Doc 7192
AN/857

Training Manual

Part E-2
Air Traffic Safety Electronics Personnel (ATSEP)

Approved by the Secretary General and published under his authority

First Edition — 2011

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Published in separate English, French, Russian and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 University Street, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

First edition. 2011

Doc 7192, *Training Manual*
Part E-2, *Air Traffic Safety Electronics Personnel (ATSEP)*

Order Number: 7192E2
ISBN 978-92-9231-708-9

AMENDMENTS

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

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA		
No.	Date	Entered by

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FOREWORD

During the 30th Assembly of the International Federation of Air Traffic Safety Electronics Associations (IFATSEA), which was held in Montréal in 2000, an exchange of views between members of the International Civil Aviation Organization's (ICAO) Air Navigation Commission, the ICAO Secretariat and members of the IFATSEA highlighted the fact that personnel involved in the maintenance and installation of Communication, Navigation and Surveillance/Air Traffic Management (CNS/ATM) systems were trained to differing standards. Some States had implemented a comprehensive programme of training, certification, and in some cases, 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, 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 a new Part of the ICAO *Training Manual* to address the training requirements for this technical group of personnel which is recognized as Air Traffic Safety Electronics 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 associated manuals as well as with the training required for these systems.

The constant evolution of 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 as generic as possible to provide the flexibility needed to address future systems and 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's *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.

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:

The Secretary General
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Montréal, Quebec, H3C 5H7
Canada

DEFINITIONS

Air traffic management. The dynamic, integrated management of air traffic and airspace (including air traffic services, airspace management and air traffic flow management) — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.

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 a component part of the trainees' required performance that is described in the intermediate objectives. 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. 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 information stored in the student's mind that can be retrieved when necessary, and the understanding of concepts and performances. Knowledge is a component part of the trainees' expected performance described in the intermediate objectives.

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 or 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 a component part of the expected trainees' performance that is described in the intermediate objective.

System. In this context, one or more types of electronic equipment and ancillary devices functioning to provide a service.

System and equipment rating training. System and equipment knowledge, attitude and skills leading to recognized competency.

Terminal objectives. What a trainee is expected to accomplish upon completion of training. For example, "when the trainee completes training, he[1] will be able to troubleshoot and repair a piece of XYZ equipment in twenty 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.

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

GLOSSARY

2DRMS	2 distances root mean square
2F	2 frequency

A

AAIM	Aircraft autonomous integrity monitoring
ABAS	Aircraft based augmentation system
ABI	Advance boundary information
ACARS	Aircraft communications addressing and reporting system
ACAS	Airborne collision avoidance system
ACC	Area control centre
ACT	ACTivation (OLDI message)
ACT	Activation message designator
A/D	Analog-to-digital
ADF	Automatic direction finding system
ADS	Automatic dependent surveillance
ADS-B	Automatic dependent surveillance — Broadcast
ADS-C	Automatic dependent surveillance — Contract
AE	Antenna
AFTN	Aeronautical fixed telecommunications network
AGC	Automatic gain control
AIC	Aeronautical information circular
AIP	Aeronautical information publication
AIRAC	Aeronautical information regulation and control
AIRMET	Information concerning en-route weather phenomena which may affect the safety of low-level aircraft operations
AIS	Aeronautical information services
ALARP	As low as reasonably possible
ALRS	Alerting service
AM	Amplitude modulation
AM MSK	Amplitude modulation minimum shift keying
AMSS	Aeronautical mobile satellite service (or system)
AMSS	Automatic message switching system
ANS	Air navigation services
ANSP	Air navigation service provider
APP	Approach
ARINC	Aeronautical Radio Incorporated
ARTAS	ATC radar tracker and server
ASAS	Airborne separation assurance system
ASM	Airspace management
ASM	Airspace system management
ASR	Airport surveillance radar
ASTERIX	All purpose structured Eurocontrol radar information exchange
ATC	Air traffic control

ATCO	Air traffic controller/Air traffic control officer (US/UK)
ATFM	Air traffic flow management
ATIS	Automatic terminal information service
ATM	Air traffic management
ATN	Aeronautical telecommunication network
ATS	Air traffic services
ATS QSIG	Standard for ATC G/G voice communications
ATSEP	Air traffic safety electronics personnel
ATSO	Air traffic service operator

B

BER	Bite error rate
BITE	Built-in test equipment
BIX	Byte information exchange
B-RNAV	Basic area navigation

C

CAA	Civil Aviation Administration (Authority)
CB	Cumulonimbus
CBA	Cost/benefit analysis
CCITT	Comité consultatif international télégraphique et téléphonique
CDI	Course deviation indicator
CDTI	Cockpit display of traffic information
CDU	Control and display unit
CEP	Circular error probable
CFMU	Central flow management unit
CIDIN	Common ICAO data interchange network
CISM	Critical incident stress management
CMS	Central message switch
CNS	Communications, navigation and surveillance
CNS/ATM	Communication, navigation and surveillance/Air traffic management
COM	Communications
CORBA	Common object request broker architecture
COTS	Commercial off-the-shelf equipment
CPDLC	Controller-pilot data link communications
CRT	Cathode ray tube
CSU	Control sector unit
CTR	Controlled zone
CVFR	Controlled VFR
CVOR	Conventional very high frequency omni range

D

DAIW	Danger area infringement warning
DDF	Doppler direction finder
DDM	Data display monitor
DF	Direction finding

DGPS	Differential global positioning system
DIS	Director(ate) infrastructure, ATC systems and support (EUROCONTROL Headquarters, SDE)
DL	Data link
DLC	Data link communication
DME	Distance measuring equipment
DME/N	DME/Normal
DME/P	Precise DME
DP	Data processing
DPC	Data processing chain
DRC	Dynamic route change
DSP	Domain specific part
DTMF	Dual tone multi-frequency
DTU	Data terminal unit
DVOR	Doppler very high frequency omni range (Doppler VOR)

E

E1	Digital channel 64-kbps for voice or data
EAD	European AIS database or European aeronautical database
EATCHIP	European Air Traffic Control Harmonization and Integration Programme (now EATMP)
EATMP	European Air Traffic Management Programme (formerly EATCHIP)
ECAC	European Civil Aviation Conference
EDP	Electronic data processing
EGNOS	European global navigation overlay service
EGPWS	Enhanced ground proximity warning system
EHT	Extremely high tension
EJB	Enterprise java beans
ELT	Emergency locator transmitter
EMI	Electromagnetic interference
ENP	Environment data processing
EOIG	EGNOS operators and infrastructure group (Investor group)
ESARR	Eurocontrol safety regulatory requirements
ESD	Electrostatic discharge
ESDS	Electrostatic discharge sensitive
ESTB	EGNOS system test bed
ET	Executive task (EATCHIP)
ETG	European GNSS tripartite group
EU	European Union
EUROCONTROL	European Organization for the Safety of Air Navigation

F

FAA	Federal Aviation Administration
FANS	Future air navigation systems
FAT	Factory acceptance test
FDDI	Fibre distributed data interface
FDP	Flight data processing
FDPS	Flight data processing system

FFM	Far field monitor
FIC	Flight information centre
FIR	Flight information region
FIS	Flight information service
FMS	Flight management system
FoM	Figure of merit
FPL	(Filed) Flight plan
FRUIT	False replies unsynchronized in time
FSS	Fixed satellite services
FSS	Flight service station

G

G/G	Ground/ground
GAMET	Area forecast for low-level flights
GBAS	Ground based augmentation system
GLONASS	Global orbiting navigation satellite system
GNSS	Global navigation satellite system
GPS	Global positioning system
GPWS	Ground proximity warning system
GRAS	GPS (or GNSS) regional augmentation system
GS	Glideslope
GS	Ground speed

H

HCM	High capacity multiplexing
HCP	Hard copy printer
HDL	High frequency data link
HDLC	High level data link communication
HF	Human Factors
HF	High frequency
HHI	Human human interface
HIS	Horizontal situation indicator
HMI	Human machine interface
HRS	Human resources programme (EATMP, HUM)
HRT	Human resources team (EACHIP/EATMP, HUM)
HSI	Horizontal situation indicator
HUM	Human Factors
HUM	Human resources (Domain) (EATCHIP/EATMP)
HUM Unit	Human Factors and Manpower Unit (EUROCONTROL Headquarters, SDE, DIS; formerly know as the “ATM Human Resources Unit”; also known as DIS/HUM)
HV	High voltage
HW	Hardware
Hz	Hertz

I

IACA	International Air Carrier Association
IANS	Institute of Air Navigation Services (EUROCONTROL, Luxembourg)
IAOPA	International Council of Aircraft Owner and Pilot Associations
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IDF	Instantaneous direction finding
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronic Engineers
IF	Intermediate fix
IF	Intermediate frequency
IFALPA	International Federation of Air Line Pilot Association
IFATCA	International Federation of Air Traffic Controller Association
IFATSEA	International Federation of Air Traffic Safety Electronics Associations
IFPS	Integrated initial flight plan processing system
IFPS	Interactive flight plan service
IFR	Instrument flight rules
II codes	Interrogator identifier code
IISLS	Improved interrogate sidelobe suppression
ILS	Instrument landing system
INS	Inertial navigation system
IP	Internet protocol
I/Q	In-phase and quadrature channels
ISA	International standard atmosphere
ISDN	Integrated services digital network
ISLS	Interrogation side lobe suppression
ISO	International Standards Organization
ITU	International Telecommunication Union

J

JAA	Joint Aviation Authorities

K

Kb	Kilo byte
Kbps	Kilobits per second

L

L	Locator
LAM	Logical acknowledgement message
LAN	Local area network
LAPB	Link access procedure
LCD	Liquid crystal display
LF	Low frequency (30 to 300 kHz)

LNTA	Low noise transistor amplifier
LOC	Localizer
LRM	Lowest replaceable module
LRU	Line (or lowest) replaceable unit
LVA	Large vertical aperture

M

MAC	MAC address (Hardware address of device)
MAC	Medium access control
MASPS	Minimum aircraft systems performance specifications
MDS	Minimum detectable signal
METAR	Meteorological aerodrome report
MFC	Multi-frequency coding
MHz	Megahertz
MIB	Management information base
MIME	Multipurpose Internet mail extension
min.	Minute
MLS	Microwave landing system
MLT	Multilateration
MM	Middle marker
MMEL	Master minimum equipment lists
MMR	Multi-mode receiver
MMS	Maintenance management system
MODEM	Modulator demodulator
MODEM	Multiplexer/demultiplexer
Mode S	Mode select
MOPS	Minimum operational performance standards (or specifications) FAA
MOTNE	Meteorological operational telecommunications network Europe
MSAS	MTSAT satellite based augmentation system
MSAS	Multi-functional transport satellite augmentation system
MSAW	Minimum safe altitude warning
MSS	Mobile satellite service
MSSR	Monopulse secondary surveillance radar
MTBF	Mean time between failure
MTCA	Medium term conflict alert
MTD	Moving target detection
MTI	Moving target indicator
MTSAT	Multi-functional transport satellite

N

NAV	Navigation
NAVAID	Navigation(al) aid
ND	Navigation display, Network digit
NDB	Non directional beacon
N-ISDN	Narrow and integrated services digital network
NOTAM	Notice to Airmen

O

OBI	On board indicator
OCM	Oceanic clearance message
OJI	On-the-job instructor
OJM	On-the-job mentor
OJT	On-the-job-training
OJTI	On-the-job training instructor
OLDI	On-line data interchange
OM	Outer marker
OS	Operating system
OSI	Open system interconnection
OTM	Overall transaction manager

P

PABX	Private automatic branch exchange
PAC	Pre-activation message
PANS	Procedures for air navigation services
PAPI	Precision approach path indicator
PAR	Precision approach radar
PC	Personal computer
PCB	Printed circuit board (to be confirmed by originator)
PCM	Pulse code modulation
PCU	Power control unit
PDC	Pre-departure clearance
PD WRT	Probability of detection. With respect to
PFD	Planned flight data
PFD	Probability of failure
PFD	Primary flight display
POP	Proof of performance
PPI	Plan position indicator
PRF	Pulse repetition frequency
PRF-FRUIT	Pulse repetition frequency – false replies unsynchronized in time
PRI	Pulse repetition interval
P-RNAV	Precision area navigation
PSD	Phase sensitive detector
PSR	Primary surveillance radar
PTE	POEMS test environment
PTT	Post, telephone and telegraph

Q

QFE	Pressure at the airport
QFF	Corresponding pressure at sea level
QNE	Pressure at any level higher than sea level
QNH	Pressure reduced to mean sea level
QoS	Quality of Service
QSIG	Symmetrical adaptation of N-ISDN signalling

R

RA	Resolution advisory
RADAR	Radio detection and ranging
RADNET	Radar network (Benelux-Germany)
RAIM	Receiver autonomous integrity monitoring
RAPNET	Regional aeronautical packet switched network
RCA	Remote client access
RCC	Rescue coordination centre
RCMS	Remote control and monitoring system
RCP	Required communication performance
RDPS	Radar data processing system
REC	Receive or receiver
RES	Radar environment simulator
RF	Radio frequency, Radius to a fix (ARINC 424 path terminator)
RF/IF	Radius to a fix (ARINC 424 path terminator)
RGP	Required global performance
RMCDE	Radar message conversion and distribution equipment
RMI	Radio magnetic indicator
RMS	Root mean square
RNAV	Area navigation
RNP	Required navigation performance
RSLS	Receiver side lobe suppression
RSP	Required surveillance performance
RTF	Radiotelephone or radiotelephony
RUP	Rational unified process
RVR	Runway visual range
RVSM	Reduced vertical separation minimum
RX	Receiver station

S

SA	Selective availability
SADIS	Satellite distribution of world area forecast system
SARPS	Standards and Recommended Practices (ICAO)
SASS	Surveillance analysis support system
SASS-C	Surveillance analysis support system — Centre
SASS-S	Surveillance analysis support system — Sensor
SAT	Site acceptance test
SATCOM	Satellite communications
SBAS	Space/Satellite based augmentation system
SDD	Synthetic data display
SDE	Senior Director, Principal EATMP Directorate or, in short, Senior Director(ate) EATMP (EUROCONTROL Headquarters)
SDM	System definition manual
SDPS	Surveillance data processing system (ICAO)
SEP	Spherical error probable
SID	Standard instrument departure (Route)

SIGMET	Significant meteorological information
SIS	Signal in space
SITA	Société Internationale de Télécommunications Aéronautiques (F)
SLS	Side lob suppression
SMC	System monitoring and control
SMC	System monitoring and computer/control
SMGCS	Surface movement guidance and control system
SMR	Surface movement radar
S/N	Signal to noise ratio
SNMP	Simple network management protocol
SPECI	Aeronautical special meteorological report
SPI	Special position indicator
SPI	Special pulse (Position) identification (SSR)
SRA	Surveillance radar approach
SRAM	Safety regulation commission (EUROCONTROL)
SSR	Secondary surveillance radar
STC	Sensitivity time control
STCA	Short term conflict alert
SUP	Supervisor
SW	Software
SWC	Significant weather chart (also TEMSI)
SWR	Standing waves ratio

T

TA	Traffic advisory
TACAN	UHF tactical air navigation aid
TAF	Terminal area forecast
TCAS	Traffic alert and collision avoidance system
TCAS	Transponder collision avoidance system
TCP	Transmission control protocol
TCP/IP	Transmission control protocol/Internet protocol
TDG	Training development guideline
TDH Unit	Training Development and Harmonization Unit (EUROCONTROL, IANS)
TDM	Time division multiplex
TEMSI	Significant weather chart (mostly for Europe)
TFCCC	Task force common core content (EATCHIP, HUM, HRT, TSG)
TFI	Technical flight inspector
TL	Transition level
TLS	Target level of safety
TMA	Terminal area
TMG	Training management guideline
TOS	Taux d’onde stationnaire (Standing wave ratio)
TRM	Team resource management
TRSB	Time reference scanning beam
TSG	Training sub-group (EATCHIP/EATMP, HUM, HRT)
TSP	Training sub-programme (EATMP, HUM, HRS)
TSRB	Time reference scanning beam
TTTF	Time to first fix
TWR	Tower
TX	Transmitter

U

UAT	Universal access transceiver
UBSS	Unix basic system software
UDP	User datagram protocol
UHF	Ultra high frequency (300 to 3 000 Mhz)
UML	Unified modeling language
UPS	Uninterrupted power supply
UTC	Universal time coordinate

V

VASIS	Visual approach slope indicator system
VCS	Voice communication system
VDF	VHF direction finding station
VDL	VHF digital/data link
VFR	Visual flight rules
VHF	Very high frequency (30 to 300 Mhz)
VOLMET	Meteorological information for aircraft in flight
VOR	VHF omni-directional radio range
VORTAC	VOR and TACAN combination
VSP	Variable system parameter
VSWR	Voltage standing wave ratio

W

WAAS	Wide area augmentation system (USA)
WAN	Wide area network
WGS	World geodetic system
WGS84	World geodetic standard 1984
WRT	With respect to

X

X25	Packet switched data network protocol

Chapter 1

TRAINING PRINCIPLES

1.1 REGULATORY REQUIREMENTS

1.1.1 A Contracting State, or the organization authorized by the State authority providing CNS/ATM services, should establish methods for determining job competencies. All personnel directly engaged in operation, maintenance and installation activities of CNS/ATM systems should be qualified for their job functions. Air Traffic Safety Electronics Personnel (ATSEP) is the ICAO-recognized terminology for personnel involved in the operation, maintenance and installation of a CNS/ATM system.

1.1.2 State regulatory norms should define the requirements with respect to age, knowledge, experience, skill and attitude which determine ATSEP competency. Chapter 4 of ICAO Annex 1 — *Personnel Licensing*, however, contains Standards for other personnel, and States should consult them when establishing their requirements.

1.1.3 The successful application of regulations concerning the safety and regularity of CNS/ATM systems operation and the achievement of regulatory objectives depend on the appreciation by all individuals concerned of the risks involved and on a detailed understanding of the regulations. This can be achieved only by properly planned and maintained basic training, qualification training and recurrent training programmes for all persons involved. ATSEP play 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

1.2.1.1 The principal duties of the ATSEP are:

a) maintenance of CNS/ATM systems and equipment which includes:

1) calibration of flight and ground radio navigation aids;

2) certification of CNS/ATM systems and equipment;

3) modification of operational CNS/ATM equipment;

4) corrective maintenance; and

5) preventive maintenance;

b) installation of CNS/ATM systems and equipment;

c) management, monitoring and control of operational CNS/ATM systems and equipment; and

d) development, review and modification of CNS/ATM systems and equipment, and maintenance procedures and standards.

1.2.1.2 ATSEP work on a variety of CNS/ATM systems and equipment, and this requires a wide range of expertise. Training will be directed toward the specific work requirement assigned to a specific group or category of ATSEP.

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 Air Navigation Services (ANS) provider to ANS provider. It varies from the complex level, where the ATSEP could be considered the brain of the ANS, to a position of limited importance. In the former case, the ATSEP is normally required to be licensed or proved to be trained and competent to certify CNS/ATM systems and equipment, while in the latter case, the ATSEP's duties may be limited to clerical assistance only. With the widespread introduction of technologies, there is a marked tendency for States and ANS providers to make increased use of ATSEP, giving them extensive duties and responsibilities. These include:

a) carrying out technical duties related to developmental work concerning the electromechanical, electronic and computerized equipment of air navigation systems, and the testing of prototypes;

b) providing technical support in the design and layout of specific interface circuitry for air navigation and aircraft detection tracking systems;

c) preparing or contributing to cost estimates and 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 and 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 and 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 systems or equipment to ensure maximum accuracy and safety of flight, take-off and landing operations;

k) certifying CNS/ATM systems and equipment; and

l) providing technical training.

1.2.3 Minimum entry qualifications

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

a) a minimum educational level of successful completion of secondary school;

b) a minimum of 1 600 hours of post-secondary, college or military education, specialized in electronic technology; and

c) a minimum of twenty years of age.

1.2.4 ATSEP training concept

In order to cover the various backgrounds of trainees and to ensure training standardization 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. Various applications have been identified that apply to the five corresponding discipline qualifications of communication, navigation, surveillance, data processing and power supply.

System and equipment rating training (also referred to as "Specific training"): System and equipment knowledge and skills leading to recognized competency.

It also includes 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 called "recurrent training".

Refresher training. Designed to review, reinforce or upgrade existing knowledge and skills, including team skills.

Emergency training. Includes training in emergencies, in unusual situations and in degraded systems. Most of this training will be site specific or may make use of incident or accident analysis.

Unusual situations may be described as:

1) serious, unexpected, and often dangerous situations, 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) the result of a system failure or malfunction.

Conversion 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 or engineering technologist, or any other career development.

1.2.5 Phase one basic training

1.2.5.1 The training objectives in 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.

1.2.5.2 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.

1.2.5.3 To undertake the duties and responsibilities described above, ATSEP must be appropriately trained in all the subjects required to ensure that every link of the safety chain is solid. As technical specialists, ATSEP need to demonstrate a high level of responsibility and 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 who lack the necessary qualities.

1.2.5.4 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 technical environment related to ATSEP duties and all the safety aspects of civil aviation.

1.2.5.5 Trainees who do not have previous aviation experience will have to undergo the complete training programme as recommended in phase one basic training. Trainees who have had suitable aviation experience may not need to undertake this complete programme. 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 he has 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 ATSEP duties. The same flexibility can also be applied during continuation or recurrent training.

1.2.5.6 Table 1-1 provides a listing of the subjects contained in phase one basic training. In using the curriculum recommended in the following chapters, local considerations may dictate 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 and 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 programme 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.

1.2.5.7 Paragraph 1.2.5.8 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 air traffic control (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.

1.2.5.8 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.

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

Table 1-1. Subjects covered in phase one basic training

Subject matter
Chapter 3.1 – International and national organizations and standards
Chapter 3.2 – Familiarization with air traffic services, airspace standards, meteorology and altimetry
Chapter 3.3 – Familiarization with CNS/ATM concepts

1.2.6 Phase two qualification training

1.2.6.1 Following the completion of phase one basic training, the ATSEP will require specialized qualification training in a discipline such as: communications, navigational aids (Navaids), surveillance, data processing or power supply. 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.

1.2.6.2 The phase two qualification training will provide the ATSEP with in-depth knowledge of and the appropriate skills needed in the CNS/ATM discipline to be pursued. It provides job-category-related knowledge and skills appropriate to the discipline to be pursued in the CNS/ATM environment. Various applications have been identified that apply to the five corresponding discipline qualifications of communication, navigation, surveillance, data processing and power supply.

1.2.6.3 The knowledge, skills and attitude gained in the phase two qualification training are needed for the third phase the system or equipment rating training that is specific to the equipment or system.

1.2.6.4 Each discipline in the phase two qualification training has been developed in a separate multi-part chapter. While the content elements of each chapter are generic, this does not prevent the State organization from including examples to illustrate real-life situations or to use systems and equipment that are available to enhance the learning activities.

1.2.6.5 Table 1-2 provides a listing of the subjects contained in phase two qualification training. 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 or 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 and systems are covered for each discipline.

Table 1-2. Subjects covered in phase two qualification training

Subject matter
Chapter 5 – Communication systems
Chapter 6 – Radio navigation aids

Chapter 7 – Surveillance
Chapter 8 – Data processing training demand
Chapter 9 – Power supply
Chapter 10 – System safety training

1.2.7 Phase three specific training

1.2.7.1 The phase three specific training focuses on a specific area of training or on specific ATSEP functions. This phase is the final stage for ensuring ATSEP competency. It provides system and equipment knowledge and skills leading to recognized competency. It also includes 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.

1.2.7.2 The knowledge, skills and attitude gained in the phase two qualification training in areas such as communication, NavAids, surveillance, data processing and power supply are needed for the third phase, the system or equipment rating training that is specific to the equipment or system.

1.2.7.3 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 and equipment certification programmes are not defined here, however, this training is a prerequisite to certification.

Table 1-3. Subjects covered in phase three specific training

Subject matter
Chapter 11 – System or equipment rating training
Chapter 12 – Continuation training
Chapter 13 – Developmental training
Chapter 14 – Human Factors

1.2.8 Continuation training

Continuation training is designed to augment the existing knowledge and skills. This could be done in a number of ways such as: refresher training which reviews or reinforces existing knowledge and skills; emergency training which includes training for unusual, and often dangerous, situations; unusual situation training which is provided to deal with a set of circumstances which are neither habitually nor commonly experienced; degraded system training which is provided to deal with a situation that is the result of a system failure or malfunction; and conversion training which provides the knowledge and skills appropriate to a change in a job category or to a new discipline or new procedure.

1.2.9 Developmental training

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.

1.2.10 Standard of accomplishment

1.2.10.1 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.

1.2.10.2 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.

1.2.10.3 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 or 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.

1.2.11 Examination database

1.2.11.1 Where possible, States or 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 the ATSEPs' knowledge and skills.

1.2.11.2 A model answer should give the instructor enough information to establish how closely the trainee masters the tested material. 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.

1.2.12 Training reference guide

1.2.12.1 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 required to perform a clear demonstration of a desired level of accomplishment.

1.2.12.2 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 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 analyse 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.

1.2.12.3 As mentioned earlier, there is 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 ATM/airspace structure of the State. The duration will also depend on many other factors such as: the availability and the number of equipment 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. It can be appreciated that identifying course duration without looking at the specific criteria of the State would be misleading and unrealistic.

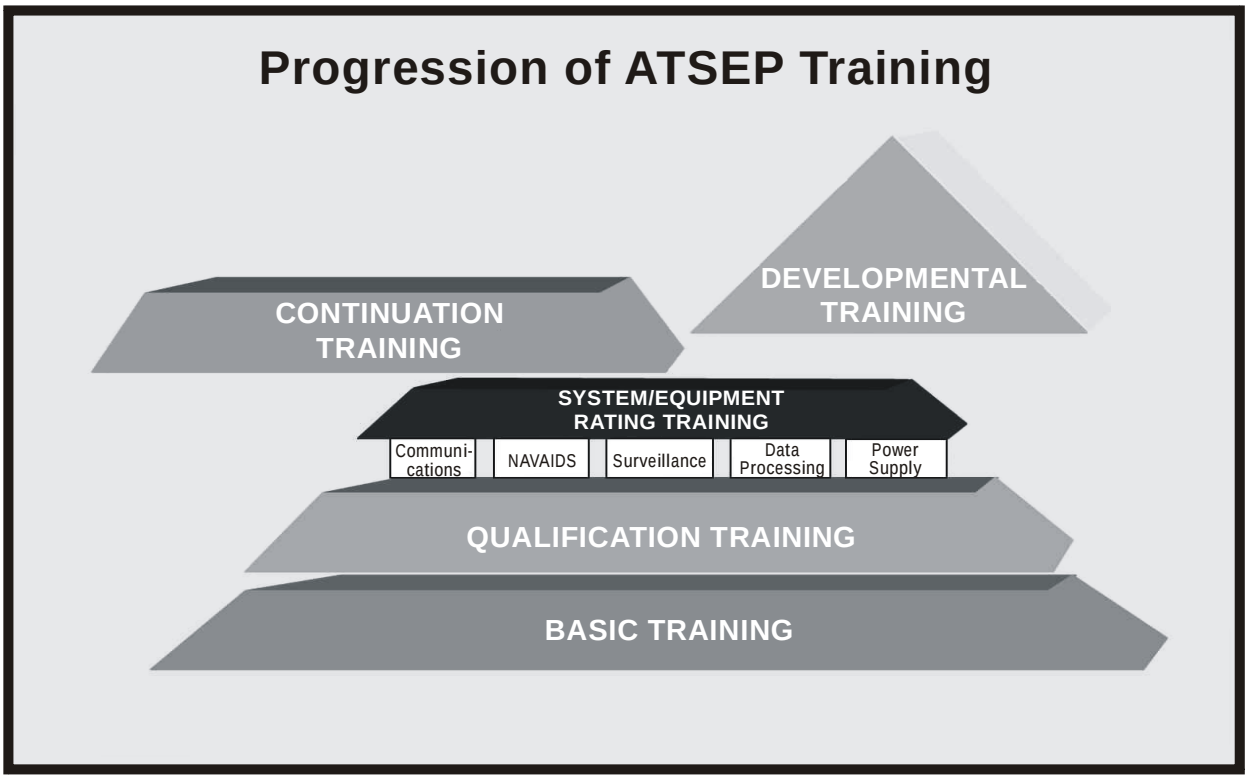

Figure 1. Progression of ATSEP training

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, among other things, training support functions, training delivery, administrative support functions, and the planning and design of training facilities. A second manual, the *TRAINAIR Training Development Guideline (TDG),* details the development methodologies of training courses for aviation personnel and provides guidelines on validation, revision and implementation of courseware, training techniques, design of tests, post-training evaluation, etc. 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, while the majority of the material included in both manuals may not be directly applied to the training of ATSEP, 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

2.1.2.1 Opinions differ on how much classroom space is 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 may 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 ratio of trainees to instructor required to achieve efficient and good quality training depends on the mode of delivery (individualized or group-paced) and the training techniques used (lesson/demonstration mediated lecture, group discussions, small group discussions, case studies, role play, supervised practice, etc.). Labs require group and individualized supervision and control that does not allow having more than 10 to 14 trainees for two instructors. This ratio may be also used for group-paced training when the trainees need a large number of reference materials and the training includes several training techniques.

2.1.2.2 The use of media and hands-on experiments and the number of 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. Room size has a considerable impact on the effectiveness of projected media (slides, overheads, television, etc.) and should be taken into consideration when assigning classrooms.

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

2.1.2.4 Trainee workstation space includes the trainee's work surface, additional equipment (computer 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. 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.

2.1.2.5 Computers are also useful training aids for ATSEP. Used as instructional media, computers usually are desktop models 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

2.1.3.1 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.

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 the comfort of workstations, which includes chair comfort.

2.2 PERFORMANCE EVALUATION (TESTING)

2.2.1 Performance evaluation (testing) is an integral part of the training process. For the trainee, testing provides incentive and motivation, and it confirms learning. From the instructor's point of view, testing confirms that the objectives have been met and indicates 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 of incorrect 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 the trainees have understood and assimilated, at the desired level, the material taught.

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

2.2.2.2 Knowledge is best tested by oral or written tests.

2.2.2.3 Attitudes are the feelings and opinions concerning the job, and other people, as well as personal conduct and responsibility. They are best tested by observation of performance, or by means of questionnaires.

2.2.3 There are no terminal objectives in this manual, because terminal objectives refer to specific tasks, and these can vary substantially between 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 AND 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. Internationally, ICAO, pursuant to the provisions of Article 37 of the Convention on International Civil Aviation, develops and adopts Standards and Recommended Practices (SARPs, contained in the 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 worldwide. Among these organizations are ICAO, the European Civil Aviation Conference (ECAC), Joint Aviation Authorities (JAA), and the Institute of Electrical and Electronic Engineers (IEEE). Achievement of safety and efficiency in air navigation operations requires that all States accept and implement a common standard for air navigation service with regard to training, licensing, certification, etc. The standardization of operational practices for international services is of fundamental importance for the prevention of costly errors, which may result from misunderstanding or inexperience. Although this manual and other ICAO manuals address international ATSEP training, the need for standardization 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

3.1.2.1 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; and

c) the standard of accomplishment.

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

3.1.2.2 This sub-section includes five parts:

Introduction;
International and national organizations and standards;
Working positions and environment;
Environmental protection;
Personal safety.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
3.1 International and 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 recommendations.	2	PANS, SARPS, FANS, ICAO Annexes 2 and 10.
2. International Standards and Recommended Practices	1) Demonstrate an awareness of ATM engineering standards and practices.	2	ICAO Annexes 1 and 10. ICAO Doc 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 at location.
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, etc.
4. Aviation associations	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	Harmonization, flow management, bilateral agreement, sharing of radar data, or other information. ICAO. ECAC. Harmonization programme 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-AI RAC. 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 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-ionizing 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 radioactive element).
	4) State any applicable legal requirements.	1	Procedures in use, company rules, national rules.

3.2 FAMILIARIZATION WITH AIR TRAFFIC SERVICES, AIRSPACE STANDARDS, METEOROLOGY AND ALTIMETRY

3.2.1 Introduction

3.2.1.1 The ATSEP are performing several critical tasks on CNS/ATM systems or equipment which could have an 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 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.

3.2.1.2 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 radio frequencies. They also must have a good appreciation of altimetry, height, altitude and flight level.

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

3.2.2 Training objectives

3.2.2.1 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.

Performance: The trainee will be able to describe:

a) the role of the national ATM services, clients and customers;

b) the importance of separation standards and collision avoidance; and

c) the importance of meteorology and altimetry, and how they can affect operations.

Standard of accomplishment: All the descriptions should include the essential points of the given situation.

3.2.2.2 This sub-section includes eight parts:

Airspace users and customer relations;
Air traffic management;
Separation standards and collision avoidance;
Meteorology, altimeter and level allocation;
Atmosphere and atmospheric processes;
Meteorological phenomenal and codification;
Meteorology tools and equipment; and
Altimetry and operational aspects.

Topic		*Intermediate Objectives. The students should be able to:*		*Level*	*Content*
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	
		2)	Recognize the means by which ATM is funded.	1	System of funding, en route charge, landing charge, system of clearing (EUROCONTROL)

Topic		*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
3.2.2	**Air traffic management**			
1.	Terminology and units of measurement	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 Annex 11. AIP, national services.
		2) Explain the division of ATM services.	2	IFR, VFR, CVFR, civil, military.
		3) Demonstrate an awareness of airspace organization and associated concepts.	2	Airways within national boundaries, TMA, CTR.
		4) Describe the functions and services provided by ATC and the different ATC tasks.	2	ICAO Annex 11.
		5) Describe the sectorization.	2	Principle of sectorization, logical sectors, physical sectors.
		6) Describe the data displayed on the screen.	2	Radar track, SSR code, labels, maps. See a controller position screen. Flight information region, area control centre, terminal manoeuvring area, APP, TWR.
		7) Describe the function of ground control.	2	
		8) Describe the function of tower control.	2	
		9) Describe the function of approach control.	2	The task of ACC, approach, tower and oceanic control.
		10) Describe en-route control.	2	
		11) Describe the transfer of control.	2	
3.	Flight information service (FIS)	1) Define FIS.	1	ICAO Annex 11, AIP.
		2) Define the scope of the FIS.	1	National organization, FIC.
		3) Explain the responsibility for the provision of FIS.	2	ATIS, VOLMET, RTF, data link.
		4) State the methods of transmitting information.	1	

Topic		Intermediate Objectives. The students should be able to:		Level	Content
		5)	Issue information to aircraft.	3	State of Navaids, weather, flight safety information, NOTAM.
4.	Alerting service (ALRS)	1)	Define ALRS.	1	ICAO Annex 11.
		2)	Define the scope of the ALRS.	1	
		3)	Differentiate between phases of emergency, and between distress and urgency signals.	2	Uncertainty, alert, distress, mayday, pan, visual signals. Responsibilities. Local organization.
5.	Air traffic flow management (AFTM)	1)	Define ATFM.	1	Flow control, Integrated Initial Flight Plan Processing System (IFPS), Central Flow Management Unit (CFMU), slot, national organization and interface.
		2)	Describe the scope of ATFM.	2	Fields of the flight plan and their uses.
		3)	Demonstrate an awareness of the content of a flight plan and state the different fields.	2	Exchanges between centres, OLDI messages, estimated times.
		4)	Explain the life cycle of a flight plan.	2	
		5)	Explain the responsibility for the provision of ATFM.	2	Database, 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 Annex 15. CAA, military.
		2)	Define the methods by which the legislation is notified and implemented.	1	ICAO Annex 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 Annex 15.
		4)	Describe the AIP.	2	ICAO Annex 11. Data contents of AIP, SUP, AIC. Types of publication (AIRAC, NON-AIRAC), data collection and preparation and data format, distribution channels.

Topic		*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
		5) Define the aeronautical charting service.	1	ICAO Annex 4. Types of charts, operational use and distribution channel.
		6) Define the AIRAC and the AIC.	1	
7.	Airspace management (ASM)	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.
		2) Describe the emergency procedure in case of equipment failure.	2	Responsibilities, restriction, emergency procedure.
10.	Coordination	1) Explain the principle of coordination and transfer.	2	Notification, negotiation, agreement, transfer of flight data, local agreements, bilateral agreements between countries.
		2) Appreciate the need for coordination.	3	
		3) Describe the means of coordination	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.

Topic		Intermediate Objectives. The students should be able to:		Level	Content
3.	Visual and geographic separation	1)	State the occasions when visual separation can be used.	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
		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.
		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. Coordination 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	

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
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 the ATC environment.	2	
	2) Explain how technical systems contribute to ATC operations.	2	
	3) Describe the function and the performance of the weather measurement systems.	2	From the operational point of view.
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 frontal systems	1) State the origin and general location of typical air masses.	1	Polar, arctic, equatorial, maritime and continental.
	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.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
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.
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.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	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, RVR, barometers, ceilometer
	2) Explain the technical principle of each piece of equipment and its 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.
4. System in use in your unit	1) Describe, with the help of a block diagram, the system that transmits the meteorological data.	2	Block diagram of the system.

Topic		Intermediate Objectives. The students should be able to:	Level	Content
	2)	Name the ATSEP who are in charge of the system maintenance.	1	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	In flight or ground QFE setting, QNH setting, standard setting, flight level and separation, QNE setting.
	2)	Show the lowest usable flight level with help of a drawing.		
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.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
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

3.3.1.1 Communication, navigation, surveillance and air traffic management systems provide essential tools for the delivery of air navigation services. The ATSEP's 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 controllers) may result in unsafe situations or cause excessive delays in airline operations.

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

3.3.2 Training objective

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

Condition: Provided with a broad outline of the national 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.

3.3.2.2 This sub-section includes twenty-nine parts:

Voice communications;
Air – Ground – Air;
Ground – Ground;
Recording (two groups may be in one topic);
Data Link communications;
Navigation;
Radio navigation aids;
Satellite-based system – GNSS technical overview – Satellite navigation;
Aircraft systems;
Flight inspections;
Surveillance and radars;
Radar;
Surface movement control;
Radar formats;

Automatic dependent surveillance;
Future systems;
Radar station;
Networks;
ATM specific networks;
Data Processing (DP);
Radar data processing;
Flight plan processing;
Display;
On-line and environmental data;
Facilities;
Power supply;
Air conditioning;
Monitoring;
Electromagnetic compatibility.

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
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, sectorization, 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, polarization.
		3) Describe the principles of electromagnetic propagation.	2	

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	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, synthesizer.
	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 service to ATIS, METAR and VOLMET.	2	Data link, ACARS, ARINC 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.

Topic	Intermediate Objectives. The students should be able to	Level	Content
	3) Describe the purpose and principles of operation of the radio switch.	2	Functionality, redundancy, basic operation of routing and switching, sectorization, 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, polarization. Environment.
	8) Describe the tools used for testing equipment.	2	Power meter, TOS measurement, spectrum. Analyser.
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).
	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.

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	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 or Airbus.)
	3)	Describe the antenna systems of an 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, Boeing, 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.
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 and AFTN.	1	Rules, needs, purpose.
	2)	Describe the national and international need for telephone and AFTN 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 operation, function.
	2)	Describe the routing and switching equipment.	2	Functionality, telephone switching, interphone switching, hotline switching.
	3)	Describe the HMI of the current system in use.	2	See function of HMI, visit.
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.

Topic		Intermediate Objectives. The students should be able to	Level	Content
	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, ambiant 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 the 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 on-board and ground architecture.	2	CDU, ACARS MU VHF RGS, network provider, message storage MSS, message routing DSP, on-board 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, 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 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 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	
	2)	Describe the principle and purpose of navigation.	2	
	3)	Characterize the navigation methods.	2	Historical overview, celestial, on board, on ground, radio aids, satellites.

Topic	Intermediate Objectives. The students should be able to	Level	Content
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 time, time zone, UTC.
4. System of coordinates, direction, distance and measurement	1) Explain the principles of the coordinates and the principle of a grid system.	2	e.g. Degrees, minutes, seconds, latitudes, longitudes, international and national references, World Geodesic Standard, WGS-84.
	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 the 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-based 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.

Topic	*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	4) Explain, with the help of an aeronautical chart, the significance of the NDB data.	2	Maps, identifier, frequency, coordinates, orientation, NDB symbol. Example for one of your NDBs.
	5) Describe the aircraft equipment using NDB.	2	Example of an aircraft system implementation, photo of cockpit (e.g. Boeing, Airbus).
	6) List the different operational uses of NDB.	1	Basic orientation, example of procedure and aeronautical chart.
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, coordinates, 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 (e.g. 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.

Topic	Intermediate Objectives. The students should be able to	Level	Content
	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, coordinates, 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.
	7) Explain the purpose of VOR/DME pairing or ILS/DME pairing.	2	VOR/DME pairing, ILS/DME pairing.
4. Landing systems, ILS, MLS	1) Explain the overall principle of ILS and the composition of an ILS system.	2	General, ground and airborne components definition, glide path beam, localizer beams, categories, markers, DME.
	2) Explain with an overall schematic the function and performance of ILS.	2	Electronics, frequencies, antenna array, phasing, identification, modulation, coverage, precision, limitation. Explain the approach categories, accuracy, Cat 1, Cat 2, Cat 3.
	3) Describe the principle of the localizer.	2	TX, antennas, frequencies, form of the beam, show photo of system.
	4) Describe the principle of glide path.	2	TX, antennas, frequencies, form of the beam, glideslope.
	5) Explain the use, precision and limitations of ILS/DME in airports.	2	Equipment, procedure, low visibility procedures, Cat 1, Cat 2, Cat 3, basic ILS orientation, critical area, service volume.
	6) Explain the working principle and operational use of on-board systems.	2	Show, with drawing, the cockpit orientation and on-board equipment.

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	7)	Explain the principle of MARKER.	2	System on board, procedures, ground transmitter, antennas, identification, distances from runway, outer, middle and inner marker. Show, with drawing, the principle, TX, ground equipment, on-board equipment.
	8)	Explain the principle of MLS.	2	Show with drawing, the principle, TX, ground equipment, on-board equipment, frequencies, possibilities, segment.
5. Visual aids	1)	Demonstrate general awareness of visual navigation systems.	0	VASIS, PAPI, rotating beacon.
3.3.8 Satellite-based system – GNSS technical overview – Satellite navigation				
1. Satellite-based system	1)	Demonstrate an awareness of the history of satellite navigation.	2	History.
	2)	Describe the architecture of relevant satellite systems.	2	What is it, general principles.
	3)	Explain the purpose and principle of the GPS.	2	GPS system, space segment, control segment, user segment, GLONASS SYSTEM.
	4)	Describe the function and performance of each system.	2	Function, precision, frequencies, clock.
2. Satellite navigation	1)	Describe the purpose and principle of GNSS.	2	
	2)	Describe the principle of differential implementation.	2	GNSS.
3. GPS technical overview	1)	Demonstrate general awareness of the history of GPS.	0	History.
	2)	Demonstrate general awareness of the principle and performance of GPS.	0	Satellite positioning theory, design principles, performance, current and future status. Triangulating from satellites, measuring distance from satellites, timing importance, knowing where the satellite is in space, selective availability.
4. GLONASS technical overview	1)	Demonstrate general awareness of the history of GLONASS.	0	History.
	2)	Demonstrate general awareness of the principle and performance of GLONASS.	0	Satellite positioning theory, design principle, performance, current and future status.

Topic		Intermediate Objectives. The students should be able to	Level	Content
5.	Systems description	1) Demonstrate general awareness of Airborne Based Augmentation Systems.	0	Requirements, inertial reference, receiver, monitor.
		2) Demonstrate general awareness of Ground Based Augmentation Systems.	0	Requirements, design principle, implementation.
		3) Demonstrate general awareness of Space Based Augmentation Systems.	0	Requirements, design principle, implementation, EGNOS.
		4) Demonstrate general awareness of the future systems.	0	GNSS-2, Galileo, GPS L5.
3.3.9	**Aircraft systems**			
1.	On-board equipment	1) List the on-board equipment.	1	
		2) Explain the working principle and use of on-board system.	2	FMS, navigational computer, ILS, RNAV.
2.	Warning systems	1) Explain the principle and performance of the Airborne Collision Avoidance System.	2	ACAS principle , frequency, radar, communication.
		2) Explain the working principle and use of on-board system.	2	Performance of the systems, GPWS.
3.3.10	**Flight inspections**			
1.	Legislation and procedures	1) Explain the purpose of flight inspection.	2	ICAO recommendation Annex 10, Volume I and Doc 8071.
		2) Demonstrate general awareness of legal requirements, recommendations and procedures.	0	National legislation and procedures.
2.	Navaids inspection	1) Demonstrate general awareness of the procedures for ILS, DME and VOR equipment.	0	Procedure in use locally.
		2) Describe the ground and aircraft equipment.	2	
		3) Demonstrate general awareness of the procedure for communication and radar flight inspection.	0	Procedure in use locally.

Topic	*Intermediate Objectives. The students should be able to*	*Level*	*Content*
3.3.11 Surveillance and RADAR — General			
1. Terminology and units of measurement	1) Describe the units of measurement appropriate to radar.	2	Glossary, range, distance measurement, azimuth, sensitivity, coverage range, cooperative, non cooperative.
2. Purpose and use of surveillance and radar systems	1) Explain the need for surveillance systems in aviation.	2	Historical overview, types of radar, en-route, approach, airport, meteorological.
	2) Describe the basic principles, purpose and operation of the surveillance systems in current use.	2	Radar location, primary radar, secondary radar, coverage, range, distance measurement, azimuth, sensitivity, propagation, safety procedures.
	3) Demonstrate general awareness of future developments.	0	Data link-based.
3.3.12 Radar			
1. Primary radar	1) Explain the working principles of primary surveillance radar.	2	Independent surveillance, non cooperative, emission, reflection, reception of signal, speed of light.
	2) Describe the use of primary radar in ATC.	2	Operational aspects, operational needs for ACC and APP, watch, monitor, vector separation.
	3) Recognize the characteristics of radar wavelengths.	2	High frequencies and microwave technology, frequency bands, polarization, health and safety.
	4) Describe the system evolution and architecture.	2	Block diagram.
	5) Explain in principle the basic elements of a typical primary radar system.	2	Antennas, power module, transmitter, receiver, parameters, extraction, clock system. Probability of detection, MTI plot extraction.
	6) Describe, using an overall block diagram, the function and the performance of the primary radar system.	2	Distance computation, azimuth computation, display information.
	7) Explain the principle of primary plot extraction and describe the content of the plot message.	2	Plot extraction (see also radar processing), plot processing, track generation, display information.
	8) List the elements which can affect radar performances.	1	Meteo, rain, clouds, lake, mountains, building, reflection.

Topic	Intermediate Objectives. The students should be able to	Level	Content
	9) Describe the differences between en-route, approach radar and airport radar.	2	PRF, PRI, pulse length, frequency and power transmitted, number of turns per min.
2. Secondary radar	1) Explain the working principles of secondary surveillance radar.	2	Cooperative independent surveillance system, radar SSR, transponder, frequencies.
	2) Explain the different interrogation modes.	2	Interrogation pulses, modes, P1, P3.
	3) Explain the different types of responses and coding of the transponder.	2	Mode A, Mode C, military, civil, altitude coding, gray code, identification, code SSR.
	4) Describe the use of secondary/monopulse radar.	2	Operational procedures, need for ACC, watch, monitor, vector.
	5) Describe the system evolution and architecture.	2	Radar station and interconnection.
	6) Explain in principle the basic elements of a typical secondary radar system.	2	Antennas, power module, transmitter, receiver, radar data processing, transponders, Modes A, C, monopulse Mode S, parameters.
	7) Describe, using an overall block schematic, the function and the performance of the secondary radar system.	2	Plot extraction. Plot processing, combined primary secondary plots. Track generation, mono tracking.
	8) Explain the principle of secondary plot extraction and describe the content of the plot message.	2	Data transmission to centres.
	9) List the elements which can affect radar performances.	1	Garbling, reflection, fruit, improvement with addressing system. (See also primary radar)
	10) Define, with the help of an example, the functionality of the different parts found in a cockpit.	1	Example of cockpit orientation.
3. Weather range	1) Describe the use of weather radar in ATC.	2	Antenna, coverage, data processing.
	2) Describe the system evolution and architecture.	2	Displays.
	3) Explain the system elements.	2	

Topic	*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	4) Describe, using an overall block schematic, the function and performances of the weather radar.	2	Integration of meteorological data on controller display.
	5) Describe airborne weather radar.	2	
4. Precision approach radar	1) State the principle of PAR.	1	History, give principle and operational use.
3.3.13 Surface movement control			
1. Surface movement control	1) Describe ATC requirements.	2	Parameters. Displays.
	2) Describe the system evolution and architecture of surface movement radar.	2	Mapping. Data processing.
	3) Explain the purpose and principles of a typical surface movement radar.	2	
	4) Describe, using an overall block schematic, the function and performance of the system.	2	
	5) Describe alternative systems (ground movement).	2	Captors and sensors.
	6) Demonstrate general awareness of airport integrated ground movement control.	0	Radar and other captors used for movement control around airport, see example of airport implementation.
3.3.14 Radar formats			
1. Radar message format	1) Describe ATC requirements.	2	Radar maps, radar data presentations.
	2) List the formats in use.	1	Formats in use in your country, plot message, track message.
	3) Describe the contents of the radar format in use in your country.	2	Radar data format (ASTERIX and national or manufacture formats).
	4) Describe the different fields of the radar format.	2	Example of format with description.
2. Transmission of radar data	1) Describe the techniques used for transmission of radar data.	2	Show, with block diagram, the complete path between radar station and the radar processing system.

Topic	Intermediate Objectives. The students should be able to	Level	Content
	2) Explain the need for harmonization.	2	National, international exchanges, technical and operational point of view.
3. Mode S	1) State the principles of Mode S.	1	Type of interrogation, addressing, type of answer, processing.
	2) Explain the use of Mode S in ATM.	2	
	3) State the technical advantages of using Mode S.	1	
3.3.15 Automatic dependent surveillance			
1. ADS System	1) State the working principles of ADS.	1	What is ADS, satellites (navigation and communication), ADS contract (ADS-C), ADS broadcast (ADS-B). GPS. Data links.
	2) Describe the system evolution and architecture.	2	Ground segment. Space segment.
	3) Explain the use and limitation of ADS.	2	Control segment. Principles of the message or signal path.
3.3.16 Future systems			
1. Future equipment	1) Demonstrate general awareness of developments in the equipment field.	0	Equipment to be introduced in the near future.
	2) Explain Future Air Navigation Systems (FANS) concepts and their impact on ATC.	2	GNSS.
3.3.17 Radar station			
1. Radar station	1) Participate in a visit to your radar stations.	0	Visit of stations, type of equipment.
	2) Describe the special environment of the stations.	2	Particular environment, mountain.
3.3.18 Networks			
1. Terminology, units of measurement and signal processing	1) Describe the different measurements appropriate to data communication, and describe the type of signal processing appropriate to data communication.	2	Analogue to digital, digital to analogue, PCM, PCM30, BIT RATE, bandwidth

Topic	*Intermediate Objectives. The students should be able to*	*Level*	*Content*
2. Purpose and use of data communication systems	1) Explain the need for data communication systems in aviation and the national and international needs.	2	Historical overview, need for the transport of voice, radar, flight plan data on network.
	2) State the need for data communication systems for air–ground communication.	1	Frequencies congestion, ATCO and pilot workload, integration, multi-path.
	3) State the need for data communication systems for ground–ground communication.	1	
	4) Explain the need for a common and integrated network for ATM.	2	ATN, what is ATN, ATN benefits.
	5) Describe the basic principles, purpose and operation of the data communication systems in current use for voice communication and data communication.	2	PCM, E1 (DS1) framing, T1, multiplexing, de-multiplexing, TDM, network sharing of data. HCM, LAN, WAN. National network for ATM data.
	6) Describe, using an overall block schematic, the function and the performance of the systems in use in your country.	2	Map of the networks, bandwidth possibilities, data transported.
	7) Demonstrate an awareness of the connectivity of systems.	2	Terminology, phraseology. Principles and theory of networks. OSI model, data links, block diagram of national and international communication system in use, MODEM, DTU, coding, D/A A/D conversion, modulation, base band, CCITT recommendations, quality check.
3. Purpose and use of network	1) Demonstrate an awareness of ATC-specific requirements for networks and data communications.	2	Terminology, phraseology. Types of data transported between centre, packet switching, terminology, phraseology, LAN, WAN. National and international network for ATM data. Principles and theory of networks, sharing of data, multiplexing, de-multiplexing.
	2) Describe basic associated software functions and application.	2	

Topic	Intermediate Objectives. The students should be able to	Level	Content
	3) Describe the different layers of the OSI model for networking.	2	7 layer model, protocols. WAN.
	4) Explain the purpose and use of each layer.	2	
	5) Demonstrate an awareness of protocols.	2	
	6) Explain the principle and use of the MAC address.	2	
	7) Explain the functionality and use of LAN.	2	
	8) Explain the principle of the IP addressing system.	2	
	9) Explain the functionality and use of WAN.	2	
	10) Explain the purpose and principle of the HUB.	2	
	11) Explain the purpose and principle of the SWITCH.	2	
	12) Explain the purpose and principle of the ROUTER.	2	
	13) Explain the purpose and the principle of the GATEWAY and FIREWALL.	2	
4. Purpose and use of protocol	1) Explain the functionality and use of protocol.	2	
	2) Explain the functionality and use of the IP protocol.	2	
	3) Explain the functionality and use of the TCP protocol.	2	
	4) Explain the functionality and use of the UDP protocol.	2	
	5) Explain the functionality and use of other protocol specific to the ATM.	2	
	6) Describe the purpose, functionality and use of protocol analyser.	2	
5. Network management	1) Explain the principles and the functions of network monitoring and management.	2	Monitoring, pooling, SNMP, MIB. Test and monitoring tools. Protocol Analyser SNMP.

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	2)	Describe the use of the SNMP protocol.	2	Display tools (open view.) Get, put, trap. Addressing, system, MIB Organization, MIB1, MIB2. Example of system, example of HMI used (e.g. HP open view.)
	3)	Explain the principle of the management information base (MIB) system.	2	
	4)	Describe one of the network management systems used in your ATC environment.	2	
3.3.19 ATM specific networks				
1. ATC specific networks and/or applications	1)	Demonstrate general awareness of a range of networks related to ATM concepts.	0	AFTN, SITA, ACARS, ARINC.
	2)	Demonstrate general awareness of a range of message formats used in ATM-related networks.	0	MOTNE.
	3)	Demonstrate general awareness of a range of international networks used for ATM.	0	ATN, VHF, SATCOM, AMSS, International harmonization.
	4)	List the specific interface with other countries which exists in your ATM environment.	1	CIDIN, OLDI, ASTERIX, Mode S, Example for countries and continents (ARTAS data, RAPNET).
2. Future development	1)	List the future developments and techniques in ATM networks.	1	National and international harmonization, evolution of air–ground, evolution of ground–ground. Integrated systems, ATN inter-network protocols, ATN benefits, transition, expectation.
3.3.20 Data Processing (DP)				
1. Units of measurement	1)	Describe the terminology appropriate to data processing,	2	Terminology, phraseology,
2. Purpose and use of data processing systems	1)	Explain the need for data processing systems in aviation and the national and international needs.	2	Historical overview, automation, radar processing. ICAO, national law, recording. Software licensing.

Topic	Intermediate Objectives. The students should be able to	Level	Content
	2) Describe the basic principles, purpose and operation of the main data processing systems in current use.	2	Radar processing (RDPS), Flight Plan Processing (FDPS), Environmental processing (ENP), other.
	3) Describe the system evolution and architecture.	2	
	4) Describe, using an overall block schematic, the function and the performance of the different EDP systems in use.	2	Functionalities, operational point of view, HMI, data.
	5) Describe how the systems interface with other systems.	2	General diagram of the interconnection of the different systems.
	6) Describe basic software functions and applications.	2	Input, output, operational use.
	7) Describe the different operating systems which support your current EDP systems.	2	Type of software in use. Type of operating systems in use.
	8) Demonstrate general awareness of legal requirements.	0	
	9) Demonstrate general awareness and have an appreciation of future developments.	0	Software licensing, supplier licensing.
3. System software and hardware principles	1) Demonstrate awareness of current operating software and hardware used in your systems.	2	Driver, interfaces, languages, type of station, workstation, PC.
	2) List operating systems which support your current EDP systems.	1	Specific systems e.g. UNIX, NT, VMS, windows, LINUX, XP.
3.3.21 Radar data processing			
1. Radar data processing	1) Demonstrate general awareness of ATC requirements.	0	Resolution/quantification, correlation, rate of error, data recording, play back, label presentation, HMI.
	2) Describe the functions of radar data processing.	2	Mosaic/multi radar tracking, display techniques, track generation.
	3) Explain the principle of sectorization.	2	Sectorization, physical sector, logical sector correlation.

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	4)	Explain the principles of processing.	2	Tracks, plots, message, format, VDF, speed vector. Calculation of real position, tracking principles.
	5)	Describe the relation and exchange between RDPS and FDPS.	2	Correlation, updating of data.
	6)	Describe the radar data inputs/outputs and messages.	2	Format, content of messages.
	7)	Explain the need for international harmonization.	2	Exchange of information. Harmonization of format, data transmission.
	8)	Be aware of the redundancies and back-up system in use.	0	Block diagram, primary RDPS, fallback, redundancy, monitoring, by pass, switching possibilities.
	9)	Demonstrate general awareness of future developments.	0	
2. Warning systems	1)	Describe the need for warning systems.	2	Conflict alert, (short-term, medium conflict alert), altitude warning (Minimum safe altitude warning).
	2)	Explain the principle and use of conflict alert systems.	2	
	3)	Explain the principle and use of altitude warning systems.	2	
	4)	Demonstrate general awareness of on-board warning systems.	0	TCAS.
3. System in your centre	1)	Describe, with a block diagram, the system in use.	2	Description of hardware and software in use, redundancy, RCMS, HMI.
	2)	Visit system.	0	Visit.
3.3.22 Flight plan processing				
1. Flight data processing (FDP)	1)	Demonstrate general awareness of ATC requirements.	0	Flight strip production.
	2)	Explain the functions of FDP.	2	Flight plan life cycle.
	3)	Describe the inputs and outputs, and the distribution of flight plan data.	2	Electronic strips, strip printing, data exchange, communication.
	4)	Describe the relation and exchange between FDPS and RDPS.	2	Flight plan, code/call sign correlation, updating.

Topic		Intermediate Objectives. The students should be able to	Level	Content
	5)	Describe the basic software functions and applications.	2	Update of data, correlation. Operating system, programming languages, rules.
2. National and international exchanges	1)	Explain the need for international exchanges and flow control.	2	Flow control (CFMU/IFPS), Flight progress monitoring.
	2)	Describe the principle of dialogue between centres.	2	OLDI, messages, ABI, ACT, LAM, REV, MAC, PAC.
	3)	State the networks used to exchange flight plan data between centres.	1	AFTN, CIDIN, X25 and other national and international networks.
	4)	Demonstrate general awareness of the redundancies and backup system in use.	0	Block diagram, redundancy, monitoring, by pass.
3. System in your centre	1)	Describe, using a block diagram, the system in use.	2	Description of hardware and software in use, redundancy, RCMS, HMI.
	2)	Visit system.	0	Visit.
3.3.23 Display				
1. Operational display systems	1)	Explain the main information which must be presented on controller displays.	2	Maps, flights, labels, vector, ADF, strips, meteorological and environmental data, setup, zoom, windows, frequencies, status.
	2)	Describe the different display technologies.	2	Random scan/raster scan, 2k/2k screen, TV, cathodic, plasma, (SONY, Barco).
	3)	Describe, using an overall block diagram, the display system in use in your country.	2	Data distribution to display, redundancy, network, ATCO position, sectors.
	4)	Describe the main components of the display system.	2	Workstation common graphic display interface, graphics accelerator, monitor, other secondary screen.
	5)	Explain the local radar processing and redundancy.	2	X-client/X-server, local RDPS processing.
	6)	Describe software applications (country specific).	2	Backup procedure, procedure, restriction, manual correlation, maps, SMC possibilities. Operating system in use (NT, UNIX, Windows, LINUX. XP, programming languages (C, C++, ADA.), X windows.

Topic		*Intermediate Objectives. The students should be able to*		*Level*	*Content*
2.	Human Machine Interface (HMI)	1)	Demonstrate general awareness of HMI aspects.	0	HMI possibilities, login, settings.
		2)	State the main data which are displayed.	1	Aircraft, labels, maps, frequencies, entry windows. Familiarization with simulator.
3.	System in your centre	1)	Describe, with a block diagram, the system in use.	2	Description of hardware and software in use, redundancy, RCMS, HMI, photo.
		2)	Visit system.	0	Visit.
3.3.24	**On-line and environmental data**				
1.	Environmental data, on-line data	1)	State the different environmental data.	1	System status/back-up systems, runway in use, transition level, MAPS, dangerous area, military restriction, clock, meteorological data.
		2)	State the sources of the environmental data.	1	NOTAM.
		3)	Describe, using an overall block diagram, the system in use in your country to process and distribute the environmental data.	2	Interfacing with adjacent centres. Distribution network.
		4)	Describe the system in use to display environmental data.	2	Explain the system use locally.
2.	System Monitoring and Control	1)	Explain the principles and the functions of a remote system monitoring and control.	2	SMC position, equipment monitored, technical and operational procedures for the system monitoring and control.
		2)	Describe how to collect remote data and what tools and HMI are used to display the data.	2	Protocol SNMP, SNMP agent, addressing system, MIB, pooling, network, other protocols. Tool in use. (Open view.)
		3)	Describe the system monitoring and control in use for the radar processing.	2	Organization, system status/back-up systems, control and monitoring possibilities, demo of the HMI procedure.
		4)	Describe the system monitoring and control in use for the display system.	2	Identify.
		5)	Describe the system monitoring and control in use for the flight plan processing.	2	Organization of the supervision. Centralized SMC position, other organization, responsibilities.

Topic		Intermediate Objectives. The students should be able to		Level	Content
		6)	State other system monitoring and control in use.	1	Integrated monitoring and control, Navaids monitoring, radar, power.
3.	System in your centre	1)	Describe, with a block diagram, the system in use.	2	Organization of the supervision, monitoring and control. Centralized SMC position, other organization, responsibilities. Description of hardware and software in use, redundancy, RCMS, HMI.
		2)	Visit system.	0	Visit
3.3.25	**Facilities**				
1.	Units of measurement and terminology	1)	Describe the terminology and units of measurement and terminology appropriate to facilities and logistics.	2	Glossary.
2.	Purpose and use of facilities and logistics	1)	Explain the need for specific facilities and logistic systems for ACC.	2	Historical overview using an overall block diagram. Power supply, air conditioning.
		2)	Demonstrate general awareness of the function and performance of logistic and support equipment.	0	The performance of the support systems. Terminology, phraseology.
		3)	Describe, using an overall block diagram, the function and the performance of the systems in use.	2	
3.3.26	**Power supply**				
1.	Power distribution	1)	Describe the main features of the current power supply systems.	2	Power, input, output, diagram of the system.
		2)	Demonstrate general awareness of safety regulations and procedures.	0	Need to have an uninterrupted system, without perturbation (i.e. spikes, harmonics).
		3)	Describe the power distribution system at a typical site.	2	Block diagram of the power distribution, redundancy (commercial power, UPS, genset).
2.	Uninterrupted power supply	1)	Explain the principle of UPS.	2	Block diagram of the UPS, rectifier, battery, inverter, by pass.
		2)	Explain the importance of UPS systems.	2	Operational and technical point of view, organization of maintenance, monitoring, redundancy.

Topic	*Intermediate Objectives. The students should be able to*	*Level*	*Content*
3. Precaution and safety	1) Explain the precautions to be taken when working on equipment.	2	High voltage, earthing techniques, personal safety, precautions to take when handling batteries, power and high voltage equipment.
	2) State any appropriate ICAO or local regulations in force.	1	Company rules.
	3) State the appropriate safety rules.	1	First aid certification.
	4) Explain the emergency systems in use in your environment.	2	Redundancy, batteries and emergency generators, by pass. Site visit.
3.3.27 Air conditioning			
1. Air conditioning	1) Describe, using an overall block diagram, the function and the performance of current air conditioning systems in use.	2	Air conditioning, water cooling, system management, humidity.
	2) State the importance and criticality of maintaining a controlled environment.	1	Importance of good environment.
	3) State the appropriate safety rules.	1	Importance of cooling system for electronic equipment, gas handling.
	4) Explain the emergency system in use in your environment.	2	Redundancy, by pass.
2. Visit	1) Visit of air conditioning equipment.	0	Visits to air conditioning equipment.
3.3.28 Monitoring			
1. Monitoring of facility and equipment	1) State the importance and criticality of maintaining a controlled environment.	1	Operational monitoring and control of power supply.
	2) Describe the methods employed to control the equipment.	2	Operational monitoring and control of air conditioning. ATSEP organization.
3.3.29 Electromagnetic compatibility			
1. Electromagnetic protection	1) State the different factors that can disturb equipment.	1	Electrostatic, lightning, motors, radio waves.
	2) Describe how these factors can affect the electronic equipment.	2	Static discharge, circuit breakdown, computer problems.
	3) State what can be done to protect building and equipment.	1	Earth probe, faraday cage, filter.

Chapter 4

TRAINING FOR EACH QUALIFICATION

4.1 OVERVIEW

Each qualification always includes the corresponding domain. In addition, it may include specific areas from the other domains. The two tables below give an overview of this distribution.

Qualification training for	**Domain**	**Subjects**
Communication	Communication	All
	Power Supply	UPS Power Supply Networks
	Safety	All
Navigation	Communication	Data
	Navigation	All
	Power Supply	UPS Power Supply Networks
	Safety	All
Surveillance	Communication	Data Transmission Path
	Surveillance	All
	Power Supply	UPS Power Supply Networks
	Safety	All
Power Supply	Power Supply	All
	Safety	All

Qualification training	Domain	Subjects	Topics	Sub-topics
Data Processing	Communication	Data Transmission Path Recorders	All All Legal Records	5.10 (1) Regulations 5.10 (3) Digital
	Navigation	Ground-based Systems Satellite-based Navigation Systems	MLS GBAS	MLS Datalink reference 6.9 (2) Reference GNSS Ground Station Architecture — Datalink
	Surveillance	Primary	ATC Surveillance	7.1 (1) Functional Safety of PSR (only 7.1 (1.2) 7.1 (5) Data Transmission (PSR) (except 6.1 (6.7 & 6.9) 7.1 (12) Displays
			SMR	7.3 (4) SMR Display System
		Secondary	SSR & MSSR	7.4 (1) Functional Safety of SSR (only 7.4 (1.2) 7.4 (5) Data Transmission (SSR) 7.4 (12) Displays (SSR)
			Mode S	7.5 (1)Introduction except 7.5 (1.3 & 2) System 7.5 (2.1) theory of operation)
		ADS	ADS-B	7.8 (3) Techniques in ADS-B
			ADS-C	7.9 (3) Techniques in ADS-C
		HMI	All	All
	Data Processing	All	All	
	Power Supply	UPS Power Supply Networks	All All	
	Safety	All	All	

Chapter 5

COMMUNICATION SYSTEMS

5.1 INTRODUCTION

Communication systems provide a means of relaying essential information for the safe and orderly operation of the ANS. They are governed by international and national standards. Nowadays, communication means a lot more than radio transmitters and receivers; it also includes communication protocols, networks, types of medium, recorders and safety aspects. The ATSEP must understand the impact of their work on the user and on the overall ANS communication system.

5.2 TRAINING OBJECTIVE

5.2.1 Students shall describe the communication systems and equipment of their national ANS provider. Since communications are universal, it is very important that the ATSEP understand the purpose of each system or equipment and the technical specifications (power, frequencies, connections, etc.).

5.2.2 This chapter has been divided into 12 parts and each part addresses a specific aspect of communications.

Condition: In a laboratory environment, given an exposure to specific communication equipment or system along with the appropriate and pertinent training material, reference documentation, test equipment and tools.

Performance: The trainee will be able to perform the:

a) preventive maintenance;
b) corrective maintenance;
c) calibration; and
d) certification.

Standard of accomplishment: All maintenance, calibration and certification should be performed as per the approved standards and procedures.

5.2.3 This chapter includes twelve parts:

Voice – Air – Ground;
Voice – Ground – Ground;
Data – Introduction to networks;
Data – National networks;
Data – International networks;
Data – Global networks;
Data – Protocols;
Transmission path – Lines;
Transmission path – Specific links;

Recorders – Legal recorders;
Safety attitude and functional safety; and
Health and safety.

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
		5. Communication Systems		
5.1	**Voice – Air – Ground**			
1.	Transmission/ reception	1) Perform typical measurements on a transmitter.	3	Frequency (single carrier, offset carrier), modulation, channel spacing, output power, SWR.
		2) Analyse and troubleshoot a generic radio transmitter.	4	Noise, intermodulation, harmonics.
		3) Design and interpret the block diagram of a transmitter.	4/5	Characteristics (modulation, single carrier, channel spacing) functionalities.
		4) Perform typical measurements on a receiver.	3	Frequency, modulation, channel spacing, sensitivity, selectivity.
		5) Analyse and troubleshoot a generic radio receiver.	4/5	Noise, intermodulation, harmonics.
		6) Design and interpret the block diagram of a receiver.	4/5	Characteristics (modulation, single carrier, channel spacing, sensitivity, selectivity) functionalities.
		7) Interpret remote monitoring and control systems information.	5	PTT, squelch, station information/ control functions, SWR, field strength, data of equipment, line quality (S/N).
2.	Radio antenna systems	1) Explain and describe antenna parameters.	2	Impedance, polar diagram, bandwidth, polarization types of antennas (HF, VHF, UHF, LF).
		2) Analyse the coverage of the radio system.	4	Impedance, polar diagram, polarization, types of antennas (HF, VHF, UHF).
		3) Calculate propagation according to various conditions.	3	Output power, geographic, meteorological, ionosphere influences, day and night (HF, VHF, UHF).
		4) Appreciate criticality of the conditions.	3	Output power, geographic, meteorological, ionosphere influences, day and night (HF, VHF, UHF).

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
	5)	Calculate the values of the elements of a simple generic antenna system.	3	Filters, combiners, RF relays, multi-cavity system.
	6)	Check the conformity of a system to ITU.	3	ITU (HF, VHF, UHF). Ref ICAO Annex 10.
	7)	Check the conformity of a system to national regulations.	3	National regulations (HF, VHF, UHF).
	8)	Identify and measure cross modulation.	3	Cross modulation, measuring tools and methods.
	9)	Detect and analyse disturbances.	4/5	Spectrum analyser, scanner, noise, figure, BITE.
3. Voice switch	1)	Describe and interpret switching functionalities with a block diagram.	2/5	General architecture, digital, analogue, multiplex types, PCM30.
	2)	Explain the principles of non blocking switches.	2	Advantages, disadvantages, delays (digital).
	3)	Describe the signal processing all along the chain.	2	Signal tracing treatment, protocols (a few), data flow.
4. Controller work position	1)	Describe the most common features of a controller working position.	2	Frequency selection, emergency, station selection, coupling, microphone (noise cancelling), headset, loudspeaker, short time recording, footswitch, PTT).
5. Radio interfaces	1)	List and describe the different types of interfaces.	1/2	Internal, external, phantom keying, in band signal.
6. Digital voice communication	1)	Explain the latest development and projects in voice communication.	2	e.g. Digital radio, VDL Mode 3 Ref.: ICAO Annex 10.
5.2 Voice – Ground – Ground				
1. Interfaces	1)	Describe the different types of interface.	2	Analogue (2, 4, 6 and 8 wires), digital (ISDN; 64Kb, 2MB).
	2)	Explain the advantages and disadvantages of each type.	2	Analogue (2, 4, 6 and 8 wires), digital (ISDN; 64Kb, 2MB).
	3)	Operate measuring equipment.	3	dB meters, level meters, generators, sniffer, special e.g. 2MB.

Topic		Intermediate Objectives. The students should be able to		Level	Content
2.	Protocols	1)	Operate standard protocol analysers.	3	MFC R2 (EUROCONTROL), ATS QSIG (Re-routing), impulse dialling and DTMF dialling, ISDN MFC R2 (EUROCONTROL), ATS QSIG (Re-routing), impulse dialling and DTMF dialling, ISDN MFC R2 (EUROCONTROL), ATS QSIG (Re-routing), impulse dialling and DTMF dialling, ISDN national protocols.
		2)	Decode a signal coded according to the standard protocols.	3	
		3)	Analyse a signal coded according to the standard protocols.	4	
		4)	Decode and analyse a signal coded according to the national protocols.	3/4	
3.	Switch	1)	State that ground–ground switches are based on the same techniques as air–ground switches.	1	See 4.1 (3).
		2)	Describe the most commonly used functionalities of PABX.	2	General architecture, digital, analogue, multiplex types, PCM30. General architecture, analog-digital-analog, specific aviation requirements (codec, rate, receiver architecture).
		3)	Describe and analyse conversion analog-digital, digital-analog.	2/4	
4.	Controller working position	1)	Describe the most common features of a controller working position and the HMI.	2	Reference: VCS procurement guidelines (WD-discom).
5.3	**Data — Introduction to networks**				
1.	Types	1)	Define LAN and WAN.	1	Architectures, size of the segments, length of the systems, quality of service.
		2)	Design network, matching the quality of service requirements.	4	Redundancy, bandwidth, BER, time response, data security.
2.	LAN	1)	Analyse the features of a LAN network.	4	Routing scheme, rate, internal networking, routers, bridges, gateways, hub, modems, switches, firewalls.

Topic		*Intermediate Objectives. The students should be able to*		*Level*	*Content*
		2)	Integrate adequately components into a LAN.	4	Network management.
3.	WAN	1)	Analyse the features of a WAN network.	4	Routing scheme, rate, internal networking, routers, bridges, gateways, hub, modems, switches, firewalls.
		2)	Integrate adequately components into a WAN.	4	Network management.
4.	Measuring tools	1)	Operate the usual set of network measuring or monitoring tools to find the values of the main parameters.	3	Data analyser (sniffer), net scout.
5.	Monitoring tools	1)	Analyse the traffic.	4	Data analyser (sniffer), net scout.
6.	Trouble shooting	1)	Troubleshoot a network.	5	Broken lines, unusable network components, overload, integrity problems.
5.4	**Data — National networks**				
1.	Proper networks	1)	Describe the characteristics of the networks.	2	National network(s), interoperability.
2.	Surrounding networks	1)	Demonstrate general awareness of the existence of other national networks.	0	Military, PTT, airlines e.g. SITA, ARINC, etc.
5.5	**Data — International networks**				
1.	Emerging	1)	Demonstrate general awareness of emerging international networks.	0	
2.	In use	1)	Describe the characteristics of the international networks in your area.	2	Users and data, architectures, quality of service (CIDIN, OLDI, CFMU-RCA, AIS, (EAD) networks).
3.	Hands on	1)	Analyse traffic of these networks.	4	Proprietary analysers, system specific analysers (CIDIN, OLDI, CFMU-RCA, AIS (EAD) networks).
		2)	Troubleshoot problems, at a national level, on a segment of these networks.	5	Broken lines, unusable network components, overload, integrity problems.
5.6	**Data — Global networks**				
1.	List and standards	1)	List the global networks and the standards on which they are based.	1	ICAO for AFTN, ICAO for ATN (SARPS-ATM package 1), FANS 1 and FANS A for ACARS applications (SITA and ARINC).

Topic		Intermediate Objectives. The students should be able to		Level	Content
2.	Description	1)	Describe the characteristics of the AFTN, MOTNE, SITA, ARINC networks.	2	Users and data, architectures, quality of service.
3.	Hands on	1)	Analyse traffic of the AFTN, MOTNE, SITA, ARINC networks.	4	Using the appropriate tools. Broken lines, unusable network components, overload, integrity problems.
		2)	Troubleshoot problems at a national level on a segment of AFTN, MOTNE, SITA, ARINC networks.	5	
4.	ATN architecture	1)	Describe the architecture of the ATN.	2	Air–ground sub-networks, ground–ground sub-networks, airborne.
5.	ATN air–ground	1)	Describe the air–ground sub-networks.	2	VDL (Modes 2, 3 and 4), HDL, AMSS, SSR mode S, SATCOM.
6.	ATN ground–ground	1)	State that the ground–ground sub-networks are composed of many private or public components.	1	PTT, commercial telecom providers, ARINC.
7.	ATN on board the aircraft	1)	Demonstrate general awareness of the existence of ATN sub-networks inside the aircraft.	0	SATCOM *Note.— Wait further development for higher level objective.*
8.	ATN applications	1)	List the main communication application over ATM system.	1	CPDLC, DLC.
5.7	**Data — Protocols**				
1.	Fundamental theory	1)	Explain the principles of layers.	2	Differences between layers.
		2)	Explain the principles of the addressing strategy.	2	Routing strategies, masks-subnets.
		3)	Explain the principles of the routing strategy.	2	Routing tables, point-to-point, connectionless, name servers, priorities, fault tolerance, management.
2.	General protocols	1)	Describe and decode the general protocols.	3	TCP/IP, X25, LAPB.
		2)	Analyse and interpret the general protocols.	5	TCP/IP, X25, LAPB.
3.	Specific protocols	1)	Describe and decode the specific protocols.	3	ACARS, ATN.
		2)	Analyse and interpret the specific protocols.	5	ACARS, ATN.

Topic		*Intermediate Objectives. The students should be able to*		*Level*	*Content*
4.	Met data protocol from satellite	1)	Describe and decode the met data protocol.	2/3	SADIS.
5.8	**Transmission path — Lines**				
1.	Providers	1)	State who are the local telecom providers and the service characteristics.	1	Type of lines, rules, type of services, global national organization and rules.
2.	Lines theory	1)	List, describe and calculate parameters of a line.	1/2/3	Equation, attenuation, impedance, S-parameters, Smith diagram, bandwidth, HF specifics (dipoles, multipoles).
3.	Digital transmission	1)	List, describe and calculate parameters for digital transmission.	1/2/3	Signal definition, Fourier theory, (spectrum), signal processing (sampling, etc.) bandwidth, carrier, modulation, noises, S/N, delays, group delay, line quality (signal distortion, rate of failure), transmission speed.
4.	Types of lines	1)	Describe and calculate the typical parameters of lines.	2/3	Copper wires (twisted pairs, symmetrical cables). Optic fibres (mono or multi modes, connectors, splitter). Coaxial (attenuation, losses, bending, characteristic impedance).
		2)	Choose the appropriate type of line for a given specific application.	3	Bandwidth, noise immunity, availability, proximity, duality of supplier, installation cost, running cost.
		3)	Measure the typical parameters of lines.	3	Impedance, insulation, signal level, signal generator, reflectometer, vector analyser, spectral delay.
		4)	Analyse and troubleshoot a line installation.	4/5	Signal generator, signal level, automatic line analysers, BITE.
5.9	**Transmission path — Specific links**				
1.	Optical	1)	Describe the parameters of an optical link.	2	Frequency spectrum.
		2)	Explain the performances and the limitations of an optical link.	2	Distances, weather conditions, obstruction, EMI immunity.
2.	Microwave Link	1)	Describe the parameters of a microwave link.	2	Carrier frequency, type of modulation, theory of fresnel, loss, atmospheric influences.

Topic	Intermediate Objectives. The students should be able to	Level	Content
3. Satellite	1) Describe the parameters of a satellite link.	2	Uplinks, downlinks, antennas, footprint, delays, atmospheric influences.
5.10 Recorders — Legal recorders			
1. Regulations	1) Explain the international regulations.	2	ICAO regulations (recording and reproducing). Appropriate national regulations. Store tapes, access to recording and reproducing room, time to store information (overwrite or erase voice or data), procedure to reproduce information.
	2) Explain the national regulations.	2	
	3) Explain the company regulations.	2	
2. Analog	1) Explain the principles of analog recording and reproducing.	2	Storage media (tape), duration tape, number of tracks, time synchronization, noise reduction. Replace tapes, calibration, cleaning heads, search information.
	2) Analyse and troubleshoot the analogue recording and reproducing.	4/5	
3. Digital	1) Explain the principles of digital recording and reproducing.	2	Storage media (tape, optical and magnetic disc), A/D – D/A converters, frequency range (300…3400 Hz), channel capacity, time synchronization, connection to a network.
	2) Analyse and troubleshoot the digital recording and reproducing.	4/5	Search information, change storage media.
5.11 Safety attitude and functional safety			
1. Safety attitude	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to communication system, safety reports and occurrences, safety monitoring.
2. Functional safety	1) Describe the implications of functional failures in terms of exposure time, environment, effect on controller and effect on pilot.	2	Total or partial, premature or delayed operation, spurious, intermittent, loss or corruption of data, missing or incorrect input or output. Ref: EATMP safety policy, safety policy and implementation, other national and international policy.

Topic		*Intermediate Objectives. The students should be able to*	*Level*	*Content*
5.12	**Health and safety**			
1.	Hazard awareness	1) Demonstrate general awareness of potential hazards to health and safety generated by communication equipment.	0	Mechanical hazards, electrical hazards (HV, EMI), chemical hazards.
2.	Rules and procedures	1) State applicable international requirement.	1	Relevant international documents.
		2) State any applicable legal national requirement.	1	Relevant national documents.
		3) State safety procedure for the persons working on or near communication equipment.	1	Isolation (clothing, tools) fire extinguisher types, safety man presence, safety interlocks, isolating switches, security of the site, climbing procedures.
3.	Practical situations	1) In a practical situation, apply and demonstrate the procedures and techniques to be followed.	3/2	e.g. Changing wave guide, replacing fuses or boards, start up/ shut down a station, climbing procedures.
4.	Resuscitation techniques	1) Apply and demonstrate resuscitation techniques.	3/2	First aid, rescue procedures, resuscitation.

Chapter 6

RADIO NAVIGATION AIDS

6.1 INTRODUCTION

Radio navigation systems provide a vital role in the operation of an ANS for approach and en-route navigational information essential for the safe and orderly operation of the ANS. They are governed by international and national standards, in particular by required navigation performance (RNP). ATSEP must understand the impact of their work on users and on the overall ANS radio navigation aids system.

6.2 TRAINING OBJECTIVE

6.2.1 Students shall describe the radio navigation aids systems and equipment of their national ANS provider. It is very important that the ATSEP understand the purpose of each system and piece of equipment, the technical specifications and the impact of the service on the users.

6.2.2 As there are many aspects to radio navigation aids, this chapter has been divided into twenty parts and each part addresses a specific aspect of navigation aids.

Condition: In a laboratory environment, given exposure to specific radio navigation equipment, along with the appropriate and pertinent training material, reference documentation, test equipment and tools.

Performance: On the radio navigation aids systems covered in this chapter, the trainee learner will perform:

a) preventive maintenance;
b) corrective maintenance;
c) calibration; and
d) certification.

Standard of accomplishment: All maintenance, calibration and certification should be performed as per the approved standards and procedures.

6.2.3 This chapter includes twenty parts:

NAV Concepts;
Ground-based systems — NDB/Locator;
Ground-based systems — VDF/DDF/IDF;
Ground-based systems — VOR;
Ground-based systems — DME;
Ground-based systems — ILS;
Ground-based systems — MLS;
Satellite-based navigation systems — GNSS1;
Satellite-based navigation systems — GBAS;

Satellite-based navigation systems — SBAS;
Satellite-based navigation systems — ABAS;
Satellite-based navigation systems — Modernized GPS;
Satellite-based navigation systems — GALILEO;
Satellite-based navigation systems — GNSS2;
On-board navigation architecture;
Display systems;
Inertial navigation;
Vertical navigation;
Safety attitude and functional safety;
Health and safety.

Topic		*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
6. Radio navigation aids				
6.1 NAV concepts				
1.	Operational requirements	1) State, define and explain the main performance of a navigation system.	1/2	Accuracy, CEP, RMS, 2DRMS, SEP, etc., integrity, availability, continuity of services, coverage, robustness, TTFF, etc.
2.	Required Navigation Performance (RNP)	1) State, define and explain the RNP concept.	1/2	Risk of collision, TLS, confinement area.
		2) Describe the standard values of RNP.	2	RNP4, RNP1, ICAO and EUROCONTROL tables.
		3) Demonstrate general awareness of the potential extension of the RNP concept.	0	RCP, RSP, RGP.
3.	Area Navigation Concept (RNAV)	1) State, describe and explain the RNAV concept.	1/2	ICAO and EUROCONTROL documents, operational impact on national and transition airspace.
		2) Describe the standard values of RNAV.	2	Basic-RNAV (B-RNAV) and precision RNAV (P-RNAV).
		3) Describe the implementation plans for RNAV.	2	ICAO plan, regional plan, national plan.
6.2 Ground-based systems — NDB/Locator				
1.	Use of the system	1) Explain the operational use of NDB.	2	En route, terminal area, procedures.
		2) Theorize the principles of NDB.	5	Relative bearing, measuring method.
		3) Explain the advantages of NDB.	2	Simplicity, cost, coverage.

Topic		*Intermediate Objectives. The students should be able to:*		*Level*	*Content*
		4)	Explain the disadvantages of NDB.	2	Lack of accuracy, lack of integrity, sensitivity to interference.
		5)	Describe the current situation.	2	Density of NDB in use in Europe, percentage of equipped aircraft.
		6)	Describe the role of NDB according to European navigation strategy.	2	NDB not part of RNAV.
2.	Ground station architecture	1)	Draw and explain the block diagram of a generic NDB ground station.	1/2	Electronic cabinet, antennas, power supply, remote controls and monitoring.
		2)	Design a NDB station according to operational requirements.	4	Coverage, identification code, VOR backup, double beacon approach.
3.	Transmitter subsystem	1)	Analyse the main signal parameters.	4	Carrier frequency stability, output power, controls.
		2)	Perform the typical measurements on the main signal parameters.	3	Power measurements, spectrum measurements.
4.	Antenna subsystem	1)	Explain and describe antenna parameters for NDB.	2	Impedance, polar diagram, polarization, types of antennas.
		2)	Calculate the interface between power stage and the antenna (tuning coil).	3	SWR, radiated power.
5.	Implementation	1)	Verify the impact of the requirements on the choice of the ground station location.	3	En route, terminal requirements procedures.
		2)	Check the conformity of the system to ITU.	3	ITU regulation, ICAO Annex 10.
		3)	Check the conformity to national regulations.	3	National regulations.
6.	On-board equipment	1)	Describe the on-board equipment (ADF) and the current procedures.	2	Receiver, antenna, pilot check.
		2)	Describe the various HMI.	2	ADF indicator, RMI, HIS, ND.
7.	Compliance with standards	1)	Define the global performance.	1	Coverage, accuracy, availability of the system, integrity, continuity.
		2)	Perform typical measurements.	3	Spectrum analysis, modulation, output power, ID code.
		3)	Calibrate.	5	Flight inspection.
		4)	Troubleshoot.	5	Carrier frequency deviation, depth of modulation, lack of power, harmonics ratio.

Topic		Intermediate Objectives. The students should be able to:		Level	Content
6.3	**Ground-based systems — VDF/DDF/IDF**				
1.	Use of the system	1)	Explain the operational use of DF.	2	Terminal and approach procedures, emergency, backup.
		2)	Describe the user HMI.	2	Indication on radar picture, DF indicator.
		3)	Theorize the principles of DF.	5	Bearing, measuring method (standard, Doppler, interferometry).
		4)	Explain the advantages of DF.	2	Simplicity, cost.
		5)	Explain the disadvantages of DF.	2	Sensitivity to interference.
		6)	Describe the current situation.	2	Density and types of DF in use in your area, effective use of DF.
2.	VDF/DDF equipment architecture	1)	Draw and explain the block diagram of VDF/DDF equipment.	2	Electronic cabinet, antennas, power supply, remote controls and monitoring.
		2)	Design VDF/DDF equipment according to operational requirements.	4	Coverage, accuracy.
3.	Receiver subsystem	1)	Design main signal parameters.	4	Frequency band (UHF, VHF).
		2)	Perform typical measurements on the receiver.	3	Frequency, channel spacing, sensitivity, selectivity.
4.	Antenna subsystem	1)	Explain and describe antenna parameters for VDF/DDF.	2	Impedance, polar diagram, polarization, types of antennas.
		2)	Design protection areas.	4	Obstacles, Annexes 10 and 14, manuals.
5.	Monitoring and control subsystem	1)	Describe and explain which parameters are used for the monitoring.	2	Noise figure, stability of measurement.
		2)	Check the operational status of the monitor system.	3	BITE, system status e.g. watchdog.
		3)	Troubleshoot wrong bearing instructions.	5	Re-adjust antenna systems.
6.	Implementation	1)	Verify the impact of the requirements on the choice of the VDF/DDF location.	3	Protection of receivers.
		2)	Check the conformity of the system to ITU.	3	ITU regulation, ICAO Annex 10.
		3)	Check the conformity to national regulations.	3	National regulations.

Topic		*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
7.	Compliance with Standards	1) Define the global performances.	2	Accuracy, coverage, Annex 10 recommendations.
		2) List VHF/UHF receiver procedures.	1	
		3) Calibrate the system.	5	Flight inspection.
6.4	**Ground-based systems — VOR**			
1.	Use of the system	1) Explain the operational use of VOR.	2	En route, terminal area, procedures.
		2) Theorize the principles of the CVOR.	5	Bearing information, phase measurements methods.
		3) Explain the advantages of VOR.	2	Type of information (azimuth), accuracy, integrity, suitable for a network of fixed routes.
		4) Explain the disadvantages of VOR.	2	Multipath, sensitivity to interference, limited coverage, not ideal for free routes, accuracy depending on distance.
		5) Justify and theorize the DVOR versus the CVOR.	4/5	CVOR, DVOR, signal broadcast differences, bearing information.
		6) Describe the current situation.	2	Density of CVOR and DVOR in use in your area.
2.	Ground station architecture	1) Draw and explain the block diagram of a CVOR ground station.	2	Electronic cabinet, antenna system, power supply, remote controls and monitoring.
		2) Design a CVOR station according to operational requirements.	4	Coverage, identification code.
3.	Transmitter subsystem	1) Analyse main signal parameters for a CVOR.	4	Carrier frequency stability, output power, signals generated.
		2) Analyse main signal parameters for a DVOR.	4	Output power, signals generated.
		3) Perform the typical measurements on the signals by using standard equipment.	3	Power measurements, spectrum measurements, modulation measurements.
4.	Antenna subsystem	1) Explain and describe the generic radiated signals required for CVOR.	2	Patterns antennas, distribution circuits, standard implementations.
		2) Explain and describe the generic radiated signals required for DVOR.	2	Patterns antennas, distribution circuits, standard implementations.
		3) Analyse the interface between power stage and the antenna.	4	Standing Wave Ratio (SWR), radiated power.

	Topic		Intermediate Objectives. The students should be able to:	Level	Content
		4)	Analyse the most typical signal errors due to the antenna.	4	Error expression components.
5.	Monitoring and control subsystem	1)	Describe and explain which parameters are used for the monitoring.	2	Near-field monitor, BITE.
		2)	Check the operational status of the monitor system.	3	BITE, system status e.g. watchdog.
		3)	Troubleshoot wrong bearing indications.	5	Re-adjust antenna systems.
6.	Implementation	1)	Verify the impact of the requirements on the location and the type of the ground station.	3	En route, terminal requirements procedures.
		2)	Check the conformity of the system to ITU.	3	ITU regulation, ICAO Annex 10.
		3)	Check the conformity to national regulations.	3	National regulations.
7.	On-board equipment	1)	Describe the on-board equipment.	2	Antenna, receiver, (MMEL/RNP).
		2)	Describe the various HMI.	2	CDI, RMI, HIS, ND, PFD.
		3)	Describe how the VOR information is used on board.	2	Single VOR, VOR-VOR, approach procedures, manual mode, automatic mode.
8.	Compliance with Standards	1)	Define the global performance criteria for CVOR and DVOR.	1	Coverage, accuracy, availability of the system, integrity, continuity.
		2)	Perform typical measurements.	3	Spectrum analysis, modulation, output power, ID code.
		3)	Calibrate.	4	Flight inspection.
		4)	Troubleshoot.	5	Carrier frequency deviation, depth of modulation, lack of power, harmonics ratio.
6.5	**Ground-based systems — DME**				
1.	Overview	1)	Describe the measurements.	2	Distance, time measurement.
		2)	Describe the basic principle of the system.	2	A/C interrogation ground reply, interrogation stagger, station frequency.
		3)	Explain the TACAN equipment and the VORTAC configuration.	2	DME compatible, amplitude modulated at 135 Hz and 15 Hz bearing information.

Topic		*Intermediate Objectives. The students should be able to:*		*Level*	*Content*
		4)	Explain the frequency spectrum and channel spacing allocated.	2	See Annex 10, links to other navigation systems.
2.	Use of the system	1)	Explain the operational use of DME.	2	En route, terminal area, procedures, instrument approaches, multi DME navigation.
		2)	Theorize the principles of the DME/N.	5	Pulse carrier modulation, coding principles, channel definitions.
		3)	Explain the advantages of DME.	2	Accuracy, integrity.
		4)	Explain the disadvantages of DME.	2	Saturation level, minimum interrogation number, sensitivity to interference, limited coverage.
		5)	Justify and theorize the DME/N versus the DME/P.	5	Technical differences.
		6)	Describe the current situation.	2	Density of DME/N and DME/P in use in your area.
		7)	Describe the role of DME according to your ANS policy.	2	Part of the RNAV concept.
3.	System architecture	1)	Describe air–ground link	2	Elements of the avionics systems, nature of air–ground and ground–air transmissions.
4.	Ground station architecture	1)	Draw and explain the block diagram of a DME ground station.	2	Electronic cabinet, antenna system, power supply, remote controls and monitoring.
		2)	Design a DME station according to operational requirements.	4	Coverage, identification code.
5.	Transmitter sub-system	1)	Define main signal parameters for a DME.	4	Carrier frequency stability, output power, signals generated.
		2)	Perform the typical measurements on the signals by using standard equipment.	4	Power measurements, spectrum measurements, modulation measurements.
6.	Antenna sub-system	1)	Explain and describe the generic radiated signals requirements for DME.	2	Patterns antennas, distribution circuit, standard implementations.
		2)	Analyse the interface between power stage and the antenna.	4	Standing Wave Ratio (SWR), radiated power.
		3)	Analyse the most typical signal errors due to the antenna.	4	VSWR.
7.	Monitoring and control sub-system	1)	Describe and explain which parameters are used for the monitoring.	2	BITE, power, interrogation rates.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
	2) Check the operational status of the monitor system.	3	BITE, system status e.g. watchdog.
	3) Troubleshoot error indications.	5	Readjust antenna systems, replace faulty LRU.
8. Implementation	1) Verify the impact of the requirements on the location and type of ground station.	2	En route, terminal requirements, procedures.
	2) Check the conformity of the system to ITU.	3	ITU regulation, ICAO Annex 10.
	3) Check the conformity to national regulations.	3	National regulations.
9. On-board equipment	1) Describe the on-board equipment.	2	Antenna, receiver; (MMEL/RNP).
	2) Describe the various HMI.	2	CDI, RMI, HIS, ND, PFD.
	3) Describe how the DME information is used on board.	2	Single DME, multi DME navigation (rho rho), approach procedures, manual mode, automatic mode.
10. Compliance with Standards	1) Define the global performance criteria for DME.	2	Coverage, accuracy, availability of the system, integrity, continuity.
	2) Perform typical measurements.	3	Spectrum analysis, modulation, output power, ID code.
	3) Calibrate.	4	Flight inspection.
	4) Troubleshoot.	5	Carrier frequency deviation, depth of modulation, lack of power, harmonics ratio.
6.6 Ground-based systems — ILS			
1. Use of the system	1) Explain the operational use of ILS.	2	Approach and landing procedures, localizer and glide path.
	2) Theorize the principles of ILS.	5	Azimuth and elevation by DDM measurements, dipole arrays, localizer and glide path beam construction, 90-150 Hz modulation, multiple course indications, runway offset arrangements.
	3) Explain the advantages of ILS.	2	Type of information, accuracy, integrity.
	4) Explain the disadvantages of ILS.	2	Only 40 channels, no segmented paths of approach, beam corruption due to multipath.

Topic		*Intermediate Objectives. The students should be able to:*		*Level*	*Content*
		5)	Describe the current situation.	2	Different operational category depending on weather, equipment and airport facilities.
2.	Ground station architecture	1)	Draw and describe all components of ILS.	1/2	Location of the antennas and the shelters.
		2)	Describe the special performance of the antenna array.	2	Location of critical and sensitive area.
		3)	Draw and explain the block diagram of LOC, GS, OM, MM and FFM.	1/2	Electronic cabinet, antennas, power supply, remote controls and monitoring.
3.	Transmitter sub-system	1)	Analyse main signal parameters for LOC, GS, OM and MM.	4	Carrier frequency, output power, signals generated.
		2)	Draw and explain the block diagram of the transmitter.	4	Synthesizer, modulator, power amplifier, control coupler, RF-change over.
4.	Antenna sub-system	1)	Analyse and describe antenna parameters.	4/5	Types, position, polarization, patterns, coverage, distribution circuits, radiated power, monitoring antennas.
5.	Monitoring sub-system	1)	Describe and explain the monitoring parameters according to ICAO Annex 10.	2	RF-Level, DDM, SDM on position and width.
		2)	Describe and explain the additional monitoring parameters.	2	External, internal and integral monitoring.
		3)	Describe and explain the far field monitoring system.	2	Position, width.
		4)	Draw and explain the block diagram.	3	Near-field, integral network, internal network, monitor signal processor.
6.	Implementation	1)	Verify the impact of the requirements on the location and the type of ground station.	3	En route, approach and airport requirements and procedures.
		2)	Check the conformity of the system to ITU.	3	ITU regulation, ICAO Annex 10.
		3)	Check the conformity to national regulations.	3	National regulations.
7.	On-board equipment	1)	Describe the on-board equipment.	2	Antennas, receiver, pilot interface (cross pointer), FMS.
8.	Compliance with Standards	1)	Define the global performance criteria for ILS.	2	Coverage, accuracy, availability of the system, integrity, continuity, category and level.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
	2) Perform the typical measurements.	3	Output power, spectrum analysis, modulation, ID code.
	3) Perform appropriate calibration tasks and assess flight inspection results.	5	Flight inspection and ground calibration results.
	4) Troubleshoot.	5	Lack of power, carrier frequency deviation, harmonic ratio, depth of modulation.
9. 2F–Systems	1) Describe and explain the capture effect.	2	Capture effect in receiver circuits.
	2) Describe and explain antenna parameters for 2F–LOC.	2	Types, position, polarization, patterns, coverage, distribution circuits, radiated power.
	3) Describe and explain antenna parameters for 2F–GS.	2	Multipath.
6.7 Ground-based systems — MLS			
1. Use of the system	1) Explain the operational use of MLS.	2	Approach and landing procedures.
	2) Theorize the principles of MLS.	5	Azimuth, back azimuth and elevation by TRSB.
	3) Explain the advantages of MLS.	2	Type of information, accuracy, data link, small critical and sensitive areas, number of channels, complex approach paths, less prone to interference, comparison with conventional ILS.
	4) Explain the disadvantages of MLS.	2	Low equipage, complexity, cost.
	5) Describe the current situation.	2	Multi mode receivers, ground and a/c equipment.
2. Ground station architecture	1) Draw and describe all components of MLS.	1/2	Locations of the sub-systems.
	2) Draw and explain the block diagram of azimuth, elevation and back azimuth station.	1/2	Electronic cabinet, antennas, power supply, remote controls and monitoring.
3. Transmitter sub-system	1) Design main signal parameters for azimuth, elevation and back azimuth station.	4	Carrier frequency, output power, signals generated, timing.
	2) Draw and describe the block diagram of the transmitter.	1/2	Synthesizer, modulator, power amplifier, control coupler, RF-change over, BITE.

Topic		*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
4.	Antenna sub-system	1) Describe and explain antenna parameters.	2	Types, position, dimensions, polarization, pattern, coverage, distribution circuits, radiated power, scan speed.
5.	Monitoring sub-system	1) Describe and explain the parameters for the monitoring according to ICAO Annex 10.	2	RF-level, beam width, scan speed.
		2) Describe and explain the additional monitoring parameters.	2	External and internal monitoring.
		3) Draw and explain the block diagram.	1/2	Monitor signal processor.
6.	Implementation	1) Verify the impact of the requirements on the location and the type of the ground station.	3	Approach and airport requirements and procedures.
		2) Check the conformity of the system to ITU.	3	ITU regulation, ICAO Annex 10.
		3) Check the conformity to national regulations.	3	National regulations.
7.	On-board equipment	1) Describe the on-board equipment.	2	Antennas, receiver, cross pointer, FMS, MMR.
		2) Describe how the MLS information is used on board.	2	Approach procedures, ILS-like display.
8.	Compliance with Standards	1) Define the global performances for MLS.	2	Coverage, accuracy, availability of the system, integrity, continuity, category and level.
		2) Perform the typical measurements.	3	Output power, spectrum analysis, data link modulation, ID code.
		3) Calibrate.	5	Flight inspection.
		4) Troubleshoot.	5	Lack of power, carrier frequency deviation, harmonic ratio.
6.8	**Satellite-based navigation systems — GNSS1**			
1.	General view	1) Explain civil aviation requirements for navigation.	2	GNSS panel.
		2) Define all the components of the GNSS1.	1	GPS, GLONASS, augmentation.
		3) Draw a diagram illustrating the architecture of GNSS1 and the interdependencies.	1	
		4) Explain how GNSS1 fulfils the civil aviation requirements.	2	

Topic		Intermediate Objectives. The students should be able to:	Level	Content
2.	GPS	1) Describe the architecture of the system.	2	Space segment, control segment, user segment, current situation of the constellation.
		2) Recognize the institutional issues related to GPS.	1	Ownership, control, users, security.
		3) Describe and calculate the main performance criteria for the GPS system.	2/3	Link budget, receiver performance, coverage, integrity, availability, time to fix, SA.
		4) Monitor how GPS performance criteria compare to civil aviation requirements and demonstrate the limited use of GPS.	3	
		5) Given an aircraft route, estimate using a software package or/and GPS receiver, the availability of the constellation.	3	Ref: software, GPS, receiver.
3.	GLONASS	1) Describe the architecture of the system.	2	Space segment, control segment, user segment, current situation of the constellation.
		2) Recognize the institutional issues related to GLONASS.	1	Ownership, investment, security, continuity .
		3) Describe and compute the main performance criteria of the GLONASS system.	2/3	Link budget, receiver performance, coverage, integrity, availability, time to fix.
		4) Compare GLONASS performance criteria to civil aviation requirements and demonstrate the limited use of GLONASS.	3	Number of satellites, coverage, investment, continuity.
6.9	**Satellite-based navigation systems — GBAS**			
1.	General	1) Describe the improvements using GBAS concept.	2	Accuracy, integrity within a local coverage.
		2) Monitor how GBAS performance criteria compare to civil aviation requirements and demonstrate the possible use of GBAS for approach and landing.	3	Integrity, accuracy; appropriate designators.
2.	Reference GNSS ground station	1) Describe the principles of local differential augmentation.	2	Space and time errors correlation.
		2) Describe the architecture of a reference station.	2	Reference ground station (redundancy level of receivers and antennas, monitoring systems, data link, service volume, frequencies).

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	3) Consider institutional issues and service provider responsibilities.	2	Liability, integrity, monitoring and test.
3. GRAS	1) Demonstrate general awareness of the GRAS proposal and of its application to area navigation.	0	
6.10 Satellite-based navigation systems — SBAS			
1. Generalities	1) Describe the architecture of the SBAS systems.	2	Definitions, explain ICAO implementation plan.
	2) Explain message structure of SBAS systems.	2	Messages defined in the MOPS and MASPS.
	3) Explain expected performance of the SBAS.	2	Performance defined in the SARPS.
	4) Explain intended usage of the SBAS.	2	Phases of flight in which SBAS can be used, and types of operations.
	5) List strengths and weaknesses of the SBAS.	1	Large area, limited infrastructure but dependency on GPS and coverage at high latitudes.
2. EGNOS	1) State EGNOS history.	1	Timeline from inception to now.
	2) Draw and explain a diagram illustrating the EGNOS architecture.	1/2	Segments of EGNOS.
	3) Explain EGNOS current status.	2	Validation through ESTB.
	4) Explain EGNOS operation concept.	2	EGNOS operational concept document.
	5) Explain EGNOS institutional issues.	2	EOIG, tripartite, agreement (ETG), relation to GALILEO.
3. WAAS	1) Demonstrate general awareness of the existence of WAAS.	0	
	2) List WAAS architecture.	1	
	3) Explain WAAS current status.	2	WAAS operational.
	4) Explain WAAS issues.	2	Future.
4. MSAS	1) Demonstrate general awareness of the existence of MSAS.	0	
	2) List MSAS architecture.	1	
	3) Explain MSAS current status.	2	MSAS operational.
	4) Explain MSAS issues.	2	Future.
5. Interoperability	1) Explain the interoperability needs of the 3 SBAS.	2	

Topic	Intermediate Objectives. The students should be able to:	Level	Content
	2) Describe the GNSS receivers.	2	
	3) Describe the signal in space (SIS) for the 3 SBAS.		
6.11 Satellite-based navigation systems — ABAS			
1. Generalities	1) State that the improvement of integrity is the main purpose of ABAS.	1	Definitions.
2. Principles	1) Describe and explain the principles of ABAS.	2	RAIM, AAIM.
3. Impact	1) Demonstrate how the principles of ABAS impact on the navigation performance criteria.	2	Integrity, continuity and availability, Baro VNAV.
6.12 Satellite-based navigation systems — Modernized GPS			
1. Improvement of GPS	1) List the improvements of GPS between now and 2015.	1	L2 and L5.
	2) Describe the signal structure of L2 and L5.	2	
	3) Describe the impact of L2 and L5 on the receiver.	2	
	4) List the modernization schedule.	1	
	5) List the future accuracy of the GPS system.	1	
	6) List the limitations of the future GPS system (no integrity, single nation, military control).	1	
6.13 Satellite-based navigation systems — GALILEO			
1. GALILEO	1) Describe the European satellite navigation policy.	2	EU documents.
	2) List the sequence of events that lead to the development of GALILEO.	1	EU decisions.
	3) List the GALILEO schedule.	2	The plan.
	4) Describe the GALILEO costs and benefits analysis (CBA).	1	
	5) Define the current GALILEO architecture.	5	Costs, jobs, market, revenues.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	6) Discuss the distribution of integrity information through GALILEO.	1	GALILEO documents, ground segment, space segment (constellation, signals and frequencies), control segment.
	7) Define the GALILEO services.	1	Compare to GPS.
	8) Define the performance criteria of GALILEO.	5	GALILEO documents.
	9) Discuss the aviation views of GALILEO.	2	The aviation views document.
	10) Discuss the US views of GALILEO.	2	Military views and FAA views.
	11) Discuss the interoperability of GALILEO and GPS.	2	
	12) Discuss the integration of EGNOS in GALILEO.	2	Political views and technical views.
6.14 Satellite-based navigation systems — GNSS2			
1. General view	1) Explain performance improvements over GNSS1.	3	
	2) Define all components of GNSS2.	1	Modernized GPS, GALILEO.
	3) Explain the institutional issues of GNSS2.	2	Control of system, levels of service.
2. Modernized GPS	1) State the US satellite navigation policy.	1	
	2) List the improvements provided by modernized GPS.	1	New civil frequencies (L2 and L5), new signal structure, new control segment, etc.
	3) Evaluate the impact of these improvements.	5	Performances, receiver architecture.
3. GALILEO	1) Explain GALILEO's role in GNSS2 with specific reference to European policy.	2	EU documents.
6.15 On-board navigation architecture			
1. Architecture	1) Describe the current navigation architecture.	2	Sensors, HMI, FMS, navigation data base.
6.16 Display systems			
1. HMI	1) Demonstrate general awareness of the presentation of different HMI.	0	Horizontal situation indicator (HIS), navigation display (ND), primary flight display (PFD).

Topic	Intermediate Objectives. The students should be able to:	Level	Content
6.17 Inertial navigation			
1. Inertial navigation	1) Describe the principles and key features of INS navigation.	2	Sensors and process.
6.18 Vertical navigation			
1. Barometry	1) Describe the principles and key features.	2	QFE, QNH, flight level, ICAO standard atmosphere, phases of flight, link to SSR Mode C and Mode S.
	2) Describe the performances.	2	Accuracy, integrity, availability, requirements, recent improvement (RVSM) capability.
2. Radio altimetry	1) Describe the principles and key features.	2	Phases of flight (approach and landing), safety net, aural warning.
	2) Describe the performance criteria.	2	Accuracy, integrity, availability, requirements.
6.19 Safety attitude and functional safety			
1. Safety attitude	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to navigation system, safety reports and occurrences, safety monitoring.
2. Functional safety	1) Describe the implications of functional failures in terms of exposure time, environment, effect on controller and pilot.	2	Total or partial, premature or delayed operation, spurious, intermittent, loss or corruption of data, missing or incorrect input or output, safety policy, safety policy and implementation, other national and international policies.
6.20 Health and safety			
1. Hazard awareness	1) Demonstrate general awareness of potential hazards to health and safety generated by navigation equipment.	0	Mechanical hazards, electrical hazards (HV, EMI), chemical hazards.
2. Rules and procedures	1) State applicable international requirements.	1	Relevant international documents.
	2) State any applicable legal national requirement.	1	Relevant national documents.
	3) State safety procedure for persons working on or near navigation equipment.	1	Isolation (clothing, tools), fire extinguisher types, safety man presence, safety interlocks, isolating switches, security of the site, climbing procedures.

	Topic		*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
3.	Practical situation	1)	In a practical situation, apply and demonstrate the procedures and techniques to be followed.	2	Replacing fuses or boards, start up/shut down a station, climbing procedures.
4.	Resuscitation techniques	1)	Apply and demonstrate resuscitation techniques.	3/2	First aid, rescue procedures, resuscitation.

Chapter 7

SURVEILLANCE

7.1 INTRODUCTION

Surveillance systems provide a means of relaying essential information for the safe and orderly operation of ANS. They are governed by international and national standards. Surveillance systems can be located anywhere on the airport, in its vicinity, or at a great distance from the airport.

7.2 TRAINING OBJECTIVE

7.2.1 Students shall describe the surveillance systems and equipment of their national ANS provider. It is therefore very important that the ATSEP understand the purpose of each system and piece of equipment and the technical specifications (power, frequencies, connections, etc.).

7.2.2 It is also imperative that the ATSEP understand the effect and impact on the service while working on these systems or equipment.

Condition: In a laboratory environment, given exposure to specific communication equipment along with the appropriate and pertinent training material, reference documentation, test equipment and tools.

Performance: The trainee will be able to perform:

a) preventive maintenance;
b) corrective maintenance;
c) calibration; and
d) certification.

Standard of accomplishment: All maintenance, calibration and certification should be performed as per the approved standards and procedures

7.2.3 This chapter includes twelve parts:

Surveillance/Primary — ATC Surveillance;
Surveillance/Primary — Meteorology;
Surveillance — SMR;
Surveillance/Secondary — SSR and M-SSR;
Surveillance/Secondary — Mode S;
Surveillance/Secondary — SSR Environment;
Surveillance — General View on ADS;
Surveillance — ADS-B;
Surveillance — ADS-C;
Surveillance — HMI;
Safety attitude and functional safety; and
Health and safety.

Topic		Intermediate Objectives. The students should be able to:	Level	Content
		7. Surveillance		
7.1	**Surveillance/Primary — ATC Surveillance**			
1.	Functional safety of PSR	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to primary surveillance system, safety reports and occurrences, safety monitoring.
		2) Describe, in terms of exposure time and environment, the effect on controller and pilot, relative to the types of functional failures.	2	Total or partial failure. Premature or delayed operational implementation. Spurious and intermittent failure or degradation. Loss or corruption of data, missing or incorrect input or output (Ex: Ref: Safety policy and implementation, ESARR).
2.	Use of PSR for en route services	1) Define the operational requirements of an en route radar and calculate the key parameters necessary to achieve this performance.	1/3	Range, resolution, coverage, probability of detection, MTBF, availability, PRF, frequency WRT range, frequency diversity, blind speed, range WRT Tx power, antenna gain, receiver MDS, update rate, PD WRT resolution, PRF, beam-width, extractor minimum target threshold.
		2) State the key parameters of an en route primary radar.	1	Frequency, PRF, rotation rate, power.
3.	Use of PSR for terminal and approach services	1) Define the operational requirements and special parameters of an approach radar and calculate the key parameters necessary to achieve this performance.	1/3	ASR, SMR, range, resolution, coverage, update rate, probability of detection, MTBF availability, PRF, frequency WRT range, frequency diversity, blind speed, range WRT Tx power, antenna gain, receiver MDS, update rate, PD WRT resolution, PRF beam-width, extractor minimum target threshold, PD WRT weather, polarization.
		2) State the key parameters of an approach primary radar.	1	Frequency, PRF, rotation rate, power.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
4. Antenna (PSR)	1) Describe antenna types, accuracy and problems.	2	Antenna beam, sidelobes, reflector antenna, active (phased array) antenna, rotating joints, waveguide interface, pressurization de-humidification, polarization, azimuth encoding, drive systems, lubrication system.
5. Data Transmission (PSR)	1) Describe the requirements of radar data transmission.	2	Latency, redundancy, quality, error detection.
	2) Describe the implementation options.	2	ASTERIX, RADNET, RMCDE, HDLC, X25, ETHERNET, FDDI.
	3) Decode all the details from an ASTERIX message.	3	Type range, azimuth and time, etc.
	4) Decode data from a locally used message format.	3	As appropriate to local format.
	5) Describe the specialized test tools and their purpose in maintaining the correct operation of the system.	2	Data analyser, line analyser, debug, BITE, spectrum analyser, vector voltmeter, oscilloscope, etc.
	6) Interpret fault report based on various test tool measures.	5	Data analyser, line analyser, debug, BITE, spectrum analyser, vector voltmeter, oscilloscope, etc.
	7) Operate test tools to analyse the system.	3	Vector voltmeter, oscilloscope.
	8) Design a radar network comprised of four radar sites feeding two control units, with full redundancy.	4	Fault tolerance, redundancy of line equipment, software fallback capability.
	9) Characterize system degradations.	2	Saturation, late plots, DRC, latency.
6. Transmitters	1) Describe the basic characteristics of a transmitter.	2	Timing, coherency, modulation, pulse width, pulse energy, frequency agility power output devices (details of pro-cons).
	2) Describe the signals at all key points in a block diagram.	2	Supply, EHT, RF source (appropriate to type chosen), modulation, interlocks, BITE.
	3) Draw and explain a generic transmitter block diagram for both a compressed and non-compressed system.	1/2	Klystron, magnetron, travelling wave tube, solid state.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
	4) List the possible failures and where they can occur with reference to the block diagram.	1	Arcing, corona discharge, component stress, control loops, isolation. Example design for HV stabilization.
	5) Describe the constraints and problems on the high voltage circuitry.	2	Corona discharge, dielectric stress, isolation, arcing, ageing, interlocks, stability (including control loop), health and safety.
	6) Describe methods to diagnose faults.	2	Crystal detectors, spectrum. Analyser, calorimeter, power meters, BITE.
	7) Operate measuring equipment.	3	Crystal detectors, spectrum. Analyser, calorimeter, power meters, BITE.
	8) Using special techniques, detect faults.	4	Crystal detectors, spectrum. Analyser, calorimeter, power meters, BITE.
7. Characteristics of primary targets	1) Describe the characteristics of a primary target.	2	Backscatter, radar cross section, reflectivity, stealth technologies, aspect, doppler shift.
8. Receivers	1) Describe the basic characteristics of a receiver.	2	Low noise, high dynamic range, bandwidth, detection, frequency, sensitivity, selectivity.
	2) Draw and explain a generic receiver block diagram.	1/2	LNTA, local oscillator, coherent oscillator, down mixing, filtering, rejection, IF, PSD, AGC, STC, beam switching, BITE.
	3) Explain the importance of STC.	2	Saturation, RF-IF dynamic range.
	4) Describe the special testing methods and techniques which are required.	2	Termination, crystal detector, range azimuth triggering, test target injection, power measurement, spectrum analyser.
9. Plot extractions	1) Describe the basic function of a data processor.	2	Plot extraction (range bin reports, range correlation, azimuth correlation), target reports, weather vector generation, sliding window, centre of gravity.
10. Signal processing	1) Describe the basic functions of a modern radar signal processor.	2	A/D-Conversion, I/Q-matching, target detection, detection criteria (fixed, adaptive), MTD and clutter-maps.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
11. Surveillance processing	1) Describe the processing techniques to improve the quality of target reports using scan to scan information.	2	Tracking, environment mapping, adaptive feedback to extraction parameters.
12. Displays	1) Describe the basics of PPI displays with long persistence phosphor and electronic retiming.	2	Plan position indicator (PPI), time basis, re-scanners, video data.
13. Control tests and monitoring	1) Describe testing possibilities.	2	BITE System in modern equipment (online, offline), SASS (C&F).
14. Unique characteristics of primary radar	1) Explain the basic principles of electromagnetism, propagation, signal detectability, power generation and distribution, problems on transmitters and receivers (general).	2	Basic fundamentals frequency and phase, electromagnetic radiation, spectrum and bandwidth, noise, powertubes, waveguide problems.
	2) Describe the radar in the ATC environment.	2	Non safety critical element, target identification, operational coverage area, relative and absolute accuracy.
15. PAR	1) Explain the basic principles of PAR.	2	Elevation and azimuth scanning (mechanical, electronic) capable of approach guidance independently of avionics.
7.2 Surveillance/Primary — Meteorology			
1. Meteorological radar	1) List the main type of information provided by weather radar.	1	Weather radar, wind profile radar, wind shear radar.
	2) Describe the combining of a weather channel in a surveillance radar.	2	Scan rate, polarization, limited height estimation frequency.
	3) State the characteristics of a meteorological radar.	1	Range, power, scan rate, AE type, Rx processing.
7.3 Surveillance — SMR			
1. Functional safety of SMR	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to SMR, safety reports and occurrences, safety monitoring.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
	2) Describe, in terms of exposure time and environment, the effect on controller and pilot, relative to the types of functional failures.	2	Total or partial failure. Premature or delayed operational implementation. Spurious and intermittent failure or degradation. Loss or corruption of data, missing or incorrect input or output (Ex: Ref: Safety policy and implementation, ESARR).
2. Use of radar for aerodrome services	1) Define the operational requirements of an SMR and calculate the key parameters necessary to achieve this performance.	2/3	Range, resolution, coverage, update rate, probability of detection, MTBF availability, PRF, frequency, range WRT Tx power, antenna gain, receiver MDS, update rate PD WRT resolution, PRF beam-width, PD WRT weather, polarization.
3. Radar sensor	1) Draw and explain a layout of the SMR sensor system.	1/2	Dual system, service display.
	2) Describe the basic functions of the receiver/transmitter unit.	2	Hardware/function overview.
	3) Describe how to operate a sensor.	2	Block diagram, timing relations, video path, frequency agility, frequency diversity, polarization, controller structure.
	4) Describe the basic functions of the antenna unit.	2	Hardware function overview, control/switch unit, external interface, azimuth encoding.
4. SMR display system	1) Describe the layout of the SMR display system and its capabilities.	2	Hardware block diagram, software structure, external interfaces.
	2) Describe the basic functions of the display SMR system.	2	Video processing and tracking, map creation and blanking.
	3) Describe how to operate the system.	2	Sensor interface, scan to scan correlator processor, identification and alerting, display subsystem, control and monitoring system.
7.4 Surveillance/Secondary — SSR and M-SSR			
1. Functional safety of SSR	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to secondary surveillance system, safety reports and occurrences, safety monitoring.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	2) Describe the effect on the controller and pilot, with respect to the types of functional failures.	2	Total or partial failure. Premature or delayed operational implementation. Spurious and intermittent failure or degradation. Loss or corruption of data, missing or incorrect input or output (Ex: Ref: Safety policy and implementation, ESARR).
2. Use of SSR for en route services	1) Define the operational requirements for an en route radar and identify the key parameters necessary to achieve this performance.	1	Range, coverage, PD, resolution, performance, update rate, PRF, interface, rotational speed, power budget (uplink, downlink) Ref: ICAO *Manual of the SSR systems* (Doc 9684).
	2) State the key parameters of an en route secondary radar.	1	Rotation rate, PRF, interface, capacity.
	3) Describe, in terms of exposure time and environment, the effect on controller and pilot relative to the types of functional failures.	2	Total or partial failure. Premature or delayed operational implementation. Spurious and intermittent failure or degradation. Loss or corruption of data, missing or incorrect input or output (Ex: Ref: Safety policy and implementation, ESARR).
3. Use of SSR for terminal and approach services	1) State the key parameters of an approach SSR radar.	1	Tx power, receiver MDS, rotation speed, PRF, interface, electronic scanning.
	2) Describe, in terms of exposure time, environment, the effect on controller and pilot, relative to the types of functional failures.	2	Total or partial failure. Premature or delayed operation implementation. Spurious and intermittent failure or degradation. Loss or corruption of data, missing or incorrect input or output (Ex: Ref: Safety policy and implementation, ESARR).
4. Antenna (SSR)	1) Describe the principle of SSR/MSSR antenna.	2	Active antenna, monopulse antenna, LVA, waveguide, phasing – monopulse antenna, sum, difference and control pattern. Error angle measurement, beam sharpening.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
5. Data transmission (SSR)	1) State that primary radar and secondary radar data transmissions are using the same techniques.	1	See PSR data transmissions for details (this objective requires that PSR transmission objective has been covered).
	2) Describe data message output from secondary equipment.	2	Type, range, Azimuth, A and C codes (12 bit), emergency, validation, garble.
	3) Describe the requirements of radar data transmission.	2	Latency, redundancy, quality, error detection.
	4) Describe the implementation options.	2	Point to point network.
	5) Decode all the details of an ASTERIX message.	3	Call sign, range, azimuth, altitude, time, SPI and emergency, etc.
6. Interrogator	1) Describe the characteristics of an interrogator.	2	Frequency, spectrum, interrogation modes, duty cycle, SLS, IISLS, rotational interlock.
	2) Draw and explain a generic interrogator block diagram.	2	Timing, interface, modulator, BITE.
	3) Explain the need for integrity monitoring.	2	Safeguards against erroneous transmission, BITE.
7. Transponder	1) Explain the operational use of the transponder.	2	Diagram of interaction between transponder and aeroplane.
	2) Define the global performances.	1	Range, accuracy, fixed delay to respond.
	3) Describe the basic characteristics of a transponder.	2	Dual electronics, aerial location/switching and polar diagram, size, ACAS MODE-S compatibility, maximum replay rate, ISLS.
	4) Explain the advantages of the transponder.	2	Longer range, more information.
	5) Explain the limitations of the transponder.	2	100’s of feet precision, 3A limited codes, squawk switch.
	6) Describe the HMI presented to the pilot.	2	Mode 3A switch settings, SPI.
	7) Check the conformity to national regulations.	3	National regulations corresponding to ICAO Annex 10.
	8) Describe the data format of the received transponder messages.	2	P1, P2, P3 signals.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	9) Describe the data format of the transmitted transponder messages.	2	Field lengths, data bits, grey code, unused bits.
	10) Decode a transponder message.	3	Standard message with SPI set.
	11) Describe the basic characteristics of a transmitter.	2	Timing, modulation, pulse width, power output, ISLS, IISLS.
8. Receiver	1) Describe the basic characteristic of an SSR receiver.	2	Standard receiver/MSSR receiver, sensibility, bandwidth, dynamic range, STC (normal, sectorized), amplitude processor, phase processor, RSLS, multipath and interferences.
9. Extraction	1) Describe monopulse extraction.	2	Phase and amplitude modulation, off boresight angle calculation, azimuth encoding.
	2) Describe sliding window SSR extraction.	2	Leading edge, trailing edge, azimuth accuracy, azimuth encoding.
10. Signal processing	1) Describe the signal processing.	2	Video-digitizer, pulse processor, reply decoder (bracket pair detector) synchronous replay correlator.
11. Surveillance processing for replay verification	1) Describe the SSR processing techniques.	2	Discrete code correlation, general association, zones, categories, code swapping, general correlation Mode A code data, Mode C data, target position report.
12. Displays (SSR)	1) Describe the SSR display options.	2	Video, video + label, synthetic.
13. Surveillance processing for plot verification	1) Explain the reasons for surveillance processing and the key options.	2	False target identification and elimination, data validation, data correction, reflection identification and processing, enhanced resolution performance.
7.5 Surveillance/Secondary — Mode S			
1. Introduction to Mode S	1) Explain the working principles of Mode S.	2	Mode S interrogation, Mode S reply, Mode S uplink and downlink capability, Mode S formats/protocols.
	2) List the advantages of Mode S.	1	Resolution, integrity, enhanced data (e.g. 25 feet resolution, call sign).

Topic	Intermediate Objectives. The students should be able to:	Level	Content
	3) Explain how Mode S is compatible with MSSR.	2	RF signals in space, the operational use of P1 to P4, the use of side-lobe suppression to control a/c response, all-call and lockout facility, timescales.
	4) Explain Mode S implementation strategy in your area.	2	Elementary surveillance, clusters and II codes.
2. Mode S system	1) Describe the theory of operation of hardware and software.	2	Mode S performance of the system, theory of operation of the system, interfaces to customer equipment, other Mode S station clusters.
	2) Describe testing possibilities for Mode S.	2	SASS-C, SASS-S, PTE, RES.
7.6 Surveillance/Secondary — SSR Environment			
1. SSR environment	1) Explain the operational use of ACAS and implications for pilots and controllers.	2	Traffic advisories (TA), resolution advisories (RA), pilot responses and controller information.
	2) Explain the working principles of ACAS.	2	Aircraft interrogations, whisper/shout, cockpit displays and warnings, multipath effects.
	3) Describe the users of the 1 030 Mhz –1 090 Mhz channels.	2	Modes 1, 3, A, C, S, military, Mode S uplink and downlink capability ACAS (TCAS), acquisition and extended squitter, PFR-FRUIT ratios, DME and other interference.
	4) Explain the working principles of multilateration (MLT).	2	Principles of MLT, use of Mode S squitter, benefits for the airport.
7.7 Surveillance — General View on ADS			
1. Definition of ADS	1) Recognize on a diagram all the elements of the ADS.	1	Navigation solution, link, scheduling.
	2) Describe the basic characteristics of an ADS.	2	Contract/broadcast performance, integrity, latency, QoS, implementation options (e.g. ATN/FANS).
	3) List the types of navigation sensors.	1	GNSS, ins, radio Navaids, navigation solutions from FMS, FoM.

Topic		*Intermediate Objectives. The students should be able to:*		*Level*	*Content*
		4)	Demonstrate general awareness of latest developments, implementation plans and projects.	0	Current and recent test and trials, ICAO status, EUROCONTROL, FAA and other authorities positions, airline and equipment manufacturer positions, ATC procedures, timescales.
7.8	**Surveillance — ADS-B**				
1.	Functional safety of ADS-B	1)	Describe, in terms of exposure time and environment, the effect on controller and pilot relative to the types of functional failures.	2	Total or partial failure. Premature or delayed operational implementation. Spurious and intermittent failure or degradation. Loss or corruption of data, missing or incorrect input or output (Ex: Ref: Safety policy and implementation, ESARR).
2.	Introduction to ADS-B	1)	Explain the basic principles of ADS-B.	2	Autonomous operation, navigation solutions, link options, aircraft situation awareness. Navigation solution, FMS, encoding, scheduling, link.
		2)	Differentiate on a diagram all the possible elements of ADS-B.	2	
		3)	Define the ASAS concept.	1	
		4)	Explain the use of ADS in support of the ASAS concept.	2	
3.	Techniques in ADS-B	1)	Explain the characteristics of the techniques used in ADS-B.	2	Mode S extended squitter, UAT.
		2)	List the advantages/limitations of ADS-B.	1	Advantages (global situational awareness, minimum ground investments, remote areas); limitations (level of confidence, use according to density of traffic).
4.	VDL Mode 4 (STDMA)	1)	Describe the use of VDL Mode 4.	2	High level description.
		2)	Use the ICAO documentation to explain the principles relating to signals in space.	3	Modulation scheme, signal structure, key data and frequency channels.
		3)	Use the ICAO documentation to explain the principles relating to access technology.	3	Timing, self organizing reservation mechanism.

Topic	Intermediate Objectives. The students should be able to:	Level	Content
	4) Explain the relevant protocols.	2	Burst structure (fields, fixed part, variable part).
	5) Explain the relevant messages.	2	Information in each field, information encoding and decoding.
	6) Describe a VDL Mode 4 signal.	2	Show signal timings (remark: it is not a single package, it is a set of messages).
	7) Decode and analyse a signal coded according to the Asterix relevant standard.	3/4	Reference to Asterix standard.
5. Mode S extended squitter	1) Describe the use of the Mode S extended squitter.	2	High level description.
	2) Use the ICAO documentation to explain the principles relating to signals in space.	3	Modulation scheme, signal structure, key data and frequency.
	3) Use the ICAO documentation to explain the principles relating to random access technology.	3	Consequences on the RF environment (1 090 MHz).
	4) Explain the relevant messages.	2	Information in each field, information encoding and decoding.
	5) Decode and analyse a Mode S extended squitter signal.	3/4	Signal timing and sequencing, position encoding.
	6) Decode and analyse a signal coded according to the Asterix relevant standard.	3/4	Reference to Asterix standard.
7.9 Surveillance — ADS-C			
1. Functional safety of ADS-C	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation relating to ADS-C technique, safety reports and occurrences, safety monitoring.
	2) Describe, in terms of exposure time and environment, the effect on controller and pilot, relative to the types of functional failures.	2	Total or partial failure, premature or delayed operation implementation. Spurious and intermittent failure or degradation. Loss or corruption of data, missing or incorrect input or output (Ex: Ref: Safety policy and implementation, ESARR).
2. Introduction to ADS-C	1) Explain the basic principles of ADS-C.	2	Contract, multi-contract, time, event triggering, long latency.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	2) Differentiate on a diagram all the possible elements of the ADS-C system.	3	Navigation solution, processor, link, ground station.
3. Techniques in ADS-C	1) Explain the characteristics of the techniques possibly used in ADS-C.	2	ATN application, ATN air–ground sub-networks (VDLs, Mode S DL, AMSS, HDL).
	2) List advantages and limitations of the ADS-C system.	1	Advantages (minimum ground investment, remote area); limitations (quality of service, latency, common mode of failure).
	3) Explain the relevant messages.	2	Information in each field, information encoding and decoding.
	4) Decode the ADS-C messages coming from the ATN router.	3	Decode and analyse a signal coded according to the relevant standard (ADS Panel documentation).
	5) Identify and locate data transmission problems.	3	Subject to system development and availability.
7.10 Surveillance — HMI			
1. ATCO HMI	1) Describe the display types available.	2	Video, synthetic, mixed.
	2) State the type of selections available.	1	Source, range, maps, filters.
	3) Describe the advantages of different display types.	2	Clarity, configurability, fallback, data integration.
2. ATSEP HMI	1) Describe the user interface scope and ergonomics as seen by different users and at different locations.	2	System management displays characteristics, both control and monitoring.
	2) Describe the analytical and status data available to the users.	2	Radar video, front panel and CMS data. HMIs on each subsystem.
3. Pilot HMI	1) Describe the transponder interface.	2	Mode A, change procedure, SPI.
	2) Demonstrate general awareness of the ACAS/TCAS display and of future potential developments.	0	Mode C, de-selection, hijack.
	3) Demonstrate general awareness of the EGPWS display and of future potential developments.	0	Characteristics, accuracy, alerts, ADS-B, CDTI.

Topic		Intermediate Objectives. The students should be able to:		Level	Content
4.	Displays	1)	Describe the display types available and their advantages and disadvantages.	2	Raster/rotating, raw/synthetic, monochrome/colour, CRT/LCD, performances (cost, availability, maintainability, ergonomics).
7.11	**Safety attitude and functional safety**				
1.	Safety attitude	1)	State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to surveillance system, safety reports and occurrences, safety monitoring.
2.	Functional safety	1)	Describe the implications of functional failures in terms of exposure time and environment, and the effect on controller and pilot.	2	Total or partial, premature or delayed operation, spurious, intermittent, loss or corruption of data, missing or incorrect input or output. Ref: EUROCONTROL EATCHIP safety policy, safety policy and implementation, other national and international policies.
7.12	**Health and safety**				
1.	Hazard awareness	1)	Demonstrate general awareness of potential hazards to health and safety generated by surveillance equipment.	0	Mechanical hazards, electrical hazards (HV, EMI), chemical hazards, radiation hazards.
2.	Rules and procedures	1)	State applicable international requirement.	1	Relevant international documents.
		2)	State any applicable national legal requirements.	1	Relevant national documents.
		3)	State the safety procedures for persons working on or near surveillance equipment.	1	Isolation (clothing, tools), fire extinguisher types, safety man presence, safety interlocks, isolating switches, security of the site.
		4)	State the rules and procedures relevant to the manipulation and storing of hazardous products and environmental protection.	1	Relevant company procedures.
3.	Practical situations	1)	In a practical situation, apply and demonstrate the procedures and techniques to be followed.	3/2	e.g. Changing wave guide, replacing fuses or boards, start up/shut down a station.
4.	Resuscitation techniques	1)	Apply and demonstrate resuscitation techniques.	3/2	First aid, rescue procedures, resuscitation.

Chapter 8

DATA PROCESSING

8.1 INTRODUCTION

Data processing systems provide the means of relaying essential information for the safe and orderly operation of ANS. Data processing includes a combination of hardware platforms and operating system software. Proper hardware and software configurations are essential for a safe and orderly ANS. These systems are governed by international and national standards. Data processing systems can be located anywhere at the ACC, on the airport, or in its vicinity, or remote from the ACC or airport.

8.2 TRAINING OBJECTIVE

8.2.1 Students shall describe the data processing systems and equipment of their national ANS provider. It is therefore very important that the ATSEP understand the purpose of each system and piece of equipment, and the technical specifications (software, hardware, interoperability, connections, etc.).

8.2.2 It is also imperative that the ATSEP understand the effect and impact on the service while working on these systems and equipment.

Condition: In a laboratory environment, given exposure to specific communication equipment along with the appropriate and pertinent training material, reference documentation, test equipment and tools.

Performance: The trainee will be able to perform:

a) preventive maintenance;
b) corrective maintenance;
c) calibration; and
d) certification.

Standard of accomplishment: All maintenance, calibration and certification should be performed as per the approved standards and procedures.

8.2.3 This chapter includes nine parts:

Data processing — User functional view;
Data processing chain;
Data processing — Software process;
Data processing — Hardware platform;
Data processing — Data essential features;
Data processing — Life cycle;
Data processing — Aviation data detailed structure;
Safety attitude and functional safety; and
Health and safety.

Topic and Subtopic		Objectives. The students should be able to:		Level	Content
8. Data Processing					
8.1 Data processing — User functional view					
1.	Tools for ATM strategy	1)	Explain the main features of your strategy in your area.	2	Give examples of strategy; Ex: ICAO, EUROCONTROL, etc.
2.	Controller role development	1)	Explain the controller role development.	2	
3.	ATC data processing directions for change overview	1)	Demonstrate general awareness of the projects concerning ATC data processing.	2	
4.	Trajectories– prediction, calculation and negotiation	1)	Explain the main process.	2	
		2)	State what decisions are predicated on these calculations.	1	
5.	Collaborative planning and decision making	1)	Demonstrate general awareness of the current state of research and regulations in this area.	0	
6.	FMS development	1)	Demonstrate general awareness of the current state of the art in this area.	0	
7.	Ground safety nets	1)	List the safety nets, their functions and their legislative status.	1	
8.	Decision support	1)	List the steps in ATM traffic planning process.	1	ATFM with strategic, pre-tactical and tactical, ATC sector planning, tactical control.
		2)	List the four areas of improvement for ATC decision support.	1	Conflict detection, conflict resolution, traffic complexity reduction, acquisition of aircraft data.
		3)	Explain the principles of trajectory prediction, conformance monitoring and medium- and short-term conflict detection.	2	
		4)	Discuss the benefit of these tools for safety and efficiency.	5	

Topic and Subtopic	*Objectives. The students should be able to:*	*Level*	*Content*
9. Arrival, departure and surface movement management	1) Demonstrate general awareness of current developments and future possibilities.	0	
10. Operational aspects of future communication and surveillance support	1) Demonstrate general awareness of current developments and future possibilities.	0	
11. Collaborative ATC, delegation of separation	1) Demonstrate general awareness of current developments and future possibilities.	0	
8.2 Data processing chain			
1. Flight data processing	1) Demonstrate general awareness of the system scope of FDPS and the life cycle of the FPL.	0	Automation levels, FDPS, core FDP functions, added FDP functions.
2. Surveillance data processing	1) Demonstrate general awareness of the system scope of SDPS and the life cycle of the major data items.	0	Data distribution, radar plots, mono radar tracks, multi radar tracks, ADS report.
3. Associated DPC functions	1) List the associated DPC functions.	1	Correlation, vertical tracking, conflict prediction.
8.3 Data processing — Software process			
1. Middleware	1) Define middleware.	1	Additional specialized functional, built on the OS.
	2) List the middleware used on the national major systems.	1	E.g. CORBA, UBSS, OTM, EJB.
	3) Demonstrate the use of a middleware in an ATM environment.	2	Duel processing system.
2. Operating systems	1) Perform operating systems commands, exercising the major features of a target OS.	3	Unix, Linux, Windows etc. according to the systems in use.
	2) Characterize consequences of an OS upgrade.	2	List the possible implications on HW (performance, memory, etc.), middleware (compatibility) and SW components.
	3) Explain downward compatibility.	2	Checks on embedded SW modules ability to run under new OS-version.
	4) Take account of hardware/software compatibility.	2	HW-requirements of specific SW implementations.

Topic and Subtopic		Objectives. The students should be able to:		Level	Content
		5)	Describe interactions between application and OS.	2	Examples of OS-calls by the application software if no middleware is in use.
3.	Software development process	1)	List the main software development processes used in industries.	1	e.g. Lifecycle, waterfall model, RUP.
		2)	List the main steps of the classical process.	1	Specification, analysis, design, realization, test.
		3)	List the main elements of RUP.	1	Iterative development, management, UML.
		4)	List the main differences between RUP and classical process.	1	Advantages and disadvantages of the different methods.
		5)	List the main differences of the various methods.	1	Advantages and disadvantages of the different methods.
		6)	Discuss the advantages, disadvantages and constraints from the RUP and procedural process.	5	
8.4	**Data processing — Hardware platform**				
1.	Equipment upgrade	1)	Identify the key points that have to be considered when EDP equipment is upgraded (or changed).	3	Specification, compatibility, “proven technology” or “state-of-the-art”, maintenance and operating consequence (e.g. personnel, training, spares, procedures), environmental requirements (e.g. size, power requirements, temperature, interfaces), testing.
2.	COTS	1)	Explain the advantages and disadvantages of commercial off the shelf equipment.	2	Cost, multiplicity of suppliers, quality, maintainability, life-cycle, liability.
3.	Interdependence	1)	Describe the technical issues regarding the interdependence of various equipment and systems.	2	Interface requirements, common point of failure, data conditioning, response time.
4.	Maintainability	1)	Identify the issues that will affect the maintainability of hardware for the planned life of a system.	3	Commercial product life, commercial support commitments, company volatility, spares provision, shelf life and logistics.
5.	Awareness of details of hardware platform	1)	Demonstrate general awareness that further studies shall be done during type rating.	0	

Topic and Subtopic	*Objectives. The students should be able to:*	*Level*	*Content*
8.5 Data processing — Data essential features			
1. Data significance	1) Explain the significance of data.	2	Criticality (critical, non critical), legality (ICAO, CAA, company), use (advisory, control).
2. Data configuration control	1) Name who is designated to authorize changes in operational data.	1	Mechanisms and procedures.
	2) Name who verifies and checks the changes.	1	Appropriate details from a system used in house.
	3) Explain the control procedure on data.	2	Appropriate details from a system used in house.
3. Data responsible authority	1) Name the authority responsible for standards.	1	Speed of light, nautical mile, world geodesic model, aircraft performance.
4. Data standards	1) List the standards related to aviation, their sources and their status.	1	ASTERIX, WGS84, OLDI, FPL.
	2) Use defining documents to encode and decode a typical ATC data item.	3	The EUROCONTROL official defining documents to encode and decode typical plot data in ASTERIX.
8.6 Data processing — Life cycle			
1. Appropriate model	1) Apply the appropriate model to the analysis of a relevant aviation system.	3	V model, waterfall, requirements, design, coding, testing, maintenance, cover detailed description of approved model(s) used in the administration.
2. Domain orientation	1) Demonstrate general awareness of nature of aviation processing requirements.	0	Data volatility (e.g. radar), system integrity. Consequence of failure.
3. Coding practice	1) Describe the coding practices in your own ATM environment.	2	
	2) Demonstrate the application of coding practice on a target language.	3	C, C++, ADA, Pascal.
4. Configuration control	1) Describe the principles of configuration control.	2	Clear identification of all versions, proof of testing and “build state”, tool and mechanisms to aid control, authorization, audit trail, appropriate quality standard requirements of the administration.

Topic and Subtopic	Objectives. The students should be able to:	Level	Content
5. Testing	1) Identify the techniques available in software testing, for both functional and integrity testing.	3	Test specifications, user requirements, performance requirements, code walkthrough, modelling, simulation real time and fast time, black box testing, regression testing, formal methods, use of independent test personnel.
	2) Identify the techniques available in system testing and integration.	3	System integration testing, load testing, hardware failure simulation, data corruption simulation.
8.7 Data processing — Aviation data detailed structure			
1. System sarea	1) List the elements of system area.	1	
	2) Describe the structure of the data related to system area.	2	
2. Characteristics points related to geography	1) List the type of variables.	1	Airports and runways, ILS, radar characteristics for ocp, limits points.
	2) Describe the structure of all these variables.	2	Airports and runways, ILS, radar characteristics for ocp, limits points.
	3) Choose constants and variables.	3	
3. Characteristics points related to routing and sectors	1) List the type of variables.	1	Coded routes, SID allocation parameters, adjacent FIRs, sectors, holding.
	2) Describe the structures of these variables.	2	Coded routes, SID allocation parameters, adjacent FIRs, sectors, holding.
	3) Choose constants and variables.	3	
4. Aircraft performances	1) List the performance data used in FDPS.	1	Example of data from in-house system.
	2) Describe the structure of aircraft performance data.	2	
	3) Define speeds, rates, levels.	1	
	4) Explain the consequences of the use of the wrong type of aircraft.	2	
	5) Demonstrate general awareness of the latest developments in FMS and DL.	0	

Topic and Subtopic	*Objectives. The students should be able to:*	*Level*	*Content*
5. HMI interface parameters (Screen manager descriptives)	1) Describe the basic functions of the display SMR system.	2	Screen manager description, strip format, function eligibility, HCP header information, SDD parameters, descriptive line numbers.
	2) Describe the layout of the display system and its capabilities.	2	Screen manager description, strip format, function eligibilities, HCP header information, SDD parameters, descriptive line numbers.
	3) Describe how to operate the system.	2	
	4) Handle the operational HMI and assist in the tuning of the screens.	3	
6. Auto coordination messages	1) Describe the meaning of every coordination message in the control process.	2	Coordination parameters, conditions groups, OLDI conditions groups, characteristics of remote centres (civil and military).
	2) Describe the characteristics of the remote centres relevant to OLDI.	2	
7. Configuration control data	1) Explain the structure of the configuration data.	2	Sector CSU link, sectorization plan, control parameters.
8. Physical configuration data	1) Explain the structure of the physical configuration data.	2	External configuration, device configuration.
9. Relevant meteo data	1) Explain the organization of the data related to meteorology.	2	Meteo, QNH TL areas, CB activity.
10. Alert and error messages to ATSEP	1) Characterize the importance of each message.	2	
	2) Describe one message of each category of importance.	2	
11. Alert and error messages to ATCO	1) Describe the structure of the data used in these types of message.	2	MSAW, conflict alert parameters.
	2) List the alerts and messages and explain their importance from an ATCO point of view.	1/2	MSAW, conflict alert.
	3) Identify the importance of alert and error messages through studies of real or mocked cases.	3	

Topic and Subtopic	Objectives. The students should be able to:	Level	Content
8.8 Safety attitude and functional safety			
1. Safety attitude	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to data processing system, safety reports and occurrences, safety monitoring.
2. Functional safety	1) Describe the implications of functional failure in terms of exposure time and environment, and the effect on controller and pilot.	2	Total or partial, premature of delayed operation, spurious, intermittent, loss or corruption of data, missing or incorrect input or output. Ref EATMP safety policy, safety policy and implementation, other national and international policies.
3. Software integrity and security	1) Appreciate how a system can be protected against potential hostile intent via the data processing systems.	3	Input verification, secure sources e.g. leased lines, private networks, eligibility, etc.
	2) Appreciate how the normal output of a system could be used by non-authorized persons with hostile intent.	3	Terrorists using radar data to coordinate an attack.
	3) Estimate the impact of security and integrity failure to the operational service.	3	E.g. system crashes due to incorrect input data, main and standby and fallback systems all have same input, possible loss in total system. Results in capacity reductions and safety consequences, etc.
	4) Appreciate error detection and handling in data, hardware and process.	3	Identification, consequence, scope, reporting, fault tolerance, soft fail, failsafe, monitoring, fallback.
8.9 Health and safety			
1. Hazard awareness	1) Demonstrate general awareness of potential hazards to health and safety generated by data processing equipment.	0	Mechanical hazards, electrical hazards (HV, EMI), chemical hazards.
2. Rules and procedures	1) State applicable international requirement.	1	Relevant international documents.

Topic and Subtopic	*Objectives. The students should be able to:*	*Level*	*Content*
	2) State any applicable legal national requirement.	1	Relevant national documents. Isolation (clothing, tools), fire extinguisher types, safety man presence, safety interlocks, isolating switches, security of the site.
	3) State safety procedure for persons working on or near data processing equipment.	1	Relevant company procedures.
	4) State the rules and procedures relevant to the manipulation and the storing of hazardous products and environmental protection.	1	
3. Practical situations	1) In a practical situation, apply and demonstrate the procedures and techniques to be followed.	3/2	E.g. changing parts, replacing fuses or boards, start up/shut down a station.
4. Resuscitation techniques	1) Apply and demonstrate resuscitation techniques.	3/2	First aid, rescue procedures, resuscitation.

Chapter 9

POWER SUPPLY

9.1 INTRODUCTION

9.1.1 Power supply equipment and systems provide a vital role in the operation of CNS/ATM systems and consequentially in the safe and orderly operation of ANS. The quality, availability, capacity and reliability of electrical power supply sources, equipment and systems are among the basic technical prerequisites for high integrity and reliability of CNS/ATM systems.

9.1.2 Proper design, installation and maintenance of an electrical power supply system for CNS/ATM systems and equipment are prerequisites for the safety, regularity and efficiency of civil aviation. They are governed by international and national standards. ATSEP must understand the impact of their work on the user and on the overall CNS/ATM power supply system.

9.2 TRAINING OBJECTIVE

9.2.1 Students shall describe the power supply systems and equipment of their national ANS provider. It is very important that the ATSEP understand the purpose of each system and piece of equipment, the technical specifications and the impact of the service on the users.

9.2.2 As there are many aspects to power supply systems, this chapter has been divided into six parts, and each part addresses a specific aspect of the power supply.

Condition: In a laboratory environment, given an exposure to specific power supply equipment along with the appropriate and pertinent training material, reference documentation, test equipment and tools.

Performance: On the power supply systems covered in this chapter, the learner will perform:

a) preventive maintenance;
b) corrective maintenance;
c) calibration; and
d) certification.

Standard of accomplishment: All maintenance should be performed as per the approved standards and procedures.

9.2.3 This chapter includes seven parts:

Power distribution;
UPS (Uninterruptible Power Supply);
Engine generator set (GenSet);
Batteries and battery stations;
Power supply network;

Safety attitude and functional safety; and
Health and safety.

Topic		Intermediate Objectives. The students should be able to:		Level	Content
			9. Power Supply		
9.1	**Power distribution**				
1.	Introduction	1)	Describe the power distribution system at a typical site.	2	Commercial net, UPS, engine generator set, battery stations, redundancy, solar systems.
		2)	Design the block diagram of the power distribution system at a typical site.	4	Components.
2.	Safety	1)	Explain any appropriate local and ICAO regulation in force.	2	Company rules.
		2)	Discuss the precautions to be taken when working on power equipment.	5	High voltage, earthling techniques, personal safety, precaution to take to handle batteries.
9.2	**UPS (Uninterruptible Power Supply)**				
1.	Design and operational requirements	1)	Explain the importance and use of UPS systems.	2	Operational and technical point of view (CNS/ATM equipment demands) and ICAO Standards table, organization of maintenance.
		2)	Design a block diagram of a UPS.	4	Inputs/outputs, rectifier, inverter, converter, static switch, control panel, filters, bypass, batteries.
		3)	Analyse and interpret the components and performances of a UPS.	5	Inputs/outputs, rectifier, inverter, converter, static switch, control panel, filters, bypass, batteries.
		4)	Check and troubleshoot an existing UPS.	5	Monitoring, maintenance, periodic testing.
9.3	**Engine generator set (GenSet)**				
1.	Design and operational requirements	1)	Explain the importance and use of GenSet systems.	2	Operational and technical point of view (CNS/ATM equipment demands) and ICAO Standards table, organization of maintenance.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	2) Design a block diagram of GenSet system.	4	Engines, generator, control panel, power transfer switch, bypass, fuel system, air supply system and filters.
	3) Analyse and interpret the components and performances of GenSet.	5	Engines, generator, control panel, power transfer switch, bypass, fuel system, air supply system and filters.
	4) Check and troubleshoot an existing GenSet.	5	Monitoring, maintenance, periodic testing.
9.4 Batteries and battery stations			
1. Design and operational requirements	1) Explain the importance and use of batteries and battery stations.	2	Operational and technical point of view (CNS/ATM equipment demands) and ICAO Standards table, organization of maintenance.
	2) Design a block diagram of a battery station.	4	Batteries, connections (parallel, serial), chargers, types, characteristics.
	3) Explain and analyse the main components and performances of batteries and battery station.	5	Batteries, connections (parallel, serial), chargers, types, characteristics.
	4) Check and troubleshoot an existing battery station.	5	Monitoring, maintenance, periodic testing.
9.5 Power supply network			
1. Design and operational requirements	1) Explain the importance of a power supply network for a CNS/ATM system.	2	Operational and technical point of view (CNS/ATM equipment demands) network types and circuits (HV, LV, primary, secondary, power lines/cables), redundancy.
	2) Design a block diagram of a power supply network for a CNS/ATM system.	5	Fuses, circuit breakers, contactors, relays, measuring and protection devices, distribution boards.
	3) Check and troubleshoot a power supply network.	5	Monitoring, maintenance, periodic testing.
9.6 Safety attitude and functional safety			
1. Safety attitude	1) State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to power supply system, safety reports and occurrences, safety monitoring.

	Topic		Intermediate Objectives. The students should be able to:	Level	Content
2.	Functional safety	1)	Describe the implications of functional failures in terms of exposure time, environment, effect on controller and pilot.	3	Total or partial, premature or delayed operation, spurious, intermittent, loss or corruption of data, missing or incorrect input or output, safety policy, safety policy and implementation, other national and international policy.
9.7	**Health and safety**				
1.	Hazard awareness	1)	Be aware of potential hazards to health and safety generated by power supply equipment.	4	Mechanical hazards, electrical hazards (HV/LV, EMI), chemical hazards.
2.	Rules and procedures	1)	State applicable international requirement.	2	Relevant international documents.
		2)	State any applicable legal national requirement.	2	Relevant national documents.
		3)	State safety procedure for the persons working on or near power supply equipment.	4	Isolation (clothing, tools), fire extinction types, safety man presence, safety interlocks, isolating switches, security of the site, climbing procedures.
3.	Practical situation	1)	In a practical situation, apply and demonstrate the procedures and techniques to be followed.	5	e.g. Replacing fuses or boards, start up/shut down a station, climbing procedures.
4.	Resuscitation techniques	1)	Apply and demonstrate resuscitation techniques.	3	First aid, rescue procedures, resuscitation.

Chapter 10

SYSTEM SAFETY TRAINING

10.1 INTRODUCTION

10.1.1 In each of the previous chapters, the elements of functional safety, safety attitudes and health and safety were discussed at a specific level depending on the field of activities of the ATSEP.

10.1.2 This chapter also deals with safety elements. It complements the information found in each chapter. It relates to safety management and policies, concepts of risk assessment, hazard assessment, etc. So, it is important that ATSEP realize that the safety aspects related to their work are vital and should not be pushed to the side or forgotten about.

10.1.3 Also in this chapter, the ATSEP will be instructed to differentiate between acceptable and unacceptable risk, and between a safe and an unsafe condition.

10.2 TRAINING OBJECTIVE

10.2.1 Students shall describe the system safety training provided by the national ANS. It is therefore very important that ATSEP understand the purpose of each part and relate these safety items to their work.

10.2.2 It is also imperative that ATSEP understand the effect and impact on the service, the user, the systems and equipment, and themselves if they do not follow the proper safety practises.

Condition: Given a description of a specific situation relating to a State ANS provider and the relationship with international and national authorities.

Performance: The trainee will be able to describe:

a) the impact of their safety management programme on their ANS organization; and
b) the principles of safety, the concepts of risk and risk assessment, hazard assessment and safety regulation.

Standard of accomplishment: All the descriptions should include the essential points of the given situation.

10.2.3 This chapter includes seven parts:

Principles of safety management;
ANS safety policy statements and principles;
Concept of risk and principles of risk assessment;
Safety assessment process;
Air navigation system risk classification scheme;
Functional hazard assessment process description; and
Safety regulation.

Topic and Subtopic	Objectives. The students should be able to:	Level	Content
10. System Safety Training			
10.1 Principles of safety management			
1. Principles of safety management	1) Describe the underlying need for safety management policy and principles.	2	Lessons learned from accidents, rising traffic levels, best practice.
	2) Appreciate the reactive and proactive nature of safety management policy and principles.	3	Nature of accidents, reason model, incident investigation, safety assessment.
	3) Explain why safety management policy and principles have to be implemented, not just documented.	2	Principles of safety management, the means of managing safety.
10.2 ANS safety policy statements and principles			
1. ANS safety policy statements and principles	1) Describe the ANS safety policy statement.	2	Safety management, safety responsibility, the priority of safety, the safety objective of ANS.
	2) Describe the ANS safety management principles.	2	Safety achievement, safety assurance, safety promotion.
	3) Relate the safety management principles with the life cycle of an Air Navigation System.	4	Competency, safety culture, quantitative safety levels, system safety assessment, safety surveys, safety monitoring, system safety assessment documentation, lesson dissemination, safety improvement.
10.3 Concept of risk and principles of risk assessment			
1. Concept of risk and principles of risk assessment	1) Describe the concept of risk.	2	Types of risk, components of risk.
	2) Describe ways of measuring risk.	2	Risk comparisons, risk analysis.
	3) Describe the concept of risk tolerability.	2	Risk perception, risk management, risk tolerability, ALARP principle.
	4) Appreciate how risk assessment can aid decision making.	3	Risk assessment, risk contributors (people, procedure and equipment) strengths and limitations of risk assessment.

Topic and Subtopic	*Objectives. The students should be able to:*	*Level*	*Content*
10.4 Safety assessment process			
1. Safety assessment process	1) Describe the concepts of hazardous and failure conditions.	2	
	2) Appreciate the importance of adopting a total system approach covering human, procedural and equipment elements.	3	ATM system description, the need for safety assessment, end to end integrity of safety assessment.
	3) Appreciate the importance of systematic safety assessment for the new generation of air navigation systems.	3	Major characteristic of the new generation of air navigation systems.
	4) Describe the overall safety assessment process and its relationship with risk assessment.	2	Risk-based process, functional hazard assessment, preliminary system safety assessment, system safety assessment.
10.5 Air navigation system risk classification scheme			
1. Air navigation system risk classification scheme	1) Describe the air navigation system risk classification scheme.	2	Failure scenario of air navigation system (incident chain), components of a risk classification scheme, severity classes, probability classes (qualitative and quantitative).
	2) Describe the application of the ALARP principle.	2	Risk classification matrix, ALARP application.
10.6 Functional hazard assessment process description			
1. Functional hazard assessment process description	1) Describe the process of functional hazard assessment, including the derivation of safety objectives.	2	Description of the functional hazard assessment process, application of the process on ANS function.
10.7 Safety regulation			
1. Safety regulation	1) Describe the role of safety regulation.	2	The purpose of regulation, objectives of the safety regulation commission, objectives of the safety regulation unit, objectives of the national regulator.
	2) Describe the safety regulation documents and their impact on ANS.	2	ICAO documentation, EUROCONTROL safety regulatory requirements, regulation advisory documentation, national regulation.

Chapter 11

SYSTEM OR EQUIPMENT RATING TRAINING

11.1 INTRODUCTION

11.1.1 After completing phase one basic training and phase two qualification training or having the equivalent knowledge and skills, all ATSEP must undergo training that is specially oriented to the equipment and its environment. The system and equipment rating training is system- and equipment-specific training. This system and equipment rating training will provide training on systems and equipment used in the operational environment, allowing the ATSEP to gain valuable knowledge and skills. Each ATSEP who is rated on a specific piece of equipment or system must receive the associated system and equipment rating training.

11.1.2 The course should be split into three parts:

a) environmental knowledge for the equipment or system;

b) theoretical section of the equipment or system; and

c) practical section enhanced by OJT on the equipment or system.

11.1.3 The system and equipment rating training can be taught at a specialized training centre, at the factory or at the site; however, at least the OJT portion dealing with the environment and logistic support must be done at the operational site.

11.1.4 The level of training will be done up to the lowest replaceable module (LRM) or electronic boards of the system and equipment. The repair of these modules or boards is not taken into account, and if necessary should be done through a specific training session.

11.1.5 For new systems and equipment, the State organization is responsible for foreseeing, planning and providing the training for the ATSEP. This training must be completed prior to the system becoming fully operational. ATSEP who participate in the factory acceptance test (FAT) and the site acceptance test (SAT) must receive the theoretical section of the training.

Condition: In a laboratory environment, given exposure to a specific system or equipment along with the appropriate and pertinent training material, reference documentation, test equipment and tools.

Performance: The trainee will be able to perform:

a) preventive maintenance;
b) corrective maintenance;
c) calibration; and
d) certification.

Standard of accomplishment: All maintenance, calibration and certification should be performed as per the approved standards and procedures.

11.2 ENVIRONMENTAL KNOWLEDGE

This part of the training provides a detailed view of the technical and operational environment of the system and equipment. It gives information on the logistic aspects which can directly influence the system such as power supply, air conditioning, interference, security and handling of spares.

11.2.1 Objectives

11.2.1.1 At the end of this training stage, the trainee must be able to:

a) explain the logistic environment of the system and equipment (access to the station, power supply, air-conditioning, safety rules, etc.);

b) identify and describe the different constituting parts of the system and equipment;

c) identify the main interactions between the system or equipment, and its environment;

d) explain the proper vocabulary relative to the system and equipment; and

e) explain the maintenance procedures.

11.2.1.2 For trainees who might have some previous experience working with that system or equipment, the course could be adapted to teach only the missing information (after having defined the gap).

11.3 THEORETICAL SECTION OF THE EQUIPMENT OR SYSTEM

11.3.1 The purpose of this section is to familiarize the trainee with the system or equipment, in particular with the principles of its design, the different constitutive elements and their interactions and functionality, and the hardware and software elements.

11.3.2 This section of the course will provide in-depth knowledge of the system or equipment by explaining its principles, descriptions, characteristics, performance standards and functionality. This training complements the knowledge received during the phase two qualification training but is specific to the equipment hardware and software components.

11.3.3 The different parts of the system or equipment will be explained in detail. All the information needed to control, calibrate and maintain the equipment, and if necessary provide training on particular new technology which could be used in this equipment, will be provided.

11.3.4 The HMI and SMC (system monitoring and control) parts of the equipment should also be described in detail.

Objectives

11.3.5 At the end of this module, the trainee will be able to meet the following objectives:

a) identify and explain the details of the different components of the system;

b) describe the protocols used and the data flow;

c) explain the different functionality and the performance of the system;

d) explain the significance of the parameters and error messages;

e) explain how to measure and check the different modules and parameters;

f) explain how to perform unit replacement and calibration; and

g) explain the functionality of the HMI and SMC and their operation.

11.4 PRACTICAL SECTION ENHANCED BY ON-THE-JOB TRAINING

11.4.1 The purpose of this section is to give the trainee the practical skills required to apply the knowledge gained in the environment and theoretical courses. These skills will enable the trainee to operate and maintain the equipment.

11.4.2 Within this section, the trainee will perform basic operations, troubleshooting exercises, replacement and testing of faulty modules and alignment and calibration (if needed). The trainee will also apply the procedures particular to the measurement, testing and restarting of the system or equipment in order to certify that it meets the standards.

11.4.3 This section includes practical exercises and OJT training where the trainee works on live equipment under the supervision of an experienced ATSEP or instructor.

Objectives

At the end of this session, the trainee will be able to meet the following objectives:

a) follow the logistic processes and apply the safety procedures (access to the station, power supply, air-conditioning, safety rules, etc.);

b) operate the system or equipment, perform the necessary control and monitoring functions (start or restart, configuration, etc.), including the HMI and SMC;

c) perform checks and determine the cause of any faults by analysing the warnings, errors, alarms or failure messages or indications;

d) measure and verify the parameters;

e) run all available built-in tests, diagnostics and checks on the system or equipment;

f) identify the problem area and faulty module or LRM;

g) perform replacement of units or LRM and calibrate, if required;

h) load the software and configure the system or equipment including the VSP; and

i) restore the system or equipment to an operational mode.

11.5 RATING OF THE ATSEP

11.5.1 After the ATSEP successfully complete the system and equipment rating training and competency assessment, they will obtain their rating.

11.5.2 The assessment shall be designed using criteria based on consistency and reliability as stated in the performance objectives listed in the training plans. The procedures shall also include a performance assessment of each ATSEP during a typical set of exercises or simulation.

11.5.3 The duration of the assessment will depend on the complexity of the system and equipment.

11.5.4 The State organization should abide by the standards of accomplishment described in Chapter 1 of this manual and adhere to the general recommendations described in Chapter 2.

11.6 DOCUMENTATION

The training course, assessment and competency will be documented and logged for each ATSEP.

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Chapter 12

CONTINUATION TRAINING

12.1 INTRODUCTION

12.1.1 The ICAO State letter AN 7/5-01/52 requests States or Air Navigation Service Providers (ANSP) to provide recurrent training to their ATSEP. In order to meet competency requirements and international or national safety regulatory requirements, States or ANSP have to provide refresher training to their ATSEP. For example, in Europe, ESARR 5 sets out the general safety requirements for all ATM services personnel responsible for safety-related tasks within the provision of ATM services across the ECAC area. The specific safety requirements for ATSEP, ESARR 5, require that technical and engineering personnel have and maintain sufficient knowledge and competence.

12.1.2 This chapter provides guidelines to States and ANSP in the preparation and provision of continuation training for ATSEP. Refresher training and emergency training are two types of recurrent training. Conversion training is evolutionary training allowing ATSEP to migrate from a specific work area to another.

12.1.3 In this manual, continuation training is the expression used to describe the following three types of training:

a) refresher training;
b) emergency training; and
c) conversion training.

12.1.4 Continuation training is given to augment existing knowledge and skills and/or to prepare for new technologies.

12.1.5 The objective of continuation training is to ensure that the ATSEP has up-to-date operational knowledge and experience in all required topics. The provision of such training will contribute to the development and maintenance of ATSEP skills, improve the services provided and facilitate the introduction of a competency scheme.

Condition: In a laboratory environment, given exposure to a specific system or piece of equipment along with the appropriate and pertinent training material, reference documentation, test equipment and tools.

Performance: The trainee will be able to perform:

a) preventive maintenance;
b) corrective maintenance;
c) calibration; and
d) certification.

Standard of accomplishment: All maintenance, calibration and certification should be performed as per the approved standards and procedures.

12.2 REFRESHER TRAINING

12.2.1 Introduction

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

12.2.1.2 It should ideally be site- and/or rating-specific and cover theoretical knowledge, practical skills, and a number of simulations or practical exercises. Refresher training is not meant to be just another type of training; it is complementary and should be done on a regular basis.

12.2.2 Target audience

a) ATSEP who hold only a single rating should receive refresher training specific to that rating.

b) ATSEP who hold ratings for a number of systems or equipment within the same unit could receive specific refresher training for each system or piece of equipment or follow a global training course covering all relevant systems and equipment.

c) In the case of multi-rated ATSEP (e.g. COM, NavAids, surveillance), refresher training specific to that rating and/or endorsement is likely to be most effective, however, a generic course to cover a number of ratings could be designed and provided to such ATSEP. Discretion on this matter is left to individual States or ANSP subject to approval by their national regulatory authority.

d) ATSEP who hold a position of system monitoring and control should receive refresher training on every system and all equipment under their control and also on any new operational procedures.

12.2.3 Training objectives

12.2.3.1 Refresher training should be objective-based and designed to familiarize the ATSEP with any system or equipment changes or procedure and practice updates that may have occurred since the last training session. It should relate directly to ATSEP tasks and enable the ATSEP to undergo assessment and work on the system or equipment with confidence.

12.2.3.2 The following items should be taken into account when developing a refresher training course:

a) updates on reference material from relevant ICAO Annexes and Docs and from AIPs;

b) new maintenance procedures;

c) new calibration procedures;

d) new standards and operating procedures;

e) coordination procedures;

f) new factors affecting system performance;

g) system monitoring and control changes;

h) dealing with radio EMI;

i) practical routines;

j) performing scheduled maintenance as appropriate;

k) diagnosing faults, making efficient use of special test equipment, tools and devices provided for system maintenance, including built-in test facilities;

l) restoring the system to operational service;

m) introduction of new technology;

n) new projects;

o) new monitoring, calibrating and measuring equipment available for ATSEP;

p) situational awareness;

q) leadership;

r) coordination between services;

s) team resource management (TRM);

t) new operational request;

u) site visits;

v) Human Factors; and

w) other items that have changed since the ATSEP last received training.

12.2.4 Frequency and duration

12.2.4.1 Refresher training should be made available periodically for all ATSEP. It is recommended that ATSEP receive refresher training every two to three years following their system or equipment rating training.

12.2.4.2 A balance needs to be struck between the requirement for refresher training and resource demands. The duration of the training will depend on the number of systems or equipment under the responsibility of the ATSEP. The duration is left to individual States but a minimum of one day per system or equipment is considered necessary.

12.2.5 Delivery of training

Refresher training may be carried out at either a national training academy, a local training unit, or in the live environment, whichever is the most practical. Where possible, it is advantageous that part of the training be carried out on real systems or equipment (e.g. on a spare system).

12.3 EMERGENCY TRAINING

12.3.1 This training includes training in emergencies, in unusual situations and in degraded systems. Most of this training will be site-specific or may make use of incident or accident analysis.

12.3.2 With the reliability of new technology, ATSEP could go through lengthy periods without exposure to any critical or emergency situations. While this trend for increased reliability is welcome, it does point out the need to prepare ATSEP to deal with unusual situations that may arise. This will enhance safety.

12.3.3 Consequently the requirement to provide periodic emergency training for all ATSEP is necessary to avoid incorrect actions being taken (e.g. bad settings, bad calibration, wrong network or systems configuration) and ensure a timely response to a major failure or emergency situation that could jeopardize air traffic safety.

12.3.4 This training should include:

a) emergency situations;
b) unusual or critical situations; and
c) degraded systems.

12.3.5 Most of this training will be site-specific and can be designed by using real incidents, accidents and occurrence reports.

Emergency situations

12.3.6 This training is oriented to a serious, unexpected and often dangerous situation requiring immediate and precise actions. This training is particularly necessary for the system manager or ATSEP directly involved in the monitoring and reconfiguration of live equipment.

Unusual and critical situations

12.3.7 Training in unusual and critical situations is oriented to a set of circumstances that are not commonly experienced.

12.3.8 The essential difference from an emergency situation is that a volatile situation exists and if appropriate action is not taken, a major failure or emergency situation will result.

12.3.9 This training is most important for ATSEP in charge of system monitoring and control. Part of this training should include dialogue with ATCO.

Degraded systems

12.3.10 Training in degraded systems is oriented towards dealing with unusual situations that are the result of a system malfunction or failure leading to a loss of system redundancy or service elements.

12.4 CONVERSION TRAINING

12.4.1 This training is designed to provide knowledge and skills appropriate to a change in either the job category (new discipline or new type rating), environment (new maintenance or other procedures) or systems or equipment (system upgrade or change of system, new project).

12.4.2 In practice, conversion training is not a new type of training. New or updated knowledge and skills may be required each time an ATSEP changes jobs, needs a new rating, has to deal with new equipment or is involved in a new project.

12.4.3 In order to be efficient, the first step is to identify the gap between the actual knowledge and skills of the ATSEP and the new requirements. The ATSEP will then go through the different steps of training defined in the manual but for only the part necessary to fill the gap.

Practical training and simulation

12.4.4 ATSEP should be briefed beforehand on what is required in the practical training and simulation. The number of exercises that can be run during the limited time available may be small and should be well selected in terms of the real needs.

12.4.5 The training centre or location of training must be well equipped with the necessary materials to ensure the success of the practical exercises.

Competency assessment

12.4.6 The structure and conduct of the competency assessment, whether carried out in the live environment or on a simulator, or by means of continuous assessment, will be a matter for decision by individual member States or ANSP and their regulatory authorities.

Documentation

12.4.7 The training course, assessment and competency will be documented and logged for each ATSEP.

Chapter 13

DEVELOPMENTAL TRAINING

13.1 INTRODUCTION

13.1.1 In the course of their careers, ATSEP may occupy positions requiring an additional level of training and specialization.

13.1.2 In this chapter, we address in generic terms the training required for these positions. Normally, the incumbents of such positions are experienced ATSEP and have gone through phase one and two basic and qualification training. The positions and functions described in this chapter are:

a) technical flight inspector;
b) system monitoring and control (SMC);
c) training instructor; and
d) engineering ATSEP/installation technologist.

13.2 TECHNICAL FLIGHT INSPECTOR

13.2.1 Introduction

13.2.1.1 Paragraph 2.7 of ICAO Annex 10, Volume I, requires States or ANSP to perform flight tests on aeronautical telecommunications systems. Flight tests are carried out following guidance documentation provided in ICAO's *Manual on Testing of Radio Navigation Aids* (Doc 8071). States or ANSP involved in flight tests have developed documents, standards and procedures which meet the requirements of Doc 8071. Specialized electronic test equipment such as high precision navigation receivers, sensors, data recorders, computers and signal analysers are installed in an aircraft for the calibration of radio navigational aids. In most cases the aircraft is used for the sole purpose of flight calibration. The personnel required to maintain and operate the flight calibration equipment are identified as technical flight inspectors, and they may come from the ATSEP environment.

13.2.1.2 The functions of the ATSEP, as a technical flight inspector (TFI), are generally related to the operation of the airborne recording and positioning equipment which include:

a) calibration of radio navigational receivers;

b) operation of computer and data recording equipment;

c) real-time data analysis and decision-making;

d) preparation and operation of aircraft positioning equipment (theodolite, laser tracker or differential GPS);

e) communications with ground personnel as required; and

f) preparation of inspection report.

13.2.2 Training objective

13.2.2.1 Every effort should be made to ensure that each student receives the full benefit of the training programme thus ensuring a high quality of service delivery during all phases of the flight calibration.

13.2.2.2 Trainees should perform flight test duties in accordance with standards and procedures approved by the States or ANSP.

Condition:

a) airborne in the real environment, given exposure to a specific situation of flight calibration along with the appropriate and pertinent training material and reference documentation.

b) alternatively, using laboratory simulation or scenarios to enable the realization of the objective without the need of the actual equipment.

c) given a description of a specific situation relating to flight calibration.

Performance: The TFI ATSEP should be able to:

a) operate all airborne and ground systems and equipment to be used during the flight calibration;

b) analyse and evaluate technical problems related to the radio navigational aid under inspection;

c) provide advice and recommendations to ground personnel with a view to achieving compliance with the applicable standards;

d) understand instrument procedures used in all phases of a flight;

e) describe relative standards and procedures.

Standard of accomplishment:

a) all the descriptions should include the essential points of the given situation; and

b) all work should be performed as per the approved standards and procedures.

13.2.3 Technical flight inspector training programme

13.2.3.1 This section provides a generic list of subjects to be part of a typical training programme. The training programme recommended in this section may not apply to some States or ANSP.

13.2.3.2 *Radio navigation.* All radio navigation described in ICAO Annex 10, Volume I, should be either a prerequisite or be included in the training programme. The recommended prerequisite is three years of experience working on radio navigation aids. The radio navigation aids are:

- Instrument landing system (ILS) for aircraft approaches;
- Microwave landing system (MLS) for aircraft approaches;
- VHF omnidirectional radio ranges (VOR);
- Non-directional radio beacons (NDB);
- UHF distance measuring equipment (DME);

- Direction finders (DF);
- Secondary surveillance radar (SSR); and
- VHF/UHF communication systems.

13.2.3.3 In addition to the qualification training relating to radio navigation aids, the training must also be oriented to the flight inspection parameters to be recorded and then compared to the prescribed tolerance for each system.

13.2.3.4 The training must therefore cover the following items:

a) ILS – localizer: (course/clearance field strength, clearance, identification, degree of modulation, composite phasing, modulation degree consistency, course, course structure, course monitoring alarms, displacement sensitivity, DS monitor alarms, polarization, clearance at maximum DS, range, etc.);

b) ILS – glidepath: (course path/below path clearance field strength, below path clearance, degree of modulation, modulation degree consistency, course path, course path structure, course path monitoring alarms, displacement sensitivity, DS monitor alarms, polarization, clearance at maximum DS, range, etc.);

c) markers (identification, modulation);

d) en-route facilities DME, VOR: (degree of modulation, identification, cone of confusion, alignment, structure, field strength, distance accuracy, coverage, etc.); and

e) en-route NDBs (identification, coverage, signal fluctuation, etc.).

13.2.3.5 *Type of flight calibration.* The TFI should also receive training in order to perform the different types of flight calibration. These are:

a) initial flight calibration, which is performed before the equipment is put into service or before it is put into service following major repairs;

b) routine flight calibration performed after a predetermined flight calibration interval;

c) major flight calibration performed after a predetermined number of flight calibration intervals; and

d) special flight calibration performed upon demand, after repairs, after interference through external factors or in the event of air accident investigation.

13.2.3.6 The training should also include the following subjects:

a) the flight calibration process (intervals, planning, flight preparation, performance, documentation, follow-up and filing);

b) the technical requirement (Standards and Recommendations specified in ICAO Annex 10 and Doc 8071);

c) duties and responsibilities;

d) the flight calibration equipment and stated procedures;

e) planning and performing flight calibrations;

f) analysing and evaluating the value recorded;

g) compiling and issuing the provisional flight calibration report;

h) compiling and issuing the final flight calibration report with summary conclusions of the values recorded and evaluated;

i) the maintenance and surveillance unit;

j) maintenance and operation of the flight calibration equipment; and

k) maintenance and operation of the aircraft positioning system (theodolite, laser tracker, DGPS).

13.3 SYSTEM MONITORING AND CONTROL (SMC)

13.3.1 Introduction

13.3.1.1 The proliferation of CNS and ATM systems and equipment has brought up new ways of providing system monitoring and control. Most ANSP have centralized the system monitoring and control functions within a geographical area, typically the FIR. Generally, each ACC has a system monitoring and control (SMC) suite or position staffed by qualified SMC ATSEP. These ATSEP are responsible for the day-to-day operation (normally 24 hours per day, 7 days per week) of all operational systems and equipment within their FIR. The SMC ATSEP ensures a quick response to malfunctions or failures by diagnosing the problem, activating fallback procedures and initiating the repair. All this necessitates a lot of coordination, and the SMC ATSEP is the link between the operational controllers and the operational CNS and ATM ATSEP within a whole FIR. Inter FIR coordination is also done by the SMC ATSEP.

13.3.1.2 The SMC ATSEP need appropriate training in order to be competent and to retain this competency. This training must be oriented on performing their job functions relating to CNS/ATM electronic systems and equipment and also include TRM and other HMI and HHI skills.

13.3.1.3 This training shall be designed to:

a) establish qualification standards;

b) provide a basis against which student performance will be evaluated;

c) provide the student with a comprehensive description of the training plan; and

d) provide the SMC ATSEP with detailed knowledge of SMC functions and with operational practices and exercises of applied standards and procedures.

13.3.1.4 A generic list can be used in grouping the principal duties of the SMC ATSEP. Description of site procedures to complete each of the tasks identified in the list. Numbering system to identify the tasks in each of the areas of responsibility, following the naming conventions for categorizing as below:

a) LR – logging and reporting;

b) MC – monitor and control;

c) RR – release and restoration;

d) PI – problem isolation and service restoration;

e) PO – position operation; and

f) SS – site specific SMC tasks.

13.3.2 Training objective

13.3.2.1 The SMC competency training programme will be developed, implemented and delivered based on the job functions and enhanced by OJT. Every effort shall be made to ensure that each student receives the full benefit of the training programme thus ensuring confidence in managing the SMC position or function.

13.3.2.2 Trainees shall perform system monitoring and control duties in accordance with approved procedures and apply TRM, HMI and HHI concepts.

Condition: a) in a SMC environment, given exposure to specific system monitoring and control equipment along with the appropriate and pertinent training material, reference documentation and tools.

b) alternatively, use of simulation or scenario to enable the performance of the objective without the need of the operational equipment.

c) given a description of a specific situation relating to an FIR/ACC.

Performance: On the monitoring and control systems covered in this section, the SMC ATSEP shall be able to:

a) operate all systems and equipment installed at the SMC position;

b) monitor and control all systems and equipment under his or her responsibility;

c) describe the relevant airspace;

d) apply the TRM, HMI, HHI skills;

e) describe relative standards and procedures.

Standard of accomplishment:

a) all the descriptions should include the essential points of the given situation;

b) all work should be performed as per the approved standards and procedures.

13.3.3 SMC ATSEP competency — knowledge and skills requirements

This aspect of the training programme addresses the knowledge and skills requirements for ATSEP in order to achieve SMC competency. The elements of the training programme will be derived from the SMC job tasks and will address the following subject areas:

a) ANS structure

- ANS organization and operation
- ANSP maintenance programme
- airspace and FIR structure (national; FIR/inter-FIR ATC and FSS)
- systems and equipment providing ANS services
- ANSP administrative practices
- technical operations and ATC policies, procedures, agreements

b) ANS system and equipment

- operational impacts to end users and customers due to loss or degradation of system and equipment services or evaluation of system performance
- system and equipment operation (SMC reconfiguration, restoration) (monitoring and control)
- user position functionality and operation
- facilities support
- facility power distribution configuration and operation

c) SMC tools, processes and procedures

- ISO instructions and procedures (on-site quality control programme)
- maintenance agreements with outside agencies
- SMC general processes (NOTAM, accident/incident, EMI, ELT)
- MMS/WS/etc. (operation, management, reports, logs, database)

d) Technology

- telecommunication, CNS/ATM technologies and principles
- computer, data communications and networking principles
- electromagnetic interference, antenna and cavity networks, RF propagation

e) Human Factors

- effective communication and coordination skills (oral and written)
- interpersonal skills (HHI)
- TRM
- HMI
- stress management

f) Risk assessment.

13.3.4 SMC ATSEP competency — experience elements

The completion of the tasks listed below will confirm the work experience requirements for SMC competency. The completion of these tasks is in two stages:

a) skills development — where the qualified person (OJI) mentors and assists the candidate through each of the tasks; and

b) skills assessment — where the qualified person (OJI) assesses the candidate's ability to perform the task without assistance.

Under the OJM/OJI supervision, the SMC ATSEP shall be able to:

a) regarding SMC logging and reporting (LR):

- demonstrate effective use of maintenance management system (MMS);
- demonstrate SMC accident/incident/unit investigation procedures (data/voice security/release);
- demonstrate significant outage report process;
- demonstrate use of local SMC operations manual or ISO work instructions.

b) regarding system monitoring and control (MC):

- demonstrate effective use of monitoring and control tools (WS, MCP's, system and equipment panels, etc.);
- demonstrate ability to gather user complaint data.

c) coordinate release and restoration (RR) procedures (system and/or equipment):

- demonstrate ability to effectively prioritize multiple tasks in each of the following areas:
  - CNS system and equipment;
  - ATM system and equipment;

- facility;
- telecommunications;
- external agencies.

- demonstrate ability to issue various types of NOTAMs.

d) regarding problem isolation (PI) and service restoration:

- describe problem (correlation and interpretation of systems' error messages and user complaints);
- demonstrate use of tools and test equipment used in SMC problem isolation;
- describe operational impact to users (internal and external);
- demonstrate SMC system and equipment reconfiguration and reload activities;
- verify service restoration in each of the following areas:
  - CNS system and equipment;
  - ATM system and equipment;
  - facility;
  - telecommunications;
  - external agencies.

e) position operation (PO) (routine and key operate tasks):

- communications system;
- situation display system;
- flight data processing system;
- information system.

f) execution of site-specific (SS) TOC tasks:

- fire warden procedures;
- maintenance support function;
- technical advisory.

13.4 ATSEP INSTRUCTOR TRAINING

13.4.1 Introduction

ATSEP training is covered in detail in this document. ATSEP training is specialized and usually not available in conventional public training institutes. Therefore a requirement arises to train ATSEP in becoming ATSEP instructors. This chapter explains the type of training the instructor must complete in order to be able to teach in a classroom and to provide OJT and coaching on equipment.

13.4.2 Classroom instructional techniques

13.4.2.1 This course is designed for ATSEP who are, or will be, involved in classroom instruction. Each instructor should have special training in the form of a practical course which aims to provide the basic instructional skills necessary for the efficient conduct of classroom training.

13.4.2.2 In a classroom simulation and a modern interactive training environment, the future instructor has to follow specific guidelines to plan, prepare and deliver presentations and lessons. During the course, the student will play alternatively the role of instructor and class participant. Performance as an instructor is subsequently assessed.

13.4.2.3 The topics should include:

a) qualities of a good instructor;

b) principles of adult learning;

c) use and structure of a lecture;

d) how to design and structure a lesson and lesson plan, including design of instructional events, selection of training techniques and selection of media options;

e) questioning techniques;

f) elements and formulation of training objectives;

g) use of teaching aids;

h) principles of student motivation;

i) qualities and types of written tests;

j) how to administer practical exercises (written, small group discussion, group discussion, lab, role play, simulator); and

k) practical exercises presenting one lecture and one lesson.

13.4.3 On-the-job training and coaching training

13.4.3.1 The course is designed for ATSEP who are already, or will be, carrying out OJT or coaching at a technical unit. The OJT phase and practical exercises on equipment (standby or real equipment or special equipment for

development and training purpose) are well recognized as critical in the training of an ATSEP. It is necessary to give the instructor a series of teaching techniques and coaching practices which, if adopted, will increase the quality and the efficiency of the OJT and will also increase the safety and decrease risk when dealing with equipment. The course should provide appropriate training for those involved in coaching and practical training on equipment, suggesting the appropriate means of carrying out this training. It should also provide and recommend a code of practise for the instructor.

13.4.3.2 The programme should include:

a) safety precautions to take before teaching practical training on equipment;

b) learning processes, cognitive aspects and motivation theories;

c) effective verbal communication, non-verbal communication and effective listening skills;

d) personal interaction, personal styles and attitudes, building positive relationships, the influence of recognition, interpersonal conflict;

e) training practises such as briefing a student, monitoring the student's progress, intervention methods, feedback and debriefing;

f) task training, how to build practical exercises and sessions dealing directly with equipment, measurement technique, etc.;

g) progressive application of coaching theory with feedback; and

h) stress recognition and stress management.

13.4.4 Assessment training

13.4.4.1 This course is designed for an experienced engineer, technologist or OJT instructor who will be required to act as a competency assessor.

13.4.4.2 The assessor should follow a course which focuses on procedures for evaluating the initial and continued operational competency of ATSEP.

13.4.4.3 The task of assessor is recognized as being a difficult task and essential to ensuring that competency standards are maintained. It is essential to safety. Furthermore assessors may have to comment and take action on the competency of colleagues, ATSEP and friends. This is not a task that everybody is capable of doing and involves professional and personal criteria.

13.4.4.4 This particular course should endorse the use of both practical and oral assessment as a process to determine operational competency and aims to provide its participants with the rationale, initial knowledge, skills and techniques for the role of competency assessor. Such a course should help the assessors fulfil their jobs, but also help the administration to establish the required infrastructure in order to meet the regulatory requirements.

13.4.4.5 Programme outline:

a) role and task of assessor;

b) international safety regulatory requirement;

c) concept of assessment;

d) Human Factors affecting assessment;

e) the oral part of the assessment and the interview scenario;

f) the practical part of the assessment process and work on equipment;

g) assessment for competency;

h) maintenance of competency;

i) competency assessment debriefing; and

j) exercises in practical and oral assessment.

13.5 ENGINEERING ATSEP — INSTALLATION TECHNOLOGIST

13.5.1 Introduction

Most States have regulatory requirements for ensuring that CNS/ATM systems and equipment are installed by qualified ATSEP. Generally, ANSP create a distinct group of specialized ATSEP who are responsible for the engineering and the installation of all CNS/ATM systems and equipment.

13.5.2 Training objective

13.5.2.1 This session provides generic objectives for training of engineering and installation ATSEP. This training programme will be developed, implemented and delivered in compliance with ATSEP job functions.

13.5.2.2 The students shall perform their duties in accordance with approved standards and procedures.

Condition: a) in a laboratory environment, given exposure to specific systems or equipment along with the appropriate and pertinent training material, reference documentation and tools.

b) alternatively, use of simulation or scenario to enable the performance of the objective without the need of the real equipment.

c) given a description of a specific system installation.

Performance: On a given situation, the engineering or installation ATSEP shall be able to:

a) demonstrate installation dexterity;

b) design installation drawings;

c) apply the TRM skills;

d) perform on-the-job duties.

Standard of accomplishment:

a) all the descriptions should include the essential points of the given situation;

b) all work should be performed as per the approved standards and procedures.

13.5.3 The typical training package for engineering and installation ATSEP

a) With references, the participant will describe the functions in ANSP operations and responsibilities:

- describe the relationship between the ANSP and the regulator;
- describe the purpose of the regulations;
- describe the importance of engineering standards and procedures;
- describe the life-cycle management principles;
- describe ATM and CNS specialties;
- describe design and implementation specialties;
- describe the various phases of an installation project.

b) With references, the participant will prepare for installation activities:

- describe ESD and safety standards;
- explain the drawing system;
- gather installation documents;
- interpret documentation;
- procure installation materials;
- describe how to configure installation items.

c) With references, the participant will assemble PCBs and panels:

- assemble PCBs;
- fabricate panels and interface panels;
- assemble panels.

d) With references, the participant will prepare power and ground cables:

- describe power systems and cables;
- assemble power cords for equipment racks;

- assemble ground cables;
- prepare exothermic welded ground connection (outdoor demonstration).

e) With references, the participant will prepare RF cables and components:

- describe RF cables and systems;
- prepare RF cables for testing and installation;
- prepare tuned resonant cavities for installation;
- describe how to prepare RF cable to specified electrical length.

f) With references, the participant will terminate control cables:

- describe control cables and systems;
- terminate a 25 pair control cable with an Amp connector and with a TRW connector;
- terminate a 25 pair control cable into a BIX terminal block;
- terminate ribbon cables;
- terminate Cat 5 cables;
- terminate fiber optic cables;
- terminate cross connect wiring using wire wrap;
- verify control cable connections.

g) With references, the participant will prefabricate racks:

- plan equipment rack;
- assemble rack;
- install equipment into rack (mechanical assembly);
- install equipment cables into racks (electrical assembly).

h) With references, the participant will install cross connections:

- plan cross connections;
- install cross connect wiring.

i) With references, the participant will describe the workshop-to-site transition processes:

- describe the pre-POP tests;

- describe the implementation review process;
- prepare equipment and/or shelter for shipping.

j) With references, the participant will install equipment racks:

- install racks into shelter;
- install ladder tray and conduits.

k) With references, the participant will install system interconnects and interfaces:

- install power and ground systems;
- install interconnect wiring;
- install RF system;
- install fire stopping.

l) With references, the participant will complete documentation requirements:

- describe post-project activities;
- track inventory.

m) With references, the participants will restore site:

- remove all cables from racks, ladder trays, and conduits;
- pack all equipment from racks;
- remove racks, ladder trays, and conduits;
- clean up site.

Chapter 14

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 single most significant opportunity to make aviation both safer and more efficient. The purpose of this chapter is to introduce ATSEP to fundamental Human Factors concepts in ANS.

14.2 THE MEANING OF HUMAN FACTORS

14.2.1 Human Factors as a term has to be clearly defined because when these words are used in the vernacular they 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 which 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 which 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 overall performance of human beings within the Air Navigation 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 of the ATSEP in the ANS. These include human behaviour, decision-making and other cognitive processes, the maintenance and repair of electronic systems, the installation and/or modification of electronic systems, communication and software aspects of computers, 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.

14.2.5 Human Factors in the ANS for the ATSEP 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 all concerned with the operation and administration of the ANS recognize the inevitability of human error. No person, whether designer, engineer, manager, controller or ATSEP can perform perfectly at all times. 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 the provision of 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 concerned to enhance the safety of the complex systems which make up today's civil air transport.

14.3 AWARENESS

14.3.1 Awareness is the essential first phase and usually comprises instructional presentations focusing on the roles of interpersonal and group factors of the ATSEP. A useful way of beginning the awareness phase might be to introduce ATSEP skills as they pertain to communication, situational awareness, problem solving, etc. It is important to recognize that awareness is only a first step; classroom instruction alone will probably not significantly alter ATSEP attitudes and behaviour in the long term.

14.3.2 This section includes nine parts:

Introduction to Human Factors;
Working knowledge and skills;
Psychological factors;
Medical;
Organizational and social factors;
Communication;
Stress;
Human error; and
Working methods.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
	14. Human Factors		
14.1 Introduction to Human Factors			
1. Introduction	1) Consider the necessity to constantly extend one's knowledge.	2	Module objectives, presentation of the general concept of training for Human Factors. Impact on rapid evolution, new technology, upgrade of systems, new procedures.
	2) List factors which can affect personal and team performance.	1	Psychological, medical, physiological, social, organizational, communication, stress, human error, working methods, to maintain knowledge.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
14.2 Working knowledge and skills			
1. ATSEP knowledge and skills	1) Explain the importance of maintaining and updating professional knowledge and skills for ATSEP.	2	Assure safety, licensing.
	2) Maintain and update professional knowledge and skills to retain competence in the technical and operational environment.	3	New system, new procedures, monitoring system, maintenance procedure, new technology, upgrade of old system (radar, navaids, communication, processing, hardware, software).
	3) List the available means to maintain professional knowledge and skills.	1	Personal study, briefing, seminars, courses, technical periodicals, technical books, OJT, simulation, computer-based training, e-learning, visits.
14.3 Psychological factors			
1. Cognitive	1) Describe the factors which influence decision making.	2	Stress, learning, knowledge, fatigue, alcohol, drugs, distraction, interpersonal relations, team resource, management, working environment, redundancies.
	2) Relate human performance to decision making.	4	Problems which will affect decision making: problems related to learning new things, problems related to high level of concentration, problems related to high stress level and fatigue, problems related to changes in the working environment or in the organization.
14.4 Medical			
1. Fatigue	1) Describe the effect of fatigue on human performance.	2	Lack of concentration, irritability, frustration.
	2) Identify the influence of fatigue in self and in others.	3	Making frequent mistakes, unable to concentrate, being of bad humour all the time, sleeping disorders, eating disorders.
	3) Respond to indications of fatigue in an appropriate manner.	3	Take time off, rest for short period of time, consult professional help.

Topic		Intermediate Objectives. The students should be able to:		Level	Content
2.	Fitness	1)	Interpret one's own fitness and recognize signs of lack of personal fitness.	5/1	Physical and mental fitness.
		2)	Describe actions to be taken when aware of a lack of personal fitness.	2	
3.	Work environment	1)	Describe the influence of the work environment.	2	Work environment, ergonomics, effects of noise, electromagnetic waves, tools.
4.	Alcohol and drugs	1)	Explain the influence of alcohol and drugs on human performance.	2	Nervous system, medication.
14.5	**Organizational and social factors**				
1.	Human relations	1)	Interpret the factors involved in human relations and the factors of work satisfaction.	5	Feeling of being useful to the organization, teamwork, being listened to.
		2)	Apply social and organizational factors to work with other team members.	3	Feeling of being part of the team, leadership, respect of others.
2.	Team resource management	1)	State the principle and objectives of TRM.	1	
3.	Group dynamics	1)	Identify the professional relationships between members of the ATSEP group.	3	Role of members, responsibilities within the team, benefits of having other team members to rely on, safety aspects, assistance in abnormal and difficult situations.
		2)	Identify reasons for conflict and actions to prevent it and prevent repetition.	3	Roles poorly defined, goals poorly identified, bad planning, too many leaders or not enough, respect of others, divergence in values.
		3)	Take account of the team resource management programmes.	2	
14.6	**Communication**				
1.	Written report	1)	Record information by writing effectively.	3	ATSEP technical report, log-books, system degradation reports, specification, system manager report.
		2)	Pass information by writing effectively.	3	Be concise, clear, use proper level of language with proper technical terms.

Topic	*Intermediate Objectives. The students should be able to:*	*Level*	*Content*
2. Verbal communication	1) Describe human communication theory.	2	Different languages, technical language (English).
	2) Characterize the factors which affect verbal communication.	2	Some cognitive factors such as: lack of knowledge of the procedures, of the technical terms. Some affective factors such as: being shy, feelings of not being listened to, not being part of the group, not being assertive. Some physiological factors: such as stuttering, low voice level, poor eye contact while talking.
	3) Use language effectively in the practice of technical matters.	3	Technical “jargon”.
14.7 Stress			
1. Stress	1) Take account of the effects on stress.	2	Stress and its symptoms on self and on others, during on line intervention, during maintenance, during training (stress on instructor and student).
2. Helplessness	1) Respond to feeling of helplessness.	3	Normal and abnormal situations.
3. Stress management	1) Act to relieve or minimize stress in self and/or others.	3	The effect of personality in coping with stress, benefits of active stress management.
	2) Obtain assistance in stressful situations.	3	Benefits of offering and accepting help in stressful situations.
	3) Recognize the effects of stressful events.	1	On self and on others in abnormal situations.
	4) Consider the benefits of critical incident stress management.	2	CISM.
	5) Explain the procedures used in case of problem on system or incident.	2	National and local technical and operational procedures and/or regulation, counselling human element.
14.8 Human error			
1. Human error	1) Explain the relationship between error and safety.	2	Number and combination of errors.
	2) List the different types of error.	1	
	3) Differentiate between errors and violation.	2	

Topic		Intermediate Objectives. The students should be able to:	Level	Content
	4)	Describe error-prone conditions.	2	
14.9 Working methods				
1. Efficiency	1)	Consider, from a Human Factors point of view, the factors affecting efficiency in the provision of installation, commissioning and maintenance of CNS equipment.	2	Own workload, safety, many projects, economy, ecology, new technology, customer requirements.

Appendix

LIST OF VERBS TO PREPARE TRAINING OBJECTIVES

Definition of verbs for each level of accomplishment

Definition of verbs — Level 0

Level 0: Requires from the trainee a simple level of awareness.

Verb	Definition	Example	Level
Demonstrate familiarization	To become acquainted with a subject	To demonstrate familiarization with technical and operational ATM facilities.	0
To demonstrate general awareness of	Condition of being conscious, level of awareness	To demonstrate general awareness of potential hazards to health and safety generated by navigation equipment.	0

Definition of verbs — Level 1

Level 1: Requires a basic knowledge of the subject. It is the ability to remember essential points; the trainee is expected to memorize and retrieve data.

Verb	Definition	Example	L
Define	State what it is and what its limits are; state the definition	Define the global performances for CVOR and DVOR.	1
Draw	Produce a picture, pattern or diagram	Draw the block diagram of the transmitter.	1
List	Say one after the other	List the main SW development processes used in industries.	1
Name	Give name of objects or procedures	Name who is designated to authorize changes in operational data.	1
Quote	Repeat what is written or said to underline	Quote ICAO definition of ATC service.	1
Recognize	To know what it is because you've seen it before	Recognize on a diagram all the elements of the ADS.	1

State	Say or write in a formal or definite way	State who are the local telecom providers and the service characteristics.	1

Definition of verbs — Level 2

Level 2: Requires an understanding of the subject sufficient to enable the student to discuss intelligently. The individual is able to represent for himself or herself certain objects and events in order to act upon these objects and events.

Verb	Definition	Example	Level
Characterize	To describe the quality of features in something	Characterize consequences of an OS upgrade.	2
Consider	To think carefully about it	Consider institutional issues and service provider responsibilities.	2
Demonstrate	Describe and explain; logically or mathematically proves the truth of a statement	Demonstrate the possible use of GBAS for approach and landing.	2
Describe	Say what it is like or what happened	Describe the architecture of the ATN network.	2
Differentiate	Show the differences between things	Differentiate on a diagram all the possible elements of the ADS-C system.	2
Explain	Give details about something or describe so that it can be understood	Explain the principles of non blocking switches.	2
Take account of	Take into consideration before deciding	Take wind influence into account when calculating a ground speed.	2

Definition of verbs — Level 3

Level 3: Requires a thorough knowledge of the subject and the ability to apply it with accuracy. The student should be able to make use of his or her repertoire of knowledge to develop plans and activate them.

Verb	Definition	Example	Level
Act	Carry out, execute	Act in accordance with the rules.	3
Apply	Use something in a situation or activity	Apply the appropriate model to the analysis of a relevant aviation system.	3
Appreciate	To understand a situation and know what is involved in a problem-solving situation, to state a plan without applying it	Appreciate criticality of the conditions.	3

Verb	Definition	Example	Level
Assist	Help somebody to do a job by doing part of it	Handle the operational HMI and assist in the tuning of the screens.	3
Calculate	To discover from information you already have by arithmetic; to think about a possible cause of action in order to form an opinion or decide what to do	Calculate the values of the elements of a simple generic antenna system.	3
Check	Make sure the information is correct (satisfactory)	Check the operational status of the monitor system.	3
Choose	Select out of number, decide to do one thing rather than another	Choose the appropriate type of line for a given specific application.	3
Collect	Assemble, accumulate, bring or come together	Collect remote data.	3
Conduct	Lead, guide	Conduct coordination.	3
Confirm	Establish more firmly, corroborate	Confirm sequence order.	3
Decode	Turn into ordinary writing, decipher	Decode a transponder message.	3
Encode	Put into code or cipher	Encode a typical ATC data item.	3
Estimate	Form an approximate judgment of a number; form an opinion	Being given an aircraft route, estimate thanks to a software package or/and GPS receiver the availability of the constellation.	3
Execute	Perform action	Execute an arrival sequence.	3
Extract	Copy out, make extracts from, find, deduce	Extract data from a flight plan.	3
Identify	Associate oneself inseparably with, establish the identity	Identify and locate data transmission problems.	3
Inform	Inspire, tell	Inform the planning controller.	3
Initiate	Begin, set going, originate	Initiate a coordination procedure.	3
Input	Enter in the system	Input data.	3
Issue	Send forth, publish	Issue ATC clearance.	3
Maintain	Carry on, keep up, refresh	Maintain flight data display.	3
Measure	Ascertain extent or quality of (thing) by comparison with fixed unit or with object of known size	Measure the typical parameters of lines.	3
Monitor	Keep under observation	Monitor traffic.	3
Notify	Make known, announce, report	Notify runway in use.	3
Obtain	Acquire easily, without research	Obtain aeronautical information.	3

Verb	Definition	Example	Level
Operate	Conduct work on equipment	Operate test tools to analyse the system.	3
Pass	Move, cause to go, transmit	Pass essential traffic information without delay.	3
Perform	Carry into effect, go through, execute	Perform typical measurements on a receiver.	3
Record	Register, set down for remembrance or reference	Record information by writing effectively.	3
Relay	Arrange in, provide with, replace by	Relay pilot message.	3
Respond	Make answer, perform answering or corresponding action	Respond to the loss of aircraft radar identification.	3
Scan	Look intently at all parts successively	Scan data display.	3
Transfer	Hand over	Transfer information to receiving controller.	3
Update	Refresh, make up to date	Update professional knowledge and skills.	3
Use	Employ for a purpose, handle as instrument, put into operation	Use the ICAO documentation to explain the principles related to signals in space.	3
Verify	Establish truth of	Verify the impact of the requirements on the location and the type of ground station.	3

Definition of verbs — Level 4

Level 4: Ability to establish a line, within a unit of known applications, following the correct chronology, and the adequate methods to resolve a problem situation. This involves the integration of known applications in a familiar situation.

Verb	Definition	Example	Level
Acquire	Gain by oneself and for oneself; obtain after research	Acquire relevant aeronautical information.	4
Adjust	Change to a new position, value or setting	Adjust antenna system.	4
Allocate	Assign, devote	Allocate the responsibility of separation during transfer.	4
Analyse	Examine minutely the constitution of	Analyse the coverage of the radio system.	4
Assign	Allot as a share, make over	Assign take off number.	4

Verb	Definition	Example	Level
Coordinate	Bring part into proper relation	Coordinate with RCC.	4
Comply	Act in accordance with	Comply with rules.	4
Delegate	Commit authority to somebody	Delegate separation in case of aircraft continuing visually.	4
Design	Conceive mental plans for	Design a NDB station according to operational requirements.	4
Detect	Discover existence of	Detect disturbances.	4
Ensure	Make safe, make certain	Ensure the agreed course of action is carried out.	4
Expedite	Assist the progress of, do speedily	Expedite the traffic.	4
Integrate	Combine into a whole, complete by addition of parts	Integrate adequately components into a LAN.	4
Justify	Show the rightness of a choice or of an option	Justify and theorize the DME/N versus the DME/P.	4
Manage	Handle, wield, conduct	Manage aerodrome surface movements.	4
Organize	Give orderly structure to, frame and put into working order	Organize arrival sequence.	4
Predict	Forecast	Predict evolution of a conflict situation.	4
Provide	Supply, furnish	Provide separation.	4
Relate	Establish link with	Relate a pressure setting to an altitude.	4

Definition of verbs — Level 5

Level 5: Ability to analyse new situation, in order to elaborate and apply one or other relevant strategy, to solve a complex problem. The defining feature is that the situation is qualitatively different from those previously met, requiring judgment and evaluation of options.

Verb	Definition	Example	Level
Appraise	Estimate, determine the benefit	Appraise the interest of a traffic management option.	5
Assess	Estimate value or difficulty, evaluate	Assess flight inspection results.	5
Balance	Weigh (a question, two arguments, etc., against each other)	Balance two control actions.	5
Calibrate	Correct and adjust to enable the provision of accurate data	Calibrate the NDB system according to flight inspection.	5

Verb	Definition	Example	Level
Discuss	Investigate by reasoning or argument	Discuss the distribution of integrity information through GALILEO.	5
Evaluate	Ascertain amount of, find numerical expression for	Evaluate workload.	5
Extemporize	Produce without preparation, improvise	Extemporize phraseology in abnormal situations.	5
Imagine	Form mental image of, conceive	Imagine possible actions to cope with unusual situations.	5
Interpret	To decide on something's meaning or significance when there is a choice	Interpret fault report based on various test tool measures.	5
Resolve	Solve, clear up, settle	Resolve conflict.	5
Review	Survey, look back on	Review previous clearance according to the latest aircraft relative positions.	5
Select	Pick out as best or most suitable	Select the runway in use.	5
Solve	Find answer to	Solve separation problems.	5
Theorize	Extract general principles from a particular experience	Theorize the principles of ILS.	5
Troubleshoot	Trace and correct faults	Troubleshoot wrong bearing indications of a VOR.	5
Validate	Make valid, ratify, confirm	Validate one radar vectoring option to expedite the traffic.	5

Classes of skills

Skill	Examples
Intellectual skills	
Classifying	Distinguishes between average flight distance and average stage length.
Rule-using	Identifies different classes of aircraft.
Discriminating	Defines the concept of insurance.
Problem-solving	Determines expected approach times for aircraft in an approach sequence. Generates a weather forecast. Decides whether or not a fire is completely extinguished. Judges whether an aircraft cabin has been adequately cleaned. Diagnoses an equipment fault.
Physical (motor) skills	Manipulates a fire hose. Operates a computer keyboard.

Action verbs associated with classes of skill

CLASSIFYING	RULE-USING	DISCRIMINATING	PROBLEM-SOLVING
to allocate	to calculate	to accept	to accommodate
to arrange	to calibrate	to adjudicate	to adapt
to assign	to check	to appraise	to analyse
to catalogue	to compute	to appreciate	to compose
to categorize	to convert	to arbitrate	to conclude
to characterize	to correct	to assess	to construct
to classify	to deduce	to authenticate	to contrive
to collect	to design	to choose	to coordinate
to compile	to determine	to compare	to correlate
to define	to equate	to criticize	to create
to file	to examine	to discriminate	to develop
to grade	to expect	to estimate	to devise
to group	to explain	to evaluate	to diagnose
to index	to extrapolate	to gauge	to discover
to itemize	to foresee	to judge	to find a way
to order	to illustrate	to match	to generalize
to rank	to interpolate	to rate	to infer
to reject	to interpret	to recognize	to invent
to screen	to monitor	to review	to programme
to sort	to organize	to value	to project
to specify	to plan	to weigh	to realize
to survey	to predict		to reason
to tabulate	to prescribe		to resolve
	to schedule		to solve
	to solve		to synthesize
	to translate		to trouble-shoot
	to verify		

— END —

ISBN 978-92-9231-708-9