

WORLD METEOROLOGICAL ORGANIZATION

GUIDELINES FOR THE EDUCATION AND TRAINING OF PERSONNEL IN METEOROLOGY AND OPERATIONAL HYDROLOGY

SUPPLEMENT No. 1:

TRAINING AND QUALIFICATION REQUIREMENTS
FOR AERONAUTICAL METEOROLOGICAL
PERSONNEL

Edited by the Expert Team on Accreditation and Certification in
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Chapter 1:

THE SCOPE AND STATUS OF THIS SUPPLEMENT

1.1 *Background information*

The recent publication WMO-No. 258, *Guidelines for the education and training of personnel in meteorology and operational hydrology*¹ describes the current WMO classification of personnel in meteorology and hydrology, and outlines curricula for the basic qualification and early specialisation of those personnel. According to this publication, the primary purpose of the WMO system of classification is “to provide an international framework for common understanding of the basic qualifications required of persons performing the meteorological and hydrological functions prescribed in the WMO Convention”.

In the gradual implementation of this system of classification, there has been found to be some ambiguous interpretation of the Guidelines in respect of the qualifications of some meteorological personnel who trained under the provision of the former classification, particularly those formerly designated as Class II. It is recalled that the former Class II meant university-level graduate personnel in some countries, but only technician-level personnel in other countries. Under the current WMO classification, only the former Class II possessing a degree (or equivalent education) would be reclassified as Meteorologists; the others would be referred to as (senior) Meteorological Technicians.

While WMO-No. 258 explicitly acknowledges, “in practice mid/senior level technicians may perform duties similar or overlap with duties of entry/mid-level meteorologists” (see section 1.3), the training and qualifications requirements for **weather forecasters** are currently only explicitly listed under the Meteorologists sections. There is consequently a possibility to misinterpret the position of Meteorological Technicians currently assigned independent weather forecasting responsibilities, but who were initially trained to the specifications set out for former Class II personnel.

However, even in those cases where the changeover from the former to the current classification may go beyond the recommended time limit (1 January 2005²), the spirit of the above provisions will stand: meeting the competency requirements stipulated under WMO-No. 258, section 2.2, sub-section “*Weather analysing and forecasting*” represent a mandatory prerequisite for any person assuming weather forecasting responsibilities, irrespective whether that person is an entry-level Meteorologist or an experienced Meteorological Technician.

Clarification of the position of former Class II personnel may also assist private firms whose staff are engaged in weather forecasting duties, particularly where they issue products for international air navigation. These staff may have been trained and qualified outside of the WMO-recommended system, and there could also be ambiguity as to the appropriateness of their training and qualifications.

¹ Hereafter, any reference to WMO-No. 258 will apply to the 4th edition (2002) Vol. I Meteorology.

² The WMO Executive Council, at its 57th session (June 2005) agreed to extend the transitional period for the implementation of the Guidelines WMO-No. 258 to 31 December 2006

1.2 Purpose

The purpose of this Supplement is to present in a concise and unambiguous manner the WMO requirements for training and qualification of aeronautical meteorological personnel (AMP), and to facilitate the development of specialized syllabi for the initial qualification of those personnel.

The Supplement should also assist both AMP who received their training under the former WMO classification scheme and staff who received training outside of the WMO system, to check that their knowledge and competences, however gained, meet the current WMO training and qualification requirements. In particular, the Supplement allows meteorological service providers to check whether their traditional Class II forecasters, who do not possess a university-level degree (or equivalent education), have received the necessary training and possess the appropriate competencies and experience. Any knowledge and/or competency shortfall can thereby be identified and corrected, ensuring that the quality of service delivery by those forecasters meets the provisions of the “ICAO Manual / WMO Guide on the Quality Management System for the Provision of Meteorological Service to International Air Navigation ” (2005).

It is stressed that the provisions of this Supplement are not new but are the result of the re-ordering and collating of existing information from WMO *Technical Regulations* (C.3.1) – Meteorological Service for International Air Navigation [WMO-No. 49, Volume II]; and from WMO-No. 258, including its companion technical publication WMO/TD-No. 1101, *Initial Formation and Specialisation of Meteorological Personnel – Syllabus Examples*. However, the opportunity has been taken to update some of the language used in these publications, in order to reflect more accurately the modern aeronautical forecasting practice.

Accordingly, this Supplement is considered an integral part of WMO-No. 258. Formal reference by the WMO *Technical Regulations* to these Guidelines (see Note [B.4] 1.2, under WMO-No. 49, Volume I, Chapter B.4) shall automatically imply references to the provisions of this Supplement.

1.3 Content and Structure

The requirements for training and qualification of AMP derive from their mission to contribute towards the safety, regularity and efficiency of international air navigation. The meteorological services required for the implementation of this mission are set out in Chapter [C.3.1] of WMO-No. 49, Volume II, which provides detailed descriptions of the functions to be carried out by the aerodrome and/or other meteorological offices (section [C.3.1.] 3), as well as of the observations and reports to be provided by the aeronautical meteorological stations (section [C.3.1.] 4). Essentially, those services are designed to:

- Observe, monitor, and predict the weather in the assigned area of responsibility.
- Provide meteorological information (observational data, forecasts and warnings) and related services in support of air navigation.
- Meet relevant international commitments under the WMO and International Civil Aviation Organization (ICAO) Conventions.

The balance between the duties and tasks implied by this mission, the precise manner in which they are carried out, and the degree to which aeronautical meteorological observers (AMO) interact and work alongside aeronautical meteorological forecasters (AMF) vary from country to country. In any case, in the context of the current WMO classification, an AMF is a Meteorologist specializing in aeronautical meteorology and an AMO is a Meteorological

Technician specializing in weather observing for aviation purposes. Those operational aeronautical forecasters who had fully qualified as “WMO Class II Meteorologists” prior to 31 December 2004, and who continue to meet all the competency requirements as set out in the current Supplement would also be categorized as AMF.

The training and qualifications requirements recommended in this Supplement are the minimum necessary for all AMP providing services for international air navigation. These requirements are expressed in terms of the:

- (a) Duties and tasks that AMF/AMO are required to perform; section 2.1/3.1 respectively.
- (b) Basic meteorological knowledge and skills that they must possess; section 2.2/3.2.
- (c) Specific knowledge and skills required in aeronautical meteorology; section 2.3/3.3.
- (d) Job competencies³ that they must be able to demonstrate; section 2.4/3.4.

The syllabus recommendations (adapted essentially from WMO/TD-No. 1101) were assembled into single checklists given in section 2.5 (for AMF) and section 3.5 (for AMO) within the working arrangements between WMO and ICAO.

In accordance with the Working Arrangements between ICAO and WMO (ICAO Doc 7475; WMO Basic Documents No. 3), ICAO is responsible for establishing the aeronautical meteorological requirements while WMO is responsible for specifying the technical methods and practices to be used in the provision of meteorological services to meet the requirements stated by ICAO. The underlying provisions are given in Annex 3 to the ICAO Convention – Meteorological Services for International Air Navigation which is issued *mutatis mutandis* by WMO as a Technical Regulation (C.3.1). Guidance to assist Members in the implementation of these provisions is contained in relevant ICAO and WMO documents which are listed in the Reference list at the end of this document.

³ WMO-No. 258 defines *job-competency* as “an ensemble of related knowledge, understanding and skills, as well as positive work attitudes, required for the efficient execution of a given job”.

Chapter 2:

AERONAUTICAL METEOROLOGICAL FORECASTERS

The basic education and training of meteorological personnel engaged in the provision of meteorological forecasts for aeronautical purposes is similar to that of all meteorological personnel engaged in operational weather forecasting. Details on the required knowledge and skills are given in WMO-No. 258, Volume I – Meteorology, Chapter 3.

However, for AMF, the weather forecasting instruction should be supplemented by special courses in aviation knowledge and procedures for meteorological service to international air navigation. Particular emphasis is to be placed on the study, analysis and forecasting of the influence of the atmosphere on the operation of aircraft. Particular hazardous weather phenomena to be considered include: low visibility and/or low cloud at aerodromes; low-level wind shear; turbulence (including clear-air turbulence); icing; thunderstorms; tropical cyclones; upper winds and temperatures; jet streams and tropopause; and volcanic ash. Syllabi for these subjects are given in section 2.3 below, which reiterates the provisions of WMO-No. 49 and WMO-No. 258.

The time taken to acquire this aeronautical meteorology specialization will primarily depend on the prior meteorological training and experience of the individual trainee. As a guide, an experienced forecaster from an alternative specialization would likely require around 60 hours tuition combined with some two to six weeks' supervised on-the-job experience in order to perform competently as an aeronautical forecaster. However, for a trainee with little forecasting experience, the aeronautical specialization would likely require a minimum of around 240 hours tuition combined with some three to nine months' supervised on-the-job experience. In order to gain the maximum benefit of the on-the-job experience, this period should encompass situations where the trainee will be exposed to both hazardous and non-hazardous weather conditions.

Alternatively, some nations could assess competency of aeronautical meteorological forecasters before they would be assigned to the position of aeronautical meteorological forecasters. Passing this assessment could be regarded as a proof of fulfilling competency requirements, irrespective of the length of the training period (which may fall outside the above recommended number of tuition hours).

2.1 Duties and tasks in aeronautical meteorological offices

The functions of meteorological offices serving international air navigation are set out in WMO-No. 49, Vol. II, C.3.1, sub-sections [C.3.1.] 3.3 and [C.3.1.] 3.4. The primary duties extracted from that Chapter might be summarised as follows:

- (a) Prepare and/or obtain forecasts and other relevant information for aerodromes, flight information regions, routes and flights with which it is concerned.
- (b) Maintain a continuous survey of meteorological conditions over the aerodromes, flight information regions and routes for which it is designated to prepare forecasts.

The extent of the office's responsibilities to prepare forecasts shall be related to the local availability and use of en-route and aerodrome forecast material received from other offices.

2.2 Knowledge and skills requirements in weather forecasting

Forecasters working in meteorological offices serving international air navigation must have the knowledge and skills to maintain an appropriate weather watch, to analyse the weather situation and to prepare and communicate weather forecasts. The guidance below is taken from WMO-No. 258, Chapter 2:

- (a) *Atmospheric processes and phenomena.* Know and be able to explain the main atmospheric processes and phenomena from the planetary to local scales; and know the region-specific weather phenomena, and be able to interpret the major meso-local scale particularities of the atmospheric dynamics over the assigned area.
- (b) *Analysing and monitoring the weather.* Analyse and interpret synoptic charts, diagrams and graphics; integrate all available data to produce a consolidated diagnosis; perform real-time weather monitoring, utilising all available remote sensing technologies such as radar surveillance and satellite imagery; constantly monitor the actual weather evolution, particularly the severe weather aspects associated with microclimates in the assigned area.
- (c) *Weather forecasting.* Know and be able to apply weather forecasting principles, methods and techniques; understand the operation of NWP models; and be able to utilize their strengths while being aware of their weaknesses. Verify, interpret and use NWP output; adding value to model or guidance forecasts where appropriate.
- (d) *User-specific forecasts and warnings.* Elaborate and distribute regional/local and user-specific forecasts; verify the ongoing forecasts; identify errors and amend erroneous forecasts as appropriate; issue warnings; and provide reliable emergency services. Comprehend users' needs and risk-taking limitations.
- (e) *Information technology and data processing.* Know and be able to use the operational system technology; and understand and be able to apply basic operating system functions, data processing and visualization technology.

2.3 Specific knowledge and skills for aeronautical forecasting

In addition to the general weather analysis and forecasting skills, an aeronautical forecaster is required to have skills in diagnosing and forecasting aviation specific phenomena, knowledge and skills in the use of aviation specific codes and practices, as well as an appreciation of the impact of their forecasts on aviation operations. These, which have been extracted from WMO-No. 258, Chapter 2, are summarized below.

- (a) *Weather phenomena.* Understand the weather phenomena hazardous to aviation, and their analysis and forecasting; understand which meteorological parameters are crucial for the safety and regular operations of aviation user groups.
- (b) *Aviation specific phenomena.* Enable to forecast aircraft icing; turbulence; wind shear; volcanic ash dispersal; other hazardous phenomena.
- (c) *Weather monitoring.* Perform continuous monitoring of weather phenomena relevant to aviation including the use of reports from aircraft where available; understand the evolution of the weather phenomena observed at the aerodrome; carry out the required observations and measurements.

- (d) *Meteorological codes.* Know all aeronautical meteorological codes, and criteria applied for warnings and change groups in TAF and TREND forecasts; follow the standard regulations contained in WMO Technical Regulations.
- (e) *Satellite and radar interpretation.* Know how to interpret satellite and radar imagery, including analysis of the evolution of convective systems, frontal systems and tropical cyclones, location of fog and stratus, gravity waves in cirrus cloud and jet streams; and detection of icing potential in layer cloud, and of volcanic ash and wind-shear.
- (f) *Weather forecasting.* Know and apply standard methods, techniques, and other numerical tools for forecasting low clouds, winds (including gusts), fog and reduced visibility, thunderstorms, heavy precipitation, hail, tropical cyclones, and volcanic ash cloud displacement; and know and apply customary algorithms and methods to forecast icing, mountain waves and turbulence (including clear-air turbulence).
- (g) *Local forecaster's responsibilities.* Perform proficiently the 'local' forecaster's responsibilities, including the evaluation and dissemination of aerodrome warnings and short period forecasts; and understand and appreciate competently the local users' operational requirements.
- (h) *Special air-reports.* Be able to assess special air-reports and, if appropriate, issue the corresponding SIGMET message.
- (i) *International Programmes.* Understand the functioning, interpretation and use of products from the World Area Forecast System (WAFS); understand the functioning, interpretation and use of products provided by the Volcanic Ash Advisory Centres (VAACs) and the requirements of the International Airways Volcano Watch (IAVW); understand the functioning of the Tropical Cyclone Advisory Centres (TCACs); and co-operate operationally with air traffic services units.
- (j) *Aviation operations.* Know meteorological aspects of flight planning; definitions; procedures for meteorological services for international air navigation; Air Traffic Services (ATS); aerodromes; operation of aircraft; Aeronautical Information Services (AIS); aeronautical telecommunications.
- (k) *WMO and ICAO documentation* – Familiarize with the documents contained in the references list.

A syllabus framework for the training required to acquire this knowledge and skill is given in section 2.5.

2.4 Competency requirements in aeronautical meteorology

In addition to the knowledge requirements set out above, a practising forecaster should have developed appropriate 'job competencies'. These comprise the characteristics that should be displayed on a day-to-day basis. They demonstrate not only that a forecaster can apply the knowledge identified in sections 2.2 and 2.3 above, but also that the knowledge has been adapted to the local area. Additional to this, job competencies also demonstrate whether the forecaster has understood the special requirements of the area of operations, and can interpret which elements of the job competencies are of high and which are of lower importance. That balance will change depending on region.

Job competency will vary from country to country and job to job but the following are the minimum generic competencies that should be demonstrated by all aeronautical forecasters:

- (a) Perform weather watch and monitoring, including the ability to detect and forecast hazards relevant to the aviation community, in accordance with ICAO and WMO requirements.
- (b) Derive forecast and warning products to the standards required by the user community.
- (c) Communicate effectively, using appropriate language, with aeronautical users, including oral briefings to pilots and dispatchers as necessary.
- (d) Tailor meteorological products and services to aviation operations, in accordance with local aviation procedures and regulatory requirements.

2.5 Syllabus framework for AMF

The training of new aeronautical meteorological forecasters is set out in detail in the Guidelines (WMO-No. 258). The following syllabus is intended to be used to both confirm that the training of existing aeronautical forecasters is adequate and to help identify any gaps or omissions so that they may be corrected and the integrity of air safety maintained. The following list, taken from WMO/TD-No. 1101, section 3.3, enumerates the topics that should be covered; however, bearing in mind that this syllabus provides the underpinning skills and knowledge for the competencies in Section 2.4, the order of presentation and the extent to which the topics are addressed may vary from one country to another depending on local conditions.

- (a) *Aircraft Icing:*
 - Theory of formation of icing; processes and dependence upon temperature, drop size, liquid-water content, airframe configuration and aircraft speed.
 - Types of icing, clear ice, rime ice, hoar frost and mixed ice.
 - Ice accretion rates; association with cloud types; thunderstorms; freezing precipitation; orographic and frontal lifting effects.
 - ICAO criteria for reporting icing.
 - Methods of diagnosing and forecasting the risk of icing, and means of avoiding icing areas.
 - Operational problems associated with icing: formation and effects of in-flight icing on different types of aircraft; formation or deposition on parked aircraft; formation of in-flight icing in engines.
- (b) *Turbulence:*
 - Turbulence near the ground; mechanical turbulence; convective turbulence; effects of boundary-layer turbulence on take-offs and landings; turbulence related to clouds, fronts and thunderstorms.
 - High-level Clear Air Turbulence (CAT); association with wind shear, jet streams, stability and tropopause inversion.
 - Mountain wave turbulence (both boundary layer and high-level).
 - Gravity waves.
 - Wake vortex.
 - ICAO criteria for reporting turbulence and mountain waves.
 - Methods of diagnosis and forecasting the risk of turbulence.

- Operational problems associated with turbulence; means of avoiding turbulence areas.
- (c) *Other hazardous phenomena:*
- Reduced surface visibility; fog types and their formation and dissipation; and other weather phenomena causing reduced surface visibility.
 - Low-level clouds; operational problems associated with low-level clouds in the terminal area and en-route.
 - Thunderstorms; associated phenomena; types: air-mass and severe thunderstorms.
 - Use of weather/Doppler radar for detecting and forecasting hazardous phenomena.
 - Wind shear; operational problems associated with wind shear in the approach and landing phases of flight.
 - Tropical cyclones; operational problems associated with tropical cyclones.
 - Volcanic ash; operational problems associated with volcanic ash.
- (d) *Meteorological services for international air navigation:*
- Air navigation plans; the associated facilities and implementation document (FASID).
 - WAFS; and World Area Forecast Centres (WAFCs) and their functions.
 - Warnings for volcanic ash; VAACs and their functions; and IAVW.
 - Warnings for tropical cyclones; TCACs and their functions.
 - Meteorological offices and their functions; trend forecasts and TAF; wind shear and aerodrome warnings.
 - Meteorological watch offices; scope of meteorological watch; SIGMET and AIRMET information.
 - Aeronautical meteorological stations; their functions; local routine and special reports, METAR and SPECI.
 - Information for operators and flight crew members prior to departure, display of meteorological information and flight documentation.
 - Information for aircraft in flight, VOLMET broadcasts and D-VOLMET.
 - Information for and from air traffic services; types of meteorological information required by ATS; transmission of aircraft meteorological reports by ATS.
 - Forms of meteorological messages; local routine and special reports; METAR and SPECI, TAF and amendments thereto; trend forecasts; route and area forecasts (including GAMET); SIGMET and AIRMET information; tropical cyclone and volcanic ash advisory; units of measurements.
 - Information for search and rescue.
 - Aeronautical climatological information.
- (e) *Meteorological aspects of flight planning:*
- Meteorological basis for flight planning: great circle track; composite tracks; wind components; minimum time tracks; D-value; drift angle.
 - Requirements for en-route and aerodrome forecasts and reports; use of forecasts from the WAFS; direct supply of information to operators for centralised operational control.
 - Preparation of area and route forecasts.
 - Briefing of flight crews and operational personnel.
- (f) *Air traffic services:*
- Visual and Instrument Flight Rules (VFR/IFR); and Visual and Instrumental Meteorological Conditions (VMC/IMC).
 - Flight Information Service, Automatic Terminal Information Service (ATIS).
 - Low Visibility Procedures (LVP)

- Air Traffic Control Service; terrain clearance; cruising level system; vertical separation minima; horizontal separation.
 - Functions of Area Control Centre, Approach Control Unit, Aerodrome Control Tower and Flight Information Centre; holding and approach procedures.
 - Search and Rescue Services.
 - CNS/ATM systems.
 - Air reporting; position reporting and meteorological reporting procedures, Automatic Dependent Surveillance (ADS).
 - Co-ordination between ATS units and the meteorological service; meteorological observations performed by ATC.
 - Transition levels, layers and altitudes; the lowest usable flight level en-route.
 - Category II and III operations; role of runway visual range and height of cloud base.
- (g) *Aerodromes:*
- Aerodrome lighting; its relation to operations in lower visibility conditions and to runway visual range (RVR) assessment.
 - Effects of meteorological parameters on aerodrome ground services; snow (snow clearing), precipitation (the effect of wet runways on braking action).
 - Parameters related to meteorology required by aerodrome authorities; aerodrome reference temperature, state of the runway, local climatological conditions (their effects on noise and atmospheric emissions by aircraft operations).
 - Aerodrome capacity management and its relation to operations in poor weather conditions.
- (h) *Operation of aircraft:*
- Aerodrome operating minima; minima applicable to the regular and alternate international aerodromes.
 - Approach systems: visual and instrumental.
 - Categories of operations.
 - Altimeter setting procedures; the ICAO Standard Atmosphere.
 - Basic flight navigation, the principal aids to navigation basic aerodynamics; methods of determining wind in flight. .
 - Effects of meteorological parameters and phenomena on aircraft performance and fuel consumption.
 - Special requirements of general aviation (IGA) and helicopter operations.
- (i) *Aeronautical information services:*
- Aeronautical Information Publication (AIP); Aeronautical Information Circular (AIC); meteorological elements required.
 - NOTAM/ASHTAM/SNOWTAM.
 - ICAO Abbreviations and Codes.
 - Information concerning the meteorological service aeronautical charts.
- (j) *Aeronautical telecommunications:*
- Organization of aeronautical telecommunications; procedures applicable to the preparation of meteorological messages.
 - Operation of the Aeronautical Fixed Service (AFS); Aeronautical Fixed Telecommunication Network (AFTN); Aeronautical Telecommunications Network (ATN).
 - Message headings, addressing of messages, priorities of messages; regional aeronautical MET telecommunication procedures (AMBEX, ROBEX).
 - Satellite distribution system for information relating to air navigation (SADIS) and international satellite communications system (ISCS).

- (k) *ICAO definitions and terms (as defined in ICAO Annex 3, Chapter 1):*
- Air-report, meteorological report, briefing, forecast, observation, GAMET area forecast, SIGMET and AIRMET information.
 - Visibility (for aeronautical purposes); prevailing visibility; runway visual range.
 - Altitude, elevation, height, density altitude, pressure altitude, flight level, cruising level, transition altitude, transition level, transition layer.
 - Operator, operator's local representative, pilot-in-command.
 - Flight information region, terminal area, controlled airspace, advisory airspace, control zone, ATS route, airway, advisory route, air traffic control service, air traffic advisory service, flight information service, alerting service; aerodrome control tower, area control centre, approach control unit.
 - Aerodrome, instrument runway, landing area, movement area, obstacle free zone, final approach, circling approach, initial visual approach, missed approach; take-off and initial climb-out phase.
 - "Service"; "provide", "issue", "make available", "supply"; "designated meteorological authority", "meteorological service provider".
- (l) *ICAO and WMO documentation – see References list.*

Chapter 3:

AERONAUTICAL METEOROLOGICAL OBSERVERS

The basic education and training of meteorological personnel engaged in meteorological observing for aeronautical purposes are similar to that of all meteorological personnel engaged in all operational weather observing. Details on the required knowledge and skills are given in WMO-No. 258, Volume I – Meteorology, Chapter 4.

However, for AMO, the weather observing instruction should be supplemented by special courses in aviation knowledge and procedures for meteorological service to international air navigation. Particular emphasis is to be placed on the observing phenomena that influence the operation of aircraft. Syllabi for these subjects are given in section 3.3 below, which reiterates the provisions of WMO-No. 49, Vol. II, and WMO-No. 258, Vol. I.

The time taken to acquire this aeronautical meteorology specialization will primarily depend on the prior meteorological training and experience of the individual trainee. As a guide, an experienced observer from an alternative specialization would likely require around 30 hours tuition combined with some two to four weeks' supervised on-the-job experience in order to perform competently as an aeronautical observer. However, for a trainee with little practical observing experience, the aeronautical specialization would likely require around 120 hours tuition training combined with a minimum two to four months' supervised on-the-job experience. In order to gain the maximum benefit of the on-the-job experience, this period should encompass situations where the trainee will be exposed to both hazardous and non-hazardous weather conditions.

Alternatively some nations could assess competency of aeronautical meteorological observers before they would be assigned to the position of aeronautical meteorological observers. Passing this assessment could be regarded as a proof of fulfilling competency requirements, irrespective of the length of the training period (which may fall outside the above-recommended number of tuition hours).

3.1 Duties and tasks in aeronautical meteorological stations

The functions of aeronautical meteorological stations serving international air navigation are set out in section 4 of WMO-No. 49, Vol. II, C.3.1. The primary tasks, extracted from sub-section [C.3.1.] 4.1.3 may be summarized as follows:

- (a) Make routine meteorological observations at fixed intervals.
- (b) Make special weather observations whenever specified changes occur in respect of surface wind, visibility, runway visual range, present weather, clouds and/or air temperature.

3.2 Knowledge and skills requirements in weather observing

In order to carry out these duties and tasks, observers need to constantly monitor the local meteorological conditions. Their training should be guided by WMO-No. 258, Chapter 2, from which the following summary has been extracted:

- (a) *Surface observations.* Make surface meteorological observations; observe and record the parameters that make up a meteorological message; encode the observations in the standard format; transmit coded information.
- (b) *Weather watch.* Analyse observations in the local area and be in a position to identify probable significant changes in weather at the station; know and understand the region-specific weather phenomena; be aware of likely weather sequences that are expected to affect the station.
- (c) *Weather alert.* Understand a basic weather briefing or forecast, so as to be able to identify changes from the expected evolution at the station; alert the duty forecaster and external users to observed changes in the weather within the local area.
- (d) *Product distribution.* Distribute data and information; disseminate messages to users; issue routine and non-routine reports in accordance with normal working practice; answer questions from users.
- (e) *Equipment maintenance.* Carry out routine maintenance of observing/office equipment; operate and maintain automated weather stations, as appropriate.

3.3 **Specific knowledge and skills for aeronautical observing**

In addition to the general observing skills, an aeronautical observer is required to constantly monitor the meteorological conditions at the aerodrome and its vicinity; and to have skills and knowledge in the use of aviation specific codes and practices as well as an appreciation of the impact of their observations on aviation operations. These, which have been extracted from WMO-No. 49, Vol. II and from WMO-No. 258, Chapter 4, are summarized below.

- (a) *Aeronautical observations.* Knowledge of the procedures for the making of routine and special observations and reports ^(*).
- (b) *Hazardous phenomena.* Elementary knowledge of the phenomena hazardous to aviation ^(**).
- (c) *Meteorological aspects of flight planning.* Knowledge of the technical regulations ^(*).
- (d) *Reporting, coding, and dissemination of weather information.* Knowledge of the technical regulations ^(*).
- (e) *Definitions.* Knowledge of the aeronautical definitions ^(**).
- (f) *Procedures for meteorological services for international aviation* ^(**).
- (g) *Air traffic services.* Knowledge of the technical regulations ^(*).
- (h) *Operation of aircraft.* Elementary knowledge of the operations ^(**).
- (i) *Aeronautical telecommunications.* Elementary knowledge of the general organization of aeronautical telecommunications ^(**).

^(*) As described in WMO-No. 49, Vol. II

^(**) As listed in the Annex to Chapter 4 of WMO-No. 258.

- (j) *WMO and ICAO documentation.* Knowledge of the documents.

A syllabus for the training required to acquire this knowledge and skill is framed in section 3.5 below.

3.4 Competency requirements in aeronautical observing

Following training, it is usual for observers to undergo a period of on-the-job training at an aviation observing office before being permitted to operate unsupervised. During this period of training, observers develop the job competencies set out in WMO-No. 258 (Annex to Chapter 4) and WMO-No. 49, learn any special procedures relevant to the country or office in which they are working and also how products are generated and issued. When establishing the minimum job competencies that an observer must reach before becoming 'independent', it is essential to understand the area of operations and to interpret which job competencies are of high and which are of lower importance. That balance will change depending on region. Therefore, a critical part of the on-the-job training is to become familiar with the procedures used in the area.

Job competencies will vary from country to country and job to job but the following are the generic competencies that should be demonstrated by an aeronautical meteorological observer:

- (a) Make and disseminate aeronautical weather observations in accordance with ICAO and WMO regulations.
- (b) Identify hazardous aviation conditions and their likely impact on aircraft operations.
- (c) Describe the impact of a range of meteorological conditions on aviation operations and procedures.
- (d) Assist the aeronautical aviation forecaster.

3.5 Syllabus framework for AMO

The training of new aeronautical meteorological observers is set out in detail in WMO-No. 258. The following syllabus is intended to be used to both confirm that the training of existing aeronautical observers is adequate and to help identify any gaps or omissions so that they may be corrected and the integrity of air safety maintained. The following list, taken from WMO-No. 258, Annex to Chapter 4, enumerates the topics that should be covered; however, bearing in mind that this syllabus provides the underpinning skills and knowledge for the competencies in Section 3.4, the order of presentation and the extent to which the topics are addressed may vary from one country to another depending on local conditions.

- (a) *Observing techniques:*
 - Surface wind direction and speed; wind variations.
 - Visibility; definition of visibility for aeronautical purposes.
 - RVR, spatial and temporal variations, methods of assessment;
 - Vertical visibility.
 - Cloud amount, height and type; spatial and temporal variations;
 - Pressure; determining QFE and QNH;

- Meteorological observing equipment calibration standards and maintenance procedures.
- (b) *Hazardous phenomena:*
- Aircraft icing; icing types; formation, accretion rates and association of icing with clouds, freezing precipitation, orographic and frontal lifting.
 - Turbulence; turbulence near the ground, high-level turbulence (CAT).
 - Reduced surface visibility.
 - Low-level clouds.
 - Thunderstorms; associated phenomena.
 - Tropical cyclones.
 - Wind shear.
 - Volcanic ash.
- (c) *Meteorological aspects of flight planning:*
- Meteorological requirements for en-route and aerodrome forecasts and reports.
 - Interpretation of area, route and terminal forecasts.
 - Preparation of material for briefing of flight crews.
- (d) *Reporting, coding and dissemination of weather information.*
- Meteorological codes related to observations and forecasts; METAR, SPECI, SYNOP, PILOT, TEMP, TAF and ROFOR.
 - Dissemination of weather information at the aerodrome; special needs of ATC units.
 - Plain language forms of meteorological messages. Local routine and special reports.
- (e) *ICAO definitions and terms:*
- Meteorological report, observation.
 - Visibility (for aeronautical purposes), runway visual ranges.
 - Altitude, elevation, height, aerodrome elevation, flight-level, transition level.
 - Aerodrome meteorological minima, instrument runway, landing area.
 - Landing forecast, aerodrome forecast, GAMET area forecast.
 - SIGMET and AIRMET information; briefing; routine and special air-report.
 - Operator, pilot-in-command.
- (f) *Meteorological services for international aviation:*
- Meteorological offices and meteorological watch offices; their functions.
 - Aeronautical meteorological stations; their functions.
 - Local routine and special observations and reports, METAR and SPECI.
 - Aircraft observations and reports; their ground-to-ground dissemination.
 - Responsibilities of ICAO and WMO in aeronautical meteorology.
- (g) *Air traffic services:*
- Meteorological information required by air traffic services units; duplicate displays required in ATS units.
 - Category II and III operations; role of runway visual range and height of cloud base information.
 - Low Visibility Procedures (LVP).
- (h) *Operation of aircraft:*
- Flight planning.
 - Navigation and landing aids.
 - Effects of meteorological parameters on aircraft performance and fuel consumption.

- Altimeter setting procedures, standard atmosphere.
 - Effects of meteorological phenomena on aerodrome ground services.
- (i) *Aeronautical telecommunications:*
- Organization of aeronautical telecommunications.
 - Aeronautical fixed service (particularly AFTN and ATN), and any special broadcasts and/or regional telecommunications networks applicable to the region concerned.
 - Message headings, addressing of messages, priorities of messages and any appropriate regional procedures.
 - ICAO abbreviations and codes.
- (j) *ICAO and WMO documentation* – see References list.

Note: Some civil aviation administrations in specific circumstances authorise air traffic services (ATS) personnel to make meteorological observations at an aerodrome. As indicated in *ICAO Annex 1— Personnel Licensing*, the training syllabi for the ATS personnel concerned should be supplemented by relevant parts of the syllabus of the Aeronautical Meteorological Technician given under items (a) to (d) above.

APPENDIX: Abbreviations and Terms

ADS	Automatic Dependent Surveillance
AFI	African Indian Ocean (ICAO Region)
AFS	Aeronautical Fixed Service
AFTN	Aeronautical Fixed Telecommunication Network
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AIREP	Air-report
AIRMET	Information concerning en-route weather phenomena which may affect the safety of low-level aircraft operations
AIS	Aeronautical Information Services
AMBEX	AFI MET Bulletin Exchange
AMF	Aeronautical Meteorological Forecaster
AMO	Aeronautical Meteorological Observer
AMP	Aeronautical Meteorological Personnel
AMS	Aeronautical Meteorological Service
ANP	Air Navigation Plan(s)
APT	Automatic Picture Transmission (satellite; now LRPT)
ARFOR	Area forecast for aviation
ASDAR	Aircraft to satellite data acquisition and relay
ASHTAM	A special series NOTAM related to volcanic eruption and/or volcanic ash clouds
ATC	Air traffic control
ATIS	Automatic Terminal Information Services
ATM	Air Traffic Management (systems)
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
AVHRR	Advanced very high-resolution radiometer (satellites)
AWS	Automatic weather station
BIP	Basic Instruction Package (WMO)
CAT	Clear air turbulence
CNS	Communication, Navigation and Surveillance (systems)
D-VOLMET	Data link-VOLMET
EC	Executive Council (WMO)
ETR	Education and Training Department of WMO
FASID	Facilities and Services Implementation Document
GAMET	Area forecast for low-level flights
GIS	Geographic Information Systems
GTS	Global Telecommunication System
HRPT	High resolution picture transmission (satellite)
IAVW	International Airways Volcano Watch
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technology
IFR	Instrument Flight Rules
IGA	International General Aviation
IMC	Instrument Meteorological Conditions
ISCS	International Satellite Communication System
IT	Information Technology (now ICT)
LRIT	Low rate information transmission (satellite, formerly APT, WEFAX)
LVP	Low Visibility Procedures
MET	Meteorology
METAR	Aerodrome routine meteorological report (<i>in meteorological code form</i>)

MOR	Meteorological optical range
MSL	Mean sea level
MSS	Message switching system
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological Service
NOTAM	A notice distributed by means of telecommunication 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
NWP	Numerical Weather Prediction
PILOT	Upper-wind report from a land station
PWS	Public Weather Services
QFE	Atmospheric pressure at aerodrome elevation (or at runway threshold)
QNH	Altimeter sub-scale setting to obtain elevation when on the ground
ROBEX	Regional OPMET Bulletin Exchange
ROFOR	Route forecast (<i>in meteorological code</i>)
RVR	Runway Visual Range
SADIS	Satellite distribution system for information relating to air navigation
SATEM	Report of satellite remote upper-air soundings of pressure, temperature and humidity
SATOB	Report of satellite observations for wind, surface temperature, cloud, humidity and radiation
SHIP	Report of surface observation from a sea station
SIGWX	Significant Weather
SIGMET	Information concerning en-route weather phenomena which may affect the safety of aircraft operations
SNOWTAM	Message describing the condition of the runways, taxiways and aprons at an aerodrome
SPECI	Aerodrome special meteorological report (<i>in meteorological code form</i>)
SYNOP	Report of surface observation from a fixed land station
TAF	Aerodrome forecast (<i>in meteorological code</i>)
TCAC	Tropical Cyclone Advisory Centre
TCP/IP	Transmission control protocol/internet protocol
TEMP	Upper-level pressure temperature, humidity and wind report from a fixed land station
TEMP DROP	TEMP message from a sonde released by carrier balloons or aircraft
TEMP SHIP	TEMP message from a sea station
VAAC	Volcanic Ash Advisory Centre
VFR	Visual Flight Rules
VISSR	Visible and infrared spin scan radiometer (satellites)
VOLMET	Meteorological information for aircraft in flight
VMC	Visual Meteorological Conditions
VSAT	Very small aperture terminal
WAFC	World Area Forecast Centre
WAFS	World Area Forecast System (ICAO)
WEFAX	Weather facsimile transmission (now LRIT)
WMO	World Meteorological Organization

REFERENCES: ICAO and WMO Documents

ICAO Annex 1: *Personnel Licensing*

ICAO Annex 3: *Meteorological Service for International Air Navigation*

ICAO Annex 6 *Operation of Aircraft, Part I – International Commercial Air Transport – Aeroplanes, Chapter 4.4.1*

ICAO Annex 15: *Aeronautical Information Services*

ICAO Doc 4444: *Procedures for Air Navigation Services – Air Traffic Management*

ICAO Doc 7030: *Regional Supplementary Procedures*

ICAO Doc 7192: *Part F-1 Meteorology for Air Traffic Controllers and Pilots; Training Manual;*

ICAO Doc 7488/3: *Manual of the ICAO standard atmosphere*

ICAO Doc 7910: *Location Indicators*

ICAO Doc 8400: *Procedures for Air Navigation Services – ICAO Abbreviations and Codes*

ICAO Doc 8896: *Manual of Aeronautical Meteorological Practice*

ICAO Doc 9328: *Manual of Runway Visual Range Observing and Reporting Practice*

ICAO Doc 9365: *Manual of All-Weather Operations*

ICAO Doc 9377: *Manual on Co-ordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services*

ICAO Doc 9691: *Manual on volcanic ash, radioactive material and toxic chemical clouds*

ICAO Doc 9766: *Handbook on the International Airways Volcano Watch – Operational Procedures and Contact List*

ICAO Doc 9817: *Manual on Low-level Wind Shear*

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ICAO Misc.: *Relevant Air Navigation Plans (ANPs and FASID)*

WMO-No. 8, 1996: *Guide to meteorological instruments and methods of observation* 6th ed.,

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WMO-No. 732, 2003: *Guide to practices for meteorological offices serving aviation*, 2nd edition; 42 pp.

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