Doc 7192-AN/857
Part D-3

training manual

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FLIGHT OPERATIONS OFFICERS/FLIGHT DISPATCHERS

SECOND EDITION — 1998

Approved by the Secretary General and published under his authority

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 applicable	Date entered	Entered by

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

FOREWORD

In 1955, the Air Navigation Commission of ICAO noted that, from time to time, requests had been received from air operators for clarification in the exercise of operational control. There was at that time a lack of universally established principles to govern the exercise of such control by operators although, in certain parts of the world, such principles and practices had long been in existence. For this reason, a circular was published which explained the concept of shared advice and responsibilities between the pilot-in-command and ground personnel, the extent of co-operation depending on many factors such as the size of the operation, the facilities available and the system of operation set up by the operator. This concept varied from simple dispatching, where the ground personnel's primary function was to assist the pilot-in-command in pre-flight planning, to en-route and post-flight assistance to the pilot-in-command, where many of the duties for the operation were shared by the ground personnel. Emphasis was placed on the responsibility for obtaining and providing information of interest to aircraft in flight. This first circular, therefore, formed the basis for consideration of this subject by the Third Air Navigation Conference of ICAO held in Montreal in 1956. The discussions were mostly related to the provision of meteorological information, and little clarification of the general concept and purpose of operational control resulted. Over the intervening years, however, many States came to the conclusion that, for the efficient and safe flow of air traffic, it was necessary to have supervision of flight operations. Flight Operations Officers, also known as Flight Dispatchers or Aircraft Dispatchers, were, therefore, introduced to provide such supervision and act as a close link between aircraft in flight and the ground services, and also between the crew members and the operator's ground staff.

In time, as the nature of the requirement for flight operations officers/flight dispatchers (FOO/FDs) stabilized and the scope of their duties and responsibilities became more defined, it was deemed necessary to establish knowledge and experience requirements and licensing provisions and these are contained in Annex 1 to the Convention on International Civil Aviation. Although these officers are not issued with licences or certificates in some States, the need for their appropriate training and qualification has been accepted throughout the world and has been provided for in international Standards and Recommended Practices. This *Flight Operations Officers/Flight Dispatchers Training Manual*, Part D-3 of Doc 7192, contains acceptable methods for approved courses of training, based on the requirements of Annexes 1 and 6 and on the generally accepted scope and nature of the requirements and duties of such officers.

The first edition, published by ICAO in 1975, was designed to provide guidance on course content, but the development of detailed syllabi and lesson plans was left to the discretion of instructors or other training centre specialist personnel. However, standardization in training courses was recognized as essential for the safe conduct of international air navigation. ICAO, through its technical co-operation programme, developed a model of a detailed training syllabus which was published as Course 201 — *Flight Operations Officers* in 1982, with the specific objective of preparing the trainee for the licensing examinations required in Annex 1[1] under 4.5.

This second edition has been developed on the basis of the first edition of Doc 7192, Part D-3, and Course 201. It contains training syllabi for flight operations officers/flight dispatchers covering knowledge requirements and applied practical training. Subject matter that must be addressed during phase one and phase two training is indicated in 1.2.5 — *Training reference guide* which also includes the approximate duration of the course (both for basic training and re-qualification training) and the degree of expertise required in each subject. Details of training included in this manual are not all-inclusive and are provided as a guideline to the minimum requirement for the training of flight operations officers/flight dispatchers. The training syllabus of FOO/FDs assigned to duties on the basis of the requirements of Annexes 1 and 6 must include syllabi suggested in this manual but should not be limited by it.

1. Throughout this document, references to Annex 1 take into account all amendments up to and including Amendment 161.

This manual has been prepared by the Personnel Licensing and Training Section of ICAO and replaces ICAO Doc 7192 — *Training Manual,* Part D-3 — *Flight Operations Officers* (First Edition, 1975) and ICAO Course 201 — *Flight Operations Officers* (August 1982). ICAO would like to acknowledge the contribution received from the International Federation of Airline Dispatchers Federation (IFALDA) and individual experts who have provided support, advice and input.

Throughout this manual, the use of the male gender should be understood to include male and female persons.

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

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SELECTED ABBREVIATIONS

ADF Automatic direction finder
AFTN Aeronautical fixed telecommunication network
AID Aeronautical Inspection Directorate
AIP Aeronautical information publication
AIREP Air-report
AIS Aeronautical information service
ATC Air traffic control
ATIS Automatic terminal information service
ATM Air traffic management
ATS Air traffic service
BOW Basic operating weight (mass)
CADC Central air-data computer
CDU Control and display unit
CG Centre of gravity
CofA Certificate of airworthiness
CP Critical point
CRM Crew resource management
DME Distance measuring equipment
DOW Dry operating weight (mass)
DRM Dispatch resource management
ETOPS Extended range operations by aeroplanes with two turbine power-units
FIR Flight information region
FIS Flight information service
FOO/FD Flight operations officer/flight dispatcher
GNSS Global navigation satellite system
IATA International Air Transport Association
IAVW International airways volcano watch
ILS Instrument landing system
INS Inertial navigation system
ITCZ Inter-tropical convergence zone
LMC Last-minute change
LOFT Line-oriented flight training
MAC Mean aerodynamic chord
MAT Mass/altitude/temperature
MEL Minimum equipment list
METAR Aviation routine weather report
MMEL Master minimum equipment list
MNPS Minimum navigation performance specifications
MPTOW Maximum permissible take-off operating weight (mass)
MPZFW Maximum permissible zero-fuel operating weight (mass)
MTT Minimum time track
NDB Non-directional radio beacon
NOTAC Notification to the captain (pilot-in-command)
NOTAM Notices to airmen
PANS Procedures for air navigation services
PNR Point of no return
RMI Radio magnetic indicator
RNAV Area navigation
RVR Runway visual range
SID Standard instrument departure
SPECI Aviation selected special weather report
STAR Standard instrument arrival
TAS True airspeed
TOW Take-off weight (mass)
UTC Coordinated universal time
VFR Visual flight rules
VOR VHF omnidirectional radio range
WAFC World area forecast centre
WAFS World area forecast system
WMO World Meteorological Organization (United Nations Agency)
ZFW Zero-fuel weight (mass)

CHAPTER 1. TRAINING PRINCIPLES

1.1 Regulatory requirements

1.1.1 Paragraph 4.2.1.3 of Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes*, requires that operators demonstrate an adequate organization, method of control and supervision of flight operations, training programme and maintenance arrangements consistent with the nature and extent of the operations specified. A flight operations officer/flight dispatcher (FOO/FD) is normally employed to provide supervision of flight and to act as a close link between aircraft in flight and the ground services, and also between the air crew and the operator's ground staff. The duties of flight operations officers/flight dispatchers are specified in section 4.6 of Annex 6, Part I.

1.1.2 The requirements in respect of age, knowledge, experience and skill for the licensing of flight operations officers/flight dispatchers, when employed in conjunction with a method of flight supervision in accordance with 4.2.1 of Annex 6, Part I, are detailed in Annex 1 — *Personnel Licensing*. Annex 1 and Annex 6 specifications are used by States as a basis for their national regulations both for the licensing of flight operations officers/flight dispatchers and for approving operators' flight supervisory systems and the training of said personnel.

1.1.3 The successful application of regulations concerning the safety and regularity of aircraft operation and the achievement of regulatory objectives are greatly dependent on the appreciation by all individuals concerned of the risks involved and on a detailed understanding of the regulations. This can only be achieved by properly planned and maintained initial and recurrent training programmes for all persons involved in aircraft operation. Flight operations officers/flight dispatchers play a significant role in the safe operation of an aircraft, and international regulations require that they be appropriately trained.

1.2 Training requirements

1.2.1 Principal duties

1.2.1.1 The principal duties of the flight operations officer/flight dispatcher (FOO/FD) as specified in Annex 6, Part I, are:

a) assist the pilot-in-command in flight preparation and provide the relevant information required;

b) assist the pilot-in-command in preparing the operational and ATS flight plans, sign when applicable and file the ATS flight plan with the appropriate ATS unit;

c) furnish the pilot-in-command while in flight, by appropriate means, with information which may be necessary for the safe conduct of the flight; and

d) in the event of an emergency, initiate such procedures as may be outlined in the operations manual.

1.2.1.2 It must be noted that some States go beyond Annex 6 requirements and prescribe the sharing of responsibility between the pilot-in-command and the FOO/FD for certain elements affecting the safety of flight operations; for example, in one State this is regulated along the following lines:

> "Joint responsibility of aircraft dispatcher and pilot-in-command: The aircraft dispatcher and the pilot-in-command shall be jointly responsible for the pre-flight planning, delay, and dispatch release of the flight in compliance with ... appropriate regulations."

1.2.1.3 In both situations, the FOO/FD relieves the pilot-in-command of a considerable burden by providing him with the opportunity to consult on critical and non-critical issues with professionals who are familiar with all factors bearing on an operation and have the knowledge of the whole network of operations of which any particular flight is only a part.

1.2.1.4 During flight, a continued assessment of flight conditions, the monitoring of fuel adequacy, and the recommendation of alternative plans such as diversion necessitate an extension of the pre-flight duties throughout the course of the actual flight operation. The advent of improved ground/air communications allows the FOO/FD to relay to an aircraft information received after it has become airborne, thus increasing the value of the "in-flight" assistance.

1.2.1.5 The FOO/FD not only contributes to the safety and regularity of flight operations but also makes a positive contribution to the economy and efficiency of aircraft operation by improving the payload, reducing excessive fuel reserve, positioning or repositioning the aircraft more efficiently, and saving flying hours by reducing the number of abortive flights. The FOO/FD must constantly know the position and monitor the progress of all flights in his area, and this involves a constant process of analysis, evaluation, consultation and decision. The FOO/FD must at all times have the courage of his convictions and let nothing influence him contrary to his better judgement.

1.2.1.6 In applying these basic philosophies and, in particular, bearing in mind the need to keep the aircraft operating safely and efficiently, the FOO/FD must always:

a) plan conservatively;

b) failing normal operation, plan so as to give the best alternative service; and

c) keep flights operating on schedule in so far as possible.

1.2.1.7 Planning must be based upon realistic assumptions since the inevitable results of overoptimism are delays, inconvenience to passengers and uneconomical utilization of the aircraft, all of which can impact the safety of the operation.

1.2.1.8 In preparing the necessary basic material and criteria that will help the pilot-in-command decide on some of the essential features of each flight, the FOO/FD must:

a) consult with the meteorological office and refer to meteorological information, as necessary;

b) issue information concerning operations plans to the appropriate departments of the operator's organization;

c) issue such instructions concerning aircraft and crew utilization as are necessary to the appropriate departments of the operator's organization;

d) consider with the pilot-in-command the existence of, and method of ensuring compliance with, noise abatement procedures;

e) ascertain load requirements;

f) determine load availability;

g) outline to the pilot-in-command what may be expected in the way of en-route and terminal weather, explain how other flights have been planned or what they have encountered en route, indicating their altitude, procedure, ground speed, etc., and offer suggestions that may be of help to the pilot-in-command in his flight planning;

h) advise the pilot-in-command on the routes, altitudes, tracks and technical stops that will be necessary and what alternate aerodromes are considered suitable for the various terminals, and why;

i) determine fuel requirements, aircraft gross weight and balance (the pilot-in-command makes an independent calculation);

j) bring to the pilot-in-command's attention any irregular operation of airport, airway, navigation or communication facilities, with particular regard to noise curfews affecting the availability of airports; and

k) outline what may be expected in the way of delays to or irregularities in the flight while en route or what is expected of other flights operating over the route at the same time.

1.2.1.9 During the in-flight stage, the FOO/FD must be ready to assist the pilot-in-command, for example:

a) by issuing such instructions concerning revised plans for aircraft and crew utilization as are necessary to the appropriate departments of the operator's organization, if a diversion, flight return, en-route delay, or cancellation occurs;

b) by recommending revised routes, altitudes and alternates;

c) by advising the pilot-in-command of commercial and technical considerations of which he could not be aware and which could influence operational decisions, such as enforced diversion to an alternate destination;

d) by monitoring adequacy of remaining fuel; and

e) by supplying or arranging for the supply of supplementary information (including significant weather information, irregularities in operation of navigation and communication facilities, etc.) to the pilot.

1.2.1.10 When such irregularities in flight operations occur, the FOO/FD must look far ahead and consider the many factors involved in order to determine the most practical plan or solution. Some of the main factors are as follows:

a) How long will the flight be delayed, or when is it expected to operate?

b) How long can the flight be delayed?

Note.— The exigencies of crew flight time limitation legislation render this consideration one of the critical factors in flight departure delays or flight time extension. The possible need to warn a fresh crew or to revise the flight schedule must be foreseen and planned for.

c) In the event that the flight is delayed beyond the maximum limit established or is cancelled, what is the best alternative for passengers and cargo?

d) How will the delay affect other sections of the airline and can they keep operating on schedule?

e) Is there an aircraft available to originate the flight at the next terminal ahead and what is the most practical time to so originate?

f) What is the second best point to originate the flight?

g) What is the latest time the flight can originate and still allow necessary placement of aircraft?

h) Is there revenue available at the time origination is most desired?

i) If necessary to cancel, what is the best time in order to fit in with alternative transportation?

j) How can the plans of an FOO/FD be integrated by the FOO/FD who will next handle the flight?

1.2.1.11 In the event of a security incident on an aircraft, the FOO/FD assumes significant responsibilities for the operational aspects of any actions initiated from the ground. He must also be prepared to render the pilot-in-command and crew every possible assistance during the emergency.

1.2.1.12 Delays in and irregularities of operation often upset crew members and passengers and may significantly affect aircraft cycles. Therefore, it is necessary for the FOO/FD to check closely with the operator's departments responsible for crew and aircraft routing in order to maintain a well-balanced positioning of crew and aircraft for the smooth operation of all flights.

1.2.1.13 These are some of the factors that normally govern the day-to-day practical work of the FOO/FD. The degree of responsibility given to him varies from State to State and from operator to operator; it varies from the complex level where the FOO/FD is almost considered the counterpart of the pilot-in-command, to a position of limited importance. In the former case he is normally required to be licensed, enabling him to sign and approve operational flight plans, while in the latter case his duties may be limited to clerical assistance only. There is a marked tendency, however, for States and operators to make increased use of FOO/FDs, giving them extensive duties and responsibilities.

1.2.1.14 To undertake the duties and responsibilities described above, an FOO/FD must be appropriately trained in all the subjects required for adequate control and supervision of aircraft operation. As a specialist, an FOO/FD needs to demonstrate a high sense of responsibility, dependability and the ability to think clearly and to make appropriate decisions as required. The training of FOO/FDs should, invariably, include several stages of selection in order to eliminate trainees lacking the necessary qualities.

1.2.2 Minimum qualifications

Annex 1, section 4.5, specifies the minimum requirements for the issuance of the FOO/FD licence. Although Annex 1 does not provide direct guidance on the qualifications required (e.g. educational level) for admittance to training school for FOO/FDs, experience has shown that successful completion of training generally requires:

— a minimum age of 20 years;

— a functional knowledge of the English language;

— a medical fitness for duty; and

— a minimum educational level of successful completion of high school (10 years of schooling or more).

1.2.3 Types of training

1.2.3.1 Annex 1 mentions various forms of past aviation experience that are adequate for the FOO/FD, and many States select their FOO/FD trainees from personnel who have had such aviation experience. However, other States have found it necessary to train persons who do not have such previous experience and who must, therefore, be trained from the very beginning and allowed to obtain the necessary experience either during their training or immediately after it. It is obvious that the training requirements of these two groups of trainees will vary.

1.2.3.2 To cover the various backgrounds of trainees, it is recommended that training be divided into two phases as follows:

Phase one consists of basic knowledge; its completion ensures that a trainee has the necessary background to proceed with phase two of the training. The training syllabus covered in Chapters 3 to 15 needs to be covered during this phase.

Phase two consists of applied practical training and route experience. A training syllabus for this phase is detailed in Chapter 16 and guidance on training duration is provided in Table 1-1.

1.2.3.3 Trainees who do not have previous aviation experience will have to undergo the complete training programme as recommended in phase one. Trainees who have had suitable aviation experience, however, may not need to undertake this complete programme; for example, a professional pilot, a flight navigator, an air traffic controller, or a flight radio operator can be assumed to have, at least, partially completed phase one if they have been actively employed in these occupations within the past few years. In such cases, training institutes, with the approval of the State authorities, are encouraged to apply the necessary flexibility in arranging appropriate training courses, emphasizing subjects of particular concern to FOO/FDs. The same flexibility can also be applied during requalification or recurrent classroom training. Table 1-1 provides an approximate duration for the training of the FOO/FD (phase one). It also contains a shortened training duration to serve as a guideline for the training of experienced personnel and for the requalification of FOO/FDs.

1.2.3.4 In using the curriculum recommended in the following chapters, local considerations may dictate the advisability of changing the sequence of the subjects. However, the relative importance accorded to each subject should, as much as possible, remain unchanged. The multiplicity of types of aircraft, navigation aids and operational practices throughout the world makes it undesirable to define too rigidly many of the headings of the syllabus, and it is necessary to leave some flexibility to those in charge of the training course. Instructors must, however, ensure that all items in the training manual syllabus are adequately covered and any requirements relevant to individual authorities should be treated as additional subjects and not as substitutions for the syllabus recommended in this manual. Instructors must also ensure that all items required in their State's licensing examination are adequately covered. Any choices in the examination itself should be confined to the additional subjects dealing with those practices and procedures which the trainee is most likely to use in the first period of his duties as an FOO/FD. This choice of additional subjects will very often be made easy by specific requests by operators, and by the type of aircraft used operationally.

1.2.4 Standard of accomplishment

1.2.4.1 Each training objective in this manual is described with reference to the establishment of conditions, performance and a standard of accomplishment. The conditions describe the scenario where trainee performance will be developed and tested while indicating whether actual equipment, mock-ups, or simulators, etc., are to be used. The standard of accomplishment establishes the level of trainee performance that must be attained and may differ from school to school depending on the training equipment available.

1.2.4.2 In measuring the standard of accomplishment, the use of only two grades, *pass* and *fail*, is recommended. It must, however, be noted that many training establishments prefer to use a numerical grading system as trainees strive harder and learn more when rewards increase. If the same grade, *pass*, is given for a 99 per cent score as for a 75 per cent score, trainees may not strive for perfection.

1.2.5 Training reference guide

1.2.5.1 Table 1-1 presents the recommended duration (in hours) of the various subjects that need to be covered during phase one training (basic knowledge) for trainees with and without previous aviation experience, and Phase two (applied practical training). In appreciation of the fact that differences in requirements may necessitate changes in the suggested syllabus to allow completion of the course within the period allotted for training, the total hours required for the completion of a subject are given. Instructors should, however, ensure that all sections of the syllabus are adequately covered to the necessary degree in order to meet the desired level of accomplishment before the trainees are assigned to phase two training.

1.2.5.2 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 – 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 1-1. Recommended duration and degree of expertise for phase one and phase two training

PHASE ONE — BASIC KNOWLEDGE

Subject matter	*Recommended duration (hours)*		*Degree of expertise*
	*Trainees **without** previous aviation experience*	*Trainees **with** previous aviation experience*	
Chapter 3 — Civil air law and regulations	**30**	**18**	
Certification of operators			2
The Convention on International Civil Aviation (The Chicago Convention)			2
International air transport issues addressed by the Chicago Convention			2
The International Civil Aviation Organization (ICAO)			2
Responsibility for aircraft airworthiness			3
Regulatory provisions of the flight manual			3
The aircraft minimum equipment list (MEL)			3
The operations manual			3
Chapter 4 — Aviation indoctrination	**12**	**6**	
Regulatory			3
Aviation terminology and terms of reference			3
Theory of flight and flight operations			2
Aircraft propulsion systems			2
Aircraft systems			2
Chapter 5 — Aircraft mass (weight) and performance	**27**	**15**	
Basic principles for flight safety			3
Basic mass (weight) and speed limitations			3
Take-off runway requirements			3
Climb performance requirements			3
Landing runway requirements			3
Buffet boundary speed limitations			3
Chapter 6 — Navigation	**24**	**12**	
Position and distance; time			3
True, magnetic and compass direction; gyro heading reference and grid direction			2
Introduction to chart projections: The gnomonic projection; the Mercator projection; great circles on Mercator charts; other cylindrical projections; Lambert conformal conic projection; the polar stereographic projection			2
ICAO chart requirements			3
Charts used by a typical operator			3
Measurement of airspeeds; track and ground speed			3

Subject matter	*Recommended duration (hours)* Trainees **without** previous aviation experience	Trainees **with** previous aviation experience	*Degree of expertise*
Use of slide-rules, computers and scientific calculators			3
Measurement of aircraft altitude			3
Point of no return; critical point; general determination of aircraft position			3
Introduction to radio navigation; ground-based radar and direction-finding stations; relative bearings; VOR/DME-type radio navigation; instrument landing systems			2
Navigation procedures			3
ICAO CNS/ATM systems (an overview)			1
Chapter 7 — Air traffic management	**39**	**21**	
Introduction to air traffic management			2
Controlled airspace			3
Flight rules			3
ATC clearance; ATC requirements for flight plans; aircraft reports			3
Flight information service (FIS)			3
Alerting service and search and rescue			3
Communications services (mobile, fixed)			3
Aeronautical information service (AIS)			3
Aerodrome and airport services			3
Chapter 8 — Meteorology	**42**	**21**	
Atmosphere; atmospheric temperature and humidity			2
Atmospheric pressure; pressure-wind relationships			2
Winds near the Earth's surface; wind in the free atmosphere; turbulence			3
Vertical motion in the atmosphere; formation of clouds and precipitation			2
Thunderstorms; aircraft icing			3
Visibility and RVR; volcanic ash			3
Surface observations; upper-air observations; station model			3
Air masses and fronts; frontal depressions			2
Weather at fronts and other parts of the frontal depression; other types of pressure systems			2
General climatology; weather in the tropics			1
Aeronautical meteorological reports; analysis of surface and upper-air charts			3
Prognostic charts; aeronautical forecasts			3
Meteorological service for international air navigation			4
Field trip to local meteorological office			2

Subject matter	*Recommended duration (hours)* Trainees **without** previous aviation experience	Trainees **with** previous aviation experience	Degree of expertise
Chapter 9 — Mass (weight) and balance control	**27**	**15**	
Introduction to mass and balance			3
Load planning			3
Calculation of payload and loadsheet preparation			3
Aircraft balance and longitudinal stability			3
Moments and balance			3
The structural aspects of aircraft loading			3
Dangerous goods and other special cargo			3
Issuing loading instructions			3
Chapter 10 — Transport of dangerous goods by air	**9**	**9**	
Introduction			
Dangerous goods, emergency and abnormal situations			3
Source documents			3
Responsibilities			3
Emergency procedures			3
Chapter 11 — Flight planning	**18**	**9**	
Introduction to flight planning			2
Turbo-jet aircraft cruise control methods			3
Flight planning charts and tables for turbo-jet aircraft			3
Calculation of flight time and minimum fuel for turbo-jet aircraft			3
Route selection			3
Flight planning situations			3
Reclearance			3
The final phases			3
Documents to be carried on flights			3
Flight planning exercises			3
Threats and hijacking			3
ETOPS			2
Chapter 12 — Flight monitoring	**16**	**16**	
Position of aircraft			3
Effects of ATC reroutes			3
Flight equipment failures			3
En-route weather changes			3
Emergency situations			3
Flight monitoring resources			3
Position reports			3
Ground resource availability			3

Subject matter	Recommended duration (hours) — Trainees **without** previous aviation experience	Recommended duration (hours) — Trainees **with** previous aviation experience	Degree of expertise
Chapter 13 — Communications — Radio	**18**	**6**	
International aeronautical telecommunications service			2
Elementary radio theory			2
Aeronautical fixed service			2
Aeronautical mobile service			2
Radio navigation service			2
Automated aeronautical service			2
Chapter 14 — Human Factors	**15**	**15**	
The meaning of Human Factors			3
Dispatch resource management (DRM)			4
Awareness			3
Practice and feedback			3
Reinforcement			3
Chapter 15 — Security (emergencies and abnormal situations)	**8**	**6**	
Familiarity			3
Security measures taken by airlines			3
Procedures for handling threats, bomb scares, etc.			3
Emergency due to dangerous goods			3
Hijacking			3
Emergency procedures			3
Personal security for the FOO/FD			3

PHASE TWO — APPLIED PRACTICAL TRAINING

Subject matter	*Recommended duration*
Chapter 16 — Applied practical training	
Applied practical flight operations	25 hours
Simulator LOFT observation and synthetic flight training	4 hours
Flight dispatch practices (on-the-job training)	13 weeks
Route familiarization	1 week

CHAPTER 2. GENERAL RECOMMENDATIONS

2.1 Accommodation and equipment for classroom-based training

2.1.1 General

2.1.1.1 The *TRAINAIR Training Management Guideline (TMG)*, developed by the ICAO TRAINAIR Programme, provides detailed information on training support functions, training delivery, administrative support functions, planning and design of training facilities, etc. Another manual, the *TRAINAIR Training Development Guideline (TDG)*, details the development methodologies of training courses for aviation personnel and provides guidelines on training techniques, validation, revision and implementation of course ware, design of tests, post-training evaluation, etc. Although the majority of the material included in both manuals may not be directly applied to the training of flight operations officers/flight dispatchers (FOO/FDs), the aim of both the TMG and TDG is to provide civil aviation training managers with the tools they need to effectively manage their training organizations, and the providers of FOO/FD training can effectively benefit from utilizing these tools. Both the TMG and TDG contain detailed information on the issues discussed in this chapter.

2.1.2 Classrooms and equipment

2.1.2.1 Opinions differ on the amount of classroom space required for each trainee. The range of "ideal" space for each adult in a classroom varies from a low of 1.4 m^2 to a high of 6.7 m^2. The reason for the wide range in "ideal" figures is that classroom designers either envision different classroom environments or account for certain spaces within the classroom, such as aisles and front setback, differently.

2.1.2.2 The sizes of classrooms are affected by:

— number of trainees in a class;

— trainee workstation size;

— class configuration;

— size of aisles; and

— use of media (in particular, projected media and hands-on projects).

Note.— ICAO recommends that the ratio of trainees per instructor be taken into account when planning the classroom size. In order to provide for sufficient supervision and control, a ratio of one instructor for every 15 trainees and 2 instructors for every 25 trainees is recommended.

2.1.2.3 The use of media and hands-on experiments is an important factor in determining the amount of common space required in a classroom. The most commonly used visual media are slides, chalk/marker boards, overhead projectors, video tape and easels. The use of projected media (slides, overheads, TV, etc.) has considerable impact on room size and should be taken into consideration when assigning classrooms.

2.1.2.4 In planning for space requirements for the training of FOO/FDs, training managers must take into consideration the trainee workstations, area required for hands-on training, faculty workstations and storage area.

2.1.2.5 Trainee workstation space includes the trainee's work surface, any additional equipment (terminal, audio/visual, etc.), a chair, and the space for chair pushback and manoeuvrability. The concept of workstation space is important when sizing rooms for classes containing different numbers of trainees. The total area allowed in a classroom for each trainee varies with the size of the class. An adequate work surface within the work space is very important. The large amount of reference material used in the training of FOO/FDs requires considerably larger work surfaces than would be provided by the attached writing surface of an auditorium chair.

2.1.2.6 Computers can also be considered as useful training aids for FOO/FDs. Used as instructional media, computers usually take the form of desktop microcomputers with keyboard and monitor. They can communicate verbal and graphic information and can accept verbal as well as manual or tactile responses. Computers may be used for drills, computer-managed instruction, testing and simulations. For detailed information about the use of computers as a training tool, training managers are advised to refer to the ICAO TRAINAIR document — *Computer Application in Training*.

2.1.3 The learning environment

2.1.3.1 The key to a good learning environment is the elimination of discomforts and other undesirable characteristics. Ten primary factors have been identified:

— the climate must be comfortable;

— lighting must be of adequate level for work or viewing;

— distracting sound must be kept to a minimum;

— work areas must be aesthetically pleasing;

— workstations must be comfortable;

— work space must be adequate;

— work area must be reasonably clean;

— training equipment must be adequate;

— visual media must be visible; and

— audio media must be listenable.

2.1.3.2 If any of these factors are unsatisfactory, the result can be distraction from the task at hand, and fatigue can result from the effort required of the trainee to adapt to a poor environment. One of the most widely recognized factors listed is that of the comfort of workstations which includes the comfort of the chair.

2.2 Performance evaluation (tests)

2.2.1 Performance evaluation (tests) is an integral part of the training process. Tests should always be prepared with the sole purpose of measuring whether or not the trainee has achieved the training objective. Trainees must always be informed on how they are going to be evaluated, so they can orient their efforts. The information must include the conditions that will exist during the test, the performance that is expected from the trainees, the standards of accomplishment that have to be met and the consequences of an inadequate performance. It is recommended that errors on knowledge exams and skill tests be reviewed with trainees to reflect corrections to achieve 100 per cent. Trainees must be informed of the result of their evaluation and instructors must offer correction of improper responses.

2.2.2 Time and resource constraints may limit the amount of testing that can be given to each objective. However, the criticality of the subject and the performance difficulties which can be encountered should give some indication as to when, how and what performance evaluation should be required. Generally speaking, performance measurement is undertaken to evaluate whether or not courses taught have been understood by the trainees at the desired level:

— *Skills* are best tested by performance tests (the trainee performs the task described in the objective under real or simulated conditions).

— *Knowledge* is best tested by oral or written tests.

— *Attitudes* are tested by observations of performance or by means of questionnaires.

PHASE ONE

CHAPTER 3. CIVIL AIR LAW AND REGULATIONS

3.1 Introduction

3.1.1 International aircraft operation is governed by the rule of law; that is to say, a number of Conventions, Regulations, Legislation, Orders, Agreements, etc. have been promulgated among and within States since the first flight by a heavier-than-air machine to ensure that flights are operated in a safe and orderly manner. Achievement of safety and regularity in air transportation operation requires that all States accept and implement a common standard of aircraft operation in regards to training, licensing, certification, etc., for international operations. The standardization of operational practices for international services is of fundamental importance to prevent costly errors which may be caused by misunderstanding or inexperience. Although this manual and other ICAO manuals address international aircraft operation, the need for standardization is equally applicable to any aircraft operation.

3.1.2 International and national regulations and air laws are promulgated to ensure safety, regularity and efficiency of international aircraft operation. On the international scene, ICAO, pursuant to the provisions of Article 37 of the Convention on International Civil Aviation, develops and adopts Standards and Recommended Practices (Annexes to the Convention) as the minimum requirement for aircraft operation. National regulations are developed on the basis of those Standards and Recommended Practices with some variations to suite the specific requirements of individual States. States may enact legislation that may significantly differ from that enacted in other States. However, international aircraft operations share many regulations, laws and statutes. The syllabus contained in this chapter gives a general view on air law as adopted by ICAO and practised in international aircraft operations.

3.2 Training objectives

Conditions: Provided with a broad outline of the regulatory requirements to be met by an operator engaged in commercial air transport and outlining significant regulatory documents to the flight operations officer/flight dispatcher (FOO/FD) including operational control concepts that illustrate the application of regulatory requirements to the FOO/FD's work,

Performance: The trainee will be able to identify the role of international and national aviation regulatory bodies, identify the importance of applicable regulations to aircraft operation and apply regulations relating to aircraft operation in those areas which fall under the duties and responsibilities of the FOO/FD.

Standard of accomplishment:
The regulations and legislation applicable to the described case will be thoroughly identified and its provisions and practical applications understood and implemented as required.

3.3 Required knowledge, skill and attitude

3.3.1 Certification of operators

Goal: *To enable the trainee to identify the basic requirements for authorization to operate a commercial air transportation service.*

State authority functions

- protecting public interests by:
  - — establishing the need for and feasibility of air service
  - — ensuring the safety of flight operations conducted within the State
- regulating the degree of competition between operators
- exercising control over commercial air operators
- controlling requirements for State-owned or State-operated facilities and services

Common methods of exercising State authority

- incorporation of civil aviation acts, laws and statutes into the State's legal system
- establishment of a State Civil Aviation Authority (CAA) with power to:
  - — apply principles set forth in aviation law
  - — develop civil air regulations and orders
  - — establish requirements for issue of licences, certificates and other instruments of authority deemed necessary for commercial air transport
  - — inspect all aspects of commercial air transport operations to ensure continuing compliance with State requirements
  - — recommend corrective action to air operators
  - — revoke air operators' licences

Air operator certificate

- operator's authority to engage in specific air transportation operations including:
  - — categories of operations
  - — routes and frequency of operation for scheduled services
  - — areas of operation for non-scheduled services
  - — terminal, alternate and emergency airports
  - — aircraft types as well as major equipment such as navigation and communication systems
- requirement for an operator to satisfy the State with respect to:
  - — managerial and technical competency to operate the proposed service
  - — qualifications, training and competency of personnel
  - — financial resources
  - — equipment
  - — maintenance
  - — flight manuals
  - — operations manual(s)
- requirement for the satisfactory completion of a State operational inspection:
  - — ground operations
- fixed facilities
- mobile equipment
- operational control provisions:
  - — provisions for record keeping
- flight operations officer competency and licences
- flight crew competency and licences
- cabin crew competency and licences
- state/operator duty and flight time limitations:
  - — flight operations
- inspections or proving flights without passengers
- operational control efficiency:
  - — provisions for aircraft maintenance and inspection

3.3.2 The Convention on International Civil Aviation

Goal: *To outline the general provisions of the Convention on International Civil Aviation (Chicago, 1944) and to identify some of the international air transport problems addressed by the Convention and the "Five Freedoms" of the air.*

The Convention on International Civil Aviation

- a brief history of the Convention on International Civil Aviation held at Chicago in 1944 and commonly referred to as "The Chicago Convention" or "The Convention"
- Contracting States
- principal considerations:
  - — sovereignty of States over their airspace
  - — rights of flight over territory of Contracting States
  - — measures to facilitate international air navigation
  - — international Standards and Recommended Practices
  - — establishment of an authority to administer and regulate civil aviation activities

Sovereignty of airspace

- State sovereignty over the airspace above its territories
- legal problems related to a State's airspace not resolved by the Convention:
  - — height airspace extends to
  - — distance beyond the State land mass
- sovereignty over international airspace (such as high seas)

Rights of commercial flight over the territories of Contracting States

- conditions for overflying a Contracting State's airspace without special permission or agreement for aircraft NOT engaged in scheduled service, not carrying any payload (passengers, cargo, mail, etc):
  - provisions of the Convention
  - rights to make stops for non-traffic purposes
  - possibilities for the privilege of taking on payload
  - aircraft excluded (State aircraft such as military aircraft)
- agreements and special permissions required by aircraft engaged in scheduled services:
  - the freedoms of the air
  - the Two Freedoms Agreement (common)
  - the Five Freedoms Agreement (rare)
  - bilateral and multilateral treaties (most common)
- privileges granted by the Two Freedoms Agreement:
  - overfly without landing
  - land for non-traffic purposes
- privileges granted by the Five Freedoms Agreement:
  - overfly without landing
  - land for non-traffic purposes
  - offload payload from the State of aircraft registry
  - take on payload destined for the State of aircraft registry
  - take on payload destined for other States that have accepted the Five Freedoms Agreement

3.3.3 International air transport issues addressed by the Convention

Goal: *To enable the trainees to identify issues of concern to international air transportation that are addressed by the Convention.*

Note.— Examples of problems in international air transportation operation are included under this item to enable trainees to appreciate the need for international agreement (the Convention) and an international organization (ICAO) to oversee the development and implementation of international standards (Annexes to the Convention). Issues identified below are not exhaustive, and instructors and trainees are encouraged to discuss issues that they deem important.

Problems addressed by the existence of an international agreement

- issues concerning the travelling public:
  - availability of regular services
  - fares and baggage allowances
  - facilitation
  - safety in flight and on the ground
  - reliability of services
- issues concerning the State:
  - protection of the public's interest
  - effects on national economy
  - effects on the environment
  - effects on national security
  - services to be provided to operators
  - efficient and economic interface with other States on services such as air traffic control and search and rescue, and on facilities such as those required for communication, navigation and air traffic control
  - charges for services and facilities made available to operators
- issues concerning aircraft manufacturers:
  - standard of certification in various States
  - modifications required and additional limitations imposed by States
  - variety of aircraft equipment required to operate with different ground-based facilities
  - support and maintenance for the manufacturer's product
- issues concerning operators:
  - traffic rights
  - protection of commercial interests
  - legal liabilities
  - custom and immigration services
  - availability of required services and facilities to a given standard
- issues concerning flight crew members:
  - differences in air traffic control, navigation, communication procedures and operational standards
  - availability of critical information for aircraft operation, facilities and other essential services
  - major differences in State regulations and rules of the air promulgated by different States

— different standards of performance for operational personnel, creating misunderstandings and confusion

— differences in the requirements of States regarding the documents to be carried on board an aircraft

— issues to be discussed in the following paragraph (all FOO/FD concerns)

- issues concerning FOO/FDs:

  — most of the items indicated above

  — specific flight planning problems including the availability and reliability of meteorological information, serviceability of facilities, flight plan format, and time and method of filing

  — flight monitoring problems due to lack of updated information and communication facilities

3.3.4 The International Civil Aviation Organization (ICAO)

Goal: *To familiarize the trainee with the functions of the International Civil Aviation Organization (ICAO) and to identify documents and publications produced by ICAO that are related to the FOO/FD's responsibilities.*

The International Civil Aviation Organization

- brief history of the organization and its functions:

  — terms of reference and objectives

  — organizational structure

  — the process of making international standards

  — end-product of its activities

ICAO documents and publications

Note.— A list of relevant ICAO documents and publications is in the Appendix — References.

- the ICAO Annexes to the Convention on International Civil Aviation:

  — brief outline of the purpose and content of each Annex with special emphasis on provisions directly related to FOO/FD duties and responsibilities (the instructor is expected to link these provisions to the issues identified in the previous lesson)

  — practical application of the provisions of the Annexes to FOO/FD duties and responsibilities, normally by referring to the aircraft manual and the operations manual

- publications related to the Procedures for Air Navigation Services (PANS) and technical publications related to FOO/FD duties and responsibilities:

  — brief outline of information on PANS and technical publications to further assist the FOO/FD recognize:

    - the scope of his responsibility
    - location of useful reference material
    - abbreviations and terms used in aircraft operation

  — Air Navigation Plans:

    - examine the Air Navigation Plan most relevant to the area in which the trainee's organization operates:

      — for general familiarization and possible on-the-job reference

      — to outline problems of implementation and maintenance of facilities

      — for use of plan data for planning and conducting current operations

3.3.5 Responsibility for aircraft airworthiness

Goal*:* *To identify responsibilities for the airworthiness and maintenance of aircraft from an FOO/FD's viewpoint.*

State responsibility for the maintenance of aircraft airworthiness

- the Convention's requirement for each Contracting State to:

  — comply with international standards

  — ensure that each aircraft on register and all essential on-board equipment are maintained in airworthy condition

- State enactment of legislation and the establishment of a Civil Aviation Authority (CAA) with the responsibility for:

  — aircraft registration

  — airworthiness certificate (CofA) which may be based on CofA of State of manufacture

- — any required modifications to the aircraft limitations, operating procedures and the associated aircraft flight and maintenance manuals
- — the issuance of orders and regulations including those required to implement the provisions of the Annexes
- — the establishment of an Aeronautical Inspection Directorate (AID)

- responsibilities of the AID including:
  - — inspection of records
  - — aircraft and equipment tests
  - — personnel qualifications
  - — surveillance of the aircraft maintenance process

Operator's responsibility for the maintenance of aircraft airworthiness

Note.— Operators may have their own State-approved maintenance organization or may enter into an agreement with an external approved maintenance organization. Detailed information for the approval of maintenance organizations is provided in Annex 1 — Personnel Licensing *and Annex 6 —* Operation of Aircraft*, Part I.*

- responsibility for providing a maintenance release before an aircraft can engage in commercial operations, signed as per Annex 1 and Annex 6 requirements, and for ensuring that all maintenance work has been completed to the required standards in accordance with the provisions specified in the approved maintenance manuals

Operator's responsibility for loading data (loadsheet)

- the requirements for all aircraft to be operated within the certified mass and centre of gravity (CG) limitations given in the approved flight manual
- operator requirement for a mass control organization to:
  - — maintain a record of the mass and its distribution for each aircraft
  - — incorporate changes due to aircraft and equipment modifications
  - — prepare loading schedules suitable for the operator's mathematical, tabular, mechanical, or computer methods of load control
  - — periodically sample the mass and CG of its aircraft
- means of controlling mass (normally exercised by maintenance or engineering personnel)

Note.— Basic data for each aircraft are provided to personnel engaged in the day-to-day calculations of mass and CG and the application of this data is covered in Chapter 9 — Mass (Weight) and Balance Control. The FOO/FD's responsibility in this regard is to ensure that each flight operates within its mass and CG limitations.

3.3.6 Regulatory provisions of the flight manual

Goal: *To outline the content of a typical flight manual and to identify aircraft limitations that are of significance to the FOO/FD.*

Flight manual authority

- production and initial approval of a flight manual as an integral part of the aircraft certification process by the State of aircraft manufacture
- possible format, provisions and title modification by the State of registry
- requirement to adhere to the provisions of the flight manual, approved by the State of registry, before an aircraft is allowed to be dispatched or operated

Contents of a typical flight manual

- limitations
- performance data
- normal operating procedures
- emergency and abnormal operating procedures
- aircraft description
- aircraft systems:
  - — description
  - — normal operation
  - — abnormal operation
- general operating limitations that must be completed:
  - — certification status
  - — kinds of aircraft operation
  - — flight manoeuvring load acceleration limits
  - — flight crew

- mass and balance limitations that must be completed:
  - — maximum structural mass
  - — empty/basic/dry operating mass and passenger capacity
  - — centre of gravity limits
  - — fuel density loading limits
  - — deficiencies
- performance limitations that must be completed:
  - — operational limits
  - — wind vector limits
  - — runway contamination limits
  - — conditions under which thrust deterioration can take place
  - — deficiencies
- operating speed limitations that must be completed:
  - — maximum operating speed limit, V_{mo}
  - — maximum manoeuvring speed limit, V_a
  - — maximum flap extended speed limit, V_{fe}
  - — maximum landing gear extended speed limit, V_{le}
  - — maximum landing gear operating speed limit, V_{lo}

Aircraft systems that are of significance to the FOO/FD, and the effect of their serviceability

- air conditioning and pressurization system:
  - — operating altitude
  - — route operation
  - — passenger comfort
  - — cargo sensitivity
  - — structural integrity, cycles
- automatic flight control system:
  - — landing minima
  - — fuel consumption
  - — minimum navigation performance specifications (MNPS)
- communication systems:
  - — route operation
- equipment and furnishings:
  - — route operation
  - — altitude
  - — maximum passenger numbers
  - — speed
- flight controls:
  - — speed, altitude, mass, aircraft handling
  - — permissible flights
- fuel systems:
  - — fuel types
  - — fuel density
  - — maximum tank capacity/range
  - — maximum zero-fuel mass
  - — minimum/maximum fuel tank temperatures
  - — maximum altitude/outside air temperature
  - — minimum fuel
  - — distribution
  - — mass and balance
- ice and rain protection systems:
  - — route operation versus meteorological forecast
- navigation equipment:
  - — route operation
  - — landing minima
  - — minimum navigation performance specifications (MNPS)
- auxiliary power unit:
  - — suitability alternate/en-route alternate airport
  - — route operation

3.3.7 The aircraft minimum equipment list (MEL)

Goal: *To enable the FOO/FD to use the aircraft minimum equipment list (MEL) during flight planning.*

General description

- contents and purpose
- general policy on:
  - — multiple deferments
  - — continued deferments
  - — authority for use and interpretation of the MEL
- definitions and standards nomenclature:
  - — item number
  - — system or component
  - — quantity per aircraft

— aircraft dispatch minimum

— qualifying conditions

- use of the MEL by the FOO/FD:

— to determine if State regulations and company policy permit the flight to be planned with an aircraft that is not completely serviceable

— to determine what qualifications and additional limitations must be observed in the preparation of the flight plan

- use of the MEL by maintenance:

— precautions to be observed prior to maintenance release of aircraft when the MEL is applied

— specific MEL maintenance procedures to be observed

— where and when maintenance may apply the MEL

- use of the MEL by the flight crew:

— flight planning considerations

— specific MEL flight operating procedures to be observed

— final authority in the event of disagreement over use or interpretation of the MEL

3.3.8 The operations manual

Goal: *To identify the authority of the operations manual and to outline typical contents and regulations that are of significance to the FOO/FD.*

Note.— ICAO Doc 9376, Preparation of an Operations Manual, *may be used as an example of the content of an operator's operations manual.*

Authority of the operations manual

- a prime source of authoritative information required by the FOO/FD to comply with:

— State regulations

— operator policies and procedures

- State requirement for the operator to produce an operations manual:

— before getting an air operator certificate

— to ensure that the operator is aware of and complies with all relevant State regulations

— to ensure that the operator complies with the provisions of Annex 6 for international air transport

— to ensure that all amendments of a regulatory nature are approved by the State

Note.— In addition to meeting State requirements, the operator may include details of corporate policies and procedures in the operations manual. Other details may be included in other manuals such as the maintenance manual, aeronautical information manual, flight operations manual, and mass and balance control manual, as applicable. If such manuals are used by the operator, the instructors must acquaint FOO/FD trainees with the content of such manuals.

Operations manual format and content

- varies widely to meet the specific requirements of States and operators
- the use of several independent sections or volumes permits the individual to use, carry and amend those parts applicable to their duties

CHAPTER 4. AVIATION INDOCTRINATION

4.1 Introduction

4.1.1 Flight Operations Officer/Flight Dispatcher (FOO/FD) training should, in addition to those subjects which directly concern FOO/FD responsibilities, include knowledge of other aspects of aviation operations. This consideration will provide the trainees with a more complete comprehension of their working environment.

4.1.2 Under this general subject, FOO/FDs are expected to learn commonly used aviation terminologies and be able to apply them in the appropriate context as required. They will also be introduced to the theory and physiology of flight which should enable them to acquire knowledge of the principles of flight.

4.1.3 Knowledge gained by FOO/FDs in these subjects constitutes an important part of aircraft operation; it will permit a more comprehensive operational understanding, develop general awareness of air transport operation and improve communication with crew members and maintenance personnel, thus improving the over-all safety of aircraft operation. Nevertheless, it must be realized that the knowledge imparted in most of the items presented is basic and not meant to produce FOO/FD experts on the subjects. However, their value as an introduction to the aircraft operation environment and their capacity to promote better understanding with flight crew members and other personnel in the industry cannot be overstated.

4.2 Regulatory

Note.— Knowledge, skill and attitude relevant to the responsibilities of the FOO/FD are covered in the previous chapter. Those aviation regulatory and other relevant bodies not discussed in Chapter 3 are covered here. FOO/FDs, performing their normal duties, may come into contact with these bodies, and introductory knowledge of their activities is considered beneficial.

4.2.1 Training objectives

Conditions: Given pertinent information on relevant aviation regulatory and other bodies and a description of a situation related to FOO/FDs,

Performance: The trainee will be able to identify other aviation organizations and their role in the over-all operation of aircraft in international air navigation.

Standard of accomplishment:
The legislation applicable to the described case will be thoroughly identified and its provisions and practical applications understood.

4.2.2 Required knowledge, skill and attitude

- objectives of and roles played by the International Air Transport Association (IATA) and other relevant international, regional and national aviation organizations;
- objectives of and roles played by national civil aviation regulatory bodies (e.g. civil aviation authorities and airport authorities) and other aviation regulatory bodies (e.g. customs, immigration, health, and security) that FOO/FDs may come into contact with;
- the airline's organizational structure, administrative requirements relating to FOO/FDs, organizational links between FOO/FDs and crew members;
- specific State and company regulations applicable to the dispatch of an aircraft.

4.3 Aviation terminology and terms of reference

Note.— To emphasize working relationships and enhance communication between FOO/FDs and crew *members, it is recommended that the following subjects be delivered by personnel from the flight operations department.*

4.3.1 Training objectives

Conditions: Given short descriptions of aircraft/air transport operation,

Performance: The trainee will be able to define aviation terminologies common to air transport operation and identify relevant terms of reference common to aircraft operation, applying them in the appropriate context.

Standard of accomplishment:
For safety-related items and for items of daily routine use, a 100 per cent correct response is required. For other items, a different standard may be established.

4.3.2 Required knowledge, skill and attitude

- identify terminologies common to air transport operation and apply them in the appropriate context;
- importance to flight safety of using correct terminologies;
- measurement units used in aircraft operation;
- the correct application of the phonetic alphabet in aviation-related communication; examples of misunderstandings that may arise from improper use and their effect on flight safety (use factual accident/incident examples, if available).

4.4 Theory of flight and flight operations

Note.— Please note that some of the subjects discussed here may, because of their importance to the aircraft dispatch profession, be covered in more detail in the following chapters, as applicable.

4.4.1 Training objectives

Conditions: Using realistic models, photographs or drawings of aircraft, or during a tour of an actual aircraft,

Performance: The trainee will be able to identify and describe the basic components of an aircraft, their use and operation, and the effect of those components on flight and cabin conditions. He will have a clear understanding of the theory of flight and the basic environment relating to aircraft operations.

Standard of accomplishment:
Basic components must be correctly associated with basic use and operation. Safety-related items such as critical surfaces, ice formation, and surface contamination must be 100 per cent correct.

4.4.2 Required knowledge, skill and attitude

- identification of the main components of an aircraft and their basic function both on the ground and in flight; flight deck equipment including weather radar, cockpit voice recorder; basic flight instruments: airspeed indicator, altimeter, magnetic compass, etc.;
- hazards associated with volcanic ash/dust, ice formation on wings and control surfaces, the recognition and reporting of such phenomena;
- flight control surfaces and flight controls and their function; the four forces (thrust, lift, drag and gravity) acting on an aircraft; the three axes (yaw, pitch and role) and the movement around each axis;
- recognition of aircraft critical surfaces and hazards to flight associated with the contamination of those surfaces; awareness of conditions most likely to produce surface contamination; role of the FOO/FD if surface contamination is suspected before aircraft departure;
- the timely communication, to the flight crew, of observed or reported deficiencies in the safe operation of the aircraft.

4.5 Aircraft propulsion systems

4.5.1 Training objectives

Conditions: Provided with appropriate reference material and, if practicable, participating in an actual inspection of an aircraft engine, Performance: The trainee will be able to identify the principal differences in the different types of aircraft propulsion systems and their significance to aircraft operation.

Standard of accomplishment:
Principles of aircraft propulsion systems must be thoroughly understood and the trainee must be able to describe the significance to flight operation of the various types of aircraft propulsion systems.

4.5.2 Required knowledge, skill and attitude

- types of aircraft propulsion systems:
  - — propeller-driven aircraft
  - — jet-propelled aircraft
- propeller-driven aircraft:
  - — type of engine used (turboprop, piston)
  - — basic principles of operation
  - — propulsion efficiency
- jet-propelled aircraft:
  - — pure jet engine
  - — fan jet or bypass engine
  - — basic principles of operation
  - — propulsion efficiency
- operational differences between jet, turboprop and piston engine aircraft:
  - — due to different means of propulsion
  - — due to significant differences in performance

4.6 Aircraft systems

4.6.1 Training objectives

Conditions: Provided with appropriate reference material and study guides and aids,

Performance: The trainee will be able to gain a general understanding of principal aircraft systems and the effects of system deficiencies.

Standard of accomplishment:
The trainee is expected to demonstrate adequate understanding of the basic systems and satisfactorily explain the effects of their failure on aircraft performance.

Note 1.— It is recommended that items such as general description, operating principles, normal functions, system redundancy and provisions for alternative operations for typical systems in a modern jet aircraft be briefly covered during this session.

Note 2.— It is also recommended that emphasis be put on the possible sequences of systems deficiencies or failures that are not self-evident to the trainee. Those listed under "planning" are relevant to the FOO/FD while the aircraft is on the ground. Those listed under "in-flight" are of significance to the FOO/FD when the aircraft is airborne.

4.6.2 Required knowledge, skill and attitude

Air-conditioning and pressurization systems

- planning:
  - — cruising altitude restrictions
  - — ground support requirements for passenger comfort and live or perishable cargo
- in-flight:
  - — safety and comfort jeopardized
  - — possible requirements for rapid descent
  - — reduced range at lower altitudes

Automatic flight control systems

- planning and in-flight:
  - — prerequisite for category II and III instrument approaches
  - — flight crew fatigue

Electrical power

- in-flight:
  - — reduced communications and navigation capabilities
  - — requirements for and limitations on the use of alternative power sources to operate systems

Flight controls

- planning and in-flight:
  - — restricted operating speeds
  - — increased runway length requirement

Fuel

- planning:
  - fuel load and distribution
  - mass limitations
- in-flight:
  - fuel dumping system

Hydraulic power

- in-flight:
  - requirement for the use of alternative power sources for various systems
  - possible increased runway length requirement

Ice and rain protection

- planning and in-flight:
  - ability to operate under adverse weather conditions

Landing gear

- planning and in-flight:
  - restricted operating speeds
  - increased runway length requirement
  - restricted ground manoeuvrability

Navigation systems

- planning:
  - route restrictions
  - increased landing minima
- in-flight:
  - deviation from planned route (time and fuel consumption)
  - increased landing minima

Communications systems

- planning:
  - route restrictions
- in-flight:
  - deviation from planned route (time and fuel consumption)
  - possible need to initiate distress procedures, alert search and rescue facilities

Note.— Navigation and communication systems, facilities and procedures are covered in more detail in their respective chapters.

Pneumatic systems

- planning:
  - take-off mass restrictions
- in-flight:
  - air-conditioning and pressurization problems
  - requirements for alternative power sources
  - possible requirements to descend to lower altitude
  - increased runway length requirement

Airborne auxiliary power unit

- planning:
  - ground support equipment required for electrical and electronic systems, air-conditioning and engine starting

CHAPTER 5. AIRCRAFT MASS (WEIGHT) AND PERFORMANCE

5.1 Introduction

5.1.1 Today, aviation technology has evolved to such an extent that aircraft manufacturers can and do design and produce aircraft whose performance is designed to match the requirements of the market. Aircraft performance has, through the years, been refined to such a degree that it has literally become the nucleus for the growth of the air transportation industry. When the performance of aircraft is improved or when aircraft are designed to perform so that they satisfy a given market, the running cost is decreased and that translates into lower fares, creating the possibility of carrying more passengers. Of course, modern commercial aircraft operation demands that a high level of performance be achieved without prejudicing the high safety standards.

5.1.2 The commercial value of improved aircraft performance mainly depends on the efficiency with which the aircraft is operated. The wide range of fleet available to the operator may lead to the misuse or mismatch of equipment to the operation. One of the main responsibilities of the flight operations officer/flight dispatcher (FOO/FD) is to ensure that this mismatch does not occur and that aircraft are operated within their mass and performance limitations.

5.1.3 In this chapter, the trainee will be introduced to aircraft performance by outlining some of the factors that must be considered by the FOO/FD during flight planning. It is also designed to enable the trainee to determine the maximum permissible take-off and landing mass under variable operating conditions using flight manual data.

5.2 Basic principles for flight safety

5.2.1 Training objectives

Conditions: Provided with appropriate and pertinent reference material and aircraft performance data, including an outline of the factors that must be considered for flight planning purposes,

Performance: The trainee will be able to identify basic principles of safety of aircraft mass and performance limitations.

Standard of accomplishment:
The basic principles for flight safety must be thoroughly understood and the trainee must be able to determine the maximum permissible take-off and landing mass under variable operating conditions using flight manual data.

5.2.2 Required knowledge, skill and attitude

Aircraft certification considerations

- aircraft structural strength
- loads to which an aircraft will be subjected
- speed limitations
- operating environment
- performance capabilities
- runway lengths
- terrain over which the aircraft will operate

Aircraft certification standards

- variation among different aircraft categories
- detail variation between States
- provision of a high degree of safety by ensuring that all significant factors, from take-off to landing, are considered
- insurance that the aircraft operating mass or centre of gravity never exceeds that at which all requirements can be met for the planned conditions

- FOO/FD's responsibility to ensure that every flight plan complies with all the mass and performance limitations in the flight manual

Aircraft operating environment envelope

- consideration of extreme situations under which the aircraft is certified for operation
- consideration of factors in addition to aircraft structural and performance limitations:
  — pressurization capability
  — aircraft systems limitations
  — use of aircraft operating environment envelope chart in a typical flight manual

5.3 Basic mass and speed limitations

5.3.1 Training objectives

Conditions: Provided with appropriate and pertinent reference material and aircraft performance data, including an outline of the factors that must be considered for flight planning purposes,

Performance: The trainee will be able to identify the reasons for the various mass and speed limitations of an aircraft.

Standard of accomplishment:
The principal reasons for the basic mass and speed limitations of an aircraft must be thoroughly understood and the trainee must be able to determine mass and speed limitations of an aircraft under variable operating conditions using flight manual data.

5.3.2 Required knowledge, skill and attitude

Maximum structural mass

- basic consideration of the positive and negative load factor limits:
  — normal
  — ultimate
- bending moments and mass distribution
- zero-fuel mass
- take-off mass
- ramp mass
- landing mass etc.

Speed limitations

- requirement to express in terms of:
  — indicated airspeed (IAS)
  — Mach number
- designed dive speed
- maximum operating speed
- normal operating speed

Flight strength diagram

- coordinates:
  — positive and negative load factors
  — indicated airspeed
- the boundary of the aircraft operating envelope for a specified mass:
  — stall regions
  — limiting load factors
  — limiting airspeed
- use of the envelope to illustrate:
  — effects of wind gusts
  — reasons for margins between designed, maximum and normal operating speed limits
  — manoeuvring speed limit
  — some turbulence penetration speed considerations

5.4 Take-off runway requirements

5.4.1 Training objectives

Conditions: Provided with appropriate and pertinent reference material and aircraft performance data, including an outline of the factors that must be considered for determining take-off runway length, Performance: The trainee will be able to identify all factors considered necessary for establishing take-off runway length requirements and for calculating those requirements accurately and within a reasonable time frame.

Standard of accomplishment:
All factors involved in establishing take-off runway length must be thoroughly understood and the trainee must be able to determine required take-off runway length using aircraft operations and flight manual data.

5.4.2 Required knowledge, skill and attitude

Note 1.— The fundamental principle is that the take-off mass must never exceed that for which runway length and subsequent aircraft performance standards have been established.

Note 2.— Different States have developed different standards and regulations but the principles are similar.

Piston engine aircraft take-off requirements

- basis for take-off runway length requirement on the assumption that:
  - — the most critical engine fails at the most critical time
  - — the aircraft is loaded to the most adverse centre of gravity
- the effect of loss of power of the most critical engine (outboard engine), adverse aircraft handling problems
- critical engine failure speed V_1 characteristics:
  - — theoretically it depends on:
    - mass
    - runway slope
    - runway braking coefficient
    - pressure altitude
    - temperature
    - wind component
    - flap position
  - — it is actually established:
    - primarily on mass and flap position
    - making small corrections for altitude, temperature and wind
    - using methods found in the aircraft flight manual
- the meaning and calculation of take-off safety speed V_2
- effect of runway limitation on take-off mass to meet the above criteria for actual conditions of:
  - — usable runway length
  - — pressure altitude
  - — temperature
  - — headwind or tailwind component
  - — runway slope
  - — runway contamination
  - — flap position

Turbo-jet aircraft take-off requirements

- clearways
- runway requirement
- alternatives to the balanced field length method normally used to select the critical engine failure speed V_1 for piston engine aircraft
- consideration of available stopways and clearways to calculate critical engine failure speeds which maximize the permissible take-off mass from available runways
- the application of the same basic principles as for piston engine aircraft and the requirement for the mass of the aircraft not to exceed that which will enable it to:
  - — be well above the end of the runway during a normal take-off
  - — brake to a stop if an engine fails at any time up to V_1
  - — reach at least 35 feet over the clearway if engine failure occurs at V_1 or above

Note.— For turbo-jets, V_2 must be 120 per cent of stalling speed and 110 per cent of the minimum speed for straight flight without excessive bank.

- flap position for take-off
- reduced thrust take-off

Take-off speeds and runway length calculations

- practical exercises requiring trainees to obtain data from representative flight manuals for both piston engine and turbo-jet aircraft and from tables and graphs:
  - — to determine runway limitations due to:
    - crosswinds
    - tailwind component
    - rain, slush, and snow

- to calculate V_1, VR, and V_2V_2 for different aircraft types
- to calculate required runway lengths for a very wide range of conditions

- the normal source of information for:
  - runway length
  - stopways and clearways
  - runway slope
  - airport pressure altitude
  - airport temperature
  - wind components

5.5 Climb performance requirements

5.5.1 Training objectives

Conditions: Provided with appropriate and pertinent reference material and aircraft performance data, including an outline of the factors that must be considered in determining aircraft climb performance,

Performance: The trainee will be able to identify the performance requirements throughout flight that the FOO/FD must consider during flight planning and for the calculation of climb performance.

Standard of accomplishment:
All factors involved in establishing aircraft climb performance limitations must be thoroughly understood and the trainee must be able to apply climb performance derived from planning the whole flight.

5.5.2 Required knowledge, skill and attitude

Note.— Runway length requirements only ensure that aircraft reach a safe height over the end of the runway or clearway. Climb performance requirements must be calculated and applied to determine the effective over-all performance of the aircraft.

The take-off flight path

- extension: from the end of the runway or clearway until the aircraft is 1 500 feet above the airport
- the four segments in which the aircraft configuration and climb gradients are specified
- the need to ensure terrain clearance by at least 35 feet without obstacles in the take-off flight path
- consideration of obstacles in an area where the dimensions increase with distance from the end of the runway

The climb sequence

- the first segment
- the second segment
- the third and final segment during which the aircraft is in transition with flaps being raised and the aircraft accelerating to commence the en-route phase

Mass/altitude/temperature (MAT) limits for take-off

- the effects of mass, altitude and temperature on the aircraft's ability to meet the required climb gradients in each segment
- MAT limitations to establish the maximum permissible take-off mass from a performance viewpoint in terms of airport pressure altitude and temperature
- MAT limitations that are included in the flight manual and must always be observed by the FOO/FD

En-route considerations

Note.— Aircraft performance must always be adequate to reach a suitable airport for landing, should an engine fail.

- factors to be considered include:
  - requirements to specify minimum climb performance 2 000 feet above the terrain using maximum continuous power
  - application of two engine-out en-route climb requirements when there is no suitable airport within 90 minutes' flying time

Note.— En-route climb performance data are not included in all operators' flight manuals because route analysis to meet all requirements is relatively complex, en-route climb requirement and aircraft drift-down considerations need only be considered for one set of standard conditions, and the requirements can be met by publishing limiting take-off mass for aircraft flying over terrain-critical routes.

- requirement for FOO/FDs to:
  - — be aware of the requirements for en-route performance
  - — ensure that no flight is planned to take off at a greater mass than will permit those requirements to be met anywhere along the route
  - — be particularly cautious when planning new routes over high terrain, bearing in mind that they may not have been subject to detailed performance analysis

Approach and landing

- establishment of requirements to ensure an adequate margin of performance during approach and landing
- requirements for an aircraft in approach configuration to meet approach climb performance requirements with a failed engine
- requirements for an aircraft in landing configuration to meet landing climb requirements with all engines operating

Mass/altitude/temperature (MAT) limits for landing

- the effects of mass, altitude and temperature on the aircraft's ability to meet the approach and landing climb requirements
- MAT limitations to establish the maximum permissible landing mass from a performance viewpoint in terms of airport pressure altitude and temperature
- MAT limitations that are included in the flight manual and must always be observed by the FOO/FD

Take-off and landing MAT calculations

- practical exercises requiring trainees to obtain MAT limit data from representative flight manuals for both piston engine and turbo-jet aircraft and from tables and graphs to:
  - — determine the maximum permissible take-off and landing mass from a MAT performance viewpoint for a wide range of pressure altitudes, temperature and flap positions
  - — determine airport temperatures that will restrict take-off and landing mass from a MAT performance viewpoint
  - — identify the sensitivity of aircraft with respect to airport temperature and pressure when MAT is limited for take-off or landing mass
  - — identify the need for MAT limits and mass corrections thereto from tables designed for specific airport altitudes (for non-standard pressure)
  - — identify flight manual provisions for compliance with en-route climb requirements

Note.— The instructor should remind trainees of the limitations other than MAT that may determine maximum permissible take-off and landing mass.

5.6 Landing runway requirements

5.6.1 Training objectives

Conditions: Provided with appropriate and pertinent reference material and aircraft performance data, including an outline of the factors that must be considered for determining landing runway length,

Performance: The trainee will be able to identify all factors considered necessary for establishing landing runway length requirements and for calculating the length.

Standard of accomplishment:
All factors involved in establishing landing runway length must be thoroughly understood and the trainee must be able to determine required landing runway length using aircraft operations and flight manual data.

5.6.2 Required knowledge, skill and attitude

Note.— In addition to meeting structural and climb performance requirements, the landing mass must never be planned to exceed that for which there is adequate landing distance. The runway length requirements are similar for piston engine aircraft and turbo-jets.

Landing distance requirements

- the assumption that an aircraft is expected to cross the end of the runway at 130 per cent of the stall speed for landing configuration
- measurement of the distance required to stop on a hard dry runway using full braking

- length of the required distance — 167 per cent of that needed to stop on a hard runway
- margin required (15 per cent) when landing weather conditions are poor or the runway is wet or slippery
- relaxation of margins for alternate airports used to meet the en-route climb performance requirements

Calculation of landing distance

- factors to be considered in the calculation of landing distance:
  - — mass
  - — pressure altitude
  - — temperature
  - — headwind or tailwind component
  - — runway contamination
  - — flap position
  - — serviceability of brakes, spoilers, thrust reversers
  - — obstacles in the landing flight path
  - — use of tables and graphs to calculate factors enumerated above
  - — requirement for additional distance if brake systems are not fully serviceable or manual spoiler extension is required
  - — additional margin of safety provided by reverse thrust to compensate for wet and slippery runways
  - — methods used to estimate runway braking coefficients
  - — effect of obstacles that project into the imaginary horizontal plane of the approach path, resulting in the elimination of the value of part of the runway for planning purposes. Stress that only the distance from the displaced threshold may be considered.

Landing runway calculations

- practical exercises requiring trainees to obtain landing runway length from representative flight manuals using available tables and graphs to:
  - — determine the landing runway lengths required for a wide range of mass, altitudes, temperatures, winds, and flap positions
  - — determine the maximum permissible landing mass using a wide range of runway limiting factors
  - — determine flight manual limitations on landing due to runway contaminants and crosswinds

Note.— The instructor should remind trainees of why the runway lengths used in practical operations may differ from their calculated distances and should explain why the pilot-in-command may be reluctant to use a runway that is slippery or likely to cause hydroplaning, particularly if it also has a strong crosswind.

5.7 Buffet boundary speed limitations

5.7.1 Training objectives

Conditions: Provided with appropriate and pertinent reference material, and aircraft flight and operations manuals,

Performance: The trainee will be able to identify aircraft buffet characteristics that must be considered during flight planning.

Standard of accomplishment:
Effects of low- and high-speed buffet for a wide range of mass, altitudes and normal accelerations must be thoroughly understood and the trainee must be able to determine the speeds at which buffets are encountered.

5.7.2 Required knowledge, skill and attitude

The aircraft buffet boundaries

- low-speed buffet
- high-speed (Mach) buffet
- variation of buffet speeds with altitude for a given mass
- variation of buffet speeds with mass for a given altitude
- load factor variations due to banked turns and turbulence cause short-term increases in aircraft mass

Examination of buffet boundary curves

- the range of speeds for which flight is possible without buffet (shown for a combination of mass and altitude)
- the reduction of the range of possible speeds at a given mass as altitude is increased
- the possibility for some flights to be planned at mass and altitudes for which there is little safe speed margin

- decrease or disappearance of the margin between low- and high-speed buffet as normal acceleration is increased due to turbulence or bank angle
- consideration of lower than maximum possible cruising altitudes to avoid possibility of buffet under known turbulent conditions

Significance of buffet boundary to the FOO/FD

- flights must not be planned at mass, altitudes or speeds close to buffet boundaries
- flight planning data are normally restricted to the relevant flight manual to ensure that "buffet boundaries" and "coffin corner" altitudes are not approached

Practical use of buffet boundary curves

- using flight manual charts and graphs, the trainee should be able to determine the speeds at which low- and high-speed buffet will be encountered for a wide range of mass, altitudes, and normal acceleration

CHAPTER 6. NAVIGATION

6.1 Introduction

6.1.1 Air navigation, the science of locating the position and plotting the course of aircraft, governs the act of directing the aircraft to fly from place to place, in the most efficient and safe manner and within a given time. Thus, air navigation knowledge is an essential requirement for persons who aspire to be flight operations officers/flight dispatchers (FOO/FDs).

6.1.2 Air navigation courses are taught to FOO/FDs so that they will acquire knowledge of the basic navigation principles and practices required for flight planning and monitoring. They will also be provided with a general outline of the systems, equipment and procedures used by flight crew from take-off to landing. It is, therefore, very important that this training enable the FOO/FD to provide maximum assistance to the pilot-in-command in order to achieve safe and efficient aircraft operation.

6.1.3 For the trainees to properly follow the course and fully participate in class exercises, it is recommended that, in addition to standard equipment such as pencils and erasers, they be provided with scientific calculators, navigation computers, protractors, dividers, compasses and scaled rulers. It is also suggested that the air navigation course be preceded by a refresher course on basic trigonometry, quadratic equations and the use of scientific calculators and navigation computers, as required. Actual examples of the different projection charts for all regions (equatorial, mid-latitude and polar) should be used for trainee classroom practice including measuring distances, measuring great circle and rhumb-line tracks, plotting great circle lines and fixes, plotting great circle paths as determined on gnomonic charts and comparing them with the straight lines of charts derived from other methods of projecting (Mercator, Lambert conformal, etc.), measuring grid tracks, and converting grid to true and magnetic directions. Classroom exercises should be completed at the end of each lesson on chart projection, as appropriate.

6.1.4 Courses in air navigation comprise several subjects, each of which may, when delivered separately, require a specific training objective indicating training conditions, performance, and standard of accomplishment. However, as most of the training objectives specify similar conditions (such as the provision of appropriate and pertinent documentation and training material), a goal rather than a training objective is given at the beginning of each subject.

6.2 Training objectives

Conditions: Provided with appropriate and pertinent training materials, references, documentation, charts including realistic representation of the earth, and instruments (such as airspeed indicators and altimeters), as required,

Performance: The trainee will be able to identify knowledge, skill and attitude requirements indicated in the topic objectives of each subject and to demonstrate an ability to perform the required action identified by the subject in the most efficient and effective manner.

Standard of accomplishment:
Concepts (position, distance, time, etc.), properties such as those of the different navigation charts, ICAO Standards and Recommended Practices (SARPs) relating to air navigation, the provision of charts, etc., as defined in the training subjects must be thoroughly understood, and the trainee must demonstrate an ability both to convert, measure, and determine (time, distance, headings, altitude, airspeed, etc.) as is required by the specific subjects and to use charts, calculators, navigation computers, as appropriate and required to perform the duties of the FOO/FD.

6.3 Required knowledge, skill and attitude

6.3.1 Position and distance

Goal: *To enable the trainee to describe the form of the earth and identify units used in navigation for determining bearings, position and distance.*

Frame of reference for position

- form of the earth
- great circles
- small circles
- earth axis and geographic poles
- equator
- parallels of latitude
- latitude
- meridians and anti-meridians
- convergency of meridians
- prime meridian
- longitude

Measurement of distance

- nautical mile
- practice in calculating distances between places
- distances between places on the same parallel of latitude other than the equator
- general methods of determining distance:
  - — spherical geometry
  - — distance tables
  - — measurement on chart or globe
  - — navigation computers

Use of model globe of the reduced earth

- great circle tracks
- great circle distances

6.3.2 Time

Goal: *To enable the trainee to identify the need for an accurate time standard and convert local time to co-ordinated universal time (UTC).*

Change in time zones around the earth

- need for time zone
- normal extent of time zone
- local variations in time zones
- seasonal variations in daylight saving time
- international date-line

Co-ordinated universal time and dates

- need for universal time standard for aviation
- conversion of standard time and date into UTC
- practical examples and practice

Need for accurate time

- aircraft separation standards
- astronomical navigation

Time signals

- availability
- signal format (date/time group)

6.3.3 True, magnetic and compass directions

Goal: *To enable the trainee to identify the difference between true, magnetic and compass directions and describe how they are measured or determined.*

Definition

- angle in horizontal plane measured clockwise through 360 degrees relative to:
  - — true north
  - — magnetic north
  - — compass north
  - — grid north

True direction

- measured relative to meridian on charts and globes
- direct measurement difficulties in flight unless special equipment, such as inertial navigation system (INS) or global navigation satellite system (GNSS), is available on board the aircraft

- changes in true direction of a great circle track due to meridian convergency
- difficulty in determining direction in the vicinity of geographic poles due to limitations on the use of a magnetic compass

Rhumb-line

- definition — mid-latitude sailing
- appearance on a globe

Relationship between great circles and rhumb-lines

- the position of rhumb-line track on the equatorial side of a great circle
- difference between initial and final track directions
- comparison of the length of rhumb-line distances *vis-à-vis* great circle distances
- Practical demonstration of rhumb-lines and great circle tracks and their differences using a model terrestrial globe and string

Terrestrial magnetism and direction

- method of measurement by magnet influenced only by the earth's magnetism relative to local direction of magnetic north
- location and movement of magnetic poles
- variation and isogonal
- conversion of magnetic direction to true direction and vice versa
- required change in magnetic direction to follow a:
  - — great circle
  - — rhumb-line
- limitations on the use of magnetic direction in the vicinity of magnetic poles

Compass direction

- method of measurement by magnetic compass influenced by aircraft and earth magnetic fields
- deviation
- conversion of compass direction to magnetic direction and vice versa
- conversion of compass to true direction and vice versa

Aircraft magnetic compass systems

- direct-reading magnetic compass
- remote-indicating gyro-magnetic compass

6.3.4 Gyro heading reference and grid direction

Goal: *To enable the trainee to describe the method for overcoming navigation problems near the magnetic and geographic poles by the use of gyros and grid headings.*

The simple gyroscope

- description
- properties

Directional gyro

- description
- need for initial alignment with true or magnetic or grid north
- associated errors

Grid navigation

- description

Polar navigation

- description

Grid north

- description

Grivation and isogrivs

- description

6.3.5 Chart projections

6.3.5.1 Introduction

Goal: *To enable the trainee to identify desirable chart properties and describe the general methods used to project a round earth on flat paper.*

The reduced earth

- World geodetic system (WGS84) and Soviet geodetic system (SGS85)
- typical representation of the earth
- scale
- desirable properties
- undesirable navigational properties

Charts

- definition
- problems associated with and the impossibility of correctly representing a sphere on a plane surface
- desired properties for navigation
- the construction of charts to the scale required for a wide range of practical applications
- representation of the earth's features

Chart projections

- definition
- chart development on a plane
- chart development on a cylinder
- chart development on a cone
- the correct portrayal of earth's graticule with departure from point of tangency and standard parallels on all charts
- the progressive distortion of earth's graticule with departure from point of tangency or standard parallels on all charts
- conformalism (orthomorphism)
- the effect of chart graticules on mathematical development (not a true geometric projection from the centre of the earth)

6.3.5.2 The gnomonic projection

Goal: *To enable the trainee to identify the chart projection on which all great circles are shown as straight lines.*

6.3.5.3 The Mercator projection

Goal: *To enable the trainee to identify the chart projection on which rhumb-lines are shown as straight lines and distortion is small in the equatorial region.*

6.3.5.4 Great circles on Mercator charts

Goal: *To enable the trainee to plot and measure great circle tracks and bearings on Mercator projection.*

6.3.5.5 Other cylindrical projections

Goal: *To enable the trainee to identify other cylindrical chart projections that are commonly used in air navigation.*

6.3.5.6 The Lambert conformal conic projection

Goal: *To enable the trainee to describe a chart projection widely used for mid-latitude navigation.*

6.3.5.7 The polar stereographic projection

Goal: *To enable the trainee to describe a chart projection widely used for high-latitude and polar navigation.*

6.3.6 ICAO chart requirements

Goal: *To enable the trainee to identify charts to be used in the planning and conduct of flights as recommended by ICAO.*

Note.— A full appreciation of the purpose of some charts may not be evident until after the lessons on air traffic control and radio navigation facilities and procedures. The instructor should only emphasize those which are of particular significance to the FOO/FD. However, typical examples of each type of chart should be available to the trainees.

General specifications

- chart symbols
- relief:
  - — contours
  - — colouring

- — hachures
- — spot heights
- units of measurement
- scale and projection
- obstructions
- restricted and danger areas

Airport obstruction charts

- purpose of type A and B charts

Plotting chart

- purpose
- elements
- projection
- scale
- graticules
- isogonal and isogriv
- culture and topography
- navigation grid
- aeronautical data:
  - — limited
  - — frequency of revision
- use

Radio navigation chart

- purpose
- elements
- projection
- coverage and scale
- graticules
- culture and topography
- aeronautical data
- use

Terminal area chart

- purpose
- elements
- coverage and scale
- culture and topography
- aeronautical data
- use

Instrument approach chart

- purpose
- elements
- coverage and scale
- colours
- culture and topography
- aeronautical data
- procedural information
- use

World aeronautical charts

- purpose
- elements
- projection
- graticules
- hydrography
- topography
- culture
- aeronautical information
- use

Aeronautical chart 1: 500 000

- description

Visual approach chart

- purpose
- elements
- scale
- culture and topography
- aeronautical information
- use by pilots

Landing chart

- purpose
- elements
- scale
- culture, hydrography and topography
- aeronautical data
- use

Airport chart

- purpose
- elements
- scale
- airport data
- use

Aeronautical navigation chart (small scale)

- purpose
- elements and colours
- projection and scale
- graticules
- culture, hydrography and topography
- aeronautical information
- use

Precision approach terrain chart

- purpose
- elements
- scale
- use

6.3.7 Charts used by a typical operator

Goal: *To enable the trainee to identify specific charts used and describe the application of ICAO chart recommendations* vis-à-vis *such charts.*

Source of charts

- government agency
- air pilot publications
- private agencies such as Jeppesen & Co.
- airline groups
- individual airlines

Charts normally used for planning flights

- route charts
- radio navigation charts
- small-scale plotting charts

Charts normally used in typical flight sequence

- airport charts
- terminal area charts for standard instrument departure (SID)
- radio navigation charts
- route charts
- small-scale plotting charts
- terminal area charts for standard instrument arrivals (STARs)
- instrument approach charts
- airport charts

Note 1.— The above assumes a normal IFR intercontinental jet flight with a self-contained navigation system such as INS or GNSS.

Note 2.— The trainees must be provided with the opportunity to inspect the complete ramp-to-ramp sequence of charts normally used by a major international operator. In addition to consolidating trainees' knowledge of the various charts required, this exercise should be used to outline the various phases of flight.

6.3.8 Measurement of true airspeed by airspeed indicator

Goal: *To enable the trainee to accurately calculate true airspeed from direct airspeed indication.*

Principle of the airspeed indicator

- definition of airspeed
- basic construction of airspeed indicator

- pitot static system
- basic calibration of airspeed indicator

Uses of the airspeed indicator

- navigation
- aircraft performance
- aircraft handling
- aircraft limitations

Airspeed indicator errors

- instrument errors:
  - — definition
  - — instrument calibration
  - — correction:
    - correction card
    - central air-data computer (CADC) system
- indicated airspeed (IAS)
- pitot static source errors:
  - — definition
  - — aircraft calibration
  - — correction:
    - calibration charts and tables in the flight manual
    - CADC system
- calibrated airspeed (CAS)
- compressibility effects (error):
  - — definition
  - — varies with CAS and pressure altitude
  - — correction:
    - tables
    - factor
    - airspeed computers
    - CADC
- density error:
  - — calibration of airspeed indicator assumes an air density equivalent to that of mean sea level in the international standard atmosphere (ISA)
  - — required corrections for any combination of ambient air temperature and pressure that gives non-standard density
  - — correction normally made by:
    - circular slide-rule
    - CADC
- true airspeed (TAS)
- use of Dalton-type computer to calculate TAS
- use of Jeppesen-type computer to calculate TAS
- classroom exercises (trainees are encouraged to use both types of computers):
  - — determination of corrections for pitot static system error for CAS using flight manual data
  - — finding equivalent airspeed (EAS) using F factors on E-10A-type computer or compressibility correction charts
  - — calculation of TAS for a wide range of CAS or EAS pressure altitude and temperature

6.3.9 Measurement of true airspeed by other means

Goal: *To enable the trainee to identify additional airspeed-indicating instruments available to pilots and calculate TAS from Mach numbers.*

True airspeed indicator

- general principles
- errors
- accuracy
- application

Central air-data computer

- inputs
- correction and computations
- outputs
- application

Machmeter

- definition of Mach number
- principle of construction
- errors
- corrections
- application

Calculation of true airspeed from true Mach number

- variation in speed of sound in air with ambient temperature
- variation in TAS with Mach number and static air temperature
- calculation of TAS by means of Mach Index using Dalton or Jeppesen computers
- calculation of TAS using Mach number window on Jeppesen
- classroom exercises using:
  - — true temperatures
  - — temperature relative to that of standard atmosphere

Relationship between indicated airspeed and Mach number

- varies only with pressure altitude
- temperature considerations cancel out in equation
- enables a specific Mach number to be flown at a specific flight level by maintaining a constant indicated airspeed
- examples

6.3.10 Track and ground speed

Goal: *To enable the trainee to identify components of track and ground speed and identify the method of measuring track and ground speed and the method used to follow tracks in flight.*

Track, ground speed and drift

- velocity of the aircraft relative to the air defined by heading and airspeed
- velocity of the air relative to the ground defined by wind speed and direction
- velocity of the aircraft relative to the ground is the sum of the above velocities
- definition of drift

Outline of methods used in flight to measure track and ground speed

- from inertial navigation system:
  - — stabilized north-oriented platform
  - — two accelerometers
  - — integration of accelerations provides continuous readout of instantaneous true track and ground speed on control and display unit (CDU)
  - — accuracy
  - — airline application
- from Doppler navigation system:
  - — three earth-directed radar beams
  - — lateral and longitudinal speeds
  - — readout of instantaneous drift and ground speed
  - — derivation of track from drift and aircraft heading
  - — errors
  - — airline application
- from area navigation systems:
  - — position automatically determined relative to short-range aids
  - — computation and direct readout of track and ground speed
  - — accuracy
  - — airline application
- from drift meters:
  - — visual tracking and timing of objects on the earth
  - — measurement of drift
  - — calculation of ground speed
  - — limited application
- from tracking by ground radar
- from fixes determined by the flight crew

Outline of common methods of following desired tracks

- automatically or by direct pilot indication of tracks inserted in or defined by way-points in the CDUs of INS
- automatically or by direct pilot indication of tracks set in doppler navigation computer system
- automatically or by direct pilot indication of tracks defined by:
  - — VHF omnidirectional radio range (VOR) radials
  - — instrument landing system (ILS) localizers
- pilot use of automatic direction finders (ADF) in conjunction with non-directional beacons (NDBs)
- radar vectors from ground stations

Pre-computation of heading and ground speed

- use of vectors
- triangle of velocity
- graphical method of estimating heading and ground speed when wind velocity, TAS and required track are known
- limited trainee practice in estimating heading and ground speed

6.3.11 Use of slide-rules, computers and scientific calculators

Goal: *To enable the trainee to use slide-rules, computers and scientific calculators for identifying vector triangle problems, to determine wind components drift and ground speed, and to solve some arithmetical problems by using common air navigation computers.*

6.3.12 Measurement of aircraft altitude

Goal: *To enable the trainee to identify aircraft altimetry systems and their uses, errors, corrections and terminology.*

The absolute altimeter (radio altimeter)

- principles
- provision of true height above surface directly beneath the aircraft
- range and general accuracy
- cockpit instrument indication
- use and limitations for general application

The pressure altimeter

- principles
- construction
- scales and sub-scales
- calibration
- errors

Altimeter settings

- sub-scale set to standard pressure — altimeter reads pressure altitude
- sub-scale set to current airport QNH — altimeter reads correct airport elevation above mean sea level for that airport
- sub-scale set to current airport QFE — altimeter reads zero for that airport
- sub-scale set to QFF — altimeter reads zero at sea level for that location

Correction of pressure altimeter errors

- instrument errors
- static source errors
- non-standard pressure
- non-standard air temperature

Altimeter settings for a low-altitude flight

- QNH set for departure airport
- QNH reset for locations en route
- QNH set for arrival airport

Altitude setting for a high-altitude flight

- QNH set for departure airport
- altitudes used during climb until transition altitude reached
- transition altitude
- standard altimeter setting made at transition altitude
- flight levels used in conjunction with standard altimeter setting until transition level reached on descent
- local QNH and altitudes used below transition level

Precautions taken for terrain clearance

- restrictions on use of lowest flight level with standard pressure
- restrictions on use of lowest flight plan altitude with standard pressure
- flight crew calculations of altitude with sub-standard temperatures

Classroom exercises

- altimeter corrections from the flight manual
- calculation of true altitude above mean sea level and height above terrain for a range of temperatures, pressure altitudes and indicated altitudes
- estimation of altimeter errors due to sub-scale setting errors (use standard atmosphere tables)

6.3.13 Point of no return (PNR)

Goal: *To enable the trainee to understand the significance of the point of no return in aircraft navigation and to estimate it for all flights.*

Definition and type of PNR

- returning to airport of departure
- proceeding to alternate airport
- all powerplants operating
- powerplants failure

The basic PNR formula

- description

Practical uses of PNR

- flight plan
- en route

Classroom exercises

- for a given true track TAS and endurance, calculate distance to PNR by basic formula for conditions of:
  - — zero wind
  - — strong tailwind
  - — strong beam wind
- establish wind condition for maximum PNR
- simple exercises with all engines operating and with failed engine to demonstrate application of the above principle for cases involving:
  - — return to departure airport
  - — proceeding to alternate airport

6.3.14 Critical point (equal time point)

Goal: *To enable the trainee to identify the significance of the critical point or equal time point in aircraft navigation and to estimate it for all flights.*

Definition and type of critical point (CP)

- returning to airport of departure or proceeding to planned destination
- proceeding to alternate airport
- all engines operating
- engine failure

The basic CP formula

- $d = (D * H)/(O + H)$, where:
  D is distance to critical point
  O is ground speed outbound
  H is ground speed to departure or alternate airport

Classroom exercises

- for a given true track, TAS and D, calculate d using basic formula for conditions of:
  - — zero wind
  - — strong headwind
  - — strong tailwind
  - — strong beam wind
- establish under what conditions d will be farthest along track

Practical shortcomings of a basic formula

- suggests that there is a single important equi-time point along flight plan track
- does not cater to all airports that may be available in an emergency
- does not cater to different wind velocities to various airports

Practical uses of CP

- to assist the pilot-in-command in making in-flight decisions regarding contingencies in the event of rapid depressurization, severe power loss, etc.

A practical method of estimating CP

- description

Classroom exercises

- simple exercises with all engines operating and with failed engine to demonstrate application of the above principle for cases involving:
  - — return to departure airport
  - — proceeding to alternate airport

Note.— The route selected should be one for which the presence of alternates established more than one critical point.

6.3.15 General determination of aircraft position

Goal: *To enable the trainee to identify the method used by flight crew to determine aircraft position.*

Inertial navigation system

- description

Global navigation satellite system (GNSS)

- description

Visual navigation system

- description

General position-fixing methods

- depend on intersection of lines of position
- position circles obtained by various means
- hyperbolic lines of position from:
  - — Loran A or C navigation systems
- great circle bearings
- bearings measured relative to aircraft heading
- fixes which may be obtained by:
  - — direct readout of latitude and longitude from area navigation systems
  - — plotting simultaneous range and bearing from single site
  - — plotting lines of position from multiple origins
  - — making allowances for aircraft movement between time of position lines
  - — analysing intersection of multiple position lines to estimate position

Classroom exercises

- plotting fixes on Lambert and polar stereographic charts when bearings plotted relative to same meridian as measured:
  - — simultaneous ground direction-finding station bearings
  - — simultaneous range and bearing from ground radar station
  - — simultaneous magnetic bearing and distance from collocated VOR, DME or TACAN station (few stations in polar regions are true or grid north-oriented)
  - — position lines that are not simultaneous
- plotting the above fixes on Mercator chart where conversion to rhumb-line bearings by application of conversion angle is required

6.3.16 Introduction to radio navigation

Goal: *To enable the trainee to identify the fundamental principles and properties of radio transmission and to apply them to radio navigation.*

Note.— The theory and principles of radio are covered in greater detail in Chapter 13 — Communications — Radio.

Principles of radio transmission

- the radiation of energy into space at a constant velocity as a result of wire excited by alternating current
- relationship between frequency and wavelength
- interception of some of the radiated power by remote parallel wire
- detector indication of magnitude and frequency of radiated energy
- requirement for antenna sizes proportional to wavelength for efficient transmission

Transmission of signals

- modulation of continuous wave transmissions
- modulation, timing and coding of pulses
- international Morse code

Radio frequency bands and wavelengths

- description

Propagation characteristics at different frequencies

- ground waves
- isopheric layers
- sky waves
- line-of-sight waves

General applications to radio navigation

- measurement of direction of transmitter to determine bearing
- mixing and directing of transmitted signals to define paths in space
- measurement of interval between transmission and reception of signal to determine range
- measurement of interval between reception of synchronized signals to determine relative distance from transmitters
- rotating of radar antennas to enable bearing as well as range of targets to be determined and displayed

6.3.17 Ground-based radar and direction-finding stations

Goal: *To enable the trainee to identify those ground stations which are used to directly determine aircraft position or bearing.*

VHF and UHF direction-finding stations

- information provided — great circle bearings
- location and availability of services
- range
- accuracy
- uses

Primary ground radar

- information provided — great circle bearings
- location and availability of services
- range
- accuracy
- uses

Secondary surveillance radar (SSR)

- general principles
- advantages over primary radar
- location and availability of services
- transponder codes
- accuracy
- uses

6.3.18 Relative bearings

Goal: *To enable the trainee to plot position lines from ADF or from weather radar measured bearings.*

Relative bearings

- definition
- method of measurement
- conversion of relative bearings to:
  - compass bearings
  - magnetic bearings
  - true bearings
  - grid bearings
- plotting bearings

Aircraft ADF systems and facilities used

- principles
- non-directional beacons (NDBs)
- marine beacons
- caution on use of broadcast stations
- sources and correction of ADF errors
- radio magnetic indicator (RMI)
- general accuracy of ADF position lines

Classroom exercises

- on Mercator, Lambert conformal and polar stereographic charts, practise:
  - — conversion angle application
  - — convergency applications
  - — plotting relative to true north
  - — plotting relative to grid north

6.3.19 VOR/DME-type radio navigation

Goal: *To enable the trainee to identify the characteristics and uses of those radio navigation systems which provide flight crews with direct indications of range and bearing.*

Principles of VHF omnidirectional radio range (VOR)

- status of VOR
- range and accuracy
- airborne VOR equipment

Principles of aircraft distance measuring equipment (DME)

- status of DME
- range and accuracy
- aircraft DME
- frequency selection paired with VOR

VORTAC

- radial from VOR
- DME range from collocated TACAN

6.3.20 Instrument landing system (ILS)

Goal: *To enable the trainee to identify the components and principles of operation of the radio navigation system widely used for instrument approach and landing.*

Ground equipment

- description

Localizer

- description

Glide path

- description

ILS categories

- category I
- category II
- categories IIIa and IIIb

Aircraft equipment

- localizer receiver
- glide path receiver — frequency paired to localizer
- marker receiver
- cross-pointer indications
- coupling to autopilot

Normal operational minima

- decision height and runway visual range (RVR) minima for each category
- additional requirements for category II and III approaches

6.3.21 Navigation procedures

Goal: *To enable the trainee to identify the radio navigation and instrument flight procedures utilized in flight.*

Standard instrument departures (SIDs)

- purpose
- effect on flight operations
- establishment and designation
- facilities and procedures used to follow SIDs
- transition to airway routes
- trainee inspection of SIDs on charts

Airway and air route navigation

- use of facilities
- radials flown with reference to horizontal situation indicator (HSI) or radio magnetic indicator (RMI)
- principle of ADF tracking using RMI
- use of INS when cleared on airway

Direct and area navigation (RNAV) system routes

- definition of “direct” and “RNAV” routes
- use of INS, GNSS, and area navigation systems

Holding

- ATC reasons for holding instructions
- minimum fuel consumption considerations
- holding patterns
- holding entry patterns
- maintaining aircraft within the pattern
- expected approach time
- descending while holding
- transition to approach control

Transition to terminal area

- standard instrument arrivals (STARs)
- trainee inspection of STARs on charts
- transition to approach control

The instrument approach

- transition to approach facility
- outbound track
- procedure turn
- final track
- descent and landing

The ILS approach

- transition to ILS localizer
- glide path interception
- altitude over markers
- radar monitoring
- pressure and radio altimeters for minimum altitudes and decision height
- transition from instrument indications to visual cues for flare and landing
- manually flown approach
- automatic approach
- automatic landing using automatic approach and auto flare
- trainee inspection of ILS charts

The non-precision approach

- commonly used facilities
- tracking procedures
- descent procedures
- final descent based on calculated rate and time to minimum altitude
- trainee inspection of non-precision approach charts:
  - — ILS localizer without glide slope
  - — ILS localizer back course
  - — VOR approach
  - — NDB approach

Ground-controlled approach

- VHF direction finder
- airport surveillance radar
- precision approach radar

6.4 The CNS/ATM concept

6.4.1 By the end of the 1980s, ICAO as well as the entire aviation community had recognized the fundamental limitations of the existing air traffic system and the fact that the situation was going to get progressively worse. The characteristics and the capabilities of the present-day systems and of their implementation in various parts of the world revealed the following shortcomings in the present communications, navigation and surveillance (CNS) systems:

a) the propagation limitations of current line-of-sight systems and/or accuracy and reliability limitations imposed by the variability of propagation characteristics of other systems;

b) the difficulty in large parts of the world, for a variety of reasons, in implementing present CNS systems and operating them in a consistent manner; and

c) the limitations of voice communications and the lack of digital air-ground data interchange systems to support modern automated systems in the air and on the ground.

6.4.2 Although the effects of these limitations are not the same for every part of the world, it is evident that one or more of these factors inhibit the further development of air navigation almost everywhere. It was obvious that new CNS systems which would permit the proper development of an improved air traffic control system should be developed.

6.4.3 At the end of 1983, the ICAO Council established the Future Air Navigation Systems (FANS) Committee to study, identify and assess new concepts and new technology in the field of air navigation, including satellite technology, and to make recommendations thereon for the development of air navigation on a global basis.

6.4.4 The FANS Committee completed its task and presented its findings and recommendations to ICAO's Tenth Air Navigation Conference, held in Montreal from 5 to 20 September 1991. It concluded that the exploitation of satellite technology appeared to be the only viable solution to overcome the shortcomings of the existing CNS system and also fulfil the global needs and requirements of the foreseeable future. The committee developed an overall long-term projection for the co-ordinated evolutionary development of air navigation for international civil aviation over a period of the order of 25 years, in which, complementary to certain terrestrial systems, satellite-based CNS systems will be the key to world-wide improvements.

6.4.5 The main features of the global concept of the new CNS/ATM system are:

Communications

- In the future, aeronautical mobile communication will make extensive use of digital modulation techniques to permit high-efficiency information flow, optimum use of automation both in the aircraft and on the ground, and economical frequency spectrum utilization. Except for high-density areas within coverage of terrestrial-based communications systems, aeronautical mobile communications services (data and voice) will use satellite relay, operating in the frequency bands allocated to the aeronautical mobile satellite service (AMSS). Terrestrial-based air-ground communication will continue to serve in terminal areas and in other high-density airspace.

- VHF will remain in use for voice and certain data communication in many continental and terminal areas. However, steps should be taken to preclude future saturation.

- The SSR Mode S will provide an air-ground data link which will be used for ATS purposes in high-density airspace. Interoperability with other data links will be facilitated through the application of the open systems interconnection (OSI) model.

- The aeronautical communication network (ATN) concept, through the use of an agreed communication protocol structure, will provide for the interchange of digital data packets between end-users of dissimilar air-ground and ground-ground communication sub-networks.

Navigation

- Area navigation (RNAV) capability will be progressively introduced in compliance with the required navigation performance criteria. Studying the modern developments in aircraft navigation systems, the committee identified that the method most commonly used at present, i.e. requiring mandatory carriage of certain equipment, constrained the optimum application of modern airborne equipment. Now that new navigation aids (notably satellites) are available, it will be possible for aircraft operators to select, from among competing systems, the one that is most adaptable to their needs. To enable that flexibility and to support the development of more flexible route systems and RNAV environment, the concept of required navigation performance (RNP) has been developed. This concept is very similar, in principle, to the minimum navigation performance specification (MNPS) concept now in use in North Atlantic and northern Canadian airspace. Both concepts enable a required navigational performance to be achieved by a variety of navigation equipment; however, as distinct from MNPS, RNP is primarily intended for application in airspace where adequate surveillance is available to air traffic control (ATC).

- Global navigation satellite systems (GNSS) will provide world-wide coverage and will be used for aircraft navigation and for non-precision type approaches. Systems providing independent navigation, where the user performs on-board position determination from information received from broadcast transmissions by a number of satellites, will potentially provide highly reliable and accurate and high-integrity global coverage and could meet the navigation system requirements for sole means of navigation for civil aviation.

- The present radio navigation systems serving en-route navigation and non-precision approaches will be able to meet the RNP conditions and coexist with satellite navigation systems. However, it is foreseen that satellite systems will eventually become the sole means of radio navigation. The timing of withdrawal of the present terrestrial systems will depend on many factors, among which the implementation and quality of the new systems will be prominent.

Surveillance

- Secondary surveillance radar (SSR) will remain in wide use in many parts of the world. By enhancing SSR with Mode S, the selective address and data link capabilities will further enhance the beneficial role of SSR for surveillance purposes.

- Automatic dependent surveillance (ADS) will be used mainly in non-radar coverage areas. ADS is a function in which aircraft automatically transmit, via a data link, data derived from on-board navigation systems. As a minimum, the data include aircraft identification and three-dimensional position. Additional data may be provided as appropriate. The introduction of air-ground data links, together with sufficiently accurate and reliable aircraft navigation systems, presents the opportunity to provide surveillance services in areas which lack such services in the present infrastructure, in particular oceanic areas and other areas where the current systems prove difficult, uneconomical or even impossible to implement. In addition to areas which are at present devoid of traffic position information other than the pilot-provided position reports, ADS will find beneficial application in other areas, including high-density areas, where it may serve as an adjunct to or backup for secondary surveillance radar and thereby reduce the need for primary radar.

Air traffic management (ATM)

- The term air traffic management (ATM) is used to describe the airspace and traffic management activities carried out in a co-operative manner by the aeronautical authorities concerned with planning and organizing the effective use of the airspace and air traffic flows within their area of responsibility. ATM consists of a ground part and an air part, where both parts are integrated through well defined procedures and interfaces. The ground part of ATM comprises air traffic services (ATS), air traffic flow management (ATFM) and airspace management (ASM). The general objectives of ATM are to enable aircraft operators to meet their planned times of departure and arrival and adhere to their preferred flight profiles with minimum constraints and without compromising the agreed level of safety. The goals of the ATM system are to maintain or increase the existing level of safety, to accommodate different types of equipped aircraft, to increase system capacity and to minimize delays through the realization of an efficient use of the airspace.

6.4.6 The ICAO CNS/ATM systems concept is widely seen as advantageous because it permits the enhancement of safety. Improved reliability of the aeronautical mobile satellite communications system, for example, will mean more complete and less interrupted ATS communications in some parts of the world. In addition, ADS and data communications systems facilitate improved conflict detection and resolution and assist the controller by providing advice on conflict resolution. More rapid and detailed information on weather warnings such as storm alerts will also contribute to the safety and effectiveness of flight operations. Further, the concept introduces air traffic management improvements which will permit more flexible and efficient use of airspace. A global introduction of the ICAO CNS/ATM concept can, within a short period, achieve a system which is capable of balancing the advantages of both strategical planning and short-term tactical control, thereby enhancing flight safety and efficient airspace utilization world-wide.

CHAPTER 7. AIR TRAFFIC MANAGEMENT

7.1 Introduction

Note.— Air traffic management (ATM) and air traffic service (ATS), as used in this chapter, are interchangeable.

7.1.1 Air traffic service is provided by States to ensure a safe, orderly and expeditious flow of air traffic. In addition, it also has several less known objectives such as fuel conservation, noise abatement, minimum environmental disturbance, cost effectiveness, impartiality towards all users within the rules and regulations, and the granting of users' requests whenever possible — objectives that are of importance to a flight operations officer/flight dispatcher (FOO/FD) who is responsible for flight planning, monitoring and co-ordination within the airlines.

7.1.2 As air traffic service is a major element in the operation of an aircraft, FOO/FDs must gain considerable knowledge of what it is, how it operates and how it relates to their responsibilities. This chapter is designed to provide the trainees with a thorough knowledge of the organization and operation of air traffic management and of some of the facilities required for the safe and efficient operation of commercial air transportation services.

7.1.3 To satisfactorily achieve the objective of the training course, it is recommended that a visit to a well-equipped air traffic management unit and an aeronautical information service unit be undertaken in order to allow trainees to observe the provision of the services in real time. Such a visit can be undertaken at the end of the training programme or during the period the specific items are being discussed. Following the examples in Chapter 6, a goal is provided for each subject item in the course. At the end of the training, the trainees will be able to identify the different types of air traffic services provided and describe the relationship between flight dispatch and the air traffic flow in the area of their responsibility.

7.2 Training objectives

Conditions: Provided with pertinent information and reference material on air traffic control, including a series of visits to different types of air traffic control centres,

Performance: The trainee will be able to identify basic principles of air traffic management and apply such principles in planning and monitoring flight operations.

Standard of accomplishment:
Principles of air traffic management must be thoroughly understood and the trainee must be able to apply such knowledge in the planning and monitoring of flight operations.

7.3 Required knowledge, skill and attitude

7.3.1 Introduction to air traffic management

Goal: *To enable the trainee to identify air traffic services and to understand their objectives and when they are provided.*

Air traffic management

- definition (description)

Responsibility for the provision of services

- over sovereign territory
- over the high seas or in airspace of undetermined sovereignty

- objectives of air traffic management

Divisions of air traffic management

- air traffic control (ATC):
  - — area control

— approach control
— aerodrome control

- alerting service

- units providing air traffic services

Airspace where air traffic services are provided

- flight information regions (FIRs)
- control areas
- control zones
- controlled aerodromes

Trainee examination of charts

- typical FIRs
- control areas
- control zones
- controlled aerodromes

7.3.2 Controlled airspace

Goal: *To enable the trainee to identify airspace in which air traffic control service is available and in which commercial aircraft normally operate.*

Controlled airspace

- definition
- control zone
- terminal control areas
- low-level control areas
- high-level control areas
- restricted airspace
- minimum navigation performance specifications (MNPS) airspace
- RNAV routes

Trainee examination of charts

- terminal control areas
- airways:
  — low level
  — high level
  — jet
  — vector
- high-level control areas
- restricted airspace

7.3.3 Flight rules

Goal: *To enable the trainee to identify VFR and IFR flights and the locations where and the conditions under which they may operate.*

Visual flight rules (VFR)

- definition
- definition of visual meteorological conditions (VMC)
- special VFR flight
- VFR flight restrictions
- requirement to comply with ATC instructions in controlled airspace

Instrument flight rules (IFR)

- definition
- definition of instrument meteorological conditions (IMC)
- minimum flight altitudes
- IFR cruising levels
- requirement to comply with ATC instructions in controlled airspace
- requirements to maintain a listening watch and establish communication with ATS units
- requirement to file a flight plan and make position reports

Table of cruising levels

- standard
- exceptions

7.3.4 Air traffic control clearance

Goal: *To enable the trainee to identify ATC requirements for issuing clearances and specify what minimum separation standards are applied.*

- air traffic control unit requirements
- ATC clearances
- ATC information display
- separation methods
- separation minima
- outline of clearances for a typical oceanic flight:
  - — ATC clearance
  - — start-up clearance
  - — taxi clearance
  - — clearance for take-off
  - — departure instructions
  - — reclearances en route
  - — oceanic clearance
  - — domestic clearance
  - — descent clearance
  - — approach instructions
  - — clearance to land
  - — ground control clearances
  - — ramp control clearances

7.3.5 ATC requirements for flight plans

Goal: *To enable the trainee to identify flight planning requirements to be met prior to ATC issuing IFR clearance.*

- purpose of the flight plan
- responsibility for filing the flight plan
- contents and format
- description of ICAO flight plan form
- practice in completing ATC flight plans
- filing of revised flight plans in flight
- responsibility for closing flight plan

7.3.6 Aircraft reports

Goal: *To enable the trainee to identify the value and the content of aircraft reports.*

- types of aircraft reports
- value of aircraft reports
- position reports
- air reports (AIREPs)

7.3.7 Flight information service (FIS)

Goal: *To enable the trainee to identify the type of information available to pilots in flight from the flight information service.*

- definition of flight information service
- responsibility for providing service
- services provided
- method by which pilots obtain services
- an outline of the information services available to flight crew on a typical long oceanic flight

7.3.8 Alerting service and search and rescue

Goal: *To enable the trainee to identify the organization, procedures and facilities used to assist aircraft in distress.*

- definition of alerting service
- responsibility for providing service
- air traffic services that provide alerting service
- flights for which alerting service is provided
- rescue co-ordination centres
- procedures for notifying rescue co-ordination centres:
  - — by air traffic services
  - — by the operator
- action taken during emergency phases:
  - — by rescue co-ordination centres
  - — by air traffic services
  - — by the operator
  - — by the pilot-in-command of the aircraft in distress during:
    - uncertainty phase
    - alert phase
    - distress phase
- emergency signals:
  - — radiotelephony procedures:
    - distress signal (MAYDAY)
    - urgency signal (PAN, PAN)
  - — Morse code (SOS "... --- ...")
  - — SSR transponder codes:
    - code 7700

- code 7600
- code 7500

— radar-alerting manoeuvres by aircraft

— emergency locator transmitter (ELT)

- search and rescue signals
- procedures for pilots-in-command
- aircraft bomb warnings:
  - — analysis of threat by operator and security personnel
  - — notifying pilot-in-command
  - — after-landing action
- FOO/FD's responsibility during emergency phase

7.3.9 Communications services — mobile

Goal: *To introduce the various communications services and enable the trainee to identify the means and procedures used to communicate with aircraft.*

- communications services
- types of messages
- mobile services

Classroom exercises

- exchange of a wide variety of messages emphasizing:
  - — need for preparation before transmission
  - — clarity and brevity
  - — use of correct call signs
  - — correct message format
  - — use of phonetic alphabet
  - — correct pronunciation of numbers
  - — acknowledgement and sign-off

Note.— The class should be divided into groups to simulate the role of the flight crew and communicator at various ground facilities.

7.3.10 Communications services — fixed

Goal: *To introduce the fixed telecommunications networks used by air traffic services and operators.*

- definition of aeronautical fixed service (AFS)
- responsibility for providing services
- purpose of aeronautical fixed telecommunication network (AFTN)
- AFTN facilities
- operator's access to AFTN

7.3.11 Aeronautical information service (AIS)

Goal: *To enable the trainee to identify the types and the sources of aeronautical information available to the FOO/FD.*

- definition of aeronautical information service
- responsibility for providing AIS
- function of AIS
- exchange of aeronautical information:
  - — international notices to airmen (NOTAM) offices
  - — communication methods
- general specifications:
  - — language
  - — place names
  - — units of measurement
  - — abbreviations
  - — identification and delineation of prohibited, restricted and danger areas
  - — nationality letters
- aeronautical information publication (AIP):
  - — standard format and contents
  - — amendments and supplements to AIP
  - — parts of the AIP designated for flight operational use
- other government and commercial publications:
  - — publications produced by private companies, e.g. Jepppesen
  - — publications produced by operators
- NOTAM
- aeronautical information regulation and control (AIRAC) NOTAM
- aeronautical information circulars
- aeronautical information units (flight service station)
- classroom exercises:
  - — inspection of typical AIP and air pilot publications
  - — decoding NOTAM

7.3.12 Aerodrome and airport services

Goal: *To enable the trainee to identify airport features and facilities of significance to the FOO/FD.*

Aerodrome administration

- aerodrome operators
- aerodrome certification

Airport data

- reference positions
- elevations
- international designators

Airport design criteria

- runway dimensions and related information
- graded areas
- displaced thresholds
- stopways
- clearways
- declared distances
- control of obstacles
- bearing strength of pavement

Measuring and expressing runway friction

- variation in braking action on wet, snowy or icy runways
- measurement of runway friction
- expression of estimated braking action
- variations in measurements and their effects on different aircraft
- runway surface variations (grooved/porous)

Airport visual aids

- runway markings
- closed markings
- taxiway exit and holding markings
- guidance signs
- wind direction indicator
- obstruction markings
- airport beacon
- visual approach slope indicator systems

Airport lighting

- approach lighting
- runway identification lights
- runway lighting
- displaced threshold lights
- centre line lights
- touchdown zone lights
- high-speed runway exit lights
- taxiway lighting
- airport emergency lighting
- change-over time requirement for instrument approach runways

Airport emergency services

- airport emergency planning
- responsibility for planning and co-ordination
- rescue and fire fighting services:
  - — classification of airports
  - — removal of disabled aircraft

Classroom exercises

- extraction of airport data of significance to FOO/FDs from airport charts published by:
  - — the State
  - — private companies such as Jeppesen
  - — international operators

CHAPTER 8. METEOROLOGY

8.1 Introduction

8.1.1 While all transport is subject to weather conditions which vary from benign to vicious, it can be argued that aviation is the most sensitive to weather conditions. 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.

8.1.2 It is most important, therefore, that the flight operations officers/flight dispatchers (FOO/FDs) have sufficient skill and knowledge to interpret meteorological information, reports, forecasts and warnings correctly and efficiently. They must be able to use this information when preparing or amending flight schedules, when preparing flight plans or briefing flight crew, and during flight watch when important weather data must be quickly interpreted and passed to the flight crew.

8.1.3 In order to ensure that the trainee fully understands the role that the local meteorological office plays in the preparation, coding and dissemination of weather data, it is strongly recommended that he be taken on a guided tour of the nearest meteorological office, where questions and discussion should be encouraged. The maintenance of good co-ordination between the aerodrome meteorological office and flight dispatch has a major positive impact on the quality of the work of both units.

8.1.4 The following syllabus outlines the minimum knowledge and skill that is necessary if the FOO/FDs are to perform their job efficiently and productively. While it may be necessary for authorities to enhance some part(s) of the outlined syllabus, it must not be at the expense of other parts.

8.2 Training objectives

Conditions: The trainee must be provided with all relevant documentation, examples of actual 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 meteorological office is strongly recommended.

Performance: In addition to demonstrating theoretical knowledge, trainees will also be able to demonstrate practical application at every opportunity using actual weather folders in conjunction with simulated or actual aviation situations and/or problems.

Standard of accomplishment:
The basic physical principles of meteorology, an understanding of meteorological observations as well as their interpretation, dissemination, and use in making forecasts must be thoroughly understood. The trainee must have a broad understanding of the general circulation and world climate, and a thorough basis for understanding weather conditions at specific locations and along specific routes. The trainee must be able to understand weather conditions and make intelligent deductions therefrom.

8.3 Required knowledge, skill and attitude

8.3.1 Atmosphere

Goal: *To outline the composition and structure of the atmosphere and the definition of the international standard atmosphere (ISA).*[1]

- composition of the atmosphere
- structure of the atmosphere:
  - troposphere
  - tropopause
  - stratosphere

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

- — mesosphere
- — thermosphere

- international standard atmosphere (ISA):
  - — purpose of a standard atmosphere
  - — definition
  - — description
- classroom exercise:
  - — use of international standard atmosphere

8.3.2 Atmospheric temperature and humidity

Goal: *To identify the physical processes related to the transfer of heat and moisture in the atmosphere and to outline the reasons for temperature and humidity variations both horizontally and vertically.*

- units of measurement for temperature
- 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
    - water vapour content
    - dew-point temperature
    - relative humidity
  - — evaporation, condensation and sublimation
- adiabatic processes:
  - — definition
  - — unsaturated air
  - — saturated air
- stability of the atmosphere:
  - — definition
  - — stable equilibrium
  - — neutral equilibrium
  - — unstable equilibrium
  - — absolute stability
- 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 take-off performance
  - — trade wind inversions

8.3.3 Atmospheric pressure

Goal: *To identify horizontal and vertical variations in atmospheric pressure and how pressure distributions are shown on meteorological charts.*

- definition and measurement:
  - — definition of pressure
  - — measurement of pressure
  - — units of measurement
- pressure at sea level:
  - — common reference
  - — surface synoptic chart
  - — corrections
  - — 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
— altimetry, QNH (altimeter setting), 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
- production of constant pressure charts by the two world area forecast centres (WAFCs):
  — WAFC London, U.K
  — WAFC Washington, U.S.A

Classroom exercise

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

8.3.4 Pressure-wind relationships

Goal: *To identify the physical factors that determine wind velocity.*

Definitions and measurement of wind

- definitions:
  — wind
  — wind direction
  — wind speed
  — wind velocity
  — wind shear
  — veering
  — backing
- units of measurement
- methods of measuring wind velocity

Horizontal forces acting on the air

- pressure gradient force
- Coriolis force
- centripetal force
- surface friction

- geostrophic wind
- cyclostrophic wind
- gradient wind

8.3.5 Winds near the Earth's surface

Goal: *To identify the principal reasons why surface winds deviate from those expected from surface pressure distributions.*

Effects of surface friction

- gusts:
  — winds reported averaged over 2 or 10 minutes
- squalls
- diurnal variations in wind
- topographical effects

Local wind systems

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

8.3.6 Wind in the free atmosphere

Goal: *To provide an understanding of upper winds and enable the trainee to estimate winds and temperatures from upper-air charts.*

Relationship between wind and isobars/contours

- geostrophic approximation:
  — northern hemisphere
  — southern hemisphere

- cyclostrophic approximation:
  — tropical regions

Behaviour of the wind with increasing height

- 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

Classroom exercise

- estimation of winds and temperatures:
  — at flight levels corresponding to upper-air charts
  — at intermediate flight levels
- interpretation of tropopause and maximum wind charts

8.3.7 Turbulence

Goal: *To identify the characteristics of atmospheric turbulence and its effect on aircraft operations.*

- types of atmospheric turbulence

Clear air turbulence (CAT)

- occurrence
- role of jet streams
- aircraft response
- ICAO criteria for reporting turbulence:
  — light
  — moderate
  — severe

Mountain waves (rotors)

- occurrence
- ICAO criteria for reporting mountain waves:
  — moderate
  — severe

8.3.8 Vertical motion in the atmosphere

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

Localized vertical motion

- produced by:
  — topography
  — convection

Widespread vertical motion

- role of convergence/divergence

8.3.9 Formation of clouds and precipitation

Goal: *To identify the processes involved in the formation of clouds and precipitation and to classify clouds.*

Processes involved

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

Role of upward motion in cloud formation 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, Altocumulus)
- 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

8.3.10 Thunderstorms

Goal: *To identify the characteristics of thunderstorms and their effects on surface weather and flight conditions.*

Conditions for formation

- deep layer of unstable air
- high relative humidity
- mechanism to initiate the uplift of the air

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 to 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
  - reduced visibility due to heavy precipitation
- effects of lightning

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

8.3.11 Aircraft icing

Goal: *To identify the factors that cause icing and the problems associated with the different classifications of aircraft icing, and to provide an outline of the operation of various icing protection systems.*

Definitions

- static air temperature
- total air temperature
- occurrence of aircraft icing:
  - sublimation (of water vapour)
  - freezing (of supercooled water droplets) — predominant
- icing 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

Forms of icing

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

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

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

Icing intensity

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

8.3.12 Visibility and runway visual range (RVR)

Goal: *To define visibility and identify the processes and conditions that result in significant visibility reductions.*

Types of visibility used in aviation

- visibility:
  - minimum and prevailing visibility
  - observation

- runway visual range (RVR):
  - — definition
  - — use
  - — assessment
  - — reporting
  - — impact on aircraft operations
  - — slant visual range (SVR)
- vertical visibility
- meteorological components of aerodrome operating minima (visibility and RVR)

Causes of reduced visibility

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

Fog types

- radiation fog
- advection fog
- upslope fog
- steaming fog
- frontal fog

8.3.13 Volcanic ash

Goal: *To identify the problems caused by volcanic ash.*

- impact on flight operations
- detection
- reporting of volcanic ash including colour code
- forecasting movement of volcanic ash “clouds”
- ICAO International Airways Volcano Watch (IAVW):
  - — volcanic ash advisory information
  - — volcanic ash advisory centres (VAACs)

8.3.14 Surface observations

Goal: *To identify types and contents of surface observations and the units, terms and equipment used.*

Requirements for aviation

- routine and special observations
- regional/global networks

Elements of observations

- 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

8.3.15 Upper-air observations

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

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 and special AIREPs)

- routine AIREPs
- special AIREPs
- other aircraft observations (aircraft communications addressing and reporting system (ACARS), aircraft to satellite data relay (ASDAR), aircraft meteorological data relay (AMDAR))

Observations from meteorological satellites

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

8.3.16 Station model

Goal: *To describe the plotting of surface and upper-air synoptic charts.*

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)
- station model for upper-air charts

Classroom exercise

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

8.3.17 Air masses and fronts

Goal: *To identify air masses, their transition zones and the general weather characteristics associated with each type.*

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
  — inter-tropical 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

8.3.18 Frontal depressions

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

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

8.3.19 Weather at fronts and at other parts of the frontal depression

Goal: *To identify the surface weather and flying problems associated with fronts and other parts of the frontal depression.*

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:
  - — definitions
  - — depiction on surface charts
  - — vertical structure
  - — associated weather conditions
- weather in the final stages of a frontal depression

Upper winds over frontal depressions

- general circulation
- location of the jet stream relative to frontal depression

8.3.20 Other types of pressure systems

Goal: *To identify the weather characteristics of depressions not associated with polar/arctic fronts or anticyclones.*

Non-frontal depressions

- thermal depressions
- orographic depressions
- secondary depressions
- tropical cyclones[1]
- troughs of low pressure (without fronts)

Anticyclones

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

1. To be discussed separately under 8.3.22

8.3.21 General climatology

Goal: *To describe the characteristic weather patterns in regions for which the FOO/FD will eventually assume responsibilities.*

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
- one-cell model
- modification of circulation due to Earth's rotation
- resultant pressure distribution and air circulation:
  — horizontal cross-sections
  — vertical cross-sections
- identification of prevailing winds, pressure systems, fronts and tropopause

Modifications to idealized climatic zones

- due to climatic controls:
  — intensity of sunshine and its variation with latitude
  — distribution of land and water
  — ocean currents
  — prevailing winds
  — mountain barriers
  — position of main high- and low-pressure areas

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
- comparison of idealized model with actual values:
  — role of climatic controls
  — using values for both summer and winter
- deviations from average on a particular day:
  — particularly over land masses
  — absence of some phenomena (e.g. jet streams):
    - because of wide variations in their day-to-day locations

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)

Classroom exercise

- aeronautical climatology of a specific route:
  — a long route of general interest to the group should be selected
  — each trainee should be assigned a project related to the route and be expected to prepare a brief report
  — assignments should include the following:
    - prevailing distribution of surface pressure and corresponding wind pattern
    - positions of main frontal zones
    - cause and frequency of poor surface visibility
    - variations in surface and upper-air temperatures
    - variations in upper winds
    - average cloudiness of the route
    - frequency and intensity of precipitation and thunderstorms
    - frequency and severity of conditions favourable to aircraft icing
    - frequency and severity of conditions favourable to clear air turbulence
    - conditions at terminal airports and alternates

8.3.22 Weather in the Tropics

Goal: *To identify the significant features of the weather in the Tropics.*

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
- 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

8.3.23 Aeronautical meteorological reports

Goal: *To identify aeronautical meteorological reports and describe their decoding and interpretation.*

Types of reports

- aviation routine weather report (METAR)
- aviation selected special weather report (SPECI)
- air-report (AIREP):
  - — routine air-report
  - — special air-report

Aviation routine weather report (METAR)

- reporting times:
  - — reasons for greater frequency than for synoptic observations
- issued in two forms:
  - — coded (METAR) — disseminated beyond the aerodrome
  - — abbreviated plain language — 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 (EUR and NAT Regions)

Aviation selected special weather report (SPECI)

- criteria

- ASHTAM and SNOWTAM

Use of aviation weather reports in air traffic services

- automatic terminal information service (ATIS)
- meteorological information for aircraft in flight (VOLMET)

Classroom exercise

- decoding aviation weather reports (coded and in abbreviated plain language)
- analysing a series of reports from the same station to:
  - — 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

Note.— This course is designed to enable the trainee to understand weather and make intelligent deductions from available information. The FOO/FD is not responsible for making any weather forecasts or observations.

8.3.24 Analysis of surface and upper-air charts

Goal: *To outline the procedures used to analyse observations in order to obtain a three-dimensional view of weather.*

Analysis methods

- computer:
  - increasing use
- manual

Surface chart analysis

- locating fronts
- drawing isobars
- fixed times for surface chart analysis

Sequence of analysing surface charts manually

- plot surface observations using station model
- refer to previous chart for earlier position of pressure centres, fronts and isobars (continuity)
- draw in and identify types of surface fronts
- draw isobars

Analysis of upper-air charts

- fixed times for upper-air chart analysis
- upper-air charts complete the weather picture in the vertical dimension by indicating:
  - upper winds
  - upper-air temperatures
- interrelation of surface and upper-air charts

Synoptic charts in the Tropics

- no temperature contrasts:
  - no "classical" fronts
- three well-organized systems:
  - tropical cyclones
  - ITCZ
  - easterly waves
- outside the well-organized systems:
  - weak pressure gradients
  - no regular isobaric patterns
  - irregular movement
- geostrophic wind formula fails and winds frequently at variance with isobars:
  - upper contours of limited assistance
  - use of streamlines and isotachs
- synoptic chart does not describe the over-all weather situation well:
  - local (exposure, orography etc.), diurnal and seasonal effects dominant

Classroom exercise

- examination of actual surface and upper-air charts:
  - in mid-latitude areas
  - in tropical regions
- thorough examination and discussion of weather situation in various latitudes using actual charts:
  - a few minutes at the beginning of each day
- drawing vertical cross-sections (including frontal surfaces) along various routes

8.3.25 Prognostic charts

Goal: *To outline the procedures used for the preparation and interpretation of prognostic charts.*

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 world area forecast system (WAFS) by:
  - WAFC London
  - WAFC Washington
  - regional area forecast centres (RAFCs) (gradually being phased out)

- upper wind and upper-air temperature charts
- significant weather (SIGWX) charts:
  - — depiction of SIGWX phenomena

Classroom exercise

- examination of synoptic and aeronautical prognostic charts
- preparation of a subjective "forecast" related to a pressure system and its fronts:
  - — movement
  - — time evolution (development)

8.3.26 Aeronautical forecasts

Goal: *To identify and interpret all types of aeronautical weather forecasts.*

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 flight planning

- required for flight planning at least two hours before ETD
- basic requirements:
  - — upper winds 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 ETOPS

Forecasts for landing at destination/alternate

- en-route alternates:
  - — oceanic equal time point (critical point) alternates
  - — drift down alternates
- trend-type landing forecast:
  - — METAR or SPECI + a two-hour trend forecast
  - — change indicators in the trend forecast
- aerodrome forecast:
  - — TAF format

Warnings

- SIGMET information:
  - — en route
  - — role of SIGMET information related to tropical cyclones and volcanic ash
- aerodrome warnings:
  - — terminal area
- wind shear warnings:
  - — terminal area
- wake turbulence

Classroom exercise

- examination of typical charts and forecasts for flight planning:
  - — practice in decoding aerodrome and trend-type landing forecasts

Note.— The models given in the Appendix to Annex 3 and the Manual of Aeronautical Meteorological Practice *(Doc 8896) are well suited for this purpose.*

8.3.27 Meteorological service for international air navigation

Goal: *To outline the international organization of aeronautical meteorological services and to list the responsibilities of the centres.*

Role of international organizations

- role of the World Meteorological Organization (WMO):
  - — international Standards related to basic meteorological data:
    - observations

    - telecommunications
    - data processing

- role of ICAO:
  — international Standards related to aeronautical meteorology
  — main components:
    - world area forecast system (WAFS)
    - international airways volcano watch (IAVW)
    - tropical cyclone warning system
    - meteorological offices
    - meteorological watch offices (MWOs)
    - aeronautical meteorological stations

World area forecast system (WAFS)

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

International airways volcano watch (IAVW) and tropical cyclone warning system

- centralization of services concerning volcanic ash and tropical cyclones:
  — 9 volcanic ash advisory centres (VAACs)
  — 6 tropical cyclone advisory centres (TCACs)
- role of VAACs and TCACs
- advisory information issued

Organization of aeronautical meteorological services within States

- role of the Meteorological Authority
  — (Aerodrome) meteorological office:
    - role (including designation of the Meteorological Authority by Contracting States)
    - products and services provided:
      — terminal forecasts (TAF, TREND)
      — aerodrome warnings
      — wind shear warnings
    - reliance on WAFS for en-route information for flight planning and flight documentation
  — Meteorological watch office (MWO):
    - role (in particular, in relation to FIRs)
    - products and services provided:
      — SIGMET (and AIRMET) information for the en-route phase
  — Aeronautical meteorological station:
    - role
    - products issued:
      — routine and special reports (METAR, SPECI)
- responsibilities assigned to States:
  — provision of pre-flight meteorological documentation
  — provision of meteorological briefing and consultation facilities
  — provision of flight documentation
  — details included in ICAO Annexes and Procedures for Air Navigation Services
  — reference to aeronautical publications, identifying relevant chapters:
    - ICAO Annex 3 — *Meteorological Service for International Air Navigation*[2]
    - ICAO *Manual of Aeronautical Meteorological Practice* (Doc 8896)
    - ICAO Air Navigation Plans (ANPs) (Part IV — Meteorology)
    - States' Aeronautical Information Publications (AIPs)

Meteorological telecommunications

- detailed exchange requirements included in ANP:
  — role of MET tables

2. Identical to the Technical Regulations (Chapter C.3.1) of the World Meteorological Organization (WMO).

- satellite broadcasts:
  - — satellite distribution system (SADIS)
  - — international satellite communications system (ISCS)
- AFTN:
  - — Meteorological Operational Telecommunications Network Europe (MOTNE)
  - — AFI MET bulletin exchange (AMBEX) scheme
  - — regional OPMET bulletin exchange (ROBEX) scheme
- WMO global telecommunication system (GTS)

Operator's responsibilities to the Meteorological Authority

- consultation on additional criteria for issuance of special reports
- routine and special aircraft observations (AIREPs and special AIREPs):
  - — frequency required
  - — parameters to be reported
  - — means of reporting
- provide adequate notification of requirements of individual flights:
  - — scheduled operations on new routes may require about two months' advance notice
  - — notice required for ad hoc non-scheduled flights

8.3.28 Field trip to local meteorological office

Goal: *To give a practical illustration of the services and products provided to aviation by a meteorological office.*

Introduction

- visit to the local (aerodrome) meteorological office
- division into small groups
- allocation of assignments to the meteorological 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 meteorological 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 meteorological office in the global context

Classroom exercise

- practical experience in using meteorological data when preparing flight plans:
  - — assessing whether conditions are within aircraft limits
  - — calculating maximum payloads
- Examples

  1. Given all the necessary weather and operational data and in conjunction with the flight planning and the air navigation sections of the course, complete a minimum time track flight plan from Schiphol, Amsterdam (Kingdom of the Netherlands) to Washington Dulles International (U.S.A.).

  2. Given the latest METAR information (including crosswinds), runway lengths and aircraft data, determine whether different airports are within landing limits for three different aircraft types, using company data for visibility minima and aircraft crosswind maximum limitations for at least two different aircraft types.

  3. Given the latest METAR information and in conjunction with the aircraft performance section of the course, determine whether different aircraft types may take off at specific mass under differing weather conditions at various airports.

  4. Given a series of METARs for aerodromes in a given area, establish the prevalent trend and outline the weather conditions to be expected over the next six hours for a selected destination. Identify suitable alternates for periods of below minimum weather at destination.

CHAPTER 9. MASS (WEIGHT) AND BALANCE CONTROL

Note.— It should be noted that the term "weight" is used in place of "mass" in some States. Mass as used in this manual is interchangeable with "weight" and the abbreviation "W" for weight is also used to indicate mass in several places.

9.1 Introduction

9.1.1 Mass and balance control affects aircraft handling and safety as well as optimization of payload and economy of fuel. An overloaded aircraft is extremely dangerous, and many accidents and incidents have been attributed to overloading. A badly loaded aircraft, though perhaps not actually overloaded, can be equally dangerous and can adversely affect aircraft handling and safety. Accidents have been caused by unclear loading instructions and careless loading.

9.1.2 An aircraft with its centre of gravity (CG) located outside aircraft limits will be difficult, if not impossible, to control. Centre of gravity location can be changed dramatically by movement of an insufficiently secured load. Incorrect fuel management can also adversely affect the CG. Although fuel management is not a prime responsibility of the FOO/FD, nonetheless an understanding of the effects of fuel mismanagement is necessary to underline the importance of correct use of fuel index sheets and fuel graphs when completing loadsheets/trimsheets. The aircraft load must be planned and completed in such a manner as to ensure that the CG stays within aircraft limits at all stages of flight, that all zone and compartment limits are respected and that none of the structural aircraft mass are exceeded at any time, i.e. maximum zero-fuel mass, maximum ramp mass or taxi mass, maximum take-off mass (either structural or conditionally restricted) or maximum landing mass.

9.1.3 Mass and balance and load planning are not just about the correct load distribution of mass in order to achieve the optimum CG location. Structural limits such as floor strengths, as well as zone load and compartment load maxima, must also be considered. Secure tie-down must be ensured. Some compartments are better equipped than others with tie-down equipment, and loads must be planned accordingly. Dimensional statistics of cargo pieces must be compared to compartment door (the door through which the load has to enter the aircraft) limits during load planning. Compatibility of substances with dangerous goods must also be considered. There are obvious examples of this such as not positioning live animals near food, sensitive films near radioactive material, or videotape near magnetic material. There are many other less obvious examples of incompatibility. Potential damage to or interference with aircraft equipment by substances or materials must be considered; for example, magnetic material may interfere with aircraft compasses if loaded in the wrong area or if its strength exceeds limits. Radioactive material must be correctly located and must not exceed limits either by actual amounts or accumulative effects. Incorrectly handled or loaded, it can constitute a hazard to passengers, crew and ground personnel. Load planning must also consider loading and unloading sequences. An aircraft with en-route stops must be loaded to minimize unloading and reloading at the intermediate stops. It should not be necessary to completely unload and then reload an aircraft at an intermediate airport in order to access air freight or baggage destined for that airport.

9.2 Training objectives

Conditions: The trainee will be provided with all the necessary documentation, blank loadsheets as well as moment and arms data from more than one aircraft. The use of a calculator is mandatory for basic exercises.

Performance: The principles of moments and arms must be clearly understood before the trainee is shown how to complete an index- or graph-based loadsheet. It is recommended that a loading exercise be completed, initially by using moment and arms data and finally by using the appropriate loadsheet as utilized by a typical carrier. This will serve to clearly demonstrate the mathematical logic of mass and balance. It must be demonstrated that the principles and logic of CG location apply equally to all aircraft whether one is referring to a large wide-body commercial jet or to a single-engined aircraft used for training pilots.

Supervised classroom discussions are to be encouraged regarding the possible multiple solutions to loading problems, and the class should be guided to the optimum solution with explanations regarding practical loading considerations as well as fuel savings. A guided visit to the load planning and cargo departments of a carrier would be beneficial.

Standard of accomplishment:

The trainee is expected to demonstrate adequate knowledge of load planning, calculation of payload, including the optimum use of available payload space, loadsheet preparation, aircraft balance and longitudinal stability, calculation of centre of gravity, structural aspects of aircraft loading, and the issuing of loading instructions within laid-down restrictions and limitations, including those imposed by dangerous goods considerations.

9.3 Required knowledge, skill and attitude

9.3.1 Introduction to mass and balance

Goal: *To identify the reasons for mass and balance control and methods for its accomplishment and to outline typical organizations.*

Mass and balance control

- definitions:
  - — basic operating mass (BOW)
  - — dry operating mass (DOW)
  - — zero-fuel mass (ZFW)
- ramp mass or taxi mass:
  - — take-off mass (TOW)
  - — landing mass
- mass control
- balance control
- terminology

Objectives

- to ensure that all mass limitations are observed during flight preparation
- to ensure that minimum fuel is always boarded
- to carry extra fuel when desired without affecting payload
- to carry maximum amount of available payload
- to ensure that the aircraft centre of gravity is within aircraft limits and that its position is established for take-off, for flight and for economic fuel usage
- to minimize ground handling of baggage, cargo and mail by efficient planning of load distribution

Organization of mass and balance control responsibilities

- for some small aircraft, data and instruction in the approved flight manual permit an individual to assume complete responsibility.
- in the operator's organization, technical departments are normally required to:
  - — maintain a current record of the basic operating mass and centre of gravity for each aircraft;
  - — periodically revise the basic operating mass and centre of gravity on the basis of actual measurements carried out; and
  - — produce the basic data methods from which the mass and CG for each flight are determined.
- the responsibility for load planning, controlling mass and balance, and calculating take-off mass and CG varies between operators.
- no commercial flight can be legally dispatched without a load clearance from the authorized department or individual.
- procedures must be developed to guard against the possibility of communications error, particularly when radio is used.

Mass and balance calculation methods

- computer systems which may be completely integrated with flight planning and load control systems
- graphical
- arithmetical
- mass $\times$ arm = moment

- $\frac{\text{total moments}}{\text{total mass}}$ = arm of centre of gravity (CG)

$$\text{MAC\%} = \frac{(\text{CG}) - (\text{Leading edge MAC})}{\text{MAC}} \times 100$$

- automated — using the carrier's electronic data processing (EDP) system to produce a load plan allied to the final loadsheet/trimsheet. Trainees should be proficient in all aspects of arithmetical systems before being introduced to or allowed to use an EDP system. Computer skills should be developed but only after the trainee has attained thorough knowledge and understanding of the principles that form the basis of mass and balance.

The load clearance (loadsheet)

- form, content and methods vary considerably between operators. The essential elements include certification that the aircraft is correctly loaded in accordance with the certified mass and CG limitations.
- a more comprehensive load clearance would include:
  - — flight number
  - — aircraft number/registration
  - — dry operating mass and dry operating CG
  - — zero-fuel mass
  - — zero-fuel mass CG (may be shown as Index value)
  - — take-off mass
  - — take-off mass CG (may be shown as Index value and MAC% value, or as MAC% value only)
  - — landing mass
  - — landing mass CG (may be shown as Index value and MAC% value, or as MAC% value only)
  - — passenger distribution
  - — deadload distribution — baggage, cargo, mail
  - — details of dangerous goods as defined by the relevant authority and clearly itemized on an approved pilot-in-command's traffic alert or notification to the Captain (NOTAC)
  - — details of live, perishable or any other sensitive cargo on board requiring special care and handling.
- the pilot-in-command must be satisfied that the aircraft is loaded in accordance with the load clearance, that no mass limits are or will be exceeded at any time during the flight and that the aircraft CG is and will remain within limits at all times during the flight.

9.3.2 Load planning

Goal: *To introduce load planning procedures and to explain how payload space is determined in advance and how problems are dealt with during actual flight preparation.*

Three aspects of load planning

- to make reasonable commitments to the traffic department on payload space available for advance sales
- to carry maximum possible payload when flight plan details are known
- to plan optimum distribution and segregation of cargo, mail and baggage at down-line and originating stations with respect to:
  - — volumetric limitations
  - — floor loading and running load limitations
  - — minimizing time and effort to unload/reload at intermediate stations
  - — centre of gravity limits
  - — dangerous goods requirements and limitations

Advance allotment of maximum payload

- for some route and aircraft combinations, fuel required and take-off and landing limitations do not restrict payload under any operating conditions.
- these combinations may be identified by analytical or statistical methods.
- maximum payload is then limited by:
  - — differences between aircraft dry operating and maximum zero-fuel mass
  - — volumetric or floor loading or running load limitations of cargo holds
  - — passenger capacity
  - — a combination of any or all of the above.

Tables of advance allotment of payload

- these are generally required to restrict advance sales to the maximum payload that the operator can be reasonably certain of carrying.
- tables may be produced by the FOO/FD after analysis of the probable mass limitations and fuel minima and may vary between seasons.

- tables normally provide breakdown by payload categories such as:
  - number of passengers
  - cargo
  - mail.
- tables assume standard passenger and baggage mass which may be established by:
  - State regulations
  - statistical analysis.
- under some conditions, the FOO/FD may be able to release additional payload details prior to completing flight plan details.
- under unusual conditions, the payload sold in accordance with the advance allotment may exceed that which can be carried. The FOO/FD's options then include:
  - assigning larger capacity aircraft to the flight
  - originating a section flight
  - planning an en-route landing
  - flight delay until conditions allow all committed payload to be carried
  - leaving payload behind.
- the FOO/FD should fully appreciate the potential problems associated with:
  - denied boarding of confirmed passengers
  - failure to meet contractual commitments for mail and cargo.
  - failure to load shipments of live animals or perishable cargo.
- the operator normally establishes a list of priorities for FOO/FD guidance in the situations outlined above.

- recognized numbering system (e.g. IATA) for compartments, positions, etc.

Classroom exercise

- examination of an operator's tables of advance allotment of payload (or similar data) to determine typical values for various routes and aircraft types
- simulated situations in which the flight is oversold for actual flight planned conditions and the trainee must decide on the most appropriate operating plan
- ample time should be allowed for instructor-directed discussion and analysis of the individual trainees' operating plans in order to obtain a consensus on the best operating plan

9.3.3 Payload calculation and loadsheet preparation

Goal: *To enable the trainee to accurately compute the maximum permissible payload and gain proficiency in completing loadsheets.*

Review of aircraft design mass

- maximum design taxi mass
- maximum design take-off mass
- maximum design landing mass
- maximum design zero-fuel mass

Review of operational factors that may restrict mass

- take-off and landing runway limitations
- take-off and landing performance (mass/altitude/temperature) limitations
- en-route climb performance requirements
- take-off mass limited to maximum permissible landing mass for that flight + mass of fuel consumed en route
- abnormal fuel loading or fuel management schedule may reduce maximum zero-fuel mass
- aircraft powerplant or equipment deviation from standard

Summary of operating mass

- basic operating mass (BOW)
- BOW + crew, crew baggage, catering supplies and standard flight spares = dry operating mass (DOW)
- DOW + payload/traffic load = zero-fuel mass (ZFW)
- DOW + take-off fuel = operating mass (OW)
- OW + payload/traffic load = take-off mass (TOW)
- ZFW + take-off fuel = take-off mass (TOW)
- TOW + taxi fuel = taxi mass
- TOW – fuel consumed en route = landing mass
- TOW – take-off fuel = zero-fuel mass (ZFW)

Passenger mass

- standard mass assumed based on:
  - — State regulations
  - — approved statistical analyses
  - — seasonal variations
  - — variation by destination (based on analyses)

Review of mass of minimum fuel

- minimum fuel normally calculated during flight planning before payload is known
- minimum fuel usually based upon an operating mass assumption such as ZFW
- if the assumed mass is too low, the minimum fuel must be increased
- minimum fuel is normally calculated in kilograms
- generally assumed that heat content per mass unit (kilogram) of fuel is constant for the fuel types approved for that aircraft type
- fuel may be boarded in terms of litres or gallons (US or Imperial) provided the conversion from mass to volume is made using the specific gravity appropriate for the fuel type and its temperature

Determining available payload

- the FOO/FD determines the following for the specific conditions affecting each flight:
  - — maximum permissible take-off operating mass (MPTOW) and regulated take-off weight (RTOW)
  - — minimum fuel (MF)
  - — taxi fuel (TF).
- the MPTOW and the MF are used by the FOO/FD, or the operator's department responsible for mass and balance control, to calculate maximum permissible payload for the flight:
  - — MPTOW – MF = ZFW
  - — ZFW compared with maximum design (or restricted) ZFW gives maximum permitted ZFW, i.e. MPZFW
  - — MPZFW – DOW = maximum permissible payload.
- the calculations may be made:
  - — by computerized load planning system
  - — manually.

Manual preparation of loadsheets

- loadsheets are normally used by operators without computerized systems to:
  - — record the actual location and amount of each type of payload
  - — calculate operational mass including last-minute changes (LMCs)
  - — provide a basis for calculating take-off and landing centre of gravity.

Classroom exercises

- further practice in calculating maximum permissible payload when limited by each of the many factors
- practice in completing typical loadsheets

9.3.4 Aircraft balance and longitudinal stability

Goal: *To provide the trainee with an understanding of the principles of aircraft balance and longitudinal stability.*

Introduction

- definition of balance
- definition of centre of gravity
- aircraft balance on the ground

Longitudinal stability in flight

- aircraft supported principally by lift produced by the wings
- lift considered to be located at wings' centre of pressure
- aircraft CG must be located at centre of pressure for balance without other forces
- definition of mean aerodynamic chord (MAC) and percent MAC (%MAC)
- functions of horizontal stabilizer and elevators
- aircraft with fixed horizontal stabilizers
- aircraft with variable stabilizers

Variations in aircraft centres of gravity

- the CG for the empty aircraft is recorded
- the amount of CG change depends on where the mass is added

9.3.5 Moments and balance

Goal: *To familiarize the trainee with the principles of calculating the point of balance using basic data provided by the aircraft manufacturer.*

Definition of a "moment"

- the product of mass × distance or "arm" from an arbitrary datum
- any units may be used in CG calculations provided they are used consistently, e.g.:
  - — inch pounds
  - — metre kilograms
- a moment that tends to produce a clockwise rotation about the datum is "positive"
- a moment that tends to produce anticlockwise rotation about the datum is "negative"

Conditions for balance

- positive and negative moments about the same datum must be equal
- beam weigher example with equi-length arms
- beam weigher example of balance achieved with dissimilar mass

Classroom exercises

- given the unequal lengths of arm of a beam balance and the mass of one pan, calculate the mass required in the other pan for balance
- given unequal mass in the pans of a beam balance and the total length of the beam, calculate the point of suspension for balance
- the trainee should also identify the CG in each example
- moments about an aircraft in flight
- in this example consider nose of aircraft pointing left as datum
- the basic operating mass of the aircraft may be considered concentrated at its CG, a known distance from the nose and creating a positive moment
- each additional mass creates a further positive moment
- for balance, an equal and opposite moment must be produced by the lift of the wing and the horizontal stabilizer
- net lift equals total mass of the loaded aircraft
- since total moment and mass are known, the distance of the balancing point CG from the nose may be calculated

Simplifying assumptions

- although the precise location of each item is theoretically required to calculate CG, practical assumptions can be made:
  - — passenger and cargo sections are divided into compartments and specific loads assigned to each
  - — within a compartment or section, the load is assumed to be uniformly distributed throughout
  - — since the location of the centre of the section (the centroid) is known in relation to the datum, the total moment created by the load in that section can be quickly determined

Classroom exercises

- calculate CG of a fully loaded aircraft with several passenger and cargo compartments.
- repeat same exercise using a different datum to prove that datum selection is arbitrary.
- assume aircraft in same exercise is completely loaded except for rear cargo compartment provide CG limits and determine:
  - — how much load could be carried in the rear cargo compartment without exceeding CG aft limits
  - — course of action if an acceptable CG cannot be obtained by loading the rear cargo department.
- prepare load plan and calculate CG after determining final locations for individual mass within predetermined limits.

Practical methods of calculating CG

- the index method in which the moments are calculated arithmetically using established station numbers and loads as in previous examples
- graphical methods devised specifically for a given aircraft type which basically do the same

Practical methods of ensuring CG is within acceptable range

- in some aircraft types for which a specific value is not required, CG may be controlled within acceptable limits by simple limitations and tables

- with a single cargo compartment, for example, its load limits may ensure an acceptable CG
- with multiple cargo holds, it may be possible to devise cargo tables showing, for example, the range of acceptable mass in the rear compartment for a given traffic load
- tables and procedures are developed by most operators to decide how to distribute the load even if a specific CG value must subsequently be calculated
- trainee inspection of operator load planning and distribution tables

Classroom exercises

- for a given load, calculate CG using datum and arm data, as provided by an operator's technical department, for a given aircraft with multiple compartments and sections.
- calculate CG for the same load on the same aircraft using the operator's graphical method.

9.3.6 The structural aspects of aircraft loading

Goal: *To identify the structural limitations that must be observed when loading an aircraft and to explain the need to keep the load from moving.*

Fuselage strength

- the achievement of a satisfactory balance does not ensure that the aircraft is safely loaded.
- the load must also be distributed so that neither the over-all fuselage strength nor the local strengths of the floors are exceeded.
- loads must always be properly restrained to prevent harm to passengers, crew, load or aircraft structure.

Fuselage structure

- cabin and cargo hold floors rely on a network of supporting beams attached to the fuselage frame.
- the fuselage structure transmits loads to the wings and undercarriage.
- fuselage loads furthest from the wings create greatest bending moment and strain on the structure.
- the cargo section is normally divided into loading bays or compartments forward and aft of the wing.
- the bays nearer the wing can normally carry heavier loads.
- the combined load in each cargo bay and the area directly above it must not exceed the mass limitation for that fuselage section.
- load planners have tables for controlling the load in each zone or area and these must be rigidly followed.

Permissible loading illustrations

- the instructor should use a diagram that divides the fuselage into upper and lower and fore and aft compartments.
- the maximum permissible load in each compartment and vertical column should be shown.
- examples of actual loads in each compartment should illustrate situations for which:
  - — loading is possible but outside stress limits
  - — stress on fuselage is minimal
  - — problems are unlikely to be experienced in ensuring the CG will be within limits.

Local floor strength

- the floor of each cargo hold is designed for a maximum load per unit area to prevent damage to the floor.
- the floor is also limited to load per unit length to ensure support by a sufficient number of floor beams.
- spreaders are used to further distribute the mass of heavy items and meet the limitations of unit area and unit length.

Note.— Provided that spreaders of standard dimensions are used, tables can be prepared for quick calculation of the minimum number of spreaders required for specific mass at specific dimensions. Particular note should be taken of sharp-edged objects and their potential for damage to aircraft floors, bulkheads, etc.

Maximum package tables

- aircraft manufacturers provide tables that give the maximum width, height and length combinations for acceptable pieces of cargo.
- tables take into consideration both hold dimensions and compartment door size.

Load restraints

- all loaded items must be secured:
  - — to prevent injury to passengers and crew
  - — to prevent damage to the cargo and aircraft
  - — to prevent a possibly catastrophic shift of the CG
- principle of inertia and forces developed by the load during:
  - — take-off acceleration
  - — landing or abandoned take-off deceleration
  - — yawing, rolling and pitching in turbulence
- methods of securing bulk cargo in passenger and cargo compartments

Cargo pallets

- description and advantages over bulk loading
- limitations and requirement for specialized ground-handling equipment
- methods of securing cargo to pallets and pallets to the aircraft

Cargo containers

- certified containers and non-certified containers
- description and advantages over bulk loading
- limitations and requirement for specialized ground-handling equipment
- methods of securing

9.3.7 Loading instructions

Goal: *To familiarize the FOO/FD with the main components and importance of clear, concise and correct loading instructions for loading staff and to provide practice in preparing loading instructions.*

Introduction

- the person responsible for issuing loading instructions, whether specialist load control agent or FOO/FD, is governed by the following limitations and special requirements:
  - — aircraft mass limitations
  - — hold and compartment limitations
  - — floor loading limitations
  - — balance limitations
  - — regulations concerning the carriage of dangerous goods
  - — loads for which specific temperature and ventilation conditions must be set.
- it must be ensured that cargo in close proximity is compatible.
- the location and loading sequence of cargo and baggage must be planned to:
  - — minimize ground handling at down-line stations
  - — give priority to accessibility of baggage as well as urgent or perishable cargo.

Loading instructions

- issued to those responsible for the actual loading when all of the foregoing considerations have been taken into account by the load planner
- a special form is normally used, containing:
  - — very explicit instructions from the load planner
  - — an area for deviations to be entered by the loading supervisor
  - — an area for certification by loading supervisor that instructions have been followed and that the load has been correctly secured
- when this special form is issued by computer, the instructions must be in full agreement with the prepared loadsheet. Areas of "Free Text" should be treated with extreme caution as they are error-prone because they were prepared manually and therefore independent of loadsheet structure and logic
- trainee inspection of typical loading instruction form
- trainee practice in completing loading instruction form

Last-minute changes (LMCs)

- limits within which LMC is allowed:
  - — standard loadsheet and trimsheet for several aircraft types
  - — mathematical formulae (based on datum and arms)

Load clearance (loadsheet)

- issued to pilot-in-command after:
  - — actual amount and location of total load are positively established

— load is repositioned in aircraft (if required)

— any LMC has been annotated

— all mass and balance limitations have been met

— take-off mass, CG, etc., have been recalculated as required

- trainee load clearance practice — ideally on-the-job training under supervision both in the load control centre and at the aircraft

Classroom exercises

- comparative use of graph-type trimsheet and moments and arms systems for same load on same aircraft
- use of "Index" system to determine CG (e.g. DC8-63F)
- exercises using as many different types of aircraft loadsheets and trimsheets as possible. These (together with relevant data concerning mass and indices) can normally be obtained from different carriers but should never be used without permission.

Sample exercise. Given: an aircraft with the following dimensions:

Location	Arm (inches from datum)
Nose wheel	220
Main landing gear	500
LEMAC	420
TEMAC (Trailing edge MAC)	570
Centrum for Hold-A	290
Centrum for Hold-B	360
Centrum for Hold-C	570
Centrum for Hold-D	640

Main cargo deck extends from 230 to 734 inches aft of datum.

Load details: 5 igloos, 84 inches long, are to be loaded on the main cargo deck. 14 inches between each igloo. Also 14 inches between each end igloo and the adjacent aircraft structure.

3 igloos @ 2 000 kg each
1 igloo @ 1 500 kg
1 igloo @ 1 400 kg
4 equal size cartons @ 300 kg each, to be loaded in lower holds
Maximum 2 cartons per hold
CG limits are from 26.0% to 28.0% MAC

a) State how cargo is to be loaded.
b) Give the CG as MAC% after the aircraft has been loaded.

9.3.8 Dangerous goods and other special cargo

Goal: *To familiarize the FOO/FD with cargo requiring special handling during loading and storage. To emphasize the importance of correct labelling and handling of dangerous goods as well as the importance of full crew briefing concerning dangerous goods and any other special cargo that is loaded on a given flight.*

Dangerous Goods (see also Chapter 10 — Transport of Dangerous Goods by Air)

- type, amount, and location of dangerous goods must be controlled:

  — to ensure the safety of the aircraft, passengers, crew and other cargo if leakage or breakage occurs

  — to ensure no harmful effects on passengers, crew or photographic film due to radiation

  — to ensure that the aircraft compass systems are not affected by magnetic materials.

- dangerous goods must be packed, labelled, handled and loaded in accordance with the relevant handling instructions: e.g. dangerous goods bearing the "Cargo Aircraft Only" label must be loaded only on an all-cargo aircraft. Packages containing liquids must be loaded and stored according to the orientation markings.
- dangerous goods must be loaded so that incompatible substances are kept apart and so that the correct separation distances between radioactive materials, human beings and animals, and undeveloped films are ensured.
- the required distances between individual radioactive packages must also be ensured in order to avoid undue buildup and concentration of radiation. Loading must also be carried out in such a way as to ensure required accessibility in flight (where applicable).
- packages of dangerous goods must be inspected for signs of damage or leaking before loading, incidents reported immediately and reports prepared as necessary.
- Before departure, the pilot-in-command must be provided with the required information concerning any dangerous goods on board. A Notification to the Captain (NOTAC) must be prepared giving the type, a full description as given in the ICAO *Technical Instructions for the Safe Transport of Dangerous Goods by Air* and/or the IATA Dangerous Goods Regu-

lations, labelling, quantity, UN number, classification, location on aircraft and (if applicable) details of accessibility in flight.

Note.— It is recommended that a photocopy of the relevant page(s) from the ICAO and/or IATA Dangerous Goods Manual be attached to the NOTAC for examination by the pilot-in-command.

Live cargo (AVI)

- requirements for temperature, ventilation and protection of the aircraft, passengers, crew and the live cargo must be observed.
- requirements for ground handling and treatment (including during any intermediate stops) must be considered and followed.

IATA numbering scheme for cargo holds, etc.

- most carriers use a common numbering system for holds, compartments, sections, and pallet/container positions.
- these numbers must be used in the loading instructions issued by the load control agent.

CHAPTER 10. TRANSPORT OF DANGEROUS GOODS BY AIR

10.1 Introduction

10.1.1 Air freight is classified as dangerous goods if it is listed in ICAO Doc 9284 — *The Technical Instructions for the Safe Transport of Dangerous Goods by Air.* This does not mean that this document is all embracing and that a dangerous substance, if not listed there, can be loaded on an aircraft. The Technical Instructions provide detailed instructions which must be followed. Other obviously dangerous materials must be referred to the appropriate company and State authorities for instructions regarding packing, labelling and loading. Remember, new materials (some of which are dangerous) are constantly emerging onto the market and some items of dangerous goods are completely forbidden for transport by air.

10.1.2 Annex 18 — *The Safe Transport of Dangerous Goods by Air,* adopted by the ICAO Council in 1981, contains the broad Standards and Recommended Practices governing the transport of dangerous goods by air; the detailed provisions are contained in the Technical Instructions. This document is binding on all States and has been recognized as the primary authority on dangerous goods. IATA also publishes Dangerous Goods Regulations which are widely used by operators and shippers. However, it should be remembered that the IATA manual is based on the requirements of Annex 18 and ICAO Doc 9284, and that it is the latter which contains the legally binding provisions for the transport of dangerous goods by air.

10.2 Training objectives

Conditions: Each trainee must be provided, in the classroom, with a copy of the current issue of the ICAO Technical Instructions and/or IATA Dangerous Goods Regulations. Practical problems must be used to illustrate the application of the regulations. Samples of cartons, correct and incorrect, should also be shown to the trainee and all relevant safety practices should be observed.

Performance: The trainee will be able to recognize that dangerous goods are on a given flight and that they require checking by qualified people. The FOO/FD will be able to brief the pilot-in-command accordingly. For personnel who actually handle, store and load dangerous goods as part of their duties, a more comprehensive dangerous goods course lasting several days is required.

Standard of accomplishment:
A broad outline of the rules governing dangerous goods will be given to the trainee. He must have an understanding of the classification of dangerous goods and the listings in the ICAO Technical Instructions and/or IATA Dangerous Goods Regulations.

10.3 Required knowledge, skill and attitude

10.3.1 Dangerous goods, emergency and abnormal situations

Goal: *To provide the FOO/FD with basic knowledge of the requirements for the handling, labelling, transport by air and stowage of dangerous goods as defined by ICAO and as listed in Annex 18, the associated ICAO Technical Instructions and the IATA Dangerous Goods Regulations.*

- class content and suggested schedule

Limitations on aircraft

- OK for both passenger and cargo aircraft
- OK for cargo aircraft only
- forbidden substances

- definitions, units of measurement and conversion factors

Classification of dangerous goods

- shipper's responsibilities
- operator's responsibilities

- use of documentation

10.3.2 Source documents

***Goal**: To familiarize the FOO/FD with the official documents that specify whether commodities are acceptable or not for transport by commercial airlines and, if acceptable, under what conditions (e.g. labelling, packing, quantity limitations, loading and handling).*

While it is normal for airlines to employ trained specialists in the Air Cargo Department who control acceptance, handling, storage and loading procedures for dangerous goods, the FOO/FD should be familiar with the following:

- Annex 18 and the associated Technical Instructions (Doc 9284) are the sole authentic legal source material for the transport of dangerous goods by air. Doc 9284 is published every two years.
- The IATA Dangerous Goods Regulations, published annually by IATA, is a commercial document used by the industry for practical reference. It is based on the requirements of Annex 18 and the associated ICAO Technical Instructions.
- ICAO Doc 9481, *Emergency Response Guidance for Aircraft Incidents involving Dangerous Goods*, is published every two years.

Limitations of dangerous goods on aircraft

- OK for both passenger and cargo aircraft
- OK for cargo aircraft only
- forbidden substances
- risk categories

- definitions, units of measurement and conversion factors

Classification of dangerous goods

- Class 1
  — Explosives
- Class 2
  — Gases
- Class 3
  — Flammable liquids
- Class 4
  — Flammable solids
  — Substances liable to spontaneously combust
  — Substances which, in contact with water, emit flammable gases
- Class 5
  — Oxidizing substances
  — Organic peroxides
- Class 6
  — Toxic substances
  — Infectious substances
- Class 7
  — Radioactive material
- Class 8
  — Corrosives
- Class 9
  — Miscellaneous dangerous goods

10.3.3 Responsibilities

***Goal:** To clarify the responsibilities relating to dangerous goods as they apply to the different parties concerned.*

Shipper's responsibilities

- packing
- labelling
- documentation

Operator's responsibilities

- passenger briefing and check-in procedures
- staff training
- acceptance procedures
- storage and loading

- inspection and decontamination
- provision of information to pilot-in-command and employees
- information by pilot-in-command in case of in-flight emergency
- reporting of dangerous goods accidents and incidents
- information by operator in case of aircraft accident or incident

10.3.4 Emergency procedures

Goal: *To outline the FOO/FD's responsibilities in the event of an emergency involving dangerous goods.*

- procedures to be carried out in the event of:
  - — aircraft accident where there are dangerous goods on board
  - — incident due to dangerous goods on board an aircraft:
    - in flight
    - on board an aircraft on the ground
  - — dangerous goods incident when air freight has been accepted by the operator

Note.— In the event of the FOO/FD being responsible for the actual acceptance, handling, storage and loading of dangerous goods, a far more comprehensive and detailed dangerous goods training course shall apply.

CHAPTER 11. FLIGHT PLANNING

11.1 Introduction

The purpose of good flight planning is to produce a flight plan that gives minimum time allied with minimum fuel, on the best possible route, avoiding bad weather conditions and following all safety procedures, and air law and air traffic management requirements. In order to perform flight planning, the FOO/FD must use all the skills learned and knowledge gained from the other parts of this course, including air navigation, aircraft performance, meteorology, air law, mass and balance and air traffic management (services). Checking security matters and for the presence of dangerous goods will play a part, as will the application of human resource management in the dispatch department. In addition, communications skills and technology will be used to file the flight plan and advise all down line of scheduled departure and arrival times, load on board, etc. It is important to note that flight watch/operational control cannot be conducted without access to flight plan details.

11.2 Training objectives

Conditions: Trainees must be provided with copies of climb, cruise and descent tables, route maps as well as approach and departure charts, with access to applicable performance data, mass and balance information and any other information deemed necessary for completion of a flight plan. Trainees must be equipped with a scientific calculator, Dalton-type navigation computer and a notebook with a supply of pens, pencils, etc.

Performance: Given the appropriate data and access to the appropriate sections of the operations manual, the trainee will be able to complete an operational flight plan in accordance with laid-down rules and standards.

Standard of accomplishment:
All requirements for flight planning will be readily identified by the trainee. He will be an asset to any flight dispatch department, knowing "what questions to ask", what procedures are imperative, what flight plan information is most important, how to file a flight plan and how to monitor the progress of the flight in accordance with the flight plan.

11.3 Required knowledge, skill and attitude

Goal: *To provide the trainee with detailed knowledge of flight planning methods and procedures, practice in the use of charts and tables to determine flight time and fuel, and practice in making operational decisions and in the preparation of flight plans and flight clearances.*

11.3.1 Introduction to flight planning

Goal: *To introduce flight planning procedures and to explain the need for flight plans and the FOO/FD's function in flight planning.*

The operator's flight planning objectives

- to co-ordinate and integrate all essential pre-flight activities
- to ensure safety of flight
- to provide a maximum of comfort and convenience to passengers
- to avoid forecast severe weather
- to schedule so as to avoid times of known adverse weather
- to operate on time
- to carry all available payload
- to operate economically
- to estimate:
  - — fuel requirements
  - — flight time
  - — payload

Conflicting flight planning objectives

- safety is always the prime objective.
- it is seldom possible to plan a flight to simultaneously:
  - — carry all available payload
  - — operate on schedule
  - — operate at minimum cost
  - — provide the smoothest possible flight
  - — conform with crew time limitations.

Operating costs

- Direct operating costs (DOC) which vary with flight duration and over which the FOO/FD has some measure of control such as:
  - — fuel
  - — direct maintenance labour and material costs that are time-dependent
  - — flight and cabin staff salaries based on time-dependent formulae
  - — alternate selection — landing and handling fees

Flight planning for different objectives

- maximum speed requires use of maximum thrust or power within airframe limits at altitude that produces maximum ground speed.
- minimum fuel consumption requires use of most fuel-efficient cruise control procedure, route and altitude.
- minimum cost requires analysis of both fuel and other time-dependent direct operating costs.
- since fuel costs dominate other time-dependent direct operating costs, minimum cost cruise control procedures, routes and altitudes are generally close to those for minimum fuel consumption.

The value of the flight plan to the flight crew

- establishes the optimum route, altitudes, and cruise control procedure based on careful analysis of the best available information
- predetermines or estimates:
  - — tracks and distances
  - — speeds and headings
  - — flight times between reporting points
  - — fuel consumption and reserve fuel
- plans for contingencies such as:
  - — terminal weather below operating minima
  - — situations for which point of no return or critical point estimates would be valuable
  - — drift down after engine failure

The value of the flight plan to air traffic services

- co-ordination and integration of flight plans and traffic flows by ATC
- co-ordination with other ATS units
- assistance in the prompt issue of a clearance that most closely meets the operator's request

Role of the FOO/FD in the flight planning process

- determine that the appropriate State and operator departmental authorizations have been obtained to operate special flights such as:
  - — extra sections of scheduled flights
  - — charters
  - — publicity flights
  - — ferry flights
  - — ferry flights with inoperative engine or system test flight
  - — training flights
  - — choice of call signs
- analyse weather to determine if flight can operate
- establish aircraft availability
- establish availability of flight crew and cabin staff
- determine available payload
- make operational decisions:
  - — departure time:
    - on schedule
    - delayed
    - early
  - — aircraft type:
    - normal type as scheduled
    - smaller
    - larger
  - — cancel scheduled flight
  - — originate new flight

— consolidate flights
— omit scheduled stop(s)
— add unscheduled stop(s)
(in accordance with State regulations and operator's policies)

- analyse weather, route and performance data to determine optimum flight trajectory using operator's criteria
- select alternate airports
- prepare the flight plan
- distribute relevant flight plan details to other departments
- brief flight crew
- reach agreement with pilot-in-command on final flight plan
- issue flight release
- file flight plan with ATC

ATC flight plan

- integration of performance data, route data and meteorological information
- requirement for judgement as well as proficiency in mechanical processes
- types of flights for which flight plans are required
- flight plan formats:
  — VFR
  — IFR
  — ICAO form
  — operator's forms to meet flight crew requirements
- filing of flight plans:
  — time before estimated time of departure
  — agency
  — communication method
  — normally an FOO/FD responsibility
- repetitive flight plan:
  — purpose
  — format
  — amendments prior to departure
  — amendments after take-off
- differences between flight plans:
  — reciprocating engine aircraft
  — turboprop aircraft
  — jet aircraft
  — with respect to:
    - cruise control methods
    - routes and altitudes
    - speeds and Mach number
    - identification
    - fuel reserve requirements

11.3.2 Turbo-jet aircraft cruise control methods

Goal: *To review turbo-jet aircraft performance and explain cruise control procedures used in commercial aviation.*

- review of turbo-jet principles
- jet aircraft performance graphs
- jet aircraft cruise control methods
- jet aircraft performance variations

11.3.3 Flight planning charts and tables for turbo-jet aircraft

Goal: *To familiarize the trainee with cruise control and flight planning charts and to enable him to become proficient at extracting usable data from them.*

- climb and descent charts and tables
- constant Mach number flight planning tables
- constant Mach number flight planning charts
- long-range cruise flight planning charts and tables

11.3.4 Calculation of flight time and minimum fuel for turbo-jet aircraft

Goal: *To enable the trainee to become proficient in calculating flight time and minimum fuel for turbo-jet aircraft.*

- principles and procedures
- taxi fuel
- optimum altitude
- use of charts
- fuel reserves

- critical point fuel
- trainee practice calculating flight time and minimum fuel including at least one example where CP fuel is required

11.3.5 Route selection

***Goal**: To identify factors to be considered in the selection of optimum tracks and to provide practice in the selection and application of same.*

- selection of optimum track
- the great circle in relation to minimum time track (MTT)
- general appearance of MTT on upper-air charts
- selecting the MTT from limited alternatives
- modifications to theoretical MTTs
- trainee practice in estimating MTTs:
  - — from limited alternative routes
  - — by time front analysis:
    - modification to time front analysis MTT

11.3.6 Flight planning situations

***Goal:** To outline fuel-tankering principles and to provide practice in their application.*

Introduction

- flights are normally planned on the basis of the minimum fuel that allows for all reasonable contingencies.
- more than minimum fuel should be considered when:
  - — weather conditions are marginal and greater operational flexibility is desirable
  - — fuel shortages exist at down-line airports
  - — fuel costs considerably more at down-line airports.
- decisions to carry additional fuel should take into consideration the cost of "tankering".
- a simple graph can be prepared showing the costs involved, taking into account the purchase prices at both airports and the cost of "tankering".

Classroom exercise

- using the simplest available method, calculate flight time and fuel for a typical long flight.
- recalculate with take-off mass 10 000 pounds/kilos heavier.
- calculate fuel consumed when carrying 10 000 pounds/kilos extra fuel.

11.3.7 Reclearance

***Goal:** To outline reclearance technique and to provide practice in its application.*

Reclearance technique
flight planning

- an alternative to planning an unscheduled landing or deplaning payload when minimum fuel to destination is restrictive
- fuel-saving technique valid under favourable weather conditions
- principle involves planning the flight to an alternate airport short of final destination:
  - — along optimum route to final destination up to reclearance point
  - — minimum fuel based on flight to alternate
  - — additional fuel may be carried if mass is available
- prior to clearance point, fuel to destination is calculated using normal criteria and latest meteorological data
- flight is recleared to final destination if fuel on board at the reclearance point is adequate from reclearance point to destination plus alternate, hold and en-route reserve
- probability of being recleared is enhanced by reduced fuel reserve requirement for shorter remaining route segments

Classroom exercise

- using the simplest available method, calculate normal minimum fuel for a typical long flight to destination with a 300-mile alternate.
- recalculate minimum fuel for same flight to an airport 300 miles short of destination and using destination as the alternate. Then calculate the additional payload that could be carried.
- estimate how much fuel could be saved by good flight planning.

11.3.8 The final phases

Goal: *To identify the final phases of the flight planning process and the FOO/FD's role in their completion.*

The flight release (where applicable)

- issued by FOO/FD when satisfied that all conditions for safe operation, in accordance with all limitations and regulations, have been met
- if based on a computer-generated flight plan, the clearance should not be given until a gross error check has been made
- normally includes items such as:
  - — flight designator
  - — points between which cleared
  - — aircraft registration
  - — minimum fuel
  - — maximum permissible take-off mass
  - — taxi fuel
  - — alternate(s) when required
  - — fuel over destination
  - — wind component and temperature
  - — route
  - — name of FOO/FD
- the FOO/FD may issue a series of releases for each of the legs of a pilot's cycle subject to time constraint
- revised releases may be transmitted directly to the pilot-in-command or made available on his arrival at down-line stations

The flight crew briefing

- flight crew briefing includes:
  - — meteorological information
  - — status of airports, navigation aids and communications facilities (NOTAM)
  - — aircraft equipment deviations
  - — reasons for the recommended flight plan

Filing the flight plan

- normally done by the FOO/FD at a time specified by ATC
- normal format for international flights is as specified by ICAO
- exceptions include domestic flight plan formats acceptable to that State
- the importance of filing a flight plan strictly in accordance with the prescribed format should be emphasized

- repetitive flight plans
- company departure message

11.3.9 Documents to be carried on flights

Goal: *To explain the purpose and establish the responsibility for ensuring that all essential documents are on board the aircraft.*

Flight crew and cabin staff documents

- valid flight crew licences, passports and visas
- current NOTAM and amendments
- special instructions and documentation for charter flights
- flight permit for special circumstances where CofA or CofR is void such as for test, ferry, or demonstration flight

Aircraft library

- aircraft flight operating manual
- sections of the operations manual applicable to flight crews
- aeronautical information publications
- aircraft journey log book

Aircraft documents pouch

- certificate of airworthiness
- certificate of registration
- aircraft radio licence (see Chapter 13 — Communications — Radio)
- fuel supplier carnet for purchase at off-line stations
- emergency en-route charts for emergencies
- sabotage checklist

Customs and immigration clearance forms

- general declaration (GD) form — required by some States
- declaration of health form (may be combined with GD)
- passenger manifest
- crew manifest

Note.— Requirements for many of these documents vary from State to State.

11.3.10 Flight planning exercises

Goal: *To enable the trainee to practice making operational decisions and preparing flight plans, thereby developing proficiency and confidence.*

Purpose and objective

- the purpose is to simulate typical operational situations in which the trainee is required to exercise judgement and apply and integrate knowledge and skills for efficient flight planning.
- the objective is to provide proficiency in operational decision making and in the detailed preparation of flight clearances and flight plans, using information only normally available to the FOO/FD.

Availability of information

- the exercises should be based on aircraft types for which the appropriate sections of a flight operating manual are available.
- the airports and routes selected should be those for which appropriate aeronautical information is available. Meteorological information should be varied for each exercise and provided in standard format.
- the available payload and aircraft are to be specified by the instructor.
- at least one exercise should include an aircraft equipment deviation that constrains the flight plan.

Exercise objectives

- to decide on the best operational plan which should include situations in which:
  - a flight can be cancelled, delayed, consolidated
  - all available payload cannot be carried
  - all available payload can only be carried by use of a feasible reclearance technique operation
  - normal operation is possible
- for each flight actually operated, the trainee should prepare a flight clearance and a flight plan in standard format

11.3.11 Threats and hijacking
(see also Chapter 15 on a related subject)

Goal: *To ensure that the FOO/FD is aware of his responsibilities, knows what to do and how to do it quickly and efficiently, knows how and where to get assistance without delay and can assist company and State authorities, where appropriate.*

The FOO/FD must:

a) have general knowledge of what actions he must take when information is received concerning threats or hijacking;

b) have general knowledge of his carrier and local authority policy and procedures as well as his responsibilities in the event of information being received concerning threats or hijacking; and

c) be familiar with the operator's safety and emergency procedures manual.

11.3.12 ETOPS

Goal: *The FOO/FD must, sooner or later, expect to be involved in flight planning, crew briefing and operational control concerning extended range operations by aeroplanes with two turbine power-units (ETOPS).*

Terminology and application

- adequate airport:
  - An airport sufficiently equipped to support the aircraft operation. This includes runway length, lighting, approach facilities, fire fighting, and a sufficient number of hotel rooms for accommodating passengers from diverted, delayed or cancelled flights. This concept of adequate airport is included in the definition of the area of operation.
- suitable airport:
  - An adequate airport with weather reports or forecasts, indicating that the weather conditions are at or above operating minima, and the field conditions at that airport indicate that a safe landing

can be made at the time of intended operation. As opposed to the concept of adequate airport, this suitable airport definition is actually used in the dispatch phase and in actual flight with specific weather requirements.

- auxiliary power unit
- ETOPS configuration maintenance and procedures
- engine
- extended range operations
- extended range entry point
- fail-safe
- In-flight shutdown
- system:
  - — airframe
  - — propulsion
- airworthiness standards
- operational in-service experience requirements for:
  - — 75-minute operation
  - — 120-minute operation
  - — 180-minute operation

Flight dispatch considerations

- 75-minute operation:
  - — master minimum equipment list (MMEL)
  - — weather
  - — fuel
  - — operational control practices and procedures
  - — flight planning
- 120-minute operation:
  - — MMEL
  - — weather
  - — fuel
  - — operational control practices and procedures
  - — flight planning
- 180-minute operation:
  - — MMEL
  - — weather
  - — fuel
  - — operational control practices and procedures
  - — flight planning

Dispatch considerations in addition to normal dispatch requirements

- MMEL
- communication and navigation facilities
- fuel and oil supply
- alternate airport requirements:
  - — suitable airport parameters
  - — airport services and facilities
  - — meteorological forecast requirements
- operational control (flight watch)
- aeroplane one-engine inoperative performance data covering:
  - — drift down (includes net performance)
  - — cruise altitude coverage including 10 000 feet
  - — holding
  - — altitude capability (includes net performance)
  - — missed approach
- all-engines operating performance data for standard and non-standard atmospheric conditions covering:
  - — cruise
  - — holding
- details of any other conditions relevant to extended range operations that can cause significant deterioration of performance

Operational limitations

- authorized area of operation
- flight dispatch limitation specifying maximum diversion time from a suitable airport
- use of maximum diversion time to ensure that extended range operation is limited to routes where the approved maximum diversion time to suitable airports can be met
- contingency procedures are not to be interpreted in any way that prejudices the responsibility and the final authority of the pilot-in-command

En-route alternate airports

- adequate airport
- suitable airport
- standard en-route alternate weather minima:
  - — a single precision approach

— two or more separate precision approach-equipped runways

— non-precision approach(es)

Note.— Lower than standard en-route alternate airport weather minima may be considered for approval for certain operations on an individual basis by the relevant Civil Aviation Authority depending on the facilities at the airport(s) concerned.

- en-route alternate suitability in flight

CHAPTER 12. FLIGHT MONITORING

12.1 Introduction

12.1.1 While the flight operations officer/flight dispatcher (FOO/FD) will spend most of his time and energy making flight plans that are safe, legal, and economically prudent, his most important task is flight monitoring. The FOO/FD is the only person on the ground who has the knowledge and resources available to provide the pilot-in-command with information necessary for the safe completion of the flight. While air traffic services are charged with traffic separation, they do not have the information or the means to evaluate changing operational conditions. These conditions are affected by changes to en-route and terminal weather and winds aloft, newly developed turbulence, changing airfield capability and availability, the unique equipment on board each aircraft, the fuel endurance based upon aircraft mass/balance and other aircraft-specific performance factors, the ramifications of en-route on-board equipment failures and other operational considerations including engine-out drift down, en-route alternates, and ozone exposure, among others. No other person, including the pilot-in-command, has as much information or as many resources available to effectively evaluate changes to the original flight release as does the FOO/FD.

12.1.2 ICAO Annex 6, Part I — *Operation of Aircraft, International Commercial Air Transport — Aeroplanes*, 4.6.1 requires that the FOO/FD furnish the pilot-in-command while in flight with information that may be necessary for the safe conduct of the flight. Several States carry this a step further and require the FOO/FD and the pilot-in-command, in the interests of maintaining the highest level of safety, to share joint responsibility for the safe conduct of each flight except in emergency situations. This recognizes that while the pilot-in-command will always remain in sole command of the flight, he shares responsibility with the FOO/FD for its safe conduct. In the event of an emergency, Annex 6, Part I, 4.6.1 requires that the FOO/FD initiate such procedures as may be outlined in the air carrier's operations manual. This duality of joint responsibility, where applied, has served the interests of the highest level of safety over the years.

12.1.3 FOO/FDs are proactive. It is their responsibility to look for problems, probing for information, solutions, and options to present to the pilot-in-command during both routine and irregular operations. The FOO/FD always knows where his flight is and how much fuel is remaining, is familiar with the en-route and terminal conditions, and is prepared to intervene when it becomes apparent that the flight will not be able to continue to operate under the conditions of its original release. In order for the FOO/FD to comply with the requirements of Annex 6, it is incumbent upon the pilot-in-command to consult with him any time air traffic services offers or attempts to direct a substantial change in the routing of the flight. The FOO/FD must evaluate all of the factors involved in order to confirm that the flight may proceed on the new route safely. If it appears that the flight cannot proceed safely, he must make this evaluation known to the pilot-in-command who will either concur with him to redispatch or cancel the flight or, if the pilot-in-command believes that proceeding is the safest course, continue on his emergency authority.

12.2 Training objectives

Conditions: Provided with the resources necessary to provide safe, effective flight monitoring and operational control in routine and emergency in-flight situations,

Performance: The trainee will be able to identify and evaluate routine and emergency airborne situations. He will be able to apply the skills acquired to effectively maintain a flight watch, and monitor fuel consumption, en-route weather including winds, aircraft performance including the limitations imposed by MEL restrictions, in-flight equipment failures, security problems, and the effects of and on hazardous materials, restricted articles, and perishable cargo. He will be familiar with appropriate communications tools including VHF/HF radio, ACARS/data link, SATCOM, and transponder codes, including the various security codes, and with weather conditions and the availability of facilities at en-route aerodromes, should a diversion be required. The trainee will be able to effectively consult with the various air traffic services regarding potential reroutes and en-route delays, recommending options within the capabilities of the aircraft that would minimize potential diversions, off-schedule operations, and events that would compromise the safety, comfort and economy of the operation.

Standard of accomplishment:

The trainee will be able to effectively demonstrate the knowledge and skills necessary to participate in the operational control of flights through flight watch and advocation of action to safely minimize disruptions to flight operations.

12.3 Required knowledge, skill and attitude

12.3.1 Position of aircraft

Fuel remaining

- fuel required for completion
- fuel exhaustion

En-route weather

- en-route winds at altitude and adjacent altitudes

Time estimated at next fix

- update estimated time of arrival (ETA) at destination

12.3.2 Effects of ATC reroutes

- fuel consumption
- cleared “direct” over long distances
- unanticipated severe weather penetration
- engine-out drift down when transiting high terrain
- penetration of moderate or severe turbulence areas not on original release and not known by ATC
- penetration of moderate or severe icing conditions not known by ATC, particularly with MEL items that reduce de-icing ability
- effect on ETA at destination, including passenger connections and curfews
- crew time

12.3.3 Flight equipment failures

Effect on performance

- potential for diversion
- effect on subsequent flights

Availability of maintenance at diversion aerodrome

- effect on other systems
- ETOPS considerations
- emergency potential

12.3.4 En-route weather changes

- winds
- en-route alternate terminal weather (including ETOPS)
- turbulence
- icing
- weather reroutes initiated by FOO/FD

12.3.5 Emergency situations

- overdue position report
- overdue at destination
- fuel exhaustion
- inability to communicate with aircraft
- continuing to operate in unsafe conditions
- in-flight fire
- loss of engine(s)
- loss of cabin pressure
- security threat
- incapacitation of flight crew member
- ditching/emergency landing
- rescue co-ordination
- Government/ATC co-ordination and notification

12.3.6 Flight monitoring resources — position reports

Company radio

- Aeronautical Radio Incorporated (ARINC) reports
- commercial radio net reports
- aircraft situation display (ASD)

- departure station reports
- destination station reports
- ATC reports
- SATCOM

12.3.7 Ground resource availability

- maintenance
- systems analysts
- meteorology
- performance engineering
- medical resources
- crew routing
- manufacturer/tech representative
- law enforcement
- company management
- aerodrome availability
- ground handling
- volcano activity information
- passenger service information

CHAPTER 13. COMMUNICATIONS — RADIO

13.1 Introduction

Radiocommunication is one of the major means available to the FOO/FD to effectively discharge his flight planning and monitoring functions under both normal and abnormal situations. As such, it is imperative that FOO/FDs be trained to an acceptable proficiency in the use of radiocommunication equipment and be able to communicate clearly and concisely in the language used for such purposes.

13.2 Training objectives

Conditions: Provided with relevant regulations and essential information and an environment where the use of both a radio microphone, real or simulated, and radio terminology including the phonetic alphabet can be practised under supervision,

Performance: The trainee will be able to communicate clearly and concisely using voice and data transmission.

Standard of accomplishment:
Trainee attainment of the levels of knowledge and radiotelephony competency that will satisfy the requirements of:

a) ICAO aeronautical station operator — Annex 1, 4.6; and

b) International Telecommunications R/T Certificate (Aero) Rules and Regulations, ITU Convention, Nairobi, 1982. The trainee will demonstrate his ability to conduct communications in the aeromobile service using the ICAO language, phonetic alphabet, procedure words, etc., of Annex 10, Doc 4444 and Doc 9432. (By means of State examination, as defined by the ITC, it shall be established that the trainee meet the requirements of the ITU Convention, Nairobi, 1982. The successful trainee should be issued with the appropriate State Radio Licence.)

13.3 Required knowledge, skill and attitude

International aeronautical telecommunications service

- fixed
- mobile radio navigation service
- broadcasting telecommunications service

Elementary radio theory

- amplitude
- frequency
- period
- wavelength
- electromagnetic wave
- sound wave
- E-M spectrum
- radio spectrum:
  - — VLF
  - — LF
  - — MF
  - — HF
  - — VHF
  - — UHF
- propagation of radio waves
- skip distance and hops
- D, E, and F layers
- aerials:
  - — polar diagrams

- — Figure “8”
- — cardioid

- modulation:
  - — AM
  - — FM
  - — sidebands: SSB, DSB
- elementary radio TX/RX

Aeronautical fixed service

- message format
- national practical fixed network:
  - — AFTN
  - — SITA (Société Internationale de Télécommunications Aéronautiques)

Aeronautical mobile service

- VHF band frequency utilization
- phonetic alphabet
- standard words
- call signs
- abbreviations
- communications
- priorities:
  - — distress
  - — urgency
  - — traffic
- practical operations

Radio navigation service

- standard navigation aids
- operational objectives:
  - — CAT I
  - — CAT II
  - — CAT III
  - — ILS
  - — Ground controlled approach (GCA)
  - — VOR/DME
  - — NDB, D/F

Automated aeronautical service

- telecommunications service
- VOLMET
- VHF/HF
- ATIS

CHAPTER 14. HUMAN FACTORS

Note.— For more detailed information on the importance of Human Factors in civil aviation operations, instructors and trainees can refer to ICAO Human Factors Digests 1 through 12. Human Factors Digest No. 1, Fundamental Human Factors Concepts, *is essential reading for those who would like to acquire an understanding of aviation Human Factors.*

14.1 Introduction

Lapses in human performance are cited as causal factors in the majority of accidents. If the accident rate is to be decreased, Human Factors must be better understood and Human Factors knowledge more broadly applied. Increasing awareness of the importance of aviation Human Factors presents the international aviation community with a significant opportunity to make aviation both safer and more efficient. The purpose of this chapter is to introduce flight operations officers/flight dispatchers (FOO/FDs) to fundamental Human Factors concepts in aviation and to provide guidelines for introducing crew resource management (CRM) concepts in the emergency training and exercise phases of FOO/FD training.

14.2 The meaning of Human Factors

14.2.1 Human Factors as a term has to be clearly defined because these words, when used in the vernacular, are often applied to any factor related to humans. The human element is the most flexible, adaptable and valuable part of the aviation system, but it is also the most vulnerable to influences that can adversely affect its performance. Throughout the years, some three out of four accidents have resulted from less than optimum human performance.

14.2.2 Human Factors is a technology that deals with people: it is about people in their working and living environments, and it is about their relationship with machines, equipment and procedures. Just as important, it is about their relationship with each other as individuals and in groups. It involves the over-all performance of human beings within the aviation system. Human Factors seeks to optimize the performance of people by the systematic application of the human sciences, often integrated within the framework of system engineering. Its twin objectives can be seen as safety and efficiency.

14.2.3 Human Factors has come to be concerned with diverse elements in the aviation system. These include human behaviour; decision-making and other cognitive processes; the design of controls and displays; flight deck and cabin layouts; air traffic control display systems; communication and software aspects of computers; maps, charts and documentation; as well as training.

14.2.4 Cultural differences have been recognized as issues of concern to Human Factors. The subject has been studied by many Human Factors specialists, and as is the case with many Human Factors issues, the jury is still out and universal definition and explanation have yet to be determined. In the context of the FOO/FD's training, cultural differences should be addressed in the light of the misunderstanding that may be created among FOO/FDs and crew members of differing cultural backgrounds and the resulting possible break in communication and co-ordination. When addressing this issue, instructors must exercise caution as discussion on cultural differences is subject to misunderstanding and can result in unnecessary friction. During this phase of the training, emphasis should be placed on the development of an organizational culture that encourages a team work approach to the FOO/FDs' and crew members' responsibilities.

14.2.5 In spite of the reliance on the academic sources of information, aviation Human Factors is primarily oriented toward solving practical problems in the real world. There are a growing number of integrated Human Factors techniques or methods; these varied and developing techniques can be applied to problems as diverse as accident investigation and the optimization of personnel training.

14.2.6 It is most important that everyone concerned with the operation and administration of the aviation system recognize the inevitability of human error. No person, whether designer, engineer, manager, controller, flight dispatcher or crew member, can perform perfectly all the time. Also, what could be considered perfect performance in one set of circumstances might well be unacceptable in another. Thus, people need to be seen as they really are; to wish that they be intrinsically "better" or "different" is futile, unless such a wish is backed by a recommendation for remedial action. Such a recommendation can be further supplemented by provision of the means to achieve better design, training, education, experience, motivation, etc., with the objective of positively influencing relevant aspects of human performance.

14.2.7 An understanding of the predictable human capabilities and limitations and the applications of this understanding are the primary concerns of Human Factors. Human Factors has been progressively developed, refined and institutionalized since the end of the last century and is now backed by a vast store of knowledge which can be used by those involved in enhancing the safety of today's complex civil air transport system.

14.3 Dispatch resource management (DRM)

14.3.1 Dispatch resource management training is but one practical application of Human Factors. Although DRM can be approached in many different ways, there are some essential features. Training should focus on the functioning of the FOO/FDs as part of a larger team which may include flight crew members, and not simply as a collection of technically competent individuals, and should provide opportunities for FOO/FDs to practise their skills in the roles they normally perform. The programme should teach FOO/FDs how to use their interpersonal and leadership styles in ways that foster flight safety. The programme should also teach FOO/FDs that their behaviour during normal, routine circumstances can have a powerful impact on how well or safely the flight for which they share responsibility is conducted. Similar situations experienced in training increase the probability that FOO/FDs will handle actual stressful situations more competently.

14.3.2 Research studies from the behavioural sciences strongly suggest that behaviour change in any environment cannot be accomplished in a short period of time, even if the training is very well designed. Trainees need time, awareness, practice and feedback, and continual reinforcement to learn lessons that will long endure. DRM addresses the challenge of optimizing the person/machine interface and related interpersonal issues. These issues include effective team building and maintenance of teams, information transfer, problem solving, decision making, maintaining situational awareness and dealing with automated systems. Thus, to be effective, DRM training must be accomplished in several phases and over several years.

14.3.3 Accordingly, DRM training should include at least three distinct phases:

a) an awareness phase where DRM issues are defined and discussed;

b) a practice and feedback phase where trainees gain experience with DRM techniques; and

c) a continual reinforcement phase where DRM principles are addressed on a long-term basis.

14.4 Awareness

14.4.1 Awareness is the essential first phase and usually comprises instructional presentations focusing on the roles of interpersonal and group factors in the maintenance of FOO/FDs and crew co-ordination. It is important because it provides a common terminology and a conceptual framework for FOO/FDs and crew members to begin thinking about dispatch/crew co-ordination problems and how such factors may have contributed to accidents and incidents. A useful way of beginning the awareness phase might be to introduce DRM skills as they pertain to communication, situation awareness, problem solving, etc. Actual situations in which dispatch/crew co-ordination and communication had a direct impact on the outcome of the event should be examined and the positive and negative interactions reviewed.

14.4.2 It is important to recognize that awareness is only a first step; classroom instruction alone will probably not significantly alter the FOO/FD's attitudes and behaviour in the long term.

14.5 Practice and feedback

14.5.1 The second phase of DRM training is practice and feedback. Some programmes use role-playing techniques to provide group skills practice, as well as attitude-measuring questionnaires, as a means of providing feedback to individuals on their own interpersonal styles, some aspects of which they probably have not previously evaluated. Attitude insights allow individuals to recognize some of their strengths and weaknesses. Alone, however, they may not provide guidance on how those attitudes will positively or negatively affect each situation. Role-playing or group exercises can provide useful practice in areas of dispatcher decision-making and other skills discussed in the awareness phase of the DRM curriculum. They can also demonstrate the critical responsibility of FOO/FDs and the effect of stress on their ability to perform their tasks under actual emergency situations. The interrelationship between the actions of FOO/FDs and flight crew members must be examined.

14.5.2 Videotape feedback is particularly effective because the third-person perspective creates a level of awareness not possible with other techniques. This perspective provides insight and provokes "self-critique" which appears to be a strong stimulus for attitude and behaviour change. It is easy to identify less-than-optimum managerial or interpersonal styles if one sees it for oneself. Moreover, these video feedback exercises will provide opportunities for peer critiques. There is ample evidence of the effectiveness of the video feedback technique, which should be used whenever possible. If video feedback is not possible, each exercise must be followed by a carefully guided debriefing session. Participants should be able to identify the objectives of each exercise and be encouraged to provide constructive feedback on performance ("peer review" should be highly encouraged), identify areas of concern, propose alternatives and relate all exercises to practical experience.

14.6 Reinforcement

The third phase is reinforcement. No matter how effective the DRM classroom curriculum, interpersonal drills and feedback techniques are, a single exposure will be insufficient. Undesirable attitudes and norms which contribute to ineffective FOO/FD performance are ubiquitous and may have developed over a lifetime. It is unrealistic to expect a short training programme to counteract a lifetime of development. For maximum effect, DRM must be embedded in the total training programme, be continually reinforced, and become an inseparable part of the organiz-ation's culture. This last factor is often overlooked; it is clear, however, that effective DRM training requires the support of the highest levels of management.

14.7 Training objectives

Conditions: Using guidance already developed for flight crew members (CRM) and other groups in respect to training in resource management and role-playing simulating conditions that require the application of DRM concepts,

Performance: The trainee will be able to apply concepts learned in DRM training in the performance of their duties and responsibilities. They will be able to develop awareness of "good'' versus "poor" performance, to accept the need for supportive and co-operative inter-relationships between FOO/FDs and crew members, and to cope with difficult situations.

Standard of accomplishment:
During training, the recorded performance of the trainee can be compared with models provided as references.

14.8 Required knowledge, skill and attitude

14.8.1 Basic concepts of DRM

Operating environment

- pilots
- air traffic controllers
- other dispatchers
- managers
- station personnel
- meteorology information
- aircraft maintenance staff
- load planners
- crew rostering staff
- aircraft routers (fleet assignment staff)
- communication systems and related personnel
- flight planning systems and related personnel

Situational awareness (FOO/FD)

- The ability to absorb information in a dynamic environment, to evaluate and refine the information, to anticipate contingencies and to initiate appropriate action as necessary.

Communications

- The FOO/FD's chief function is as a centre for communications. He continually receives and disseminates information, and interfaces with the flight crew and many others in the operational environment. Communication skills are at the heart of this work. Communication must be in standardized language that is easily understood by individuals in the different departments. Joint training and communications between departments should be encouraged. Emphasis must be given to:
  - — inquiry/advocacy/assertion;
  - — conflict resolution; and
  - — radiocommunication (phraseology and technique) (refer to Chapter 13).

Handling information

- One of the FOO/FD's main responsibilities is to keep the flight crew updated with any information that affects flight safety. The FOO/FD is required to review large quantities of real-time information and to decide what information is pertinent to each flight under his operational control.
- Other missing information must be obtained by the dispatcher. All pertinent information is then passed on to each flight providing timely information to the flight crew and reducing workload.

Interpersonal skills

- DRM concentrates on the FOO/FD's attitudes and behaviour and the effects of same on others.

Workload management

- DRM will have a powerful influence on how the FOO/FD will function during high workload and stressful situations. Prioritizing tasks is one key element in consistent, effective operational control.

Effective decision making

- Through inquiry, advocacy and assertion, the FOO/FD assumes a leadership role within the operational environment. This leadership role in workload management and situational awareness supports the pilot-in-command. It requires the FOO/FD, together with the pilot-in-command, to apply problem-solving skills including the following:
  - — weighing up competing needs;
  - — awareness of resources available to various parties involved in the decision making;
  - — applying effective problem-solving strategy to help in decision making; and
  - — avoiding error-producing situations and behaviour.

14.8.2 Fundamentals of DRM training implementation

- Assess the status of the organization before implementation.
- Get commitment from all managers.
- Customize training to reflect the needs of the organization.
- Define the scope of the programme.
- Communicate the nature and scope of the programme before startup.

14.8.3 Components of DRM training

- Training consists of classroom presentations that focus on the interpersonal relations and co-ordination involved in the decision-making process.
- Indoctrination/awareness training modules for experienced FOO/FDs are not the only way that this DRM training component may be provided. DRM concepts should be addressed in the FOO/FD initial qualification training.
- Curriculum development should address those DRM skills which are known to influence FOO/FD performance.

Recurrent training and feedback

- DRM training should be included as a regular part of required recurrent training. Recurrent DRM training should include refresher practice and feedback exercises.
- Recurrent training allows participants to practice newly improved skills in communication and interpersonal relationships and to receive feedback on their effectiveness.

- Effective feedback refers to the co-ordination concepts identified in indoctrination/awareness training and relates to specific behaviours. Practice and feedback are best accomplished through the use of some form of simulation and audio or videotape.

Continuing reinforcement

- Technical training (e.g. initial and recurrent training).
- Interdepartmental training.
- Effective resource management skills are not acquired by passively listening in a classroom but by active participation and practice.

14.8.4 Assessment in DRM training programmes

Self

- One of the best learning opportunities occurs when FOO/FDs examine, with the assistance of a trained facilitator, their own behaviour and performance.
- Each organization should design a systematic assessment programme to track the effects of its training programme and to make continuous programme adjustments.

14.8.5 Effectiveness of the developer

The effectiveness of any training programme is directly related to the expertise of the developers and facili-tators. Ideally they should be qualified FOO/FDs, with valid licences or the requisite qualifications, with skills and training in the following:

a) listening and communicating;

b) role-playing, simulations and group discussions; and

c) debriefing and feedback.

14.8.6 Evolving concepts of DRM

14.8.6.1 More and more carriers are discovering the value of DRM training. Just as the FOO/FD is a resource to the pilot, the pilot is a resource to the FOO/FD. Similarly other groups are resources to the FOO/FD, the pilot, and each other. Concurrent training of FOO/FDs, pilots, flight attendants and air traffic controllers has been found to be valuable; some carriers also include management staff. The objective is to improve the effectiveness of all the groups within the operating team.

14.8.6.2 Effective DRM begins in initial training, is strengthened by recurrent practice and feedback, and is sustained by continuing reinforcement.

CHAPTER 15. SECURITY (EMERGENCIES AND ABNORMAL SITUATIONS)

15.1 Introduction

15.1.1 Aviation security has been one of the major concerns of the air transport industry. The FOO/FD is one of the key players in the operation of aircraft and, in particular, is responsible for assisting the pilot-in-command to safely complete a flight in progress; as such, he has a vital role to play in matters affecting the safety and the security of an aircraft, both on the ground and in the air. As he is responsible for flight watch and flight monitoring, including his close working relationship with the flight crew members of a flight operation in progress, he is in an ideal position to be a point of focus when a security threat against an aircraft has been revealed.

15.1.2 In order for an FOO/FD to positively and effectively assist in a positive conclusion to a security threat against an aircraft operation, it is important that he undergo a training course designed to give him a good understanding of international and national aviation security regulations and operator's procedures and directives in managing security threats both to aircraft operation as well as to operational personnel both on the ground and in the air. Such training will enable the FOO/FD to be constantly alert to potential sources of hazards and risks that may threaten the security and safety of an aircraft operation and respond speedily and efficiently in accordance with official carrier, airport and State Authority procedures and practices in the event of emergency, incident or accident.

Note.— Since security training varies considerably from carrier to carrier, the type, endurance and content of training will vary accordingly. Any security training programme should include the following as the bare minimum and as the basis for a complete programme which would include local requirements as specified by carriers, and airport and national authorities.

15.2 Training objectives

Conditions: The trainee must be provided with copies of documents, airport directives and ICAO Annexes relevant to security. He must also be made familiar with local and national security systems and structures of authority.

Performance: The trainee will be able to identify a security problem and will know who to contact and where to get information and instructions without delay.

Standard of accomplishment:
The trainee is expected to demonstrate adequate understanding of local and national security procedures so that he will react in an efficient and logical manner to situations involving security matters.

15.3 Required knowledge, skill and attitude

Goal: *To make the FOO/FD familiar with emergency and security policy and procedures as laid down and practised by carriers, airport authorities and State authorities.*

Familiarity

- security measures taken by governments, airport authorities, etc.
- airport directives
- requirements of Annex 17
- explosive detection devices at access points to buildings, etc.
- check-in procedures
- questions asked to passengers
- hand baggage X-ray
- control of the amount of hand baggage
- normal baggage reconciliation procedures
- baggage reconciliation procedures for "missing" passengers

- control of duty-free items
- air-side/land-side boundary, closed circuit television (CCTV), police patrols, etc.
- controls for the handling of baggage, cargo, mail etc.
- security of flight catering supplies and deliveries

Security measures taken by airlines

- airline crew and personnel training, vigilance and alertness
- familiarity with security procedures
- careful walk around to check the aircraft for the unusual or abnormal
- wearing of uniforms and personal identification cards
- compliance with security checks and co-operation with security staff
- challenging any unknown or unidentified person(s)
- reporting fully any incidents or deficiencies
- reconciliation of passenger load and checked baggage
- diplomatic passengers and their baggage
- prisoners as passengers escorted by officers
- deportee/inadmissible person: acceptance for carriage, escorted/unescorted

Procedures for handling threats, bomb scares, etc.

- different procedures for handling red or green alerts:
  — Red (specific: e.g. flight number, scheduled time of departure (STD), company name)
  — Green (vague: e.g. of a general nature, non-specific)
- sequence to follow when alerting authorities: who to contact first, etc.
- security alert signals and format
- procedures in the event of a threat affecting aircraft:
  — on ground
  — in flight
  — on airways
  — on MNPS or oceanic tracks
  — airborne search
- procedures in the event of a device actually being found:
  — in an aircraft in flight
  — in an aircraft on the ground
- aircraft search by trained personnel, by crew
- device recognition by crew and "handling"
- company policy and procedures regarding release of information to public media

Emergency due to dangerous goods

- handling advice to crew
- advice to emergency services

Hijacking

- crew procedures, transponder code, etc.
- security of aircraft at off-line stations
- FOO/FD procedures
- international convention regarding power of aircraft commander including power of delivery into custody:
  — Tokyo Convention on offences and certain other acts committed on board aircraft
  — Hague Convention for the suppression of unlawful seizure of aircraft
  — Montreal Convention for the suppression of unlawful acts against the safety of civil aviation

Emergency procedures

- emergency co-ordination centre
- the role of the FOO/FD when dealing with an emergency
- emergency procedures manual
- procedures for contacting and dealing with relevant emergency authorities and services

Personal security for the FOO/FD

- threats to personnel
- pressure on FOO/FD through threats to family of FOO/FD

PHASE TWO

CHAPTER 16. APPLIED PRACTICAL TRAINING

16.1 Introduction

16.1.1 Phase two of the course takes the form of a series of supervised exercises in which trainees are given the opportunity to develop decision-making abilities by applying knowledge gained in earlier parts of the course. The exercises consist of operational flight planning based on weather analysis, fuel and load calculations, selection of navaids, and compliance with regulations, procedures and amendments thereto. If on-the-job training can be arranged, then this part of the curriculum should be omitted at the training school and given in a convenient dispatch office where the trainee can receive the required practical training under the guidance and supervision of an FOO/FD instructor. In the latter case, however, it will expedite the trainee's training if, in addition to "real" flights, hypothetical situations are set up as exercises when time allows.

16.1.2 The simulated or assumed operating conditions for each exercise must be clearly specified by the instructor. The exercises should be made as realistic as possible. Past flight records, meteorological forecasts, charts, weather observations, etc., can be used to advantage, and answers arrived at by the trainees compared to what actually took place. A group discussion after each exercise will prove beneficial in eliminating possible misconceptions.

Note.— Exercises provided in this phase of the training are additional to the class exercises carried out as part of the training covered in phase one.

16.2 Applied practical flight operations

Goal: *To provide the trainee with practical experience in aircraft dispatch and the associated duties and responsibilities of the FOO/FD.*

16.2.1 Materials and publications required:

a) specimen meteorological surface and upper-air charts; forecasts and meteorological folders;

b) specimen NOTAM;

c) flight manual, including cruise control charts and performance limitation tables (may be included in the operations manual);

d) route guide and operations manual; and

e) flight operation forms including flight plan and message forms.

16.2.2 In defining the operating conditions for the exercise, the instructor should include the following, as applicable for each case:

a) the flight programme showing scheduled departure and arrival times at terminals including type of aircraft to be used;

b) load available at each terminal; destination of such loads;

c) commercial considerations having any possible effect upon operational decisions, e.g. availability of passenger accommodation in the event of an enforced diversion;

d) aircraft and flight crew routing if more than one flight is involved;

e) meteorological charts and forecasts;

f) in-flight reports from other flights;

g) status of navigation aids (aeronautical information publication and NOTAM);

h) status of aerodrome serviceability (aeronautical information publication and NOTAM);

i) the ATC situation; and

j) passenger and cargo-handling facilities at terminals and at alternates.

16.2.3 Exercises should be designed to give the trainees practice in the following:

a) making decisions as to scheduled operation, delayed operation, re-routing or cancellation of flights;

Note.— In this group of exercises, it will be necessary to give instruction on the application of the operator's procedures relevant to the FOO/FD's actions in cases of delayed, cancelled or diverted flights, handling of passengers and freight, and repositioning of aircraft.

b) flight crew briefing, including the preparation of briefs for the use of pilots-in-command, on changes in Regional Procedures, on States' Regulations or on subjects referred to in NOTAM and which may affect the planned flight;

c) flight planning including selection of routes, tracks, altitudes, cruise procedures, and alternates and calculation of fuel requirements;

d) compilation of ICAO and operator's operation messages;

e) provision of flight plan information to ATC;

f) provision of flight progress information to company offices;

g) calculation of maximum permissible take-off and landing weights;

h) calculation of payload;

i) preparation of flight documents;

j) information to flights en route;

k) revisions to flight plans, including recalculation of fuel requirements en route;

l) plotting of position reports and of flight progress;

m) unreported flights;

n) emergency situations. (Special emphasis should be given to the operator's emergency procedures, including the alerting of State, company and private agencies.); and

o) any of the above using a hand-held digital computer and/or digital computer terminal if computerized flight planning is available in the operational control system used in the State.

16.3 Simulator LOFT observation and synthetic flight training

Goal: *To provide trainees with a better understanding and awareness of the working environment in the cockpit of a commercial air transport aircraft and the practical duties of the flight crew under normal, abnormal and emergency operational situations.*

16.3.1 When FOO/FDs have been recruited from one of the operational disciplines such as pilots, their background of active experience has proven invaluable in equipping them with an appreciation of the operational effect of their work as FOO/FDs. A large number of FOO/FD trainees, however, are recruited from other sources and may lack a factual appreciation of the duties and responsibilities of flight crew members in a commercial air transport aircraft under normal, abnormal and emergency operational situations.

16.3.2 To enable FOO/FDs to gain an understanding and practical knowledge of the operational environment in the cockpit of a commercial air transport aircraft, it is essential that they spend some time observing a representative training session of flight crew members undertaken in an appropriate synthetic trainer. It is recommended that this training include participation in pre-simulator CRM briefing and observation of at least one full line-oriented flight training (LOFT) which includes simulated exercises under normal, abnormal and emergency flight conditions.

16.3.3 If practicable, an effort must also be made to give an FOO/FD trainee practical synthetic (link) training to enable him to appreciate the "feel" of the time element involved in the handling of aircraft and to allow him to compare the difficulties of flying characteristic patterns using specific aids to navigation, and performing aerodrome procedures. Such exercises, if undertaken, should be conducted with the aim of teaching an understanding of the procedures rather than their faultless execution.

16.4 Flight dispatch practices (on-the-job training)

Goal: *To develop trainee confidence by providing him with an opportunity to apply his newly acquired knowledge in an actual operational control environment.*

16.4.1 After the completion of the classroom training and the training on applied practical flight operations including LOFT training observation and synthetic (link) flight exercise, it is essential that the trainee be assigned to actual operational control duties under supervision. The provision of on-the-job training will enable the trainee to develop the necessary confidence to perform the duties and responsibilities of a full-fledged FOO/FD. In addition, on-the-job training will enable him to have first-hand experience on the exigencies of the profession as it is performed by experienced dispatchers under an actual operational environment.

16.4.2 On-the-job training must be provided for at least 90 days (thirteen weeks) to allow the trainee a reasonable opportunity to acquire adequate experience and to comply with the requirements of 4.5.1.3 of Annex 1 — *Personnel Licensing*.

16.5 Route familiarization

Goal: *To allow the trainee to appreciate the route characteristics in the selected area of operation and familiarize himself with the different procedures and services available over different route sectors.*

16.5.1 Route familiarization is considered an essential and integral part of the training of FOO/FDs since it supplements that part of the appreciation of pilot work which cannot be learned in a flight simulator. It also allows a realistic appreciation by the trainee of route characteristics in the selected area of operation, such as the differences in procedure and services available over different route sectors and at different aerodromes, of the effects of prevailing meteorological conditions and topographical features, and of the handling of in-flight difficulties occasioned by environmental conditions. Such practical experience will assist the FOO/FD in the performance of his duties to the highest possible standards. For the trainee to derive the maximum benefit from each flight, the following should be observed:

a) The co-operation of the pilot-in-command must be secured.

b) Arrangements must be made with the pilot-in-command for the position(s) that the trainee is to occupy during the various stages of the flight to enable him to observe and monitor proceedings as far as is practicable. The planned workload of the trainee must be realistic and not overly demanding.

c) The trainee must participate with the crew through all the operational phases of pre-flight preparations.

d) The trainee should prepare a complete “dummy” dispatch for the flight. This “dummy” dispatch should be compared at some convenient time with the actual dispatch sequence adopted for the flight.

e) At the end of the flight, the trainee must again accompany the crew in its ground activities until the flight is closed and the aircraft handed over, including all company procedures.

16.5.2 The contents of the trainee’s plan for the flight will necessarily vary depending on the character of the flight. The following are points of primary interest and should be included if possible:

a) pre-flight check-compliance with safety standards; loading, load distribution, carriage of dangerous goods, amount of fuel, aircraft instrumentation, operational equipment and rescue equipment, “go/no go” check-off system;

b) pre-flight check-crew; composition, flight and duty time limitation, licences and other documents, summary of NOTAM;

c) pre-flight meteorological briefing; MET folder;

d) flight briefing; flight plan, flight documents, flight kit, company orders;

e) derivation of take-off data in the environmental runway conditions;

f) ATC clearances;

g) in-flight procedures, position reporting, weather reporting, altimeter setting changes, etc.;

h) comparison of forecast to actual flight and weather conditions;

i) communications with ATS along route and reason for such communication;

j) performance of navigation aids and facilities;

k) derivation of landing data in the environmental conditions;

l) landing sequence, holding time, taxiing time;

m) test flight arrival report, including snag reports; and

n) intermediate stop, refuelling, handling of passengers, reclearing the flight, meteorological briefing.

16.5.3 After the flight, a step-by-step analysis of the data collected should be made. This analysis should be carried out with a group of trainees to allow the widest use to be made of the flight information collected and to illustrate the practical application of the classroom subjects.

Appendix — References

Annexes

Annex 1 — *Personnel Licensing*

Annex 2 — *Rules of the Air*

Annex 3 — *Meteorological Service for International Air Navigation*

Annex 4 — *Aeronautical Charts*

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

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

Annex 7 — *Aircraft Nationality and Registration Marks*

Annex 8 — *Airworthiness of Aircraft*

Annex 9 — *Facilitation*

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

Annex 11 — *Air Traffic Services*

Annex 12 — *Search and Rescue*

Annex 13 — *Aircraft Accident and Incident Investigation*

Annex 14 — *Aerodromes*
- Volume I — *Aerodrome Design and Operations*
- Volume II — *Heliports*

Annex 15 — *Aeronautical Information Services*

Annex 16 — *Environmental Protection*
- Volume I — *Aircraft Noise*
- Volume II — *Aircraft Engine Emissions*

Annex 17 — *Security — Safeguarding International Civil Aviation against Acts of Unlawful Interference*

Annex 18 — *The Safe Transport of Dangerous Goods by Air*

Circulars

Circ 52 — *Flight Crew Fatigue and Flight Time Limitations*

Circ 120 — *Methodology for the Derivation of Separation Minima Applied to the Spacing between Parallel Tracks in ATS Route Structures*

Circ 185 — *Satellite-aided Search and Rescue — The COSPAS-SARSAT System*

Circ 186 — *Wind Shear*

Circ 211 — *Aerodrome Flight Information Service (AFIS)*

Circ 216 — *Human Factors Digest No. 1 — Fundamental Human Factors Concepts*

Circ 227 — *Human Factors Digest No. 3 — Training of Operational Personnel in Human Factors*

Circ 234 — *Human Factors Digest No. 5 — Operational Implications of Automation in Advanced Technology Flight Decks*

Circ 238 — *Human Factors Digest No. 6 — Ergonomics*

Circ 240 — *Human Factors Digest No. 7 — Investigation of Human Factors in Accidents and Incidents*

Circ 241 — *Human Factors Digest No. 8 — Human Factors in Air Traffic Control*

Circ 247 — *Human Factors Digest No. 10 — Human Factors, Management and Organization*

Circ 249 — *Human Factors Digest No. 11 — Human Factors in CNS/ATM Systems*

Documents

Doc 7101 — *Aeronautical Chart Catalogue*

Doc 7300 — *The Convention on International Civil Aviation*

Doc 7333 — *Search and Rescue Manual*

Doc 7383 — *Aeronautical Information Services Provided by States*

Doc 7488 — *Manual of the ICAO Standard Atmosphere (extended to 80 kilometres (262 500 feet))*

Doc 7910 — *Location Indicators*

Doc 8126 — *Aeronautical Information Services Manual*

Doc 8335 — *Manual of Procedures for Operations Inspection, Certification and Continued Surveillance*

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

Doc 8643 — *Aircraft Type Designators*

Doc 8896 — *Manual of Aeronautical Meteorological Pracice*

Doc 9137 — *Airport Services Manual*

Doc 9156 — *Accident/Incident Reporting Manual (ADREP Manual)*

Doc 9284 — *Technical Instructions for the Safe Transport of Dangerous Goods by Air*

Doc 9284SU — *Supplement to the Technical Instructions for the Safe Transport of Dangerous Goods by Air*

Doc 9328 — *Manual of Runway Visual Range Observing and Reporting Practices*

Doc 9332 — *Manual on the ICAO Bird Strike Information System (IBIS)*

Doc 9365 — *Manual of All-Weather Operations*

Doc 9375 — *Dangerous Goods Training Programme*
Book 1 — *Shippers, Cargo Agents and Operators' Cargo Acceptance Staff*
Book 2 — *Load Planners and Flight Crew*

Doc 9376 — *Preparation of an Operations Manual*

Doc 9377 — *Manual on Co-ordination between Air Traffic Services and Aeronautical Meteorological Services*

Doc 9388 — *Manual of Model Regulations for National Control of Flight Operations and Continuing Airworthiness of Aircraft*

Doc 9422 — *Accident Prevention Manual*

Doc 9432 — *Manual of Radiotelephony*

Doc 9481 — *Emergency Response Guidance for Aircraft Incidents involving Dangerous Goods*

Doc 9501 — *Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft*

Doc 9554 — *Manual Concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations*

Doc 9625 — *Manual of Criteria for the Qualification of Flight Simulators*

Doc 9640 — *Manual of Aircraft Ground De/Anti-icing Operations*

Doc 9654 — *Manual on Prevention of Problematic Use of Substances in the Aviation Workplace*

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