Doc 7192
AN/857

Training Manual

Part F-1
Meteorology for Air Traffic Controllers and Pilots

Approved by the Secretary General and published under his authority

First Edition — 2002

International Civil Aviation Organization

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AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio-visual Training Aids*, which holders of this publication should consult. 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

The importance of meteorology for the safety of civil aviation has been acknowledged since the early days of aviation. The ICAO *Training Manual* has provided guidance on meteorological training for aviation operations personnel since its inception. However, this new part of the *Training Manual* is the first that is exclusively dedicated to aeronautical meteorology. This approach has been chosen to outline, in a more efficient way, the important developments which have taken place in the dissemination of meteorological information.

This manual has been prepared by the Meteorology and the Personnel Licensing and Training Sections of ICAO. It updates the meteorological part of the syllabus that is included in Doc 7192 — *Training Manual,* Part B-5 — *Integrated Commercial Pilot Course*, and provides guidance for the training of air traffic controllers.

Comments on this manual, particularly with respect to its application, usefulness and scope of coverage, would be appreciated from States, ICAO Technical Co-operation field missions and training organizations. They will be taken into consideration in the preparation of subsequent editions. Comments concerning this manual should be addressed to:

The Secretary General
International Civil Aviation Organization
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Canada

TABLE OF CONTENTS

GLOSSARY

ACC	Area control centre
ACARS	Aircraft communications addressing and reporting system
ADS	Automatic dependent surveillance
AFI	Africa-Indian Ocean
AFTN	Aeronautical fixed telecommunication network
AIP	Aeronautical information publication
AIRMET	Information concerning en-route weather phenomenon which may affect the safety of low-level aircraft operations
AIREP	A report from an aircraft in flight prepared in conformity with requirements for position and operational and/or meteorological reporting
AIS/MET	Aeronautical information service/ meteorology
AMBEX	AFI MET bulletin exchange
AMDAR	Aircraft meteorological data acquisition and relay
ANP	Air navigation plan
APP	Approach control office
ASDAR	Aircraft-to-satellite data relay
ASHTAM	A special series NOTAM notifying, by means of a specific format, change in activity of a volcano, a volcanic eruption and/or volcanic ash cloud that is of significance to aircraft operations
ATCO	Air traffic controller
ATIS	Automatic terminal information service
ATP	Airline transport pilot
ATPL	Airline transport pilot licence
ATS	Air traffic service
ATS/MET	Air traffic service/meteorology
AWOS	Automated weather observation system
CAT	Clear air turbulence
CAVOK	Visibility, cloud and present weather better than prescribed values or conditions
CP	Commercial pilot
CPDLC	Controller-pilot data link communications
CPL	Commercial pilot licence
D-ATIS	Data link automatic terminal information service
D-VOLMET	VOLMET data link service
ETD	Estimated time of departure
ETOPS	Extended range operations by twin-engined aeroplanes
EUR	European
FIC	Flight information centre
FIR	Flight information region
GAMET	Area forecast for low-level flights
GRIB	Processed meteorological data in the form of grid point values expressed in binary form
GTS	Global telecommunication system
IAVW	International airways volcano watch
ISA	International standard atmosphere
ISCS	International satellite communications system
ITCZ	Intertropical convergence zone
MET	Meteorological
MET REPORT	Local routine meteorological report
METAR	Aviation routine weather report
MOTNE	Meteorological Operational Telecommunications Network Europe
MWO	Meteorological watch office
NAT	North Atlantic
NOTAM	Notice to airmen
OPMET	Operational meteorological information
PP	Private pilot
PPL	Private pilot licence
QFE	Atmospheric pressure at aerodrome elevation
QNH	Altimeter subscale setting to obtain elevation when on the ground
ROBEX	Regional OPMET bulletin exchange
RVR	Runway visual range
SADIS	Satellite distribution system for information relating to air navigation
SIGMET	Information concerning en-route weather phenomena which may affect the safety of aircraft operations
SIGWX	Significant weather
SNOWTAM	A special series NOTAM notifying the presence or removal of hazardous conditions due to snow, ice, slush or

	standing water associated with snow, slush and ice on the movement area, by means of a specific format
SPECI	Aviation selected special weather report
SPECIAL	Local special meteorological report
SVR	Slant visual range
SYNOPs	Report of surface observation from a fixed land station
TAF	Aerodrome forecast
TCAC	Tropical cyclone advisory centre
TEMPS	Upper-level pressure, temperature, humidity and wind report from a fixed land station
TWR	Aerodrome control tower
VAAC	Volcanic ash advisory centre
VOLMET	Meteorological information for aircraft in flight
WAFC	World area forecast centre
WAFS	World area forecast system
WMO	World Meteorological Organization

Chapter 1

INTRODUCTION

1.1 While all transport is subject to weather conditions which can vary from benign to vicious, it can be argued that aviation is the most sensitive to weather conditions. Moreover, an international or small local airport can be equally affected by weather conditions. Even relatively low-speed cross-winds combined with wet runway conditions can effectively close an airport, and conditions of poor visibility can cause major disruptions to aviation schedules. Meteorological (MET) conditions may also compromise safety, efficiency and regularity of flight operations en route.

1.2 It is most important, therefore, that the air traffic controllers (ATCOs), private pilots (PPs), commercial pilots (CPs) and airline transport pilots (ATPs) have sufficient skill and knowledge to interpret MET information, reports, forecasts and warnings correctly and efficiently. They must be able to use this information when exercising their duties.

1.3 In order to ensure that the trainee fully understands the role that the local MET office and aeronautical MET station play in the preparation, coding and dissemination of weather data, it is strongly recommended that the trainee be taken on a guided tour of the nearest MET office and/or aeronautical MET station, where questions and discussion should be encouraged. It should be emphasized to the ATCO trainees that the maintenance of good coordination between the designated MET office and the respective air traffic service (ATS) units and search and rescue services centres has a major positive impact on the quality of the work of both units.

1.4 The following syllabus outlines the minimum knowledge and skill that are necessary if the ATCOs, PPs, CPs and ATPs are to perform their jobs efficiently and productively. While it may be necessary for authorities to enhance some parts of the outlined syllabus, it must not be at the expense of other parts. For the private pilot licence (PPL) instrument rating, the minimum knowledge required for commercial pilot licences (CPLs) applies.

1.5 The minimum required knowledge may be presented to ATCO trainees in two separate courses: the initial course and the ATCO licence course. The composition of the suggested course content given in Table 2-1 reflects such an arrangement.

Chapter 2

TRAINING GOALS

2.1 CONDITIONS

The trainee must be provided with all relevant documentation, examples of actual aeronautical MET reports and forecasts, and copies of all the appropriate charts and publications currently in use and relevant to flight operations. At least one visit to an aerodrome MET office and/or aeronautical MET station is strongly recommended.

2.2 PERFORMANCE

ATCO, CPL, ATPL (airline transport pilot licence): In addition to demonstrating theoretical knowledge, trainees will also be able to demonstrate practical application at every opportunity using actual aeronautical MET reports, forecasts, warnings and other aeronautical MET products[1] in conjunction with actual aviation situations and/or problems.

PPL: In addition to demonstrating basic theoretical knowledge, trainees will also be able to demonstrate sufficient practical application using actual aeronautical MET reports, forecasts and warnings.

2.3 STANDARD OF ACCOMPLISHMENT

2.3.1 The trainee shall have a thorough understanding of:

a) the basic physical principles of meteorology;

b) MET observations as well as their interpretation and dissemination; and

c) the use of MET observations in making forecasts.[1]

2.3.2 The trainee must have an adequate understanding of:

a) the general circulation and world climate;[2] and

b) weather conditions:

— at aerodromes

— along specific routes[3]

— in relevant flight information regions (FIRs) and control areas.[1]

2.3.3 The trainee should be able to understand weather conditions and make intelligent deductions therefrom.

2.4 TRAINING REFERENCE GUIDE

2.4.1 The recommended duration (in hours) and the degree of expertise of the various subjects that need to be covered for trainees with and without previous aviation experience for the ATCO, PPL, CPL and ATPL courses are presented in Tables 2-1 to 2-4, respectively.

2.4.2 In addition, the various parts of the course have been marked with a coding from 1 to 4 indicating an increasing degree of expertise to clarify understanding of the desired level of accomplishment:

1. Applicable for ATCO only.

2. Not applicable for PPL.

3. Not applicable for ATCO.

1 — denotes a basic knowledge of a subject. Trainees should have a basic understanding of the subject but are not expected to apply that knowledge.

2 — denotes knowledge of the subject and the ability, where applicable, to apply it in practice with the help of reference materials and instructions.

3 — denotes a thorough knowledge of the subject and the ability to apply it with speed and accuracy.

4 — denotes extensive knowledge of the subject and the ability to apply procedures derived from it with judgement appropriate to the circumstances.

Table 2-1. Recommended duration and degree of expertise for the ATCO course

Subject matter	*Recommended duration (hours)*		*Degree of expertise*
	*Trainees **without** previous aviation experience*	*Trainees **with** previous aviation experience*	
	33	**21**	
Initial course			
Atmosphere; atmospheric temperature and humidity			2
Atmospheric pressure			3
Pressure-wind relationship; vertical motion in the atmosphere			2
Formation of clouds and precipitation			3
Air masses and fronts; frontal depressions; weather at fronts and other parts of the frontal depression			2
Other types of pressure systems			2
Surface observations			3
Upper-air observations; station model			2
Licence course			
Winds near the earth's surface; winds in the free atmosphere			2
Turbulence; thunderstorms			3
Aircraft icing; visibility and runway visual range (RVR)			3
Volcanic ash			3
General climatology			1
MET service for international air navigation			2
Aeronautical MET reports			4
Prognostic charts			2
Aeronautical forecasts and warnings; aircraft observations and AIREPs			4
MET information for ATS units and search and rescue services centres			4
*Weather in the tropics (where the topic is considered necessary)**			2
Field trip to a local MET office and station (about 1.5 hours)			2

* When this topic is included in the course, the recommended duration becomes as follows: 34.5 hours for trainees without previous aviation experience and 22.5 hours for trainees with previous aviation experience.

Table 2-2. Recommended duration and degree of expertise for the PPL course

Subject matter	*Recommended duration (hours)*		*Degree of expertise*
	*Trainees **without** previous aviation experience*	*Trainees **with** previous aviation experience*	
	19.5	**13.5**	
Atmosphere; atmospheric temperature and humidity			1
Atmospheric pressure; pressure-wind relationships			2
Vertical motion in the atmosphere			1
Formation of clouds and precipitation; visibility and RVR			2
Winds near the earth's surface; turbulence			2
Winds in the free atmosphere			1
Thunderstorms; aircraft icing			2
Air masses and fronts; frontal depressions			1
Weather at fronts and other parts of the frontal depression; other types of pressure systems			2
Surface observations; station model			2
Upper-air observations			1
MET service for international air navigation			1
Aircraft observations and AIREPs; volcanic ash			2
Aeronautical MET reports			3
Prognostic charts			2
Aeronautical forecasts and warnings; sources of MET information			3
*Weather in the tropics (where the topic is considered necessary, 1.5 hours)**			2
Field trip to a local MET office or station (about 1.5 hours)			1

* When this topic is included in the course, the recommended duration becomes as follows: 21 hours for trainees without previous aviation experience and 15 hours for trainees with previous aviation experience.

Table 2-3. Recommended duration and degree of expertise for the CPL course

Subject matter	*Recommended duration (hours)*		*Degree of expertise*
	*Trainees **without** previous aviation experience*	*Trainees **with** previous aviation experience*	
	33	**21**	
Atmosphere; atmospheric temperature and humidity			2
Atmospheric pressure			3
Pressure-wind relationships; winds near the earth's surface; vertical motion in the atmosphere			2
Formation of clouds and precipitation; visibility and RVR			3
Winds in the free atmosphere			2
Turbulence			3
Thunderstorms; aircraft icing			3
Air masses and fronts; frontal depressions			2
Weather at fronts and other parts of the frontal depression; other types of pressure systems			3
Surface observations; station model			2
Upper-air observations			1
MET service for international air navigation			2
Volcanic ash			3
General climatology			1
Aeronautical MET reports; prognostic charts			3
Aeronautical forecasts and warnings; sources of MET information			3
Aircraft observations and AIREPs			3
*Weather in the tropics (where the topic is considered necessary)**			2
Field trip to a local MET office or station (about 1.5 hours)			2

* When this topic is included in the course, the recommended duration becomes as follows: 34.5 hours for trainees without previous aviation experience and 22.5 hours for trainees with previous aviation experience.

Table 2-4. Recommended duration and degree of expertise for the ATPL course

Subject matter	*Recommended duration (hours)*		*Degree of expertise*
	*Trainees **without** previous aviation experience*	*Trainees **with** previous aviation experience*	
	40.5	**25.5**	
Atmosphere; atmospheric temperature and humidity			2
Atmospheric pressure			3
Pressure-wind relationships; winds near the earth's surface			2
Winds in the free atmosphere; turbulence			3
Vertical motion in the atmosphere			2
Formation of clouds and precipitation			3
Thunderstorms; aircraft icing			3
Visibility and RVR; volcanic ash			3
Air masses and fronts; frontal depressions			2
Weather at fronts and other parts of the frontal depression; other types of pressure systems			3
Surface observations			3
Upper-air observations; station model			2
General climatology; weather in the tropics			2
MET service for international air navigation			2
Prognostic charts			4
Aeronautical MET reports			4
Aeronautical forecasts and warnings			4
Sources of MET information; aircraft observations and AIREPs			4
Field trip to a local MET office or station (about 1.5 hours)			2

Chapter 3

SYLLABI

Note.— The duration (hours) and the degree of expertise required for each subject are indicated under "Objective".

3.1 ATMOSPHERE

3.1.1 Objective — all courses

To outline the composition and structure of the atmosphere and the definition of the international standard atmosphere (ISA).[4]

[ATCO: 1.0/2 PPL: 0.5/1 CPL: 1.0/2 ATPL: 1.0/2]

3.1.2 Required knowledge and skill

Atmosphere

- composition
- structure:
  - — troposphere
  - — tropopause
  - — stratosphere
  - — mesosphere
  - — thermosphere

ISA

- purpose of a standard atmosphere
- definition
- description

3.2 ATMOSPHERIC TEMPERATURE AND HUMIDITY

3.2.1 Objective — all courses

To describe the physical processes related to the transfer of heat and moisture in the atmosphere; to outline the reasons for temperature and humidity variations both horizontally and vertically; and to explain the effect of temperature on the take-off performance. To indicate the units of measurement for temperature and humidity and related conversions.

[ATCO: 1.0/2 PPL: 0.5/1 CPL: 1.0/2 ATPL: 1.0/2]

3.2.2 Required knowledge and skill

Measurement of temperature

- units of measurement
- conversions

Heat transfer in the atmosphere

- mechanisms:
  - — conduction
  - — convection
  - — advection
  - — radiation
- actual heating of the atmosphere:
  - — short-wave radiation
  - — long-wave radiation
  - — absorption

Temperature at the earth's surface

- definition
- standard method of measurement
- factors that influence surface temperature
- diurnal variation (over land and water)

Atmospheric humidity

- variables used:
  - — measurement

4. Refer also to the *Manual of the ICAO Standard Atmosphere (extended to 80 kilometres (262 500 feet))* (Doc 7488).

  - — water vapour content
  - — dew-point temperature
  - — relative humidity

Adiabatic processes
- definition
- unsaturated air
- saturated air

Vertical distribution of temperature (lapse rate)
- thermodynamic charts (e.g. tephigrams):
  - — description
  - — principal uses
- lapse rate
- convection
- diurnal variations of lapse rate in the lower layers:
  - — low-level inversions/jets and their effect on take-off performance
- trade-wind inversions

Stability of the atmosphere
- definition
- stable equilibrium
- neutral equilibrium
- unstable equilibrium
- absolute stability

Effect of temperature on take-off performance

3.3 ATMOSPHERIC PRESSURE

3.3.1 Objective — all courses

To describe horizontal and vertical variations in atmospheric pressure and how pressure distributions are shown on MET charts. To indicate the units of measurement for atmospheric pressure and related conversions. To outline the MET aspects relating to altimetry.

[ATCO: 1.0/3 PPL: 1.0/2 CPL: 1.0/3 ATPL: 1.0/3]

3.3.2 Required knowledge and skill

Definition and measurement
- definition of pressure
- measurement of pressure
- units of measurement
- conversions

Pressure at sea level
- common reference
- surface synoptic chart
- lines of equal pressure (isobars)
- pressure patterns (highs, lows, troughs and ridges)
- pressure gradient
- surface pressure changes (diurnal and synoptic)

Variation of pressure with height
- reduction of pressure to aerodrome and mean sea level
- altimetry:
  - — pressure altitude, density altitude
  - — height, altitude, flight level
  - — altimeter subscale setting to obtain elevation when on the ground (QNH), atmospheric pressure at aerodrome elevation (QFE)
  - — calculation of terrain clearance, lowest usable flight level, regional QNH

Constant pressure charts
- common constant pressure levels and their standard altitudes
- lines of equal height (contours or isohypses)
- slope of the constant pressure (isobaric) surface and its relation to pressure gradient
- construction of constant pressure charts

Effect of pressure on take-off performance

Classroom exercise
- inspection of actual and forecast charts:
  - — identification of pressure patterns on surface and upper-air charts
  - — identification of pressure gradients

3.4 PRESSURE-WIND RELATIONSHIPS

3.4.1 Objective — all courses

To identify the physical factors that determine wind velocity. To indicate the units of measurement for wind and related conversions.

[ATCO: 1.0/2 PPL: 0.5/2 CPL: 1.0/2 ATPL: 1.5/2]

3.4.2 Required knowledge and skill

Definitions and measurement of wind
- definitions:
  - — wind

  - — wind direction (magnetic and true)
  - — wind speed
  - — wind velocity
  - — wind shear
  - — veering
  - — backing
- units of measurement
- conversions
- methods of measuring wind velocity

Horizontal forces acting on the air
- pressure gradient force
- Coriolis force
- centripetal force
- surface friction

Geostrophic wind (including Buys-Ballot Law)

Behaviour of the wind with increasing height including jet streams
- thermal wind concept:
  - — relationship between temperature distribution and upper winds
- jet streams:
  - — definition
  - — cause
  - — major areas and orientation
  - — maximum wind speeds
  - — cross-section of a typical jet stream
  - — low-level jet streams and associated wind shear
  - — impact on flights

Classroom exercise
- inspection of jet streams at upper air charts
- interpretation of tropopause and maximum wind charts

3.5 WIND IN THE FREE ATMOSPHERE

3.5.1 Objective

PPL

To recognize and interpret the wind and temperature fields on upper air charts. To outline the characteristics of jet streams.

ATCO, CPL

To recognize and interpret the wind and temperature fields on upper air charts. To outline the characteristics of jet streams and their impact on flights.

ATPL

To recognize and interpret the wind and temperature fields on upper air charts. To describe jet streams and their impact on flights.

[ATCO: 1.5/2 PPL: 0.5/1 CPL: 1.5/2 ATPL: 1.5/3]

3.5.2 Required knowledge and skill

Relationship between wind and isobars/contours
- geostrophic approximation:
  - — northern hemisphere
  - — southern hemisphere

3.6 WINDS NEAR THE EARTH'S SURFACE

3.6.1 Objective — all courses

To explain the principal reasons why surface winds deviate from those expected from surface pressure distribution. To describe various local winds systems.

[ATCO: 1.0/2 PPL: 0.5/2 CPL: 1.0/2 ATPL: 1.5/2]

3.6.2 Required knowledge and skill

Effects of surface friction
- gusts:
  - — winds reported averaged over two or ten minutes
- squalls
- diurnal variations in wind
- topographical effects

Local wind systems
- anabatic and katabatic winds
- land and sea breezes
- chinook (foehn) winds

Effect of surface wind on take-off and landing
- selection of runway:
  - — crosswind, tailwind limits

3.7 TURBULENCE

3.7.1 Objective

PPL

To outline the basic characteristics of atmospheric turbulence and its effect on aircraft operations. To address methods and criteria for observing and reporting turbulence. To describe mountain waves and rotors and their effect on aircraft operations.

ATCO, CPL, ATPL

To describe the characteristics of various types of atmospheric turbulence and its effect on aircraft operations. To outline methods and criteria for observing and reporting turbulence. To describe mountain waves and rotors and their effect on aircraft operations.

[ATCO: 1.5/3 PPL: 1.0/2 CPL: 1.5/3 ATPL: 1.5/3]

3.7.2 Required knowledge and skill

Types of atmospheric turbulence

Clear air turbulence (CAT)
- occurrence
- role of jet streams
- aircraft response
- ICAO criteria for reporting turbulence (both in manual and automated air-reports):
  - — nil
  - — light
  - — moderate
  - — severe

Impact of turbulence on flight operations

Technologies for turbulence detection and warning

Mountain waves (rotors)
- occurrence
- cloud types associated with mountain waves
- ICAO criteria for reporting mountain waves:
  - — moderate
  - — severe
- impact on flight operations

Wake turbulence

3.8 VERTICAL MOTION IN THE ATMOSPHERE

3.8.1 Objective — all courses

To identify the causes of vertical motion and outline in general terms its influence on aircraft operations.

[ATCO: 0.5/2 PPL: 0.5/1 CPL: 0.5/2 ATPL: 1.0/2]

3.8.2 Required knowledge and skill

Localized vertical motion
- produced by:
  - — topography
  - — convection

Widespread vertical motion
- role of convergence/divergence
- role of stability

3.9 FORMATION OF CLOUDS AND PRECIPITATION

3.9.1 Objective — all courses

To describe the processes involved in the formation of clouds and precipitation and classify clouds.

[ATCO: 1.0/2 PPL: 0.5/2 CPL: 1.5/3 ATPL: 2.0/3]

3.9.2 Required knowledge and skill

Processes involved
- condensation and related warming due to latent heat release
- evaporation and related cooling due to latent heat stored
- sublimation
- cloud constituents:
  - — water droplets
  - — ice crystals
  - — supercooled water droplets
- cloud formation:
  - — adequate moisture content
  - — cooling by conduction, radiation and adiabatic ascent
  - — adiabatic ascent predominant
- precipitation

Role of upward motion in the formation of clouds and precipitation

- turbulence:
  - — stratus/stratocumulus clouds
- convection:
  - — fair-weather cumulus
  - — cumulonimbus and associated showers
- orographic ascent:
  - — orographic clouds and associated precipitation
- slow, widespread (frontal) ascent:
  - — layer clouds and associated continuous precipitation

Classification of clouds

- low clouds (stratus, stratocumulus)
- medium-level clouds (altostratus, nimbostratus, alto-cumulus)
- high-level clouds (cirrus, cirrostratus, cirrocumulus)
- convective clouds (cumulus, cumulonimbus)
- subdivided into species based upon their:
  - — form
  - — structure
  - — physical formation process
  - — examples (lenticularis, castellanus, fractus, congestus)

Formation of various types of precipitation (including associated cloud type)

- drizzle (including freezing drizzle)
- rain (including freezing rain)
- snow (including blowing snow)
- snow grains
- ice pellets
- ice crystals
- hail
- small hail and snow pellets

Intensity of precipitation (for aeronautical purposes)

- light
- moderate
- heavy

Effect on aerodrome operations

- height of cloud base:
  - — part of aerodrome operating minima
- effect of precipitation on runway surface:
  - — liquid, freezing precipitation, snow (including slush)icing
- information on the state of runway surface:
  - — SNOWTAM (role and dissemination)
  - — runway state group (in aviation routine weather reports (METARs)/aviation selected special weather reports (SPECIs))

3.10 THUNDERSTORMS

3.10.1 Objective

PPL

To outline the characteristics and types of thunderstorms and their effects on surface weather and flight conditions. To explain the requirement for the avoidance of flight in thunderstorms.

ATCO, CPL, ATPL

To explain the characteristics, types and development stages of thunderstorms and associated phenomena, such as wind shear, and their effects on surface weather and flight conditions. To explain the requirement for the avoidance of flight in thunderstorms.

[ATCO: 1.5/3 PPL: 1.0/2 CPL: 1.5/3 ATPL: 1.5/3]

3.10.2 Required knowledge and skill

Conditions for formation

- deep layer of unstable air
- high relative humidity
- mechanism to initiate the uplift of the air:
  - — convection
  - — wind and orography
  - — convergence in frontal and non-frontal depressions

Types

- air mass thunderstorms
- severe thunderstorms:
  - — gust front and microburst
  - — supercell storm
  - — squall line

Development stages

- cumulus stage
- mature stage
- dissipating stage

Characteristics

- vertical extent
- circulation within the cloud
- precipitation within the cloud

Funnel cloud (tornado or waterspout)

Surface weather associated with thunderstorms

- gusty, turbulent winds:
  - — wind shifts

- wind shear (including gust fronts and dry and wet microbursts)
- heavy precipitation (rain and/or hail)
- changes in temperature and pressure
- lightning

Effects on aircraft operations

- aircraft operations in thunderstorms should be avoided:
  - — often impossible to get above or around the storm due to its great extent
  - — severe turbulence (also above the storm)
  - — severe icing
- aircraft take-off and landing affected by:
  - — gusty, turbulent winds
  - — wind shear (including gust fronts and micro-bursts)
  - — reduced visibility due to heavy precipitation or hail
- effects of lightning on:
  - — airframe
  - — compass and radio communications

Detection

- use of radar systems:
  - — airborne weather radar
  - — ground-based radar
  - — Doppler radar to detect wind shear
- use of satellite imagery
- use of lightning detection systems

Classroom exercise

- interpretation of processed ground-based radar data
- inspection of satellite images with cumulonimbus clouds and thunderstorms

3.11 AIRCRAFT ICING

3.11.1 Objective

PPL

To enumerate the factors that cause icing and to identify the problems associated with different types of aircraft icing. To describe criteria for reporting icing. To outline the operation of various icing protection systems.

ATCO, CPL, ATPL

To describe the factors that cause icing and the problems associated with different types of aircraft icing. To describe criteria for reporting icing. To outline the operation of various icing protection systems.

[ATCO: 1.5/3 PPL: 1.0/2 CPL: 1.5/3 ATPL: 1.5/3]

3.11.2 Required knowledge and skill

Definitions

- static air temperature
- total air temperature
- sublimation (of water vapour)
- freezing (of supercooled water droplets):
  - — predominant process for formation

Occurrence

- in clouds
- in freezing precipitation
- in temperatures above 0°C:
  - — cold-soak effect

Factors affecting the intensity of icing

- temperature
- humidity
- cloud liquid water content
- drop-size distribution
- aircraft type and speed

Forms of icing

- hoar-frost
- rime ice
- clear ice
- mixed ice

Icing intensity

- in various cloud types
- ICAO criteria for reporting icing:
  - — light
  - — moderate
  - — severe

Operational problems associated with icing

- reduced aerodynamic, propeller and engine efficiency:
  - — loss of aircraft performance
- impaired controllability due to contaminated aerofoil and asymmetric deposition of ice
- impaired cockpit vision
- air data instrument error
- loss of performance due to increased mass
- damage to airframe and engines
- strategies to minimize the effect of icing on flight operations

Common forms of ice protection
- heating
- pneumatic de-icer boots
- de-icing and anti-icing sprays:
  — type I fluid
  — type II fluid
  — inspection
  — hold-over/endurance times

3.12 VISIBILITY AND RVR

3.12.1 Objective — all courses

To define visibility and RVR. To describe the processes and conditions that result in significant visibility reduction. To address the MET components of aerodrome operating minima.

[ATCO: 1.5/3 PPL: 1.0/2 CPL: 1.5/3 ATPL: 1.5/3]

3.12.2 Required knowledge and skill

Types of visibility used in aviation
- visibility:
  — definition
  — minimum and prevailing visibility
  — observation
  — reporting
- RVR:
  — definition
  — use
  — assessment
  — units, conversions
  — reporting
- slant visual range (SVR)
- vertical visibility

MET components of aerodrome operating minima
- visibility, RVR
- height of cloud base, vertical visibility

Causes of reduced visibility
- fog and mist
- haze
- smoke
- sand and dust (widespread)
- volcanic ash
- precipitation
- sunrise/sunset effect:
  — not accounted for in MET visibility measurements

Fog types
- radiation fog
- advection fog
- upslope fog
- steaming fog
- frontal fog

3.13 VOLCANIC ASH

3.13.1 Objective

PPL

To identify the problems caused by volcanic ash. To describe warnings for volcanic ash.

ATCO, CPL, ATPL

To identify the problems caused by volcanic ash. To describe the ICAO international airways volcano watch (IAVW), warnings for volcanic ash and observations and reports on volcanic activity.

[ATCO: 1.0/3 PPL: 0.5/2 CPL: 1.0/3 ATPL: 1.5/3]

3.13.2 Required knowledge and skill

Volcanic ash and flight operations
- impact on flight operations (requirement for avoidance to be emphasized):
  — engines
  — airframe
  — instruments, radio communications
  — en route
  — at aerodromes
- detection
- reporting of volcanic ash including colour code

ICAO IAVW
- observation component
- notice to airmen (NOTAM), ASHTAM
- volcanic ash advisory centres (VAACs):
  — forecasting movement of volcanic ash clouds
- volcanic ash advisories issued
- information concerning en-route weather phenomena which may affect the safety of aircraft operations (SIGMET) information on volcanic ash clouds

Classroom exercise
- inspection of reports, warnings, advisories and products in graphical form relating to volcanic ash

3.14 AIR MASSES AND FRONTS

3.14.1 Objective — all courses

To describe air masses, their transition zones and the general weather characteristics associated with each type.

[ATCO: 0.5/2 PPL: 0.5/1 CPL: 0.5/2 ATPL: 0.5/2]

3.14.2 Required knowledge and skill

Concept of air masses
- troposphere can be divided into air masses:
  - — with different characteristics
  - — do not readily mix
  - — separated by narrow transition zones, fronts
- definition of an air mass
- air masses:
  - — source regions

Classification of air masses
- main air masses (arctic, polar, tropical)
- transition zones:
  - — arctic front
  - — polar front
  - — intertropical convergence zone (ITCZ)
  - — Mediterranean front
- subdivisions of air masses on basis of moisture content:
  - — continental
  - — maritime
- classification:
  - — maritime tropical
  - — continental tropical
  - — maritime polar
  - — continental polar
  - — maritime arctic
  - — continental arctic

Characteristics of air masses
- initial characteristics
- air mass modification

General properties of fronts
- definitions
- slope
- wind shift
- movement

3.15 FRONTAL DEPRESSIONS

3.15.1 Objective — all courses

To describe the formation and life cycle of a frontal depression.

[ATCO: 0.5/2 PPL: 0.5/1 CPL: 0.5/2 ATPL: 0.5/2]

3.15.2 Required knowledge and skill

Frontal depressions
- formation
- life cycle
- characteristics
- families of frontal depressions

3.16 WEATHER AT FRONTS AND AT OTHER PARTS OF THE FRONTAL DEPRESSION

3.16.1 Objective — all courses

To outline the surface weather and flying problems associated with fronts and other parts of the frontal depression.

[ATCO: 1.5/2 PPL: 1.0/2 CPL: 1.5/3 ATPL: 1.5/3]

3.16.2 Required knowledge and skill

Warm front
- structure
- factors determining weather at warm fronts
- surface weather changes
- flight problems associated with warm fronts

Cold front
- structure
- factors determining weather at cold fronts
- surface weather changes
- flight problems associated with cold fronts

Occluded front
- structure
- factors determining weather at occluded fronts
- surface weather changes
- flight problems associated with occluded fronts

Stationary front
- structure
- factors determining weather at stationary fronts
- surface weather changes
- flight problems associated with stationary fronts

Other parts of the frontal depression
- warm sector characteristics
- cold air mass characteristics
- upper fronts characteristics:
  — associated weather conditions

3.17 OTHER TYPES OF PRESSURE SYSTEMS

3.17.1 Objective — all courses

To describe the weather characteristics of depressions not associated with polar/arctic fronts or anticyclones.

[ATCO: 0.5/2 PPL: 0.5/2 CPL: 0.5/3 ATPL: 0.5/3]

3.17.2 Required knowledge and skill

Non-frontal depressions
- thermal depressions
- orographic depressions
- secondary depressions
- tropical cyclones (see also 3.22)
- troughs of low pressure (without fronts)

Anticyclones
- description
- general properties
- types
- ridge of high pressure
- col

3.18 SURFACE OBSERVATIONS

3.18.1 Objective — all courses

To identify types of surface observations. To address the surface observations and measurements at aerodromes.

[ATCO: 1.0/3 PPL: 0.5/2 CPL: 1.0/2 ATPL: 1.5/3]

3.18.2 Required knowledge and skill

Requirements for aviation
- routine and special observations

Elements of observations at aerodromes
- wind direction
- wind speed
- visibility
- RVR
- present weather
- cloud
- air temperature
- dew-point temperature
- pressure
- supplementary information
- differences filed by States

Automated weather observing system (AWOS)
- current limitations and related issues

Synoptic stations
- land and maritime stations

Ground-based radar observations
- principles of cloud and precipitation detection
- interpretation of radar observations

3.19 UPPER-AIR OBSERVATIONS

3.19.1 Objective — all courses

To outline the methods of making upper-air observations and the elements that are routinely measured.

[ATCO: 0.5/2 PPL: 0.5/1 CPL: 0.5/1 ATPL: 0.5/2]

3.19.2 Required knowledge and skill

Upper-wind and upper-air temperature observations
- radiosondes:
  — pressure, temperature, humidity (by radiosonde)
  — wind finding (by radar, radio or navigation aid)
- pilot balloons

Aircraft observations and reports (AIREPs)

- AIREPs and special AIREPs:[5]
  - — routine AIREPs
  - — special AIREPs
  - — other non-routine observations
- aircraft observations for MET purposes (aircraft communications addressing and reporting system (ACARS), aircraft-to-satellite data relay (ASDAR), aircraft MET data acquisition and relay (AMDAR))

Observations from MET satellites

- types of MET satellites
- types of satellite images and their interpretation
- parameters measured

3.20 STATION MODEL

3.20.1 Objective — all courses

To describe the basics of plotting surface and upper-air synoptic charts.

[ATCO: 1.0/2 PPL: 0.5/2 CPL: 1.0/2 ATPL: 1.0/2]

3.20.2 Required knowledge and skill

Collecting observations

- observations made at fixed times
- need for weather analysis and forecasting:
  - — limited value of a single observation
- analysis done by computers for the entire earth:
  - — available to States and operators in digital or chart form

Presentation of surface observations on charts

- parameters reported (in SYNOPs)
- station model

Presentation of upper-air observations on charts

- parameters reported (in TEMPs (upper-level pressure, temperature, humidity and wind report from a fixed land station))
- station model for upper-air charts

Classroom exercise

- interpretation of weather observations plotted in standard format on synoptic charts

3.21 GENERAL CLIMATOLOGY

Note.— No lectures on this topic in the PPL course.

3.21.1 Objective

ATCO, CPL, ATPL

To describe the general circulation, associated wind, pressure and weather patterns in regions for which the trainees may assume responsibilities.

[ATCO: 1.0/1 PPL: N/A CPL: 1.0/1 ATPL: 1.5/2]

3.21.2 Required knowledge and skill

Idealized general circulation

- assumption of uniform surface of the earth
- variation of heating with latitude
- circulation to transfer heat from the equator to the poles:
  - — to maintain average global temperature
- modification of circulation due to the earth's rotation
- resultant pressure distribution and air circulation:
  - — horizontal cross-sections
  - — vertical cross-sections
- identification of prevailing winds, pressure systems, fronts and tropopause

Distribution of weather elements

- global temperatures:
  - — surface temperature
  - — upper-air temperature
- global pressure patterns
- global circulation:
  - — surface wind systems
  - — upper winds
- global cloudiness and precipitation:
  - — occurrence of thunderstorms
  - — occurrence of fog
  - — occurrence of duststorms/sandstorms

5. Also to be addressed under 3.27.

Climatic classification

- Köppen's classification
- general characteristics of:
  - — polar climates (E)
  - — moist mid-latitude climates with severe winters (D)
  - — moist mid-latitude climates with mild winters (C)
  - — dry climates (B)
  - — tropical moist climates (A)

Aeronautical climatological information

3.22 WEATHER IN THE TROPICS

Note.— Except for the ATPL course, this section is to be given only in selected courses, where the subject is applicable.

3.22.1 Objective

ATPL (ATCO, PPL, CPL, where applicable)

To identify the significant features of the weather in the Tropics. To analyse tropical cyclones and to describe the operation of tropical cyclone advisory centres (TCACs).

[ATCO: 1.5/2 PPL: 1.0/2 CPL: 1.0/2 ATPL: 1.5/2]

3.22.2 Required knowledge and skill

General weather features

- small temperature contrasts (no frontal depressions):
  - — precipitation and wind systems as the main changing weather elements
- dry weather associated with subtropical anticyclones
- widespread precipitation (thunderstorms) associated with:
  - — active portions of ITCZ
  - — easterly waves
  - — tropical cyclones
  - — monsoons
- factors to be considered:
  - — diurnal effects
  - — seasonal effects
  - — orographic effects

Easterly waves

Tropical cyclones

- classification
- structure
- occurrence of tropical cyclones:
  - — regions exposed
  - — seasons
- impact on flight operations

TCACs[6]

- forecasting movement, central pressure and maximum wind of tropical cyclones
- tropical cyclone advisories issued
- SIGMET information for tropical cyclones

3.23 MET SERVICE FOR INTERNATIONAL AIR NAVIGATION

3.23.1 Objective — all courses

To outline the organization of aeronautical MET services established for the provision of MET service for international air navigation.

[ATCO: 1.0/2 PPL: 0.5/1 CPL: 1.0/2 ATPL: 1.5/2]

3.23.2 Required knowledge and skill

Role of international organizations

- role of the World Meteorological Organization (WMO):
  - — international standards (technical regulations) related to basic MET data:
    - observations
    - telecommunications
    - data processing
- role of ICAO:
  - — international Standards and Recommended Practices related to aeronautical meteorology
  - — main components:
    - world area forecast system (WAFS) IAVW
    - tropical cyclone warning system
    - MET offices
    - meteorological watch offices (MWOs) aeronautical MET stations

6. Also to be addressed under 3.23.

WAFS

- centralization of en-route forecasting at two world area forecast centres (WAFCs) in the final phase of the system:
  - — WAFC London
  - — WAFC Washington
- role of WAFCs
- products and data issued
- means of communication used
- institutional issues:
  authorized access

IAVW and tropical cyclone warning system

- centralization of services concerning volcanic ash and tropical cyclones:
  - — nine VAACs of IAVW
  - — seven TCACs
- role of VAACs and TCACs
- advisory information issued

Organization of aeronautical MET services within States

- role of the MET authority
- (aerodrome) MET office:
  - — role
  - — products and services provided:
    - aerodrome, take-off and landing forecasts (TAF, trend forecasts) aerodrome warnings and wind shear warnings
    - reliance on WAFS for en-route information for flight planning and flight documentation
    - issuance of en-route forecasts for low-level flights
    - briefing and consultation
    - display of MET information
- MWO:
  - — role (in particular, in relation to FIRs)
  - — products and services provided:
    - maintain watch over en-route weather
    - SIGMET (and AIRMET) information for the en-route phase
- aeronautical meteorology station:
  - — role
  - — products issued:
    - routine and special reports (METAR, MET REPORT, SPECI, SPECIAL)
- responsibilities assigned to States:
  - — provide in accordance with ICAO requirements MET service in the State concerned
  - — designate the MET authority
  - — reference to aeronautical publications, identifying relevant chapters:
    - Annex 3 — *Meteorological Service for International Air Navigation*[7]
    - *Manual of Aeronautical Meteorological Practice* (Doc 8896)
    - air navigation plans (ANPs/Facilities and Services Implementation Document (FASID), Part VI — *Meteorology*)
    - States' aeronautical information publications (AIPs)

Exchange of MET information

- detailed exchange requirements included in the ICAO ANPs:
  - — role of meteorology tables
- satellite broadcasts:
  - — satellite distribution system for information relating to air navigation (SADIS)
  - — international satellite communications system (ISCS)
- aeronautical fixed telecommunication network (AFTN):
  - — Meteorological Operational Telecommunications Network Europe (MOTNE)
  - — AFI MET bulletin exchange (AMBEX) scheme
  - — regional operational meteorological information (OPMET) bulletin exchange (ROBEX) scheme
- WMO global telecommunication system (GTS)

3.24 AERONAUTICAL MET REPORTS

3.24.1 Objective — all courses

To identify aeronautical MET reports and describe their decoding and interpretation.

[ATCO: 2.5/4 PPL: 1.5/3 CPL: 2.0/3 ATPL: 3.0/4]

3.24.2 Required knowledge and skill

Types of reports

- routine reports (MET REPORT, METAR)
- special reports (SPECIAL, SPECI)

7. Identical to the WMO Technical Regulations (C.3.1).

Routine reports
- reporting times:
  — reasons for greater frequency than for synoptic observations
- issued in two forms:
  — coded (routine report in the METAR code form (METAR))
  — disseminated beyond the aerodrome
  — abbreviated plain language (local routine report (MET REPORT))
  — disseminated locally at the aerodrome
- METAR code:
  — format
  — abbreviations and terminology
  — use of CAVOK
  — may be supplemented by trend forecast
  — may be supplemented by runway state groups (European (EUR) and North Atlantic (NAT) Regions)
- MET REPORT:
  — format
  — abbreviations and terminology
  — differences between METAR and MET REPORT

Special reports
- criteria
- issued in two forms:
  — coded (special report in the SPECI code form), disseminated beyond the aerodrome
  — abbreviated plain language (local special report (SPECIAL)), disseminated locally at the aerodrome
- SPECI code:
  — format similar to METAR
- SPECIAL:
  — format similar to MET REPORT

Use of reports in ATSs
- automatic terminal information service (ATIS) (in ATIS broadcasts and data link automatic terminal information service (D-ATIS))
- meteorological information for aircraft in flight (VOLMET) (in VOLMET broadcasts and VOLMET data link service (D-VOLMET))

Classroom exercise
- decoding of routine and special reports (coded and in abbreviated plain language)
- analysing a series of reports from the same station:
  — observe trend in weather
  — estimate frontal passage
- analysing a sequence of simultaneous reports for adjacent stations to identify the air masses involved and the location of fronts
- analysing a series of sequences of simultaneous reports to forecast conditions at specific stations

3.25 PROGNOSTIC CHARTS

3.25.1 Objective — all courses

To outline methods used for the preparation of prognostic charts. To describe aeronautical prognostic charts.

[ATCO: 0.5/2 PPL: 0.5/2 CPL: 1.0/3 ATPL: 1.5/4]

3.25.2 Required knowledge and skill

Methods of preparing prognostic charts
- mostly numerical methods (computer models)
- subjective methods:
  — decreasing use
  — in aeronautical meteorology: preparation of significant weather (SIGWX) charts

Aeronautical prognostic charts
- prepared and issued as part of the WAFS by:
  — WAFC London
  — WAFC Washington
- upper-wind and upper-air temperature charts
- SIGWX charts:
  — depiction of SIGWX phenomena
- for flights below FL 100:
  — charts prepared locally by the MET office

WAFS grid point forecasts in digital form
- contain upper-wind and upper-air temperature forecasts in the GRIB code
- provided by WAFC London and Washington for:
  — computer flight planning
  — issuance of upper-wind and upper-air temperature charts at MET offices

Classroom exercise
- examination and interpretation of aeronautical prognostic charts

3.26 AERONAUTICAL FORECASTS AND WARNINGS

3.26.1 Objective — all courses

To identify and interpret aeronautical weather forecasts and warnings.

[ATCO: 2.0/4 PPL: 1.0/3 CPL: 2.0/3 ATPL: 3.0/4]

3.26.2 Required knowledge and skill

Take-off forecasts

- required to plan maximum permissible take-off mass
- parameters included
- formats established by local arrangement
- required to ensure compliance with operating minima

En-route forecasts for pre-flight planning

- required for flight planning at least three hours before estimated time of departure (ETD)
- basic requirements:
  - — upper-wind and upper-air temperatures
  - — significant en-route weather
  - — valid for time and route of flight
- methods of meeting the requirements:
  - — fixed time WAFS prognostic charts
- upper-wind and upper-air temperature charts:
  - — WAFS grid point forecasts in digital format (GRIB code)
- SIGWX charts
- SIGMET information:
  - — in particular those related to tropical cyclones and volcanic ash
- specific issues related to extended range operations by twin-engined aeroplanes (ETOPS)
- GAMET (area forecast for low-level flights)

Forecasts for landing at destination/alternate

- trend-type landing forecast:
  - — METAR or SPECI followed by a two-hour trend forecast
  - — change indicators in the trend forecast
- aerodrome forecast (TAF):
  - — TAF code format

Warnings

- SIGMET/AIRMET information:
  - — en route
  - — criteria for issuance
  - — role of SIGMET information related to tropical cyclones and volcanic ash
  - — format
- aerodrome warnings:
  - — terminal area
  - — content
- wind shear warnings:
  - — terminal area
  - — format
- wake turbulence

Classroom exercise

- examination of charts and forecasts used for flight planning and included in flight documentation
- practice in decoding and interpretation of aerodrome and trend-type landing forecasts
- practice in reading of aerodrome and wind shear warnings

3.27 AIRCRAFT OBSERVATIONS AND AIREPs

3.27.1 Objective

PPL

To outline the purpose of air-reporting. To identify the requirement for special air-reports, describing their format and criteria to be applied.

ATCO, CPL, ATPL

To outline the purpose and modes of air-reporting. To identify the requirement for air-reporting, reporting procedures, format, content, criteria and dissemination pattern of various types of air-reports.

[ATCO: 1.0/4 PPL: 0.5/2 CPL: 1.5/3 ATPL: 2.0/4]

3.27.2 Required knowledge and skill

Purpose of aircraft observations and reports

- identifying conditions affecting the safety and efficiency of flight operations
- supplementing upper-air observations to contribute to the quality of WAFS forecasts

Types of aircraft observations and AIREPs

- routine AIREPs
- special AIREPs
- other non-routine aircraft observations and reports

Modes of aircraft observations and reports

- automatic by data link
- manual by voice communications

Routine AIREP

- routine AIREP by data link:
  - — preferred mode
  - — elements:
    - wind direction and speed
    - temperature
    - turbulence (if available)

    - humidity (if available)
  - — frequency of reporting:
    - 15 minutes en route
    - 30 seconds in the climb-out phase for the first 10 minutes of flight
  - — data link systems used:
    - automatic dependent surveillance (ADS) report with MET information data block
    - controller pilot data link communications (CPDLC) application "position report"
  - — dissemination:
    - to WAFC London, Washington
    - fully automated
- routine AIREP by voice communications:
  - — where air-ground data link is not available
  - — elements observed by pilots:
    - temperature
    - wind direction and speed
    - turbulence
    - aircraft icing
    - humidity (if available):
      - — detailed instructions on reporting in Appendix 1 to the PANS-ATM (Doc 4444)
    - reporting at designated ATS/MET reporting points
    - dissemination:
      - — to the associated MWO

Special AIREP

- observations made at all flight phases
- reported by voice communications or semi-automatically through suitable data link applications
- criteria for reporting identical to those for SIGMET information
- dissemination:
  - — to the associated MWO
- action by the ATS units concerned:
  - — supply the special AIREP received to aircraft in-flight until relevant SIGMET is issued by MWO

Other non-routine aircraft observations and reports

- pilot reports MET conditions affecting the safety and efficiency of flights which are not subject to special AIREPs

Classroom exercise

- interpret examples of routine AIREPs (to be reported by voice communication)
- interpret examples of special AIREPs (to be reported by voice communication)
- inspect the current list of ATS/MET reporting points

3.28 SOURCES OF MET INFORMATION

Note.— Applicable for PPL, CPL and ATPL courses only.

3.28.1 Objective

PPL, CPL and ATPL

To specify the sources of MET information for pre-flight planning. To describe the requirement for timely notifications before the flight. To outline the methods used for the provision of VOLMET.

[ATCO: N/A PPL: 0.5/3 CPL: 1.0/3 ATPL: 1.0/4]

3.28.2 Required knowledge and skill

Sources of MET information for pre-flight planning

- local MET office
- automated systems:
  - — established by the MET authority
  - — accessible through dedicated or public communications and information systems
- aeronautical information service/meteorology (AIS/MET) pre-flight planning packages
- published by the MET authority, included in the AIP

Adequate notification required from pilots and operators to MET offices

- scheduled and non-scheduled flights
- new routes and special services

Sources of MET information in flight

- ATS units concerned
- VOLMET, ATIS
- non-routine requests to be addressed to ATS units concerned

Classroom exercise

- familiarization with the services available in the State concerned

3.29 MET INFORMATION FOR ATS UNITS AND SEARCH AND RESCUE SERVICES CENTRES

Note.— Applicable for the ATCO course only.

3.29.1 Objective

ATCO

To outline MET information to be supplied to ATS units and search and rescue centres. To analyse various aspects of ATS/MET coordination.

[ATCO: 1.5/3 PPL: N/A CPL: N/A ATPL: N/A]

3.29.2 Required knowledge and skill

Requirements
- relating to:
  - — aerodrome control tower (TWR)
  - — approach control office (APP)
  - — flight information centre (FIC) or area control centre (ACC)
  - — rescue coordination centres
- format of information
- use of communications:
  - — minimum requirements for direct speech communications
  - — minimum requirements for printed communications

Designated MET offices to ATS units
- role and functions

Displays of MET instruments at ATS units
- requirements for TWR
- use of AWOS displays at TWR, APP

Observing and reporting of MET information by ATS units
- ad hoc visual MET observations by ATS personnel:
  - — to be transmitted to MET stations or offices

ATS/MET coordination
- Letter of Agreement:
  - — between the ATS and MET authorities
  - — detailed local agreements

Role of the ATS authority in establishing certain criteria for MET information
- called for in Annexes 3, 11 and the PANS-ATM (Doc 4444)
- applicable to:
  - — criteria for special observations at aerodromes
  - — requirement for routine observations at aerodromes
  - — displays of MET instruments at TWR
  - — ATS/MET reporting points, etc.

3.30 FIELD TRIP TO LOCAL MET OFFICE OR STATION

3.30.1 Objective — all courses

To outline the services and products provided to aviation by a MET office and/or an aeronautical MET station.

[ATCO: 1.5/2 PPL: 1.0/1 CPL: 1.5/2 ATPL: 1.5/2]

3.30.2 Required knowledge and skill

Introduction
- visit to the local (aerodrome) MET office
- division into small groups
- allocation of assignments to the MET staff during the visit
- copies of reports, charts and other flight documentation to be given to trainees

Objectives of the visit
- see the equipment and methods used to make observations
- witness the issuance of METAR/SPECI reports
- see the communications equipment
- see examples of reports from other aeronautical MET stations
- see examples of preparation of flight documentation
- witness preparation of surface charts and issuance of aerodrome and landing forecasts
- see briefing facilities and witness briefing and debriefing of crews
- gain insight into the role of the local MET office in the global context
- discuss typical local weather conditions

— END —

12/02, E/P1/2000

Order No. 7192F1
Printed in ICAO

ISBN 92-9194-009-7