to Meteorological Instruments and Methods of Observation *regarding the effects of variations in anemometer height on the wind measurement. This relationship depends upon the roughness length (i.e. the number and size of buildings in the vicinity of the anemometer and the general terrain of the surrounding area) of the site concerned. However, it could normally be expected that variations in measurement would be within the desirable accuracy of measurement, given in Annex 3, Attachment A, with anemometer heights between 9 m (27 ft) and 11 m (33 ft).*

2.3.7.1 Wind observations in local routine reports used for arriving or departing aircraft should be representative of the touchdown zone and the conditions along the runway, respectively. Positions of wind sensors along individual runways should be indicated in local routine reports together with the reported wind data by the sections of the runway for which the wind data are to be representative. When wind observations are available from more than one runway in use, the indication of the relevant runway should also be attached to the wind data in local routine reports. Surface wind observations included in the METAR should be representative of the whole runway complex at the aerodrome, and no indication of the runway or runway sections should be included therein.

2.3.7.2 Direction (true) from which surface wind is blowing should be indicated in degrees rounded off to the nearest 10°. The unit used for wind speed should be indicated both in local routine reports and METAR. In local routine reports, the term “CALM” is used when a wind speed of less than 0.5 m/s (1 kt) is observed. Wind speed of 50 m/s (100 kt) or more is to be indicated as ABV49MPS or ABV99KT.

Note 1.— Wind direction reported to aircraft for landing or take-off purposes must be converted into degrees magnetic. This conversion is normally carried out by the ATS unit concerned.

Note 2.— For wind speed, either metres per second or knots may be used.

2.3.7.3 In local reports, surface wind should be based on an averaging period of two minutes.

2.3.7.4 In METAR, surface wind should be based on an averaging period of ten minutes, except that when the ten-minute period includes a marked discontinuity in the wind direction and/or speed, only data occurring since the discontinuity should be used for obtaining mean values, and the time interval should be correspondingly reduced. A marked discontinuity occurs when there is an abrupt and sustained change in wind direction of 30° or more, with a wind speed of 5 m/s (10 kt) before or after the change, or a change in wind speed of 5 m/s (10 kt) or more, lasting at least two minutes. The wind direction should be reported in steps of 10 degrees using three figures, e.g. 030 or 240. The wind speed is reported in steps of 1 metre per second or 1 knot using two figures, e.g. 05 or 15, supplemented by the units used (MPS or KT). (For further details, see 2.3.8.3 a) and b). Calm conditions are reported as 00000.

2.3.8 Significant speed and directional variations
(Table 2-2)

2.3.8.1 Variations of wind direction and speed given in meteorological reports always refer to the ten-minute period preceding the observation.

2.3.8.2 In local routine reports and in METAR (see Table 2-2), directional variations are indicated when the wind direction varies by 60° or more and when:

a) the mean speed is 1.5 m/s (3 kt) or more **and** the wind direction varies by less than 180°:

— report the two extreme directions (reported clockwise) between which the wind has varied, in degrees, after indication of the mean wind direction and speed, for example: mean surface wind direction 10°; wind speed 9 kt; wind direction variable between 350° and 050°:

- in local routine reports: "WIND 010/9KT VRB BTN 350/ AND 050/"
- in METAR: "01009KT 350V050";

b) the mean speed is less than 1.5 m/s (3 kt) **and** the wind direction varies by less than 180°:

— indicate the wind direction by the term "variable" (VRB) followed by the mean wind speed, with no indication of the mean wind direction, e.g.: mean surface wind direction 10°, wind speed 1 metre per second, wind direction variable between 350° and 050°:

- in local routine reports: "WIND VRB1MPS"
- in METAR: "VRB01MPS";

c) the wind direction varies by 180° or more:

— indicate the wind direction by the term VRB followed by the mean wind speed, with no indication of the mean wind direction, e.g.: mean surface wind direction 10°, wind speed 5 m/s; wind direction variable between 350° and 190°:

— in local routine reports: "WIND VRB5MPS"

— in METAR: "VRB05MPS".

2.3.8.3 When the wind is gusty, with variations from the mean wind speed (gusts) exceeding 5 m/s (10 kt), speed variations are indicated (see Table 2-3). When noise abatement procedures are applied in accordance with paragraph 7.2.6 of the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444), wind speed (gusts) exceeding 2.5 m/s (5 kt) are indicated in local routine reports. Speed variations are given:

a) in local routine reports, as the maximum and minimum values of the wind speed, after indication of the mean wind direction and speed, in the form "WIND 180/10MPS MAX 18 MNM5" or "WIND 180/20KT MAX 35 MNM 10"; and

b) in METAR, as the maximum value of the wind speed, after indication of the mean wind direction and speed and preceded by the letter indicator G (for gusts). The minimum wind speed is never included. When wind speed is 50 m/s (100 kt) or more, the wind speed is reported as P49MPS (P99KT).

Table 2-2. Reporting procedures related to directional variations of wind.
ddd = mean wind direction, ddd_1 and ddd_2 = extreme wind directions, $\Delta = |ddd_1 - ddd_2|$,
VV = mean wind speed. Averaging period applied indicated as a subscript.
V = indicator of variability.

Type of report	*Directional variations during preceding 10 minutes*			
	$\Delta \leq 60°$	$\Delta > 60°$		
		$VV \geq 1.5$ m/s (3 kt)		$VV < 1.5$ m/s (3 kt) [but $VV \geq 0.5$ m/s (1 kt)]*
		$\Delta < 180°$	$\Delta \geq 180°$	
Local routine report	ddd/$VV_{2\ min}$	ddd/$VV_{2\ min}$ VRB BTN ddd_1/ AND ddd_2/**	VRB/$VV_{2\ min}$	VRB/$VV_{2\ min}$
METAR	ddd$VV_{10\ min}$	ddd$VV_{10\ min}$ ddd_1**V**ddd_2**	VRB$VV_{10\ min}$	VRB$VV_{10\ min}$

* If VV < 0.5 m/s (1 kt), the wind shall be reported as “CALM” and “00000” in local routine reports and METAR, respectively.
** ddd_1 ddd_2 in clockwise order.

Table 2-3. Reporting procedures related to speed variations of wind.
ddd = mean wind direction, VV_{mnm} and VV_{max} = minimum and maximum
wind speed, VV = mean wind speed. Averaging period applied
indicated as a subscript. G = indicator for gusts.

Type of report	*Speed variations during preceding ten minutes*	
	$\Delta \leq 5$ m/s (10 kt)	$\Delta > 5$ m/s (10 kt)*
Local routine report	ddd/$VV_{2\ min}$	ddd/$VV_{2\ min}$ MAX VV_{max} MNM VV_{mnm}
METAR	ddd$VV_{10\ min}$	ddd$VV_{10\ min}$ G VV_{max}

* 2.5 m/s (5 kt) in local routine reports when noise abatement procedures are applied.

2.3.9 Visibility

(VIS RWY 09 TDZ 600M) — Local routine report
(0600) — METAR

2.3.9.1 Visibility may be observed by a human observer or measured by instruments. The following definition for visibility for aeronautical purposes applies.

Visibility for aeronautical purposes is the greater of:

a) the greatest distance at which a black object of suitable dimensions, situated near the ground, can be seen and recognized when observed against a bright background; and

b) the greatest distance at which lights in the vicinity of 1 000 candelas can be seen and identified against an unlit background.

Note 1.— The two distances have different values in air of a given extinction coefficient, and the latter (b) varies with the background illumination. The former (a) is represented by the meteorological optical range (MOR).

Note 2.— Guidance on the conversion of instrumented readings into visibility is given in Annex 3, Attachment D.

Note 3.— Transmissometers and/or forward-scatter meters should be used as sensors in instrumented systems for the measurement of visibility.

2.3.9.2 In local routine reports used for:

a) *departing aircraft*, the visibility observations should be representative of the conditions along the runway; and

b) *arriving aircraft*, the visibility observations should be representative of the touchdown zone.

In METAR, visibility observations should be representative of the aerodrome. In such observations, special attention should be paid to significant directional variations in visibility.

2.3.9.3 In local routine reports and METAR, visibility is reported in steps of: 50 m when visibility is less than 800 m; 100 m when visibility is 800 m or more but less than 5 km; and 1 km when visibility is 5 km or more but less than 10 km. When visibility is 10 km or more, it is given as 10 km, except when conditions for the use of CAVOK apply (Annex 3, 2.2 refers). Any observed value that does not fit the reporting scale in use shall be rounded down to the nearest lower step in the scale.

2.3.9.4 When instrumented systems are used, the averaging period should be one minute for local routine reports.

2.3.9.5 In local routine reports, visibility along the runway(s) is reported together with the units of measurement, e.g. "VIS 600M". When the visibility is observed for more than one runway in use and at more than one location along the runway, the relevant runways and locations along the runways should be identified and attached to the reported value(s) of visibility, e.g. "VIS RWY 19 TDZ 6KM".

2.3.9.6 When instrumented systems are used, the averaging period should be ten minutes for METAR.

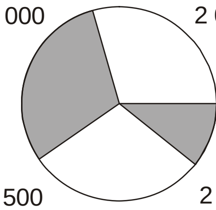
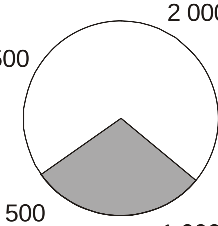
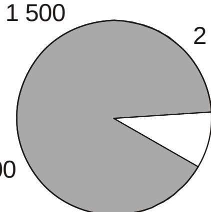
2.3.9.7 In METAR, prevailing visibility is reported. Prevailing visibility is defined as the greatest visibility value which is reached at least within half the horizon circle or within half of the aerodrome surface. This could be formed by sectors, which could be contiguous or non-contiguous. Examples of various situations are given in Figure 2-1 together with an assessment of how the prevailing visibility would be reported in each case. Where instrumented systems are used for the measurement of visibility at an aerodrome (often used for the assessment of RVR as well), the prevailing visibility can be obtained based on the visibility measured in certain sectors by these instruments. Detailed guidance is given in Appendix 3 for the reporting of prevailing visibility using fully automatic observing systems.

2.3.9.8 In METAR, visibility is reported by four figures, e.g. 0200, 1500, 4000. When visibility is 10 km and above and the conditions for the use of CAVOK do not apply, visibility is indicated as 9999. When the visibility is not the same in different directions and when the lowest visibility is different from the prevailing visibility and:

a) less than 1 500 m; or

b) less than 50 per cent of the prevailing visibility and less than 5 000 m,

the lowest visibility observed should also be reported and, when possible its general direction in relation to the aerodrome reference point indicated by reference to one of the eight points of the compass, e.g. "2000 1200NW". If the prevailing visibility cannot be determined due to rapid fluctuation, the lowest visibility should be reported with no indication of direction (Table 2-4 refers).

<table>
<tr><th colspan="4">Determining visibility
(sectors* considered for prevailing visibility indicated by shading)</th><th>Minimum visibility</th><th>Prevailing visibility</th></tr>
<tr><td colspan="3">1. Four sectors</td><td rowspan="6"></td><td rowspan="6">1 500</td><td rowspan="6">2 500</td></tr>
<tr><td>Visibility (metres)</td><td>Approximate degrees</td><td></td></tr>
<tr><td>5 000</td><td>90</td><td rowspan="2">180</td></tr>
<tr><td>2 500</td><td>90</td></tr>
<tr><td>2 000</td><td>90</td><td></td></tr>
<tr><td>1 500</td><td>90</td><td></td></tr>
<tr><td colspan="3">2. Five sectors</td><td rowspan="7"></td><td rowspan="7">1 000</td><td rowspan="7">2 000</td></tr>
<tr><td>Visibility (metres)</td><td>Approximate degrees</td><td></td></tr>
<tr><td>5 000</td><td>50</td><td rowspan="3">270</td></tr>
<tr><td>2 500</td><td>90</td></tr>
<tr><td>2 000</td><td>130</td></tr>
<tr><td>1 500</td><td>50</td><td></td></tr>
<tr><td>1 000</td><td>40</td><td></td></tr>
<tr><td colspan="3">3. Six sectors</td><td rowspan="8"></td><td rowspan="8">1 000</td><td rowspan="8">2 500</td></tr>
<tr><td>Visibility (metres)</td><td>Approximate degrees</td><td></td></tr>
<tr><td>5 000</td><td>60</td><td rowspan="3">190</td></tr>
<tr><td>3 000</td><td>50</td></tr>
<tr><td>2 500</td><td>80</td></tr>
<tr><td>2 000</td><td>90</td><td></td></tr>
<tr><td>1 500</td><td>70</td><td></td></tr>
<tr><td>1 000</td><td>10</td><td></td></tr>
</table>

* Sectors represent hypothetical situations with different visibility conditions.

Figure 2-1. Determination of "prevailing visibility" under three hypothetical visibility conditions

Table 2-4. Reporting procedures related to visibility — to be applied in METAR in the case of directional variations

Condition	*Action*
VIS not the same in different directions, with the lowest VIS 1 500 m or more **and** 50 per cent or more of the prevailing VIS	Report the prevailing VIS
The lowest VIS is less than 50 per cent of the prevailing VIS and less than 5 000 m or The lowest VIS is less than 1 500 m	Report the prevailing VIS together with the lowest VIS with its general direction in relation to the aerodrome. Example: "2000 1200S"
Note.— If the lowest VIS is observed in more than one direction, include the most operationally significant direction.	
VIS fluctuating rapidly; the prevailing VIS cannot be given	Report lowest VIS without indication of direction
Note.— Direction is to be reported by reference to one of the eight points of the compass.	

2.3.10 RVR

(RVR RWY 12 1000M) — Local routine report
(R12/1000U) — METAR

2.3.10.1 RVR should be reported whenever visibility or RVR is less than 1 500 m, particularly at aerodromes having precision approach runways or runways used for take-off with high-intensity edge lights and/or centre line lights, including aerodromes with runways intended for Category I approach and landing operations. RVR is reported using instrumented systems at all runways intended for Category II or III instrument approach and landing operations. Steps of 25 m are used for RVR below 400 m, steps of 50 m for RVR between 400 m and 800 m and steps of 100 m for RVR above 800 m. RVR values which do not fit the reporting scale are rounded down to the next lower step in the scale.

2.3.10.2 In local routine reports, one-minute mean values are reported. RVR is reported in metres with an indication of the unit, and the runway(s) to which the values refer, e.g. RVR RWY 20: 500M RVR RWY 26: 800M (RVR runway 20: 500 metres, RVR runway 26: 800 metres). If RVR is observed for more than one position along a runway, the value representative of the touchdown zone is given first, followed by the locations representative of the mid-point and stop-end, e.g. RVR RWY 16 TDZ 600M MID 500M END 400M (RVR runway 16 at the touchdown zone 600 metres, at the mid-point 500 metres and at the stop-end 400 metres). When RVR is above the maximum value that can be determined by the system in use, it is reported in the form RVR ABV 1200M where 1 200 m is the maximum value for that system. When RVR is below the minimum value that can be determined by the system in use, it is reported in the form RVR BLW 150M, where 150 m is the minimum value for that system. For assessment of RVR, 50 m is considered the lower limit and 2 000 m the upper limit. The RVR reporting range from 1 500 to 2 000 m caters to cases whereby the visibility is less than 1 500 m combined with an RVR above 1 500 m (if both visibility and RVR were above 1 500 m, no RVR would be reported). Outside these limits of 50 and 2 000 m, reports merely indicate that the RVR is less than 50 m or more than 2 000 m in the form RVR BLW 50M (RVR below 50 metres) or RVR ABV 2 000M (RVR above 2 000 metres), respectively.

2.3.10.3 The provisions given in 2.3.10.1 also apply to METAR. In these reports, RVR values in metres are reported by four figures preceded by the letter indicator R and the runway designator in two figures (e.g. R12/0500, R26/1200). Additional reporting procedures are given in Table 2-5.

Note 1.— RVR is the best possible assessment of "the range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line". For this assessment, a height of approximately 2.5 m (7.5 ft) above the runway is regarded as corresponding to the average eye level of a pilot in an aircraft. This assessment should be based on readings of transmissometers or forward-scatter meters for CAT I, CAT II and CAT III runways but may be determined by an observer, for non-precision runways, counting markers, runway lights or, in some cases, specially installed lights on the side of the runway.

Note 2.— Detailed information on RVR observing and reporting is contained in the Manual of Runway Visual Range Observing and Reporting Practices *(Doc 9328).*

2.3.11 Present weather

(FG MOD DZ) — Local routine report
(FZ DZ) — METAR

2.3.11.1 As a minimum, the following weather phenomena are to be identified and reported:

a) precipitation (and its intensity);

b) freezing precipitation (and its intensity);

c) fog;

d) freezing fog; and

e) thunderstorms (also those occurring in the vicinity).

2.3.11.2 In local routine reports, present weather information should be representative of conditions at the aerodrome, i.e. within a radius of approximately 8 km of the aerodrome reference point. The word "approximately" is used to cater for aerodromes that have perimeters which are not precisely a radius of 8 km from the aerodrome reference point. In METAR, present weather information should be representative of conditions at the aerodrome and, for certain specified present weather phenomena, in its vicinity, i.e. the area that lies within a radius of approximately 8 km and 16 km of the aerodrome reference point.

2.3.11.3 In local routine reports, present weather phenomena are reported in terms of types and characteristics and are qualified with respect to intensity, as appropriate.

2.3.11.4 In METAR, present weather phenomena are reported in terms of types and characteristics and are qualified with respect to intensity or proximity to the aerodrome, as appropriate.

2.3.11.5 The *types* of present weather phenomena of significance to aviation, their respective abbreviations and relevant criteria for their reporting are given in Table 2-6.

2.3.11.6 The *characteristics* of present weather phenomena that are reported, as necessary, and their respective abbreviations are given in Table 2-7.

2.3.11.7 The relevant *intensity* or, as appropriate, the *proximity* to the aerodrome of reported present weather phenomena are indicated in Table 2-8. The proximity indicator is used only in METAR.

Table 2-5. Additional reporting procedures related to RVR data in METAR

Condition	*Reporting procedure*
More than one runway in use	Include all such runways up to a maximum of four. RVR values from parallel runways may be included in a report by attaching "L, C, R" (L = left, C = centre, R = right) to the runway designator D_rD_r)
Section of the runway	Only the value representative of the touchdown zone is given, without indication of position.
RVR information determined using instruments	Report of the mean value during the ten-minute period immediately preceding the observation
When RVR is greater than the maximum value which can be determined by the system in use	Report the highest value which can be determined by the system preceded by the letter indicator P
When RVR is below the minimum value which can be determined by the system in use	Report the lowest value which can be determined by the system preceded by the letter indicator M
When RVR is more than 2 000 m	Report 2000 preceded by the letter indicator P
When RVR is less than 50 m	Report 0050 preceded by the letter indicator M
RVR variations in time	If the one-minute extreme RVR values during the ten-minute period immediately preceding the observation vary from the mean value by more than 50 m or more than 20 per cent of the mean value, whichever is greater, the one-minute mean minimum and the one-minute mean maximum values should be reported instead of the ten-minute mean value, in the form "R09/0350V0600". (The letter indicator V is included between the maximum and minimum values.)
Discontinuities in RVR values	If the ten-minute period immediately preceding the observation includes a marked discontinuity in RVR values, only those values occurring after the discontinuity should be used to obtain mean values and variations. A marked discontinuity occurs when there is an abrupt and sustained change in RVR, lasting at least two minutes, which reaches or passes through the values included in the criteria for the issuance of selected special reports given in 2.4.2.1 f).
Tendency in RVR values	If the RVR values during the ten-minute period have shown a distinct tendency, such that the mean value during the first five minutes varies by 100 m or more from the mean value during the second five minutes of the period, this should be indicated as follows: a) when the variation of the RVR values shows an upward or downward tendency, this should be indicated by "U" or "D", respectively, in the form "R12/1000U" appended to relevant RVR values; b) when actual fluctuations during the ten-minute period indicate no distinct tendency, this should be reported using the indicator "N"; c) when indications of tendency are not available, no indicator should be included.

Table 2-6. Types of present weather phenomena

Type	*Phenomenon*	*Abbreviation**	*Remarks*
Precipitation	Drizzle	DZ	
	Rain	RA	
	Snow	SN	
	Snow grains	SG	
	Ice pellets	PL	
	Ice crystals (very small ice crystals in suspension, also known as diamond dust)	IC	Reported only when associated visibility is 5 000 m or less
	Hail	GR	Reported when diameter of largest hailstones is 5 mm or more
	Small hail and/or snow pellets	GS	Reported when diameter of largest hailstones is less than 5 mm
	Unknown precipitation	UP	Reported for unidentified precipitation only when automatic observing systems are used
Obscurations (hydrometeors)	Fog	FG	Reported when visibility is less than 1 000 m, except when qualified by "MI", "BC", "PR" or "VC"
	Mist	BR	Reported when visibility is at least 1 000 m but not more than 5 000 m
Obscurations (lithometeors)	Sand	SA	The obscurations by lithometeors should be used only when the obscuration consists predominantly of lithometeors and the visibility is 5 000 m or less except "SA" when qualified by "DR" and volcanic ash
	Dust (widespread)	DU	
	Haze	HZ	
	Smoke	FU	
	Volcanic ash	VA	
Other phenomena	Dust/sand whirls (dust devils)	PO	
	Squall	SQ	
	Funnel cloud (tornado or waterspout)	FC	
	Duststorm	DS	
	Sandstorm	SS	

* Used in both local routine reports and METAR.

Table 2-7. Characteristics of present weather phenomena

Characteristic	*Abbreviation**	*Remarks*
Thunderstorm	TS	Used to report a thunderstorm with rain "TSRA", snow "TSSN", ice pellets "TSPL, hail "TSGR", small hail and/or snow pellets "TSGS", unknown precipitation "TSUP" (automatic observing systems only) or combinations thereof, for example, "TSRASN". When thunder is heard during the ten-minute period preceding the time of observation but no precipitation is observed at the aerodrome, the abbreviation "TS" is used without qualification. *Note.— At aerodromes with human observers, lightning detection equipment may supplement human observations. For aerodromes with automatic observing systems, guidance on the use of lightning detection equipment intended for thunderstorm reporting is given in the* Manual on Automatic Meteorological Observing Systems at Aerodromes *(Doc 9837).*
Shower	SH	Used to report showers of rain "SHRA", snow "SHSN", ice pellets "SHPL", hail "SHGR", small hail and/or snow pellets "SHGS", unknown precipitation "SHUP" (automatic observing systems only) or combinations thereof, for example, "SHRASN". In METAR, showers observed in the vicinity of the aerodrome should be reported as "VCSH" without qualification regarding type or intensity of precipitation.
Freezing	FZ	Supercooled water droplets or precipitation, used only with FG, DZ, RA and UP (automatic systems only).
Blowing	BL	Used to report DU, SA or SN raised by the wind to a height of 2 m (7 ft) or more above ground level.
Low drifting	DR	Used with SA, DU or SN raised by the wind to less than 2 m (7 ft) above ground level.
Shallow	MI	Less than 2 m (7 ft) above ground level.
Patches	BC	Fog patches randomly covering the aerodrome.
Partial	PR	A substantial part of the aerodrome covered by fog while the remainder is clear.

* Used in both local routine reports and METAR.

Table 2-8. Intensity/proximity of present weather phenomena

Intensity/proximity	*Local routine reports*	*METAR*
Light	FBL	–
Moderate	MOD	(no indication)
Heavy used only with: DZ, FC (heavy used to indicate tornado or waterspout; moderate to indicate funnel cloud not reaching the ground), GR, GS, PL, RA, SG, SN and UP (automatic observing systems only), or in combinations involving these present weather types (in these cases, intensity refers to precipitation) DS, SS (in these cases, only moderate and heavy intensities to be indicated)	HVY	+
Vicinity Between approximately 8 and 16 km of the aerodrome reference point and used only in METAR with DS, SS, FG, FC, SH, PO, BLDU, BLSA, BLSN, TS and VA when not reported under the characteristics of the present weather phenomena *Note.— The actual range for which the qualifier vicinity is to be applied will be determined locally, in consultation with the civil aviation authority.*	not used	VC

2.3.11.8 One or more, up to a maximum of three, of the present weather abbreviations given in Tables 2-6 and 2-7 are to be used, as necessary, together with an indication, where appropriate, of the characteristics and intensity or proximity to the aerodrome, so as to convey a complete description of the present weather at or near the aerodrome of significance to flight operations. The following general rules apply:

a) an indication of intensity or proximity (METAR only), as appropriate, is to be reported first;

b) this is followed by both the characteristics and the type of weather phenomena in the form “HVY TSRA” (in local routine reports) and “+TSRA” (in METAR) or “VCFG” (in METAR only);

c) where two different types of weather are observed, they are to be reported in two separate groups, in the form “HVY DZ FG” (in local routine reports) and “+DZ FG” (in METAR) or “–DZ VCFG” (in METAR only), where the intensity or proximity indicator refers to the weather phenomenon which follows the indicator; and

d) different types of precipitation occurring at the time of observation are to be reported as one single group with the dominant type of precipitation reported first, preceded by only one intensity qualifier which refers to the intensity of the total precipitation, in the form “HVY TSRASN” (in local routine reports) and “+TSRASN” (in METAR) or “FBL SNRA FG” (in local routine reports) and “–SNRA FG” (in METAR).

2.3.11.9 In cases where the visibility is less than 1 000 m and the temperature is below minus 30º C it is unlikely that suspended supercooled water droplets are present (unless there are sources of open water nearby). Under these circumstances “FG” rather than “FZFG” is to be reported since airlines tend to experience operational penalties whenever FZFG is reported.

2.3.11.10 Additional criteria for the reporting of present weather phenomena are in Table 2-9.

Table 2-9. Additional criteria for the reporting of present weather phenomena

Condition	*Local routine reports*	*METAR*
More than one present weather phenomena occurring	Up to a maximum of three phenomena together with an indication, as appropriate, of their characteristics and intensity	Up to a maximum of three phenomena together with an indication, as appropriate, of their characteristics and intensity or proximity to the aerodrome
Indication of the intensity and characteristics of the present weather phenomena required	Report the present weather in the following order: 1. its intensity; 2. its characteristics; and 3. the present weather phenomenon e.g. "HVY TSRA" (in local routine reports) and "+TSRA" (in METAR)	
Indication of the proximity of the present weather phenomena required	Do not report	Report the present weather in the following order: 1. its proximity; and 2. the present weather phenomenon e.g. "VCFG" (METAR only)
Two different types of weather phenomena observed	Report in two separate groups	
	The intensity indicator refers to the present weather phenomenon which follows the indicator e.g. "HVY DZ FG": the qualifier "HVY" refers to drizzle	The intensity or proximity indicator refers to the present weather phenomenon which follows the indicator. e.g. "+DZ FG": the qualifier "+" refers to drizzle "DZ VCFG": the qualifier "VC" refers to fog
Different types of precipitation occurring	Report as one single group in the following order: 1. intensity qualifier referring to the intensity of the total precipitation 2. dominant type of precipitation 3. secondary type of precipitation e.g. "HVY TSRASN" or "FBL SNRA FG" (in local routine reports) "+TSRASN" or "-SNRA FG" (in METAR)	

2.3.12 Cloud

(CLD SCT 300M OVC 600M) — Local routine report
(SCT010 OVC020) — METAR

2.3.12.1 Cloud observations included in local routine reports should be representative of the approach area. Cloud observations in METAR should be representative of the aerodrome and its vicinity, this combined area being the area located within a radius of approximately 16 km of the aerodrome reference point.

2.3.12.2 The height of cloud base is reported in steps of 30 m (100 ft) up to 3 000 m (10 000 ft), together with the units used, in the form “CLD 300M” or “CLD 1000FT” in local routine reports and in the form “010” in METAR. In local routine reports from aerodromes where low-visibility procedures are established for approach and landing, as agreed between the meteorological authority and the appropriate ATS authority, the height of cloud base may be reported in steps of 15 m (50 ft) up to 90 m (300 ft) and in steps of 30 m (100 ft) between 90 m (300 ft) and 3 000 m (10 000 ft), together with the units used, in the form “CLD 45M” or “CLD 150FT”.

Note.1.— The reporting increments to be used above 3 000 m (10 000 ft) are not specified in Annex 3 since only clouds of operational significance are to be reported, and clouds of operational significance with bases exceeding 3 000 m (10 000 ft) (i.e. cumulonimbus (CB) and/or towering cumulus (TCU) clouds) only occur under exceptional conditions.

Note 2.— Clouds of operational significance are clouds with a height of cloud base below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater or a CB cloud or TCU cloud at any height. TCU is used to indicate cumulus congestus clouds of great vertical extent. Guidance on the reporting of CB and TCU is provided in Doc 9837, 7.4.4.

2.3.12.3 In local routine reports and METAR, only clouds of operational significance are to be reported. Cloud amount is given using the abbreviations FEW (1-2 oktas)*, SCT (3-4 oktas), BKN (5-7 oktas) or OVC (8 oktas). The type of cloud is identified only for CB and TCU clouds when observed at or near the aerodrome. When several layers or masses of cloud of operational significance are observed, their amount, type (CB and TCU only) and height of cloud base should be reported in increasing order of the height of cloud base and in accordance with the following criteria:

a) the lowest layer or mass, regardless of amount, reported as FEW, SCT, BKN or OVC, as appropriate;

b) the next layer or mass, covering more than 2 oktas, reported as SCT, BKN or OVC, as appropriate;

c) the next higher layer or mass, covering more than 4 oktas, reported as BKN or OVC, as appropriate; and

d) CB and/or TCU clouds independently of their height(s) of cloud base, whenever observed and not reported in previous parts of the report.

2.3.12.4 When an individual layer or mass of cloud is composed of CB and TCU clouds with a common cloud base, the type of cloud is reported as CB only.

2.3.12.5 If no clouds of operational significance are present and no restriction on vertical visibility exists and the abbreviation “CAVOK” is not appropriate, the abbreviation “NSC” (i.e. nil significant cloud) should be used.

Note 1.— The term CAVOK is used when the following visibility/cloud/weather conditions occur simultaneously:

— *Visibility:* *10 km or more, and the lowest visibility is not reported.*

— *Cloud:* *No cloud of operational significance.*

— *Weather:* *No weather of significance to aviation as given in Tables 2-6 and 2-7.*

* Eighths of the sky.

Note 2.— In local routine reports used for arriving aircraft, where a precision approach runway has a touchdown elevation of 15 m (50 ft) or more below the aerodrome elevation, arrangements are made for height of cloud base to be given with reference to the touchdown elevation.

Note 3.— In reports from offshore structures, the height of cloud base is given above mean sea level.

2.3.12.6 When the cloud base is diffused or ragged or fluctuating rapidly, the minimum height of the cloud, or cloud fragments, is given.

2.3.12.7 Where local routine reports include cloud base data from more than one runway in use, the runway indication should be attached to the reported cloud base data, e.g. “CLD RWY 08 BKN 200FT”.

2.3.12.8 When the sky is obscured, the observations of vertical visibility should be reported in lieu of cloud amount, cloud type and height of cloud base. The reporting steps for vertical visibility are 30 m (100 ft) up to 600 m (2 000 ft). In local routine reports from aerodromes where low-visibility procedures are established for approach and landing, as agreed between the meteorological authority and the appropriate ATS authority, the vertical visibility may be reported in steps of 15 m (50 ft) up to and including 90 m (300 ft) and in steps of 30 m (100 ft) between 90 m (300 ft) and 600 m (2 000 ft). In local routine reports, the abbreviations VER VIS (vertical visibility) are used, followed by the value of the vertical visibility and the units used, e.g. “CLD OBSC VER VIS 150M”. In METAR, the vertical visibility value is reported in the same manner as the height of cloud base preceded by the letter indicator VV. The absence of vertical visibility data in METAR is indicated by VV///.

2.3.12.9 In automated local routine reports and METAR, when the cloud amount or cloud type cannot be identified by the automatic observing system, the cloud amount or cloud type in each cloud group should be replaced by “///”; when no clouds are detected by the automatic observing system, this should be indicated by using the abbreviation “NCD”.

2.3.13 Air temperature/dew-point temperature

(T17 DP16) — Local routine report
(17/16) — METAR

2.3.13.1 Observations of air temperature and dew-point temperature should be representative of the whole runway complex.

2.3.13.2 In local routine reports and METAR, the temperatures are reported in steps of whole degrees Celsius, with observed values involving 0.5° rounded up to the next higher whole degree Celsius, for example, +2.5°C is rounded up to +3°C and –2.5°C is rounded up to –2°C.

2.3.13.3 In local routine reports, the air temperature is identified by T and the dew-point temperature by DP in the form T17 DP16 (temperature 17, dew point 16). For a temperature below 0°C, the value is preceded by MS (minus), e.g. TMS8.

2.3.13.4 Air temperature and dew point temperature values are reported in METAR in two figures separated by “/”, e.g. air temperature of +20.4 and dew-point temperature of +8.7 are reported as “20/09”. Temperatures below 0°C are preceded by M (meaning minus). Temperatures in the range of –0.5°C to –0.1°C are reported as “M00”, while temperatures in the range of 0.0° to 0.4°C are reported as “00”.

2.3.14 Atmospheric pressure

(QNH 1018 HPA) — Local routine reports
(Q1018) — METAR

2.3.14.1 QNH is the altimeter showing aerodrome elevation when the aircraft is on the ground and QNH is set on the altimeter sub-scale. QFE is the altimeter showing zero elevation when the aircraft is on the ground and QFE is set on the altimeter sub-scale. QFE is normally used only at the aerodrome where it is provided on request or, by local agreement, on a regular basis, in addition to QNH. Only QNH is included in METAR.

2.3.14.2 In local routine reports and METAR, atmospheric pressure is given in hectopascals, rounded down to the nearest lower whole hectopascal and reported in four figures, e.g. QNH 1011.4 is reported as “QNH 1011HPA” in local routine reports and “Q1011” in METAR, and QFE 995.6 is reported as “QFE 0995HPA” or “QFE RWY 18 0995HPA” (where the number of the runway is indicated). (QFE is used only in local routine reports.)

Note.— When a QFE altimeter setting is provided, it corresponds to the aerodrome elevation except for:

a) non-precision approach runways, if the threshold is 2 m (6 ft) or more below the aerodrome elevation; and

b) precision approach runways;

in which cases, the QFE corresponds to the relevant runway threshold elevation.

2.3.15 Supplementary information

2.3.15.1 In local routine reports and METAR, supplementary information includes information on recent weather as given in Table 2-10, observed at the aerodrome during the period since the last issued routine report or last hour, whichever is the shorter, but not at the time of observation. Up to three groups of recent weather information selected from Table 2-10 may be included in these reports.

2.3.15.2 Local routine reports may also include available supplementary information on significant meteorological conditions, particularly those in the approach or climb-out area. The abbreviations in Table 2-11 should be used in reporting this supplementary information.

Note.— Observations of supplementary information, in particular the conditions relating to the occurrence of icing, and turbulence are often derived from aircraft observations during the approach and climb-out phases of flights. (For details concerning aircraft observations and air-reports, see Chapter 4.)

2.3.15.3 In METAR, where local circumstances so warrant, wind shear should be included as necessary. Information on wind shear is added in the form “WS RWY 12” or “WS ALL RWY”.

Note 1.— The “local circumstances” referred to above include, but are not necessarily limited to, wind shear of a non-transitory nature such as might be associated with low-level temperature inversions or local topography.

Note 2.— Warnings of wind shear in the climb-out and approach paths are detailed in Chapter 4.

Table 2-10. Abbreviations to be used in reporting recent weather phenomena in local routine reports and METAR

Abbreviation	*Phenomenon/Decode*
REFZDZ	Recent freezing drizzle
REFZRA	Recent freezing rain
REDZ	Recent drizzle (moderate or heavy)
RERA	Recent rain (moderate or heavy)
RESN	Recent snow (moderate or heavy)
RERASN	Recent rain and snow (moderate or heavy)
RESG	Recent snow grains (moderate or heavy)
REPL	Recent ice pellets (moderate or heavy)
RESHRA	Recent rain showers (moderate or heavy)
RESHSN	Recent snow showers (moderate or heavy)
RESHGR	Recent showers of hail (moderate or heavy)
RESHGS	Recent showers of small hail and/or snow pellets (moderate or heavy)
REBLSN	Recent blowing snow
RESS	Recent sandstorm
REDS	Recent duststorm
RETSRA	Recent thunderstorm with rain
RETSSN	Recent thunderstorm with snow
RETSGR	Recent thunderstorm with hail
RETSGS	Recent thunderstorm with small hail
RETS	Recent thunderstorm without precipitation
REFC	Recent funnel cloud (tornado or waterspout)
REVA	Recent volcanic ash
REUP	Recent unidentified precipitation (only when automatic observing systems are used)
REFZUP	Recent freezing rain with unidentified precipitation (only when automatic observing systems are used)
RETSUP	Recent thunderstorm with unidentified precipitation (only when automatic observing systems are used)
RESHUP	Recent showers of unidentified precipitation (only when automatic observing systems are used)

Table 2-11. Supplementary information for inclusion in local routine reports

Abbreviation	*Condition/Decode*
a) Significant weather conditions	
CB	Cumulonimbus
TS	Thunderstorm
MOD TURB	Moderate turbulence
SEV TURB	Severe turbulence
WS	Wind shear
GR	Hail
SEV SQL	Severe squall line
MOD ICE	Moderate icing
SEV ICE	Severe icing
FZDZ	Freezing drizzle
FZRA	Freezing rain
SEV MTW	Severe mountain wave
SS	Sandstorm
DS	Duststorm
BLSN	Blowing snow
FC	Funnel cloud (tornado or waterspout)
b) Location	
IN APCH	In the approach
IN CLIMB-OUT	In the climb-out
RWY	Runway

Note.— Additional information may be included using abbreviated plain language.

2.3.15.4 In METAR, subject to RAN agreement, two additional groups may be included as supplementary information:

a) information on sea-surface temperature and the state of the sea at aeronautical meteorological stations established on offshore structures in support of helicopter operations; and

b) information on the state of the runway(s).

Note 1.— The state of the sea is specified in WMO Publication No. 306, Manual on Codes — International Codes, *Volume I*, *Code Table 3700.*

Note 2.— The state of the runway is specified in WMO Publication No. 306, Manual on Codes — *International Codes*, *Volume I, Code Tables 0366, 0519, 0919 and 1079.*

2.3.16 Landing forecasts

A trend forecast, when provided, is attached to a local routine report as well as a METAR; details of the trend forecast are given in Annex 3, Appendix 3, Tables A3-1 and A3-2.

2.4 SPECIAL REPORTS

2.4.1 Local special reports

2.4.1.1 Local special reports are issued in addition to local routine reports to provide information on significant deteriorations or improvements in aerodrome meteorological conditions at the aerodrome concerned. They are issued whenever one or more elements of a routine report change in accordance with criteria established by the meteorological authority in consultation with the ATS authority, the operators and others concerned. These criteria include:

a) those values which correspond to the operating minima of the operators using the aerodrome;

b) those values which satisfy other local requirements of ATS units and of the operators;

c) an increase in air temperature of 2°C or more from that given in the latest report, or an alternative threshold value as agreed upon between the meteorological authority, the appropriate ATS authority and the operators concerned;

d) the available supplementary information concerning the occurrence of significant meteorological conditions in the approach and climb-out areas; and

e) the criteria given below (2.4.2.1 refers) for the issuance of SPECI.

Local special reports in respect of RVR, surface wind or other elements need not be issued if the local ATS unit(s) has displays for these elements corresponding to the displays in the meteorological station, or if changes in RVR are continuously reported to the ATS unit by an observer at the aerodrome. Displays of automated aerodrome meteorological observing stations located at the local ATS units are widely used to meet this requirement.

2.4.1.2 Local special reports carry the identifier SPECIAL and, as Example 2-2 shows, have the same content and sequence of elements as local routine reports (2.3.3 to 2.3.15 refer). As with local routine reports, a trend forecast is appended, as required, to the local special report.

2.4.2 Aerodrome special meteorological report (SPECI)

2.4.2.1 SPECI are issued in accordance with the following criteria:

a) when the mean surface wind direction has changed by 60° or more from that given in the latest report, the mean speed before and/or after the change being 5 m/s (or 10 kt) or more;

b) when the mean surface wind speed has changed by 5 m/s (or 10 kt) or more from that given in the latest report;

c) when the variation from the mean surface wind speed (gusts) has increased by 5 m/s (or 10 kt) or more from that given in the latest report, the mean speed before and/or after the change being 7.5 m/s (or 15 kt) or more;

d) when the wind changes through values of operational significance. The threshold values should be established by the meteorological authority in consultation with the appropriate ATS authority and operators concerned, taking into account changes in the wind which would:

1) require a change in runway(s) in use; and

2) indicate that the runway tailwind and crosswind components have changed through values representing the main operating limits for typical aircraft operating at the aerodrome;

e) when the visibility is improving and changes to, or passes through, one or more of the following values; or when the visibility is deteriorating and passes through one or more of the following values:

1) 800, 1 500 or 3 000 m; and

2) 5 000 m, in cases where significant numbers of flights are operated in accordance with visual flight rules;

Note.— In local special reports, visibility refers to the value(s) to be reported in accordance with 2.3.9.5. In SPECI, visibility refers to the value(s) to be reported in accordance with 2.3.9.7 and 2.3.9.8.

f) when RVR is improving and changes to, or passes through, one or more of the following values; or when RVR is deteriorating and passes through one or more of the following values:

150, 350, 600 or 800 m;

g) when the onset, cessation or change in intensity of any of the following weather phenomena or combinations thereof occurs:

— freezing precipitation
— moderate or heavy precipitation (including showers thereof)
— thunderstorm (with precipitation)
— duststorm
— sandstorm
— funnel cloud (tornado or waterspout);

h) when the onset or cessation of any of the following weather phenomena or combinations thereof occurs:

— ice crystals
— freezing fog
— low drifting dust, sand or snow
— blowing dust, sand or snow
— thunderstorm (without precipitation)
— squall;

i) when the height of the base of the lowest cloud layer of BKN or OVC extent is lifting and changes to, or passes through, one or more of the following values; or when the height of the base of the lowest cloud layer of BKN or OVC extent is lowering and passes through one or more of the following values:

1) 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft);

2) 450 m (1 500 ft), in cases where significant numbers of flights are operated in accordance with visual flight rules;

j) when the amount of a cloud layer below 450 m (1 500 ft) changes:

1) from SCT or less to BKN or OVC; or

2) from BKN or OVC to SCT or less;

k) when the sky is obscured and the vertical visibility is improving and changes to, or passes through, one or more of the following values; or when the sky is obscured and the vertical visibility is deteriorating and passes through one or more of the following values:

30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft); and

l) any other criteria based on local aerodrome operating minima, as agreed between the meteorological authority, the appropriate ATS authority and the operators.

Note.— Other criteria based on local operating minima are to be considered in parallel with similar criteria for the inclusion of change groups and for the amendment of TAF.

2.4.2.2 When a deterioration of the weather element is accompanied by an improvement in another element, a single SPECI shall be issued; it shall then be treated as a deterioration report.

2.4.2.3 SPECI carry the identifier SPECI and, as Example 2-2 shows, have the same content and sequence of elements as METAR (2.3.3 to 2.3.15 refer). As with METAR, a trend forecast is appended, as required, to these reports.

2.4.2.4 SPECI are disseminated beyond the aerodrome of origin to other aerodromes in accordance with RAN agreement, which ensures, *inter alia*, that the special reports are available for VOLMET broadcasts, for D-VOLMET, and for individual transmissions to aircraft in flight through ATS units or operators.

Note.— Details on requirements for the exchange of SPECI between meteorological offices can be found in the relevant ANP/FASID.

2.5 REPORTS OF VOLCANIC ACTIVITY

As mentioned in 1.4.2, aeronautical meteorological stations (and other meteorological stations) located in the vicinity of active volcanoes are required to make observations of volcanic activity. The volcanic activity reports resulting from these observations should contain:

a) message type VOLCANIC ACTIVITY REPORT;

b) station identifier, location indicator or name of the station;

c) date/time of the message;

d) location of volcano, and name, if known; and

e) concise description of the event including, as appropriate, the level of intensity of the volcanic activity, including significant pre-eruption volcanic activity, occurrence of the eruption and its date and time, and the existence of a volcanic ash cloud in the area together with the direction of the ash cloud movement and height.

Note.— Pre-eruption volcanic activity in this context means unusual and/or increasing volcanic activity which could presage a volcanic eruption.

The reports should be issued in abbreviated plain language and disseminated, as a matter of urgency, to the associated ATS units, MWOs and AIS units. These reports are important for the operations of the IAVW.

2.6 BASIC METEOROLOGICAL DATA

2.6.1 Weather radar observations

2.6.1.1 Weather radar observations permit the locating and tracking of thunderstorms and tropical cyclones, and the evaluation of precipitation and cloud height. This information is used for early warning of certain meteorological phenomena hazardous to aviation, particularly in the vicinity of aerodromes, and in the preparation of trend forecasts. Radar data are usually available only locally, but in many parts of the world, data from large radar networks are distributed in coded or pictorial forms and, in particular, in digital form, to meteorological offices and other aeronautical users by means of various data processing systems and high-speed communication channels. The processed and integrated weather radar information is often displayed for ATS personnel through ATS systems.

2.6.1.2 Increasing use is being made of Doppler weather radar both for storm warning purposes and, specifically, to detect low-level wind shear. In the latter case, fully automated terminal Doppler weather radar is available, which can provide wind shear warnings to ATC and directly to aircraft equipped with an air-ground data link.

2.6.2 Automated aircraft observations and air-reports

Automated meteorological reports from aircraft constitute an important source of upper-air data. They are especially useful in areas where ground-based observations are sparse or not available. Air reporting is also useful in the observation of volcanic ash, wind shear and turbulence. A substantial proportion of upper-air wind and temperature information is obtained through the WMO aircraft meteorological data relay (AMDAR) programme based on the use of standard equipment carried on board most modern aircraft. All these data are disseminated in code forms established by WMO and are used for the preparation of upper-air forecasts. In view of its importance, air-reporting is discussed further in Chapter 7.

2.6.3 Basic surface and upper-air observations

2.6.3.1 Meteorological observations containing elements similar to those in aerodrome reports, but with additional details of cloud, weather, pressure, etc., are made at many aerodromes and other locations (including ships) for basic meteorological purposes. They are made at three-hour or six-hour intervals (0000 UTC, 0300 UTC, 0600 UTC, etc.), disseminated in a code form (SYNOP) established by WMO, and used, *inter alia*, for the calculations involved in numerical weather prediction.

2.6.3.2 Upper-air information is obtained principally from instruments carried aloft by balloons released from fixed ground observation sites or from ships. These balloon-borne instruments reach altitudes approaching 30 km (100 000 ft) and provide data on wind speed and direction, temperature, pressure and relative humidity to approximately 15 km (50 000 ft). Upper-air observations of this type are made at standard hours, 0000 UTC and 1200 UTC and additionally in some areas at 0600 UTC and 1800 UTC.

2.6.4 Meteorological satellite data

In addition to information on cloud type, cloud amount and height of cloud tops, meteorological satellite data also provide information on vertical temperature and humidity distribution and on upper winds derived from cloud movement and, increasingly, are used to detect volcanic ash. The information provided by satellites is of particular importance in the areas where ground-based observations are sparse. It is received directly from geostationary or polar-orbiting satellites by ground-receiving equipment. The processed satellite data can be used to supplement the integrated weather radar data. Data from geostationary and polar-orbiting meteorological satellites are also used by VAACs for the detection and tracking of volcanic ash clouds.

Chapter 3

FORECASTS

3.1 GENERAL

A forecast is a concise statement of expected meteorological conditions at an aerodrome or over an area or along a route. Owing to the variability of meteorological elements in space and time, the limitation of forecasting techniques, and the limitations imposed by the definitions of some of the individual meteorological elements (e.g. surface wind, weather), the specific value of any forecast element is to be understood as being the most probable value which the element is likely to assume during the period of the forecast. Similarly, when the time of occurrence or change of an element is given in a forecast, this is to be understood to be the most probable time.

3.2 ACCURACY OF AERONAUTICAL METEOROLOGICAL FORECASTS

The accuracy of aeronautical forecasts depends upon the accuracy, spacing and frequency of observations, the period of the forecast and various factors associated with analysis and forecasting techniques. In general, the forecast elements are the best estimate of the conditions expected to occur within a range of values. Guidance on the operationally desirable accuracy of aeronautical forecasts is contained in Annex 3, Attachment B.

3.3 TYPES OF AERONAUTICAL METEOROLOGICAL FORECASTS

3.3.1 There are different types of aeronautical forecasts designed to meet requirements for the various stages of flight planning. They differ in respect of area or airspace covered and in respect of the offices preparing and issuing them, as shown in Table 3-1.

Note.— While forecasts generally refer to the meteorological conditions expected to occur (i.e. in the future), SIGMET and AIRMET information, aerodrome warnings and wind shear warnings may refer to existing as well as expected conditions. (For further details on SIGMET and AIRMET information, aerodrome warnings and wind shear warnings, see Chapter 4.) Similarly, volcanic ash advisories containing information concerning location, extent and trajectories of volcanic ash clouds and tropical cyclone advisories containing information concerning tropical cyclones and the movement of their centres can also be considered as forecasts. Details concerning the advisories are given in Chapter 4.

3.3.2 The various formats in which forecasts are normally issued (abbreviated plain language, code or graphic, i.e. chart form) are listed in Table 3-2.

3.3.3 Forecasts also differ in regard to the period of validity or fixed time of validity for which they are normally prepared, as shown in Table 3-3.

Table 3-1. Types of aeronautical meteorological forecasts, including SIGMET and AIRMET information, warnings, volcanic ash advisories and tropical cyclone advisories

Type of forecast	*Area/airspace covered*	*Stage of flight planning*	*Responsibility for preparing/issuing the forecast*
TAF	Aerodrome	Pre-flight and in-flight	Aerodrome meteorological office, or other designated office
Landing forecast (trend)	Aerodrome	In-flight	Aerodrome meteorological office, or other designated office
Take-off forecast	Runway complex	Pre-flight	Aerodrome meteorological office, or other designated office
Forecasts of en-route conditions	Route(s), an area or flight levels applicable to the operation	Pre-flight and in-flight	WAFC (Aerodrome meteorological office for low-level flights)
SIGMET information	FIR or control area/ encompassing all flight levels used for flight operations	Pre-flight and in-flight	MWO
AIRMET information	FIR or control area or a sub-area thereof/encompassing all flight levels up to FL 100 (FL 150 or higher in mountainous areas)	Pre-flight and in-flight	MWO
Aerodrome warnings	Aerodrome surface conditions	Not-applicable (intended for parked aircraft, aerodrome installations)	Aerodrome meteorological office, or other designated office
Wind shear warnings	Aerodrome and approach/take-off paths between runway level and 500 m (1 600 ft), or higher, if necessary	In-flight	Aerodrome meteorological office, or other designated office
Volcanic ash advisories	Area affected by volcanic ash cloud	Pre-flight and in-flight	VAAC
Tropical cyclone advisories	Area affected by tropical cyclone	Pre-flight and in-flight	TCAC

Note.— For details on SIGMET and AIRMET information and warnings, as well as volcanic ash and tropical cyclone advisories, see Chapter 4.

Table 3-2. Formats of forecasts, including SIGMET and AIRMET information, warnings, tropical cyclone advisories and volcanic ash advisories

Type of forecast	*Abbreviated plain language*	*Code*	*Charts*
TAF		X[1]	
Trend forecasts	X	X[1]	
Take-off forecasts	X		
Forecasts of en-route conditions	X	X[2]	X
SIGMET information	X[3]	X[2]	X[4]
AIRMET information	X[3]		
Aerodrome warnings	X[3]		
Wind shear warnings	X[3]		
Volcanic ash advisories	X[3]	X[2]	X[4]
Tropical cyclone advisories	X[3]	X[2]	X[4]

1. Alphanumeric and binary code forms.
2. Binary code form for graphical products.
3. See Chapter 4.
4. In portable network graphic (PNG) format.

3.4 TAF

3.4.1 TAF follow the general form of METAR. They include surface wind, visibility, weather phenomena and cloud, and relevant significant changes thereto (see Example 3-1). Forecasts of weather phenomena are for the area at the aerodrome, i.e. the area within a radius of approximately 8 km of the aerodrome reference point. The word "approximately" is used to cater for aerodromes that have perimeters which are not precisely a radius of 8 km from the aerodrome reference point. Forecasts of cloud are for the aerodrome and its vicinity, i.e. the area within a radius of approximately 16 km of the aerodrome reference point. Forecasts of maximum and minimum temperatures are included subject to RAN agreement. Detailed technical specifications for TAF are in Annex 3, Appendix 5, Table A5-1, which also includes an extensive set of examples relating to individual portions of the forecast. TAF valid for less than 12 hours are issued every 3 hours and those valid for 12 hours or more are issued at 6-hour intervals. The validity period of TAF is determined for each region on the basis of RAN agreement but must be between 6 and 30 hours inclusive. When issuing TAF, meteorological offices ensure that only one TAF is valid at an aerodrome at any given time.

3.4.2 TAF should be kept under continuous review to enable the issuance of amendments as necessary. Annex 3 does not explicitly require that complete METAR be available to maintain such a review (although many States do stipulate in their national regulations that METAR be required for this purpose). It is recommended that other sources of meteorological information be used in the absence of full METAR, e.g. weather radar data, observations from automatic weather stations, satellite images, etc. TAF that cannot be kept under continuous review must be cancelled.

3.4.3 The specific values of elements and the time of expected changes indicated in TAF are understood as being approximate and as representing the most probable mean of a range of values or times. Criteria for giving expected changes, or for amending TAF, are based on values given in Table 3-4.

Example 3-1. TAF

TAF for YUDO

TAF YUDO 160000Z 16061624 13005MPS 9000 BKN020 BECMG 16061608 SCT015CB BKN020 TEMPO 16081612 17007G12MPS 1000 TSRA SCT010CB BKN020 FM161230 15004MPS 9999 BKN020 T25/1612Z TM02/1623Z

Meaning of forecast:

TAF for Donlon/International* issued on the 16th of the month at 0000 UTC valid from 0600 UTC to 2400 UTC on the 16th of the month; surface wind direction 130 degrees; wind speed 5 metres per second; visibility 9 kilometres; broken cloud at 600 metres; becoming between 0600 UTC and 0800 UTC on the 16th of the month, scattered cumulonimbus cloud at 450 metres and broken cloud at 600 metres; temporarily between 0800 UTC and 1200 UTC on the 16th of the month; surface wind direction 170 degrees, wind speed 7 metres per second gusting to 12 metres per second; visibility 1 000 metres in a thunderstorm with moderate rain, scattered cumulonimbus cloud at 300 metres and broken cloud at 600 metres; from 1230 UTC on the 16th of the month; surface wind direction 150 degrees, wind speed 4 metres per second; visibility 10 kilometres or more; and broken cloud at 600 metres; maximum air temperature 25 degrees Celsius at 1200 UTC on the 16th of the month;** minimum air temperature minus 2 degrees Celsius at 2300 UTC on the 16th of the month.**

* Fictitious location

** Inclusion of temperature forecasts (maximum and minimum expected to occur during the aerodrome forecast validity period and their corresponding times of occurrence) is subject to RAN agreement.

3.4.4 The expected changes referred to in 3.4.3 are given using the following indicators and associated time groups:

a) *BECMG (abbreviation for "becoming")* — this change indicator describes changes where the conditions are expected to reach or pass specified values at a regular or irregular rate;

b) *TEMPO (abbreviation for "temporary")* — this indicator is used to describe temporary fluctuations in the meteorological conditions, lasting less than one hour in each instance and, in the aggregate, covering less than half of the forecast period. For forecast changes in excess of these criteria, the change group "BECMG" should be used;

c) *PROB (abbreviation for "probability")* — followed by a percentage (rounded to the nearest ten) indicates the probability that a certain change or value will occur. Only PROB30 or PROB40 are used, as less than 30 per cent probability is considered in aviation to have little operational significance and 50 per cent or more should be indicated as BECMG or TEMPO, as appropriate; and

d) *FM (abbreviation for "from")* — is used to indicate self-contained time periods within the overall validity period during which certain conditions prevail.

A full description of the usage of the above indicators is given in Annex 3, Appendix 5, 2.3. It should be noted that the number of change indicators used should be kept to a minimum and should not exceed five groups.

3.4.5 TAF (and amendments thereto) for intended destinations and alternates will normally be supplied by meteorological offices upon appropriate notification by operators. All TAF issued are to be disseminated to the international OPMET databanks and to the uplink stations of the AFS satellite distribution systems for onward dissemination to States.

Note.— Information on regional differences in period of validity of TAF, and on requirements for their exchange between meteorological offices, can be found in the relevant ANP/FASID.

3.4.6 An amended TAF is identified as “TAF AMD” in place of “TAF”; it covers the whole of the remaining period of the original forecast. (For amendment criteria, see 3.4.3 and Table 3-4; an example is provided in Example 3-2). A TAF is amended as a result of changes to the forecast or current meteorological conditions leading to the original TAF no longer accurately reflecting the expected meteorological situation. A TAF can also be issued as a corrected TAF using TAF COR which indicates that the original TAF contained errors in terms of *syntax* and that the correction is merely to correct this rather than any change in the meteorological conditions.

3.4.7 A TAF is cancelled using CNL if the TAF cannot be kept under continuous review or is no longer valid owing to the closure of the aerodrome. If a TAF is not available for a particular aerodrome, it is identified with the abbreviation NIL within a bulletin that may contain TAF for several aerodromes.

Table 3-3. Validity of forecasts, including SIGMET and AIRMET information, warnings, tropical cyclone advisories and volcanic ash advisories

Forecast	*Usual validity period or fixed time of validity*
TAF	Between 6 and 30 hours inclusive
Trend forecast	2 hours
Take-off forecast	For specified period (usually short)
Forecasts of en-route conditions	*In chart and binary code forms:* up to 36 hours for fixed valid times, usually 0000, 0300, 0600, 0900, 1200, 1500, 1800 and 2100 UTC*
SIGMET information	Not more than 4 hours
SIGMET information for volcanic ash and tropical cyclones	6 hours
AIRMET information	Not more than 4 hours
Aerodrome warnings	Usually not more than 24 hours
Wind shear warnings	For as long as wind shear is expected to last
Volcanic ash advisory	18 hours
Tropical cyclone advisory	24 hours

* All the forecasts issued within WAFCs are issued for fixed valid times of 0000, 0300, 0600, 0900, 1200, 1500, 1800 and 2100 UTC. These forecasts should be used as follows:

Validity time (UTC)	*Period for use (UTC)*
0000	2230–0130
0300	0130–0430
0600	0430–0730
0900	0730–1030
1200	1030–1330
1500	1330–1630
1800	1630–1930
2100	1930–2230

Table 3-4. Criteria for the indication of changes and/or preparation of amendments to TAF

Meteorological element	*Criteria for the inclusion of change groups or for the amendment of TAF*	*Remarks*
Surface wind	— When the mean surface wind *direction* is forecast to change by 60 degrees or more, the mean speed before and/or after the change being 5 m/s (10 kt) or more;	
	— When the mean surface wind *speed* is forecast to change by 5 m/s (10 kt) or more;	
	— When the *variation* from the mean surface wind speed (gusts) is forecast to increase by 5 m/s (10 kt) or more, the mean speed before and/or after the change being 7.5 m/s (15 kt) or more;	
	— When the surface wind is forecast to change through values of operational significance, for example: • changes that require changes in the runway(s) in use; and • changes in runway tailwind/crosswind component through values representative of operating limits of typical aircraft using the airport.	Threshold values to be established by the MET authority in consultation with the appropriate ATS authority and operators.
Visibility	— When the visibility is forecast to improve and change to, or pass through, one or more of the following values; or — When the visibility is forecast to deteriorate and pass through one or more of the following values: 150, 350, 600, 800, 1 500 or 3 000 m.	At aerodromes with a significant number of VFR flights, the value of 5 000 m is also included in the criteria.
Weather	— When any of the following weather phenomena or combinations thereof are forecast to begin or end or change in intensity: • freezing precipitation • moderate or heavy precipitation (including showers) • duststorm • sandstorm • thunderstorm (with precipitation).	
	— When any of the following weather phenomena are forecast to begin or end: • ice crystals • freezing fog • low drifting dust, sand or snow • blowing dust, sand or snow • thunderstorms (without precipitation) • squall • funnel cloud (tornado or waterspout).	
Cloud	— When the height of base of the lowest layer or mass of cloud of BKN or OVC extent is forecast to lift and change to, or pass through one or more of the following values; or — When the height of base of the lowest layer or mass of cloud of BKN or OVC extent is forecast to lower and pass through one or more of the following values: 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft).	At aerodromes with a significant number of VFR flights, the height of cloud base of 450 m (1 500 ft) is also included in the criteria.
	— When the amount of a layer or mass of cloud below 450 m (1 500 ft) is forecast to change: • from NSC, FEW or SCT to BKN or OVC; or • from BKN or OVC to NSC, FEW or SCT.	

Meteorological element	*Criteria for the inclusion of change groups or for the amendment of TAF*	*Remarks*
Vertical visibility	— When the vertical visibility is forecast to improve and change to, or pass through, one or more of the following values; or — When the vertical visibility is forecast to deteriorate and pass through one or more of the following values: 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft).	
Temperature	None.	
Other	Other criteria based on local aerodrome operating minima.	As agreed between the MET authority and the operators concerned to be considered in parallel with similar criteria for the issuance of SPECI.

Example 3-2. Cancellation of TAF

Cancellation of TAF for YUDO

TAF AMD YUDO 161500Z 16061624 CNL

Meaning of the message:

Amended TAF for Donlon/International* issued on the 16th of the month at 1500 UTC cancelling the previously issued TAF valid from 0600 to 2400 UTC on the 16th of the current month.

* Fictitious location

3.5 TREND FORECASTS

3.5.1 In most ICAO regions, landing forecasts are supplied. They are prepared in the form of trend forecasts which consist of a concise statement indicating any significant changes expected to occur during the next two hours in one or more of the following meteorological elements: surface wind, visibility, weather and cloud (see Example 3-3). The trend forecast is always appended to a local routine or special report, or METAR or SPECI. Forecasts of weather phenomena are for the area at the aerodrome, i.e. the area within a radius of approximately 8 km of the aerodrome reference point. The word “approximately” is used to cater for aerodromes that have perimeters which are not precisely a radius of 8 km from the aerodrome reference point. Forecasts of cloud are for the aerodrome and its vicinity, i.e. the area within a radius of approximately 16 km of the aerodrome reference point. Detailed technical specifications concerning trend forecasts can be found in Annex 3, Appendix 3, Tables A3-1 and A3-2.

Note.— The aerodromes for which trend forecasts are to be prepared are indicated in the relevant ANP/FASID.

3.5.2 The trend forecast appended to the report has the same order of elements (i.e. surface wind, visibility, weather phenomena and cloud), terminology, units and scales as the preceding report and is introduced by one of the following change indicators if a significant change or changes is or are expected:

a) BECMG; or

b) TEMPO.

Example 3-3. Trend forecasts appended to a local routine and special report and to METAR and SPECI

a) Routine reports with trend

Local routine report with a trend forecast:

MET REPORT YUDO* 221630Z WIND 240/5MPS VIS 600M RVR RWY 12 1000M MOD DZ FG CLD SCT 300M OVC 600M T17 DP16 QNH 1018HPA TREND BECMG TL1700 VIS 800M FG BECMG AT 1800 VIS 10KM NSW

METAR with a trend forecast:

METAR YUDO* 221630Z 24004MPS 0800 R12/1000U DZ FG SCT010 OVC020 17/16 Q1018 BECMG TL1700 0900 FG BECMG AT1800 9999 NSW

Meaning of both reports with trend:

Routine report for Donlon/International* issued on the 22nd of the month at 1630 UTC; surface wind direction 240 degrees; wind speed 5 or 4 metres per second (averaged over 2 and 10 minutes, respectively); visibility along the runway(s) 600 metres (in the local routine report); prevailing visibility 800 metres (in METAR); runway visual range representative of the touchdown zone for runway 12 is 1 000 metres (averaged over 1 and 10 minutes, respectively); the runway visual range values have shown a distinct upward tendency during previous 10 minutes); (RVR tendency to be included in METAR only); moderate drizzle and fog; scattered cloud at 300 metres; overcast at 600 metres; air temperature 17 degrees Celsius; dew-point temperature 16 degrees Celsius; QNH 1 018 hectopascals; trend during next two hours; visibility becoming 800 metres (along runway(s) in the local report) and 900 metres (prevailing visibility in METAR) in fog by 1700 UTC; at 1800 UTC visibility becoming 10 kilometres or more (along the runway(s) in the local routine report; prevailing visibility in METAR) and nil significant weather.

b) Special reports with trend

Local special report with a trend forecast:

SPECIAL YUDO* 151115Z WIND 050/26KT MAX37 MNM10 VIS 1200M HVY TSRA CLD BKN CB 500FT T25 DP22 QNH 1008HPA TREND TEMPO TL1200 VIS 600M BECMG AT1200 VIS 8 KM NSW NSC

SPECI with a trend forecast:

SPECI YUDO* 151115Z 05025G37KT 3000 1200NE +TSRA BKN005CB 25/22 Q1008 TEMPO TL1200 0600 BECMG AT1200 8000 NSW NSC

Meaning of both reports with trend:

Special report for Donlon/International* issued on the 15th of the month at 1115 UTC; surface wind direction 050 degrees; wind speed 26 and 25 knots (averaged over 2 and 10 minutes, respectively), gusting between 10 and 37 knots (for SPECI "gusting to 37 knots", minimum not to be included); visibility along the runway(s) 1 200 metres (in the local special report); prevailing visibility 3 000 m (in SPECI) with minimum visibility 1 200 metres to north east (directional variations to be included in SPECI only); thunderstorm with heavy rain; broken cumulonimbus cloud at 500 feet; air temperature 25 degrees Celsius; dew-point temperature 22 degrees Celsius; QNH 1 008 hectopascals; trend during next two hours; visibility temporarily 600 metres (along the runway(s) in the local special report; prevailing visibility in SPECI) from 1115 to 1200 UTC; becoming at 1200 UTC visibility 8 kilometres (along the runway(s) in the local special report; prevailing visibility in SPECI), thunderstorm ceases and nil significant weather, and nil significant cloud.

* Fictitious location.

These change indicators are used as necessary in association with the abbreviations “FM” (meaning “from”), “TL” (meaning “until”) and “AT” (dictionary meaning), each followed by a time group in hours and minutes. “FM” and “TL” are used with both “BECMG” and “TEMPO” to specify periods during which the relevant changes are expected to occur. “AT” is used with “BECMG” to indicate that a change is expected to occur at a specified time. When a change is expected to take place throughout the two-hour validity period of the trend forecast, the time period is not given. Similarly, if a change is expected to occur but the time is uncertain, the indicators “BECMG” and “TEMPO” are used alone. A full description of the usage of these indicators is given in Annex 3, Appendix 5, 2.3.

3.5.3 When no significant changes to any of the elements concerned (surface wind, visibility, weather, cloud and any other elements if so agreed between the meteorological authority and the operator concerned) are expected within two hours, the term NOSIG is used, representing the complete forecast statement. Criteria for significant changes are detailed in Annex 3, Appendix 5, 2.2.2 to 2.2.7. They can be summarized as follows:

a) a change in the mean wind direction of 60° or more, the mean speed before and/or after the change being 5 m/s (10 kt) or more;

b) a change in mean surface wind speed of 5 m/s (10 kt) or more;

c) changes through values of operational significance, i.e.:

— those that require a change of the runway(s) in use; or

— that result in a runway tailwind/crosswind component passing through the main operating limits of typical aircraft operating at the aerodrome;

> ***Example.—*** *A surface wind of 270 degrees at 13 m/s (26 kt) is* reported.
>
> An expected temporary surface wind of 250 degrees at 18 m/s (36 kt) with maximum speeds (gusts) to 25 m/s (50 kt) throughout the period is indicated in the form “TEMPO 250/18MPS MAX25” (“TEMPO 250/36KT MAX50”) (local reports) or “TEMPO 25018G25MPS” (“TEMPO 25036G50KT”) (METAR/SPECI).

d) when the visibility is forecast to improve and change to, or pass through, one or more of the following values; or when the visibility is forecast to deteriorate and pass through one or more of the following values: 150, 350, 600, 800, 1 500 or 3 000 m, and 5 000 m where many flights are conducted in accordance with visual flight rules;

Note.— Forecasts of runway visual range are not yet regarded as being feasible.

> ***Example.—*** *A visibility of 1 200 metres is reported*.
>
> A temporary reduction of the visibility to 700 m (for example in fog) is indicated in the form “TEMPO VIS 700M” (local reports) or “TEMPO 0700” (METAR/SPECI).

e) expected onset, cessation or change in intensity of the following weather phenomena or combinations thereof:

— freezing precipitation

— moderate or heavy precipitation (including showers)

— thunderstorm (with precipitation)

— duststorm

— sandstorm

— other weather phenomena given in Table 2-6 as agreed by the meteorological authority with the ATS authority and operators concerned.

The expected end of occurrence of the weather phenomena is indicated by the abbreviation “NSW”.

> ***Example.—*** *No present weather is reported*.
>
> Temporary moderate freezing rain is expected between 0300 and 0430 UTC; this is indicated in the form “TEMPO FM0300 TL0430 MOD FZRA” (local reports) and “TEMPO FM0300 TL0430 FZRA” (METAR/SPECI).

f) expected onset or cessation of one or more of one of the following weather phenomena or combinations thereof:

— ice crystals

— freezing fog

— low drifting dust, sand or snow

— blowing dust, sand or snow

— thunderstorms (without precipitation)

— squall

— funnel cloud (tornado or waterspout);

Note.— A maximum of three phenomena are to be reported in accordance with e) and f) above.

> ***Example.—*** *Thunderstorm without rain is reported.*
>
> An expected cessation at 1630 UTC of the present weather, such as a thunderstorm, is indicated in the form “BECMG AT1630 NSW” (in both local reports and METAR/SPECI).

g) changes in cloud height:

— when the height of base of the lowest cloud layer or mass of cloud of BKN or OVC extent is forecast to lift and change to, or pass through, one or more of the following values; or

— when the height of base of the lowest cloud layer or mass of cloud of BKN or OVC extent is forecast to lower and pass through one or more of the following values:

30, 60, 150, 300 or 450 m (100, 200, 500, 1 000 or 1 500 ft);

h) changes in cloud amount from "NSC, FEW, or SCT" to "BKN or OVC" or from "BKN or OVC" to "NSC, FEW or SCT" for the height of the base of a cloud layer being below, falling below, or rising above 450 m (1 500 ft);

Note.— When no clouds of operational significance are forecast, and "CAVOK" is not appropriate, the abbreviation "NSC" is used.

Example.— *Scattered clouds with the height of base at 300 m (1 000 ft) are reported*.

A forecast rapid increase in cloud at 1130 UTC from SCT to OVC at 300 m (1 000 ft) is indicated in the form "BECMG AT1130 OVC 300M" (local reports) or "BECMG AT1130 OVC010" (METAR/SPECI).

i) at aerodromes where vertical visibility observations are available:

— when the vertical visibility is forecast to improve and change to, or pass through, one or more of the following values; or

— when the vertical visibility is forecast to deteriorate and pass through one or more of the following values:

30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft).

A tabular presentation of the criteria for trend forecasts is given in Appendix 4.

3.5.4 In addition to the criteria specified in 3.5.3, other criteria based on local aerodrome operating minima may be established as a result of an agreement between the meteorological authority and the operators concerned.

3.5.5 As trend forecasts are intended to be of particular usefulness to pilots in deciding whether to commence/continue a flight towards the aerodrome of destination or to hold/divert, it is important that the operationally significant criteria for those forecasts are strictly followed. In order to ensure the desirable accuracy of these short-period forecasts, use needs to be made of all available aids, in particular ground-based weather radar, automatic or manned observation sites in the vicinity of the aerodrome (particularly in the direction from which weather, such as advection fog, is known to approach the aerodrome), etc. If trend forecasts are made at locations some distance from the aerodrome concerned, it is essential that arrangements be made to provide the forecaster with up-to-date information on meteorological conditions at the aerodrome.

3.6 FORECASTS FOR TAKE-OFF

A forecast for take-off contains information on expected conditions over the runway complex in regard to surface wind and wind variations, temperature, pressure (QNH) and other elements, as agreed locally. It is supplied on request to operators or flight crew members within the three hours before the expected time of departure. The order of the elements and the terminology, units and scales used in forecasts for take-off are the same as those used in reports for the same aerodrome; the format of the forecast is subject to agreement between the meteorological authority and the operators concerned. Meteorological offices preparing forecasts for take-off must keep these forecasts under continuous review and issue necessary amendments promptly. The criteria for the issuance of amendments to forecast elements are to be agreed between the meteorological authority and the operators concerned. These criteria should be consistent with the corresponding criteria for local special reports established for the aerodrome in accordance with 2.4.1.

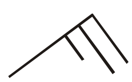
3.7 FORECASTS OF EN-ROUTE CONDITIONS — GENERAL

While forecasts for the aerodrome generally continue to be prepared by aerodrome meteorological offices, all forecasts of en-route conditions are provided within the framework of the WAFS by the two WAFCs except for forecasts of en-route conditions for low-level flights which are prepared locally or regionally, by meteorological offices.

Note.— Further details on the WAFS are given in Appendix 1.

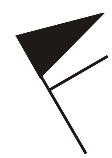
3.7.1 WAFS upper-air forecasts

3.7.1.1 Upper-air forecasts are received from WAFCs in digital form and supplied to users in digital or chart form. Wind and temperature data selected from the global forecasts should be depicted on the upper wind and upper-air temperature charts in a sufficiently dense latitude/longitude grid. On the charts, the wind direction is shown by arrows with a number of feathers or shaded pennants to indicate the wind speed, and temperatures are given in degrees Celsius as thus:



+10

25 kt, temperature
+10° Celsius



35

60 kt, temperature
– 35° Celsius

Note.— Negative temperatures are indicated without sign, but positive temperatures are shown with a preceding "+" sign.

Wind and temperature information is given for points on a grid sufficiently dense to provide meaningful information. On computer-drawn charts, wind arrows normally take precedence over temperatures, and temperatures take precedence over the chart background.

Note.— Examples of forecast charts of upper winds and upper-air temperatures are shown in Annex 3, Appendix 1.

3.7.1.2 The forecasts of:

a) upper wind;

b) upper-air temperature;

c) flight level and temperature of tropopause;

d) direction, speed and flight level of maximum wind;

e) geopotential altitude of flight levels; and

f) upper-air humidity

prepared in digital form four times daily by WAFCs are valid for 6, 9, 12, 15, 18, 21, 24, 27, 30, 33 and 36 hours after the time (0000, 0600, 1200 and 1800 UTC) of the synoptic data on which they are based. The forecasts should be available for the transmission from WAFCs to users no later than six hours after the respective standard time of observation. The upper wind and upper-air temperature forecasts are prepared for the following flight levels (which correspond to the fixed pressure levels indicated in brackets):

FL 50 (850 hPa),	FL 320 (275 hPa),
FL 100 (700 hPa),	FL 340 (250 hPa),
FL 140 (600 hPa),	FL 360 (225 hPa),
FL 180 (500 hPa),	FL 390 (200 hPa),
FL 240 (400 hPa),	FL 450 (150 hPa),
FL 270 (350 hPa),	FL 530 (100 hPa).
FL 300 (300 hPa),	

Note.— Upper-air humidity forecasts are prepared only up to flight level 180 (500 hPa) while geopotential altitude forecasts are issued for all the above flight levels except for the flight level 270 (350 hPa).

3.7.1.3 The foregoing forecasts prepared by WAFCs consist of computer-processed meteorological data for grid points in a regular grid with a horizontal resolution of 1.25° of latitude and longitude. The data are prepared in a format suitable for automated use, i.e. in the WMO GRIB code form:

a) for transmission from one meteorological computer to another, e.g. an airline flight planning computer, an ATS computer, or the computer of a national meteorological service or an aerodrome meteorological office; and

b) for the extraction and production of the required wind and temperature information.

Three satellite broadcasts (i.e. the AFS satellite distribution systems) are used for their transmission.

Note.— The GRIB code form is contained in WMO Publication No. 306, Manual on Codes — International Codes*, Volume I.2, Part B —* Binary Codes*.*

3.7.1.4 In addition, forecasts of CB clouds, icing, and clear-air and in-cloud turbulence are prepared in digital form four times daily by WAFCs and are valid for 6, 9, 12, 15, 18, 21, 24, 27, 30, 33 and 36 hours after the time (0000, 0600, 1200 and 1800 UTC) of the synoptic data on which they are based. These forecasts are currently of an experimental nature, to be labelled as "trial forecasts" and only distributed through the Internet-based FTP services.

3.7.1.5 The forecasts of CB clouds depict the horizontal extent and flight level of base and top of CB clouds. Forecasts of icing, clear air turbulence and in-cloud turbulence are prepared for layers centred at flight levels as shown in Table 3-5. The layers regarding icing and in-cloud turbulence forecasts have a depth of 100 hPa and the layers regarding clear air turbulence have a depth of 50 hPa.

3.7.2 WAFS forecasts of significant en-route weather phenomena

3.7.2.1 SIGWX forecasts are prepared by WAFCs four times a day for fixed, valid times of 0000, 0600, 1200 and 1800 UTC in binary format, i.e. in the WMO BUFR code form. The transmission of SIGWX forecasts should be completed at least 15 hours before their validity time.

Table 3-5. Details of forecasts of icing, and clear-air and in-cloud turbulence.

Layer centered at flight level (pressure in brackets)	*Icing*	*Clear-air turbulence*	*In-cloud turbulence*
60 (800)	X	—	—
100 (700)	X	—	X
140 (600)	X	—	X
180 (500)	X	—	X
240 (400)	X	X	X
270 (350)	—	X	—
300 (300)	X	X	X
340 (250)	—	X	—
390 (200)	—	X	—
450 (150)	—	X	—

3.7.2.2 High-level and medium-level SIGWX forecasts concentrate on significant en-route weather phenomena of relevance to flights operating at medium and high levels, namely:

a) tropical cyclone;

Note.— The maximum of the 10-minute surface wind speed must reach or exceed 17 m/s (34 kt).

b) severe squall lines;

c) moderate or severe turbulence (in cloud or clear air);

d) moderate or severe icing;

e) widespread sandstorm/duststorm;

f) CB clouds associated with a) to e) above;

g) flight level of tropopause;

h) jet streams;

i) information on the location of volcanic eruptions which are producing ash clouds of significance to aircraft operations depicted on the chart by the volcanic eruption symbol at the location of the eruption. Further details concerning the name of the volcano, the latitude and longitude, the date and time of the first eruption, if known, and a reference to the SIGMET and NOTAM or ASHTAM issued for the area concerned are given under the volcanic ash symbol at the side of the chart; and

j) information on the location of an accidental release of radioactive material into the atmosphere, of significance to aircraft operations, depicted on the chart by the radioactivity symbol at the location of the accident. Further details concerning the latitude and longitude of the site of the accident; the date and time of the accident; and a reminder to users to check NOTAM issued for the area concerned are given under the radioactivity symbol at the side of the chart.

3.7.2.3 The following criteria are used by the WAFCs when including items in the SIGWX forecasts:

a) tropical cyclones, severe squall lines, moderate and severe turbulence, moderate and severe icing, sandstorm/duststorm and CB clouds are included if expected to occur between the lower and upper level of the SIGWX forecast;

b) the abbreviation “CB” should be included only where it refers to the occurrence or expected occurrence of CB:

   1) affecting an area with a maximum spatial coverage of 50 per cent or more of the area concerned;

   2) along a line with little or no space between individual clouds; or

   3) embedded in cloud layers or concealed by haze.

c) the inclusion of “CB” should be understood to include all weather phenomena normally associated with CB clouds, namely, thunderstorm, moderate or severe icing, moderate or severe turbulence, and hail;

d) where a volcanic ash eruption or an accidental release of radioactive material into the atmosphere warrants the inclusion of the volcanic activity symbol or the radioactivity symbol in SIGWX forecasts, the symbols should be included on both high-level and medium-level SIGWX forecasts, regardless of the flight levels to which the volcanic ash column or radioactive material is reported or expected to reach; and

e) in the case of coincident or partial overlapping of items a), i) and j) in 3.7.2.2, the highest priority shall be given to item i), followed by item j) and a). The item with the highest priority shall be placed at the location of the event, and an arrow shall be used to link the location of the other item(s) to its associated symbol or text box.

3.7.2.4 WAFCs issue the following SIGWX forecasts:

a) high-level SIGWX forecasts for flight levels between 250 and 630; and

b) medium-level SIGWX forecasts for flight levels between 100 and 250 for limited geographical areas in accordance with RAN agreement.

Note 1.— Examples of the form of presentation of SIGWX forecasts for high- and medium-level flights are given in Annex 3, Appendix 1.

Note 2.— Medium-level SIGWX forecasts are planned to be phased out as soon as flight documentation generated from the gridded forecasts of CB clouds, icing and turbulence fully meet user requirements.

3.7.2.5 In order to assist WAFCs in keeping their SIGWX forecasts under continuous review, it is an important responsibility of meteorological offices receiving WAFS forecasts to notify the WAFCs concerned of significant discrepancies between SIGWX forecasts and observed conditions. The notification by meteorological offices should be based on the criteria given in Appendix 5. Abbreviated plain language should be used in preparing the notification in accordance with the guidance material given in Appendix 5. The AFTN should be used for transmission of notifications to relevant WAFCs. The priority assigned to administrative messages should be applied to the notification. The WAFC, after receiving such a notification, should acknowledge receipt and make a brief comment including, if necessary, a proposal for follow-up action.

3.7.2.6 Plain-text administrative messages, to be issued in the event of an error identified in the most recently issued WAFS SIGWX forecast (in BUFR code and/or PNG chart form) have been implemented by WAFC London and WAFC Washington. The content of such administrative messages is to be brought to the attention of users of the WAFS SIGWX forecast at the pre-flight planning stage. Where relevant to a particular flight, such correction information may be forwarded to aircraft in flight, but is not mandatory. The administrative messages contain specific information on the error(s) identified in the WAFS SIGWX forecast, including the necessary corrections to the WAFS SIGWX forecasts. Examples of administrative messages are given in Example 3-4.

Example 3-4. Administrative messages identifying corrections to issued SIGWX BUFR data and/or PNG charts
(see Figure 3-1)

a) WAFC LONDON HAS IDENTIFIED AN ERROR WITH THE FOLLOWING WAFS SIGWX BULLETIN VALID AT 111800 UTC:

PGGE06 - EGRR ISSUED AT 110145

USERS ARE ADVISED THAT THERE IS AN OBSCURED LABEL ON COMBINED CB AREA SW OF AUSTRALIA, THE AREA TO THE SOUTH BEING ISOL EMBD CB AT FL300, THE BOUNDARY BETWEEN THE TWO IS ALSO BEING PARTIALLY OBSCURED BY JET LABEL.

WAFC LONDON WILL NOT TRANSMIT CORRECTED SIGWX BULLETIN[S].

ISSUED BY WAFC LONDON=

b) WAFC LONDON HAS IDENTIFIED AN ERROR WITH THE FOLLOWING WAFS SIGWX BULLETIN VALID AT 261200 UTC.

BUFR - EGRR ISSUED AT 261200 UTC

USERS ARE ADVISED THAT SCALLOPS ASSOCIATED WITH ISOL CB TOP FL380, AT APPROXIMATELY 167 DEG W 30 DEG S, SHOULD BE REVERSED. ALL OTHER DETAILS CORRECT AS ISSUED.

WAFC LONDON WILL NOT TRANSMIT CORRECTED SIGWX BULLETIN[S].

ISSUED BY WAFC LONDON=

c) WAFC WASHINGTON HAS IDENTIFIED AN ERROR WITH THE FOLLOWING WAFS SIGWX BULLETIN(S) VALID AT 300600 UTC

BUFR FILE(S)
JUBE99

PNG CHART(S)
PGEE05
PGIE05

USERS ARE ADVISED THAT AN ERRONEOUS CB CLOUD LABEL WAS DISCOVERED ON BUFR FILE(S) JUBE99 AND PNG CHART(S) PGEE05 AND PGIE05.

THE CB CLOUD LABEL LOCATED NEAR 0717S08335W SHOULD CONTAIN THE FOLLOWING INFORMATION:

CB CLOUD COVERAGE: ISOL EMBD

CB CLOUD TOPS: 530

WAFC WASHINGTON WILL NOT RE-TRANSMIT BUFR OR PNG SIGWX PRODUCTS.

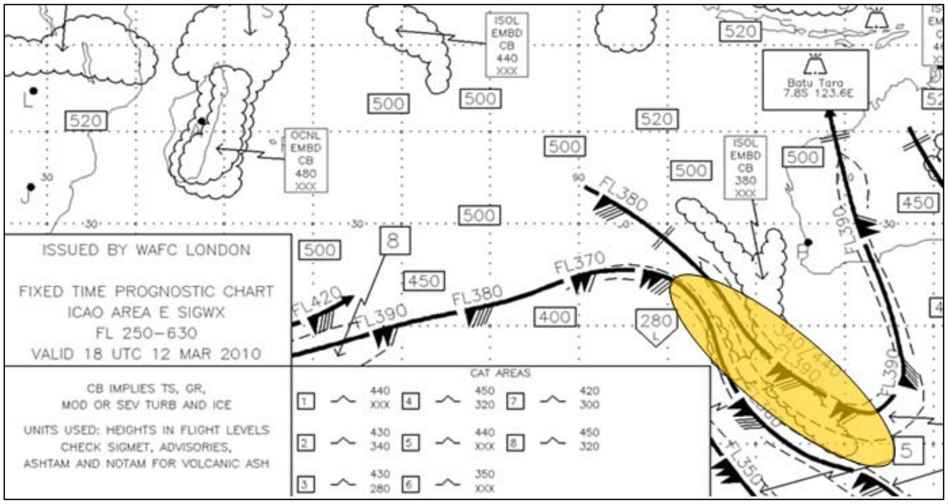


Figure 3-1. PNG chart

3.7.3 Area forecasts for low-level flights

3.7.3.1 When the density of traffic operating below FL 100 (or up to FL 150 or higher, where necessary in mountainous areas) warrants the issuance of AIRMET information in accordance with 4.4.1, on the basis of RAN agreement, area forecasts for such operations are to be prepared in a format agreed upon between meteorological authorities concerned and communicated to the MWOs responsible for the issuance of relevant AIRMET information. These area forecasts should cover the layer between the ground and FL 100 (or up to FL 150 or higher in mountainous areas) and should be prepared either in abbreviated plain language or in chart form.

3.7.3.2 When abbreviated plain language is used, area forecasts are to be prepared as an area forecast for low-level flights (GAMET) in accordance with the template shown in Annex 3, Appendix 5, Table A5-3 (see Example 3-5 and Table 3-6) using approved ICAO abbreviations and numerical values; when chart form is used, the forecast is to be issued as a combination of upper wind and upper-air temperature forecast, and of low-level SIGWX forecast.

3.7.3.3 AIRMET information is issued when specified en-route weather phenomena hazardous to low-level flights occur or are expected to occur which have not been included in the corresponding GAMET area forecast or low-level SIGWX forecast, and consequently have also not been included in the flight documentation for low-level flights supplied to pilots. Complete information regarding the en-route weather phenomena hazardous to low-level flights is contained in the first part (i.e. Section I) of the GAMET area forecast given in Annex 3, Appendix 5, Table A5-3.

3.7.3.4 Where the area forecasts for low-level flights are prepared by meteorological offices in chart form:

a) the forecasts of upper wind and upper-air temperature are to be issued for points separated by no more than 500 km (300 NM) and for at least the following altitudes: 600, 1 500 and 3 000 m (2 000, 5 000 and 10 000 ft) and 4 500 m (15 000 ft) in mountainous areas; and

Note.— A spatial resolution similar to the one specified in a) above should be applied to the element "wind and temperatures" included in GAMET area forecasts.

Example 3-5. GAMET area forecast

YUCC GAMET VALID 220600/221200 YUDO
AMSWELL FIR/2 BLW FL100
SECN I

SFC WSPD:	10/12 17 MPS
SFC VIS:	06/08 3000 M BR N OF N51
SIGWX:	11/12 ISOL TS
SIG CLD:	06/09 OVC 800/1100 FT AGL N OF N51 10/12 ISOL TCU 1200/8000 FT AGL
ICE:	MOD FL050/080
TURB:	MOD ABV FL090
SIGMETS APPLICABLE:	3,5
SECN II	
PSYS:	06 L 1004 HPA N5130 E01000 MOV NE 25 KT WKN
WIND/T:	2000 FT 270/18 MPS PS03 5000 FT 250/20 MPS MS02 10000 FT 240/22 MPS MS11
CLD:	BKN SC 2500/8000 FT AGL
FZLVL:	3000 FT AGL
MNM QNH:	1004 HPA
SEA:	T15 HGT 5M
VA:	NIL

Meaning:	An area forecast for low-level flights (GAMET) issued for sub-area two of the Amswell* flight information region (identified by YUCC Amswell area control centre) for below flight level 100 by the Donlon/International* meteorological office (YUDO); the message is valid from 0600 UTC to 1200 UTC on the 22nd of the month.
Section I:	
surface wind speeds:	between 1000 UTC and 1200 UTC 17 metres per second;
surface visibility:	between 0600 UTC and 0800 UTC 3 000 metres north of 51 degrees north (due to mist);
significant weather phenomena:	between 1100 UTC and 1200 UTC isolated thunderstorms without hail;
significant clouds:	between 0600 UTC and 0900 UTC overcast base 800, top 1 100 feet above ground level north of 51 degrees north; between 1000 UTC and 1200 UTC isolated towering cumulus base 1 200, top 8 000 feet above ground level;
icing:	moderate between flight level 050 and 080;
turbulence:	moderate above flight level 090 (at least up to flight level 100);
SIGMET messages:	3 and 5 applicable to the validity period and sub-area concerned.
Section II:	
pressure systems:	at 0600 UTC low pressure of 1 004 hectopascals at 51 degrees 30 minutes north 10 degrees east, expected to move north-eastwards at 25 knots and to weaken;
winds and temperatures:	at 2 000 feet above ground level wind direction 270 degrees; wind speed 18 metres per second, temperature plus 3 degrees Celsius; at 5 000 feet above ground level wind direction 250 degrees; wind speed 20 metres per second, temperature minus 2 degrees Celsius; at 10 000 feet above ground level wind direction 240 degrees; wind speed 22 metres per second, temperature minus 11 degrees Celsius;
clouds:	broken stratocumulus, base 2 500 feet, top 8 000 feet above ground level;
freezing level:	3 000 feet above ground level;
minimum QNH:	1 004 hectopascals;
sea:	surface temperature 15 degrees Celsius; and state of sea 5 metres;
volcanic ash:	nil.

* Fictitious locations

b) the forecast of low-level SIGWX must show the following items:

1) the phenomena warranting the issuance of a SIGMET given in 4.2.1 and which are expected to affect low-level flights; and

2) the elements in GAMET area forecasts as given in Annex 3, Appendix 5, Table A5-3, except wind and temperature, and forecast QNH.

3.7.3.5 Area forecasts for low-level flights (i.e. GAMET or a combination of upper wind, upper-air temperature and low-level SIGWX forecasts) prepared in support of the issuance of AIRMET information are issued every six hours for a period of validity of six hours and transmitted to meteorological offices concerned not later than one hour prior to the beginning of their validity period. Additional provisions concerning the issuance of GAMET area forecasts and low-level SIGWX forecasts are given in Table 3-6.

Table 3-6. Additional provisions concerning the issuance of GAMET area forecasts and low-level SIGWX forecasts in support of the issuance of AIRMET

Condition	*Action*
Specific hazardous phenomenon not expected *or* expected but already covered by a SIGMET message	Omit from the GAMET forecast; include a reference to the number(s) of SIGMET valid for the FIR in the GAMET forecast
No hazardous phenomenon expected *and* no SIGMET messages applicable	The term “HAZARDOUS WX NIL” replaces all the lines from the third line onward in Section 1 of GAMET
Specific hazardous phenomenon has been included in GAMET but does not occur *or* is no longer forecast to occur	Issue GAMET AMD *or* an updated low-level SIGWX forecast amending the element concerned (in Section 1 of GAMET *or* in the low-level SIGWX forecast, respectively).

Chapter 4

SIGMET INFORMATION, TROPICAL CYCLONE AND VOLCANIC ASH ADVISORY INFORMATION, AIRMET INFORMATION, AERODROME WARNINGS AND WIND SHEAR WARNINGS AND ALERTS

4.1 GENERAL

The preparation and issuance of information advising pilots and other aeronautical personnel of weather conditions likely to affect the safety of international civil aviation are important functions of meteorological offices. In fact, MWOs exist primarily to prepare and issue information on potentially hazardous en-route weather phenomena in their area of responsibility (see 1.3). This information is called SIGMET and AIRMET information. Tropical cyclone and volcanic ash advisories are products of TCACs and VAACs (see 1.6 and 1.7) intended for aviation users and MWOs which use these advisories in preparing SIGMET information for tropical cyclones and volcanic ash clouds. The issuance of warnings of hazardous weather conditions at or near aerodromes, including wind shear warnings, is usually the primary responsibility of aerodrome meteorological offices.

Note.— Data-type designators to be used in abbreviated headings for messages containing SIGMET and AIRMET information, and tropical cyclone and volcanic ash advisories are given in 6.2.2 and in the WMO Manual on the Global Telecommunication System *(WMO-No. 386)*.

4.2 SIGMET INFORMATION

4.2.1 The purpose of SIGMET information is to advise pilots of the occurrence or expected occurrence of en-route weather phenomena which may affect the safety of aircraft operations. The weather phenomena listed below, when occurring at cruising levels (irrespective of altitude), call for the issuance of SIGMET:

thunderstorm	
obscured	OBSC TS
embedded	EMBD TS
frequent	FRQ TS
squall line	SQL TS
obscured with hail	OBSC TSGR
embedded with hail	EMBD TSGR
frequent, with hail	FRQ TSGR
squall line with hail	SQL TSGR
tropical cyclone	
tropical cyclone with 10-minute mean surface wind speed of 17 m/s (34 kt) or more	TC (+ cyclone name)
turbulence	
severe turbulence	SEV TURB

icing	
severe icing	SEV ICE
severe icing due to freezing rain	SEV ICE (FZRA)
mountain wave	
severe mountain wave	SEV MTW
duststorm	
heavy duststorm	HVY DS
sandstorm	
heavy sandstorm	HVY SS
volcanic ash	
volcanic ash	VA (+ volcano name, if known)
radioactive cloud	
radioactive cloud	RDOACT CLD

Only one element from those listed above may be used in a SIGMET. It should be noted that although SIGMET information is required to be issued for cruising levels, there is no stated lower limit regarding the height for which a SIGMET should be issued. Since the occurrence of the above phenomena is of importance to aircraft during all phases of flight, the MWOs should issue a SIGMET irrespective of the altitude of the phenomenon. This requirement is explicitly stated in Annex 3 for all SIGMETs.

4.2.2 Messages concerning thunderstorms, tropical cyclones or severe squall lines should not include references to associated turbulence or icing.

4.2.3 SIGMET information is often based on special air-reports; it may also be based on weather satellite data and on ground-based observations, such as weather radar observations, or on forecasts.

4.2.4 SIGMET information is issued by MWOs and disseminated to aircraft in flight through associated ATS units. Aircraft in flight should be given, on the initiative of FICs, SIGMET information affecting their routes to a distance equivalent to 2 hours' flying time ahead of the position of the aircraft.

4.2.5 SIGMETs are disseminated to MWOs, WAFCs and to other meteorological offices as determined by RAN agreement. Furthermore, SIGMETs are transmitted to international OPMET databanks and to the international centres responsible for operation of the AFS satellite distribution systems. In addition, SIGMETs for volcanic ash cloud are disseminated to VAACs. Operators are supplied with SIGMET information mainly from meteorological offices. They can also obtain this information through various automated meteorological information systems or through automated information systems for pre-flight planning. SIGMETs are to be available at departure aerodromes for the whole route.

4.2.6 *Period of validity.* The period of validity of a SIGMET is not to exceed four hours. In the special case of a SIGMET for volcanic ash cloud and tropical cyclones, the period of validity is to be extended to six hours.

4.2.7 *Issuance*. SIGMETs relating to the expected occurrence of weather phenomena, with the exception of volcanic ash cloud and tropical cyclones, must not be issued more than four hours before the expected time of occurrence of such phenomena. In order to provide advance warning of the existence of volcanic ash cloud and tropical cyclones, SIGMETs related to these phenomena must be issued as soon as practicable but not more than 12 hours before the commencement of the period of validity.

4.2.8 *Update.* The SIGMETs for volcanic ash and tropical cyclones need to be updated at least every six hours. For the updating of other SIGMET, there are no provisions in Annex 3 since most phenomena prompting the issuance of SIGMETs do not last more than the maximum period of validity of such SIGMETs, i.e. four hours. However, if the phenomenon were expected to persist beyond the end of the period of validity, the SIGMET would need to be updated. The update could be timed during the period of validity of the previous SIGMET to coincide with the reception of new meteorological information by the MWO (e.g. satellite data, radar data, special air-reports, output from numerical weather prediction models) while complying with the Annex 3 provision stipulating that SIGMETs are not to be issued more than four hours before the commencement of their period of validity. SIGMETs are cancelled by the issuing office when the phenomena are no longer occurring or are no longer expected to occur in the area.

4.2.9 SiGMETs for a tropical cyclone are to be issued only by the MWO responsible for the watch of the FIR in which the centre of the tropical cyclone is located. Whenever a neighbouring FIR is influenced by CB clouds and thunderstorms associated with the tropical cyclone, the MWO concerned must issue a SIGMET for such thunderstorms.

4.2.10 It should be noted that information on volcanic ash cloud and associated volcanic activity is promulgated to users, including ATS units, also by NOTAM or by ASHTAM. ASHTAM and NOTAM for volcanic ash include information on any diversions and air route closures, etc., due to volcanic ash. ACCs/FICs receive volcanic ash advisories from the VAACs to which they are associated in accordance with RAN agreement. In view of this, it is important that MWOs maintain close coordination with their associated ACCs/FICs (and relevant AIS units) to ensure that information on volcanic ash in SIGMETs is consistent with that in NOTAM or ASHTAM.

Note.— Information on procedures to be used for the dissemination of information on volcanic eruptions is given in the Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds *(Doc 9691), and the* Handbook on the International Airways Volcano Watch (IAVW) — Operational Procedures and Contact List *(Doc 9766) (only available at http://www.icao.int/iavwopsg).*

4.2.11 SIGMETs (see Example 4-1) are issued in abbreviated plain language using approved ICAO abbreviations. In order to facilitate computer processing of the information, strict adherence to the relevant specifications concerning SIGMETs is essential. To describe weather phenomena, no additional descriptive material is therefore permitted. Detailed technical specifications for SIGMETs are contained in Annex 3, Appendix 6, Table A6-1.

Note.— For further details on the preparation and dissemination of SIGMET information messages, see also the regional SIGMET guide prepared by the ICAO regional offices for use in their respective regions. Information on the required exchanges of SIGMET information messages between meteorological offices is contained in the relevant ANP/FASID. Additional useful information including arrangements for the distribution of SIGMET messages at aerodromes and to FICs, etc., can be obtained from the Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological *Services (Doc 9377).*

4.2.12 SIGMETs in the alphanumeric format may be supplemented by the issuance of these SIGMETs in graphical format by the MWOs which are in a position to do so. SIGMETs in graphical format are issued in the WMO BUFR code form. Models of such SIGMETs can be found in Annex 3, Appendix 1.

Example 4-1. SIGMET messages

Note.— Additional examples of SIGMET can be found in the regional SIGMET guides issued by ICAO regional offices.

a) *SIGMET for severe turbulence*

YUCC* SIGMET 5 VALID 221215/221600 YUDO*–
YUCC AMSWELL* FIR SEV TURB OBS AT 1210Z AT YUSB FL250 MOV E 40KMH WKN

Meaning:

The fifth SIGMET message issued for the Amswell* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1215 UTC to 1600 UTC on the 22nd of the month; severe turbulence was observed at 1210 UTC over Siby/Bistock* aerodrome (YUSB) at flight level 250; the turbulence is expected to move eastwards at 40 kilometres per hour and to weaken in intensity.

b) *SIGMET for tropical cyclone*

YUCC* SIGMET 3 VALID 251600/252200 YUDO*–
YUCC AMSWELL* FIR TC GLORIA OBS AT 1600Z N2706 W07306 CB TOP FL500 WI 150NM OF CENTRE MOV NW 10KT NC FCST 2200Z TC CENTRE N2740 W07345

Meaning:

The third SIGMET message issued for the Amswell* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1600 UTC to 2200 UTC on the 25th of the month; tropical cyclone Gloria was observed at 1600 UTC at 27 degrees 6 minutes north, 73 degrees 6 minutes west; cumulonimbus tops at flight level 500 within 150 nautical miles of its centre; the tropical cyclone is expected to move north westwards at 10 knots; no change in intensity is expected; forecast position of the centre of the tropical cyclone at 2200 UTC is expected to be at 27 degrees 40 minutes north, 73 degrees 45 minutes west.

c) *SIGMET for volcanic ash*

YUKK* SIGMET 2 VALID 211100/211700 YUGG*–
YUKK KENTAL* FIR/UIR VA ERUPTION MT ASHVAL PSN S1500 E07348 VA CLD OBS AT 1100Z FL310/450 APRX 220KM BY 35KM S1500 E07348 – S1530 E07642 MOV ESE 65KMH FCST 1700Z VA CLD APRX S1506 E07500 – S1518 E08112 – S1712 E08330 – S1824 E07836

Meaning:

The second SIGMET message issued for the Kental* flight information region/upper flight information region (identified by YUKK Kental area control centre/upper information centre) by the Gales* meteorological watch office (YUGG) since 0001 UTC; the message is valid from 1100 UTC to 1700 UTC on the 21st of the month; a volcanic ash eruption at the Mount Ashval volcano located at 15 degrees south, 73 degrees 48 minutes east; volcanic ash cloud observed at 1100 UTC between flight levels 310 and 450 in an approximate area of 220 km by 35 km between 15 degrees south and 73 degrees 48 minutes east, and 15 degrees 30 minutes south, 76 degrees 42 minutes east; the volcanic ash cloud is expected to move to east-south eastwards at 65 kilometres per hour; at 1700 UTC the volcanic ash cloud is forecast to be located approximately in an area bounded by the following points: 15 degrees 6 minutes south and 75 degrees east, 15 degrees 18 minutes south and 81 degrees 12 minutes east, 17 degrees 12 minutes south and 83 degrees 30 minutes east, and 18 degrees 24 minutes south, 78 degrees 36 minutes east.

d) *SIGMET information message to be cancelled*

Note.— The content of the message below relates to the message in a). This type of message applies also to SIGMET information messages for tropical cyclone and volcanic ash shown in b) and c).

YUCC* SIGMET 6 VALID 221400/1600 YUDO*–
YUCC AMSWELL* FIR CNL SIGMET 5 221215/1600

Meaning:

The sixth SIGMET message issued for the AMSWELL* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1400 UTC to 1600 UTC on the 22nd of the month. The fifth SIGMET information message of the day is cancelled.

* Fictitious locations

4.3 TROPICAL CYCLONE AND VOLCANIC ASH ADVISORY INFORMATION

4.3.1 The preparation of SIGMET information is to be based, where possible, on advisory information produced by TCAC and VAAC (1.6 and 1.7 refer). The provision of advisory information from TCACs and VAACs to MWOs is described in the relevant ANP/FASID; the MWO, which is required to prepare SIGMETs for tropical cyclones and volcanic ash, is associated with the individual TCAC and VAAC designated by RAN agreement.

4.3.2 In addition to the MWO concerned, advisories should be distributed to:

a) *for tropical cyclone advisory information* — WAFCs and TCACs whose areas of responsibility may be affected, international OPMET databanks, and centres responsible for operation of AFS satellite distribution systems;

b) *for volcanic ash advisory information* — WAFCs and VAACs whose areas of responsibility may be affected, ACCs/FICs whose areas of responsibility may be affected, relevant NOTAM offices, international OPMET databanks, and centres responsible for operation of AFS satellite distribution systems.

Airline operators can obtain the advisory information through the AFS satellite broadcasts (international satellite communications system (ISCS) and the satellite distribution system for information relating to air navigation (SADIS)). Nine VAACs and seven TCACs have been designated by RAN agreement. VAACs and TCACs maintain watch throughout 24 hours.

4.3.3 The detailed content and format of volcanic ash and tropical cyclone advisory information are in Annex 3, Appendix 2, Tables A2-1 and A2-2, respectively. The advisories are issued in abbreviated plain language using approved ICAO abbreviations. The order of information presented in both advisories is to be strictly adhered to. Examples 4-2 a) and b) show a tropical cyclone advisory message and a volcanic ash advisory message. The advisories may also be issued in graphical format in accordance with the models in Annex 3, Appendix 1.

4.3.4 Graphical tropical cyclone and volcanic ash advisories

4.3.4.1 Tropical cyclone and volcanic ash advisories in graphical format display all the information contained in the corresponding alphanumeric advisory. Furthermore, graphical tropical cyclone advisories include information additional to the alphanumeric advisories concerning the extent of the gale-force surface winds and the areas affected by frequent CB clouds. Templates for a tropical cyclone and a volcanic ash advisory in graphical format are given in Appendix 1 to Annex 3 (Model TCG and Model VAG refer).

4.3.4.2 Graphical advisories are to be prepared in the portable network graphic (PNG) format or in the BUFR code form. In practice, the TCAC and VAAC concerned prepare graphical advisories in the PNG format only since no BUFR code tables exist for the graphical advisories and the BUFR code form is expected to be replaced by the extensible mark-up language (XML) during the next few years. To prepare tropical cyclone and volcanic ash advisories in graphical format, the TCAC and VAAC can use any graphical software which includes PNG format. However, for ease of use and for consistency between the alphanumeric and graphical advisories, it is useful to have both linked to a common database containing analysis and forecast data.

4.3.4.3 The graphical display of tropical cyclone and volcanic ash advisories should be clear and uncluttered, particularly in regard to labelling since graphical advisories are being increasingly used by aviation users in lieu of alphanumeric advisories and of tropical cyclone/volcanic ash SIGMET.

4.3.4.4 The ICAO AFTN which in principle should be used to exchange OPMET information cannot accommodate graphical advisories. Therefore, the TCAC and VAAC are expected to make their graphical advisories available through their public Internet websites. The following URL addresses can be used to access tropical cyclone advisories:

a) TCAC Darwin: www.bom.gov.au;

b) TCAC Honolulu: www.prh.noaa.gov/cphc;

c) TCAC La Réunion: www… [information awaited];

d) TCAC Miami: www.nhc.noaa.gov;

e) TCAC Nadi: www… [information awaited];

f) TCAC New Delhi: www.imd.gov.in/section/nhac/dynamic/cyclone.htm; and

g) TCAC Tokyo: www.jma.go.jp/en/typh/.

The websites for the VAAC are included in Doc 9766.

4.3.4.5 Moreover, graphical advisories can be delivered over the public Internet following the guidance contained in the *Guidelines on the Use of the Public Internet for Aeronautical Applications* (Doc 9855). Consideration should be given to download size, as some users may have limited bandwidth.

4.3.5 Updates to both types of advisory information are issued, as necessary, but at least every six hours.

Example 4-2. Advisory messages for tropical cyclones and volcanic ash

a) Tropical cyclone advisory

TC ADVISORY	
DTG:	19970925/1600Z
TCAC:	YUSO
TC:	GLORIA
NR:	01
PSN:	N2706 W07306
MOV:	NW 20KMH
C:	965HPA
MAX WIND:	23MPS
FCST PSN + 6 HR:	25/2200Z N2748 W07350
FCST MAX WIND + 6 HR:	23MPS
FCST PSN + 12 HR:	26/0400Z N2830 W07430
FCST PSN + 12 HR:	26/0400Z N2830 W07430
FCST MAX WIND + 12 HR:	23MPS
FCST PSN + 18 HR:	26/1000Z N2852 W07500
FCST MAX WIND + 18 HR:	21MPS
FCST PSN + 24 HR:	26/1600Z N2912 W07530
FCST MAX WIND + 24 HR:	20MPS
RMK:	NIL
NXT MSG:	19970925/2000Z

Note.— For the decode see Annex 3, Appendix 2, Table A2-2.

b) Volcanic ash advisory

VA ADVISORY	
DTG:	20000402/0700Z
VAAC:	TOKYO
VOLCANO:	USUZAN 805-03
PSN:	N4230 E14048
AREA:	JAPAN
SUMMIT ELEV:	732M
ADVISORY NR:	2000/432
INFO SOURCE:	GMS JMA
AVIATION COLOUR CODE:	RED
ERUPTION DETAILS:	ERUPTED 20000402/0614Z ERUPTION OBS VA TO ABV FL300
OBS VA DTG:	02/0645Z
OBS VA CLD:	FL150/350 N4230 E14048 – N4300 E14130 – N4246 E14230 – N4232 E14150 – N4230 E14048 SFC/FL150 MOV NE 25KT FL150/350 MOV E 30KT
FCST VA CLD + 6 HR:	02/1245Z SFC/FL200 N4230 E14048 – N4232 E14150 – N4238 E14300 – N4246 E14230 FL200/350 N4230 E14048 – N4232 E14150 – N4238 E14300 – N4246 E14230 FL350/600 NO VA EXP
FCST VA CLD + 12 HR:	02/1845Z SFC/FL300 N4230 E14048 – N4232 E14150 – N4238 E14300 – N4246 E14230 FL300/600 NO VA EXP
FCST VA CLD + 18 HR:	03/0045Z SFC/FL600 NO VA EXP
RMK:	VA CLD CAN NO LONGER BE DETECTED ON SATELLITE IMAGE
NEXT ADVISORY:	20000402/1300Z

Note.— For the decode see Annex 3, Appendix 2, Table A2-1.

4.4 AIRMET INFORMATION

4.4.1 The purpose of AIRMET information is to advise pilots of the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of low-level aircraft operations and which were not already included in the forecast issued for low-level flights (see 3.7.3) in the FIR concerned or sub-area thereof. An MWO whose area of responsibility encompasses more than one FIR and/or CTA issues separate AIRMET messages for each FIR and/or CTA within their area of responsibility. The weather phenomena listed below, when occurring at cruising levels below FL 100 (or below FL 150 or higher, when necessary in mountainous areas) call for the issuance of AIRMET:

surface wind speed	
widespread mean surface wind speed above 15 m/s (30 kt)	SFC WSPD (+ wind speed and units)
surface visibility	
widespread areas affected by the reduction of visibility to less than 5 000 m, including the weather phenomenon causing the reduction of visibility	SFC VIS (+ visibility) (+ weather phenomena or combinations thereof: BR, DS, DU, DZ, FC, FG, FU, GR, GS, HZ, IC, PL, PO, RA, SA, SG, SN, SQ, SS or VA
thunderstorms	
isolated thunderstorms without hail	ISOL TS
occasional thunderstorms without hail	OCNL TS
isolated thunderstorms with hail	ISOL TSGR
occasional thunderstorms with hail	OCNL TSGR
mountain obscuration	
mountains obscured	MT OBSC
cloud	
widespread areas of broken or overcast cloud with height of base less than 300 m (1 000 ft) above ground level:	
• broken	BKN CLD (+ height of the base and top and units)
• overcast	OVC CLD (+ height of the base and top and units)
cumulonimbus clouds which are:	
• isolated	ISOL CB
• occasional	OCNL CB
• frequent	FRQ CB
towering cumulus clouds which are:	
• isolated	ISOL TCU
• occasional	OCNL TCU
• frequent	FRQ TCU
icing	
moderate icing (except for icing in convective clouds)	MOD ICE
turbulence	
moderate turbulence (except for turbulence in convective clouds)	MOD TURB
mountain wave	
moderate mountain wave	MOD MTW

Only one element from those listed above may be used in a SIGMET. It should be noted that although SIGMET information is required to be issued for cruising levels, there is no stated lower limit regarding the height for which a SIGMET should be issued. Since the occurrence of the above phenomena is of importance to aircraft during all phases of flight, the MWOs should issue a SIGMET irrespective of the altitude of the phenomenon. This requirement is explicitly stated in Annex 3 for all SIGMETs.

4.4.2 Messages concerning thunderstorms or CB clouds should not include references to associated turbulence or icing.

Note.— The specifications for SIGMET information which are also relevant to low-level flights are given in 4.2.1.

4.4.3 AIRMET information is often based on weather satellite data and on ground-based observations, such as weather radar observations, or on forecasts.

4.4.4 AIRMET information is issued by MWOs in accordance with RAN agreement, such agreement taking into account the density of air traffic operating below FL 100 (or FL 150 in mountainous areas). AIRMET messages are disseminated to aircraft in flight through associated ATS units. Low-level flight operations should normally be provided, by FICs, with AIRMET information affecting their routes.

4.4.5 AIRMET messages are disseminated to MWOs in adjacent flight information regions and to other meteorological offices as agreed by the meteorological authorities concerned.

4.4.6 The period of validity of AIRMET cannot exceed four hours. AIRMET messages are cancelled by the issuing office when the phenomena are no longer occurring or are no longer expected to occur in the area.

4.4.7 AIRMET messages (see Example 4-3) are issued in abbreviated plain language using approved ICAO abbreviations. In order to facilitate computer processing of the information, strict adherence to the technical specifications concerning AIRMET messages is essential. To describe weather phenomena, no additional descriptive material is therefore permitted. Detailed technical specifications for AIRMET messages are in Annex 3, Appendix 6, Table A6-1.

Note.— The sequence number in the wind shear warnings referred to in the template in Table A6-3 corresponds with the number of such warnings issued for the aerodrome since 0001 UTC on the day concerned.

Example 4-3. AIRMET message

YUCC* AIRMET 2 VALID 221215/221600 YUDO*–
YUCC* AMSWELL FIR MOD MTW OBS AT 1205Z N48 E10 FL080 STNR NC

Meaning:

The second AIRMET message issued for the Amswell* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1215 UTC to 1600 UTC on the 22nd of the month; moderate mountain wave was observed at 1205 UTC at 48 degrees north and 10 degrees east at flight level 080; the mountain wave is expected to remain stationary and not to undergo any changes in intensity.

* Fictitious locations

4.5 AERODROME WARNINGS

4.5.1 The purpose of aerodrome warnings is to give concise information of meteorological conditions which could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services. Aerodrome warnings are cancelled when the conditions prompting the warning are no longer occurring or no longer expected to occur at the aerodrome.

4.5.2 Aerodrome warnings are issued in accordance with the template provided in Annex 3, Appendix 6, Table A6-2, when required by operators and/or aerodrome services and are disseminated in accordance with local arrangements to those concerned, by the meteorological office designated to provide service for that aerodrome. They normally relate to the occurrence or expected occurrence of one or more of the following phenomena:

— tropical cyclone (if the 10-minute mean surface wind speed at the aerodrome is expected to be 17 m/s (34 kt) or more)

— thunderstorm

— hail

— snow (including the expected or observed snow accumulation)

— freezing precipitation

— hoar frost or rime

— sandstorm

— duststorm

— rising sand or dust

— strong surface wind and gusts

— squall

— frost

— volcanic ash

— volcanic ash deposition

— toxic chemicals

— tsunami

— other phenomena as agreed locally.

4.5.3 The use of text additional to the abbreviations given in the template referred to in 4.5.2 should be kept to a minimum. Any additional text should, as far as possible, be in abbreviated plain language. If no approved ICAO abbreviations are available, English plain-language text can be used.

4.5.4 Where quantitative criteria are required for the issue of aerodrome warnings, e.g. expected maximum wind or expected total snow fall, these are established by agreement between the meteorological office and the users of the warnings.

4.6 WIND SHEAR WARNINGS AND ALERTS

4.6.1 Wind shear has been cited as a cause or contributory factor in a number of major aircraft accidents. At aerodromes where wind shear is considered to be a factor, it is therefore necessary to make arrangements, in addition to the inclusion of wind shear in the supplementary information of local routine and special reports and in METAR and SPECI, to provide all concerned with specific wind shear warnings, which would alert ATS units and, through them, the pilots, to the existence or expected existence of this hazardous phenomenon.

4.6.2 Evidence of the existence of wind shear should be derived from:

a) ground-based wind shear remote-sensing equipment, e.g. Doppler radar;

b) ground-based wind shear detection equipment, e.g. a system of surface wind and/or pressure sensors located in an array, monitoring a specific runway or runways and associated approach and departure paths;

c) aircraft observations during the climb-out or approach phases of flight to be made in accordance with Chapter 7; and

d) other meteorological information, e.g. from appropriate sensors located on existing masts or towers in the vicinity of the aerodrome or nearby areas of higher ground.

Note.— Wind shear conditions are normally associated with one or more of the following phenomena:

— *thunderstorms, microbursts, funnel cloud (tornado or waterspout) and gust fronts*

— *frontal surfaces*

— *strong surface winds coupled with local topography*

— *sea breeze fronts*

— *mountain waves (including low-level rotors in the terminal area)*

— *low-level temperature inversions.*

4.6.3 **Wind shear warnings** are prepared, by the meteorological office designated to provide service for the aerodrome, in abbreviated plain language in accordance with the template in Annex 3, Appendix 6, Table A6-3. The objective of wind shear warnings is to give concise information on the observed or expected existence of wind shear which could adversely affect:

a) aircraft on the approach path or take-off path or during circling approach between runway level and 500 m (1 600 ft) above that level or higher, where local topography produces operationally significant wind shear at greater heights; and

b) aircraft on the runway during the landing roll and take-off run.

The wind shear warnings are disseminated to those concerned in accordance with local arrangements with the appropriate ATS authority and operators concerned.

Note.— The sequence number in the wind shear warnings referred to in the template in Table A6-3 corresponds with the number of such warnings issued for the aerodrome since 0001 UTC on the day concerned.

4.6.4 When an aircraft report is used to prepare a wind shear warning or to confirm a warning previously issued, this report, including the aircraft type, is given unchanged in the warning.

Note 1.— Following reported encounters by both arriving and departing aircraft, two or more different wind shear warnings may exist, one for arriving aircraft and one for departing aircraft.

Note 2.— Specifications for reporting the intensity of wind shear are still undergoing development. It is recognized, however, that pilots, when reporting wind shear, may use the qualifying terms "moderate", "strong" or "severe", based to a large extent on their subjective assessment of the intensity of the wind shear encountered. Such reports are incorporated unchanged in wind shear warnings.

4.6.5 Wind shear warnings for arriving aircraft and/or departing aircraft are cancelled when aircraft reports indicate that wind shear no longer exists, or alternatively, after an agreed elapsed time. The criteria for the cancellation of a wind shear warning should be defined locally for each aerodrome, as agreed between the meteorological authority, the appropriate ATS authority and the operators concerned.

4.6.6 As an example of the use of masts for the observation of wind shear and of low-level temperature inversions, details of the system in use at Helsinki-Vantaa airport are given in Appendix 6.

4.6.7 **Wind shear alerts** are generated at aerodromes where wind shear is detected by automated, ground-based, wind shear remote-sensing or detection equipment. Wind shear alerts give concise, up-to-date information related to the observed existence of wind shear involving a headwind/tailwind change of 7.5 m/s (15 kt) or more which could adversely affect aircraft on the final approach path or initial take-off path and aircraft on the runway during the landing roll and take-off run.

Note.— Wind shear alerts can only be issued using automated equipment.

4.6.8 Wind shear alerts are updated at least every minute; they are cancelled as soon as the headwind/tailwind component falls below 7.5 m/s (15 kt). The wind shear alerts, if possible, relate to specific sections of the runway and distances along the approach or take-off path as agreed between the meteorological authority, the appropriate ATS authority and the operators concerned.

4.6.9 Wind shear alerts are disseminated to those concerned from automated, ground-based, wind shear remote-sensing or detection equipment in accordance with local arrangements.

Note 1.— Where microbursts are observed, reported by pilots or detected by ground-based wind shear detection or remote-sensing equipment, the wind shear warnings and wind shear alerts must include a reference to microbursts.

Note 2.— Guidance on the issuance of wind shear warnings and alerts is provided in the Manual on Low-level Wind Shear *(Doc 9817*).

Chapter 5

METEOROLOGICAL SERVICE FOR OPERATORS AND FLIGHT CREW MEMBERS

5.1 GENERAL PROVISIONS

5.1.1 Meteorological information is required by operators and flight crew members for:

a) pre-flight planning by operators;

b) in-flight re-planning by operators using centralized operational control of flight operations;

c) use by flight crew members before departure;

d) use by flight crew members in aircraft in flight.

Note.— The provision of OPMET information to aircraft in flight is normally the responsibility of ATS units. OPMET information supplied by aerodromes and other meteorological offices to ATS units is outlined in the Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services *(Doc 9377).*

5.1.2 The meteorological forecasts (TAF and trend forecasts) required to be provided for aerodromes by aerodrome or other meteorological offices are determined by RAN agreement and are listed in the relevant ANP/FASID. Factual information on all existing meteorological services is shown in the aeronautical information publications (AIPs) issued by individual States. These publications usually contain details of aerodrome meteorological offices and the services provided by them, together with the address of the meteorological authority responsible for the provision of meteorological information. For aerodromes without meteorological offices, the AIPs give the address and the telephone number of the office responsible for the provision of the necessary meteorological information.

5.1.3 The meteorological services provided may include briefing/consultation and display or provision of flight documentation. When such services are desired, the operator or a flight crew member must notify the aerodrome or other meteorological office concerned in sufficient time to allow that office to prepare the information required and, as necessary, to obtain information from WAFCs and other meteorological offices. The notice should include such details as:

a) aerodrome of departure and estimated time of departure;

b) destination and estimated time of arrival;

c) route to be flown and estimated times of arrival at, and departure from, any intermediate aerodrome(s);

d) alternate aerodromes needed to complete the operational flight plan;

e) cruising level(s);

f) type of flight, whether under visual or instrument flight rules;

g) type of meteorological information requested, i.e. whether flight documentation and/or briefing or consultation; and

h) time(s) at which briefings, consultations and/or flight documentation are required.

Note.— In the case of scheduled flights, the requirement for some or all of this information may be waived by agreement between the meteorological office and the operator. In those cases, operators or flight crew members must keep the meteorological authority, or the aerodrome or other meteorological office concerned, informed of any changes in schedules, or plans for non-scheduled flights.

5.1.4 Meteorological information is supplied to operators and flight crew members by one or more of the following means, as agreed between the meteorological authority and the operator concerned (the order shown does not imply priority):

a) written or printed material, including specified charts and forms;

b) data in digital form;

c) briefing;

d) consultation;

e) display; or

f) in lieu of a) to e) above, by means of automated pre-flight information systems.

5.1.5 Concerning the meteorological information, the meteorological authority must determine, in consultation with the operator:

a) its type and format; and

b) methods and means of its provision.

5.1.6 The meteorological information to be provided to operators and flight crew members includes the following information, as established by the meteorological authority in consultation with operators concerned:

a) forecasts of:

1) upper winds and upper-air temperatures;

2) upper-air humidity;

3) geopotential altitude of flight levels;

4) flight level and temperature of tropopause;

5) direction, speed and flight level of maximum wind;

6) CB clouds;

7) icing;

8) clear-air turbulence;

9) in-cloud turbulence; and

10) SIGWX phenomena;

Note 1.— Forecasts of upper-air humidity, geopotential altitude of flight levels, CB clouds, icing, and clear-air and in-cloud turbulence are used only in automatic flight planning and need not be displayed. Forecasts of CB clouds, icing, and clear-air and in-cloud turbulence are experimental in nature and provided on a trial basis.

Note 2.— When supplied in chart form, forecasts of upper wind and upper-air temperature are fixed time prognostic charts for flight levels as specified in 3.7.1.2.

Note 3.— When supplied in chart form, forecasts of SIGWX phenomena are fixed time prognostic SWH, SWM and/or SWL charts which are for an atmospheric layer limited by flight levels as specified in 3.7.2.4.

b) METAR or SPECI (including trend forecasts as issued in accordance with RAN agreement) for the aerodromes of departure and intended landing, and for take-off, en-route and destination alternate aerodromes;

c) TAF or amended TAF for the aerodromes of departure and intended landing, and for take-off, en-route and destination alternate aerodromes;

d) forecasts for take-off;

e) SIGMET information and appropriate special air-reports relevant to the whole route;

Note.— Appropriate special air-reports are those not already used in preparation of SIGMET messages.

f) volcanic ash and tropical cyclone advisory information relevant to the whole route;

g) subject to RAN agreement, GAMET area forecasts and/or area forecasts for low-level flights in chart form prepared in support of the issuance of AIRMET information and AIRMET information for low-level flights relevant to the whole route;

h) aerodrome warnings for the local aerodrome;

i) meteorological satellite images; and

j) ground-based weather radar information.

5.1.7 Forecasts listed under 5.1.6 a) 1) to 10) are to be generated from the digital forecasts provided by WAFCs in the GRIB and BUFR code forms, whenever these forecasts cover the intended flight path in respect of time, altitude and geographical extent. This implies that the meteorological authority has the obligation to make available WAFS forecasts for any operator that requires them. Forecasts issued by WAFCs should be received through the AFS satellite distribution systems which disseminate such forecasts to authorized users. If arrangements have been made between the meteorological authority and operators, the operators may obtain these forecasts directly from the WAFC concerned through AFS satellite broadcasts.

Note.— Since no forecasts of SIGWX phenomena for the layer from ground to FL 100 are issued by WAFCs, such forecasts, where required for flight planning, briefing, consultation or display, would have to be prepared by the meteorological offices concerned.

5.1.8 When forecasts are identified as being originated by WAFCs, the meteorological authority must ensure that no modifications are made to their meteorological content. Furthermore, charts generated from the digital forecasts provided by WAFCs are to be made available for fixed areas of coverage as shown in Appendix 8 to Annex 3 whenever required by operators.

5.1.9 The information listed in 5.1.6 should cover the flight in respect of time, altitude and geographical extent up to the aerodrome of intended landing. It should also cover the meteorological conditions expected between the aerodrome of intended landing and en-route and destination alternate aerodromes as required by the operator.

5.1.10 The forecasts of upper wind and upper-air temperature information, and of SIGWX phenomena above flight level 100, requested for pre-flight and in-flight planning by the operator is to be supplied as soon as it becomes available, but not later than three hours before departure; other meteorological information should be supplied as soon as is practicable.

5.1.11 Meteorological information is to be supplied to operators and flight crew members at the location and time agreed upon between the meteorological authority and the operator concerned. The service for pre-flight planning should be limited to flights originating within the territory of the State concerned.

5.1.12 For helicopter operations to offshore structures, pre-flight and in-flight planning information should include data from sea level to FL 100. The data will need to cover surface visibility, the amount, type (when available), and height of the base and top of cloud below FL 100, sea state and sea surface temperature, mean sea-level pressure, turbulence and icing. Details of the requirements in this regard vary from region to region and are therefore determined by RAN agreement. Where available, AIRMET information and the area forecasts issued for these types of operations should also be provided to operators for flight planning purposes.

5.1.13 For low-level operations, including those in accordance with visual flight rules, the pre-flight and in-flight planning information on en-route conditions should cover the layer from ground to FL 100 or up to FL 150 or more in mountainous areas. The information should include en-route weather phenomena given in Annex 3, Appendix 5, Table A5-4. In view of this, AIRMET information is of particular importance in planning low-level flights.

Note.— Details on the use of meteorological data in computer as well as in manual flight planning by flight operations officers are given in Appendix 7.

5.2 BRIEFING, CONSULTATION AND DISPLAY

5.2.1 A briefing or consultation is provided on request to flight crew members or other flight operations personnel. A briefing consists of an oral commentary, either directly by a person at the departure aerodrome or by telephone or other suitable telecommunication means from the meteorological office (which was notified of the flight and which issued the flight documentation), or through self-briefing computer terminals. A consultation consists of a personal discussion, including questions and answers. The purpose of the briefing or consultation is to supply the latest available information outlined in 5.1.6 on existing and expected meteorological conditions along the route to be flown, at the aerodrome of intended landing and at any necessary alternate aerodromes. Briefing and consultation are given either to explain or amplify the contents of the flight documentation or, if so agreed between the meteorological authority and the operator, to waive the need for providing flight documentation.

5.2.2 To assist flight crew members and others concerned with the preparation of a flight, and for use in a briefing or consultation, aerodrome meteorological offices display any or all of the information listed in 5.1.6. Meteorological information can also be displayed for users by means of various self-briefing or meteorological information systems (see 5.4).

Note.— A list of abbreviations and their decodes, which should be used in phraseologies in a briefing or consultation, is given in Appendix 8.

5.2.3 If during the briefing the meteorological office expresses an opinion on the development of meteorological conditions at an aerodrome which differs appreciably from the TAF included in flight documentation, the attention of flight crew members is to be drawn to the divergence. The portion of the briefing dealing with the divergence must be recorded at the time of briefing and this record should be made available to the operator.

5.3 FLIGHT DOCUMENTATION

5.3.1 Presentation of flight documentation

5.3.1.1 Flight documentation is written or printed information that is provided to flight crew members before take-off and which they take with them on the flight. It should comprise information listed under 5.1.6 a) 1) to10), b), c), e) f) and, if appropriate, g). However, when agreed between the meteorological authority and the operator concerned, flight documentation for flights of two hours' duration or less, after a short stop or turnaround, may be limited to only the information operationally needed; in all cases, however, the flight documentation should comprise information on at least 5.1.6 b), c), e), f) and, if appropriate, g).

5.3.1.2 The interpretation of satellite and weather radar imagery requires expert knowledge which can be imparted during a briefing. Furthermore, such imagery relates to a fixed time and cannot be used as a forecast. For these reasons such imagery should not be included in flight documentation.

5.3.1.3 Model charts and forms for use in the preparation of flight documentation are included in Appendix 1 to Annex 3. Flight documentation related to forecasts of upper wind and upper-air temperature and SIGWX phenomena is to be presented in the form of charts. For low-level flights, alternatively, GAMET area forecasts (which are in abbreviated plain language) can be used. METAR and SPECI (including trend forecasts as issued in accordance with RAN agreement), TAF, GAMET, SIGMET, AIRMET (in accordance with RAN agreement) and tropical cyclone and volcanic ash advisories are to be presented using the templates contained in Appendices 1, 2, 3, 5 and 6 to Annex 3. METAR, SPECI, TAF, GAMET, SIGMET and AIRMET, and tropical cyclone and volcanic ash advisories received from other meteorological offices and the tropical cyclone and volcanic ash advisory centres must be included in flight documentation without change. The format of flight documentation is summarized in Table 5-1.

Table 5-1. Format of flight documentation

Type of operation / *Product*	*Medium- or high-level flight (above FL 100)*	*Low-level flights (up to FL 100)*	
		Chart form	*Abbreviated plain language*
Forecasts of upper wind and upper-air temperature	WAFS chart(s)	National/regional charts for the following altitudes: 600, 1 500 and 3 000 m (2 000, 5 000 and 10 000 ft)	GAMET area forecast
Forecasts of SIGWX	WAFS chart(s)	National/regional low-level charts	GAMET area forecast
Aerodrome reports	METAR/SPECI	METAR/SPECI	METAR/SPECI
Aerodrome forecasts	TAF	TAF	TAF
En-route warnings	SIGMET	SIGMET, AIRMET	SIGMET, AIRMET
En-route advisories	Volcanic ash and tropical cyclone advisories	Volcanic ash and tropical cyclone advisories	Volcanic ash and tropical cyclone advisories

5.3.1.4 The forms and the legend of charts included in flight documentation are printed in English, French, Russian or Spanish; they should, wherever practicable, be completed in the language requested by the operator, preferably using one of those languages. The units of measurement for each element used in flight documentation should be in compliance with Annex 5 — *Units of Measurement to be Used in Air and Ground Operations* and indicated for each element. The location indicators and abbreviations used should be explained in flight documentation.

5.3.1.5 The height in relation to aerodrome meteorological conditions (e.g. in METAR/SPECI and TAF) is always given as height above official aerodrome elevation. On charts and forms related to en-route meteorological conditions, the expression of height in terms of flight levels is preferred, but pressure or altitude or, for low-level flights, height above ground level may also be used. On such charts and forms, the height indication used is always to be indicated.

Note.— Specifications for charts included in flight documentation, such as size, depiction of geographical features and grids, labels, etc., are given in Annex 3, Appendix 8. Examples of charts and forms included in flight documentation are also shown in Annex 3, Appendix 1. The appendix also includes MODEL SN containing a comprehensive set of important explanatory material relating to charts, symbols, units of measurement, and abbreviations contained in flight documentation. This model should, therefore, be supplied, or be made available to flight crew members and/or operators together with flight documentation.

5.3.1.6 Copies of flight documentation should be retained, either as printed copies or as computer files, by the issuing meteorological authority for at least 30 days.

5.3.2 Updates to flight documentation

Whenever it becomes apparent that OPMET information to be included in flight documentation will differ substantially from that made available for pre-flight planning and in-flight re-planning, the operator is to be advised and if practicable, be supplied with the updated information, as agreed between the operator and the meteorological office concerned. Should a need for amendment arise after the flight documentation has been supplied and before the aircraft has taken off, arrangements normally exist by which the meteorological office issues the updated information to the operator or to the local ATS unit for transmission to the aircraft. In case of unusual delays, completely new flight documentation may be requested by the flight crew from the meteorological office concerned.

5.3.3 Forecasts of en-route conditions

5.3.3.1 Charts displaying the forecast en-route meteorological conditions to be included in flight documentation are to be generated from the digital forecasts provided by WAFCs whenever these forecasts cover the intended flight path in respect of time, altitude and geographical extent. This implies that the meteorological authorities have the obligation to ensure that WAFS forecasts be provided as flight documentation for any operator that requires them.

5.3.3.2 WAFS charts issued as flight documentation for flights between FL 250 and FL 630 must include a high-level SIGWX chart — an SWH chart (FL 250 to FL 630) and a forecast chart of upper winds and upper-air temperature for the level of 250 hPa as a minimum. The medium-level SIGWX chart — an SWM chart, issued in accordance with RAN agreement for limited geographical areas, is to be included in flight documentation for flights between FL 100 and FL 250. The actual WAFS upper wind and upper-air temperature charts and SIGWX charts to be included in flight documentation are determined on the basis of agreements between meteorological authorities and users. Guidance on the choice of charts to be included in flight documentation is given in Table 5-2.

5.3.3.3 No amendments are issued by WAFCs to any of their forecasts (i.e. forecasts of upper wind and upper-air temperature, and of SIGWX phenomena). However, in the case of WAFS forecasts of upper wind and upper-air temperature, a newly issued forecast automatically cancels the corresponding forecast issued six hours earlier.

Table 5-2. Optimum set of forecasts of WAFS upper wind, upper-air temperature and SIGWX phenomena to be supplied as flight documentation

Type of flight / *WAFS forecast of*	*High-level (above FL 250)*	*Medium-level (from FL 100 to FL 250)*
upper wind and upper-air temperature for	• 250 hPa • pressure level closest to the actual flight level (if not 250 hPa)	• 500 hPa • pressure level closest to the actual flight level (if not 500 hPa)
SIGWX	• SWH	• SWM

5.3.3.4 All WAFS forecasts are provided as fixed time prognostic charts (5.1.6 a), Notes 2 and 3 refer) in the flight documentation; nevertheless, it may be considered that the fixed time upper wind and upper-air temperature charts are usable for flights from one and half hours before their validity time until one and half hours after their validity time, e.g. a WAFS upper wind forecast valid at 1200 UTC could be used for all flights between 1030 and 1330 UTC while the fixed time SIGWX charts are usable for flights from three hours before their validity time until three hours after their validity time, e.g. a WAFS SIGWX forecast valid at 1200 UTC could be used for all flights between 0900 and 1500 UTC. Ideally, flights with flying times exceeding 3 hours would thus require flight documentation for more than one validity time. Accordingly, a flight with a flying time of 7 hours from 1200 to 1900 UTC would require upper wind and upper-air temperature charts for three validity times (i.e. 1200, 1500 and 1800 UTC) and SIGWX forecasts for two validity times (i.e. 1200 and 1800 UTC). The actual flight documentation to be provided should be established by the meteorological authority in coordination with the operator concerned.

5.3.3.5 Flight documentation for low-level flights can be provided either in chart form (i.e. a combination of a low-level SIGWX forecast, and an upper wind and upper-air temperature forecast) or in abbreviated plain language (i.e. GAMET), as indicated in Table 5-1. Irrespective of the presentation, the forecasts of upper wind and upper-air temperature are to be provided for points separated no more than 500 km (300 NM) and for at least the following altitudes: 600, 1 500 and 3 000 m (2 000, 5 000 and 10 000 ft). When a route to be flown involves the use of both GAMET and a combination of low-level SIGWX forecast and an upper wind and upper-air temperature forecast, the users' attention should be drawn to the differences in the information content in these forecasts. They are listed in Table 5-3.

Note 1.— SIGMET messages are to be included in flight documentation in both cases.

Note 2.— The en-route forecasts for low-level flights are prepared by meteorological offices as agreed locally or in accordance with RAN agreement. This applies particularly for the regions where AIRMET information is to be issued by RAN agreement. In these regions, the GAMET forecasts or low-level SIGWX forecasts are prepared in support of the issuance of AIRMET information, and SIGMET and AIRMET information relevant to the flight concerned is to be included in flight documentation for low-level flights.

5.4 AUTOMATED PRE-FLIGHT INFORMATION SYSTEMS

5.4.1 Centralization and automation on the part of meteorological authorities prompted the development and implementation of automated pre-flight information systems. Pre-flight information, self-briefing, consultation and flight documentation can be obtained by flight crew members, operators and other flight operations personnel through an automated pre-flight information system. The meteorological information to be displayed in meteorological offices can also be made available to users through these systems. Some of these systems serve the above purposes exclusively while others allow for the provision of an integrated information system, which may not be confined to the meteorological part of pre-flight planning. Many systems assist users by providing a harmonized, common-point access to AIS and MET pre-flight information. Automated pre-flight information systems may form part of a multi-purpose aeronautical or public information system.

Table 5-3. Differences in the information contained in GAMET and the combination of low-level SIGWX forecast and an upper wind and upper-air temperature forecast

Information on / *Type of forecast*	*Phenomena already included in a SIGMET*	*Forecast QNH*
GAMET	No	Yes
Combination of low-level SIGWX and upper wind and upper-air temperature forecast	Yes	No

5.4.2 Meteorological information and services supplied to users through an automated pre-flight information system must comply with Annex 3 provisions.

5.4.3 The automated pre-flight information systems are to:

a) provide for continuous updating of the system database and the monitoring of the validity and integrity of the meteorological information stored;

b) permit access to the system by operators, flight crew members and other aeronautical users concerned through suitable telecommunication means (including public communications, such as telephone, fax, Internet and data networks);

c) use access and interrogation procedures based on abbreviated plain language, ICAO location indicators, WMO aeronautical meteorological code data-type designators or based on a menu-driven interface or other mechanisms, as agreed between the meteorological authority and the operators concerned; and

d) provide for rapid response to user requests for information.

5.4.4 Where the AIS/MET automated pre-flight information systems are established and used, the full responsibility for quality control and quality management of the OPMET information processed and supplied rests with the meteorological authority(ies) concerned, through all levels of processing up to the supply of the data to users. The same applies to the AIS authority(ies) designated by a State(s) for the AIS data processed and supplied by such systems. The information to be supplied through such systems to the personnel involved in pre-flight planning, i.e. its quality, geographical and spatial coverage, format, content, validity, time and the frequency of supply, etc., must be in conformity with the relevant provisions of Annex 3 and Annex 15.

5.5 INFORMATION FOR AIRCRAFT IN FLIGHT

VOLMET is supplied by a meteorological office to its associated ATS unit and then to the pilot through ground-to-air communications, including direct controller- to-pilot communications, and through D-VOLMET or VOLMET broadcasts as determined by RAN agreement (see also 6.6). Meteorological information for aircraft in flight is to be supplied on request, as agreed between the meteorological authority and the operator concerned. Meteorological information may be disseminated in graphical format. General guidelines for the display of such information in the cockpit are provided in Appendix 9.

Chapter 6

DISSEMINATION OF OPMET INFORMATION

6.1 GENERAL

6.1.1 Efficient telecommunications are essential for the speedy dissemination of OPMET information to all users. Suitable telecommunication facilities must therefore be available at aerodromes to ensure rapid communications between meteorological offices and stations, and to allow these offices and stations to supply the necessary OPMET information to ATS units (control towers, approach control, etc.), operators and other aeronautical users at the aerodrome. Automatic telecommunication and information systems, telephones and teletypewriters are used for this purpose; if used between meteorological offices and ATS units, telephones should allow contact with the required points within 15 seconds (even if switchboards are used), and printed communications within 5 minutes, including any necessary retransmission.

6.1.2 For the dissemination of OPMET information beyond the aerodrome, the AFTN and the aeronautical fixed service (AFS) satellite distribution systems (see 6.2 and 6.3 respectively) are the primary communication means. Both are part of the AFS, which embraces all telecommunication systems used for international air navigation, except ground-to-air transmissions. ICAO international OPMET databanks, which can be accessed through the AFTN, support inter-regional and regional exchanges and dissemination of OPMET information. In accordance with the principles for the planning of OPMET exchanges, endorsed by the COM/MET Divisional Meeting (1982), the OPMET data exchange system should make use of a limited number of international databanks; the number and location of these databanks and the areas to be served by them should be established by RAN agreement. Seven international OPMET databanks have been established by RAN agreement in Brasilia, Brussels, Dakar, Pretoria, Toulouse, Vienna and Washington. In addition, five OPMET databanks in Bangkok, Brisbane, Nadi, Singapore and Tokyo have been designated to support the ROBEX scheme (see 6.2.6) in the ASIA/PAC Regions.

6.1.3 Some concern has been expressed by a number of States regarding the use of OPMET information for non-aviation purposes. Guidelines for access to aeronautical meteorological information (i.e. OPMET information) have been developed by ICAO, in coordination with WMO and are given in Appendix 10.

6.2 DISSEMINATION OF OPMET INFORMATION ON THE AFTN

6.2.1 OPMET information in alphanumeric form is transmitted on the AFTN (and on most other networks including the public Internet) in the form of "bulletins", each bulletin containing one or more METAR, TAF or other types of information (but always only one type per bulletin) and the appropriate bulletin heading. The heading is essential to permit recognition by users and data handlers, including computers, of type, time and origin of the data contained in the bulletin. It should not be confused with the "AFTN message heading" which determines priority, routing and other telecommunication aspects of the message. All meteorological bulletins transmitted via the AFTN have to be "encapsulated" into the text part of the AFTN message format.

Note.— Details concerning the AFTN message format are given in Annex 10 — Aeronautical Telecommunications, *Volume II —* Communication Procedures including those with PANS status.

6.2.2 The meteorological bulletin abbreviated heading consists of a single line, precedes the OPMET information contained in the bulletin, and normally comprises three groups as follows:

a) an identifier;

b) an ICAO location indicator;

c) a date-time group; and

d) if necessary, a fourth group as an identifier for a delayed, corrected or amended bulletin.

The meaning of these four groups is as follows:

— The identifier comprises four letters and two figures: the first and second letters are the data-type designators, the third and fourth letters are the geographical designators, and the figures are added to identify two or more bulletins originated by the same centre. The data designators are:

SA	METAR including trend forecasts, if provided
SP	SPECI including trend forecasts, if provided
FT	TAF valid for 12 hours or more
FC	TAF valid for less than 12 hours
WA	AIRMET information
WS	SIGMET information
WC	SIGMET information for tropical cyclones
WV	SIGMET information for volcanic ash
FK	Tropical cyclone advisory information
FV	Volcanic ash advisory information
UA	Air-report (AIREP)
FA	GAMET forecasts

Example.— SAZB02 = Second of two bulletins containing routine reports in the METAR code form (SA) from Zambia (ZB).

Note.— A complete list of geographical designators is given in WMO Publication No. 386 — Manual on the Global Telecommunication System*; the data designators listed above are taken from the same WMO publication.*

— The ICAO location indicator consists of four letters (e.g. YUDO [fictitious location]) and identifies the meteorological office that compiled the bulletin. The complete list of location indicators is published in *Location Indicators* (Doc 7910).

— The date-time group consists of six figures, the first two figures indicating the day of the month and the next four figures indicating:

- for METAR and SPECI, the time of observation in UTC;

- for TAF, the full hour in UTC (of which the last two figures are always 00) preceding the transmission time; for other forecasts, the standard time of observation in UTC on which the forecast is based;

- for other OPMET bulletins, such as SIGMET information, the time of origin in UTC of the text of the bulletin(s).

> **Example.—** 151200 = METAR based on observations made on the 15th of the month at 1200 UTC.

Note.— In the case of bulletins, the time of observation of each report needs to be clearly identified.

— If necessary, the abbreviated heading may include a fourth group consisting of three letters to identify delayed (RRA), corrected (CCA) or amended (AAA) bulletins. If additional delayed, corrected or amended bulletins are necessary, they should be identified by RRB, RRC, etc.; CCB, CCC, etc.; and AAB, AAC, etc.

> **Example.—** A complete heading will be as follows:
>
> SAZB02 YUDO 151200 RRA = Delayed second of two bulletins of METAR code form for 1200 UTC on the 15th from Zambia, compiled by YUDO.*
>
> * Fictitious location

6.2.3 Bulletins containing OPMET information and disseminated on the AFTN are given priorities depending on their urgency; warnings (SIGMET information), amendments to forecasts, and other meteorological information of immediate concern to aircraft in flight or about to depart are given a relatively high priority; next are METAR, TAF, and other messages exchanged between meteorological offices.

Note.— Details concerning message priorities on the AFTN are given in Annex 10, Volume II.

6.2.4 Messages containing OPMET information should be filed promptly for transmission on the AFTN in good time. METAR and SPECI are normally filed within five minutes of the time of the observation, and TAF at least one hour before the commencement of their validity.

6.2.5 The time interval between the time of filing and the time of receipt of a message is called the “transit” time. Messages containing OPMET information transmitted on the AFTN should normally have transit times of less than five minutes, except for METAR, SPECI and TAF exchanged over distances exceeding 900 km which may have transit times of up to ten minutes.

6.2.6 In some regions, special collection and dissemination systems have been designed for the more efficient handling of OPMET information exchanged on AFTN circuits such as the Regional Operational Meteorological Bulletin Exchange (ROBEX) in the MID/ASIA/PAC Regions and the Africa-Indian Ocean Meteorological Bulletin Exchange (AMBEX) in the AFI Region.

6.3 DISSEMINATION OF OPMET INFORMATION ON THE AFS SATELLITE BROADCASTS

6.3.1 A global set of OPMET information, including WAFS forecasts, is disseminated through three AFS satellite broadcasts, directly from WAFCs to the meteorological offices. Where the necessary arrangements have been made, the broadcasts may also be received by other users, such as ATS units and operators. The transmission of WAFS forecasts through AFS satellite broadcasts is in the form of digital data, comprising forecasts of upper wind and upper-air temperature, humidity, tropopause heights and temperatures, maximum winds, CB clouds, icing, in-cloud and clear air turbulence in the GRIB code form, and SIGWX forecasts in the BUFR code form.

6.3.2 The dissemination of WAFS forecasts through the AFS satellite broadcasts is the most efficient method, as it provides excellent quality of information for relatively low-cost, user-friendly receiving equipment. States that have not already done so are therefore encouraged to arrange for the reception of the broadcasts which provide global coverage. The procedures and conditions concerning authorized access to the AFS satellite broadcasts are given in Appendix 1.

Note.— For details on the methods to be used in the various ICAO regions for the exchange of OPMET information, see the relevant ANP/FASID. Details on regional networks or systems for the exchange of OPMET information are published by ICAO regional offices on a regular basis.

6.4 DISSEMINATION OF OPMET INFORMATION ON THE INTERNET

Since the public Internet has become increasingly reliable for dissemination of data over recent years, it can be used to exchange non-time critical OPMET information subject to its availability and satisfactory operational performance. In this context, any OPMET information (including WAFS forecasts) used for flight planning can be considered non-time critical and therefore, disseminated over the public Internet. Guidance on the use of the public Internet has been issued by ICAO (*Guidelines on the Use of the Public Internet for Aeronautical Applications* (Doc 9855) refers).

6.5 INTERROGATION PROCEDURES FOR INTERNATIONAL OPMET DATABANKS

6.5.1 In addition to the dissemination means described in 6.2, 6.3 and 6.4, OPMET information can also be obtained by interrogation of one of the ICAO international OPMET databanks. This is done by means of a standardized message which triggers the automatic retrieval of the requested information and its immediate transmission to the originator. In general, the automatic retrieval provides the user with the most recent information available.

6.5.2 In order to be accepted by the databank, the interrogation message must be in agreement with the following principles:

a) it must contain the proper AFTN address used for interrogation (e.g. SBBRYZYX for Brasilia, EBBRYZYX for Brussels, LOWMYZYX for Vienna, KWBCYZYX for Washington); and

b) only one line of interrogation (69 characters of text) is allowed.

6.5.3 The standard interrogation for one message must include the elements listed below in the following order:

a) “RQM/” indicating the start of a data request line;

b) data-type identifier;

c) a four-letter ICAO location indicator; and

d) the equal sign (=) indicating the end of the interrogation line, e.g. RQM/SAMTSJ=.

Note.— MTSJ is a fictitious location indicator.

6.5.4 The accepted data-type designators are as given in 6.2.2. Some of the data types listed in that paragraph may not be available in all the international OPMET databanks.

6.5.5 The following special interrogation procedures are available if more than one message is needed:

a) the same data type may be requested for a number of stations without repeating the data-type identifier. The location indicators have to be separated by commas (,) which indicate the continuation of the request for the same type of data, e.g. RQM/SAEHAM,EHRD=;

b) various data types may be interrogated in the same message using the oblique (/) as a separator, e.g. RQM/SAKMIA/FTKMIA=.

6.5.6 There are additional features used for interrogation that are not available in all the international OPMET databanks. These are described in detail in the catalogues of OPMET data available at the OPMET databanks, prepared and updated on a regular basis by the ICAO regional offices concerned. It should be noted that some international OPMET databanks restrict access to one authorized user per State, and the computer will not respond to an unauthorized interrogation.

6.6 DISSEMINATION OF OPMET INFORMATION TO AIRCRAFT IN FLIGHT

6.6.1 The transmission of OPMET information to aircraft in flight is the responsibility of the ATS units. Details on the meteorological information provided to aircraft in flight can be found in the *Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services* (Doc 9377).

6.6.2 VOLMET broadcasts by VHF or HF voice communications and D-VOLMET by data link are parts of aeronautical mobile service communications. Both communication systems are established and operated in States, usually by the ATS authorities, in accordance with RAN agreement. Depending on these agreements, METAR, SPECI (including trend forecasts, where required), TAF and SIGMET information messages are supplied through these telecommunications systems to aircraft in flight. Details relating to the cooperation of the meteorological and ATS authorities in the provision of the services are dealt with in Doc 9377. The standard radiotelephony phraseologies to be used in VOLMET broadcasts by voice communication are given in Appendix 1 to that manual.

Note.— The following data link services of the data link flight information service (D-FIS) application should be used for the supply of OPMET information to aircraft in flight: D-METAR service, D-TAF service, D-SIGMET service. For details on these data link services, see the Manual of Air Traffic Services Data Link Applications (Doc 9694).

Chapter 7

AIRCRAFT OBSERVATIONS AND REPORTS

7.1 GENERAL

There are two kinds of aircraft observations as listed below and discussed in detail in the following paragraphs:

a) routine aircraft observations during en-route and climb-out phases of the flight; and

b) special and other non-routine aircraft observations during any phase of the flight.

7.2 REPORTING OF AIRCRAFT OBSERVATIONS DURING FLIGHT

7.2.1 Aircraft observations are to be reported using the following means:

a) *air-ground data link*. This is the preferred mode of reporting, applicable both for routine and special and other non-routine aircraft observations; and

b) *voice communication*. This is to be used only if the air-ground data link is not available or appropriate and is applicable only for special and other non-routine aircraft observations.

7.2.2 Aircraft observations are to be reported during flight at the time the observation is made or as soon thereafter as is practicable.

7.3 ROUTINE AIRCRAFT OBSERVATIONS

7.3.1 Frequency of reporting

When air-ground data link is used and automatic dependent surveillance (ADS) or secondary surveillance radar (SSR) Mode S is being applied, automatic routine observations are made every 15 minutes during the en-route phase and every 30 seconds during the climb-out phase for the first 10 minutes of the flight. When only voice communications are available, no routine meteorological observations by aircraft are made. For helicopter operations to and from aerodromes on offshore structures, routine observations are to be made from helicopters at points and times as agreed between the meteorological authorities and the helicopter operators concerned.

7.3.2 Exemptions from reporting

As indicated in 7.3.1, an aircraft not equipped with air-ground data link is exempted from making routine observations, i.e. when voice communications are used, no routine aircraft observations are required.

Note.— When air-ground data link is used, no exemptions are to be applied.

7.3.3 Designation procedures

In the case of air routes with high-density air traffic (e.g. organized tracks), an aircraft from among the aircraft operating at each flight level shall be designated, at approximately hourly intervals, to make routine observations in accordance with the frequency specified in 7.3.1. These designation procedures for the en-route phase of the flight are prescribed by RAN agreement and only applicable when air-ground data link is used. In the case of the requirement to report during the climb-out phase, an aircraft is to be designated, at approximately hourly intervals, at each aerodrome to make routine observations in accordance with 7.3.1. The details concerning the required frequency to make routine aircraft observations and the associated designation procedures are shown in Table 7-1.

Note.— Details on designation procedures for the en-route phase of the flight are contained in the Regional Supplementary Procedures *(Doc 7030), Chapter 12* — Meteorology.

Table 7-1. Frequency and associated designation procedures of routine air-reports through air-ground data link

	En-route phase		*Climb-out phase (terminal area)*
	Low-density traffic	*High-density traffic*	
	All aircraft	*Designated aircraft*	*Designated aircraft*
Frequency	One every 15 min		One every 30 s for the first 10 min of the flight
Designation procedures	None	An aircraft at hourly intervals*	An aircraft at hourly intervals at each international aerodrome
*Subject to RAN agreement included in the *Regional Supplementary Procedures* (Doc 7300), Chapter 12 — *Meteorology*.			

7.4 SPECIAL AND OTHER NON-ROUTINE AIRCRAFT OBSERVATIONS

7.4.1 Special aircraft observations

Special observations are required to be made by all aircraft operating on international air routes whenever the following conditions are encountered or observed:

a) turbulence that is:
   - severe; or
   - moderate; or

b) icing that is:
   - severe; or
   - moderate; or

c) severe mountain wave; or

d) thunderstorms, *without hail*, that are:

- obscured; or
- embedded; or
- widespread; or
- in squall lines; or

e) thunderstorms, *with hail*, that are:

- obscured; or
- embedded; or
- widespread; or
- in squall lines; or

f) heavy duststorms or heavy sandstorms; or

g) volcanic ash cloud; or

h) pre-eruption volcanic activity or volcanic eruption.

Note 1.— The exemptions from routine observations, mentioned in 7.3.2, do not apply to special observations which are required to be made by all aircraft during any phase of the flight and in all regions.

Note 2.— Pre-eruption volcanic activity in this context means unusual and/or increasing volcanic activity which could presage a volcanic eruption.

Note 3.— When air-ground data link is used, special air-reports constitute a data link application mentioned in 7.5.6, Note 1. To facilitate the issuance of special air-reports by the pilot in the data link environment, a future data link application with a menu-driven system for the cockpit is being developed. An example of this type of user-friendly system, not requiring addition of free text, is shown in Table 7-2.

Note 4.— Special air-reports of turbulence and icing during climb-out and approach are especially important, since no satisfactory method of observing these phenomena from the ground is available at this time.

Table 7-2. Downlink message menu incorporating conditions prompting the issuance of special air-reports

SEVERE TURBULENCE
MODERATE TURBULENCE
SEVERE ICING
MODERATE ICING
SEVERE MOUNTAIN WAVE
THUNDERSTORMS WITHOUT HAIL
THUNDERSTORMS WITH HAIL
HEAVY DUSTSTORM/SANDSTORM
VOLCANIC ASH CLOUD
PRE-ERUPTION VOLCANIC ACTIVITY/VOLCANIC ERUPTION

7.4.2 Other non-routine observations

Other non-routine aircraft observations are made when meteorological conditions are encountered which are different from those listed under 7.4.1 (e.g. wind shear) and which, in the opinion of the pilot-in-command, may affect the safety or markedly affect the efficiency of other aircraft operations. These observations are to be made through voice communications by advising the appropriate ATS unit as soon as practicable. In the case of wind shear reports:

a) the aircraft type **must** be included; and

b) pilots **must** inform appropriate ATS units as soon as practicable if forecast wind shear conditions are **not** encountered.

7.5 CONTENT OF AIR-REPORTS

7.5.1 A report consisting of a position report and of meteorological information is called a "routine air-report". (It may also contain operational information.) Reports containing special aircraft observations are called "special air-reports" and, in most cases, constitute a basis for the issuance of SIGMETs.

7.5.2 When voice communications are used, the elements contained in special air-reports are as follows:

Message type designator

Section 1 (position information)
- Aircraft identification
- Position or latitude or longitude
- Time
- Level or range of levels

Section 3 (meteorological information)
- Condition prompting the issuance of a special air-report (one condition to be selected from the list in 7.4.1)

7.5.3 When air-ground data link is used and ADS or SSR Mode S is being applied, the elements contained in routine air-reports are as follows:

Message type designator
Aircraft identification

Data block 1
- Latitude
- Longitude
- Level
- Time

Data block 2
- Wind direction
- Wind speed
- Wind quality flag
- Air temperature
- Turbulence (if available)
- Humidity (if available)

Note.— When ADS or SSR Mode S is being applied, the requirements of routine air-reports may be the combination of the basic ADS/SSR Mode S data block (data block 1) and the meteorological information data block (data block 2), available from ADS or SSR Mode S reports. The ADS message format is specified in the Procedures for Air Navigation Services — Air Traffic Management *(PANS-ATM, Doc 4444), and the SSR Mode S message format is specified in Annex 10 —* Aeronautical Telecommunications, *Volume III —* Communications Systems, *Part I —* Digital Data Communication Systems*. The template for the ADS message is in Appendix 11 to this manual*.

7.5.4 When air-ground data link is used and ADS and SSR Mode S are not being applied, the elements contained in routine air-reports are as follows:

Message type designator

Section 1 (Position information)
- Aircraft identification
- Position or latitude and longitude
- Time
- Flight level or altitude
- Next position and time over
- Ensuing significant point

Section 2 (Operational information)
- Estimated time of arrival
- Endurance

Section 3 (Meteorological information)
- Air temperature
- Wind direction
- Wind speed
- Turbulence
- Aircraft icing
- Humidity (if available)

Note.— The controller-pilot data link communications (CPDLC) application entitled "Position report" may be used for these air-reports. The details of this data link application are specified in the Manual of Air Traffic Services Data Link Applications *(Doc 9694) and Annex 10, Volume III, Part I*.

7.5.5 The meteorological content of routine reports using air-ground data link is summarized in Table 7-3.

7.5.6 When air-ground data link is used, the elements contained in special air-reports are as follows:

Message designator
Aircraft identification

Data block 1
- Latitude
- Longitude
- Level
- Time

Data block 2
- Wind direction
- Wind speed
- Wind quality flag
- Temperature
- Turbulence (if available)
- Humidity (if available)

Data block 3
- Condition prompting the issuance of a special air-report (one condition to be selected from the list in 7.4.1)

Note 1.— The data link flight information service (D-FIS) application entitled "Special air-report service" may be used for these air-reports. The details of this data link application are specified in Doc 9694 and Annex 10, Volume III, Part I.

Note 2.— In the case of the transmission of a special air-report of pre-eruption volcanic activity, a volcanic eruption or volcanic ash cloud, there are additional requirements (see 7.8).

Note 3.— The template for special air-reports (downlink) is given in Annex 3, Appendix 4, Table A4-1.

Table 7-3. Meteorological content of routine air-reports transmitted via air-ground data link
(All the reports include information on the position of the aircraft in four dimensions.)

ADS and SSR Mode S not being applied	*ADS or SSR Mode S being applied*
Air temperature	Wind direction
Wind direction	Wind speed
Wind speed	Wind quality flag
Turbulence	Air temperature
Aircraft icing	Turbulence (if available)
Humidity (if available)	Humidity (if available)

7.6 CRITERIA FOR REPORTING METEOROLOGICAL AND RELATED PARAMETERS IN AUTOMATED AIR-REPORTS

When air-ground data link is used, the wind direction and speed, wind quality flag, air temperature, turbulence and humidity, to be included in automated air-reports, are reported in accordance with the criteria shown in Annex 3, Appendix 4, Section 2.

7.7 EXCHANGE OF AIR-REPORTS

7.7.1 Basic principles

Air traffic services and meteorological authorities must establish appropriate arrangements to ensure that routine and special air-reports reported to ATS units by aircraft in flight are transmitted without delay to the world area forecast centres (WAFCs) and to the associated MWO.

7.7.2 Additional exchange of special air-reports beyond MWOs

Special air-reports are not normally exchanged regionally beyond the MWO. However, further dissemination is required in the following circumstances:

— When a special air-report is received but the forecaster considers that the phenomenon causing the report is not expected to persist and, therefore, does not warrant issuance of a SIGMET, the special air-report should nevertheless be disseminated in the same way that SIGMET messages are disseminated, i.e. to MWOs and other meteorological offices in accordance with RAN agreement;

— Special air-reports of pre-eruption volcanic activity, volcanic eruption or volcanic ash cloud are to be transmitted to the VAACs.

7.7.3 Additional exchange of air-reports beyond WAFCs

Air-reports exchanged beyond WAFCs are considered as basic meteorological data and therefore their further dissemination is subject to WMO provisions. An example of a dissemination pattern of air-reports is shown in Table 7-4.

Table 7-4. Dissemination pattern of air-reports

("→" indicates the centre(s)/office(s) to which the air-report received is to be transmitted)

		Type of air-report received at the ATS unit		
		Routine by air-ground data link	*Special by air-ground data link*	*Special by voice communications*
Dissemination	*Initially by ATS unit*	→ WAFCs → MWO	→ MWO → WAFCs	→ MWO
	Subsequently by MWO		→ VAACs[1]	→ WAFCs → VAACs[1] → MET offices[2] → MWOs[2]

1. Only special air-reports of pre-eruption volcanic activity, volcanic eruption or volcanic ash cloud.
2. To be disseminated in the same way as SIGMET messages (i.e. to MWOs and other MET offices in accordance with RAN agreement) **only if** the special air-report does not warrant issuance of a SIGMET.

7.8 RECORDING AND POST-FLIGHT REPORTING OF AIRCRAFT OBSERVATIONS OF VOLCANIC ACTIVITY

Special aircraft observations of pre-eruption volcanic activity, volcanic eruption or volcanic ash cloud are the only type of air-report that requires a post-flight report, which should be recorded using the *special air-report of volcanic activity form* (MODEL VAR). A copy of the form is shown in Appendix 1 to the PANS-ATM (Doc 4444). It is to be included with the flight documentation provided to flight crews operating on routes which could be affected by volcanic ash clouds. The completed form is to be handed in by the flight crew to the meteorological office and, if available, airline representative at the next point of landing.

7.9 DETAILED INSTRUCTIONS CONCERNING THE CONTENT OF SPECIAL AIR-REPORTS RECEIVED BY VOICE COMMUNICATIONS BY MWOs

The following paragraphs provide details on the content of special air-reports received by voice communications (see also Example 7-1). It is essential that special air-reports be compiled by the ATS units and retransmitted by the MWO concerned in the correct order and format to permit their use in meteorological and other computers. Of special importance is the application of the indicator "ARS" for a special air-report.

Note.— MWOs do not need to retransmit operational information concerning "next position and time over", "estimated time of arrival" or "endurance".

Example 7-1. SPECIAL AIREP messages as recorded on the ground by the MWO concerned

SPECIAL AIREP message

ARS VA812 2020N07005W 1215 F180 MTW SEV

Meaning:

Special air-report from VIASA* flight number 812. Report refers to position 20 degrees 20 minutes north and 70 degrees 5 minutes west at 1215 UTC, at flight level 180. Severe mountain wave has been encountered.

* Fictitious operator

7.9.1 Message type designator
(ARS)

A message type designator "ARS" is required.

Note.— Where air-reports are handled by automatic data processing equipment that cannot accept this message type designator, the use of a different message type designator is permitted by RAN agreement, provided that:

a) the data transmitted is in accordance with that specified in the special air-report format; and

b) measures are taken to ensure that special air-report messages are forwarded to the appropriate meteorological unit and to other aircraft likely to be affected.

7.9.2 Aircraft identification
(VA812)

Aircraft identification consists of either the operator's designator and aircraft registration, or flight number (VA812) reported as one unit without any spaces or hyphens.

7.9.3 Position

(2020N07005W)

Position is given in degrees latitude and longitude in whole degrees (two figures for latitude, followed without a space by N or S, three figures for longitude, followed without a space by E or W); degrees and minutes may also be used (four figures for latitude and five for longitude). If a coded indicator (two to five characters) for a significant point (e.g. LN, MAY, HADDY), or a significant point followed by the magnetic bearing (degrees in three figures) and distance (three figures and KM or NM) of that point (e.g. DUB180040NM) has been used in the message received, the MWO concerned should convert this information into a position expressed as latitude and longitude.

7.9.4 Time

(1215)

The time of aircraft, at the position indicated, is shown in hours and minutes UTC (4 figures).

7.9.5 Flight level or altitude

(F180)

The flight level is shown by an "F" followed by the actual level; the altitude is shown by an "F" followed by 3 figures and "M" or "FT", as appropriate. This is followed by "ASC" (level) or "DES" (level) when ascending or descending to a new level.

7.9.6 Phenomenon prompting a special air-report

(MTW SEV)

The phenomenon is reported as follows:

— severe turbulence as "TURB SEV"
— moderate turbulence as "TURB MOD"
— severe icing as "ICE SEV"
— moderate icing as "ICE MOD"
— severe mountain wave as "MTW SEV"
— thunderstorm without hail[1] as "TS"
— thunderstorm with hail[1] as "TSGR"
— heavy duststorm or sandstorm as "HVY SS"
— volcanic ash cloud as "VA CLD"
— pre-eruption volcanic activity or a volcanic eruption as "VA"

Note.— Detailed instructions for producing and transmitting air-reports, together with examples of air-reports, are contained in the PANS-ATM (Doc 4444), Appendix 1.

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1. The thunderstorms to be reported should be confined to those which are:
   - obscured in haze; or
   - embedded in cloud; or
   - widespread; or
   - forming a squall line.

Chapter 8

AERONAUTICAL CLIMATOLOGICAL INFORMATION

8.1 Aerodrome climatological information is primarily required by operators to assist them in their planning for flight operations particularly for pre-operational route planning. The information required is prepared in the form of aerodrome climatological tables and summaries.

8.2 Meteorological authorities should make arrangements for collecting and retaining the necessary observational data and have the capability to prepare climatological tables and summaries for each international aerodrome within their territory. The content of aerodrome climatological tables and summaries is given in Annex 3, Appendix 7. The format of aerodrome climatological tables and summaries is given in WMO Publication No. 49, *Technical Regulations*, Volume II — *Meteorological Service for International Air Navigation*.

8.3 Aerodrome climatological tables and summaries are exchanged on request between meteorological authorities as necessary. Operators and other aeronautical users requiring such information should contact the meteorological authority concerned.

Chapter 9

RELEVANT DOCUMENTS

9.1 ICAO DOCUMENTS OF A SPECIFICALLY METEOROLOGICAL NATURE

The following ICAO documents give additional or more detailed information on meteorological subjects that may be found useful.

Annex 3 — *Meteorological Service for International Air Navigation*
(International Standards and Recommended Practices)

This Annex contains international regulatory material covering principles and objectives, Standards and Recommended Practices (SARPs) and guidance material which have worldwide applicability. It establishes the specific responsibilities of States for providing meteorological services and the responsibility of operators using these services. The Annex is divided into two parts: Part I contains the core SARPs which are of primary interest to management level personnel, and Part II contains technical requirements and specifications of primary interest to operational personnel. The attachments (green pages) comprise material supplementary to the SARPs or included as a guide to their application.

***Regional Supplementary Procedures* (Doc 7030)**

Regional supplementary procedures (SUPPS) are approved by the Council of ICAO for application in the respective regions. Currently, the document contains specific procedures for the regional application of Annex 3, Chapter 5 (Aircraft Observations and Reports) as well as various specific regional procedures related to communications, air traffic services, etc.

Air Navigation Plans (ANPs)/Facilities and Services Implementation Documents (FASIDs)

These documents detail the requirements for facilities and services (including meteorology) in the various ICAO regions. Each ANP includes a section dealing with meteorology, both in the volume containing the basic regional ANP and in the volume containing the FASID. The former part introduces basic planning principles, operational requirements and planning criteria relating to the meteorological service to be provided to international air navigation in the ICAO region concerned. These principles, requirements and criteria stem from relevant provisions of Annex 3 and, in particular, those calling for RAN agreement. This level of service is to be considered as the minimum for planning of meteorological facilities and/or services by States in the region. A detailed description and the list of the meteorological facilities and services to be provided by States in order to fulfill the requirements of the Basic ANP are contained in the FASID. The meteorology parts of the Basic ANP and the FASID cover, as necessary, all or some of the following topics: meteorological service required at aerodromes, MWOs, meteorological observations and reports, and reports, forecasts, regional aspects of the world area forecast system (WAFS), regional aspects of the International Airways Volcano Watch (IAVW) and the International Tropical Cyclone Watch (ITCW). Current ANPs include:

Africa-Indian Ocean Region (Doc 7474)
  Volume I — *Basic ANP*
  Volume II — *FASID*

Asia and Pacific Regions (Doc 9673)
Volume I — Basic ANP
Volume II — FASID

Caribbean and South American Regions (Doc 8733)
Volume I — *Basic ANP*
Volume II — *FASID*

European Region (Doc 7754)
Volume I — *Basic ANP*
Volume II — *FASID*

Middle East Region (Doc 9708)

North Atlantic, North American and Pacific Regions (Doc 8755) (out of date)

North Atlantic Region (Doc 9634)

Facilities and Services Implementation Document (FASID) — North Atlantic Region (Doc 9635)

Manuals

In addition to this manual, the following manuals provide detailed guidance or information on specific aspects connected with meteorological services to international air navigation:

Doc 7488	*Manual of the ICAO Standard Atmosphere (extended to 80 kilometres (262 500 ft))*
Doc 9328	*Manual of Runway Visual Range Observing and Reporting Practices*
Doc 9377	*Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services*
Doc 9691	*Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds*
Doc 9817	*Manual on Low-level Wind Shear*
Doc 9837	*Manual on Automatic Meteorological Observing Systems at Aerodromes*
Doc 9873	*Manual on the Quality Management System for the Provision of Meteorological Service for International Air Navigation* (published jointly with WMO)

Regional guides

Most ICAO regional offices prepare and make available regional guides on various subjects including: regional SIGMET guides; the ROBEX system; the AMBEX system; catalogue of information available in international OPMET databanks etc. For details, regional offices should be approached directly.

IAVW documents

Handbook on the International Airways Volcano Watch (IAVW) — Operational Procedures and Contact List (Doc 9766) (only available at http://www.icao.int/anb/iavwopsg).

9.2 OTHER ICAO DOCUMENTS

In addition to the above-mentioned documents dealing with aeronautical meteorological subjects, meteorological offices serving international civil aviation may also require other ICAO documents. A list of these is given below divided into two parts:

Part 1 — ICAO publications required at both the administrative and the operational levels of meteorological services.

Part 2 — ICAO publications required mainly at the administrative level of meteorological services.

PART 1 — ICAO publications required at the administrative and operational levels of meteorological services

Annex 5 — *Units of Measurement to be Used in Air and Ground Operations*

Doc 4444 — *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM)

Doc 7910 — *Location Indicators*

Doc 8400 — *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC)

Doc 8585 — *Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services*

Doc 9713 — *International Civil Aviation Vocabulary*, Volumes I and II

PART 2 — ICAO publications required mainly at the administrative level of meteorological services

Annex 2 — *Rules of the Air*

Annex 4 — *Aeronautical Charts*

Annex 6 — *Operation of Aircraft*
- Part I — *International Commercial Air Transport— Aeroplanes*
- Part II — *International General Aviation — Aeroplanes*
- Part III — *International Operations — Helicopters*

Annex 8 — *Airworthiness of Aircraft*

Annex 10 — *Aeronautical Telecommunications*
- Volume I — *Radio Navigation Aids*
- Volume II — *Communication Procedures including those with PANS status*
- Volume III — *Communications Systems* (Part I — *Digital Data Communication Systems;* Part II — *Voice Communication Systems)*
- Volume IV — *Surveillance and Collision Avoidance Systems*
- Volume V — *Aeronautical Radio Frequency Spectrum Utilization*

Annex 11 — *Air Traffic Services*

Annex 12 — *Search and Rescue*

Annex 13 — *Aircraft Accident and Incident Investigation*

Annex 14	*Aerodromes* Volume I — *Aerodrome Design and Operations* Volume II — *Heliports*
Annex 15	*Aeronautical Information Services*
Doc 6920	*Manual of Aircraft Accident Investigation*
Doc 7100	*Tariffs for Airports and Air Navigation Services*
Doc 7475	*Working Arrangements between the International Civil Aviation Organization and the World Meteorological Organization*
Doc 8126	*Aeronautical Information Services Manual*
Doc 8168	*Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS) Volume I — *Flight Procedures* Volume II — *Construction of Visual and Instrument Flight Procedures*
Doc 8259	*Manual on the Planning and Engineering of the Aeronautical Fixed Telecommunication Network*
Doc 9082	*ICAO's Policies on Charges for Airports and Air Navigation Services*
Doc 9137	*Airport Services Manual* Part 1 — *Rescue and Fire Fighting* Part 2 — *Pavement Surface Conditions* Part 3 — *Bird Control and Reduction* Part 5 — *Removal of Disabled Aircraft* Part 6 — *Control of Obstacles* Part 7 — *Airport Emergency Planning* Part 8 — *Airport Operational Services* Part 9 — *Airport Maintenance Practices*
Doc 9150	*Stolport Manual*
Doc 9157	*Aerodrome Design Manual* Part 1 — *Runways* Part 2 — *Taxiways, Aprons and Holding Bays* Part 3 — *Pavements* Part 4 — *Visual Aids* Part 5 — *Electrical Systems* Part 6 — *Frangibility*
Doc 9161	*Manual on Air Navigation Services Economics*
Doc 9184	*Airport Planning Manual* Part 1 — *Master Planning* Part 2 — *Land Use and Environmental Control* Part 3 — *Guidelines for Consultant/Construction Services*
Doc 9261	*Heliport Manual*
Doc 9683	*Human Factors Training Manual*

Doc 9731 *International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual*

Catalogue of ICAO Publications

9.3 WMO DOCUMENTS

Apart from issuing documents of a general meteorological character, WMO also publishes documents which deal with aeronautical meteorology. The following documents are relevant:

WMO Technical Regulations**,** Volume II (WMO-No. 49) (equivalent in status to ICAO Standards and Recommended Practices and Procedures for Air Navigation Services).

Part C.3.1 — *Standards and Recommended Practices*: identical, except for a few minor editorial differences, to Annex 3.

Part C.3.2 — *Aeronautical Climatology*: enlarges on Annex 3, Chapter 8, and gives model forms for aerodrome climatological summaries.

Part C.3.3 — *Format and Preparation of Flight Documentation*: enlarges on Annex 3, Chapter 9, and gives model charts and forms.

Manuals (these often have a higher status than ICAO manuals)

Manual on Codes (WMO-No. 306): contains details of all meteorological codes, including those relevant to aviation.

Manual on the Global Telecommunication System (WMO-No. 386): contains practices and procedures to be used in the collection, exchange and distribution of observational and processed information on a worldwide scale.

Manual on the Global Data-processing and Forecasting System (WMO-No. 485): contains practices and procedures to be used in the processing, storage and retrieval of meteorological information. The manual, among others, includes regulations relating to the provision of service by WMO RSMCs in response to a nuclear emergency.

Manual on the Global Observing System (WMO-No. 544): contains practices and procedures for methods, techniques and facilities to be used for making observations on a worldwide scale.

Guides

Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8): outlines basic standards of instrument and observing practices.

Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology (WMO-No. 258), Volume I — *Meteorology*.

Guide on the Global Data-processing System (WMO-No. 305).

Guide on the Global Observing System (WMO-No. 488).

Guide on Meteorological Observation and Information Distribution Systems for Aviation Weather Services (WMO-No. 731).

Guide to Practices for Meteorological Offices Serving Aviation (WMO-No. 732).

Appendix 1

INFORMATION ON THE WORLD AREA FORECAST SYSTEM (WAFS)

(See Chapter 1, 1.5)

1. GENERAL DESCRIPTION

1.1 The world area forecast system (WAFS) brings to meteorological forecasting the concept of centralization, in designated centres, of forecasting activities for the pre-flight planning and en-route phases of flights. Its general aspects were initially developed by the Communications/Meteorology Divisional Meeting (1982), held conjointly with the Seventh Session of the World Meteorological Organization (WMO) Commission for Aeronautical Meteorology. A major review and development of the WAFS was conducted most recently at the Meteorology Divisional Meeting (2002) held conjointly with the Twelfth Session of the WMO Commission for Aeronautical Meteorology.

1.2 The objective of the system is to provide meteorological authorities and other users (e.g. pilots and airline operators) with global aeronautical meteorological en-route forecasts in digital form. This objective is achieved through a comprehensive, integrated, worldwide, uniform and cost-effective system which takes full advantage of evolving technologies. Currently, two world area forecast centres (WAFCs), i.e. WAFC London and WAFC Washington, issue global upper-air forecasts in the GRIB code form and medium- and high-level SIGWX forecasts in the BUFR code form.

1.3 WAFS forecasts are disseminated on three satellite broadcasts (i.e. the aeronautical fixed service (AFS) satellite distribution systems) implemented by the two WAFC provider States (United Kingdom and United States). They provide for global coverage by means of three International Telecommunications Satellite Organization (INTELSAT) satellites as follows:

a) International Satellite Communications System 1 (ISCS1) from WAFC Washington covering the CAR, NAM, NAT and SAM Regions (INTELSAT-903);

b) International Satellite Communications System 2 (ISCS2) from WAFC Washington covering the ASIA (eastern part) and PAC Regions (INTELSAT-701); and

c) Satellite Distribution System for Information relating to Air Navigation (SADIS) from WAFC London covering the AFI, ASIA (western part), EUR and MID Regions (INTELSAT-904).

Diagrams of the coverage of these satellites can be found at the following website: http://www.intelsat.com/flash/coverage-maps/covmaphome.htm

Note.— The 0° elevation angle contour is the theoretical extent of coverage, while the 5° elevation angle is considered to be the practical extent of coverage according to nominal design criteria.

In order to make maximum use of the available satellite broadcast bandwidth, a global set of alphanumeric OPMET information is disseminated through the satellite distribution systems in addition to WAFS forecasts. The data are received by States and users through very small aperture terminals (VSAT) or through the FTP-service.

1.4 The information broadcast is not encrypted; however, a mechanism exists to allow the control management centre of the service provider, on advice from the provider State, to control which VSAT receives the information broadcast.

1.5 The WAFS is expected to develop to ensure that it continues to meet evolving aeronautical requirements in a cost-effective manner. Its development is guided by the multi-regional World Area Forecast System Operations Group (WAFSOPSG).

2. GUIDELINES FOR AUTHORIZED ACCESS TO THE WAFS SATELLITE BROADCAST

The guidelines reproduced below were developed by ICAO to assist States in arranging for access to the WAFS satellite broadcast.

1. General

1.1 The satellite broadcast constitutes a sub-system of the ICAO aeronautical fixed service (AFS) providing an international point-to-multipoint telecommunication service via satellite for the dissemination of aeronautical information to States.

1.2 The aeronautical information disseminated by the satellite broadcast includes primarily operational meteorological (OPMET) information consisting of the WAFS upper wind and temperature and significant weather forecasts in digital grid-point and graphical formats and alphanumeric messages.

1.3 Through the use of the satellite broadcast, States may wish to meet their obligation under Article 28 of the Convention on International Civil Aviation regarding the supply to users of meteorological information for the provision of meteorological service for international air navigation.

1.4 Recovery by States of associated costs through charges on international civil aviation should be based on the principles contained in Article 15 of the *Convention on International Civil Aviation* and *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082).

2. Authorized access to the satellite broadcast

2.1 It is the prerogative of each State to determine the distribution of the OPMET information to users, in the State concerned, as well as means, links and information flow to be used for this purpose. In view of this, it is for each State to determine the users in the State concerned to be provided with the authorized access to the satellite broadcast.

2.2 Where the meteorological service for international air navigation is provided by or through arrangements made by the meteorological authority in compliance with the Standard contained in Annex 3 — *Meteorological Service for International Air Navigation* to the Convention on International Civil Aviation, Chapter 2, 2.1.4, the meteorological authorities, world area forecast centres, and aerodrome and other meteorological offices should fully enjoy the benefits of the satellite broadcast to receive the OPMET information broadcast. Furthermore, it is at the discretion of each State to determine, on advice from its meteorological authority, whether any of the following users will be provided with authorized access to the satellite broadcast: operators; air traffic services units; search and rescue services units; aeronautical information services units; volcanic ash and tropical cyclone advisory centres; and other aeronautical users.

2.3 Each State will notify ICAO and, for the purpose of efficiency, also the provider State for the satellite broadcast concerned, regarding the users in that State it has authorized to access the satellite broadcast.

Note.— Where the satellite broadcast also comprises a sub-system of the World Meteorological Organization Global Telecommunication System (WMO GTS), in accordance with the action by Council on Recommendation 4.2/5 — Relationship of satellite communication system to the WMO's GTS, of the Communications/Meteorology Divisional Meeting (1982), the WMO Member State concerned determines the users authorized to receive basic synoptic data and analyses via the satellite broadcast and notifies ICAO through WMO, accordingly.

3. DUTIES OF METEOROLOGICAL OFFICES IN THE CONTEXT OF THE WAFS

It should be noted that while the WAFS provides en-route weather forecasts, the preparation of meteorological observations and aerodrome forecasts remains the responsibility of individual meteorological offices. With the global implementation of the WAFS, they can now dedicate much more of their resources to these essential tasks.

Appendix 2

LOCATION OF INSTRUMENTS AT AERODROMES

(See 2.1.4)

1. GENERAL

1.1 The proper location of meteorological instruments, or of the sensors connected with the instruments,[1] presents many more difficulties at aerodromes than at synoptic meteorological stations. While in both cases the purpose of the instruments is to obtain as accurate information as possible on certain meteorological parameters, at the synoptic meteorological stations the only requirement in respect of location is adequate instrument exposure. At aerodromes, there is a range of requirements and conditions in addition to adequate instrument exposure which the instrument location must satisfy, and in particular these include the following:

a) a representative measurement for the aerodrome as a whole, and for take-off and landing operations in particular;

b) compliance with obstacle restriction provisions;

c) location, in certain operational areas, requiring frangibility of instrument support construction; and

d) suitability of location in respect of terrain conditions, power supply and communication facilities.

1.2 This appendix deals with the location of the main types of meteorological instruments and instrument systems in use at aerodromes, i.e. those for the measurement of surface wind, runway visual range (RVR), height of cloud base, temperature and pressure. The information is relatively general because aerodromes vary greatly in respect of the types of operations for which they are used, and the types of terrain, aspects which may considerably affect the location of instruments.

2. THE AERODROME ENVIRONMENT

2.1 Before dealing with the location of instruments at aerodromes, there is a need for a brief description of the aerodrome environment in general. It is an environment of great complexity and size, covering at times large areas with runways attaining lengths of 4 km. The runway complex may be near built-up areas with public, administrative or technical functions. (Figure A2-1 gives a schematic representation of an aerodrome and its most important features.)

2.2 The difficulties that such a large and complex area as an aerodrome can create for the provision of timely and representative meteorological measurements are often considerable:

a) the size of the runway complex, which frequently cannot be adequately covered by a single instrument or sensor;

6. 1. The term “instrument” is often used to identify both an instrument and a sensor.

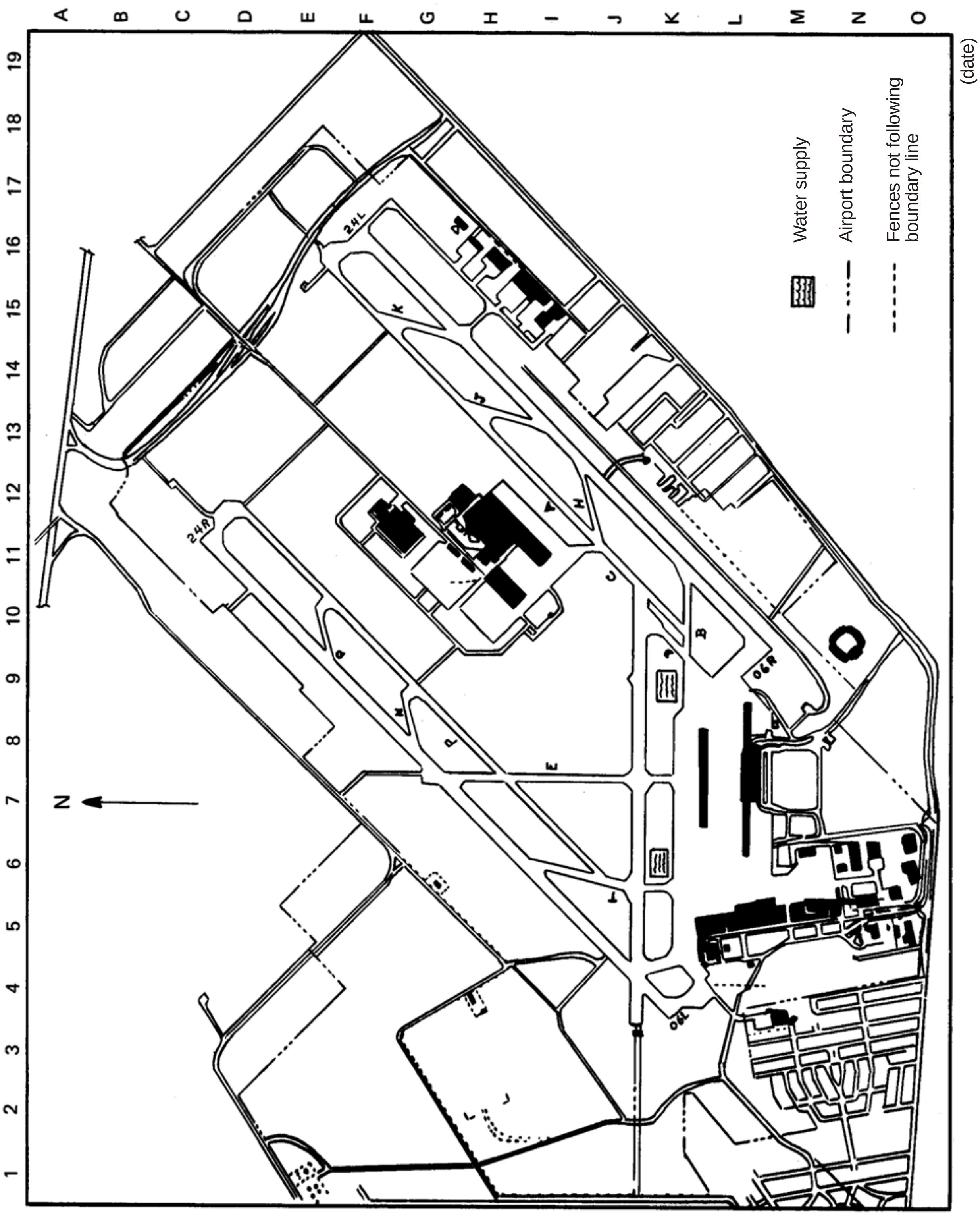


Figure A2-1. Schematic representation of an aerodrome and its most important features

b) difficulty of access to certain parts of the aerodrome, which may prevent the location of instruments at the most suitable sites or access for maintenance purposes;

c) the obstacle restriction regulations, which may have similar effects;

d) the size of buildings or of other constructions (towers, masts, etc.) which may prevent adequate instrument exposure;

e) the effects of aircraft movement and exhausts (particularly during taxiing and turning operations), and of large car parks and their associated emissions.

2.3 To overcome these difficulties, the meteorological authority must maintain close contact with the authority responsible for the aerodrome and its master plan. This involves daily contact, as well as long-range planning, because the setting up of instrument sites and the laying of cables and other connected activities must not interfere with other aerodrome systems, disturb the normal functioning of the aerodrome or become unduly expensive. Close cooperation with operators whose requirements often determine instrument location is also necessary. Finally, the local air traffic services (ATS) authority is also concerned with these difficulties as its units often use duplicate indicators and may have requirements of its own for the location of the relevant sensors.

2.4 In addition to close cooperation with aerodrome and ATS authorities and with operators, the effective determination of the most appropriate location of instruments requires a detailed on-site analysis by a meteorologist. The analysis could involve field trials, particularly in circumstances where the topography and/or prevailing weather are complex, while in more straightforward cases a simple on-site inspection may be sufficient. In the case of new aerodromes, it is usual to establish an observing station, or at least a minimum set of instruments, before the aerodrome is built in order to obtain information on meteorological conditions likely to affect operations at the aerodrome.

3. OBSTACLE RESTRICTIONS

3.1 In the choice of sites for instruments at aerodromes, account must be taken first and foremost of obstacle restrictions at the aerodrome. The meteorological instruments that are listed as objects which may constitute "obstacles" are anemometers, ceilometers and transmissometers/forward-scatter meters (for details see the *Airport Services Manual* (Doc 9137), Part 6 — *Control of Obstacles*, Chapter 5). Specifications governing the restriction of obstacles at aerodromes are given in Annex 14, Volume I, Chapters 4 and 9. The objective of these specifications is to define the airspace at the aerodromes so as to ensure that it is free from obstacles thereby permitting the intended aeroplane operations to be conducted safely. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

3.2 Aerodromes intended for use by international civil aviation are classified according to a reference code. This code provides a simple method for interrelating the numerous specifications concerning the characteristics of aerodromes, so as to provide a series of aerodrome facilities that are suitable for the aeroplanes that are intended to operate at the aerodrome. The code is composed of two elements as shown in Table A2-1; the first element is numerical (1 to 4) and is related to aeroplane performance, the second is a letter (A to F) related to aircraft dimensions. The width of the runways, the runway strips and the slope of the obstacle limitation surfaces, etc., vary according to the aerodrome reference code.

3.3 The more important obstacle limitation surfaces, from the standpoint of the siting of meteorological instruments, are the transitional surfaces which limit obstacle height along the side of the runway. The recommended runway width, strip width and slope of the transitional surfaces are given in Table A2-2, which is derived from provisions given in Annex 14, Volume I. It may be seen that all runways should be protected by a transitional surface that begins at the edge of the runway strip and slopes upwards and outwards away from the runway. The width of the strip and the slope of the transitional surface depend on the runway reference code number. A precision approach runway is protected by a second “inner” transitional surface and the airspace over the runway between the two inner surfaces is referred to as the obstacle free zone (OFZ). Once the reference code number for a particular runway is known, on the basis of Table A2-1, it is possible to obtain the recommended minimum dimensions and slopes of the associated strip and transitional surfaces from Table A2-2.

3.4 A cross-section of the transitional surfaces recommended for a precision approach runway of reference code number 3 or 4 is shown in Figure A2-2. The positions closest to the runway at which various meteorological instruments may be located without infringing the transitional surfaces are also indicated in Figure A2-2. Unless there are exceptional local circumstances, no meteorological instruments should infringe the OFZ. Where this is unavoidable, in order to ensure representative observations, the sensor support must be frangible, lighted and preferably shielded by an existing essential navigation aid. The principle of “shielding” in relation to obstacles is dealt with in Doc 9137, Part 6, Chapter 2. The most important provisions governing the siting of meteorological instruments are summarized in Table A2-3.

3.5 In addition to taking account of the distance from runway centre lines, in siting meteorological instruments, care must always be exercised to ensure that the instruments do not present an obstacle to aircraft using taxiways.

Table A2-1. Aerodrome reference code
(extract from Annex 14, Volume I)

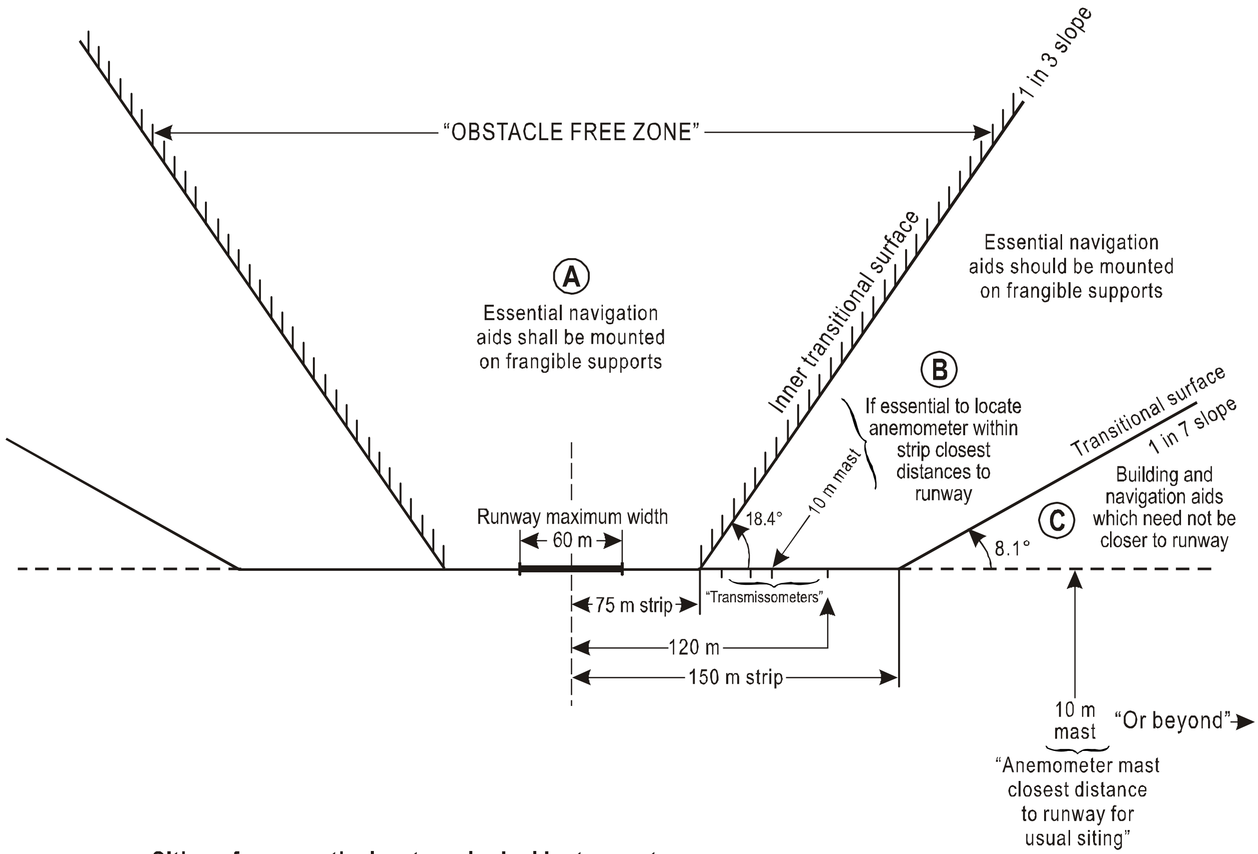
Code element 1		Code element 2		
Code number (1)	Aeroplane reference field length (2)	Code letter (3)	Wingspan (4)	Outer main gear wheel span[a] (5)
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1 200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1 200 m up to but not including 1 800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1 800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

a. Distance between the outside edges of the main gear wheels.

Table A2-2. Dimensions and slopes of obstacle limitation surfaces — approach runways
(extract from Annex 14, Volume I)

	RUNWAY CLASSIFICATION									
								Precision approach category		
	Non-instrument Code number				Non-precision approach Code number			I Code number		II or III Code number
Surface and dimensions[a]	1	2	3	4	1,2	3	4	1,2	3,4	3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	60 m	60 m	60 m
Length	—	—	—	—	—	—	—	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	150 m	300 m	300 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m[b]	3 600 mb	12 000 m	3 600 m[b]	3 600 m[b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m[b]	8 400 m[b]	—	8 400 m[b]	8 400 m[b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	—	—	—	—	—	—	—	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	c	1 800 m[d]	1 800 m[d]
Divergence (each side)	—	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	—	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Distance to the end of strip.
d. Or end of runway whichever is less.
e. Where the code letter is F (Column (3) of Table A2-1), the width is increased to 155 m. For information on code letter F aeroplanes equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre, see Circular 301 — *New Larger Aeroplanes — Infringement of the Obstacle Free Zone: Operational Measures and Aeronautical Study*.



Siting of aeronautical meteorological instrument sensors

Ⓐ "OBSTACLE FREE ZONE" — Generally speaking no MET sensors should infringe this region unless exceptional local circumstances so dictate. In the latter case sensor supports must be frangible, lighted and if possible sensor should be "shielded" by an existing obstacle.

Ⓑ 1) Transmissometer sited between 66 m and 120 m from runway centre line 2) Ceilometer may be sited in this region if not located near middle marker 3) If essential to locate within strip, anemometer height 10 m minimum distance from centre line = 90 m.

Ⓒ Usual location of anemometer masts minimum distance from runway centre line for 6 m mast is = 192 m and for a 10 m mast = 220 m, assuming surface wind observations made in this region are representative of conditions over runway.

(Cross section of typical precision approach runway reference number 3 or 4)

Note.— Slope angles not drawn to scale.

Figure A2-2. Obstacle limitation surfaces

Table A2-3. Location of meteorological instruments at aerodromes

(Minimum distances from runways are illustrated in Figure A2-2.)

Meteorological element observed or measured	*Typical equipment*	*Typical dimensions of equipment*	*Operational area for which element is to be representative*	*Siting provision in Annex 3*	*Remarks*
Surface wind speed and direction	Anemometer and wind vane	Usually mounted on tubular or lattice mast 10 m (30 ft) high. Single tube mast for both instruments appropriate in proximity to runways.	Conditions along the runway and touchdown zone in local routine and special reports; conditions above the whole runway (complex) in METAR and SPECI. Where prevailing wind varies significantly at different sections of the runway, multiple anemometers are recommended.	No specific provisions so long as observations are representative of relevant operational areas.	Siting will be governed by obstacle limitation surfaces and local prevailing surface wind regime. Generally speaking, if the wind field over the aerodrome is homogeneous, one strategically sited anemometer may suffice, preferably sited so as not to infringe transitional surfaces. However, depending on local conditions, it may be necessary to locate a frangible and lighted mast within the runway strip. Only in exceptional circumstances should the mast infringe the OFZ (i.e. inner transitional surface) for precision approach runways. In the latter case, the mast must be frangible, lighted and preferably shielded by an existing essential navigation aid. The site must not be affected by buildings, etc., or by aircraft operations (e.g. jet efflux during taxiing).
RVR	Transmissometer and/or forward-scatter meter	Usually two units, transmitter and receiver. In the case of transmissometer, they are separated over baseline (length of the order of 20 m depending on range of visibilities to be assessed). Height of units approximately 2.5 m (7.5 ft) above the runway. Solid foundation plinths required.	Up to three transmissometers or forward-scatter meters per runway (i.e. runways for which RVR is required), for touchdown zone, the mid-point and stop-end of the runway.	Not more than 120 m laterally from runway centre line. For touchdown zone, mid-point and stop-end, units should be 300 m, 1 000 m and 1 500 m along runway from threshold, respectively.	Should be sited within 120 m laterally from runway centre line but not infringing the OFZ (i.e. inner transitional surface) for precision approach runways. Should be frangible structure, e.g. tubular supports and shearing bolts at foundation.
Height of cloud base	Ceilometer	Usually less than 1.5 m (5 ft) high but rather solid structure including foundation plinth.	Generally representative of the approach area in local routine and special reports and of the aerodrome and its vicinity in METAR and SPECI.	At the middle marker site of the instrument landing system or at a distance of 900 to 1 200 m (3 000 to 4 000 ft) from the landing threshold.	May be located at the middle marker site or within the runway strip but preferably not infringing the OFZ (i.e. inner transitional surface) for precision approach runways.

4. ADEQUATE INSTRUMENT EXPOSURE

4.1 On the whole, requirements for instrument exposure at aerodromes are similar to those at other (e.g. synoptic) stations.[2] The main requirement is for the instrument or its sensor, be it an anemometer for surface wind measurement or a thermometer for temperature measurement, to be freely exposed to atmospheric conditions. This is sometimes difficult to achieve at aerodromes where circumstances may force the meteorological instruments to be in a location where it is difficult to obtain representative measurements. At times, a meteorological station and its instruments may start out at an unobstructed site, only to be gradually surrounded by masts or buildings.

4.2 In some cases, instruments may need to be protected against non-atmospheric influences, for example, from jet aircraft exhausts. This applies particularly to wind and temperature instruments, which should not be affected by exhausts from moving or parked aircraft but should be moved to more suitable sites.

4.3 The adequate exposure of wind sensors often presents the most crucial and difficult problem in respect of instrument location at aerodromes. Some details in this respect are given below under “Representative Measurements”.

4.4 As far as temperature and dew point measurements are concerned, exposure problems may occur at some aerodromes, particularly those with high temperatures and little wind. Experiments have shown that in those cases, temperatures measured over grass or in an area surrounded by vegetation may be considerably different from those experienced over the runway surface. Where those differences are found to exceed 1°C, arrangements need to be made to shift the site of the temperature measurement to one that is better exposed, or use distant reading thermometers. The latter solution is now employed at an increasing number of aerodromes.

5. REPRESENTATIVE MEASUREMENTS

5.1 The need for “representative” measurements arises largely because:

a) one usually cannot measure atmospheric parameters at exactly those places where they affect the aircraft, i.e. at or over the runway; and

b) even if one could, it would normally be impossible to carry out measurements on a sufficiently dense scale so as to obtain an accurate picture of atmospheric conditions over the whole runway or runway complex.

5.2 As a consequence, one is forced to adopt a sampling technique which, in turn, is made difficult by the inhomogeneity of the atmosphere over as large an area as that covered by an aerodrome, often made more complicated by terrain features or buildings. There is, therefore, a need for well thought-out and researched sampling techniques, tailored to the needs of and conditions at each individual aerodrome, which will provide measurements representing, within acceptable margins, conditions actually experienced in the area of interest. Experiments with surface wind measurements in a number of States unfortunately have shown that it is often not possible to state what “acceptable margins” are. They are not necessarily identical with “accuracy” requirements of measurements (see Annex 3, Attachment A) with which they are sometimes confused, although accuracy requirements can be used in the case of some parameters (for example, temperature (1°C, see 4.4)) as a first approximation.

5.3 As requirements for representative measurements depend to a considerable extent on types of aircraft and operations, close cooperation with operators will usually solve these problems. Frequently, it is the operators (i.e. pilots) who are the first to notice if measurements are not representative, and they should be encouraged to report such cases.

7. 2. Annex 3, Appendix 3, 1.2, recommends that meteorological instruments at aeronautical meteorological stations to be exposed, operated and maintained in accordance with the practices, procedures and specifications promulgated by WMO. Detailed guidance in this respect is found in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

5.4 While the question of representative measurements has a temporal as well as a spatial aspect, only the latter will be considered here, although the two are sometimes interconnected. For example, it has been shown that the degree of roughness of the terrain between the location of an anemometer and the runway may affect the optimum averaging period to be used for wind observations. Spatial representativeness has a vertical and a horizontal aspect, and the two will be considered separately in the following paragraphs. The vertical aspect is partly connected with the need to provide measurements of conditions at a level or levels above the runway surface of particular relevance to aircraft landing or taking off (e.g. height of jet intake); in addition, there is the need to avoid effects of the ground and of obstacles which may influence the height at which measurements are being taken. The horizontal aspects are those which determine the number and location of instruments so as to provide satisfactory information on meteorological conditions for all operations at the airport, irrespective of its size or terrain configuration.

5.5 Surface wind

5.5.1 The location of the sensor(s) in the vertical should be such as to provide wind information representative of conditions 10 m (30 ft) above the runway. To obtain information meeting this requirement it is essential that the sensor(s) be installed over open terrain which, in this context, is defined as terrain where any obstacles to the wind flow (buildings, trees, etc.) are at a distance corresponding to at least ten times the height of the obstruction. However, thin masts or masts of open (lattice) construction may be disregarded in such calculations.

5.5.2 The WMO *Guide to Meteorological Instruments and Methods of Observation* provides general guidance on what to do when normal, unobstructed exposure is not possible, including recommended use of the following formula for reduction of wind speed to a height of 10 m (30 ft), if the sensor (while still in the open) must be placed above that height:

$$V_h = V_{10} [0.233 + 0.656 \log_{10} (h + 4.75)]$$

In this (Hellman's) formula, V_h is the wind speed at height h metres, and V_{10} is the wind speed at 10 m (30 ft) above the ground.

5.5.3 As far as providing representative measurements of surface wind in the horizontal is concerned, the size, complexity of terrain and other features of aerodromes, and the different types of runway (non-precision, precision, etc.) and operations make this question particularly difficult. According to Annex 3, Chapter 4, 4.6.1, the portions of the aerodrome, runway or runway complex for which surface wind observations should be representative are as follows.

For local routine and special reports used for departing aircraft along the runway (but particularly the lift-off zone): see 5.5.4 of this appendix.

For local routine and special reports used for arriving aircraft: the touchdown zone.

For METAR and SPECI: the whole runway (if only one); the runway complex (if more than one runway).

5.5.4 With regard to the siting of wind sensors, Annex 3, Appendix 3, 4.1.1.2, stipulates that:

> "Representative surface wind observations should be obtained by the use of sensors appropriately sited. Sensors for surface wind observations for local routine and special reports should be sited to give the best practicable indication of conditions along the runway and touchdown zones. At aerodromes where topography or prevalent weather conditions cause significant differences in surface wind at various sections of the runway, additional sensors should be provided."

5.5.5 Information provided in States' aeronautical information publications (AIPs) shows that anemometers are generally installed in the centrefield or near the intersections of runways. At some aerodromes, anemometers are installed close to approach ends or thresholds of runways, while in a few others they are near midpoints of a runway. At an increasing number of aerodromes, multiple anemometers are provided. The case of Amsterdam/Schiphol (four sensors, one each near the threshold of a runway) is illustrated in Figure A2-3, which also provides a good example of how instrument location should be indicated on aerodrome charts.

5.5.6 The foregoing shows that it is not possible to give detailed guidance on where surface wind measurements at aerodromes should be carried out and how many sensors are needed for the purpose. Conditions and requirements vary from aerodrome to aerodrome and, in many cases, only trials and experiments over periods of time will provide answers for optimum and cost-effective installations (i.e. minimum numbers of sensors to provide the information required). It is in this connection that close cooperation with aerodrome authorities and operators will be particularly necessary.

5.6 RVR

5.6.1 The height corresponding to the average eye level of a pilot in an aircraft on the ground is approximately 5 m (15 ft). Since the runway lights are at or near ground level, this implies an average height of about 2.5 m (7.5 ft) for the light path to a pilot's eye which is the height at which RVR should be assessed.

5.6.2 Forward-scatter meters may be used in addition to transmissometers although for calibration purposes at least one transmissometer should be installed.

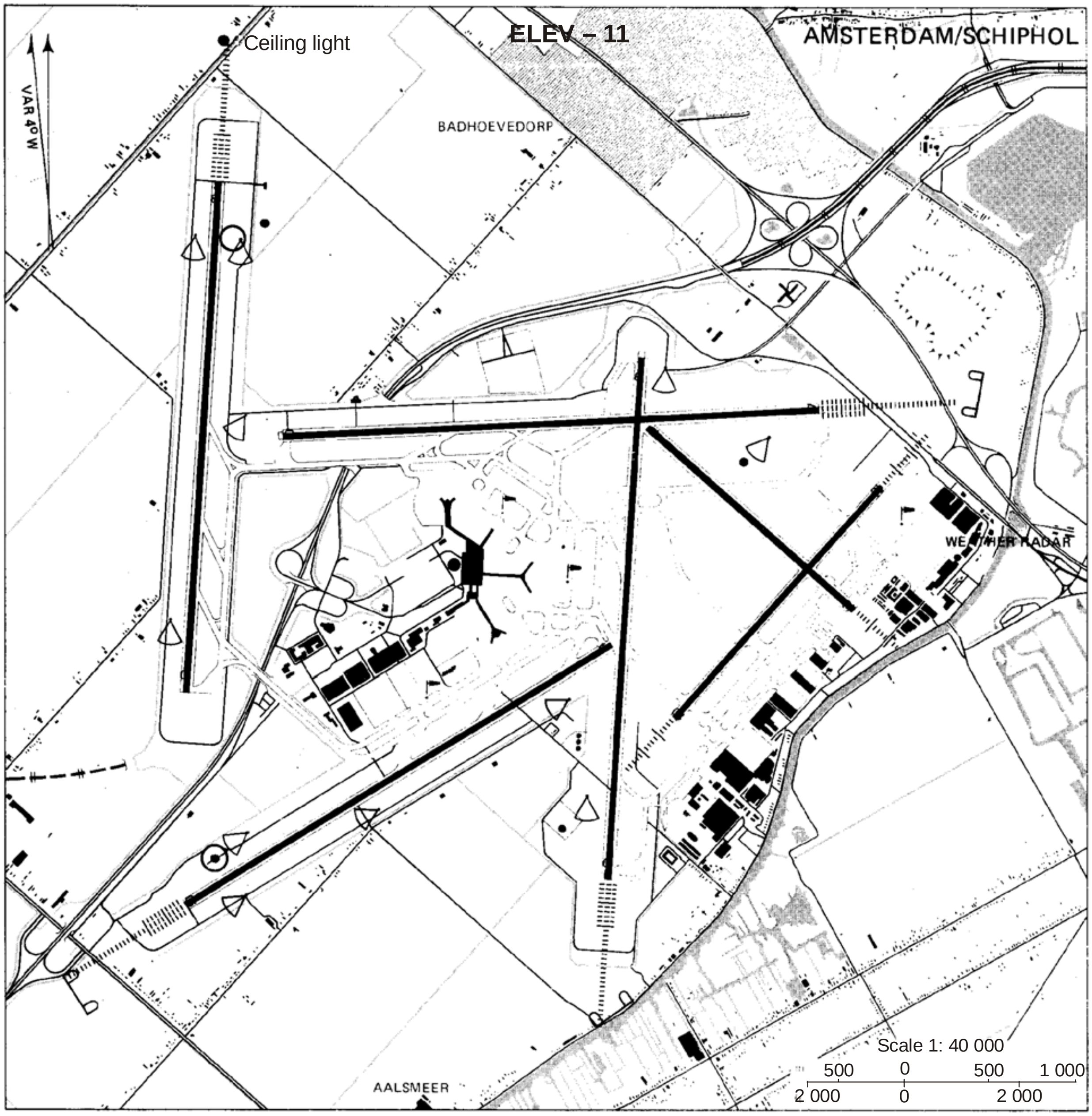
5.6.3 In respect of locations of observations, Annex 3, Chapter 4, 4.6.3.4 calls for RVR observations to be representative of the touchdown zone and of the mid-point and corresponding stop end of the runway. The site for observations to be representative of the touchdown zone should be located about 300 m along the runway from the threshold. The sites for observations to be representative of the mid-point and stop end of the runway should be located at a distance of between 1 000 m and 1 500 m respectively along the runway from the threshold and at a distance of about 300 m from the other end of the runway. The exact position of these sites and, if necessary, additional sites, should be decided after considering aeronautical, meteorological and climatological factors such as runway length, swamps and other fog-prone areas (Annex 3, Appendix 3, 4.2.1.2 refers).

5.6.4 Existing installations follow these provisions closely. All have one observation site opposite the touchdown zone — usually 300 m from the threshold — and many transmissometer systems have one to three supplementary observation sites. One of these is usually near the stop-end, which becomes the touchdown zone when the runway is used in the reverse direction.

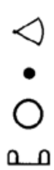
5.6.5 When RVR measurements are made in connection with Category I operations alone, one site opposite the touchdown zone is considered to be sufficient. For Category II operations, it is mandatory to have two sensors, one at the touchdown zone and another one in the vicinity of the mid-point of the runway. For Category III operations, three sites per runway (touchdown zone, mid-point and stop-end) are required.

5.6.6 Because visibility can vary considerably along a runway, particularly when fog is forming, useful information can be obtained from multiple transmissometers even if only Category I operations are being undertaken. To obtain timely information on formation and approach of advection fog, some States have also installed transmissometers at some distance from the aerodrome in the direction from which advection fog normally approaches.

5.6.7 As regards distance from runways, the point from which RVR assessment is made should be such as to present a minimum of hazard to aircraft, to instruments and to observers who should never be exposed to the risk of being hit by aircraft taking off or landing. However, in order that the observations may be closely representative of conditions over the runway, observation sites should be near the runway. This point is recognized in Annex 3, Appendix 3, 4.3.1.2, which indicates that it is desirable to locate the RVR observing site at a lateral distance from the runway centre line of not more than 120 m.



LEGEND



Runway visual range observation site

Cup anemometer

Temperature observation site

Ceilometer

Figure A2-3. Typical layout plan of meteorological instruments at an aerodrome

5.7 Cloud

5.7.1 Observations of the height of the cloud base should refer to the aerodrome elevation or to the threshold elevation of precision approach runways where these are 15 m (50 ft) or more below aerodrome elevation.

5.7.2 Cloud observations should, according to Annex 3, Chapter 4, 4.6.5, be representative of the following portions of the aerodrome.

For local routine and special reports used for arriving aircraft: the approach area.

For local routine and special reports used for departing aircraft: the climb-out area.

For METAR and SPECI: the aerodrome and its vicinity.

5.7.3 Ceilometers are normally installed at middle markers. At some aerodromes separate ceilometers are used for each middle marker. In some cases, middle marker sites may be of difficult access, e.g. on small islands, in swamps. However, the fact that a marker is installed there and needs to be serviced should usually mean that a power supply is available and access is possible for maintenance, etc.

5.8 Air temperature and dew-point temperature

5.8.1 Requirements for air temperature and dew-point temperature are generally understood to refer to the average height of aircraft engines. This requirement is normally satisfied by dry and wet bulb temperature measurements in a well ventilated screen (from which the dew point temperature may be calculated).

5.8.2 Temperature measurements should be representative of the whole runway complex. As mentioned earlier under instrument exposure, this requirement may not be satisfied by normal meteorological measurements in screens in instrument enclosures. For this reason, most aerodromes have dry bulb and wet bulb thermometers located somewhere on the runway complex, usually of a distant reading type. In fact, the thermometers are often collocated with (one of the) anemometers.

5.9 Atmospheric pressure

5.9.1 The sensors (barometers) used for obtaining atmospheric pressure for the computation of altimeter settings are usually located inside buildings. They may be precision aneroid or mercury barometers; one mercury barometer is normally sufficient for an aerodrome, unless, as is sometimes the case, a separate barometer or altimeter is kept in the local ATS unit (normally an aerodrome control tower). If a precision aneroid barometer is used for convenience, it should be checked against the station mercury barometer at least weekly.

5.9.2 In accordance with Annex 3, Appendix 3, 4.7.2, the reference level for the computation of the QFE should be the official aerodrome elevation or, in the case of precision approach runways and non-precision approach runways whose thresholds are 2 m (7 ft) or more below the aerodrome elevation, the relevant threshold elevation. As barometers are normally located in the meteorological office, which is not necessarily at the reference height (i.e. aerodrome elevation or precision approach threshold), a correction has to be applied to the barometer reading to account for this height difference when computing the QFE. When installing the barometer in the meteorological office, care should be taken to ensure the wall on which the station mercury barometer is to be mounted, or the position chosen to hold a precision aneroid barometer, is not subject to vibrations, direct sunlight or draughts.

5.9.3 Another aspect to be taken into consideration is the use of air-conditioning in large (or sometimes even in smaller) buildings as this creates an artificial atmosphere. In that case, the sensor should be vented to the outside atmosphere (e.g. pitot-static arrangements).

6. CONCLUSION

The siting of meteorological instruments at aerodromes requires close coordination between the meteorological, ATS and aerodrome authorities as well as operators. The most important practical steps to be taken in choosing appropriate locations may be summarized as follows:

Step 1: Ascertain the geometry of the relevant obstacle limitation surfaces at the aerodrome, particularly the transitional and inner transitional surfaces. Particular aerodromes could comprise parallel and crossing runways which complicate the geometry. Assess the type of aircraft operations at the aerodrome (e.g. visual flight rules (VFR) or instrument flight rules (IFR) traffic) and frequency of use of runways (e.g. preferred landing directions), which runways are equipped with instrument landing system (ILS), possible noise abatement take-off directions, etc. Check aerodrome master plan for possible plans for expansion of the aerodrome runways, taxiways, buildings, etc. Check location and height of existing essential navigation aids such as glide path antenna, localizer, etc.

Step 2: Prepare meteorological survey of the aerodrome based upon climatological statistics of the aerodrome itself or nearby observing stations. The assistance of pilots and air traffic control officers familiar with the aerodrome will be essential in this regard. In preparing the survey, account should be taken of the topography of the aerodrome and surrounding land, preferably by on-site inspection by an aviation meteorologist. Location and effect of swamp areas, hills, coastline, slope of runways, local industrial pollution, etc., and their possible effect on the operationally significant points around the aerodrome, e.g. touchdown zone, take-off areas, etc., should be considered.

Step 3: Decide on the location of the instruments that would provide representative measurements as required by Annex 3 and, at the same time, allows for adequate exposure. Observe obstacle limitation surfaces in choosing sites as shown in Figure A2-2. In particular, anemometer masts normally should be sited outside runway strips and should not infringe the transitional slope. Where it is necessary to locate them within the strip, the mast should be frangible, lighted and the site should only be as close to the runway as is absolutely essential. Unless there are exceptional local circumstances, anemometer masts should not infringe the OFZ. If the latter is necessary, then the mast must be frangible, lighted and preferably shielded by an existing essential navigation aid. Take into account also the accessibility of the sites, the availability of power, telephone and other lines without undue costs or interference with aerodrome use. Consideration should also be given to installing the minimum number of instruments necessary to provide representative values. This is cost-effective and ensures a minimum number of obstacles on the aerodrome.

Appendix 3

REPORTING OF PREVAILING VISIBILITY USING FULLY AUTOMATIC OBSERVING SYSTEMS

(See 2.3.9.7)

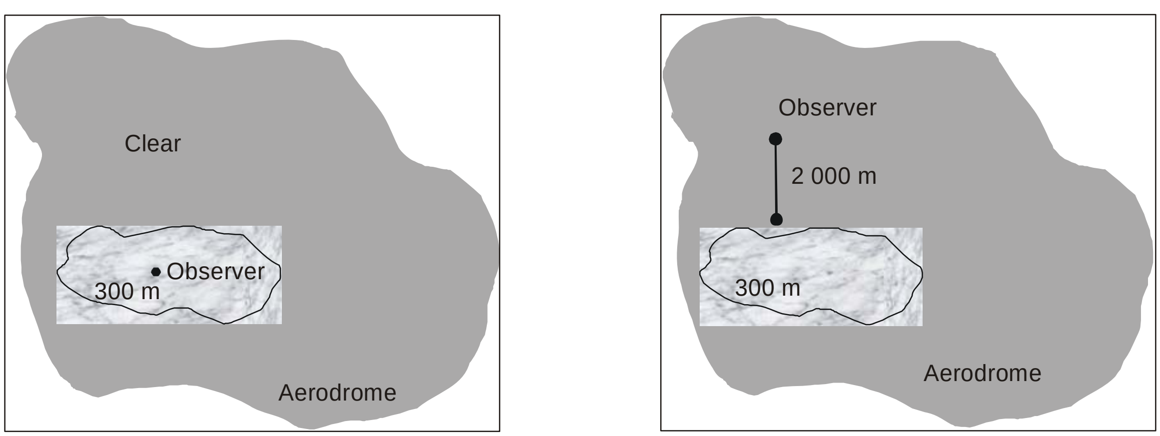
1. In METAR/SPECI, it is recommended that visibility be representative of the aerodrome and, where applicable, provide an indication of changes in direction. The visibility to be reported is the so-called prevailing visibility, which is defined in Annex 3 as:

***Prevailing visibility*.** The greatest visibility value, observed in accordance with the definition of "visibility", which is reached within at least half the horizon circle or within at least half of the surface of the aerodrome. These areas could comprise contiguous or non-contiguous sectors.

Note.— This value may be assessed by human observation and/or instrumented systems. When instruments are installed, they are used to obtain the best estimate of the prevailing visibility.

When the visibility is not the same in different directions and when the lowest visibility is different from the prevailing visibility, and 1) less than 1 500 m or 2) less than 50 per cent of the prevailing visibility and less than 5 000 m, the lowest visibility observed is also to be reported and its general direction in relation to the aerodrome indicated.

2. The advantage of having a human observe visibility using the meteorological station as a reference point is that the observation is based on an overview that covers a large volume of the atmosphere. However, there are limitations related to how effectively objects or lights can be detected by the human eye. For example, as shown in Figure A3-1 a), if the meteorological station and observer are located in a foggy area with a visibility of 300 m, the observer does not see anything beyond those 300 m. Without instruments, the observer therefore cannot be aware of visibility conditions beyond 300 m. The visibility representative of the whole aerodrome is therefore unknown. Conversely, if partial fog is located 2 000 m from the observer as shown in Figure A3-1 b), with a visible mark at 2 000 m, the observer indicates a visibility of 2 000 m, even though visibility in the partial fog is much less (for example, 300 m indicated by a sensor).



a) fog b) partial fog

Figure A3-1. Examples of observation errors

3. It is therefore important to understand that instrumented and human visibility observations are comparable only when the atmosphere is homogenous. When this is not the case, human observation and automatic observation each have their limitations. The concept of prevailing visibility, and how it may be established using automatic systems, can be explained with the aid of Tables A3-1 and A3-2. When visibility sensors are sited in such a manner that no directional variations are available, the "prevailing" visibility value reported is followed by the abbreviation "NDV".

Table A3-1. Determining prevailing visibility with one to five sensors

Number of sensors	*Visibility values observed (note: V1 < V2 < V3 < V4 < V5)*	*Prevailing visibility to be reported*
1*	V1	V1
2	V1, V2	V1
3	V1, V2, V3	V2
4	V1, V2, V3, V4	V2
5	V1, V2, V3, V4, V5	V3

* *When no directional variations can be detected, the visibility value should be followed by "NDV" (no directional variations available).*

Table A3-2. Examples of reporting visibility in METAR and SPECI using five sensors

(Median values shown in bold.)

Sensor (and its location)*	*Example 1*	*Example 2*	*Example 3*	*Example 4*
Sensor 1 (SE)	3 333	**3 333**	1 357	**3 333**
Sensor 2 (NW)	3 455	3 455	1 850	4 455
Sensor 3 (NE)	3 372	3 372	**1 900**	2 844
Sensor 4 (NE)	**3 422**	2 400	2 026	1 611
Sensor 5 (SW)	3 520	2 424	1 977	3 520
Values to be reported	3 400	3 300	1 900 1 300SE	3 300 1 600NE

* *With reference to the aerodrome reference point.*

4. Table A3-2 provides four examples of how to report visibility with automatic systems using five sensors which

are located along the runways and in various sectors in relation to the aerodrome reference point as shown in column one. Example 1 demonstrates a straightforward case whereby measurements from all of the sensors are similar to each other and hence the visibility around such an aerodrome would be homogeneous. In this case the median value (V3 = 3 422 m) should be taken as the prevailing visibility and would be reported as 3 400 m. The median value is taken rather than the mean value to ensure that the prevailing visibility actually represents the true value as observed in a part of the aerodrome. Otherwise it would be possible to have a reported value that was not strictly observed at any part of the aerodrome.

5. Example 2 demonstrates a situation whereby the five sensor readings are split into two groups, i.e. three readings in the range 3 300 m to 3 500 m and two readings in the range 2 400 m and 2 500 m. However, if it is assumed that all the sensors cover an equal area of aerodrome, the definition of prevailing visibility suggests that the visibility would still be reported as the median value (3 333 m which would be reported as 3 300 m).

6. Examples 3 and 4 demonstrate situations whereby both the prevailing visibility and the minimum visibility should be reported. Example 3 contains a series of measurements including one measurement below the critical value of 1 500 m. In this case, the prevailing visibility should be reported as 1 900 m (the median value V3) with a minimum visibility also reported at 1 300 m. Example 4 shows a similar situation whereby the lowest reading of 1 611 m is less than 50 per cent of the prevailing visibility value of 3 333 m (the median value V3). In this case both the prevailing visibility and the minimum visibility should be reported as 3 300 m and 1 600 m, respectively.

7. The examples discussed in Table A3-2 make the assumption that each of the sensors used represents an equal part of the aerodrome concerned (e.g. 20 per cent each) and therefore carries an equal weighting in any calculations made. In some cases, the local climatology of the aerodrome may indicate that sensors may be representative of fog-prone areas or simply may represent more operationally significant parts of the aerodrome. Such considerations should be carried out on an individual basis. In these cases, it would be necessary to establish the percentage of the area of the aerodrome that is nominally to be represented by each sensor. Following this, the prevailing visibility can be derived using its definition which requires that the prevailing visibility is the visibility value reached at least within half of the surface of the aerodrome.

8. Annex 3 provisions also state that when the visibility is fluctuating rapidly, and prevailing visibility cannot be determined, only the lowest visibility should be reported. This case applies only for visibility assessed by a human observer since, with automatic systems, it is always possible to determine prevailing visibility.

Appendix 4

CRITERIA FOR TREND FORECASTS

(See 3.5.3)

Element	*Observed value (given in report)*	*Trend forecasts to be issued when one or more of the following changes are expected*		
1. Surface wind	Mean speed	Change in direction	Mean speed after the change in direction	
1.1	Less than 5 m/s (10 kt)	60° or more	5 m/s (10 kt) or more	
1.2	5 m/s (10 kt) or more	60° or more	Any speed	
1.3	Any speed	Changes through values of operational significance*		
1.4	Any speed	Change in mean speed 5 m/s (10 kt) or more		
2. Visibility		Visibility reaching or passing any one of the following values: 150 m 350 m 600 m 800 m 1 500 m 3 000 m 5 000 m**		
3. Weather				
3.1	— freezing precipitation — moderate or heavy precipitation (including showers thereof) — duststorm or sandstorm — thunderstorm (with precipitation) — other weather phenomena given in Table 2-6 as agreed by the meteorological authority with the ATS authority and operators concerned	Onset, cessation or change in intensity		
3.2	— freezing fog — low drifting dust, sand or snow — blowing dust, sand or snow — thunderstorm (without precipitation) — squall — funnel cloud (tornado or water spout)	Onset or cessation		
4. Cloud	Amount	Initial height of base	Amount	Change in height of base

Element	*Observed value (given in report)*	*Trend forecasts to be issued when one or more of the following changes are expected*		
4.1	BKN or OVC	Below 450 m (1 500 ft) and expected to lift	BKN or OVC	Changing to, or passing through, any one of the following values: 30 m (100 ft) 60 m (200 ft) 150 m (500 ft) 300 m (1 000 ft) 450 m (1 500 ft)
4.2	BKN or OVC	At or above 30 m (100 ft) and expected to lower	BKN or OVC	Passing through any one of the following values: 30 m (100 ft) 60 m (200 ft) 150 m (500 ft) 300 m (1 000 ft) 450 m (1 500 ft)
4.3	NSC, FEW or SCT	Below 450 m (1 500 ft)	BKN or OVC	Any height of cloud
4.4	BKN or OVC	Below 450 m (1 500 ft)	NSC, FEW or SCT	Any height of cloud
4.5	NSC, FEW or SCT	At or above 450 m (1 500 ft)	BKN or OVC	Below 450 m (1 500 ft)
4.6	BKN or OVC	At or above 450 m (1 500 ft)	NSC, FEW or SCT	Below 450 m (1 500 ft)
5. Vertical visibility (at aerodromes where such observations are available)	Sky expected to become or remain obscured			Vertical visibility passing any one of the following values: 30 m (100 ft) 60 m (200 ft) 150 m (500 ft) 300 m (1 000 ft)

* The threshold values considered to be of operational significance are to be established by the meteorological authority in consultation with the appropriate ATS authority and the operators concerned, taking into account changes in the wind which would require a change in the runway(s) in use, and/or which would indicate that the runway tailwind or crosswind component will change through values representing the main operating limits for typical aircraft operating at the airport.

** 5 000 m is also used as a criterion when significant numbers of flights are conducted in accordance with visual flight rules.

Note.— Additional criteria may be agreed between the meteorological authority and the operators concerned based on local operating minima.

Appendix 5

NOTIFYING WAFCS OF SIGNIFICANT DISCREPANCIES

(See 3.7.2.5)

1. PURPOSE OF THE REPORT

The purpose of the report is to:

a) enable the meteorological offices to inform the WAFCs about significant discrepancies in significant weather (SIGWX) forecasts issued by WAFCs, in accordance with Annex 3 criteria (Annex 3, Appendix 2, 2.2 refers); and

b) report significant discrepancies efficiently and unambiguously.

2. BENEFITS OF THE REPORT

A WAFC benefits from being informed because the report:

a) provides valuable feedback on the content of the forecasts;

b) enables forecasters to take into account feedback in future forecasts; and

c) enables formal review of the quality of WAFC output if necessary.

3. STEPS TO BE FOLLOWED BY A METEOROLOGICAL OFFICE

a) WAFS SIGWX forecast is received by a meteorological office;

b) a meteorological office detects a significant discrepancy in accordance with the criteria for the amendment of SIGWX forecasts in Annex 3 (see Annex 3, Appendix 2, 2.2 and the attachment to this appendix), and no other differences should be reported;

c) the meteorological office describes the significant discrepancy using the following rules:

1) a notification of significant discrepancy concerning a forecast is to be sent between six and nine hours before the commencement of the validity period of the forecast;

2) the notification is to be sent only to the WAFC concerned;

3) the notification is to be sent via email or fax using the following e-mail addresses or fax numbers:

Centre	*Fax number*	*E-mail address*
WAFC Washington	+1 816 880 0652	Larry.Burch@noaa.gov
WAFC London	+44 1392 885681	servicedesk@metoffice.gov.uk

Note.— Any correspondence with WAFC London to be clearly marked with the following text: "For the attention of WAFC London forecasters."

4) the notification of significant discrepancies is to be prepared using the form in the attachment to this appendix;

5) the notification is to be written in English.

4. STEPS TO BE FOLLOWED BY A WAFC

The WAFC concerned acknowledges the receipt of the notification of the significant discrepancy to the meteorological office that originated it, together with a brief comment thereon and on any action taken, using the same means of communication employed by the meteorological office.

— — — — — — —

ATTACHMENT TO APPENDIX 5

FORM TO BE USED FOR THE NOTIFICATION OF A SIGNIFICANT DISCREPANCY ON SIGNIFICANT WEATHER FORECASTS

FORECAST INVOLVED

Originating WAFC	
ICAO Area	
Flight Level	
Validity Time	
Validity Date	

DESCRIPTION OF THE DISCREPANCY(IES)

Error in expected position or intensity of phenomena; new expected phenomena

	WAFC Forecast			*Proposal*			
Phenomena	*FL*	*Position*	*Intensity*	*FL*	*Position*	*Intensity*	*Reference*
Turbulence							
Icing							
Cumulonimbus[1]							
Sandstorms							
Duststorms							
Volcanic activity							
Radioactive material into the atmosphere							
1. Cumulonimbus clouds that are obscured, frequent, embedded or occurring at a squall line.							

Note.— The column "Reference" is to specify, for example, the observation, aircraft report or the forecast model field that directed the meteorological office to inform of a significant discrepancy. A copy of this information may be added to the form, if necessary.

Appendix 6

AN OPERATIONAL WIND SHEAR AND INVERSION WARNING SYSTEM FOR HELSINKI-VANTAA AIRPORT

(See 4.6.6)

1. THE MEASURING SITE AND AIRPORT

1.1 A 300 m high (1 000 ft) mast was installed 20 km southwest of the airport. Its elevation is 50 m (160 ft), the same as that of the airport. The terrain around the mast station is sparse forest. This kind of terrain covers most of the final approaches to Helsinki-Vantaa Airport. The mast station is 7 km from the seashore while the airport itself is 15 km from the seashore, thus allowing for timely sea fog observations.

1.2 The effect of distance of the mast station from the airport was studied by comparing aircraft-measured INS-winds with mast-measured two-minute mean winds. Results show a correlation of 0.83–0.85 for speed and 0.98–0.99 for direction at measuring levels of 90 m to 300 m (300 ft to 1 000 ft) INS-winds with mast-measured two-minute mean winds. The INS-winds are on average 1 m/s (2 kt) higher than mast winds.

1.3 During strong inversions, the surface temperatures at the airport and at the mast station coincide within ±1°C and surface inversions measured at the mast station also represent conditions at the airport.

2. SYSTEM CONFIGURATION

2.1 The system is a modified automatic weather station, which has several additional wind, temperature and humidity sensors compared to the usual surface weather station. Figure A6-1 represents the system near Kuopio Airport. In this system, the data collection is performed via a cassette count.

2.2 Because of freezing conditions during the winter, wind is measured with modified Vaisala anemometers, equipped with Lambrecht cups. These cups give more torque and also absorb IR-radiation more easily, because their aluminium surface is painted black. Besides normal axial heating, the anemometers have IR-radiators situated above them. These radiators have a maximum output of 1.5 kw. Temperature is measured with Pt-100 thermo-elements and humidity with linearized Lambrecht hair hygrometers. Temperature and humidity sensors are shielded against radiation and rain and all sensors are also shielded against falling ice blocks.

3. WEATHER WATCH

3.1 Vertical wind shear is calculated between measuring levels using two-minute mean winds. Levels 90 m to 210 m (300 ft to 700 ft) and 210 m to 300 m (700 ft to 1 000 ft) are used in routine warning services; measurements from levels 30 m to 90 m (100 ft to 300 ft) are affected by local terrain. Calculation of wind shear magnitude is done by the formula

$$V\,\mathrm{ws} = \sqrt{V^2_1 + V^2_2 - 2V_1V_2 \cos \propto}$$

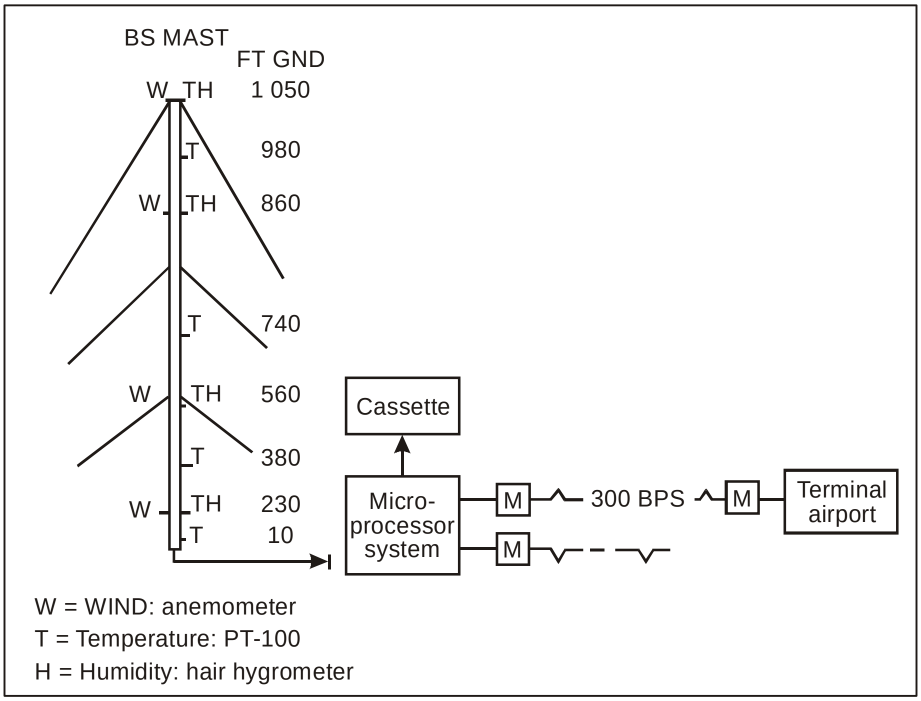


Figure A6-1. System configuration

where V_1 and V_2 are wind speeds at the levels in question and $\propto$ the angle between winds. This shear magnitude is then scaled to the unit m/s/100 ft. If a predetermined value is exceeded, the system reports it by a bell signal and shows the shear values. The shear alarm limit at the mast station is set at 10.5 m/s/100 m (1.75 m/s/100 ft), and this means about 0.1 per cent of the cases or about ten shear cases of this strength or more per year. The number of aircraft reports concerning wind shear has been about nine cases per year at Helsinki-Vantaa Airport.

3.2 A watch is also kept for temperature inversions by comparing temperatures at higher levels with the surface temperature. Adjacent levels are also compared, which means a total of 13 comparisons in this subroutine. If a predetermined value is exceeded, the system reports it by a bell signal and gives temperature values. The inversion alarm limit at the mast station is set to correspond to an inversion of 10°C in the lowest 300 m (1 000 ft) layer.

4. ROUTINE WARNING SERVICES AND USE OF MAST DATA

4.1 The mast system is a part of the unified warning service (see flow diagram in Figure A6-2).

4.2 On receiving an alarm signal from the mast system, the meteorologist on duty makes the final decision as to whether a warning should be given. The warning message is immediately reported in the ATIS broadcast. The warning message is also shown on the airport internal video network.

4.3 Besides wind shear and inversions, the strength of low-level turbulence can be estimated by the mast system. The system reports wind speed and direction variations over the averaging interval. If the speed variations exceed 10 m/s (20 kt) at levels 90 m to 300 m (300 ft to 1 000 ft), a turbulence warning is given.

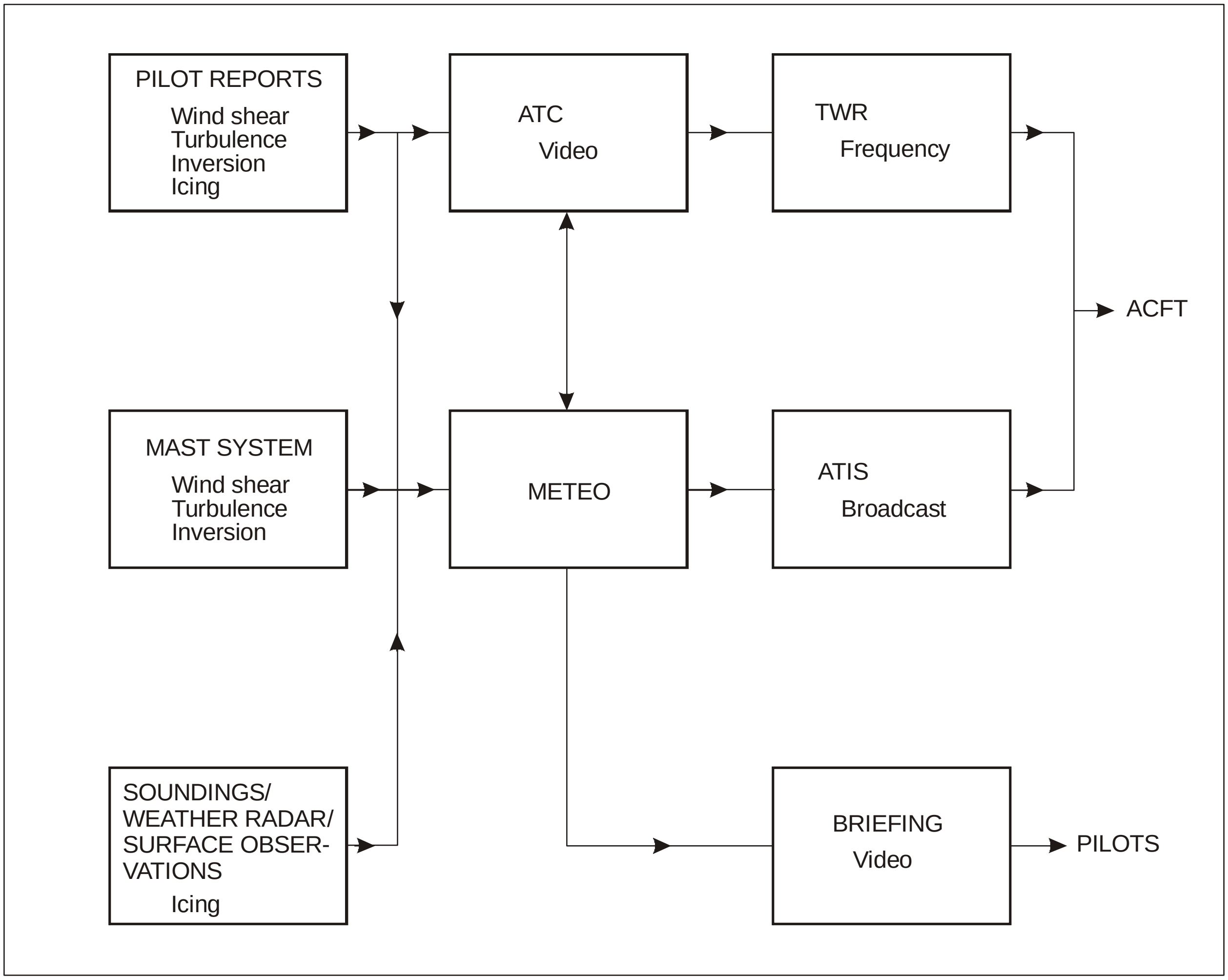


Figure A6-2. Warning service

4.4 Besides its use for warning purposes, the mast data is also used for routine forecasting. The uppermost level gives a fairly good estimate of wind for approach and holding purposes. Continuous temperature profiles provide important information when estimating the passage of a front. For example, the temperature rise associated with warm fronts (especially in winter) is seen clearly starting from the top of the mast. Humidity profiles have been used successfully when making trend forecasts, especially in case of advective fog or low cloud from the sea sector. The humidity rise is always very rapid and starts from the lowest levels in the case of a dense sea fog. Fog associated with a frontal warm advection causes the humidity to rise first at upper levels.

Appendix 7

USE OF OPMET INFORMATION FOR PRE-FLIGHT PLANNING BY OPERATORS AND FLIGHT CREW

(See 5.1)

1. INTRODUCTION

1.1 The OPMET information to be supplied to operators and flight crew is covered in Chapter 9 of Annex 3 and in Chapter 5 of this manual. The purpose of this appendix is to provide aviation meteorologists and assistants with a basic understanding of the significance each item of information used in pre-flight planning has in the preparation for a flight. Although some re-planning is often carried out in flight (e.g. when considering the acceptance of a different flight level, an alternative airway routing offered by air traffic control or a change of destination), the use made of the meteorological information required for such re-planning is similar to that in pre-flight planning.

1.2 Flight preparation has three phases: the take-off and climb to cruise altitude; the cruise to top of descent; and the approach and landing. These phases are not treated separately as they are interdependent, but for explanatory purposes, it is convenient to consider the specific use made of meteorological information in each of the three phases.

2. TAKE-OFF AND CLIMB-OUT

2.1 General

2.1.1 It is the pilot's duty to optimize the performance of the aircraft, in order to maximize the economics of the operation while at the same time complying with all the requirements for take-off (including take-off minima) specified by the operator and approved by the State of the Operator and by the authority responsible for the aerodrome. The planning for the take-off and climb-out phase includes calculating, by the pilot, the maximum permissible take-off mass (standard operating mass + passengers + cargo + fuel, etc.) given the constraints at a particular aerodrome. These constraints include runway length, runway slope, climb-out gradients (which ensure clearance of obstacles with one engine failed), aerodrome elevation, and current meteorological conditions, i.e. surface wind (specifically headwind component and limiting tailwind and crosswind components), temperature and pressure. Humidity, although theoretically also affecting aircraft performance, can be neglected as its effect is minimal. Runway contamination (snow or slush covered, wet, icy, etc.) also plays an important role, but is not usually regarded as "meteorological information". Where aircraft take-off mass is not limited by aircraft performance considerations in the prevailing meteorological conditions, temperature has an effect on take-off speeds and on engine power settings and on the possible need to initiate engine and airframe anti-ice procedures.

2.1.2 The list of items that have to be considered in take-off calculations is rendered more manageable by the use of graphs, charts, nomograms and tables, etc., produced by the operator to assist the pilot or flight operations officer. In many operations, flight planning, particularly for the en-route stage, is carried out by computer. The pilot is able to control at least some of the many variables affecting the take-off performance of the aircraft; one example would be the choice of flap setting, another would be the cargo mass and/or fuel to be uplifted, although clearly the desire is to maximize the payload consistent with take-off requirements. Any of the various requirements may limit the operation, resulting in a lower payload or fuel uplift than desired, which may result in the need to land en route in order to refuel or, in extreme circumstances, preclude take-off (at a given mass) altogether.

2.2 Surface wind

2.2.1 The magnitude of the effects of meteorological parameters on take-off performance varies with different aircraft types, although the sense of the effect (positive or negative) is the same. Headwinds will permit a greater mass to be lifted on take-off, as the presence of a headwind will permit a higher airspeed to be achieved on the runway and therefore more lift to be generated by the aerodynamic surfaces. In contrast, a tailwind results in the reduction of the maximum permissible take-off mass as a lower airspeed is achieved. Otherwise expressed, headwinds permit more weight to be lifted on take-off, while tailwinds decrease the maximum permissible take-off weight.

2.2.2 The following are some figures to indicate the magnitudes of the above effects. An example expressed in terms of mass would be that for each knot increase in headwind component, an Airbus A300 can lift some 400 kg more mass on take-off. For a Boeing 767-300, the increase would be around 220 kg for the same increase in headwind component. In addition to the headwind/tailwind component, consideration must also be given to the crosswind component. Each aircraft has crosswind limits (for large jet transports, typically between 15 kt and 35 kt for different runway conditions, e.g. wet or icy, or dry), beyond which it is very difficult for the pilot to maintain aircraft alignment along the runway, particularly in the case of an engine failure.

2.3 Temperature

2.3.1 Temperature affects air density; higher temperatures cause a decrease in density which reduces lift; hence, maximum permissible take-off mass also has detrimental effects on engine efficiency; hence, attainable speeds. Lower temperatures have the opposite effect.

2.3.2 A temperature rise of 10°C can, for a B737, reduce the permissible take-off mass by 600 kg. A decrease in temperature allows an increase in permissible take-off mass. In the case of the A310, for each degree that the temperature is below reference, the mass can be increased by 210 kg, all other factors being equal. Temperature also has an effect on the relationship between true airspeed and the airspeed indicated in the cockpit (indicated airspeed). Therefore, high ambient temperatures mean that for a given indicated airspeed the true airspeed is higher and the kinetic energy to be absorbed by the brakes and tires after landing or an abandoned take-off is also greater. Landing an aircraft on a short runway or abandoning take-off from high speed requires the aircraft brakes to absorb extremely large amounts of kinetic energy which, in turn, results in the brake assembly being heated to such high temperatures that brake cooling times as long as one hour could be necessary. The cooling time depends on, among other things, the outside air temperature. Flight crew are provided with nomograms to calculate this effect.

2.4 Pressure

2.4.1 Pressure also affects air density; the lower the surface pressure, the lower the air density and the lower the lift and the poorer the engine performance (and vice versa).

2.4.2 For a B767-300 a 10 hPa pressure change at a sea level aerodrome has about the same effect as a 3°C temperature change. Similarly, for each hectopascal that the pressure rises above 1 013.2 hPa, an additional 150 kg can be carried by an Airbus A300.

2.5 Combined effects of surface wind, temperature and pressure

Figure A7-1 illustrates the combined effects of the above-mentioned parameters on take-off performance, and Figure A7-2 gives a sample illustration of an actual take-off mass versus runway length calculation.

3. CRUISE TO TOP OF DESCENT

3.1 General

The meteorological parameters of importance in the preparation of flight plans for the cruise phase of flights consist in the first instance of upper-air temperatures and upper winds. Weather conditions en route and meteorological conditions at destination and at destination alternate and en-route alternate aerodromes also play an important role.

3.2 Temperature

As in the case of take-off performance, temperature is an important element in flight planning because, by affecting air density, it influences engine performance, fuel efficiency, true airspeed, and aircraft operating ceilings and optimum cruising levels, irrespective of aircraft type (piston, jet, etc.). For early types of jet engines, the fuel consumption increased by about 1 per cent for each degree Celsius rise in temperature above standard. For wide-bodied aircraft, the engines of which are more powerful and fuel efficient, fuel consumption increases only by about 3 per cent for each 10°C temperature increase. However, as fuel constitutes about 30 per cent of the total take-off mass of modern jets which can exceed 200 tonnes, this means that some 2 tonnes of additional fuel may be required for a 10°C temperature rise. For a given aircraft mass, temperature together with wind determines the flight level at which fuel efficiency and range (with a given cruise speed) will be at an optimum. Figure A7-3 illustrates the effects of various temperature deviations from standard temperature on optimum flight levels for a B737 aircraft.

3.3 Upper winds

Upper winds have an even more obvious effect on aircraft efficiency, decreasing or increasing flight time and consequently decreasing or increasing fuel consumption (if same ground speed is to be maintained). With wide-bodied jet aircraft, a 50 kt headwind decreases the range of the aircraft by about 11 per cent at best cruise speed; a tailwind has the reverse effect. For flight planning, the effects of wind components are usually calculated in terms of "equivalent still air distance" which is as follows:

$$\text{equivalent still air distance} = \frac{\text{TAS}}{\text{TAS} \pm \text{wind component}}$$

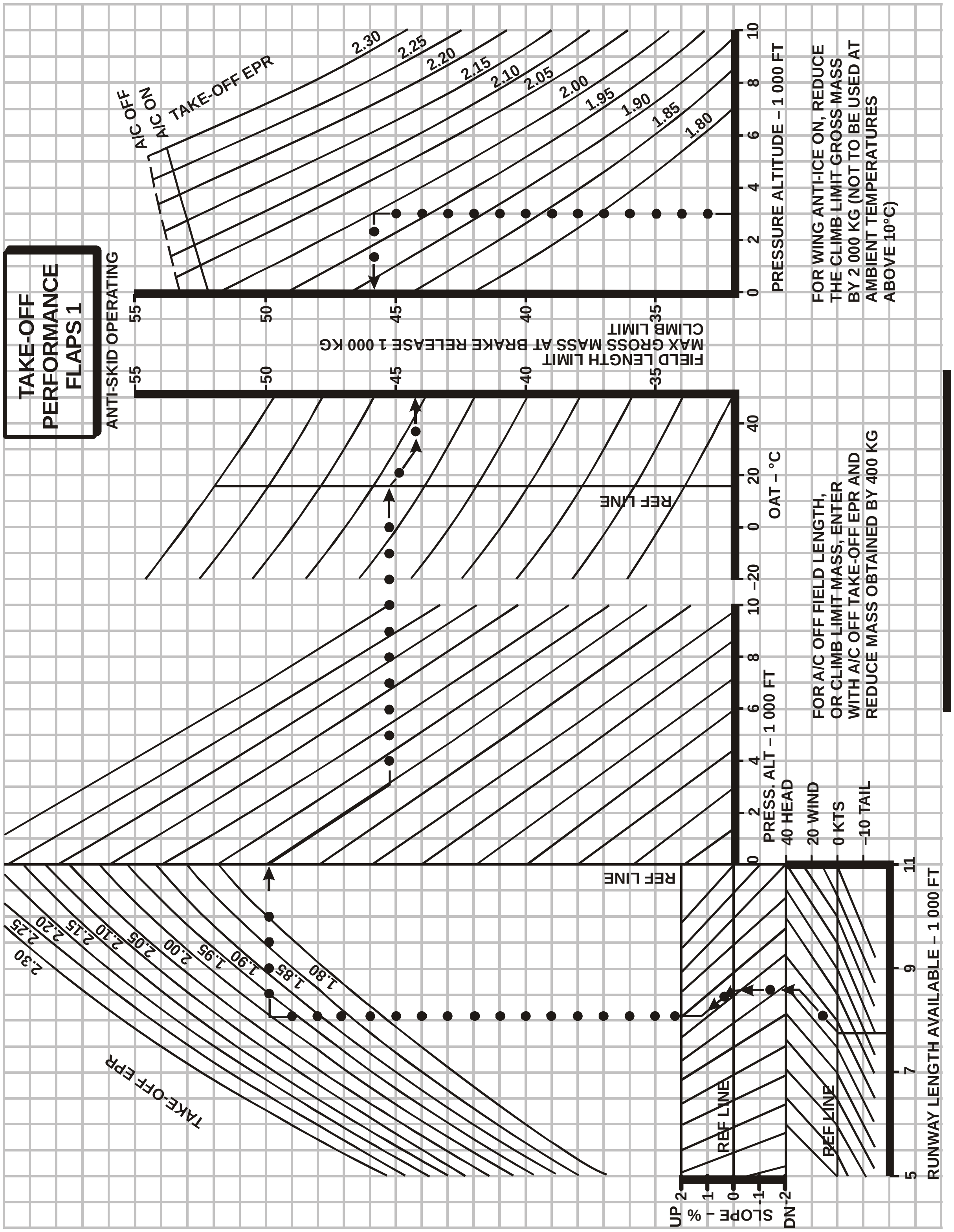


Figure A7-1. Effects of meteorological parameters on take-off performance

Calculation for maximum permissible take-off mass (for DC-8)

Type of A/C	Condition	RW	OAT	Wind	Wc	QNH	Depth of slush etc.	Braking action
DC-8-62								
Flight/Date	Estimated	22R	+2°C	230°/10 kt	–10	1005	1.0 cm slush	POOR
Airport CPH	Actual							

	Calculation					
Flaps		23°				
TOW versus RW and OBSTACLES	Equation runway-short.	–	+		–	+
Gross mass			165.6			
Rating/intermix (not DC-8)		–	+		–	+
OAT correction (27 × 270)		–	+ 7.3		–	+
Wind correction (10 × 330)		–	+ 3.3		–	+
QNH correction (8 × 160)		– 1.3	+		–	+
Ice protection (not 747) ENG.		– —	+ 176.2		–	
Rain removal (DC-8 only) ON		– 0.7			–	
Frost/ice on tanks (not 747)		– —			–	
Water, slush, snow	620 m					
Braking action	600 m					
Runway-shortening	m					
Systems U/S	m					
Sum of equation runway-short.	1 220 m	– 31.0			–	
Sum of negative corrections		– 33.0 →	– 33.0		– →	–
TOW versus RW and OBSTACLES ①			143.2			
Climb requirement limited mass						
Climb requirement limited mass			162.5			
Rating/intermix (not DC-8)		–	+		–	+
OAT correction (13 × 600)		–	+ 7.8		–	+
QNH correction (8 × 160)		– 1.3	+		–	+
Ice protection (not 747) ENG.		– 0.5	+ 170.3		–	+
Rain removal (DC-8 only) ON		– 1.3			–	
Frost/ice on tanks (not 747)		– —			–	
Sum of negative corrections		– 3.1 →	– 3.1		– →	–
CLIMB REQUIREMENT LIMITED MASS ②			167.2			
PERFORMANCE LIM. TOW For decision of derating	Min of ① & ②		143.2			
NEVER EXCEED MASS ③			152.0			
MAXIMUM PERMISSIBLE TOW	Min of ① ② ③		143.2			

(5634)

3343b

Figure A7-2. Sample of an actual take-off mass calculation

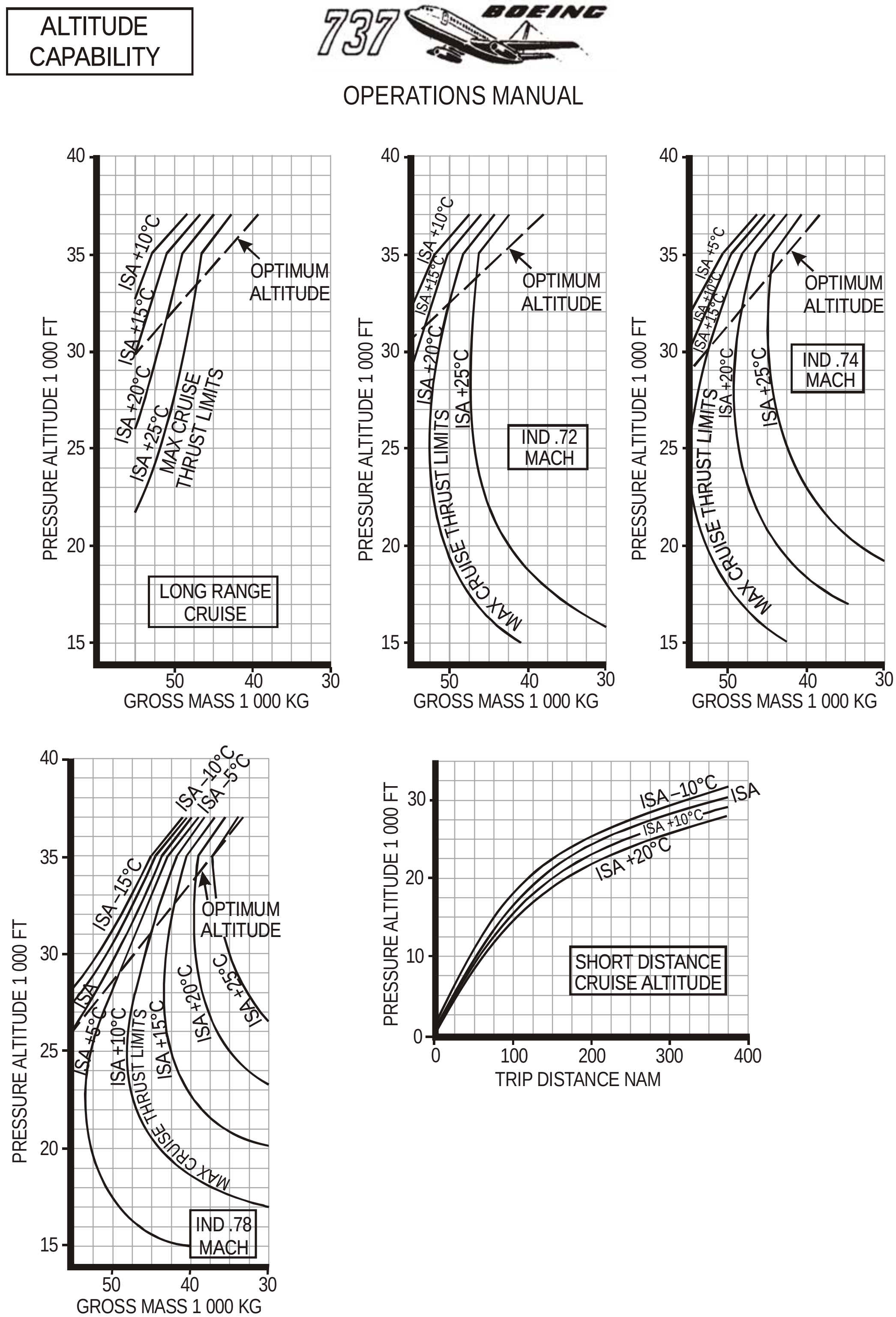


Figure A7-3. Optimum flight level (for B737) as a function of take-off mass and temperature deviation from standard

An example of a graph used for this calculation is given in Figure A7-4. This figure illustrates the effects of wind components, sometimes called "equivalent headwinds", on aircraft performance. In this connection, it should be noted that the wind component used in the still-air distance equation does not take into account only headwind or tailwind components but also the effect of crosswinds. The equivalent still-air distance is then used to calculate the fuel required for the flight, including necessary reserves.

3.4 Meteorological conditions

3.4.1 Meteorological conditions en route and meteorological conditions at destination and alternate aerodromes are elements that are superimposed on the initial flight plan based on temperature and wind. Adverse en-route weather conditions may force the choice of a flight level or route segment not conforming with the optimum one given by the flight plan, although such changes are rare with modern jet aircraft. Unfavourable conditions expected at a destination may force a delay in take-off or the preparation of additional flight plan segments to alternate aerodromes.

3.4.2 During flight, pilots may wish to optimize the aircraft performance by taking advantage of more favourable winds at another flight level. This situation may arise because initially the aircraft was unable to climb to this level due to air traffic control constraints, or it was too heavy to climb to the level with the most favourable tailwinds. As the aircraft mass progressively decreases as fuel is burned off, the pilot may request reclearance to a higher level. The information available to the pilot in considering these matters is greatly enhanced by the increased use of an on-board inertial reference system (IRS), which has the capability of giving instantaneous wind readouts. Many systems also give information on the increased headwind that can be tolerated by going to a higher level so as to take advantage of the decreased fuel consumption normally found at higher flight levels. This is usually referred to as a "wind/altitude trade".

4. APPROACH AND LANDING

4.1 For landing there are two basic considerations: the length of the runway and missed approach capability. The speed flown by the aircraft on approach is a function of the stall speed which is determined by the aircraft mass, all other things being equal. The speed on touchdown will be the indicated airspeed flown plus or minus the headwind/tailwind. The presence of a headwind means that the aircraft will land at a lower ground speed and will therefore use less distance to stop. The opposite effect is felt with a tailwind. The stopping distance on the runway is also affected by the runway being wet, as brakes are less effective in these conditions. In addition, aircraft have tailwind and crosswind limits, and again these are lower in wet conditions than in dry; typical limits are shown in Figure A7-5.

4.2 For the missed approach possibility the same factors as runway length must be considered, e.g. temperature and pressure-altitude. Also, when icing conditions are present, ice formation on the wing and fuselage will adversely affect performance. A chart illustrating the effect of relevant meteorological factors on landing performance, including climb capability for a missed approach procedure, is given in Figure A7-6.

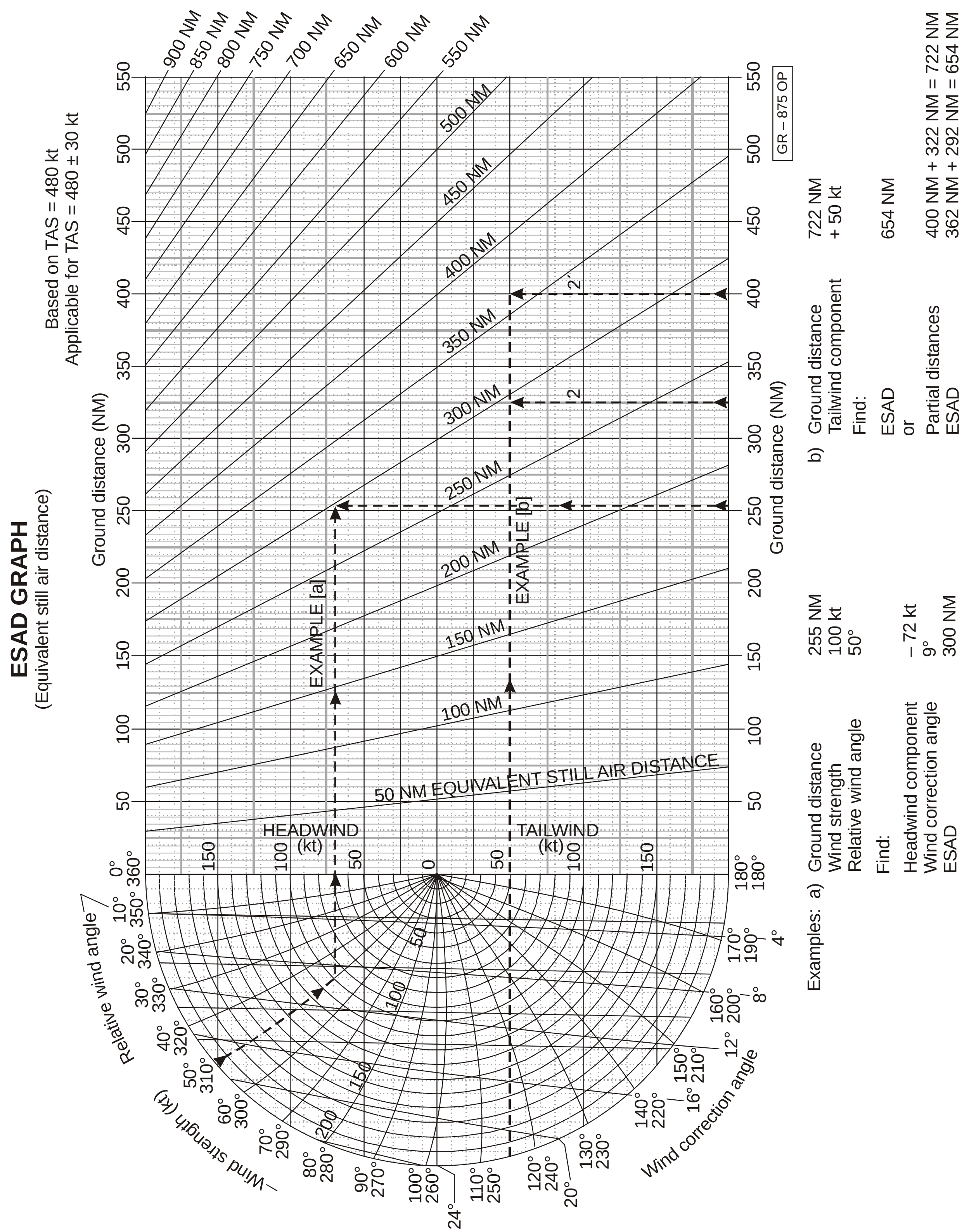


Figure A7-4. The effects of wind on aircraft performance

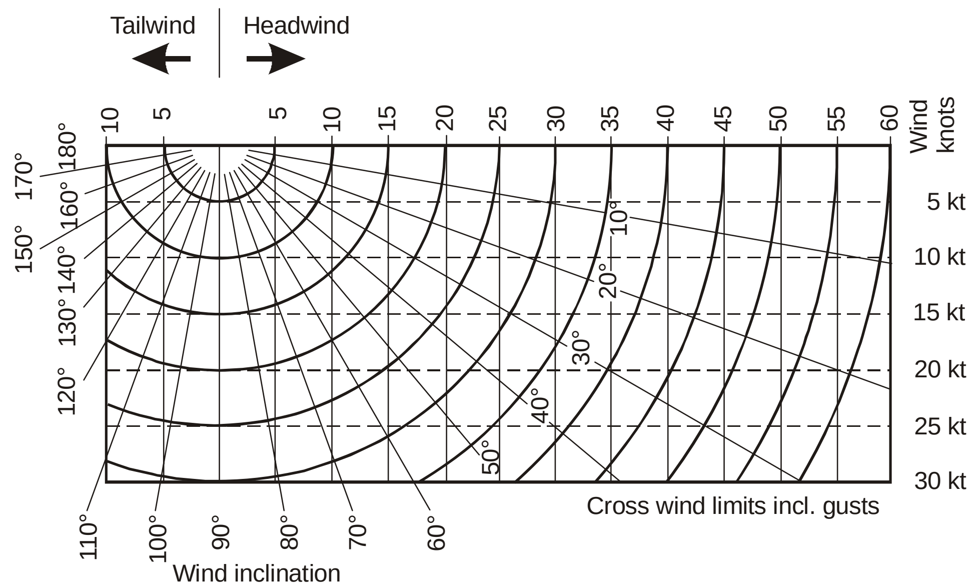


Figure A7-5. Typical wind limit diagram

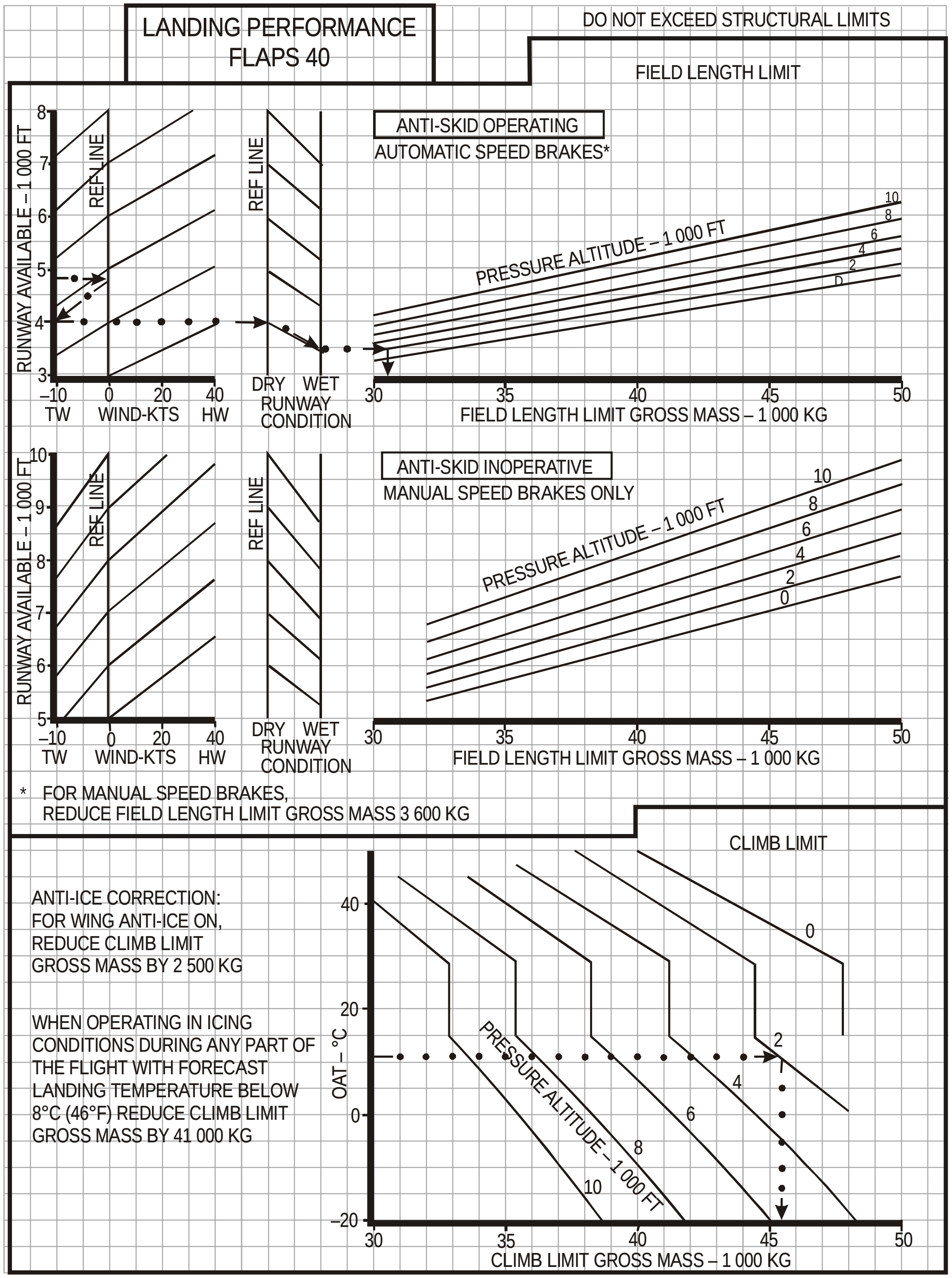


Figure A7-6. Landing performance calculations

Appendix 8

COMMONLY USED ABBREVIATIONS IN METEOROLOGICAL MESSAGES

(See 5.2.2)

(extract from the Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(PANS-ABC, Doc 8400))*

Note.— Decodes of the abbreviations should be applied in phraseologies used in meteorological briefings and consultations.

A

AAA	*(or AAB, AAC … etc., in sequence)* Amended meteorological message *(message type designator)*
ABV	Above
AC	Altocumulus
ADS-B	Automatic dependent surveillance — broadcast
ADS-C	Automatic dependent surveillance — contract
AFTN‡	Aeronautical fixed telecommunication network
AIREP†	Air-report
AIRMET†	Information concerning en-route weather phenomena which may affect the safety of low-level aircraft operations
ALT	Altitude
AMD	Amend *or* amended *(used to indicate amended meteorological message; message type designator)*
APCH	Approach
AS	Altostratus
ASHTAM	A special series NOTAM notifying, by means of a specific format, changes in activity of a volcano, a volcanic eruption and/or volcanic ash cloud that is of significance to aircraft operations
AT…	At *(followed by time at which weather change is forecast to occur)*
ATS	Air traffic services

B

BCFG	Fog patches
BECMG	Becoming
BKN	Broken
BL …	Blowing *(followed by DU = dust, SA = sand or SN = snow)*
BLW	Below …
BR	Mist
BTN	Between
BUFR	Binary universal form for the representation of meteorological data

C

… C	Centre *(preceded by runway designator number to identify a parallel runway)*
C	Degrees Celsius *(Centigrade)*
CALM▲	Calm
CAT	Clear air turbulence
CAVOK†	*(to be pronounced "KAV-OH-KAY")* Visibility, cloud and present weather better than prescribed values or conditions
CB‡	*(to be pronounced "CEE BEE")* Cumulonimbus
CC	Cirrocumulus
CCA	*(or CCB, CCC … etc., in sequence)* Corrected meteorological message *(message type designator)*
CI	Cirrus
CLD	Cloud
CLIMB-OUT	Climb-out area
COR	Correct *or* correction *or* corrected *(used to indicate corrected meteorological message; message type designator)*
CPDLC‡	Controller-pilot data link communications
CS	Cirrostratus
CTA	Control area
CU	Cumulus

D

D	Downward *(tendency in RVR during previous 10 minutes)*
DEG	Degrees
DEPO	Deposition
DIF	Diffuse
DP	Dew point temperature
DR …	Low drifting *(followed by DU = dust, SA = sand or SN = snow)*
DS	Duststorm
DU	Dust
D-VOLMET	Data link VOLMET
DZ	Drizzle

E

E	East or eastern longitude
EMBD	Embedded in a layer *(to indicate cumulonimbus embedded in layers of other clouds)*
END	Stop-end *(related to RVR)*

F

FBL	Light *(used to indicate the intensity of weather phenomena, interference or static reports, e.g. FBL RA = light rain)*
FC	Funnel cloud *(tornado or water spout)*
FCST	Forecast
FEW	Few
FG	Fog
FIR‡	Flight information region

FL	Flight level
FLUC	Fluctuating *or* fluctuation *or* fluctuated
FM …	From *(followed by time weather change is forecast to begin)*
FRONT†	Front *(relating to weather)*
FT	Feet *(dimensional unit)*
FU	Smoke
FZ	Freezing
FZDZ	Freezing drizzle
FZFG	Freezing fog
FZRA	Freezing rain

G

G …	Variations from the mean wind speed (gusts) *(followed by figures in METAR/SPECI and TAF)*
GAIN	Airspeed or headwind gain
GAMET	Area forecast for low-level flights
GR	Hail
GRIB	Processed meteorological data in the form of grid point values expressed in binary form *(meteorological code)*
GS	Small hail and/or snow pellets

H

H	High pressure area *or* the centre of high pressure
HPA	Hectopascal
HR	Hours
HURCN	Hurricane
HVY	Heavy *(used to indicate the intensity of weather phenomena, e.g. HVY RA = heavy rain)*
HZ	Haze

I

IAVW▲	International airways volcano watch
IC	Ice crystals *(very small ice crystals in suspension, also known as diamond dust)*
ICE	Icing
INC	In cloud
INTSF	Intensify *or* intensifying
ISOL	Isolated

K

KM	Kilometres
KMH	Kilometres per hour
KT	Knots

L

L	Low pressure area *or* the centre of low pressure
LAT	Latitude
LCA	Local *or* locally *or* location *or* located
LINE	Line (*used in SIGMET)*
LONG	Longitude
LOSS	Airspeed or headwind loss
LTD	Limited
LVL	Level
LYR	Layer *or* layered

M

… M	Metres *(preceded by figures)*
M …	Minimum value of runway visual range *(followed by figures in METAR/SPECI)*
MAX	Maximum
MBST	Microburst
MET†	Meteorological *or* meteorology
METAR†	Aerodrome routine meteorological report *(in meteorological code)*
MET REPORT	Local routine meteorological report *(in abbreviated plain language)*
MID	Mid-point *(related to RVR)*
MIFG	Shallow fog
MNM	Minimum
MOD	Moderate *(used to indicate the intensity of weather phenomena, interference or static reports, e.g. MODRA = moderate rain)*
MOV	Move *or* moving *or* movement
MS	Minus
MSL	Mean sea level
MT	Mountain
MTW	Mountain waves
MWO	Meteorological watch office

N

N	No distinct tendency *(in RVR during previous 10 minutes)*
N	North *or* northern latitude
NC	No change
NE	North-east
NIL*†	None *or* I have nothing to send to you
NM	Nautical miles
NOSIG†	No significant change *(used in trend-type landing forecasts)*
NOTAM†	A notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations
NS	Nimbostratus
NSC	Nil significant cloud
NSW	Nil significant weather
NW	North-west

O

OBS	Observe *or* observed *or* observation
OBSC	Obscure *or* obscured *or* obscuring
OCNL	Occasional *or* occasionally
OPMET†	Operational meteorological *(information)*
OVC	Overcast

P

P ...	Maximum value of wind speed or runway visual range *(followed by figures in METAR/SPECI and TAF)*
PL	Ice pellets
PO	Dust/sand whirls *(dust devils)*
PRFG	Aerodrome partially covered by fog
PROB†	Probability
PS	Plus
PSYS	Pressure system(s)

Q

QFE‡	Atmospheric pressure at aerodrome elevation *(or at runway threshold)*
QNH‡	Altimeter sub-scale setting to obtain elevation when on the ground

R

R …	Runway *(followed by figures in METAR/SPECI)*
RA	Rain
RAG	Ragged
RE	Recent *(used to qualify weather phenomena, e.g. RERA = recent rain)*
RNAV†	*(to be pronounced "AR-NAV")* Area navigation
ROBEX†	Regional OPMET bulletin exchange *(scheme)*
RRA	*(or RRB, RRC … etc., in sequence)* Delayed meteorological message *(message type designator)*
RTD	Delayed *(used to indicate delayed meteorological message; message type designator)*
RVR‡	Runway visual range
RWY	Runway

S

S	South *or* southern latitude
S …	State of the sea *(followed by figures in METAR/SPECI)*
SA	Sand
SC	Stratocumulus
SCT	Scattered
SE	South-east
SEA	Sea (*used in connection with sea-surface temperature and state of the sea*)
SECN	Section
SEV	Severe *(used e.g. to qualify icing and turbulence reports)*

SFC	Surface
SG	Snow grains
SH …	Shower *(followed by RA = rain, SN = snow, PL = ice pellets, GR = hail, GS = small hail and/or snow pellets or combinations thereof, e.g. SHRASN = showers of rain and snow)*
SIG	Significant
SIGMET†	Information concerning en-route weather phenomena which may affect the safety of aircraft operations
SN	Snow
SNOCLO	Aerodrome closed due to snow *(used in METAR/SPECI)*
SPECI†	Aerodrome special meteorological report *(in meteorological code)*
SPECIAL†	Local special meteorological report *(in abbreviated plain language)*
SQ	Squall
SQL	Squall line
SS	Sandstorm
STNR	Stationary
ST	Stratus
SW	South-west

T

T	Temperature
TAF†	Aerodrome forecast *(in meteorological code)*
TC	Tropical cyclone
TCAC	Tropical cyclone advisory centre
TCU	Towering cumulus
TDO	Tornado
TEMPO†	Temporary *or* temporarily
TL …	Till *(followed by time by which weather change is forecast to end)*
TN …	Minimum temperature *(followed by figures in TAF)*
TO	To … *(place)*
TOP†	Cloud top
TREND†	Trend forecast
TS	Thunderstorm *(in aerodrome reports and forecasts, TS used alone means thunder heard but no precipitation at the aerodrome)*
TS …	Thunderstorm *(followed by RA = RAIN, SN = snow, PL = ice pellets, GR = hail, GS = small hail and/or snow pellets or combinations thereof, e.g. TSRASN = thunderstorm with rain and snow)*
TURB	Turbulence
TX …	Maximum temperature *(followed by figures in TAF)*

U

U	Upward *(tendency in RVR during previous 10 minutes)*
UIR‡	Upper flight information region
UTC‡	Coordinated Universal Time

V

…V…	Variations from the mean wind direction *(preceded and followed by figures in METAR/SPECI, e.g. 350V070)*
VA	Volcanic ash

VAAC	Volcanic ash advisory centre
VC	Vicinity of the aerodrome *(followed by FG = fog, FC = funnel cloud, SH = shower, PO = dust/sand whirls, BLDU = blowing dust, BLSA = blowing sand, BLSN = blowing snow, DS = duststorm, SS = sandstorm, TS = thunderstorm or VA = volcanic ash, e.g. VCFG = vicinity fog)*
VER	Vertical
VHF‡	Very high frequency [30 MHz to 300 MHz]
VIS	Visibility
VOLMET†	Meteorological information for aircraft in flight
VRB	Variable
VV…	Vertical visibility *(followed by figures in METAR/SPECI and TAF)*

W

W	West *or* western longitude
W…	Sea-surface temperature *(followed by figures in METAR/SPECI)*
WAFC	World area forecast centre
WAFS▲	World area forecast system
WI	Within
WIND	Wind
WKN	Weaken *or* weakening
WRNG	Warning
WS	Wind shear
WSPD	Wind speed
WX	Weather

Z

Z	Coordinated Universal Time *(in meteorological messages)*

▲ Abbreviation not included in the PANS-ABC (Doc 8400).
† When radiotelephony is used, the abbreviations and terms are transmitted as spoken words.
‡ When radiotelephony is used, the abbreviations and terms are transmitted using the individual letters in non-phonetic form.
* Signal is also available for use in communicating with stations of the maritime mobile service.

Appendix 9

DISPLAY OF METEOROLOGICAL INFORMATION IN THE COCKPIT

(See 5.5)

1. INTRODUCTION

1.1 Background

1.1.1 Flight crews are now able to receive timely updates of meteorological information on cockpit displays through the continuing evolution of data link communications technology. Textual meteorological products have been available through aircraft communications and reporting service (ACARS) for many years. Graphical products are now also operationally available in the United States, and several initiatives are underway in Europe through EUROCONTROL that will result in graphical displays and cockpit applications of data link meteorological information. This cockpit access is becoming globally available through both government and private communications data link networks.

1.1.2 There are multiple options for the type of data link communications systems that may be used for transmitting meteorological information for cockpit display and user applications. There are broadcast systems that transmit a predetermined list of products on a recurring cycle (e.g. every five minutes). There are also request/reply systems that transmit specific products to a specific aircraft in response to a specific request. The broadcast and request/reply systems may also provide a contract service that only sends specific products (e.g. warnings) when they meet certain criteria. All the meteorological data link (METLINK) communications systems, however, include five basic processes or functions as described below and illustrated in Figure A9-1. The first three steps are all ground processing functions. The fourth step is the data link communications transmit/receive function (ground and aircraft). The final function is the cockpit processing for flight crew display and other cockpit user applications. The five basic functions or steps are:

a) collecting meteorological source information from various sources;

b) processing and formatting the meteorological information into aviation meteorological products;

c) processing (and segmenting or reformatting as necessary) aviation meteorological products for data link transmission;

d) transmitting and receiving the digitally-coded data into coverage volumes in the airspace; and

e) decoding, filtering (if appropriate) and displaying the data by avionics onboard the aircraft for flight crew review or other user cockpit applications.

1.2 Purpose and scope

1.2.1 The goal of providing METLINK information to flight crews is to enhance their awareness of the flight conditions and enable better strategic route planning consistent with guidance provided by ICAO and/or CAA regulations. This cockpit access supports improved and safer flight operations by providing better information to pilots for making early decisions to continue or divert a flight during hazardous weather conditions and to support optimizing flight plan changes resulting in shorter routes and/or more efficient flight profiles.

1.2.2 A key to effective use of cockpit displays and applications of METLINK products is to establish standard methods and practices in processing and displaying METLINK products (Step 5 in Figure A9-1). Establishing such standards will aid in assuring maximum possible consistency in displaying and applying METLINK products, and avoid presenting misleading information to flight crews. It will also support avionics certification and flight crew training and safety objectives.

1.2.3 Establishing standards for displaying METLINK products also identifies requirements for the ground-based processing functions, especially Step 3 and potentially Step 2. It is assumed that those steps will be specified and performed in a manner appropriate for anticipated cockpit display and user applications of METLINK products.

2. METEOROLOGICAL DATA

2.1 There are multiple categories and types of meteorological data available for METLINK. This section briefly describes those products and types along with appropriate sources for METLINK products.

2.2 Aviation weather data products and types — forecast, report and warning products

Potential METLINK products include all aviation weather data products and types included in Annex 3 and as agreed by the meteorological authority.

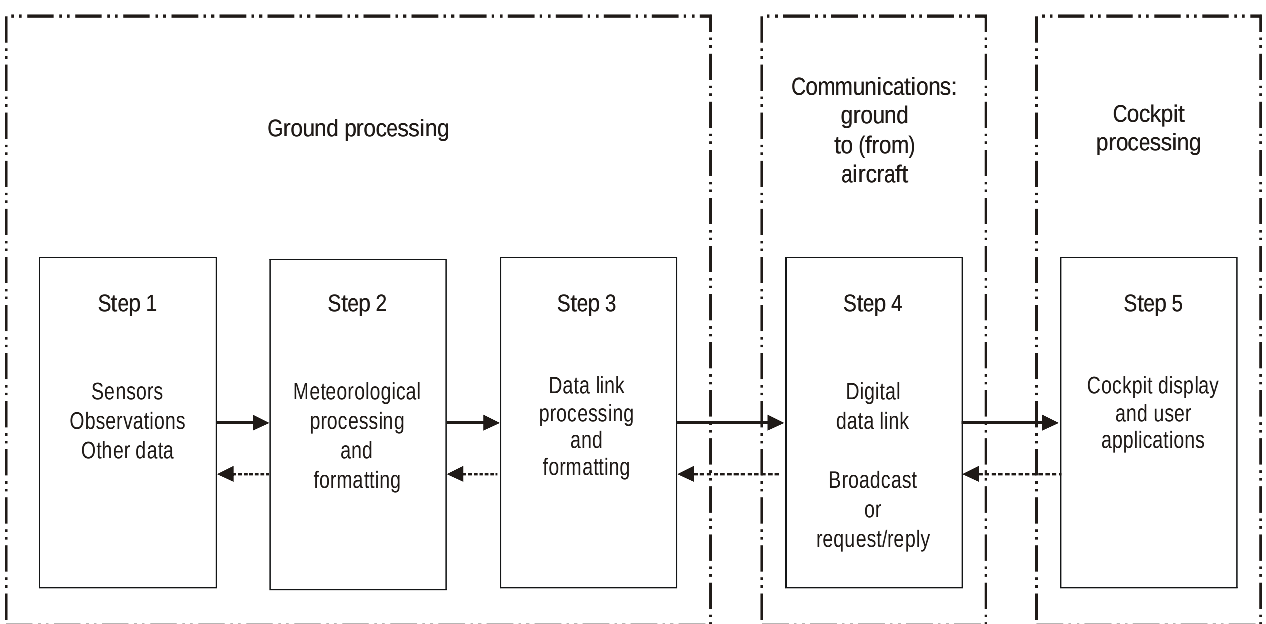


Figure A9-1. METLINK system overview

2.3 Future uplink products

Apart from the standard products specified in Annex 3, the following uplink products are useful for enhancing situational awareness in the cockpit, and could be provided subject to the agreement with the operator concerned:

a) wind profile derived from automatic downlink meteorological data;

b) weather radar images;

c) satellite images;

d) lightning location display;

e) short term forecasts (nowcasts);

f) terminal movement area (TMA) weather products for “tailored approaches”; and

g) three dimensional (3D) displays (e.g., radar, volcanic ash).

2.4 Meteorological data structures

METLINK products may include several types of meteorological data. The structure and coverage of the data will vary as suggested by the data types listed below.

a) 1D — data for a single point in time;

b) 2D — data over an area, data for cross-sections along/across flight routes or time series of data at a single location;

c) 3D — grid data over multiple levels;

d) 4D — evolution of a 3D grid over time; and

e) object-oriented.

2.5 Sources

Appropriate sources for meteorological data and/or cockpit products include: aeronautical meteorological services, MWOs, WAFCs, VAACs, TCACs, and operator and commercial databases or other sources as approved by the meteorological authority.

3. GUIDELINES FOR COCKPIT DISPLAY OF METEOROLOGICAL INFORMATION

3.1 The guidance in this document is applicable to any processing and/or display of METLINK information in the cockpit. This guidance is not exhaustive relative to all METLINK products and the absence of guidance does not imply that further requirements may not emerge. For example, ongoing research and development will contribute to the basis for further METLINK product definitions (e.g. product animations or “looping” are current topics of prototyping and human factors investigations).

3.2 Airborne processing and display

3.2.1 In the cockpit environment, the information being conveyed by METLINK products should be designed as decision aids and quickly discernable by the flight crew. The METLINK products may also be included as components of integrated processing that provides pilot route decision aids. It should be noted that the screen size available on cockpit displays is relatively small compared to ground pre-flight briefing workstations, and the METLINK product information may be integrated or overlaid on other cockpit display systems. Thus, it is highly probable that cockpit displays of METLINK products (Step 5 in Figure A9-1) will not be exact replicas of routine aviation meteorological products used for ground pre-flight briefings (Step 2).

3.2.2 Any reformatting of aviation meteorological products for METLINK cockpit display or other user application should preserve, and not understate, the display of the most intense or severe meteorological conditions regardless of projection, scaling, or any other types of processing. This requirement applies to both ground data link processing and formatting (Step 3) and cockpit processing for cockpit display and other user applications (Step 5). For example, the displayed geographical area over the earth's surface devoted to the depiction of the most severe level within a display (i.e. meteorological radar or satellite display) should not decrease following all system processing. In addition, the geo-location of meteorological area depictions should remain constant.

3.3 Essential display elements

For METLINK cockpit applications and displays, five elements are identified as essential information elements in Annex 3 for processing and displaying METLINK products. These five elements are listed below and discussed in succeeding paragraphs. They are considered essential to ensure easy recognition, correct understanding and appropriate application of METLINK information when viewed by the flight crew and/or used in other cockpit applications. These five key elements should be intuitive and easy to interpret in every METLINK product and any information beyond these key elements should not interfere with the readability or comprehension of these elements:

a) the information contained in the product;

b) the currency or age of the product;

c) the key or legend for displaying and/or decoding the product;

d) the location and/or mapping of the product; and

e) a positive, unambiguous indication of missing or corrupted data within the product.

3.4 Product content or title

Each METLINK product should include an indication of the type of information that is contained therein and as appropriate, the originating source. For example, each page displaying METLINK information should clearly indicate to the flight crew the type of information displayed, distinguishing between meteorological observations, forecasts, and warnings and alerts (e.g. METAR, SPECI, TAF, SIGMET or wind shear alerts).

3.5 Product age

Each METLINK product should include a means to determine the age and valid time(s), as appropriate, on each page displayed or for each METLINK data set. Specific METLINK product time(s) should be expressed in Coordinated Universal Time (UTC). Indications of the METLINK product age should be readily apparent to the flight crew such that they do not need to calculate the METLINK product age based on its date and time. Specifications for product age and valid time(s) for specific METLINK products are provided in the following paragraphs.

Individual meteorological observations. The date and time that the specific data is observed is the METLINK product date and time for individual meteorological observations. The observation date and time should be indicated on all displays of individual observation reports or sub-elements of those reports (e.g. METAR, SPECI, air-reports and individual meteorological radar reports).

Meteorological forecast products. The date and time the forecast product was issued and the valid time(s) for the specific forecast (e.g. the validity period of a TAF) are two separate but necessary METLINK product date(s) and time(s) for meteorological forecast products. Both the issue date and time, and the forecast validity period, should be indicated on all METLINK displays of individual forecast products.

Composite or mosaic products. These meteorological products are based on a summary or composite presentation of multiple individual observations (or forecasts) covering a defined time interval (i.e., 75 minutes for METAR/SPECI area maps and 10 minutes for weather radar mosaics). The date and time that the last individual report is incorporated into a composite or mosaic product (cut-off date and time) is the METLINK product date and time for such products.

Area METLINK map displays of mosaic precipitation based on multiple meteorological radar reports should only include single-site reports that are no more than 10 minutes prior to the cut-off date and time for that product. Any portion of a mosaic precipitation METLINK map display that exceeds the specified 10 minute requirement should be depicted as missing data.

Sequential or looping product**.** These meteorological products employ sequential replaying of historical METLINK products such as mosaic precipitation maps (e.g. weather radar mosaic maps). If a sequential METLINK data set is replayed, there should be an indication of or a means to determine the age of each METLINK data set in the sequence during replay.

Integrated product**.** Cockpit displays that integrate dissimilar METLINK products or data sets (e.g. METAR/SPECI, TAF, SIGMET, warnings and alerts) should include a means for the flight crew and/or other cockpit application to determine the age of each data set.

3.6 Product legend or key

Each METLINK product should include a legend or key that defines the meaning of any symbology or colour-coding used in the METLINK display. Each METLINK display should use consistent visual schemes, including colour, to represent different meteorological conditions. That legend or key should be easily accessible to the flight crew. The legend may optionally include other information that describes the METLINK product or data set characteristics such as the source of the product or specific production algorithm, or confidence levels for forecast products.

3.7 Product mapping or location

Each METLINK product should include geographic reference information essential for earth location and/or navigation information to facilitate flight crew use and cockpit display to include integration and/or overlay on other aircraft systems. Graphical displays should clearly indicate the geographic area covered (e.g. area defined by latitude/longitude, final approach, departure), and, when applicable, the vertical height(s) for the product (e.g. 3000 ft, 3000-5000 ft, ABV 12,000 ft).

3.8 Product missing or corrupted data

The cockpit display of METLINK products should not in any way misrepresent any METLINK information that is known to be missing or corrupted. Such missing or corrupted METLINK data should be displayed in a unique format insuring positive and unambiguous indication and location of that data. Examples include indicating areas of missing data within the region displayed that are beyond the responsibility of the issuing authority for the METLINK product displayed, due to lost or incomplete data link transmissions when decoding or reassembling the METLINK cockpit display, or areas with no contribution of data such as areas beyond the limits of meteorological radar coverage.

3.9 Product discard or suppression

The METLINK system is designed to provide timely updates of meteorological information and should only provide current METLINK products. METLINK products should be discarded or suppressed when either a newer version is received or the METLINK product expiration time is exceeded. Whenever new and/or amended observations, forecasts or other aeronautical information are received into the METLINK network, they should be incorporated into the next transmission of that METLINK product. The following general guidelines apply for discarding or suppressing METLINK products listed below. It should be noted that the States may impose more restrictive guidelines.

Note.— Trend or looping METLINK displays may include meteorological information that has expired or been superseded.

Observations (e.g. METAR/SPECI and air-report). Discard when a maximum of 120 minutes old.

Forecasts, warnings and alerts. Discard when no longer valid or when a subsequent forecast, warning or alert product is not available (e.g. flight level wind forecasts are issued every 6 hours; the forecast issued at 12 UTC should be discarded or suppressed after the time the 18 UTC forecast was due).

Composite/mosaic products. Discard 75 minutes after product creation cut-off date/time.

3.10 Text formatting and display criteria

3.10.1 Textual coded meteorological reports (e.g., METARs and TAFs) should be displayed or available for display in their original ICAO format as modified by the reporting States. If elements of such reports are extracted and displayed separately (e.g. surface visibility trend for the last three METAR reports), the integrity of the original coded text should be maintained.

3.10.2 When a METLINK product is comprised of both graphical and textual records (e.g. graphical and textual SIGMETs), a means should be provided for the flight crew to associate both records and, at a minimum, access and display the textual component of the METLINK product.

3.11 Graphic formatting and display criteria

3.11.1 Graphical METLINK products provide an efficient and effective method for conveying meteorological information to flight crews. The graphical METLINK displays should use existing conventions for plotting or displaying METLINK information to the extent those conventions are compatible with cockpit multifunction display capabilities or the flight deck philosophy. It is understood that METLINK display conventions may need to be altered to maintain consistency with other cockpit display conventions and requirements, the design philosophy of the flight deck, the display context and the intended task.

3.11.2 The use of colour in METLINK displays is recommended but is not required. For METLINK products, a consistent colour philosophy should be used throughout the display (and across applications) which is appropriate in the context of the information being displayed. To the greatest extent practical, colours should be in harmony with other sources of similar information and maintain consistency with legacy weather graphics and systems, and flight deck design. A limited number of colours should be used in a METLINK cockpit display to minimize pilot interpretation workload.

3.11.3 METLINK displays that combine multiple meteorological phenomena such as icing, turbulence and convection on a single display should use a consistent approach for depicting the various meteorological phenomena. There should be a clear differentiation between the meteorological phenomena. Colour is one technique to differentiate between the meteorological phenomena; the use of symbology is another technique (e.g. 'X' to denote lightning strikes).

3.11.4 The following table provides guidelines for sample display colours, and in some cases, sample display characters or symbols for cockpit display of precipitation based on ground meteorological radar information.

Note.— The radar intensity levels (dBZ) associated with Level 1–Level 6 provide close correlation between displays of METLINK Precipitation Products from ground meteorological radars (e.g. US NEXRAD) and installed airborne weather radar systems. There may be some small variations (e.g. 1-2 dBZ) in the quantization levels (dBZ) of METLINK Precipitation Products from different airborne weather radar sources; such variations are acceptable.

Table A9-1. Colour and symbol characterizations for METLINK precipitation product

Meteorological conditions related to the precipitation product	*Colour*	*Character/symbol*
No weather	Display background (distinct from radar intensity colours)	None
Missing Data	Distinctive colour or texture not used for background or other display elements	Distinctive character or texture not used for other display elements
Level 1: up to 30 dBZ	Green	"L" optional
Level 2: >30 – ≤40 dBZ	Amber or yellow	"M" optional
Level 3 (or greater): >40 dBZ (>40 – ≤45 dBZ if optional VIP levels used)	Red	"H" optional
(optional) Level 4: >45 – ≤50	Red or another distinguishable colour	
(optional) Level 5: >50 – 54 dBZ	Magenta	
(optional) Level 6: ≥55 dBZ	Magenta, texture may be added to aid in visual discrimination	

Appendix 10

GUIDELINES FOR ACCESS TO AERONAUTICAL METEOROLOGICAL INFORMATION

Note 1.— The "Guidelines for Access to Aeronautical Meteorological Information" were noted by the Council on 23 February 2004 (171/4).

Note 2.— The "Guidelines for Authorized Access to the World Area Forecast System (WAFS) Satellite Broadcast" noted by the Council on 5 July 1995 (145/24) provide additional guidance relevant to the subject matter (Appendix 1, section 2 refers).

1. GENERAL

1.1 Aeronautical meteorological information consists of OPMET information including the WAFS upper wind, humidity and temperature and significant weather forecasts and alphanumeric messages. The alphanumeric messages consist of tropical cyclone advisories, volcanic ash advisories, aerodrome routine meteorological reports (METAR), aerodrome special meteorological reports (SPECI), special air-reports (AIREP), aerodrome forecasts (TAF), GAMET area forecasts, route forecasts (ROFOR)[1], and SIGMET and AIRMET information.

1.2 The telecommunication facilities used for the international exchange of OPMET information should be AFS, in accordance with Annex 3 to the Convention on International Civil Aviation — *Meteorological Service for International Air Navigation* and the regional air navigation plan (ANP), Part IV — *Communications, Navigation and Surveillance* and Part VI — *Meteorology*.

1.3 Through the use of the AFS to exchange OPMET information in accordance with the regional ANP, Part VI — *Meteorology*, Contracting States will meet their obligation under Article 28 of the *Convention on International Civil Aviation* (Doc 7300) regarding the supply to users of aeronautical meteorological information for the provision of meteorological service for international air navigation.

1.4 Recovery by Contracting States of associated costs through charges on international civil aviation should be based on the principles contained in Article 15 of the *Convention on International Civil Aviation* (Doc 7300) and *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082).

Note. — Detailed guidance for determining the costs of aeronautical meteorological service is provided in the Manual on Air Navigation Services Economics *(Doc 9161).*

[1] Requirements for ROFOR have since been eliminated from Annex 3.

2. ACCESS TO AERONAUTICAL METEOROLOGICAL INFORMATION

2.1 It is the prerogative of each Contracting State to determine the distribution of the OPMET information to users, in the State concerned, as well as means to be used for this purpose.

2.2 It is for each Contracting State to determine the users in the State concerned to be provided with the access to aeronautical meteorological information. Meteorological information for international air navigation is to be provided by, or through arrangements made by, the meteorological authority as specified in Standard 2.1.4 of Annex 3 to ensure that the following users have the necessary access to aeronautical meteorological information in order to discharge their responsibilities to international air navigation or to perform their respective functions: WAFCs, and aerodrome and other meteorological offices; operators; ATS units; SAR services units; aeronautical information services units; volcanic ash and tropical cyclone advisory centres; and other aeronautical users.

Appendix 11

TEMPLATE FOR ROUTINE AIR REPORTS BY AIR-GROUND DATA LINK

Key: *M* = *mandatory, part of every message*
C = *inclusion conditional; included whenever available*

Element	*Detailed content*	*Template(s)*	*Examples*
Message type designator (M)	Type of the air-report (M)	AR	AR
Aircraft identification (M)	Aircraft radiotelephony call sign (M)	nnnnnn	VA812
Aircraft registration (M)	Aircraft registration (M)	nn[nnnnn]	4XBCD N2567GA
DATA BLOCK 1			
Latitude (M)	Latitude in degrees and minutes (M)	Nnnnn or Snnnn	S4506
Longitude (M)	Longitude in degrees and minutes (M)	Wnnnnn or Ennnnn	E01056
Level (M)	Flight level (M)	FLnnn	FL330
Time (M)	Time of occurrence in hours and minutes (M)	OBS AT nnnnZ	OBS AT 1216Z
DATA BLOCK 2			
Wind direction (M)	Wind direction in degrees true (M)	nnn/	262/
Wind speed (M)	Wind speed in metres per second(or knots) (M)	nnnMPS (or nnnKT)	040MPS (080KT)
Wind quality flag (M)	Wind quality flag (M)	n	1
Air temperature (M)	Air temperature in tenths of degrees C (M)	T[M]nnn	T127 TM455
Turbulence (C)	Turbulence in hundredths of m^2s^{-1} or m^3s^{-1} and the time of occurrence of the peak value (C)[1]	EDRnnn/nn	EDR064/08
Humidity (C)	Relative humidity in per cent (C)	RHnnn	RH054

— END —

1. The time of occurrence to be reported in accordance with Annex 3, Table A4-1.

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