

Doc 7192-AN/857
Part E-2



Training Manual

Part E-2

Air Traffic Safety Electronic Personnel (ATSEP)

Preliminary Edition — 2004

*Approved by the Secretary General
and published under his authority*

INTERNATIONAL CIVIL AVIATION ORGANIZATION

DISCLAIMER

Please note, this manual has been posted to the ICAONET as a final draft. However, the contents shown are subject to change, pending editorial revision and further technical input. The Organization accepts no responsibility or liability, in whole or in part, as to the currency, accuracy or quality of the information in the manual, nor any consequence of its use.

Foreword

An exchange of views between members of the ICAO Air Navigation Commission, the ICAO Secretariat and members of the International Federation of Air Traffic Safety Electronic Association (IFATSEA) that took place in 2000 during the 30th IFATSEA Assembly in Montreal, highlighted the fact that personnel involved in the maintenance and installation of CNS/ATM systems were trained to various standards. Some States had implemented a comprehensive program of training, certification and in some case of licensing while other States were still looking for appropriate guidance. There was, at that time, a lack of universally established principles to govern the exercise of that profession. Subsequently, the 11th Air Navigation Conference that was held at ICAO Headquarters in September 2003 expressed the view that the needs related to training, qualification and competency of air traffic safety electronics personnel required further investigation.

Air navigation systems are now implemented and operated globally. Aviation is going beyond geographical boundaries and personnel involved in the maintenance and installation of CNS/ATM systems should be trained to uniform requirements on a worldwide basis. ICAO therefore decided to develop of a new Part of the ICAO Training Manual that would address the training requirements for this technical group or personnel that is recognized as the Air Traffic Safety Electronic Personnel (ATSEP).

This manual is intended to give detailed information on the training and expertise required for personnel involved in the maintenance and installation of CNS/ATM systems. It should be used in conjunction with Annex 10 - *Aeronautical Telecommunications*- and Document 8071 – *Manual of Radio Navigation* – that provides standards, recommended practices and guidance on the operation and maintenance of CNS/ATM systems as well as the training required for these systems.

The constant evolution of the CNS/ATM technology brings new challenges to air navigation. training requirements have to be adapted regularly. This is why this Manual has been developed to be generic, as much as possible to provide the flexibility needed to address future systems/equipment.

ICAO would like to acknowledge the major contribution made by IFATSEA in the preparation of Part E-2 of the *Training Manual*. This manual is largely based on a document that was developed by IFATSEA. The manual also draws on EUROCONTROL Guidelines for a Common Qualification Level of Technical Training for Air Traffic Safety Electronics Personnel and on the contribution received from states, international organizations and individual experts who have provided support, advice and input toward this manual.

Comments on this manual would be appreciated from all States and ICAO Technical Assistance field missions. These comments will be taken into account in the preparation of subsequent editions. Comments concerning the manual should be addressed to:

Chief, Personnel Licensing and Training Section
International Civil Aviation Organization
999 University St.
Montreal, Qc, H3C 5H7
Canada

Record of Amendments

[illegible]

Table of Content

Foreword.....	3
Record of Amendments	5
Table of Content.....	7
Definitions.....	10
Chapter 1 - Training Principles.....	13
1.1 Regulatory Requirements	13
1.2 Training Requirements	13
1.2.1 Principal Duties	13
1.2.2 Day-to-day activities	14
1.2.3 Minimum Entry Qualifications	15
1.2.4 ATSEP Training Concept.....	16
1.2.5 Standard of Accomplishment.....	18
1.2.6 Examination Data Base	18
1.2.7 Training Reference Guide	18
1.2.8 Training Schedule	19
Chapter 2 - General Recommendations.....	21
2.1 Accommodations and Equipment for Classroom-based Training.....	21
2.1.1 General	21
2.1.2 Classrooms and Equipment	21
2.1.3 The Learning Environment	22
2.2 Performance Evaluation (Testing).....	22
Chapter 3 - Familiarization with Air Navigation Services.....	25
3.1 International, National Organizations and Standards	25
3.1.1 Introduction	25
3.1.2 Training Objective.....	25
3.3 Familiarizations with Air Traffic Services, Airspace Standards, Meteorology and Altimetry	29
3.3.1 Introduction	29
3.3.2 Training Objectives	29
3.4 Familiarization with CNS/ATM Concepts	38
3.4.1 Introduction	38
3.4.2 Training Objective.....	38
Chapter 4 - Training for each Qualification.....	61
4.1 Overview	61
Chapter 5 - Communication Systems.....	63
5.1 Introduction	63
5.2 Training Objective.....	63
Chapter 6 - Radio Navigation Aids	71
6.1 Introduction	71
6.2 Training Objective.....	71
Chapter 7 - Surveillance.....	87
7.1 Introduction	87
7.2 Training Objective.....	87
Chapter 8 - Data Processing.....	99
8.1 Introduction	99
8.2 Training Objective.....	99
Chapter 9 - System Safety Training.....	107
9.1 Introduction	107

9.2	Training Objective.....	107
Chapter 10	- System/Equipment Rating Training	111
10.1	Introduction	111
10.2	Environmental Knowledge.....	111
10.2.1	Objectives.....	111
10.3	Theoretical Section of the Equipment or System.....	112
10.3.1	Objectives:.....	112
10.4	Practical Section enhanced by OJT	112
10.4.1	Objectives:.....	113
10.5	Rating of the ATSEP.....	113
10.6	Documentation	113
Chapter 11	- Continuation Training	115
11.1	Introduction	115
11.2	Refresher Training.....	115
11.2.1	Introduction	115
11.2.2	Target Audience	116
11.2.3	Training Objectives	116
11.2.4	Frequency and Duration	117
11.2.5	Delivery of Training.....	117
11.3	Emergency Training.....	117
11.3.2	Emergency Situations.....	117
11.3.3	Unusual and Critical Situations	118
11.3.4	Degraded Systems	118
11.4	Conversion Training.....	118
11.4.1	Practical Training and Simulation	118
11.4.2	Competency Assessment.....	118
11.4.3	Documentation	118
Chapter 12	- Developmental Training	119
12.1	Introduction	119
12.2	Technical Flight Inspector.....	119
12.2.1	Introduction	119
12.2.2	Training Objective.....	119
12.2.3	Technical Flight Inspector Training Program	120
12.3	System Monitoring and Control (SMC).....	121
12.3.1	Introduction	121
12.3.2	Training Objective.....	122
12.3.3	SMC ATSEP Competency - Knowledge and Skills Requirements	123
12.3.4	SMC ATSEP Competency - Experience Elements	123
12.4	ATSEP Instructor Training	125
12.4.1	Introduction	125
12.4.2	Classroom instructional techniques.....	125
12.4.3	OJT and Coaching Training	125
12.4.4	Assessment Training	126
12.5	Engineering ATSEP - Installation Technologist	126
12.5.1	Introduction	126
12.5.2	Training Objective.....	127
12.5.3	The typical training package for Engineering/Installation ATSEP:.....	127
Chapter 13	- Human Factors	129
13.1	Introduction	129
13.2	The meaning of Human Factors	129
13.3	Awareness	130

Appendix A - List of Verbs to prepare Training Objectives.....	135
Definition of Verbs for each level of accomplishment.....	135
Appendix B - Glossary.....	141

Definitions

Air Traffic Management: The aggregation of the airborne functions and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations.

Approved training: Training conducted within an approved training organization under special curricula approved by a contracting State

Approved training organization: An organization approved by a Contracting State in accordance with the requirements of Annex 1, paragraph 1.2.8.2 and Appendix 2 to perform training and operating under the supervision of that state.

ATM Services Personnel: Persons assigned to perform duties directly in connection with the provision of Air Traffic Management Services.

Attitude: Attitude is understood as behaviours that are acceptable or not in a given context. Attitudes are component part of the required trainees' performance that is described in the intermediate objective. Attitudes are taught to reflect the values and beliefs that students should hold to behave in an acceptable way.

Basic Training: Fundamental knowledge and skills appropriate to the discipline to be pursued in the ATS environment.

Certification: the process of determining competence, qualification, or quality on which an aviation document is based.

Competency: The combination of knowledge, skills and attitude to perform a task to the required standards in accordance with the State Regulatory requirements.

Domain: is a set of elements of a discipline that are studied in the qualification training.

Equipment: Portion of a system that performs a function that contributes to a systems output(s).

Intermediate Objectives: What a trainee is expected to accomplish in terms of skills, knowledge and attitude, at specified points in a training course. For example, be able to use a piece of test equipment, or solder a joint. Sometimes also referred to as enabling objectives, as they lead up to, or enable, a specific terminal objective.

Job Performance Objectives: The desired level of job performance in terms of tasks to be performed and standards to be achieved.

Knowledge: A person's range of information, familiarity gained by experience or repetition, understanding. Knowledge is understood as storage of information in the student's mind that can be retrieved when necessary, and understanding of concepts and performances. Knowledge is component part of the expected trainees' performance that is described in the intermediate objective.

Level of complexity: Refers to the taxonomy of verbs used to describe the trainees' expected performance in a training objective.

Licensing Authority: The authority designated by a contracting state responsible for the licensing of personnel.

Qualification Training: Job category related knowledge, attitude and skills appropriate to the discipline to be pursued in the ATS environment.

Rated ATSEP: An ATSEP holding the qualification appropriate to the privileges to be exercised.

Service: A function and/or data critical to the system/user, provided directly or indirectly, either individually, or as part of an overall function or output.

Skill: practical or intellectual ability, ease in doing something, dexterity. Skills are classified as either intellectual or physical. Intellectual skills are those related to the use of intellect, like the abilities of classifying, rule-using, discriminating, problem-solving or cognitive strategy (the most complex of all). Physical skills are those that enable a person to make coordinated movements, perform manual tasks, and carry out physical activities. The skills are component part of the expected trainees' performance that is described in the intermediate objective.

System: One or more types of electronic equipment and ancillary devices functioning to provide a service.

Terminal Objectives: What a trainee is expected to accomplish upon completion of training. For example, "when the trainee completes training, he will be able to troubleshoot and repair a piece of XYZ equipment in 20 minutes, using standard tools and test equipment." (Objectives are best stated in terms of accomplishments.) Also called end-of-course performance objectives or behavioural objectives.

System/Equipment Rating Training: System / Equipment knowledge, attitude and skills leading to recognized competency



Chapter 1 - Training Principles

1.1 Regulatory Requirements

Paragraph 2.7 of Volume 1, Annex 10 - Ground and flight testing of Radio navigation aid and Document 8071 paragraph 1.12.7 Personnel training and qualification, as well as ICAO State letter AN 7/5-01/52 Paragraph 9, requires that Contracting States or the Organization authorized by the State authority providing CNS/ATM services, should establish methods for determining job competencies. All personnel directly engaged with maintenance and installation activities of CNS/ATM systems should be qualified for their job functions. The ICAO recognized terminology for personnel involved in maintenance and installation of CNS/ATM system is Air Traffic Safety Electronic Personnel (ATSEP).

The requirements with respect to age, knowledge, experience, skill, and attitude for the ATSEP competency should be in accordance with State Regulatory requirements. However, Chapter 4 of ICAO Annex 1 Personnel Licensing contains standards for other personnel. States should use these references in making their requirements.

The successful application of regulations concerning the safety and regularity of CNS/ATM systems operation and the achievement of regulatory objectives are greatly dependent on the appreciation by all individuals concerned of the risks involved, and a detailed understanding of the regulations. This can only be achieved by properly planned and maintained basic, qualification and recurrent training programs for all persons involved in CNS/ATM systems operations. ATSEP plays a significant role in the safe operation of CNS/ATM systems, and international regulations require that they be appropriately trained.

1.2 Training Requirements

1.2.1 Principal Duties

The principal duties of the ATSEP are:

- a) Performing maintenance on CNS/ATM system/equipment which include:
 - 1) Calibrating flight and ground radio navigation aids;
 - 2) Certification of CNS/ATM system/equipment;
 - 3) Modification of operational CNS/ATM equipment;
 - 4) Corrective maintenance;
 - 5) Preventive maintenance.
- b) Performing installation of CNS/ATM system/equipment.
- c) Management, monitoring and control of operational CNS/ATM system/equipment.
- d) Developing, reviewing and modifying CNS/ATM system/Equipment, and/or maintenance procedures and standards.

ATSEP work on a large variety of CNS/ATM systems and equipment, which requires a wide range of expertise. Training will be directed toward the specific work requirement assigned to a specific group or categories of ATSEP. The Phase One Basic Training course is all the prerequisite knowledge needed in order to prepare the ATSEP for the next phase of training, Phase Two Qualification Training. The knowledge, skills and attitude gained in the Phase Two Qualification Training such as



Communication, NavAids, Surveillance and Data Processing are needed for the Third Phase the System/Equipment Rating Training that is specific to the equipment or system. This phase is followed by the Continuation Training which is designed to augment the existing knowledge and skills. This could be done in a number of different manners such as: Refresher Training which review or re-inforce existing knowledge and skills; Emergency Training which includes training for an unusual situation and often dangerous; Unusual situation Training is provided to deal with a set of circumstances which are neither habitually nor commonly experienced; Degraded system Training is provided to deal with a situation that is the result of a system failure or malfunction; Conversion Training which provides knowledge and skills appropriate to a change in a job category, or a new discipline/new procedure. Finally the last training phase is Developmental Training needed when there is a major change in the ATSEP's job profile, for example, an ATSEP who wants to become a flight check inspector; training instructor; or an installation technologist.

The training objectives in the Phase One Basic Training are related to general duty: the design, installation, operation, maintenance and repair of air traffic control and air navigation systems. The training objectives in the Phase Two Qualification Training will be related to the specific tasks of the job duties.

To undertake the duties and responsibilities described above, an ATSEP must be appropriately trained in all the subjects required to ensure that every link of the safety chain is solid. As a technical specialist, an ATSEP needs to demonstrate a high level of responsibility, the ability to think clearly and rapidly, and to accomplish their duties carefully. The training of ATSEP should invariably include several stages of selection in order to eliminate trainees lacking the necessary qualities.

1.2.2 Day-to-day activities

The following are some of the duties that normally govern the day-to-day practical work of the ATSEP. The degree of responsibility given to them varies from state to state, and from ANS provider to ANS provider. It varies from the complex level, where the ATSEP is almost considered the brain of the ANS, to a position of limited importance. In the former case, he is normally required to be licensed, or proved to be trained and competent to certify CNS/ATM systems/equipment. In the latter case, his duties may be limited to clerical assistance only. Due to extensive implementation of technologies, there is a marked tendency for states and ANS providers to make increased use of ATSEP, giving them extensive duties and responsibilities.

- a) Carrying out technical duties related to developmental work concerning the electromechanical, electronic and computerized equipment of air navigation systems, and testing prototypes;
- b) Providing technical support in the design and layout of specific interface circuitry for air navigation and aircraft detection tracking systems;
- c) Preparing and contributing to cost estimates, technical and training specifications for air traffic control and safety equipment;
- d) Providing or assisting with the technical supervision of construction, installation and operation of ground-based air navigation equipment;
- e) Ensuring that system/equipment standards and specifications are met;
- f) Applying the knowledge and skills of air traffic safety engineering principles and practices, in order to identify and solve problems arising in the course of their work;
- g) Developing, modifying and debugging system software.

- h) Modifying CNS/ATM systems/equipment in order to improve capability, reliability and integrity, or to facilitate air traffic control procedures and airspace designation;
- i) Controlling and monitoring CNS/ATM equipment;
- j) Calibrating ground-based air navigation system/equipment to ensure maximum accuracy, and safety of flight, take-off and landing operations;
- k) Certifying CNS/ATM systems/equipment.
- l) Providing technical training.

1.2.3 Minimum Entry Qualifications

It is generally accepted that the minimum entry qualification for an ATSEP are the following:

- a) A. minimum educational level of successful completion of secondary school;
- b) A minimum of 1600 hrs of post secondary, college or military education, specialized in electronic technology; and
- c) A minimum of 20 years of age

1.2.4 ATSEP Training Concept

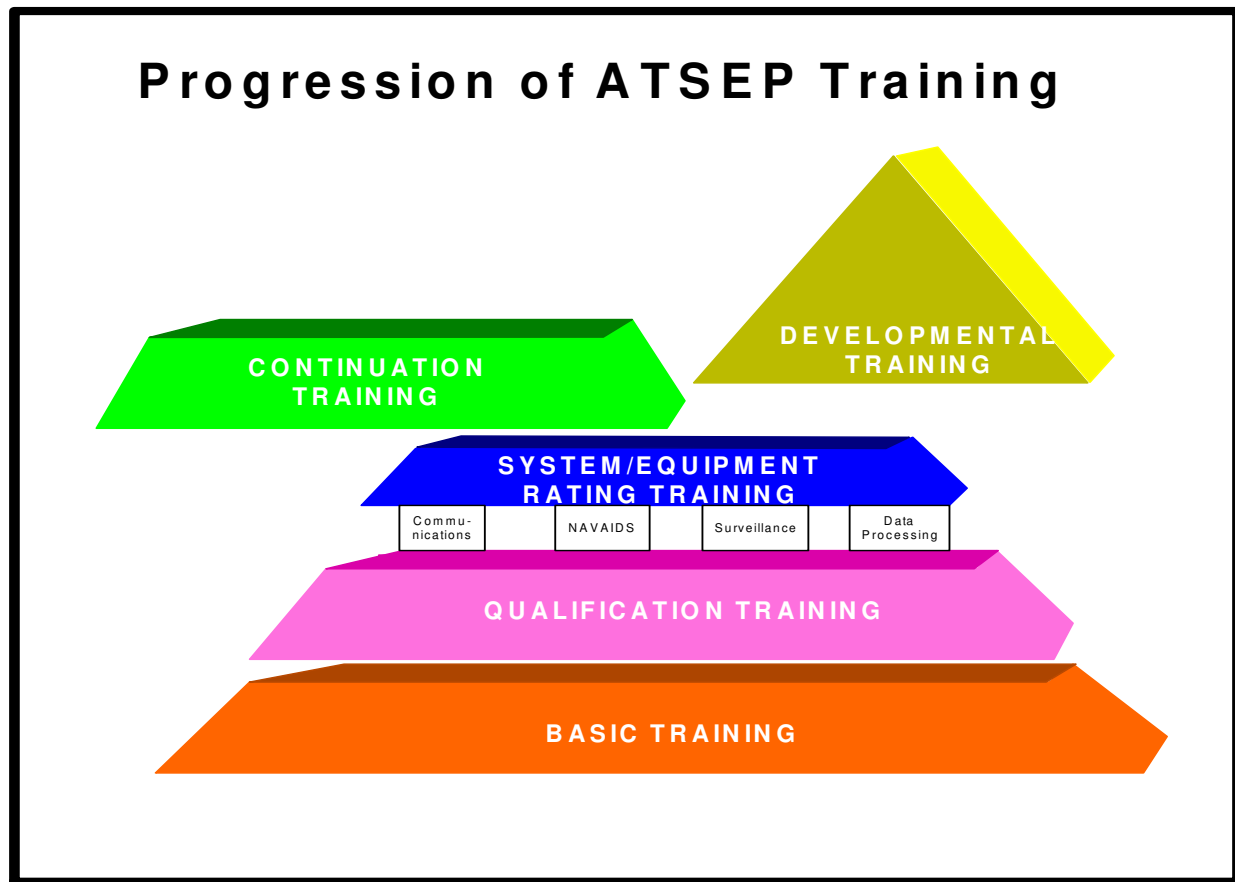


Figure 1: Progression of ATSEP Training

In order to cover the various backgrounds of trainees and to ensure training standardisation worldwide, it is recommended that training be divided into multiple levels as follows:

Basic Training	Fundamental knowledge and skills appropriate to the discipline to be pursued in the CNS/ATM environment.
Qualification Training	Job category related knowledge and skills appropriate to the discipline to be pursued in the CNS/ATM environment. Four disciplines have been identified through the four corresponding qualifications: Communication, Navigation, Surveillance and Data Processing.
System/Equipment Rating Training	System/Equipment knowledge and skills leading to recognized competency. It also includes the On-the-Job Training (OJT) , which is the practical integration of previously acquired knowledge and skills, under the supervision of a qualified On-the-Job-Training Instructor (OJTI), in an operational environment.

Continuation Training

Training given to personnel, designed to augment existing knowledge and skills and/or to prepare for new technologies. It includes refresher, emergency and conversion training. Refresher and emergency training are sometimes named 'recurrent training'.

Refresher Training: Refresher training is designed to review, reinforce or upgrade existing knowledge and skills, including team skills.

Emergency Training: Emergency training includes training in emergencies (1), unusual situations (2) and in degraded systems(3). Most of this training will be site specific, or may make use of incidents or accidents analysis.

- (1) serious, unexpected, and often dangerous situation, requiring immediate action.
- (2) A set of circumstances which are neither habitually nor commonly experienced. The essential difference with an emergency is that the element of danger or serious risk is not necessarily present in an unusual situation.
- (3) Unusual situations which are the result of a system failure or malfunction.

Conversion Training: Training designed to provide knowledge and skills appropriate to a change in either job category (new discipline or new type rating), environment (new procedures) or system (system upgrade or change).

Developmental Training

Training designed to provide additional knowledge and skills demanded by a change in the job profile e.g. Flight Check Inspector, System Monitoring and Control, Training Instructor, Installation/Engineering Technologist, or any other career development.

States and Organizations may select their ATSEP from personnel who have various forms of aviation experience. However, experience has shown in many states that ATSEP do not have a basic knowledge of the operational environment and safety related aspects of civil aviation. Therefore, it is the role of the Phase One Basic Training to cover the operational and the technical environment related to the ATSEP duties, and all the safety aspects of civil aviation. Phase One Basic Training is a pre-requisite to the Phase Two Qualification Training.

Trainees who do not have previous aviation experience will have to undergo the complete training program as recommended in Phase One Basic Training. Trainees who have had suitable aviation experience may not need to undertake this complete program. For example, a pilot, flight navigator, air traffic controller, or a flight radio operator can be assumed to have at least partially completed Phase One Basic Training if they have been actively employed in these occupations within the past few years. In such cases, training institutes organizations, with the approval of the state authorities, are encouraged to apply the necessary flexibility in arranging appropriate training courses, emphasising subjects of particular concern to ATSEP duties. The same flexibility can also be applied during continuation or recurrent training. Table 1-1 provides a listing of the subjects contained in Phase One Basic Training and Table 1-2 provides a listing of the subjects contained in Phase Two Qualification Training.

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 CNS/ATM systems/equipment 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 or certification program 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 ATSEP.

1.2.5 Standard of Accomplishment

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.

In measuring the standard of accomplishment, the use of only two grades, *pass* or *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 an 80 per cent score, trainees may strive for perfection.

Tests to assess the trainee achievement in performing the training objective should be valid and reliable. Validity of a test refers to the extent to which a test is an appropriate measure of what it was intended to measure. The validity of a test can be ascertained by checking that the conditions, performance and standards of the test correspond to those described in the training objective. Reliability is the ability of a test to consistently reproduce similar results when administered on similar groups of students under similar conditions with different instructors/assessors. To ensure that the test is reliable, the score key, providing model answers and specific instructions on how the test should be administered, is critical.

1.2.6 Examination Data Base

Where possible, states/ANSP should build an examination database, or at least a comprehensive written list, of all need-to-know questions and performance exercises for each rating (charts may be included), covering both general and critical objectives. Due to the quick evolution of technology and systems, these questions and performance exercises must be kept up-to-date to ensure the currency of ATSEPs' knowledge and skills.

A model answer should give the instructor enough information to establish how closely the trainee masters the tested performance. These three elements, score key, model answer and the conditions in which the test has been administered, provide the basis to determine a pass or fail in a consistent manner.

1.2.7 Training Reference Guide

Paragraph 1.2.8 presents the various subjects that need to be covered during Phase One Basic Training. It is recommended that Phase One Basic Training be fully completed before proceeding with Phase Two Qualification Training. The training duration for the various subjects in Phase One Basic Training will vary depending on the size and complexity of the Organizations, the CNS/ATM systems and the ATC/Airspace structure of the state. The training Organization should ensure that all sections of the syllabus are adequately covered to meet the desired level of knowledge before proceeding with Phase Two Qualification Training. Phase One Basic Training could be expanded based on the requirement of each particular state.

In addition, the various parts of the training manual have been marked with a coding level from 0 to 5, indicating the degree of expertise to clarify the understanding of a desired level of accomplishment.

The level of complexity refers to the taxonomy of verbs used (a list of these verbs can be found in Appendix A), and can be explained as follows:

- Level 0:** Denotes a simple level of awareness.
- Level 1:** Denotes a basic knowledge of the subject, and the ability to state or list the essential points. Trainees should have a basic understanding of the subject, but are not expected to apply the learned skills and knowledge.
- Level 2:** Denotes the ability to apply, in practice, the learned knowledge and skills of the subject with the help of reference manuals and instructions.
- Level 3:** Denotes a thorough ability to apply the learned knowledge and skills of the subject with speed and accuracy.
- Level 4:** Denotes extensive ability to apply the learned knowledge and skills of the subject, to procedures derived from it, with judgement appropriate to the circumstances.
- Level 5:** Denotes ability to Analyze a new situation in order to elaborate and apply one or more relevant strategies to solve a complex problem. The defining feature is that the situation is qualitatively different to those previously met, requiring judgement and evaluation of options.

As mentioned earlier, there was no training duration identified for the various subjects in each of the training phases. The duration for each phase will vary depending on the size and complexity of the Organizations, the CNS/ATM systems and the ATC/airspace structure of the state. The duration will also depend on many other factors such as: the availability and the number of equipments or systems for training, the number of trainees, the availability of the necessary test equipment, the maintenance philosophy, and the teaching strategy used by the instructors, etc. As you can appreciate, identifying course duration without looking at the specific criteria of the state would be misleading and unrealistic.

1.2.8 Training Schedule

Phase One - Basic Training

The Phase One - Basic Training is designed to give an overview of the overall CNS/ATM technical and operational environment, as well as an overview of the most important systems and equipment, and the role of all the operators within this complex environment. In order for the ATSEP to perform their role and duties, it is important that they understand each of the essential system components.

This phase has been split into three sub-sections with the possibility of teaching each chapter separately.

Subject Matter
Chapter 3.1 – International / National Organizations and Standards
Chapter 3.2 – Familiarization with Air Traffic Services, Airspace Standards, Meteorology and Altimetry
Chapter 3.3 – Familiarization with CNS/ATM Systems

Phase Two - Qualification Training

The Phase Two - Qualification Training will provide the ATSEP with an in-depth knowledge and appropriate skills needed in the CNS/ATM discipline to be pursued.

Following the completion of Phase One Basic Training, the ATSEP will be trained in a specialized discipline such as: Communications, Navigational Aids (Nav aids), Surveillance or Data Processing. The ATSEP may receive the training for more than one speciality. The ANS provider or state organization determines the number of ATSEP to be trained in each speciality.

Each discipline in the Phase Two Qualification Training has been developed in a separate multi part chapter. While the content elements of each chapter is generic, it does not prevent the state organization from including examples, to illustrate real life situations or to use systems/equipment that are available to enhance the learning activities.

This training phase is important for the ATSEP, since it makes the link between the general knowledge received in the Phase One Basic Training and the specific equipment knowledge and skills to be acquired in the System/Equipment Rating Training. In Phase Two Qualification Training, the knowledge, skills and attitudes needed for each of the specialities, will be developed and their applicability will be emphasized. Safety aspects of the personnel (ATSEP), and of the equipment/systems are covered for each discipline.

Subject Matter
Chapter 4 – Communication Systems
Chapter 5 – Radio Navigation Aids
Chapter 6 – Surveillance
Chapter 7 – Data Processing Training Demand
Chapter 8 – System Safety Training

Phase Three - Specific Training

The Phase Three Specific Training focuses on a specific area of training or on specific ATSEP functions. This phase is the final stage for insuring ATSEP competency.

Following the completion of Phase Three Specific Training, the ATSEP will be assessed in order to meet the competency requirement to receive the certification delegation.

The ATSEP licensing and the system/equipment certification programs are not defined here, however, this training is a prerequisite to do so.

Subject Matter
Chapter 9 – System/Equipment Rating Training
Chapter 10 – Continuation Training
Chapter 11 – Developmental Training
Chapter 12 – Human Factors

Chapter 2 - General Recommendations

2.1 Accommodations and Equipment for Classroom-based Training

2.1.1 General

The *TRAINAIR Training Management Guideline (TMG)*, developed by ICAO, provides detailed information on training support functions, training delivery, administrative support functions, and the 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 ATSEP, 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 ATSEP 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

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 m² to a high of 6.7 m². 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. The sizes of classrooms are affected by:

- a) number of trainees in a class;
- b) trainee workstation size;
- c) class configuration;
- d) size of aisles; and
- e) use of media (in particular, projected media and hands-on projects).

Note: The number of trainees per instructor to obtain efficient and good quality training depends of the mode of delivery (individualized or group paced) an the training techniques as well (lesson/demonstration mediated lecture, group discussions, small group discussions, case studies, role play, supervised practice etc.). Labs require groupe and individualized supervision and control that no allows having more than 10-14 trainees for two instructors. This ratio may be also used for group-paced training when the trainees need large amount of reference materials and the training combines several training techniques.

The use of media, hands-on experiments and the number of the trainees per instructor are important factors in determining the amount of common space required in a classroom. The most commonly used visual media are slides, chalk/marker boards, overhead projectors, videotape 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.

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

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 workspace is very important. The large amount of reference material used in the training of ATSEP requires considerably larger work surfaces than would be provided by the attached writing surface of an auditorium chair.

Computers can also be considered as useful training aids for ATSEP. Used as instructional media, computers usually take the form of desktop micro-computers 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.

2.1.3 The Learning Environment

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

- a) the climate must be comfortable;
- b) lighting must be of adequate level for work or viewing;
- c) distracting sounds must be kept to a minimum;
- d) work areas must be aesthetically pleasing;
- e) workstations must be comfortable;
- f) work space must be adequate;
- g) work area must be reasonably clean;
- h) training equipment must be adequate;
- i) visual media must be visible; and
- j) audio media must be at a suitable level.

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 the comfort of workstations, which includes chair comfort.

2.2 Performance Evaluation (Testing)

Performance evaluation (testing) is an integral part of the training process. Testing has many advantages for the trainee as a means of learning. It also provides incentive and motivation, and it confirms learning. The advantages for the instructors are the confirmation that the objectives have been met and whether instruction methods need to be improved. 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 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 100 per cent. Trainees must be informed of the result of their evaluation, and instructors must offer correction for improper responses.

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 the trainees have understood and assimilated the material taught, 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 the feelings and opinions concerning the job, and other people, as well as personal conduct/responsibility. They are best tested by observations of performance, or by means of questionnaires.

There are no Terminal Objectives in this manual because Terminal Objectives refer to specific tasks, and these can vary substantially from states, service providers and manufacturers. The Terminal Objectives are subject to the systems or equipment used on the course being delivered in the Type Rating Phase. These objectives should be determined and administered by the Local Training Administration or responsible authority. All of them should be tested.



Chapter 3 - Familiarization with Air Navigation Services

3.1 International, National Organizations and Standards

3.1.1 Introduction

International regulations and air laws are promulgated to ensure the safety, regularity and efficiency of international aircraft operations. 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 ANS operation. CNS/ATM systems operations are governed by international Organizations that provide rules and standards to ensure safe operation and interoperability of Air Navigation Services world-wide. Among those are ICAO, ECAC, JAA, IEEE and others. Achievement of safety and efficiency in air navigation operation requires that all states accept and implement a common standard for Air Navigation Service with regards to training, licensing, certification, etc. The standardisation 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 ATSEP training, the need for standardisation is equally applicable to any ANS operation. The syllabus contained in this chapter gives a general view on aviation law, as adopted by ICAO and practised in international ANS operations.

3.1.2 Training Objective

Students shall describe the national and international organizations, the regulations, national legislation, and the work environment.

- Condition:** Given the description of a specific situation relating to a state Air Navigation Service provider, and the relationship with International and National authorities:
- Performance** The trainee will be able to describe:
- a) the role of international and national organizations as well as the SARPS;
 - b) The importance of applicable international and national regulations.
 - c) Standard of accomplishment: All the descriptions should include the essential points of the given situation.

This sub-section includes five (5) parts:

- 3.1.1 Introduction;
- 3.1.2 International and National Organizations and Standards;
- 3.1.3 Working Positions and Environment;
- 3.1.4 Environmental Protection;
- 3.1.5 Personal Safety

Topic	Intermediate Objectives The students should be able to:	Level	Content
Chapter 3.1 - International, National Organizations and Standards			
3.1.1 Introduction			
1. National and International Organizations	1) Name the key national and international aviation Organizations	1	ICAO, ECAC, EUROCONTROL, JAA
	2) Describe the impact these Organizations have on ATM, and their interaction with each other	2	National authority, others...
	3) State the necessity to have special aviation law, the source and development of aviation law.	1	Show example of guidelines or recommendations ICAO Annex 2, Annex 10, Technical recommendations National Aviation Law
3.1.2 International and National Organizations and Standards			
1. ICAO	1) Explain the purpose and function of ICAO	2	History, convention, international agreement
	2) State the methods by which ICAO notifies and implements legislation	1	ICAO Annexes, ICAO documents, regional offices
	3) Describe the ICAO technical recommendation	2	PANS, SARPS, FANS ICAO Annexes 2 and 10
2. International Standards and Recommended Practices	1) Demonstrate the awareness of ATM Engineering Standards and Practices	2	ICAO Annexes 1 and 10 Document 8071 International Standards, IEEE, JAA: CCITT, guidance material on reliability and availability
	2) Describe the purpose of the CCITT	2	Guidance material on network, communication and frequency allocation
3. Other Agencies	1) Describe the purpose and function of other international agencies and their relevance to air traffic operations	2	ECAC, EU, JAA, ITU EUROCONTROL, other agencies from Africa, Asia,.....
4. Aviation Association	1) Describe the purpose of ATSEP, engineers, controller, pilot, airline and airspace user associations, and their interaction with ATM	2	IFATSEA, IEEE, IFATCA, IFALPA IATA, IEA, IAOPA, IACA Other civil or military services

Topic	Intermediate Objectives The students should be able to:	Level	Content
5. International Dimension	1) Explain the relationship between states and the relevance to ATC operations	2	Harmonisation, flow management, bilateral agreement, sharing of radar data, or other information International Civil Aviation Organization (ICAO) ECAC Harmonisation program EATCHIP/EATMP
	2) Demonstrate an awareness of the legal framework of International and National ATC regulations	2	ICAO, EUROCONTROL, ITU....
	3) Demonstrate an awareness of the roles and specific functions of a range of international bodies	2	Major studies, research programmes and policy documents, FANS
6. National Legislative Procedures	1) Describe the methods by which legislation is notified and implemented	2	ICAO Annex 15, AIS, AIP, AIC, SUP Type of publication, AIRAC, NON-AIRAC NOTAM, integrated aeronautical information package, national legislation
	2) State the appropriate accountabilities and responsibilities	1	Technical and operational responsibility System management
7. National Regulatory Body	1) Name the body responsible for certification and enforcing legislation for technical procedures	1	Department, quality control, safety management, documents in use
	2) Describe how the regulatory body carries out its safety regulation and responsibilities	2	Technical safety department, redundancy policy
8. National Aviation Associations	1) Describe the purpose of national ATSEP, pilot, controller, airspace user associations and their interaction with ATM	2	National Organization Professional Organization and representation to international body
9. National Organizations	1) Describe the history and Organizational structure of the national CAA	2	History of your national Organization, national policy, agencies Headquarters, regulator, provider
	2) Describe the purpose and function of appropriate national agencies and their relevance to ATM operations	2	Civil aviation administration agencies, your Organization or department, government agencies, military agencies....

Topic	Intermediate Objectives The students should be able to:	Level	Content
	3) Describe the Organizational structure and functions of the major departments within the National CAA, and particularly the technical Organization	2	Provider Organization Technical Organization flow chart, control centres, operational flow chart, airports Outstations civil/military interfaces Other national or international interfaces, bilateral agreements
	4) Describe the operational services and list the type of existing Air Navigation Services (ANS) and list the Air Traffic Services	2	ATM (ATS, ATFM, ASM) ATC (ACC, TWR, APP) FIS/AIS, Alerting....
3.1.3 Working Positions and Environment			
1. General	1) Describe the workplace, fire and safety regulations	2	Pass a simple first aid test, fire exit, safety regulation, building, rest room, ID card
	2) Describe the maintenance policy, the safety policy and quality control related to systems	2	Maintenance concept and philosophy, system certification, ISO certification
	3) Identify the equipment in the working position	3	Stores and requisitioning process Safety procedure, certification of equipment, tools, measuring instruments
	4) Describe the environment surrounding your building	2	Airport environment, tarmac rules, security, ID card, location of NAVAID....
	5) Describe the special rules that apply in this environment	2	NAVAID station, safety rules, power and logistic suppliers, fire brigade Special rules for driving in airport environment, use of radio (radio licence), ILS/localiser testing vehicle.....
2. Study Visits	1) Demonstrate Familiarization with technical and operational ATM facilities	0	Technical room, outstations, ACC, TWR, APP, AIS Radar, NAVAID and communications facilities
	2) Demonstrate Familiarization with airport facilities and local operator	0	Airport services, airlines, customs....
3.1.4 Environmental Protection			
1. Environmental Protection	1) Recognize the importance of environmental protection	1	Air, water, noise
	2) Recognize the importance and danger of non ionising electromagnetic radiation	1	Power transmitter and radar transmitter

Topic	Intermediate Objectives The students should be able to:	Level	Content
3.1.5 Personal Safety			
1. Personal Safety	1) Demonstrate general awareness of personal safety responsibilities in the work environment	0	Safety statement, high voltage precautions
	2) Demonstrate general awareness of potential hazards to health and safety generated by equipment, or contained within the work environment	0	First aid....
	3) State safety procedures for persons working on or near such equipment	1	Radar beam, handling of dangerous materials (TR cells, components with radio active element).....
	4) State any applicable legal requirements	1	Procedures in use, company rules, national rules

3.2 Familiarizations with Air Traffic Services, Airspace Standards, Meteorology and Altimetry

3.2.1 Introduction

The ATSEP are performing several critical tasks on CNS/ATM systems/equipments, which could impact on users. In order for ATSEP to fully understand the impact of their work on these systems, they must have a sound knowledge of the operational environment, such as Air Traffic Management (ATM). ATM systems are vital in order to provide safe, reliable and efficient delivery of Air Traffic Services. The consequences of system outages and their direct impact on users (i.e. pilots, air traffic controllers), may result in unsafe situations or cause excessive delays in airline operations.

ATSEP must understand the effects of varying temperature and weather conditions on the CNS/ATM Systems. For example high-level humidity or snow accumulation may impact on radio frequencies. They also must have a good appreciation of altimetry; height, altitude and flight level.

The syllabus contained in this sub-section gives a general view of these elements.

3.2.2 Training Objectives

Students shall describe Air traffic Services, Airspace Standards, Meteorology, and Altimetry.

Condition: Provided with a broad outline of Air Traffic Services, Airspace Standards, Meteorology and Altimetry, and through simulated situations:

Performance The trainee will be able to describe:

- the role of the national ATM services, clients and customers;
- the importance of separation standards and collision avoidance;
- the importance of meteorology and altimetry, and how they can affect operations.

Standard of All the descriptions should include the essential points of the given situation

accomplishment

This sub-section includes eight (8) parts:

- 3.2.1 Airspace Users and Customer Relations;
- 3.2.2 Air Traffic Management;
- 3.2.3 Separation Standards and Collision Avoidance;
- 3.2.4 Meteorology, Altimeter and Level Allocation;
- 3.2.5 Atmosphere and Atmospheric Processes;
- 3.2.6 Meteorological Phenomenal and Codification;
- 3.2.7 Meteorology Tools and Equipment;
- 3.2.8 Altimetry and Operational Aspects.

Topic	Intermediate Objectives The students should be able to:	Level	Content
Chapter 3.2 -Familiarization with Air Traffic Services, Airspace Standards, Meteorology and Altimetry			
3.2.1 Airspace Users and Customer Relations			
1. Civil Aviation	1) Demonstrate general awareness of the different airspace requirements for civil aircraft	0	Commercial flying, recreational flying, gliders, balloons, VFR, IFR....
2. Military Aviation	1) Demonstrate general awareness of the different airspace requirements for military aircraft	0	Low-level flying, test flight, special military operations, training....
3. Expectations and Requirements of Pilots	1) Demonstrate general awareness of the expectations and requirements of pilots	0	
4. Customer Relations	1) State the role of ATM as a service provider	1	System of funding, en route charge, landing charge, system of clearing (Eurocontrol)
	2) Recognize the means by which ATM is funded	1	
3.2.2 Air Traffic Management			
1. Terminology and Units of Measurements	1) Apply the terminology and units of measurement appropriate to ATM	3	Glossary, ACC, APP, TWR, TMA, CTR....
	2) Demonstrate an understanding of ATM terminology	2	
2. Air Traffic Control Services	1) Describe the types of flight	2	ICAO Annexe 11
	2) Explain the division of ATM services	2	AIP, national services
	3) Demonstrate an awareness of airspace Organization and associated concepts	2	IFR, VFR, CVFR, civil, military.... Airways within national boundaries, TMA, CTR

Topic	Intermediate Objectives The students should be able to:	Level	Content
	4) Describe the functions and services provided by ATC and the different ATC tasks 5) Describe the sectorisation 6) Describe the data displayed on the screen 7) Describe the function of ground control 8) Describe the function of tower control 9) Describe the function of approach control 10) Describe en-route control 11) Describe the transfer of control	2 2 2 2 2 2 2	ICAO Annexe 11 Principle of sectorisation, logical sectors, physical sectors.... Radar track, SSR code, labels, maps.... See a controller position screens Flight information region, Area Control Centre, Terminal Manoeuvring Area, APP, TWR. The task of ACC, approach, tower and oceanic control
3. Flight Information Service	1) Define FIS 2) Define the scope of the FIS 3) Explain the responsibility for the provision of FIS 4) State the methods of transmitting information 5) Issue information to aircraft	1 1 2 1 3	ICAO Annexe 11, AIP National Organization, FIC ATIS, VOLMET, RTF, data link.... State of Nav aids, weather, flight safety information, NOTAM....
4. Alerting Service	1) Define ALRS 2) Define the scope of the ALRS 3) Differentiate between phases of emergency, and between distress and urgency signals	1 1 2	ICAO annexe 11 Uncertainty, alert, distress, mayday, pan, visual signals Responsibilities Local Organization
5. Air Traffic Flow Management	1) Define ATFM 2) Describe the scope of ATFM 3) Demonstrate an awareness of the content of a flight plan and state the different fields 4) Explain the life cycle of a flight plan	1 2 2 2	Flow control, Integrated Initial Flight Plan Processing System (IFPS), Central Flow Management Unit (CFMU), slot, national Organization and interface.... Fields of the flight plan and their uses Exchanges between centres, OLDI messages, estimated times

Topic	Intermediate Objectives The students should be able to:	Level	Content
	5) Explain the responsibility for the provision of ATFM	2	Data base, Eurocontrol CFMU....
	6) State the methods of providing ATFM	1	
6. Aeronautical Information Services (AIS)	1) Define AIS and the responsible bodies in charge of aeronautical legislation	1	ICAO Annexe 15 CAA, military....
	2) Define the methods by which the legislation is notified and implemented	1	ICAO annexe 15 Code of the air, AIP, Notam, SUP, AIC , national services
	3) Define the structure of the AIS, its area of responsibility and its position inside the national air traffic services	1	ICAO annexe 15
	4) Describe the Aeronautical Information Publication (AIP)	2	ICAO Annexe 11 Data contents of AIP, SUP, AIC. Types of publication (AIRAC, NON-AIRAC), data collection and preparation and data format, distribution channels.
	5) Define the aeronautical charting service	1	ICAO Annexe 4 Types of charts, operational use and distribution channel
	6) Define the Aeronautical Information Regulation and Control (AIRAC) and the Aeronautical Information Circular (AIC)	1	
7. Airspace Management	1) Define ASM	1	
	2) Describe the scope of ASM	2	Procedures, airways system design, points, maps design. Reference document
	3) Explain the responsibility for the provision of ASM	2	Airspace delegation (if it exists)
	4) State the methods of managing airspace	1	Flexible use of airspace, airspace design
8. Particular Situation	1) Describe the particular problems confronting ATM	2	Weather conditions, environment, special flights, military activity, emergencies, search and rescue operation, hijacking, faulty aircraft equipment, faulty ground equipment
9. System and Equipment	1) Describe the operational importance of equipment and facilities provided for ATM	2	Reliability, redundancy, contingency, procedural backup

Topic	Intermediate Objectives The students should be able to:	Level	Content
	2) Describe the emergency procedure in case of equipment failure	2	Responsibilities, restriction, emergency procedure
10. Co-ordination	1) Explain the principle of co-ordination and transfer	2	Notification, negotiation, agreement, transfer of flight data, local agreements, bilateral agreements between countries.
	2) Appreciate the need for co-ordination	3	
	3) Describe the means of co-ordination	2	Data link, telephone, intercom, voice
3.2.3 Separation Standards and Collision Avoidance			
1. Vertical Separation	1) State the vertical separation standards and procedures	1	Standard separation, RVSM (AIP, ICAO)
2. Horizontal Separation	1) State the longitudinal separation standards and procedures	1	Separation based on time and distance
	2) State the lateral separation standards and procedures	1	Aircraft performance
3. Visual and Geographic Separation	1) State the occasions when visual separation can be use	1	Separation provided by pilot
	2) Explain the use of geographic separation	2	
4. Wake Turbulence Separation	1) Explain the wake turbulence categories and separation	2	
5. Radar Separation	1) Explain the use of radar in ATS	2	
	2) Explain the radar separation standards and procedures	2	
6. Collision Avoidance	1) Explain the Airborne Collision Avoidance System and the effect on ATC operations	2	ACAS, TCAS....
	2) Explain the conflict alert systems and their effect on ATC operations.	2	MTCA, STCA, MSAW, DAIW....
7. Separation	1) Demonstrate general awareness of the separation standards that apply to the ACC	0	Explanation of how controllers apply the ACC separation, restriction due to faulty equipment
	2) Demonstrate general awareness of the separation standards that apply to APP and TWR	0	Identify for APP and TWR (see also the function of ACC, APP and TWR)
8. Familiarization with ATM Simulator	1) Confirm an understanding of the operational ATC role through practical exercises on ATC simulators, or with flight simulator	3	Exercise on simulators (ACC/APP simulator, TWR simulator, flight simulator....), follow a flight plan

Topic	Intermediate Objectives The students should be able to:	Level	Content
	2) Explain the need for good communications between operational staff	2	During the flight see the role of ACC, TWR, APP, FIS and all the technical systems involved for each step Co-ordination between sectors, between centres
	3) Explain the need for good communications between operational staff and technical staff	2	Good communications in case of system failure, description of new specifications, identification of problems....
9. Familiarization Visits	1) Undertake station Familiarization visits	0	Visits
	2) Visit various operational stations in order to state their purpose, function and role in relation to ATC operations	0	
3.2.4 Meteorology, Altimeter and Level Allocation - Introduction			
1. Terminology and Units of Measurement	1) Demonstrate an awareness of the terminology and units of measurement appropriate to meteorology	1	Glossary and abbreviations
2. Aviation, ATM and Meteorology	1) Explain the relevance of meteorology in aviation and in ATC environment	2	From the operational point of view
	2) Explain how technical systems contribute to ATC operations	2	
	3) Describe the function and the performance of the weather measurement systems	2	
3. Organization of Meteorological Services	1) Name the basic duties, Organizations and working methods of meteorological offices	1	Local, national and international meteorological offices
	2) State the international and national standards for the exchange of meteorological data	1	Local, national and international meteorological offices
		1	National services, interface with your ATM systems Networks, satellite, Meteosat....
3.2.5 Atmosphere and Atmospheric Processes			
1. Composition and Structure	1) State the composition and structure of the atmosphere	1	Gasses, layers, troposphere, stratosphere, mesosphere, thermosphere
2. Standard Atmosphere	1) Define the elements of the ISA and why it has been defined	1	ICAO standard atmosphere, temperature, pressure, density
3. Air Masses and General Air Circulation and	1) State the origin and general location of typical air masses	1	Polar, arctic, equatorial, maritime and continental....

Topic	Intermediate Objectives The students should be able to:	Level	Content
Frontal Systems			
	2) State the major wind systems on the Earth	1	Polar, east winds, west winds, zone....
	3) Define high and low pressure systems	1	Trade winds, inter-tropical convergence zone
	4) State the differences between various fronts and the associated weather	1	Warm front, cold front, occluded front....
4. Heat and Temperature	1) Identify the processes by which heat is transferred and how the atmosphere is heated	1	Radiation, convection, conduction, turbulence
	2) Describe how temperature varies	1	
5. Water in the Atmosphere	1) Differentiate between the terms related to air saturation levels	2	Saturation, condensation, evaporation, relative humidity, dew point
6. Air Pressure	1) Define the relationship between pressure, temperature and altitude	1	QFE and QFF definition, QNH definition, QNH computation, standard pressure, use in ATM (see also altimeter setting)
3.2.6 Meteorological Phenomenal and Codification			
1. Clouds	1) Identify the different conditions for the formation of clouds, cloud types and state their characteristics	1	
	2) State how the density of clouds is measured	1	
	3) Define the cloud base and ceiling	1	
2. Precipitation	1) State the significance of precipitation in aviation, and the types of precipitation	1	Rain, snow, sleet, hail
3. Visibility	1) State how visibility is measured and the significance for ATM	1	RVR, camera, transmission of data, impact on ILS categories
4. Wind	1) State the significance of wind phenomena and types	1	
	2) State how wind is measured	1	
5. Meteorological Hazards	1) State the meteorological hazards to aviation	1	Turbulence, storms, icing, wind shear....
6. Impact on ATM	1) Demonstrate general awareness of the impact of the different atmospheric conditions on ATM operations	0	Give examples

Topic	Intermediate Objectives The students should be able to:	Level	Content
7. METAR and TAF Code	1) Explain the aim and use of METAR and TAF code	2	Observation at airport, METAR/SPEC, forecast TAF/TREND, aviation weather report
	2) Define the content of the METAR	1	Content of the message, wind, visibility, type of weather, clouds, temperature, dew point, pressure
	3) Decode a METAR by using the METAR table	2	Examples of METAR and interpretation
	4) Define the content of the TAF code	1	Example of Terminal Area Forecast message and interpretation
8. Significant Weather Information	1) Define the aim and use of SIGMET	1	Content of the Terminal Area Forecast, examples
	2) Define the aim and use of GAMET	1	
	3) Define the aim and use of AIRMET	1	
	4) Define the aim and use of SWC and TEMSI chart	1	
9. Typical Situation	1) State the typical weather situation over your region	1	Examples
3.2.7 Meteorology Tools and Equipment			
1. Meteorology Sensors	1) Explain the main functions of each tool	2	Sensors, anemometers, Runway Visual Range (RVR), barometers, ceilometer
	2) Explain the technical principle of each equipment and their location	2	Technical description of each system, photo of equipment....
	3) State the relevant measurements and instrumentation	1	System diagram (global)
	4) Define the main function of Meteosat	1	Radar, display, distribution, use for approach....
	5) Explain the main function of airborne and ground weather radar	2	Radar, display, distribution, use for approach.... Visit approach display
2. Documents	1) State the main documents, national and international	1	
3. Information	1) State the different networks for transmitting meteorological information	1	Distribution system, network, Infonet, type of data transmitted.
	2) State the types of meteorological messages and reports	1	METAR, SPECI, SIGMET, FIS....
	3) Define the content, main function and characteristic of the broadcasting system	1	ATIS, VOLMET

Topic	Intermediate Objectives The students should be able to:	Level	Content
4. System in Use in Your Unit	1) Describe with the help of a block diagram, the system that transmits the meteorological data 2) Name the ATSEP who are in charge of the of system maintenance	2 1	Block diagram of the system Name of the group of ATSEP, and how to contact them
3.2.8 Altimetry and Operational Aspects			
1. Atmosphere Parameters and Altitude	1) State general consideration of the atmosphere with respect to altimetry	1	Atmosphere, pressure, standard atmosphere
	2) Explain the difference between QNE and QFF	2	Definition of QNE and QFF
	3) Explain the different parameters of the atmosphere	2	Atmosphere layers, ICAO standard atmosphere – ISA, pressure lapse rate (ISA)
	4) Explain the atmospheric pressure QNH	2	Definition of the QNH, QNH computation, example
	5) State the two specific altimeter errors	1	Altimeter errors caused by non-standard atmospheric conditions
2. Temperature Effect on Altimeters	1) Describe the altimeter errors due to the temperature	2	Indicated altitude, true altitude
	2) Describe an example of error with the help of a temperature table,	2	Table of temperature deviation from ISA, example of map
3. Pressure Effect on Altimeter	1) Describe with the help of a drawing the altimeter errors in different pressure conditions	2	Standard, low and high pressure conditions Altimeter setting
4. Altimeter Settings	1) Describe the different altimeter settings with the help of a drawing 2) Show the lowest usable flight level with help of a drawing	2	In flight or ground QFE setting, QNH setting, standard setting, flight level and separation, QNE setting
5. Flight Procedures	1) Describe the departure, en-route and arrival procedures	2	Departure procedure transition altitude, transition level and transition layer, flight level and separation, low pressure situation Lowest usable flight level
6. Altimetry	1) Appreciate the relationship between height, altitude and flight level	3	QFE, QNH, standard pressure
7. Transition Level	1) Appreciate the relationship between transition level, transition altitude and transition layer	3	Give examples for arrival, departure....
8. Level Allocation	1) Describe the cruising level allocation system	2	Flight levels, altitudes, heights Give examples

3.3 Familiarization with CNS/ATM Concepts

3.3.1 Introduction

Communication, Navigation, Surveillance and Air Traffic Management systems provide essential tools for the delivery of Air Navigation Services. ATSEP main duties are to maintain, modify, repair, and develop these systems, while keeping them fully operational and safe. The consequences of system outages and their direct impact on the users (i.e. pilots, Air traffic controller) may result in unsafe situations, or cause excessive delays in the operation of the airline industry.

The syllabus contained in this sub-section gives a general view of these elements, including power distribution.

3.3.2 Training Objective

Students shall be familiar with Nav aids, communication, surveillance and data processing systems used for ATM.

Condition:	Provided with a broad outline of the Nation ANS customers, users, and systems, and through simulated situations
Performance	The trainee will be able to describe the navigation, communication, surveillance, data processing, power distribution and Satellite navigation systems used in the national ANS.
Standard of accomplishment	All the descriptions should include the essential points of the given situation

This sub-section includes twenty-nine (29) parts:

3.3.1 Voice Communications	3.3.16 Future Systems
3.3.2 Air – Ground – Air	3.3.17 Radar Station
3.3.3 Ground – Ground	3.3.18 Networks
3.3.4 Recording (two groups may be in one topic)	3.3.19 ATM Specific Networks
3.3.5 Data Link Communications	3.3.20 Data Processing (DP)
3.3.6 Navigation	3.3.21 Radar Data Processing
3.3.7 Radio Navigation Aids	3.3.22 Flight Plan Processing
3.3.8 Satellite Based System – GNSS Technical Overview – Satellite Navigation	3.3.23 Display
3.3.9 Aircraft Systems	3.3.24 Online and environmental data
3.3.10 Flight Inspections	3.3.25 Facilities
3.3.11 Surveillance and Radars	3.3.26 Power Supply
3.3.12 Radar	3.3.27 Air Conditioning
3.3.13 Surface Movement Control	3.3.28 Monitoring
3.3.14 Radar Formats	3.3.29 Electromagnetic compatibility
3.3.15 Automatic Dependent Surveillance	

Topic	Intermediate Objectives The students should be able to	Level	Content
Chapter 3.3 - Familiarization with CNS/ATM Systems			
3.3.1 Voice Communications - General			
1. COM System and Equipment	1) Describe the functional elements of a voice communication system	2	Radio, Ground-Air, Ground-Ground, switch, intercom, telephone
	2) Explain the purpose of voice communication system in ATC	2	Operational purpose, use of radio in ATC, sectorisation, number of frequencies, special frequencies, distress
	3) Define the concept and terminology in use for voice communication	1	
	4) Explain the principles of voice communication systems	2	
2. Radio	1) State the principles of radio	1	Frequencies, phase, power, period, pulsation, wavelength Dipole antenna
	2) Recognize the characteristics of radio waves	1	E-Field, M-Field, polarisation
	3) Describe the principles of electromagnetic propagation	2	
	4) State the use, characteristics and limitations of frequency bands	1	Frequency spectrum and bands Frequency allocations, HF, VHF, UHF, frequency channelling Frequency bands used in ATC, communications, navigation and other applications in aeronautical mobile service
	5) State the different factors that can affect propagation of radio waves	1	Absorption, reflection, refraction, diffraction
3. Radio Communications	1) Describe the working principles of a transmitting and receiving system	2	Audio frequency, carrier, different types of modulation, detection, synthesiser....
	2) Describe, with a basic block diagram, the components of a transmitter system	2	Microphone, push to talk, amplifier, oscillator, modulator, antenna....
	3) Describe, with a basic block diagram, the components of a receiver system	2	Mixer, detector, AGC, squelch....
4. Legal Requirements	1) State ICAO legal requirements	1	Recording and retention of communications Annex 10 Volume II Channel spacing
5. ATIS and VOLMET Service	1) Describe Automatic Terminal Information Services	2	Message format, content, frequencies, national
	2) Describe the automatic data link	2	Data link, ACARS, ARINC

Topic	Intermediate Objectives The students should be able to	Level	Content
	service to ATIS, METAR and VOLMET		620/623, SITA networks, METAR
3.3.2 Air – Ground - Air			
1. Requirement	1) State the requirement for secure Air-Ground voice communications	1	Sector frequency, range, emergency
2. Signal Path, Equipment	1) Describe the complete signal path from the control suite to the aircraft	2	Block diagram of the complete path, location of equipment, remote station, TX/RX separation
	2) State the Voice COM equipment situated in the operational position and describe the purpose and operation of each element	1	Microphone, headphone, switching panel, redundancy, interface with technical room....
	3) Describe the purpose and principles of operation of the radio switch	2	Functionality, redundancy, basic operation of routing and switching, sectorisation, frequency coupling, short recording and instant replay possibility, RX/TX function, flexibility, sector....
	4) Describe the transport system used from the technical room to the transmitter/receiver station	2	Telephone line, optical fibre, network, analogue interface, digital interface, multiplexing techniques, sharing transport with other data....
	5) Describe the principle of radio link equipment	2	Location, frequency used, parabolic antenna, interface, link redundancy
	6) Describe the Human Machine Interface (HMI) of current devices in use	2	Functionality....
	7) Describe the TX and RX station and the antenna system	2	TX location, RX, location, antenna switching and filtering, number of RX per antenna, number of TX per antenna, polarisation.... Environment
	8) Describe the tools used for testing equipment	2	Power meter , TOS measurement, spectrum Analyzer, ...
3. Emergency System	1) Describe how continuity and security of service is achieved	2	Redundancy, back up system, bypass
	2) Describe the emergency system in use	2	Block diagram, location of TX and RX....
4. Perturbations and How to Cope with Them	1) State the problems we can have with VHF communication and the problems caused by frequency congestion	1	Reflection, earth spherical form, absorption, refraction, diffraction, mountains, frequency congestion, not enough frequencies....
	2) Explain the purpose and principle of 8.33 channel spacing	2	8,33 and 25 Khz, 8,33 bands, 8.33 terminology (channels, frequencies)

Topic	Intermediate Objectives The students should be able to	Level	Content
	3) Explain the purpose and principle of the CLIMAX frequency system	2	Transmitter frequency, frequency shift, receiver, filter, operational use....
	4) Explain the criteria required to safely use the same frequency at different ATM units	2	Operational range, minimum distance between two TX on the same frequency
5. Aircraft Equipment, On Board Systems	1) List the voice communication systems used on board	1	VHF/UHF transmission, HF transmission
	2) Explain the functionality of the different parts found in a cockpit, with the help of an example	2	Block diagram for an aircraft (for example B-737, airbus....)
	3) Describe the antenna systems of a aircraft, with the help of a picture	2	Give examples of VHF/UHF communication system on board, (for example, picture of B-737 and other aircraft....), give example for an HF system Give examples of a typical airborne transceiver Examples, BOING, AIRBUS, P8....
6. Future Development	1) List the future developments and techniques in ATM voice communication	1	Frequency congestion, the need for data link, VHF data link, VDL3/4
7. ATIS	1) Describe the system in use to transmit ATIS, VOLMET messages	2	Block diagram of your system, location, data link....
8. National Systems, Systems in Your Country	1) Describe the complete voice communication system used in your country, with the help of a drawing	2	Name of systems, path from controller position to antennas
	2) Visit sites	1	Visit station
3.3.3 Ground – Ground			
1. Requirement	1) State the requirement for secure Ground-Ground voice communications	1	Rules, needs, purpose
	2) Describe the national and international need for telephone connections	2	Map of the different location, national network, international connection
2. Equipment	1) Describe the function and the basic operation of the Ground - Ground communications system	2	Block diagram, purpose of operational, function
	2) Describe the routing and switching equipment	2	Functionality, telephone switching, interphone switching, hotline switching
	3) Describe the HMI of current system in use	2	See function of HMI, visit

Topic	Intermediate Objectives The students should be able to	Level	Content
3. Interface	1) Describe how Ground – Ground systems interface to provide an integrated service to ATM operations	2	PTT interface, local PABX equipment, multiplexing system, digital system, protocol
	2) Describe the system to ensure interchanges between ATC centres	2	Protocol, address, ...
4. Emergency Systems	1) State how continuity and security of service is achieved	1	Redundancy, bypass, location of RX/TX
	2) Describe the emergency system in use	2	Block diagram of your system
5. Future Development	1) List the future developments and techniques in ATM Ground – Ground communication	1	
	2) List the new technologies that may impact on Ground-Ground communications	1	
3.3.4 Recording			
1. Legal	1) Demonstrate an awareness of legal requirements for recording and retention of Air-Ground and Ground – Ground communication	2	National and international rules, ICAO recommendations
	2) State the methods in use in your country	1	
	3) State the type of data recorded in your country	1	Type of data, voice, telephone, ambient microphone
2. Equipment	1) Describe the recording system in use	2	Block diagram, safe, location
	2) List the function of the equipment	1	
	3) Describe the HMI of current system in use	2	Function, data recorded, COM voice channel, telephone line
3.3.5 Data Link Communications			
1. General	1) Describe the purpose and use of data link	2	
2. System ACARS	1) Define ACARS services and describe the overall purpose of it	1	Aircraft communication, addressing, reporting, reduce flight crew, automatic transmission
	2) Describe with the help of a diagram the architecture of ACARS including the onboard and ground architecture	2	CDU, ACARS MU VHF RGS, network provider, message storage MSS, message routing DSP, onboard architecture, ground architecture, cockpit orientation, (Example for an aircraft, BOEING, AIRBUS....)

Topic	Intermediate Objectives The students should be able to	Level	Content
	3) Explain the ACARS technology	2	VHF channel used, protocol, modulation (AM-MSK)
	4) State the performance, quality and limitation of the ACARS protocol	1	Block, time out, throughput, ACARS message, FANS structure
	5) State the improvements for ATS	1	ATIS automatic terminal information service, Pre-departure Clearance (PDC), Oceanic Clearance Messages (OCM).....
3. VDL Technologies	1) State the need for improvement and new technologies	1	VHF data link technology , ICAO needs, VDL technologies
	2) List the VDL modes	1	VDL modes (Modes 1,2 3 4), VDL-2, mode use, ACARS transition issues.....
	3) Describe, with the help of a diagram, the VDL architecture	2	VDL modes (Modes 1,2 3 4), VDL-2, mode use, ACARS transition issues.....
4. Aeronautical Data Communication	1) Describe what is the significance of ATN and what are the main components of ATN?	2	Definition, Need for enhanced communication network, need for common integrated network, ATN components, ATN end system, ATN subnetwork, ATN router....
	2) State the existing network and describe the evolution of Air-Ground and Ground-Ground communications	1	Evolution of Air-Ground communications, evolution of Ground-Ground communications, ATN transition issues, expectations, supporting Organizations (see also data communication)
3.3.6 Navigation - General			
1. Definition and Units of Measurement	1) Describe the terminology and units of measurement appropriate to navigation and radio navigation	2	See Glossary
2. Purpose and Use of Navigation	1) Explain the need for navigation in aviation	2	Historical overview, celestial, on board, on ground, radio aids, satellites
	2) Describe the principle and purpose of navigation	2	
	3) Characterise the navigation methods	2	
3. Place and Movement of the Earth	1) Explain the earth's properties and their effects	2	Form, size, rotation, revolution in space, units of the time, time zone, UTC
4. System of Co-ordinates, Direction, Distance and Measurement	1) Explain the principles of the co-ordinates and the principle of a grid system	2	e.g. Degrees, minutes, seconds, latitudes, longitudes, international and national references, World Geodesic Standard, WGS-84

Topic	Intermediate Objectives The students should be able to	Level	Content
	2) Estimate position on the earth's surface and distance and direction between two points	2	Circle, rhumb line, cardinal and inter -cardinal points, latitude/longitude
	3) Describe how to measure the distance between two points	2	
5. Magnetism	1) Explain the general principles of the earth's magnetism	2	North, true north, magnetic north, variation, deviation, inclination, conversions between true magnetic and compass north....
6. Maps and Charts	1) State how the earth is projected to create a map	1	Types of projections
	2) Describe the properties of a good map and the use of different projections	2	True azimuth, rhumb line and great circle, scale, conformity....
	3) Differentiate between the various maps and charts and explain their specific use	2	AIP maps and charts, international, national, military maps and charts....
	4) Explain symbols and information found on maps and charts	2	Examples of maps in use
7. Influence of Wind	1) Explain the wind influence on the flight path	2	Heading, track, drift, wind vector, wind correction
8. Speed	1) Explain the relation between various speeds used in aviation	2	Ground speed, air speed, (true air speed. Indicated, calibrated/equivalent air speed)
	2) Explain the use of various speeds in ATM	2	
3.3.7 Radio Navigation Aids			
1. NDB	1) Explain the purpose and working principles of NDB	2	General history Ground base equipment
	2) Describe, with an overall schematic, the function and performance of NDB	2	Frequency, identification, antenna, range, location of station, photo
	3) Describe the precision and limitations of NDB	2	Operational use
	4) Explain, with the help of an aeronautical chart, the significance of the NDB data	2	Maps, identifier, frequency, co-ordinates, orientation, NDB symbol. Example for one of your NDB
	5) Describe the aircraft equipment using NDB	2	Example of an aircraft system implementation, photo of cockpit (Boeing, airbus....)
	6) List the different operational uses of NDB	1	Basic orientation, example of procedure and aeronautical chart

Topic	Intermediate Objectives The students should be able to	Level	Content
2. VOR	1) Explain the purpose and principles of VOR	2	Ground based equipment, principle, function, location, photo
	2) Describe, with an overall schematic, the function and performance of VOR	2	Frequency, identification, antenna, range
	3) Describe the principle of the conventional VOR	2	Description of VOR, electronics, frequencies, antennas, phases, identification, modulation
	4) Describe the principle of the Doppler VOR	2	D-VOR, electronics, frequencies, antennas, phases, identification, modulation
	5) Explain, with the help of an aeronautical chart, the significance of the VOR data	2	Maps, identifier, frequency, co-ordinates, orientation, VOR symbol. Example for one of your VORs on MAP
	6) Describe the precision and limitations of VOR	2	Range, precision, operational use, precision, coverage, service volume (high altitude, low altitude, terminal)
	7) Describe the aircraft equipment to use VOR	2	On board equipment, RNAV, example of an aircraft system implementation, photo of cockpit (Boeing, airbus....)
	8) Explain the working principle and operational use of on board systems	2	Basic orientation, example of procedure and aeronautical chart, OBI, angular deviation, course deviation
	9) Describe the principle of TACAN	2	Procedure
3. DME	1) Explain the principle and purpose of DME	2	Ground based equipment, definition, principle of measuring distance, ground station, on board system
	2) Describe with an overall schematic the function and performance of DME	2	Electronics, frequencies, antennas, phases, identification, modulation
	3) Describe the different parts of a DME	2	Pulse length, pulse coding, messages, identification, timing, decoder.... Visit, photo
	4) Explain with the help of an aeronautical chart the significance of the DME data	2	Maps, identifier, frequency, co-ordinates, orientation, DME symbol. Example for one of your DME
	5) Explain the working principle and operational use of on board systems	2	Pilot display, system implementation (photo of instrument), example of procedure and aeronautical chart
	6) Explain the precision and limitation of DME	2	Display distance (slant range), number of aircraft