Public Authority for Civil Aviation

Air Traffic Safety Electronics Personnel (ATSEP) Competency-based Training Manual

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FOREWORD

(1) The effective performance of the air traffic management (ATM) system depends on competent and qualified air traffic management professionals. The ATM system is evolving towards a globally integrated and collaborative system. Air traffic safety electronics personnel (ATSEP) involved in the installation, operation and maintenance of the CNS/ATM system must have a shared understanding of what is expected of them in terms of performance wherever they may work in order to support a globally interoperable system and to achieve optimum capacity within acceptable safety limits. This shared understanding becomes critical when considering the increasing traffic and the growing complexity and interconnectedness of the systems involved. As controller-pilot and system-to-system interfaces evolve, the ATSEP installing, operating and managing the CNS/ATM system need to share a common reference to ensure seamless operations.

(2) This manual provides Air Navigation Service providers with guidance on how to structure their approach to the training of ATSEP.

(3) The following standards have been basis for this manual:

(a) Civil Aviation Law, The Sultanate of Oman.

(b) Annexes:
Annex 1 — Personnel Licensing
Annex 3 — Meteorological Service for International Air Navigation
Annex 10 — Aeronautical Telecommunications
Annex 11 — Air Traffic Services
Annex 14 — Aerodromes
Annex 19 — Safety Management

(c) Procedures for Air Navigation Services (PANS)
Procedures for Air Navigation Services — Training (PANS-TRG, Doc 9868)
Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444)

(d) Manuals
Manual on Testing of Radio Navigation Aids (Doc 8071)
Performance-based Navigation (PBN) Manual (Doc 9613)
Human Factors Training Manual (Doc 9683)
Global Navigation Satellite System (GNSS) Manual (Doc 9849)
Safety Management Manual (SMM) (Doc 9859)
Aeronautical Surveillance Manual (Doc 9924)

(4) The editing practices used in this document are as follows:

(a) 'Shall' is used to indicate a mandatory requirement and may appear in CARs.

(b) 'Should' is used to indicate a recommendation

(c) 'May' is used to indicate discretion by the AUTHORITY the industry or the applicant, as appropriate.

(d) 'Will' indicates a mandatory requirement and is used to advise of action incumbent on the Authority

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GLOSSARY

DEFINITIONS

Approved training. Training conducted under special curricula and supervision approved by a Contracting State.

Competency. A combination of skills, knowledge and attitudes required to perform a task to the prescribed Standard.

Competency element. An action that constitutes a task that has a triggering event and a terminating event that clearly defines its limits, and an observable outcome.

Competency unit. A discrete function consisting of a number of competency elements.

Competency-based training and assessment. Training and assessment that are characterized by a performance orientation, emphasis on standards of performance and their measurement, and the development of training to the specified performance standards.

Evidence and assessment guide. Assessment (evidence) guide. A guide that provides detailed information (e.g. tolerances) in the form of evidence that an instructor or an evaluator can use to determine whether a candidate meets the requirements of the competency standard.

Performance criteria. Simple, evaluative statements on the required outcome of the competency element and a description of the criteria used to judge whether the required level of performance has been achieved.

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ABBREVIATIONS

The following abbreviations are used in this document:

ACC	area control center
ADS-B	automatic dependent surveillance — broadcast
AIP	aeronautical information publication
ANS	air navigation services
ANSP	air navigation service provider
ATC	air traffic control
ATCO	air traffic controller
ATM	air traffic management
ATS	air traffic services
ATSEP	air traffic safety electronics personnel
CNS	communication, navigation, surveillance
COM	communication
DF	direction finder
DME	distance measuring equipment
EMI	electro-magnetic interference
FAT	factory acceptance test
FIR	flight information region
GBAS	ground-based augmentation system
GNSS	global navigation satellite system
GPS	global positioning system
HHI	human-human interaction
HMI	human-machine interaction
IEEE	Institute of Electrical and Electronic Engineers
ILS	instrument landing system
IMS	integrated management system
LR	logging and reporting
LRM	lowest replaceable module
MLS	microwave landing system
MSSR	monopulse secondary surveillance radar
NavAid	navigation aid
NDB	non-directional beacon
OJT	on-the-job training
PO	position operation
QMS	quality management system
RF	radio frequency
RR	release and restoration
S/E	system/equipment
SAT	site acceptance test
SMC	system monitoring and control
SMS	safety management system
SS	site specific SMC task
SSR	secondary surveillance radar
TFI	technical flight inspector
TRM	team resource management
UAC	upper area control center
UHF	ultra high frequency
VHF	very high frequency
VOR	very high frequency omnidirectional radio range

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Chapter 1

INTRODUCTION

1.1 PURPOSE

(1) This manual provides guidance to aeronautical telecommunication service providers (ANSPs) and training organizations on the development of air traffic safety electronics personnel (ATSEP) competency-based training programs.

(2) This chapter introduces concepts underlying the development of ATSEP competency-based training programs.

1.2 CONTEXT

(1) **Regulatory Environment**

(a) ATSEP are described as personnel proven competent in the installation, operation and/or maintenance of a communications, navigation, and surveillance/air traffic management (CNS/ATM) system. It is the responsibility of the ANSP to define the scope of ATSEP activities.

(b) ATSEP play a significant role in the safe operation of CNS/ATM systems. All those involved in the development of competency-based training programs shall have a detailed understanding of the regulatory environment in which ATSEP work.

(c) ATSEP training programs shall be clearly linked to ATSEP activities taking into consideration the ANSP's safety management and quality assurance systems as well as security concerns.

(d) This manual does not apply to ATSEP who work on air navigation services for the military.

(2) ATSEP Scope of activities

(a) ATSEP may perform tasks on a wide variety of CNS/ATM systems and equipment requiring a wide range of competencies and expertise as well as knowledge and skills in electronics, computer sciences and network. In addition, ATSEP activities may be carried out from technician to high-level engineering.

(b) Figure 1.1 below illustrates the possible scope of ATSEP activities using as a basis the engineering lifecycle from system conception through design, operations and finally decommissioning.

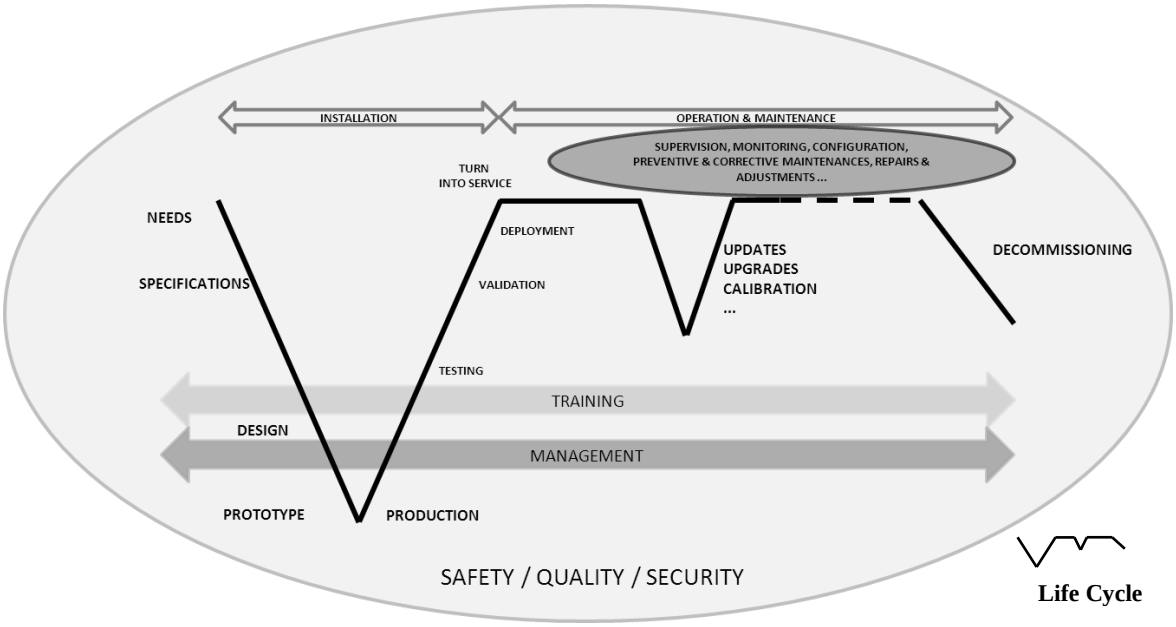

Figure 1.1. Scope of ATSEP activities

(c) The ANSP is responsible for determining the scope of its ATSEP activities by selecting the activities from within the possible scope depicted in Figure 1-1.

(i) **Scope of operational activities**. Supervision, monitoring, control and reporting in real time of technical services, supported by electronic systems and/or equipment for CNS/ATM.

(ii) **Scope of maintenance activities**. Preventive maintenance, corrective maintenance and/or modification and updates of supporting electronic systems and/or equipment for CNS/ATM.

(iii) **Scope of installation activities**. Project management, specification, conception, validation, integration, test and acceptance, safety assessment, calibration, certification, optimization and upgrade of supporting electronic systems and/or equipment for CNS/ATM, engineering activities.

(d) In addition to technical activities, others may be added related to management, teaching or assessment, safety management, security management (e.g. networks) and quality management.

(e) The ATSEP shall be proven competent to work on CNS/ATM systems or equipment ensuring safety and quality through a documented process.

(f) Once an ANSP has determined the scope of ATSEP activities, it can establish ATSEP job descriptions where tasks are identified.

(g) With the introduction of new technologies, maintenance methods and design processes, ANSPs shall regularly review the scope of ATSEP activities, to ensure that ATSEP maintain competencies appropriate to their current and future activities. Training programs shall be focused on the specific activities assigned to ATSEP within an ANSP.

1.3 ATSEP TRAINING PHASES

(1) To ensure global standardization, ATSEP training shall be organized in the following phases:

(a) Phase zero: Selection

The selection process is not a training phase. However, the ANSP will select candidates according to its ATSEP profiles and activities.

(b) Phase one: Initial training

Initial training is designed to provide underpinning knowledge and skills and is delivered in two parts: basic training applicable to all ATSEP and qualification training specific to ATSEP profiles.

(c) Phase two: Unit training

After successfully completing the initial training phase, ATSEP undergo unit training. This phase is oriented to the activities an ATSEP will perform in a specific environment. Unit training addresses theoretical and practical issues from an equipment-specific and/or site-specific perspective. It includes on-the-job (OJT) training. It is in this phase that ATSEP competencies are trained and assessed.

(d) Phase three: Continuation training

The continuation training phase is designed to maintain competencies and prepare for system upgrades and/or modifications. It includes refresher, emergency and conversion training.

(e) Phase four: Development training

This phase focuses on the development of additional competencies required by a change or evolution of an ATSEP's profile.

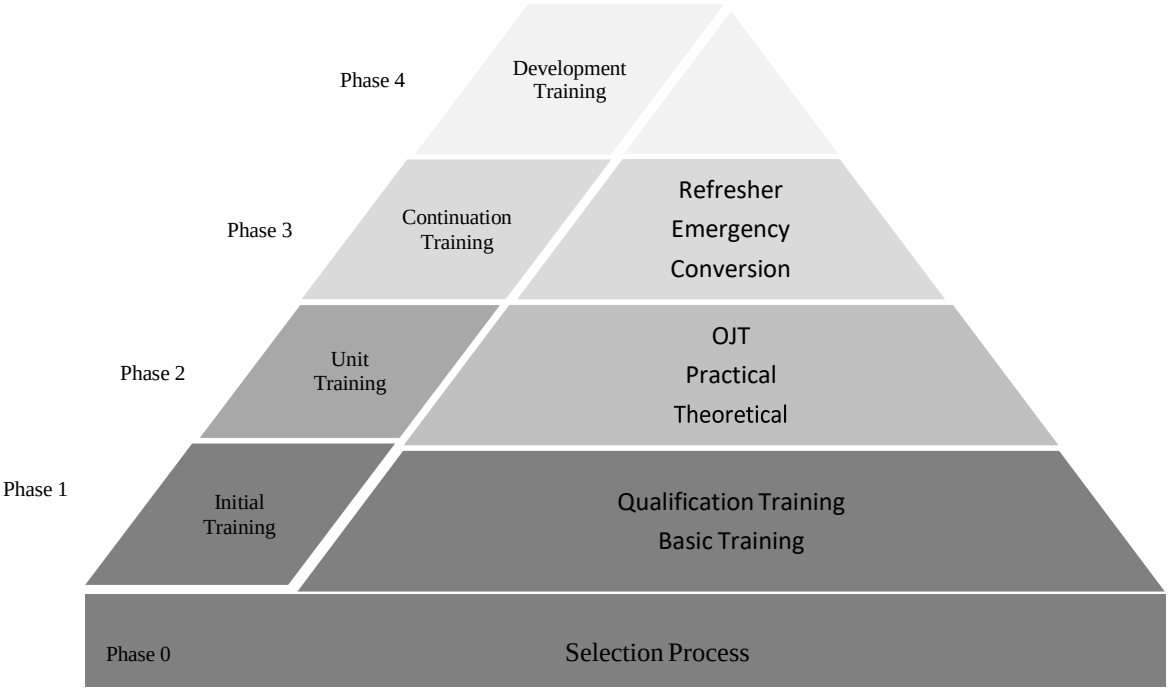

Figure 1-2. ATSEP training phases

1.4 ATSEP TRAINING PATHS

(1) ATSEP shall go through training at different points in their career. Typically, ATSEP will progress from the selection phase to the completion of the unit training phase. Then, they will go through the continuation training phase to maintain competency. In addition, ATSEP shall require training when:

a) There is a change within a system on which the ATSEP is already working. This is addressed through continuation training (see Chapter 5).

b) The ATSEP changes domains (e.g. from navigation to surveillance). This is addressed through either initial training or unit training (see Chapter 3, 4).

c) A change of activities and associated competencies (e.g. change from maintenance operations to system implementation) is addressed through development training (see Chapter 6).

d) Any additional system to be operated by an ATSEP is addressed through unit training (see Chapter 4).

(2) The progression through ATSEP training is illustrated in Figure 1-3.

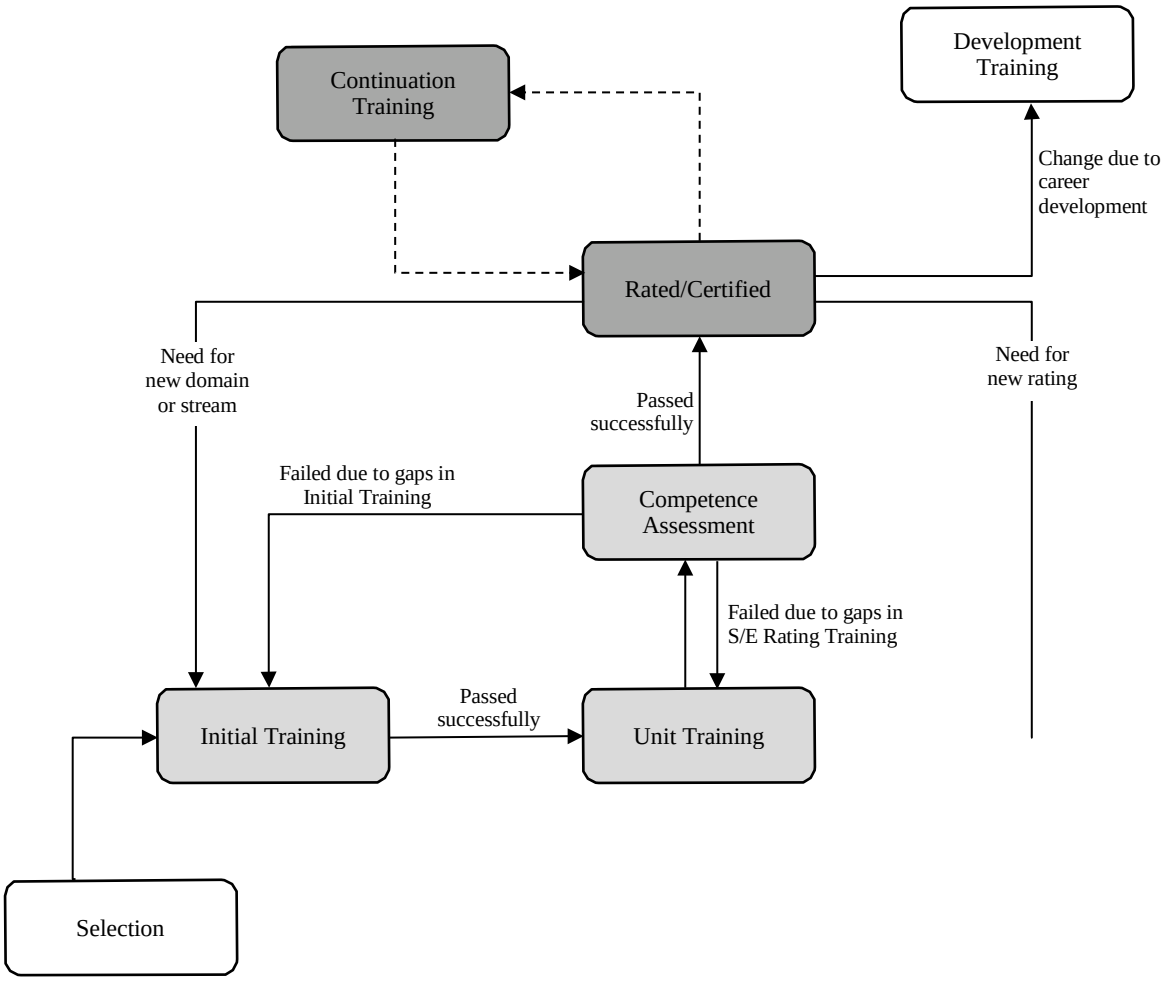

Figure 1.3: ATSEP training progression

1.5 CERTIFICATE OF COMPETENCE

(1) ATSEP Certificates of competence is a proof that someone has fulfilled the requirements of knowledge, expertise and qualification in their field issued by an approved education and/or training institution.

(2) An ANSP shall collect and maintain evidence that its ATSEP are competent to perform the activities assigned to them.

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Chapter 2

INITIAL TRAINING PHASE

2.1 INTRODUCTION

(1) The purpose of this chapter is to describe modules considered necessary for initial training. Initial training provides underpinning knowledge and skills and is delivered in two parts: basic training applicable to all ATSEP and qualification training specific to ATSEP profiles.

(2) During this phase, ATSEP acquire the knowledge and skills required prior to undertaking unit training. Initial training materials can be enhanced by including examples to illustrate real-life situations and using systems and equipment that are available. Training objectives can be added as required.

(3) Paragraph 2.2 describes the components of the basic training module and paragraph 2.3 of the qualification training modules. Proposed training objectives for these modules can be found in Appendix A.

2.2 BASIC TRAINING MODULE

(1) All ATSEP shall successfully complete basic training. At the end of basic training, trainees shall have acquired general knowledge regarding:

(a) international and national organizations and standards;

CNS/ATM systems operations are regulated by international organizations that provide rules and standards to ensure the safe operation and interoperability of air navigation services worldwide. Among these organizations are ICAO, the European Civil Aviation Conference (ECAC), the European Aviation Safety Agency (EASA) and the Institute of Electrical and Electronic Engineers (IEEE). Achievement and maintenance of safety and efficiency in air navigation operations depends on the standardization of operational practices for international services. The syllabus shall give a general view on aviation regulations as adopted by ICAO and implemented in international ANS operations.

(b) air traffic services, airspace standards, aeronautical information systems, meteorology and altimetry;

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

(c) CNS/ATM concepts;

The ATSEP's main activities are to maintain, modify, repair and develop CNS/ATM 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. The syllabus shall give a general

view of these concepts, including power distribution.

(d) human factors.

Lapses in human performance are cited as causal factors in the majority of accidents. A better understanding and knowledge of human factors in ATSEP work can potentially decrease the accident rate. This module introduces ATSEP to fundamental Human Factors concepts in ANS.

(2) The training organization shall ensure that ATSEP successfully achieve all basic training objectives before proceeding to the qualification training modules. Training objectives related to the basic training module can be found in Appendix A.

(3) Each training objective shall be associated with a condition and a standard of accomplishment. A condition refers to anything that may qualify performance in the local environment.

(4) The standard of accomplishment relates to the taxonomy level identified for the training objective. See Appendix B.

2.3 QUALIFICATION TRAINING MODULES

(1) Following the successful completion of basic training, ATSEP will require qualification training relevant to the ATSEP profile for a given ANSP.

(2) At the completion of the qualification modules, ATSEP must be able to explain the purpose of each system, piece of equipment and their technical specifications. They must also be able to explain the effect and impact on the service while working on these systems or equipment.

(3) The training objectives for the following qualification modules are described in Appendix B.

(a) communication (Appendix B2);
(b) navigation (Appendix B3);
(c) surveillance (Appendix B4);
(d) data-processing/automation (Appendix B5);
(e) system monitoring and control (Appendix B6);
(f) infrastructure (Appendix B7); and
(g) engineering (Appendix B8)

(4) Each training objective shall be associated with a condition and a standard of accomplishment. The training objectives shall include in their conditions, as appropriate, a laboratory environment, exposure to specific equipment as well as access to appropriate training materials, reference documentation, test equipment and tools.

(5) The training organization shall ensure that ATSEP successfully achieve all training objectives in accordance with the standard of accomplishment and the approved standards and procedures.

(6) Finally, ATSEP must understand the impact of their work on the users and on the overall ANS communication system.

2.3.1 Communication module

(1) Communication systems provide a means of relaying essential information for the safe and orderly operation of the ANS. Communication means a lot more than radio transmitters and receivers; it also includes communication protocols, networks, types of medium, recorders and safety aspects.

(2) Training Objectives in this module address:

(a) voice – air – ground;
(b) voice – ground – ground;
(c) data – introduction to networks;
(d) data – national networks;
(e) data – international networks;
(f) data – global networks;
(g) data – protocols;
(h) transmission path – lines;
(i) transmission path – specific links;
(j) recorders – legal recorders;
(k) safety attitude and functional safety; and
(l) health and safety.

2.3.2 Navigation module

(1) Radio navigation systems provide a means of relaying essential information for the safe and orderly operation of the ANS. Radio navigation systems can be located anywhere on the airport, in its vicinity, at a great distance from the airport, or satellite-based systems.

(2) Training objectives in this module address the following specific aspects of radio navigation systems:

(a) NAV concepts;
(b) ground-based systems — NDB/Locator;
(c) ground-based systems — VDF/DDF/IDF;
(d) ground-based systems — VOR;
(e) ground-based systems — DME;
(f) ground-based systems — ILS;
(g) ground-based systems — MLS;
(h) satellite-based navigation systems — GNSS1;
(i) satellite-based navigation systems — GBAS;
(j) satellite-based navigation systems — SBAS;
(k) satellite-based navigation systems — ABAS;
(l) satellite-based navigation systems — Modernized GPS;
(m) satellite-based navigation systems — GALILEO;
(n) satellite-based navigation systems — GNSS2;
(o) on-board navigation architecture;
(p) display systems;
(q) inertial navigation;
(r) vertical navigation;
(s) safety attitude and functional safety; and

(t) health and safety.

2.3.3 Surveillance module

(1) An aeronautical surveillance system provides the aircraft position and other essential information to ATM and/or airborne users for their safe and orderly operation. Surveillance systems can be located anywhere on the airport, in its vicinity, or at a great distance from the airport.

(2) ATSEP shall meet the standard of accomplishment whereby all maintenance, calibration and certification s be performed as per the approved standards and procedures

2.3.4 Data processing/automation module

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

2.3.5 System monitoring & control (SMC) module

(1) The implementation of CNS/ATM systems and equipment has led to new ways of providing SMC. Most ANSP have centralized the SMC functions within a geographical area, typically the FIR or the area of responsibility. Many ACC have an SMC suite or position staffed by qualified SMC ATSEP. In other cases, SMC suites or positions for CNS systems and equipment are centralized. Both options may co-exist. The SMC 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 area of responsibility.

(2) The SMC ATSEP shall ensure a quick response to malfunctions or failures by diagnosing the problem, activating fallback procedures and initiating the repair. The SMC ATSEP shall coordinate between the operational ATCO supervisor and the operational CNS/ATM ATSEP within the area of responsibility. The SMC ATSEP also shall coordinate between those responsible for different areas.

(3) Training for the SMC ATSEP shall emphasize the requirement to communicate appropriately with all relevant stakeholders such as ATCO supervisor, rescue units, military units or others. Thus, training shall address team resource management (TRM), human-machine interaction (HMI) and human-human interaction (HHI) skills.

(4) SMC ATSEP activities shall be categorized in a generic list. To complete each of these activities, ANSPs shall describe site procedures, identify the activities in each of the areas of responsibility and number them. The following naming conventions shall be used to categorize SMC activities:

(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.

(5) The SMC qualification module shall be developed, implemented and delivered based on the activities identified by the ANSP. Trainees shall perform SMC activities in accordance with approved procedures and apply TRM, HMI and HHI concepts.

(6) Training objectives related to the SMC qualification module shall include in their condition's exposure to specific SMC equipment equal or representative of the SMC environment, as well as reference documentation and tools. Alternatively, use of simulation or scenarios could be used to enable the performance of the objective without the need of the operational equipment. In addition, the performance of training objectives should be achieved in specific situations relating to a FIR/ACC. This module should include exercises of applied standards and procedures, as well as operational practices.

2.3.6 Infrastructure module

(1) Infrastructure equipment and systems play a vital role in the operation of CNS/ATM systems and consequentially in the safe and orderly operation of ANS. The integrity and reliability of CNS/ATM systems depends on the quality, availability, capacity and reliability of electrical power supply sources, equipment and systems.

(2) ATSEP must understand the impact of their work on the users and on the overall CNS/ATM power supply system.

(3) Training objectives related to the infrastructure qualification module shall include in their conditions that performance shall be achieved in a laboratory environment, given an exposure to specific power supply equipment along with the appropriate and pertinent reference documentation, test equipment and tools.

2.3.7 Engineering module

The engineering module shall be developed, implemented and delivered in compliance with the ATSEP profile and activities required by an ANSP. The trainees shall perform their tasks in accordance with approved local and/or national standards and procedures.

(1) This module has been divided as follows:

(a) engineering;
(b) requirements and specifications;
(c) design;
(d) validation and testing;
(e) documentation;
(f) installation/deployment; and
(g) audit

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Chapter 3

UNIT TRAINING PHASE

3.1 INTRODUCTION

(1) After successfully completing the initial training phase, ATSEP undergo unit training. This phase is oriented to the activities and competencies an ATSEP will perform in a specific technical and operational environment.

(2) Unit training addresses theoretical and practical issues specific to the equipment and site of an operation unit. Unit training includes on-the-job training. It is in this phase that ATSEP competencies are trained and assessed.

3.2 TRAINING PLAN

(1) In principle, the unit training can be organized in three modules:

(a) technical and operational environment;
(b) system/equipment; and
(c) on-the-job training

(2) Training content shall address:

(a) functionality of the system/equipment;
(b) actual and potential impact of ATSEP actions on the system/equipment; and
(c) impact of the system/equipment on the operational environment.

(3) Unit training builds on the theoretical knowledge and skills learned during the initial training phase. In addition, training objectives in the areas of human factors and teamwork shall also be considered relevant in unit training.

(4) The level of training must be appropriate to the ATSEP profile but would not normally go beyond the replacement of the lowest replaceable module (LRM) or electronic boards of the system and equipment. The unit training shall not cover repair of LRMs or boards. If required, training for repairs should be conducted outside the scope of unit training.

(5) Unit training can be implemented at a specialized training center, at the factory, on site or a combination thereof. However, OJT shall be conducted on site in the operational environment.

(6) Before new systems becomes fully operational, a sufficient number of ATSEP must be available to maintain the systems and shall therefore complete the relevant unit training. ATSEP initially qualified to start operation shall participate in the factory acceptance test (FAT) and/or the site acceptance test (SAT) prior to receiving a manufacturer's training course.

3.3 UNIT TRAINING MODULES

3.3.1 Technical and operational environment module

(1) ATSEP trainees shall have detailed knowledge of the technical and operational environment which can directly influence ANS such as facilities, maintenance procedures, quality, safety and security policies. At the end of this module and in accordance with the ATSEP profile, the trainee shall be able to:

(a) describe the infrastructure environment, system and equipment involved in the ANS.
(b) apply rules for circulation (e.g. access to shelters, driving certificate, technical rooms and security rules).
(c) identify facilities (power supply, air-conditioning and etc.)
(d) use the proper vocabulary relative for communication with other services.
(e) apply safety rules and maintenance procedures.

(2) For ATSEP with prior experience in the operational environment, unit training should only address the areas where a gap has been identified.

3.3.2 System/equipment module

(1) Trainees shall be familiar with the specific system or equipment for the unit, in particular with the principles of its design, the different hardware and software elements and their interactions and functionality.

(2) This module builds on what was learned during qualification training and is specific to the equipment type the ATSEP will work on.

(3) At the end of this module and in accordance with the ATSEP profile, the trainee will be able to:

(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 the functionality of the HMI and SMC and their operation; and
(f) operate appropriate action in installation and/or maintenance and/or operation activities.

3.3.3 On-the-job training module

(1) The purpose of this module is to develop, consolidate and evaluate the competencies, knowledge and skills gained within the operational environment and specific system/equipment and required for the rating.

(2) During OJT, the trainee will perform the activities for the job in the operational environment (e.g. operations, supervision, troubleshooting exercises, replacement, installations, testing of faulty modules, calibration). The trainee will also apply procedures for installation, maintenance and/or operation particular to the measurement, testing and restarting of the system or equipment in order to certify that it meets the standards.

(3) This module includes practical exercises on systems and/or equipment where the trainee works on live equipment under the supervision of an experienced ATSEP or instructor.

(4) At the end of this module and in accordance with the ATSEP tasks, the trainee will be able to:

(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 (periodic measurement, start or restart, configuration, etc.), including the HMI and SMC.
(c) run all available built-in tests, diagnostics and checks on the system or equipment.
(d) troubleshoot system/equipment in operational environment by:
(i) analyzing the warnings, errors, alarms or failure messages or indications;
(ii) identifying problem areas and faulty module or LRM.
(iii) performing replacement of units or LRM;
(iv) calibrating or reconfiguring the system if required.
(v) restoring the system or equipment to an operational mode.
(vi) conducting installation activities.

(5) After the successful completion of unit training and competency assessment, the ATSEP will obtain their certification and/or rating of competence (proven competent status).

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Chapter 4

CONTINUATION TRAINING

4.1 INTRODUCTION

(1) This chapter provides guidelines to States and ANSP in the preparation and provision of continuation training for ATSEP. The objective of continuation training is to ensure that the ATSEP maintains up-to-date operational competence.

(2) Maintaining ATSEP competence is part of Integrated Management System (IMS) in place in each ANSP. IMS is composed of a Quality Management System and Safety Management System with a risk analysis and mitigation process. This last process takes into account all changes (minor or major) made by the ANSP. Gathering evidence on the maintenance of ATSEP competence is therefore vital from an IMS point of view.

(3) There are three types of continuation training:

(a) refresher training which reviews or reinforces existing competencies;
(b) emergency training which includes training for unusual situations;
(c) conversion training (system/equipment changes, upgrade and/or changes in procedures).

4.2 REFRESHER TRAINING

(1) Refresher training is designed to review or reinforce existing ATSEP competencies. It shall be site-specific, conducted on a regular basis and related to the rating and/or certification of the ATSEP. It shall cover theoretical knowledge as well as practical skills which can be acquired through simulations or practical exercises.

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

(3) ATSEP who hold ratings/certifications 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.

(4) In the case of multi-rated/multi-certified ATSEP (e.g. COM, NAV, SUR, SMC), refresher training specific to that rating/certification is likely to be most effective.

(5) For ATSEP who are project managers in system installation or requirements, engineering role-based refresher training may be appropriate.

(6) Refresher training shall be carried out minimum every 2 years. The frequency of refresher training will depend on:

(a) activity exposure;

(b) complexity of the system/equipment/activity; and

(c) impact of the loss of the system / equipment for the service provision.

(7) Refresher training may be carried out either on-site or off-site, whichever is the most appropriate. Where possible, the training might be carried out on representative systems or equipment (e.g. on a spare system).

4.3 EMERGENCY TRAINING

(1) Emergency training refers to training for the management of non-routine situations. It is linked to the competency unit "management of non-routine situations" and the subsequent competency elements and performance criteria.

(2) Non-routine situations can be described by the following characteristics:

(a) immediate or short term; and/or
(b) human life is engaged or endangered; and/or
(c) major degradation of service provision.

(3) Training for these situations is aimed at dealing with causal factors impacting safety, such as but not limited to:

(a) natural events (e.g. earthquakes, tornado, flood, fire);
(b) security breach (e.g. terrorism, cyber-attack, sabotage); and
(c) technology breach (e.g. major system failure, power failure).

(4) Training for management of non-routine situations can be facilitated in a number of ways, including but not limited to:

(a) recurrent training or exercises based on written procedures;
(b) round table discussion dealing with hypothetical scenario;
(c) lessons learned exercises based on experience; and
(d) debriefing after major events, incidents or accidents to enhance safety and/or security.

4.4 CONVERSION TRAINING

(1) Conversion training might be triggered by a change to an existing system that impacts operations. Triggers for setting up a conversion training include:

(a) updates on reference material from relevant regulatory provisions and from AIPs;
(b) new maintenance procedures;
(c) new Standards and operating procedures;
(d) new factors affecting system performance;
(e) system monitoring and control changes;
(f) system modification (hardware, software, firmware);
(g) new monitoring, calibrating and measuring equipment available for ATSEP; and
(h) organizational changes leading to the identification of new competency elements.

(2) Conversion training is system- or equipment-specific. It shall be provided to all impacted ATSEP prior to the change being deployed. The ATSEP profile and competencies as well as other phases of training (e.g. unit training, refresher training) shall be adjusted in accordance with the change.

(3) Conversion training shall be designed to familiarize the ATSEP with any change in the system,

equipment, procedure or practice updates that may have occurred since the last training session. Training objectives shall be derived from the difference between the current situation and the situation after deploying the change.

(4) Typically, conversion training is related to a specific planned change and is scheduled once. The duration is dependent on the nature of the change and the ATSEP affected.

(5) Conversion training can be delivered through various means ranging from dedicated training sessions to briefings, operational instructions, information papers or others. It may be carried out at either on-site or off-site, whichever is the most appropriate. Where relevant, it is advantageous that part of the training be carried out on representative systems or equipment (e.g. on a spare system).

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Chapter 5

DEVELOPMENT TRAINING

5.1 Introduction

(1) Development training consists in developing the additional competencies required when taking on new activities. Typically, this is initiated as a result of career progression.

(2) These new activities may include:

(a) carrying out a training function (e.g. OJTI);
(b) managing staff;
(c) writing requirements;
(d) validating and testing equipment or systems;
(e) managing quality, safety or security; and
(f) auditing

(3) If a significant change of activities is identified, initial or unit training may be required (see Chapters 2 and 3). Development Training also part of competency-based training that the ANSP considers these new activities as part of the ATSEP profile.

5.2 Development training outline

5.2.1 Technical Flight Inspector

(1) Paragraph 2.7 of ICAO Annex 10 — *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids*, requires States or ANSP to perform flight tests on aeronautical telecommunications systems. Flight tests are carried out following guidance provided in ICAO's *Manual on Testing of Radio Navigation Aids* (Doc 8071).

(2) Electronic test equipment such as high precision navigation receivers, sensors, data recorders, computers and signal analyzers are installed on an aircraft for the calibration of radio navigational aids. 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.

(3) 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 (e.g. theodolite, laser tracker, differential GPS);
(e) communications with ground personnel as required; and
(f) preparation of inspection report.

(4) Trainees shall perform flight test activities in accordance with standards and procedures approved

by the Authority. The ATSEP TFI shall be able to:

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

(5) 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.

5.2.2 ATSEP INSTRUCTOR TRAINING

(1) ATSEP instructor training is specialized. Therefore, ATSEP shall be trained as instructors including the ability to teach in a classroom setting, to provide OJT and to coach on equipment.

(2) This training is designed for ATSEP who are, or will be, involved in classroom instruction. At the end of this course, ATSEP shall have basic instructional skills.

(3) Instructors have 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.

(4) The course shall address:

(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.

5.2.2.1 On-the-job training instructor and coaching

(1) The course is designed for ATSEP who will carry out OJT or coaching in an operational unit. The OJT phase and practical exercises on equipment (standby or real equipment or special equipment for development and training purpose) are critical in training ATSEP. The OJT instructor and coach shall apply best practices in teaching techniques and coaching which will increase the quality and the

efficiency of the OJT, increase safety, and decrease risk when dealing with equipment. The course shall also advocate a code of practice for the instructor.

(2) The program shall address:

(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 practices 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.

5.2.2.2 Assessment training

(1) This course is designed for an experienced engineer, technician or OJT instructor who will be assessor to conduct assessments for ATSEP. It focuses on procedures for evaluating the initial and continued operational competency of ATSEP.

(2) Assessors ensure that competency standards and safety are maintained. They may have to comment and take action on the competency of colleagues and friends. This is challenging and requires professional and personal integrity.

(3) Through this course, trainees will learn the rationale, initial knowledge, skills and techniques for the role of competency assessor as well as how to use practical and oral assessments to determine if a trainee achieved competence. 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.

(4) Program outline:

(a) role and task of assessor;
(b) international, regional and local 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.

5.2.3 Engineering ATSEP – Installation

5.2.3.1 Installation Engineering

(1) In case of any CNS/ATM system is installed by ATSEP, Authority requires that service provider must ensure that CNS/ATM systems and equipment are analyzed and installed by qualified ATSEP.

Generally, ANSPs create a distinct group of specialized ATSEP who are responsible for the engineering and the installation of all CNS/ATM systems and equipment.

(2) The training objectives of this module are generic and target ATSEP involved in the first part of the life-cycle (Chapter 1, paragraph 1.2. (2). This module shall be developed, implemented and delivered in compliance with an ATSEP activities and profile, and in accordance with approved standards and procedures.

(3) On a given situation, the engineering ATSEP shall be able to:

(a) demonstrate ability to collect operational needs;
(b) interpret needs and translate into specifications;
(c) use results to discuss with industrials;
(d) discuss on appropriate solutions; and
(e) appraise cots provided by industrials.

(4) 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.

5.2.3.2 Installation design

(1) The training objectives of this module are generic and target ATSEP involved in installation design. This module shall be developed, implemented and delivered in compliance with ATSEP activities and profile, and in accordance with approved standards and requirements.

(2) On a given situation, the engineering or installation ATSEP shall be able to:

a) demonstrate ability to manage a project;

b) comply with performance requirements;

c) comply with integrated management system (safety & quality);

d) use competencies in System engineering;

e) design new electronics systems, equipment or part of them;

f) respects delay and costs;

g) comply with development requirements and regulations; and

h) take into account sustainable development.

(3) 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.

5.2.3.3 Installation validation and testing

(1) The training objectives of this module are generic and target those ATSEP involved in testing of the system or equipment at the final stage of the lifecycle. This module shall be developed, implemented and delivered in compliance with ATSEP activities and profile, and in accordance

with approved local and/or national standards and procedures.

(2) Service Provider are responsible for on-site testing activities since they are also responsible for the operations of their CNS/ATM systems and equipment. The ATSEP responsible for testing must have in-depth knowledge of technical systems and strong system engineering skills.

(3) These ATSEP shall:

(a) develop testing strategies tailored to the system and to its future use in the operational environment, including the development of testing objectives, the verification against technical, safety and regulatory requirements, and the plan and resources required for testing (i.e. steps, staffs, and technical means). Note that this activity shall take into account the distribution of responsibilities between the supplier(s) and the service provider;

(b) develop detailed test documents in line with the testing strategy, including a clear link between the tests and the requirements. These test documents list the technical actions to be done and the resulting observations. These documents must be developed in such a manner as to collect evidence against the requirements to be met;

(c) implement a dedicated testing management plan to manage the testing process;

(d) conduct the testing program;

(e) carry out tests;

(f) report results and conclusions to management, the engineering services, the supplier(s) and the operational and technical services; and

(g) design a testing strategy dedicated to the transition phase, in order to demonstrate the capability of the ANSP to put the future system into operation safely, and execute this strategy in close cooperation with the operational staff.

(4) For a given testing situation, the ATSEP shall be able to:

(a) describe clearly the system to be tested: what is part of the system under tests, what are the external interfaces;

(b) identify the relevant technical, safety and regulatory requirements pertaining to the system to be tested;

(c) develop a relevant testing strategy;

(d) propose the technical and organizational processes to ensure a sound cooperation of all stakeholders involved into the testing activities; and

(e) demonstrate ability to manage a project.

(5) 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.

5.2.3.4 Installation – deployment

(1) The training objectives of this module are generic and target those ATSEP involved in the final stage of the lifecycle (See Chapter 1, paragraph 1.2.(2). This module shall be developed, implemented and delivered in compliance with ATSEP activities and profile and in accordance with standards and procedures.

(2) The deployment phase must be managed as a specific project, with its own constraints and goals. ATSEP shall manage deployment bearing in mind the safety and operations of the target environment. The goal of deployment is to deliver a "ready for tests" system to teams responsible its verification in the operational environment.

(3) ATSEP shall:

(a) define the urbanization of the system;
(b) produce blue-prints, plans, and drawings of the future system in its operational environment;
(c) develop the deployment plan including a description of the technical tasks (energy, air conditioning, supply, wiring, etc.) staff and resources required;
(d) conduct the deployment program;
(e) carry out technical activities;
(f) check installation; and
(g) report results and conclusions.

(4) For a given deployment situation, the ATSEP shall be able to:

(a) describe clearly the system to be deployed;
(b) identify all the constraints to be taken into account in course of the deployment (including operational constraints);
(c) identify all the activities and the overall rationale, milestones, dependencies;
(d) develop a relevant deployment plan;
(e) proposes the technical and organizational processes to ensure a sound cooperation of all stakeholders involved into the deployment activities (progress meetings…);
(f) demonstrate ability to manage a project.

(5) 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.

5.2.4 QUALITY, SAFETY AND SECURITY ATSEP MANAGER

Installation, operation and maintenance activities are related to the management of quality (customer-oriented), safety (goods and person-oriented) and security (integrity and protection against attacks).

5.2.4.1 Generic training objective

(1) This module provides generic objectives for training of quality, safety and/or security management. This module shall be developed, implemented and delivered in compliance with ATSEP activities and profile and in accordance with local environment and duties. ATSEP shall:

(a) in a technical service, apply and manage the ANS provider policies of quality, safety and/or security; or
(b) apply quality, safety and/or security policies on installation, operation and maintenance activities.

(2) In a local context and environment, the quality, safety and/or security ATSEP manager shall be able to:

(a) demonstrate communication abilities;

(b) design quality, safety and/or security procedures related to ATSEP activities;
(c) apply quality, safety and/or security policies deployed by the ANS provider; and
(d) promote quality, safety and/or security.

(3) Standard of accomplishment:

(a) all the descriptions shall include the essential points of the given situation; and
(b) all work shall be performed in accordance with approved standards and procedures.

(4) All training objectives below assume that trainees have access to the relevant reference material.

5.2.4.2 Training objective for safety ATSEP manager

(1) The trainee will describe the functions in ANSP operations and responsibilities:

(a) explain the purpose of safety management;
(b) explain the purpose of ICAO documents Annex 19 — Safety Management and Safety Management Manual (SMM) (Doc 9859);
(c) describe the relationship between the service provider and the Civil Aviation Authority;
(d) describe the purpose of the regulations;
(e) describe the importance of safety procedures;
(f) describe CNS/ATM services; and
(g) relate technical activities to operation activities.

(2) The trainee will prepare audit activities:

(a) explain safety standards;
(b) interpret local, national and international documentation; and
(c) explain audit referential.

(3) The trainee will describe CNS/ATM systems environment:

(a) describe local technical environment;
(b) explain CNS/ATM services to ATCO and pilots;
(c) explain the importance of the availability and integrity of information delivered to ATCO and pilot in the safety chain;
(d) explain the potential risks on safety due to installation, operation and/or maintenance activities on CNS/ATM systems; and
(e) explain the impact on the safety consecutive to a lack of availability or integrity of information delivered to ATCO and pilot.

(4) The trainee will apply safety regulation:

(a) appraise safety impact concerning installation, operation and/or maintenance activity on CNS/ATM system and/or equipment;
(b) measure the risk and the impact on safety aspect of any action undertaken on a CNS/ATM system and/or equipment;
(c) propose organizational action in order to mitigate the risk during installation, operation and/or maintenance action on CNS/ATM system and/or equipment;
(d) apply appropriate mitigation tools and/or procedure during installation, operation and/or maintenance actions;

(e) report appropriate results and comments after installation, operation and/or maintenance actions; and
(f) promote safety.

5.2.4.3 Training objective for quality ATSEP Manager

(1) The trainee will describe the functions in ANSP operations and responsibilities:

(a) explain the purpose of a quality management;
(b) describe the relationship between the service provider and its customers (air companies, stakeholders, passengers);
(c) describe the relationship between the technical service and its customers (ATCO, pilots, ANS provider, airport authority, other stakeholders);
(d) describe the importance of quality, safety and/or security procedures; and
(e) describe CNS/ATM services.

(2) The trainee will prepare audit activities:

(a) describe quality, safety and/or security standards;
(b) interpret documentation; and
(c) apply audit referential.

(3) The trainee will describe CNS/ATM systems environment:

(a) describe local technical environment.

(4) The trainee will apply safety regulation:

(a) appraise safety impact concerning installation, operation and/or maintenance activity on CNS/ATM system and/or equipment;
(b) measure the risk and the impact on safety aspect of any action undertaken on a CNS/ATM system and/or equipment;
(c) propose organizational action in order to mitigate the risk during installation, operation and/or maintenance action on CNS/ATM system and/or equipment;
(d) apply appropriate mitigation tools and/or procedure during installation, operation and/or maintenance actions;
(e) report appropriate results and comments after installation, operation and/or maintenance actions; and
(f) promote safety.

5.2.4.4 Training objectives for security ATSEP manager

This module addresses the activities of an ATSEP manager dealing with security. These ATSEP are concerned with network security and measures to protect the integrity of data-processing systems against cyber-attacks.

(1) Trainees will describe the functions in service provider operations and responsibilities:

(a) describe the relationship between the ANS provider and the airport authority;
(b) describe the relationship between the ANS provider and security forces authorities (police, customs);
(c) describe the purpose of the local and/or national regulations;

(d) describe the importance of security procedures;
(e) explain local Information security system policy; and
(f) describe CNS/ATM services.

(2) Trainees will take into account external providers:

(a) describe the relationship between the ANS provider and external providers such as: telecom providers, sub-contractors;
(b) describe the relationship between the ANS provider and security forces authorities (police, customs);
(c) describe the purpose of the local and/or national regulations;
(d) describe the importance of security procedures;
(e) explain local Information security system policy; and
(f) describe CNS/ATM services.

(3) Trainees will prepare audit activities:

(a) describe security standards;
(b) interpret documentation; and
(c) apply audit referential.

(4) Trainees will describe CNS/ATM systems environment:

(a) describe local technical environment; and
(b) explain the risks of security breach using any type of connection on CNS/ATM system and/or equipment.

(5) Trainees will apply security regulation:

(a) appraise security impact concerning installation, operation and/or maintenance activity on CNS/ATM system and/or equipment;
(b) measure the risk and the impact on security aspect of any action undertaken on a CNS/ATM system and/or equipment;
(c) propose organizational action in order to mitigate the risk during installation, operation and/or maintenance action on CNS-ARM system and/or equipment;
(d) apply appropriate mitigation tools and/or procedure during installation, operation and/or maintenance actions;
(e) report appropriate results and comments after installation, operation and/or maintenance actions; and
(f) promote security.

5.2.4.5 ATSEP team manager

(1) ATSEP teams involved in installation, operation and maintenance activities are usually managed by one who has been promoted out of their ranks.

(2) This module provides generic objectives for training of team managers. This module shall be developed, implemented and delivered in compliance with ATSEP activities and profile and in accordance with local environment and duties.

(3) The ATSEP shall manage people and a team in accordance with their status, job description, activities, profile and certifications. They shall:

(a) comply with local, national and/or international regulation;
(b) take into account quality, safety and security policies and/or regulation on installation, operation and maintenance activities; and
(c) take into account human factors.

(4) In a local context and environment, the ATSEP team Manager shall be able to:

(a) demonstrate communication abilities;
(b) organize ATSEP activities according to staff's qualification and certification;
(c) organize ATSEP team activities according to operational needs and applicable regulation;
(d) communicate and report to stakeholders; and
(e) solve personal conflicts.

(5) 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.

APPENDIX A

TRAINING OBJECTIVES FOR INITIAL TRAINING

This appendix outlines training objectives for the initial training modules described in Chapter 2. A number of training objectives are repeated because trainees need to learn aspects of two domains simultaneously. If a module covers a single domain, no double objectives will appear. If two or more domains are covered, objectives may be repeated. An efficient training plan will describe how these objectives will be taught once and applied through the rest of the modules.

A 1 – Training objectives for a basic training course

SUBJECT 1: INDUCTION

TOPIC 1: INDUCTION

SUB-TOPIC 1.1: Training and assessment overview

1.1.1	Describe the training scheme and progression towards ATSEP competence.	2	Initial (basic and qualification), S/E rating and continuation training. Course aims, objectives, and topics.
1.1.2	State the assessment requirements, procedures, and methods.	1	—

SUB-TOPIC 1.2: National organization

1.2.1	Describe the organizational structure, purpose and functions of the national service provider(s) and regulatory structures.	2	e.g. headquarters, control centers, training facilities, airports, outstations, civil/military interfaces, regulatory interfaces.
1.2.2	Describe the structure and functions of the major departments within the service provider national organization.	2	e.g. organizational handbook (plans, concepts and structure, finance model).
1.2.3	State appropriate accountabilities and responsibilities of the service provider(s) and competent authority.	1	—

SUB-TOPIC 1.3: Workplace

1.3.1	State the role of trade unions and professional organizations.	1	e.g. international, regional, national
1.3.2	Consider security of site facilities and personnel against unlawful interference	2	Environmental, physical and information security measures, employee vetting, and reference checks.
1.3.3	Describe actions when suspecting a security breach	2	e.g. inform police, security agencies and managers. Security manual and/or contingency plan.

SUB-TOPIC 1.4: ATSEP role

1.4.1	Describe the key responsibilities of an ATSEP	2	

SUB-TOPIC 1.5: National/regional/worldwide dimension

1.5.1	Explain the relationship between States and its relevance to ATM operations.	2	e.g. harmonization, flow management, bilateral agreement, sharing of ATM relevant data, major studies, research programs, and policy documents.
1.5.2	Define the regulatory framework of international and national ATM.	1	e.g. ICAO, regional and national concepts, responsibilities.
1.5.3	State the purpose of a range of international and regional bodies.	1	e.g. ICAO, EASA, FAA, RTCA, EUROCAE

SUB-TOPIC 1.6: International Standards and Recommended Practices

1.6.1	Explain how the regulatory environment of ICAO notifies and implements legislation.	2	Annexes, SARPs
1.6.2	State which major/key ATM engineering "standards" and "practices" are applicable	1	e.g. ICAO Annex 10, ICAO Doc 8071, guidance material on reliability, maintainability and availability.

SUB-TOPIC 1.7: Data security

1.7.1	Explain the importance of ATM security.	2	—
1.7.2	Describe the security of operational data.	2	Secure restricted access by authorized personnel.
1.7.3	Explain security policies and practices for information and data.	2	Backup, storing, hacking, confidentiality, copyright.
1.7.4	Describe the possible external interventions which may interrupt or corrupt ATM services.	2	Introduction of software viruses, illegal broadcasts, jamming, spoofing.

SUB-TOPIC 1.8: Quality management

1.8.1	Explain the need for quality management and the need for it.	2	e.g. ISO, EFQM
1.8.2	Explain the need for configuration management.	2	Importance for safe operations, e.g. S/E build state, software adaption/version

SUB-TOPIC 1.9: Safety management system

1.9.1	Explain why there is a need for high-level safety requirements for aeronautical activities.	2	Safety policy and rules, system safety cases, system safety requirements.

SUB-TOPIC 1.10: Health and safety

1.10.1	Explain personal safety responsibilities in the work environment.	2	Safety statement, first aid, rules about climbing
1.10.2	Explain potential hazards to health and safety generated by equipment, or contained within the work environment.	2	e.g. health consequences of electric shock and static discharges, precautions with chemical products (batteries), mechanical hazards (rotating machinery/antennas), toxic materials (beryllium), biological hazards, faulty earthning .
1.10.3	Describe fire safety and first-aid regulations and practices.	2	Requirements and rules, e.g. standards
1.10.4	State any applicable legal requirements and safety rules.	1	National, regional, international regulations, e.g. for working on power supply and/or air conditioning.
1.10.5	Describe the main features and uses of the different types of fire detectors and extinguishers.	2	e.g. VESDA, Type A, B, C, D extinguishers .

SUBJECT 2: AIR TRAFFIC FAMILIARISATION

TOPIC 1: AIR TRAFFIC FAMILIARIZATION

SUB-TOPIC 1.1: Air Traffic Management

1.1.1	Define air traffic management.	1	ICAO, regional regulations
1.1.2	Describe operational ATM functions.	2	ATFCM, ATS, ASM
1.1.3	Describe ATM concepts and associated terminology.	2	e.g. concepts: FUA, free flight, gate-to-gate, performance- based ATM operations (PBN, RCP), operational concepts (ICAO, SESAR, NextGen). Terminology: glossary
1.1.4	Explain the operational importance of technical services required for ATM.	2	
1.1.5	State future developments in systems and/or ATM/ANS practices which may impact on services provided.	1	e.g. data link, satellite-based navigation, gate-to-gate (CDM), ATC tools, continuous approach, 4D trajectory, business trajectory, SWIM, NOP, (UDPP, modes of separation), ASAS
1.1.6	List the standard units of measurement used in aviation.	1	Speed, distance, vertical distance, time, direction, pressure, temperature

SUB-TOPIC 1.2: Air traffic control

1.2.1	Define airspace organization.	1	ICAO Annex 11, e.g. additional regional regulations, FIR, UTA, TMA, CTR, ATS routes
1.2.2	Describe commonly used airspace terminologies and concepts.	2	e.g. sectorization, identification of ATS routes, restricted airspace, significant points
1.2.3	State the general organization of aerodromes.	1	e.g. obstacle limitation surfaces, different departure and arrival trajectories, approach and landing categories, operational status of radio navigation aids
1.2.4	State the purpose of ATC.	1	ICAO Doc 4444
1.2.5	State the organization of ATC services.	1	ICAO Doc 4444, e.g. area, approach, aerodrome control services

SUB-TOPIC 1.3: Ground-based Safety nets

1.3.1	Describe the purpose of ground-based safety nets.	2	e.g. STCA, MSAW, APW, runway incursion alerts

SUB-TOPIC 1.4: Air traffic control tools and monitoring aids

1.4.1	Explain the main characteristics and use of ATC support and monitoring tools.	2	e.g. MTCD, sequencing and metering tools (AMAN, DMAN), A-SMGCS, CLAM, RAM, CORA

SUB-TOPIC 1.5: Familiarization

1.5.1	Take account of ATC tasks.	2	e.g. simulation, role play, PC, Part Task Trainer, observations in the operational environment
1.5.2	Explain the need for good communication, coordination and cooperation between operational staff.	1	e.g. handovers, MIL/CIV, planner/tactical, SV Tech (SMC) and SV ATCO, site visit(s) to ATC units
1.5.3	Consider the purpose, function and role of various operational stations in respect of ATM-related operations.	2	Site visit(s) to ATC units, e.g. MET Office, e.g. meteorological providers, remote sites, airport operations
1.5.4	Define the phases of flight.	1	Take-off, climb, cruise, descent and initial approach, final approach and landing
1.5.5	Recognize the cockpit environment and associated equipment, in relation to ATC.	1	Relevant pilot HMI e.g. familiarization flight or cockpit simulator training (where practicable), antenna
1.5.6	Define airborne collision avoidance systems.	1	ACAS, EGPWS, e.g. TCAS

SUBJECT 3: AERONAUTICAL INFORMATION SERVICES (AIS)

TOPIC 1: AERONAUTICAL INFORMATION SERVICES

SUB-TOPIC 1.1: Aeronautical Information Services

1.1.1	State the organization of the AIS.	1	—
1.1.2	Define the AIP service.	1	e.g. data contents of AIP, supplementary, AIC and types of publication: AIRAC, non-AIRAC, data collection and preparation, data format, distribution channels, supporting systems and tools
1.1.3	Define the aeronautical charting service.	1	Types of aeronautical charts, operational use of charts, supporting systems and tools
1.1.4	Define the NOTAM services.	1	—
1.1.5	Define the ATS Reporting Office.	1	e.g. purpose of flight plans and other ATS messages, types of flight plans (FPL and RPL), contents of flight plans and other ATS messages, distribution of flight plans and other ATS messages, supporting systems and tools
1.1.6	Define the regional/national AIS Database.	1	e.g. paper/data, central single source, validated, redundancy
1.1.7	Define procedures for providing Communications, Navigation and Surveillance (CNS) data to AIS.	1	Information of a permanent nature, information of a temporary nature, status report of NAVAIDs

SUBJECT 4: METEOROLOGY

TOPIC 1: Meteorology

SUB-TOPIC 1.1: Introduction to meteorology

1.1.1	State the relevance of meteorology in aviation.	1	Influence on the operation of aircraft, flying conditions, aerodrome conditions
1.1.2	State the weather prediction and measurement systems available.	1	—

SUB-TOPIC 1.2: Impact on aircraft and ATS operation

1.2.1	State the meteorological conditions and their impact on aircraft operations.	1	e.g. atmospheric circulation, wind, visibility, temperature/humidity, clouds, precipitation

1.2.2	State the meteorological conditions hazardous to aircraft operations.	1	e.g. turbulence, thunderstorms, icing, microbursts, squall, macro bursts, wind shear, standing water on runways (aquaplaning)
1.2.3	Explain the impact of meteorological conditions and hazards on ATS operations.	2	e.g. effects on equipment performance (e.g. temperature inversion, rain density), increased vertical and horizontal separation, low visibility procedures, anticipation of flights not adhering to tracks, diversions, missed approaches
1.2.4	Explain the effects of weather on propagation.	2	e.g. anaprop, rain noise, sunspots

SUB-TOPIC 1.3: Meteorological parameters and information

1.3.1	List the main meteorological parameters.	1	Wind, visibility, temperature, pressure, humidity
1.3.2	List the most common weather messages and broadcasts used in aviation.	1	e.g. ICAO Annex 3 Meteorology messages: TAF, METAR, SNOWTAM Broadcasts: ATIS/flight meteorology broadcast (VOLMET)

SUB-TOPIC 1.4: Meteorological systems

1.4.1	Explain the basic principles of the main meteorological systems in use.	2	e.g. weather display and information systems, wind speed (anemometer), wind direction (weather vane), visibility (types of IRVR, forward scatter), temperature probes, pressure (aneroid barometers), humidity, cloud base (laser ceilometers)

SUBJECT 5: COMMUNICATION

TOPIC 1: GENERAL INTRODUCTION

SUB-TOPIC 1.1: Introduction to communications

1.1.1	State the structure of the communication domain.	1	Voice communication, data communication
1.1.2	State major substructures of the communication domain.	1	Air-ground, ground-ground, air-air communications
1.1.3	State ATS requirements for safe communications.	1	Safety, reliability, availability, coverage, QoS, latency
1.1.4	State the aeronautical communication services.	1	Mobile, fixed

TOPIC 2: VOICE COMMUNICATION

SUB-TOPIC 2.1: Introduction to voice communications

2.1.1	Describe system architecture.	2	—
2.1.2	Explain the purpose, principles and role of voice communication systems in ATS.	2	e.g. audio bandwidth, dynamic range, fidelity, routing, switching, lineside/deskside, coverage, communication chain between controller and pilot
2.1.3	Describe the way in which voice communication systems function.	2	Analogue/digital comparisons, distortion, harmonics
2.1.4	State methods used to route and switch voice communications.	1	e.g. multi channels, multi-users, party lines, VHF/UHF linkage, HF, SELCAL
2.1.5	State how systems interface to produce an integrated service to ATS.	1	—
2.1.6	State radio spectrum and frequency allocation constraints and procedures.	1	Spectrum, interference sources, commercial allocations, world radio conference, ITU, common aviation position, efficient utilization of frequency bands, channel spacing
2.1.7	State voice recording systems in use.	1	e.g. digital recording equipment, analogue recording
2.1.8	State ICAO and local legal requirements regarding recording and retention of voice communications.	1	Regulatory requirements, incident recording and playback, recording equipment
2.1.9	State the purpose of ATIS and VOLMET.	1	—

SUB-TOPIC 2.2: Air-ground communication

2.2.1	State the functions and basic operation of routing and switching equipment in use in the ATS environment.	1	Voice switching
2.2.2	Describe the purpose and operation of the elements of a communication chain in use in the ATS environment.	2	Functionality, emergency systems, transmission/reception, CWP, on-board equipment e.g. channel spacing, antenna switching, CLIMAX, voting systems
2.2.3	State ways of achieving quality of service.	1	e.g. importance of coverage and redundancy of equipment, overlapping coverage, backup system, functional redundancy vs element redundancy
2.2.4	Recognize the elements of the CWP that are used for air-ground communication.	1	Frequency selection, emergency, station selection, coupling, microphone, headset, loudspeaker, footswitch, PTT

2.2.5	List future developments and techniques which may have an impact on ATS voice communications.	1	e.g. CPDLC, VDL Modes 2

SUB-TOPIC 2.3: Ground-ground communication

2.3.1	State the functions and the basic operations of routing and switching equipment in use in ATS environment.	1	General architecture
2.3.2	Describe how ground-ground systems interface to provide an integrated service to ATS	2	International/national links, ACC interoperability, voice and data integration
2.3.3	Describe the purpose and operation of the elements of a system.	2	Functionality, emergency systems, PTT interfaces e.g. MFC and ATS-Qsig, switching, local PABX equipment
2.3.4	Recognize the elements of the CWP used for ground-ground communication.	1	Selection, emergency, loudspeaker, headset, microphone
2.3.5	List developments in ground-ground technologies which may impact on ATS voice communication.	1	e.g. protocols (TCP/IP, voice-over IP) future development

TOPIC 3: DATA COMMUNICATIONS

SUB-TOPIC 3.1: Introduction to data communications

3.1.1	Explain the purpose, principles and role of data communication systems in ATS.	2	e.g. terminology, principles and theory of networks, layering (e.g.: OSI or TCP/IP), data links, LAN, WAN
3.1.2	Define the concept of data transmission.	1	e.g. packet switching, protocols, multiplexing, demultiplexing, error detection and correction, routing, switching, hops, cost, bandwidth/speed
3.1.3	Describe the function of various elements of the data systems in use in ATS environment.	2	Switch, router, gateways, end systems, redundancy
3.1.4	Define protocols in current use.	1	e.g. TCP/IP, X.25, frame relay, asynchronous transfer mode

SUB-TOPIC 3.2: Networks

3.2.1	State ATS requirements for safe data communications.	1	Reliability, availability
3.2.2	Describe the different types of networks.	2	LAN, WAN, ATN, national network for ATM e.g. satellite- dedicated networks, AFTN
3.2.3	State the functions of a network management system.	1	Priorities, rights e.g. SNMP

SUB-TOPIC 3.3: Aviation specific networks, applications and ATM/ANS providers

3.3.1	Name a range of air-ground aviation related network concepts.	12	ATN e.g. Subnetworks: ATN air-ground subnetwork, AMSS, VDL, HFDL Protocols: ACARS Communication
3.3.2	Name a range of ground-ground aviation- related network concepts.	12	ATN, PENS e.g. Physical networks: PENS, AFTN/CIDIN, RAPNET e.g. Communication protocols: IP, X.25, ASTERIX, FMTP e.g. Communication service providers: SITA, ARINC, national carriers, ANSPs e.g. Applications: AMHS, AIDC, OLDI

SUBJECT 6: NAVIGATION

TOPIC 1: INTRODUCTION

SUB-TOPIC 1.1: Purpose and use of navigation

1.1.1	Explain the need for navigation in aviation.	2	Positioning, guidance, planning
1.1.2	Characterize navigation methods.	2	e.g. historical overview, visual, celestial, electronic (on- board, radio, space-based and relative)

TOPIC 2: THE EARTH

SUB-TOPIC 2.1: Form of the Earth

2.1.1	Name the shape of the Earth.	E	
2.1.2	Explain the Earth's properties and their effects.	2	East, West, North and South, polar axis, direction of rotation
2.1.3	State the accepted conventions for describing 2D position on a globe.	1	Meridians, parallels of latitude, equatorial plane

SUB-TOPIC 2.2: Coordinate systems, direction and distance

2.2.1	State the general principles of reference systems.	1	Geoid, reference ellipsoids, WGS 84 Latitude and longitude, undulation
2.2.2	Explain why a global reference system is required for aviation.	2	_

SUB-TOPIC 2.3: Earth's magnetism

2.3.1	State the general principles of Earth's magnetism.	1	True North, magnetic North e.g. variation, declination, deviation, inclination

TOPIC 3: NAVIGATIONAL SYSTEM PERFORMANCE

SUB-TOPIC 3.1: Factors affecting electronic navigation performance

3.1.1	State how radio waves propagate.	1	Ground, sky, direct
3.1.2	State why the siting of a terrestrial navigation aid is important.	1	Multipath, blanking

SUB-TOPIC 3.2: Performance of navigation systems

3.2.1	State the performance of navigation systems.	1	Coverage, accuracy, integrity, continuity of service, availability
3.2.2	explain the need for redundancy in aviation systems.	2	Ensuring continuity of service, maintainability, reliability

SUB-TOPIC 3.3: Means of navigation

3.3.1	State the different means of navigation.	1	Sole, primary, supplementary

TOPIC 4: NAVIGATION SYSTEMS

SUB-TOPIC 4.1: Terrestrial navigation aids

4.1.1	Explain the basic working principles of electronic positioning.	2	Distance measurements (time and phase), angular measurements
4.1.2	Describe ground-based navigation systems.	2	NDB, VOR, DME, ILS, DF e.g. Loran C, MLS, TACAN, marker beacons
4.1.3	Recognize how the navigation information is displayed on the relevant pilot HMI.	1	_
4.1.4	Explain the operational use of ground-based navigation systems in the different phases of flight.	2	NDB, VOR, DME, ILS, DF
4.1.5	Recognize the frequency bands used by the ground-based navigation systems.	1	_
4.1.6	State the need for calibration.	1	Flight calibration, ground-based calibration and/or maintenance

SUB-TOPIC 4.2: On-board navigation systems

4.2.1	State the use of on-board navigation systems.	1	e.g. barometric altimetry, radio altimetry, INS/IRS, compass

SUB-TOPIC 4.3: Space-based navigation systems

4.3.1	Explain the basic working principles of satellite positioning.	2	GPS e.g. Galileo
4.3.2	Recognize the basic architecture of a core satellite positioning system.	1	GPS e.g. Galileo
4.3.3	Recognize the frequency bands used by the space-based navigational systems.	1	—
4.3.4	State the benefits of satellite-based navigation.	1	Global coverage, accuracy, time dissemination e.g. redundancy, interoperability, single set of avionics

4.3.5	State the current limitations of space-based navigation systems.	1	e.g. single frequency, weak signal, ionospheric delay, institutional, military, multipath
4.3.6	State the basic working principles of satellite augmentation.	1	e.g. ABAS (RAIM, AAIM), SBAS (WAAS, EGNOS), GBAS (GRAS, S-CAT 1)
4.3.7	State the current implementations of satellite-based navigation systems.	1	GPS, GLONASS, GALILEO and augmentations e.g. ABAS, GBAS, SBAS

TOPIC 5: PERFORMANCE-BASED NAVIGATION

SUB-TOPIC 5.1: PBN

5.1.1	Describe the basic principle of area navigation.	2	ICAO RNAV definition and PBN concept Conventional and area navigation e.g. navigation computer and FMS functionality
5.1.2	List the navigation applications in use in the region.	1	e.g. B-RNAV-5, P-RNAV-1, RNP approaches

SUB-TOPIC 5.2: Future developments

5.2.1	State future navigation developments.	21	e.g. 4D-RNAV, free routes, rationalization plans, advanced RNP1

SUBJECT 7: SURVEILLANCE

TOPIC 1: INTRODUCTION TO SURVEILLANCE

SUB-TOPIC 1.1: Introduction to surveillance

1.1.1	Define surveillance in the context of ATM.	1	What (positioning/identification) and why (maintain separation)
1.1.2	Define the various surveillance domains.	1	Air-air, ground-air, ground-ground
1.1.3	List the surveillance techniques.	1	Non-cooperative, cooperative, dependent, independent techniques
1.1.4	Define the current and emerging surveillance systems in use in ATM.	1	Radar technology, ADS technology, multilateration, TIS
1.1.5	Explain the role and the current use of surveillance equipment by ATM.	2	Separation, vectoring, data acquisition Detection and ranging, safety nets, e.g. weather mapping
1.1.6	State ICAO and any local legal requirements.	1	e.g. ICAO SARPS, Annex 10 Vol. IV

1.1.7	List the main users of surveillance data.	1	HMI, safety nets, FDPS, air defense systems, flow management

SUB-TOPIC 1.2: Avionics

1.2.1	State the avionics used for the surveillance in ATM and their interdependencies.	1	Transponder, GNSS, data link equipment, ACAS, ATC control panel, e.g. FMS
1.2.2	Define the role of TCAS as a safety net.	1	e.g. FMS

SUB-TOPIC 1.3: Primary radar

1.3.1	Describe the need for and the use of primary radar in ATC.	2	Non-cooperative detection, improvement of detection and tracking eg. types of PSR (en-route, terminal, SMR, weather)
1.3.2	Explain the principles of operation, basic elements and overall architecture of a primary radar.	2	Detection, range measurement, azimuth indication Doppler shift Antenna system, TX/RX, signal processing, plot extraction, local tracking, data transmission e.g. use of the parameters of the radar equation
1.3.3	State the limitations of primary radar.	1	Line of sight, environmental, clutter, no identification of the target, no height information (in case of 2D radar)

SUB-TOPIC 1.4 Secondary radars

1.4.1	Describe needs for and the use of secondary radars in ATC.	2	Cooperative detection, ICAO-defined standard, IFF, military and civil modes (include Mode S) and related code protocols, code limitations e.g. identification, SPI, flight level, BDS, specific and emergency codes
1.4.2	Explain the principles of operation, basic elements and overall architecture of a secondary radar.	2	SSR, MSSR, Mode S antenna, TX/RX, extractor, tracking processor e.g. use of the parameters of the radar equations
1.4.3	State the limitations of secondary radar.	1	FRUIT, garbling, ghost reply, code shortage, cooperation by the aircraft needed

SUB-TOPIC 1.5: Surveillance data message format

1.5.1	State the need for harmonization.	1	Surveillance data sharing, interoperability
1.5.2	State the techniques used for transmission of surveillance data.	1	e.g. point-to-point, network, microwave, satellite
1.5.3	State main formats in use.	1	e.g. ASTERIX.

SUB-TOPIC 1.6: Automatic dependent surveillance (ADS)

1.6.1	State surveillance-related FANS concepts and their impact on ATM.	1	Sources of aircraft parameters (e.g. FMS outputs), communication mediums Application within oceanic and other non-radar airspace, ATC requirements
1.6.2	Explain the principles of operation, basic elements and overall architecture of ADS- C and ADS-B and the differences between them.	2	Advantages/disadvantages, standards, data update rates
1.6.3	State the data link technologies proposed and the current situation of deployment.	1	Extended squitter 1 090 MHz, e.g. VDL 4, HFDL, UAT, AMSS

SUB-TOPIC 1.7: Weather radar

1.7.1	Define the use of weather radar in ATM.	1	e.g. role in adverse weather in dense airspace, antenna, coverage, polarization, multielevation scanning, frequency band

SUB-TOPIC 1.8: Integration of surveillance information

1.8.1	Describe complementary use of different sensors.	2	_

SUB-TOPIC 1.9: Multilateration

1.9.1	State the use of MLAT in ATC.	1	LAM and WAM
1.9.2	Explain the principles of operation, basic elements and overall architecture of MLAT.	12	TDOA principle, hyperbolic positioning, accuracy, transmissions used

SUB-TOPIC 1.10: Airport surface surveillance

1.10.1	State typical ATC requirements.	1	e.g. safety (aircraft and mobiles), clear runway, low visibility, collision warnings, displays, mapping, data merging, aircraft identification,
1.10.2	State the current technologies for airport surface surveillance.	1	Radar-based and MLAT-based technologies, example layout of airport surveillance infrastructure e.g. other systems (acoustic, vibration, induction loop, video, infrared, GNSS, ADS-B)

SUB-TOPIC 1.11: Display of surveillance information

1.11.1	Recognize surveillance information on a display.	1	e.g. PSR and MSSR tracks, position identification, FL, speed vector, RDP and FDP information

SUB-TOPIC 1.12: Analysis Tools

1.12.1	State analysis tools.	1	e.g. SASS-C

SUBJECT 8: DATA PROCESSING/AUTOMATION

TOPIC 1: DATA PROCESSING/AUTOMATION

SUB-TOPIC 1.1: Introduction to data processing

1.1.1	Describe the functions and generic architecture of the systems.	2	Generic FDP and SDP overall functional block diagrams
1.1.2	Describe how the systems interface with other systems.	2	Surveillance sensors, displays, flight plan distribution systems, recording, international ATM networks e.g. safety nets, military interfaces
1.1.3	Define basic software functions/applications.	1	FDP (route processing, code/call sign correlation, code allocation, strip distribution, track labelling) SDP (coordinate conversion, plot and track processing, MRP, safety nets, track labelling)
1.1.4	State the legal aspects for data processing in ATM.	1	Traceability and recording of data and actions, configuration control
1.1.5	State the additional data used by ATM system.	1	e.g. MET, airlines
1.1.6	State current developments and future possibilities.	1	e.g. Coflight, iTEC, SESAR, NextGen, multi sensor tracking

SUB-TOPIC 1.2: System software and hardware principles

1.2.1	Describe the current hardware configurations used in ATM.	2	Redundancy and backup E.g. driver, interfaces, hardware platforms, fault tolerant systems
1.2.2	Describe the current software platforms, used in ATM.	2	Operating systems

SUB-TOPIC 1.3: Surveillance data processing

1.3.1	State ATC requirements.	1	QoS, mandatory data recording, dependability
1.3.2	Explain the principles of SDP.	2	e.g. single, multi, plot, track
1.3.3	Describe the functions of SDP.	2	Plot processing, tracking, single sensor and multi sensor tracker (e.g. radar, ADS, MLAT), estimating limits and accuracy of multi sensor tracker, recording e.g. ARTAS tracker
1.3.4	Describe radar data inputs/outputs.	2	Tracks, plots, messages, code/call sign, time, control and monitoring, conflict alerts, FDP interface, maps, adaptation
1.3.5	Describe the surveillance data-based monitoring functions.	2	Safety nets, ATC tools e.g. safety nets: STCA, MSAW, APW, runway incursion alerts ATC Tools: MTCD, AMAN, DMAN, A-SMGCS

SUB-TOPIC 1.4: Flight data processing (FDP)

1.4.1	State ATC requirements.	1	QoS, unambiguous, accurate, error free, timely
1.4.2	Explain the functions of FDP.	2	Flight strip production, flight plan data updates, code/call sign correlation, flight progress monitoring, coordination and transfer e.g. CIV/MIL coordination
1.4.3	Define inputs and outputs.	1	Flow control flight strips/data displays, MRT, environmental data, static data, airspace adaptation
1.4.4	Describe the basic software functions/applications.	2	FDP (route processing, code/call sign correlation, code allocation, strip distribution, track labelling)
1.4.5	Describe the FPL data update process.	2	Automatic and manual update

SUB-TOPIC 1.5: Human machine interface systems

1.5.1	Describe the different display technologies.	2	Raster scan, common graphic display interface, LCD, plasma, TFT, Touch Input Device
1.5.2	Recognize what information is normally displayed on the ATCO and ATSEP HMI.	1	—

SUB-TOPIC 1.6: Miscellaneous information

1.6.1	State the additional data used by ATM system.	1	e.g. MET, airlines

SUBJECT 9: SYSTEM MONITORING AND CONTROL

TOPIC 1: SYSTEM MONITORING AND CONTROL (SMC)

SUB-TOPIC 1.1: Overview of SMC Function

1.1.1	Describe the principles and purpose of the operational management of the technical services.	2	Service requirements, interfaces, boundaries of tactical responsibility e.g. hierarchy of authority for the technical and ATC structures
1.1.2	Describe the technical system architecture of the SMC function and its subordinate systems.	2	Main monitoring and control architecture e.g. Surveillance: Radar stations, communications, processing, display Communications: TX/RX, circuit management, networks, HMI, standby facilities, recording Navigation: NDB, VOR, ILS, DF DP: FDPS, data communications Facilities: Power, generators, UPS, battery, environmental (heating, cooling), fire and security
1.1.3	Describe the transfer of responsibility for a service.	2	Operational and technical responsibility, configuration and monitoring access and responsibility

SUB-TOPIC 1.2: System configuration:

1.2.1	Describe the range of configurations that can be used.	2	Equipment or channel switching, parameter settings
1.2.2	Describe the general techniques that are employed to make configuration changes.	2	e.g. physical switching

1.2.3	State procedures required to implement a planned major system change.	1	e.g. safety requirement, authorization, coordination, implementation plan, fallback strategies, major system change, activation of new version of software in a subordinate system, transfer of a service to a new system, change of a database

SUB-TOPIC 1.3: Monitoring and control functions

1.3.1	State the monitoring functions that are available.	1	e.g. BITE, status, parameters, software and hardware watchdogs
1.3.2	State the control functions that are available.	1	e.g. switching, parameters, set configurations
1.3.3	Explain the importance of SMC management and coordination of maintenance activities.	2	—
1.3.4	State analysis tools associated with SMC.	1	e.g. possible malfunctions (SASS-Ctrack and noise monitoring tools)

SUB-TOPIC 1.4: Coordination and reporting

1.4.1	State why coordination and reporting is required and how it is achieved.	1	Facility interrupts, deconflict multiple outages, legal requirements e.g. causes: service failure, planned outage, loss of backup, software upgrade Relevant parties: external service providers, ATC, other centres Relevant information: NOTAM, logbook

SUB-TOPIC 1.5: Emergency coordination

1.5.1	Describe situations where coordination and reporting will be necessary.	2	e.g. hijack, mayday, R/T fail, loss of aircraft, MIL action, fire, flood, security, terrorist threat or action, medical
1.5.2	State which parties may be involved in the coordination and reporting of emergency situations.	1	e.g. ATC supervisors (local and remote), ATSEP supervisors (local and remote), management, police, MIL, medical, accident investigation branch
1.5.3	Explain the responsibilities and/or duties of SMC members during an emergency situation by using an example scenario.	2	—
1.5.4	State the succession of authorities and responsibilities in the event that the nominated person or function is not available.	1	Hierarchy of responsibility

SUB-TOPIC 1.6: Equipment operating

1.6.1	Define the principles and ergonomics of the HMI of the SMC central system and its subordinate systems.	1	Permissions, control tokens, ergonomic conventions (e.g. green is good or safe, red is fail or unsafe)
1.6.2	State the routine tasks required and the criticality of their completion and any legal requirements.	1	e.g. audio circuit voice checking, audio recording checking, archive media changing and storage, VOLMET

SUBJECT 10: MAINTENANCE PROCEDURES

TOPIC 1: MAINTENANCE PROCEDURES

SUB-TOPIC 1.1: Maintenance procedures

1.1.1	Explain handling precautions to be taken to ensure equipment protection.	2	Isolation, protection devices, electrostatic sensitive devices, power supplies, heavy loads, high voltage
1.1.2	Explain the classifications of maintenance.	2	e.g. preventative, corrective, service configuration
1.1.3	Explain the maintenance strategy and rules.	2	Organization and planning of maintenance, rules controlling deviation from planned maintenance, intervention tracking, return to service
1.1.4	State the scope or responsibility of an S/E rated person.	1	e.g. tracing maintenance actions and objectives, liability of maintenance personnel actions, safety of service, safety of equipment

SUBJECT 11: INFRASTRUCTURE

TOPIC 1: FACILITIES

Sub-TOPIC 1.1: POWER SUPPLIES

1.1.1	Define the performance for power supply systems in the operational environment.	1	Availability, quality, Continuity of Service
1.1.2	Define the main features of current power supply systems.	1	e.g. UPS systems, batteries and emergency generators, high voltage, earthing techniques, power provider(s)
1.13	Describe the power distribution system at an example operational site.	2	e.g. power distribution redundancy, input, output, protections, measurements and monitoring, block schematic

Sub-TOPIC 1.1: AIR CONDITIONING

1.2.1	State the function, appropriate terminology and performance of current air conditioning systems in use.	1	e.g. air conditioning, water cooling, humidity control, air filtering system, visit to stations
1.2.2	State the importance and criticality of maintaining a controlled environment.	1	Short- and long-term effect on people and equipment

SUBJECT 12: SAFETY

TOPIC 1: SAFETY MANAGEMENT

SUB-TOPIC 1.1: Policy and principles

1.1.1	Explain the underlying need for safety management policy and principles	2	ICAO Annex 19, lessons learnt from events, evolving environment, requirements
1.1.2	State the safety management policy.	1	ICAO Annex 19, priority of safety, the safety objective of ATM, roles and responsibilities
1.1.3	Explain safety management principles.	2	ICAO Annex 19, safety achievement, safety assurance, safety promotion
1.1.4	Appreciate the reactive and proactive nature of safety management policy and principles.	3	e.g. ICAO Annex 19 e.g. nature of events, reason model, events investigation, safety assessment
1.1.5	Explain the link between safety management principles and the life cycle of an ATM system.	2	ICAO Annex 19, safety occurrences, setting of safety levels, system safety assessment, safety surveys, safety monitoring, system safety assessment documentation, lesson dissemination, safety improvement, use of safety data to assist in decommissioning or replacement of system
1.1.6	Relate the ATSEP role and responsibilities to safety management.	4	Competency, occurrence reporting e.g. 'just culture' (ref.:EAM2 GUI6), risk assessment
1.1.7	State the role and content of a typical SMS within an ANSP.	1	ICAO Annex 19
1.1.8	Explain the "just culture" concept.	2	Benefits, prerequisites, constraints e.g. EAM2 GUI6

SUB-TOPIC 1.2: Concept of risk and principles of risk assessment

1.2.1	Describe the concept of risk.	2	Types of risk, components of risk, risk contributors (people, procedure, organizations and equipment)
1.2.2	State ways of assessing risk.	1	Risk comparisons, risk analysis
1.2.3	Describe the concept of risk tolerability.	2	Risk assessment and mitigation, ALARP Principle e.g. risk perception, risk management

SUB-TOPIC 1.3: Safety assessment process

1.3.1	Explain the methods for the assessment of hazards and possible failures.	2	e.g. Failure and hazard brainstorm session, Fault tree analysis
1.3.2	Appreciate the importance of adopting a total system approach covering human, procedure, organization and equipment elements.		ATM system description (including scope definition and limitation), end-to-end integrity of safety assessment e.g. Concept of TRM
1.3.3	Describe the overall safety assessment process and its relationships with risk assessment during the total life cycle of ANS system.	2	Collection and presentation of results, contingency arrangements, back-up procedures e.g. Risk-based process, FHA, (safety objectives), preliminary system safety assessment PSSA (safety requirements), system safety assessment SSA (safety monitoring and evidence).

SUB-TOPIC 1.4: Air navigation system risk classification scheme

1.4.1	Describe the ATM system risk classification scheme.	2	e.g. Scenario of failure of air navigation system (incident chain), component of a risk classification scheme, severity classes, probability classes (qualitative and quantitative)

SUB-TOPIC 1.5: Safety regulation

1.5.1	Describe the role of safety regulation.	2	The purpose of national regulations and international standards, , objective of the national regulator
1.5.2	Explain the relationship between the safety regulation documents.	2	ICAO SARPS, regional regulations, national regulations
1.5.3	Explain how the safety regulation documents affect ATM service provision.	2	ICAO documentation (SARPS), regional Regulations, AMCs and GM, national regulation

1.5.4	Explain the interface between the safety regulator and the ANSP.	2	Information to be provided to regulator by ANSP and vice versa, importance of incident reporting

SUBJECT 13: HEALTH AND SAFETY

TOPIC 1: HAZARD AWARENESS AND LEGAL RULES

SUB-TOPIC 1.1: Hazard awareness

1.1.1	State potential hazards to health and safety generated by equipment used in CNS/ATM.	1	e.g. COM/SUR/SMC: mechanical hazards, electrical hazards (LV, HV, EMI), chemical hazards NAV: includes RF energy DP: none

SUB-TOPIC 1.2: Regulations and procedures

1.2.1	State applicable international requirements.	1	
1.2.2	State any applicable national requirements.	1	—
1.2.3	State safety procedure for the persons working on or near relevant equipment.	1	e.g. COM/NAV/SUR/SMC: isolation (clothing, tools), fire extinction types, safety man presence, safety interlocks, isolating switches, security of the site, climbing procedures, earthning, direct or indirect contact with HV

SUB-TOPIC 1.3: Handling of hazardous material

1.3.1	State regional and local regulations for electronic device disposal	1	Protection of environment e.g. recycling

SUBJECT 14: HUMAN FACTORS

TOPIC 1: INTRODUCTION TO HUMAN FACTORS

SUB-TOPIC 1.1: Introduction

1.1.1	Explain why human factors are particularly important in the ATM environment.	2	Historical background, safety impact on ATM, incidents
1.1.2	Define human factors.	1	e.g. ICAO Human Factors Training Manual
1.1.3	Explain the concept of systems and its relevance in the ATM environment.	2	People, procedures, equipment

1.1.4	Explain the use of the SHELL model.	2	e.g. ICAO Doc 9683, visits to OPS and technical rooms
1.1.5	State the factors which can affect personal and team performance.	1	e.g. psychological, medical, physiological, social, organizational, communication, stress, human error, working knowledge and skills.

TOPIC 2: WORKING KNOWLEDGE AND SKILLS

SUB-TOPIC 2.1: ATSEP knowledge, skills and competence

2.1.1	Explain the importance of maintaining and updating professional knowledge and skills.	2	Assure safety
2.1.2	Explain the importance of maintaining non- technical skills and professional competence.	2	e.g. communication, human relationship, knowledge of environment, human limit awareness
2.1.3	State the available means to maintain professional knowledge and skills.	1	e.g. practice, personal study, briefing, seminars, courses, technical periodicals, technical books, OJT, simulation, CBT, e-learning, visits, feedback, TRM

TOPIC 3: PSYCHOLOGICAL FACTORS

SUB-TOPIC 3.1: Cognition

3.1.1	Describe major aspects of human information processing.	2	Perception, attention, memory, judgement, decision-making, response execution, control of execution
3.1.2	Describe the factors which influence information processing.	2	e.g. stress and strain, experience, knowledge, distraction, interpersonal relations, working environment, risk perception, attitude, workload, fatigue, confidence, job security
3.1.3	Appreciate factors which influence information processing.	3	e.g. case study, simulation, role playing

TOPIC 4: MEDICAL

SUB-TOPIC 4.1: Fatigue

4.1.1	Describe the effect of fatigue on human performance.	2	Physiological, cognitive and relational effects e.g. lack of concentration, irritability, frustration
4.1.2	Recognize the signs of fatigue in oneself and in others.	1	e.g. making frequent mistakes, unable to concentrate, lack of normal humour, sleeping and/or eating disorders
4.1.3	Explain how to respond to indications of fatigue in an appropriate manner.	2	Take time off, rest for short periods of time, seek professional help

SUB-TOPIC 4.2: Fitness

4.2.1	Describe signs of lack of personal fitness.	2	—
4.2.2	Describe actions to prevent or resolve lack of personal fitness.	2	Healthy lifestyle e.g. healthy diet, sleeping, physical and mental activities
4.2.3	Explain the influence of psychoactive substances on human performance.	2	e.g. nervous system, medication, smoking, alcohol, habitual and occasional use of psychoactive substances

SUB-TOPIC 4.3: Work environment

4.3.1	Describe the influence of the work environment on human performance.	2	Ergonomics, effects of noise, electromagnetic waves, temperature, working circumstances

TOPIC 5: ORGANIZATIONAL AND SOCIAL FACTORS

SUB-TOPIC 5.1: Basic needs of people at work

5.1.1	Explain basic needs of people at work.	2	e.g. balance between individual ability and workload, working time and rest periods; adequate working conditions, positive working environment
5.1.2	Characterize the factors of work satisfaction.	2	e.g. money, motivation, achievement, recognition, advancement, challenge

SUB-TOPIC 5.2: Team resource management

5.2.1	State the objectives of TRM.	1	Experience sharing, feedback, improved interpersonal relations, indirect increase in safety

SUB-TOPIC 5.3: Teamwork and team roles

5.3.1	Describe the differences between social human relations and professional interactions.	2	—

5.3.2	Identify reasons for loss of team effectiveness and actions to prevent it and prevent repetition.	3	e.g. roles poorly defined, goals poorly identified, bad planning, too many leaders or not enough, respect for others, divergence in values, misunderstandings
5.3.3	Describe the principles of teamwork.	2	e.g. team membership, group dynamics, advantages/disadvantages of teamwork
5.3.4	Identify reasons for conflict.	3	—
5.3.5	Describe actions to prevent human conflicts.	2	—
5.3.6	Describe strategies to cope with human conflicts.	2	e.g. in your team

TOPIC 6: COMMUNICATION

SUB TOPIC 6.1: Written report

6.1.1	Appreciate the importance of recording information by writing effectively.	3	ATSEP technical report, logs, system degradation reports, specification, system manager report
6.1.2	Use appropriate terminology to communicate effectively in writing.	3	Be concise, clear; common technical terms; convey key points

SUB-TOPIC 6.2: Verbal and non-verbal communication

6.2.1	Describe the human communication process.	2	—
6.2.2	Characterize the factors which affect verbal communication.	2	e.g. Cognitive: lack of knowledge of the procedures, of technical terms, workload, poor receiver references Affective: being shy, feelings of not being listened to, not being part of the group, not being assertive, poor eye contact while talking, stress Physiological: stuttering, low voice level
6.2.3	Describe factors which affect non-verbal communication.	2	e.g. touch, noise, interruption, body language
6.2.4	Use appropriate vocabulary to communicate effectively on technical matters	3	Technical 'jargon', language differences, standard words/phrases
6.2.5	Use appropriate language for professional communication with non-ATSEP.	3	Term sharing, translation, being concise, simple words, selection of information and detail level according to the receiver

TOPIC 7: STRESS

SUB-TOPIC 7.1: Stress

7.1.1	Explain the process of stress.	2	Causes, stress mechanism, consequences in different work situations (e.g. online intervention, maintenance, training)
7.1.2	State the symptoms of stress.	1	e.g. frustration, anger, irritability, aggressive and/or irrational behavior, helplessness

SUB-TOPIC 7.2: Stress management

7.2.1	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
7.2.2	Appreciate how assistance is obtained in stressful situations.	3	Benefits of asking, offering and accepting help in stressful situations e.g. CISM
7.2.3	Recognize the effects of shocking and stressful situations.	1	For oneself and for others, abnormal situations
7.2.4	Consider the benefits of critical incident stress management.	2	—

TOPIC 8: HUMAN ERROR

SUB-TOPIC 8.1: Human error

8.1.1	Describe human error.	2	—
8.1.2	Explain the relationship between human error and safety.	2	Mechanism, error-prone conditions, consequences e.g. reason model, feedback
8.1.3	State different types of errors using an appropriate model.	1	e.g. Rasmussen model, Gagne model
8.1.4	Differentiate between errors and violations.	2	—
8.1.5	Explain how to detect errors.	2	e.g. individual and collective strategy, event report, procedure

8.1.6	Explain, in general terms, how errors are mitigated.	2	—
8.1.7	Appreciate two significant ATM incidents/accidents involving ATSEP/engineering contributory factors.	3	—

A 2 – Training Objectives for a Qualification Training Course on Communication

SUBJECT 1: VOICE

TOPIC 1: AIR-GROUND

SUB-TOPIC 1.1: Transmission/reception

1.1.1	Perform typical measurements on a transmitter.	3	Frequency (single carrier, offset carrier), modulation, channel spacing, output power, SWR
1.1.2	Adjust a generic radio transmitter.	4	Noise, intermodulation, harmonics, power, bandwidth
1.1.3	Analyze the block diagram of a generic radio transmitter.	4	Characteristics (modulation, single carrier, channel spacing), functionalities
1.1.4	Perform typical measurements on a receiver.	3	Frequency, modulation, channel spacing, sensitivity, selectivity
1.1.5	Adjust a generic radio receiver	4	Signal to noise ratio, harmonics
1.1.6	Analyze the block diagram of a generic radio receiver.	4	Characteristics (single carrier, channel spacing, sensitivity, selectivity)

SUB-TOPIC 1.2: Radio antenna systems

1.2.1	Explain antenna parameters.	2	Impedance, polar diagram, bandwidth, polarization, types of antennas
1.2.2	Characterize the coverage of the radio system.	2	Polar diagram, types of antennas, frequency bands, propagation mode
1.2.3	Characterize budget link according to various conditions.	2	Output power, antennae, propagation, geographic, meteorological, day and night
1.2.4	Characterize the elements of a generic antenna system.	2	Filters, combiners, multi-cavity system
1.2.5	Check the conformity of a system to ITU and national regulation.	3	Ref.: ICAO Annex 10 (VHF, UHF)

1.2.6	Perform measurements with generic radio test equipment.	3	Spectrum analyzer e.g. scanner

SUB-TOPIC 1.3: Voice switch

1.3.1	Analyze switching functionalities.	4	General architecture, digital, analogue, multiplex types, PCM, e.g. cross-coupling, split headset (radio both ears, telephone single ear)
1.3.2	Explain the principles of non-blocking switches.	2	Advantages, disadvantages, delays (digital)
1.3.3	Describe the signal processing all along the chain.	2	Signal tracing treatment, protocols (a few), data flow

SUB-TOPIC 1.4: Controller working position

1.4.1	Describe the most common features of a controller working position.	2	Frequency selection, emergency, station selection, coupling, headset, loudspeaker, footswitch, Push to Talk e.g. microphone (noise cancelling), short time recording

SUB-TOPIC 1.5: Radio interfaces

1.5.1	Describe the different types of interface.	2	Internal, external, phantom keying, in-band signal

TOPIC 2: GROUND-GROUND

SUB-TOPIC 2.1: Interfaces

2.1.1	Describe the different types of interfaces.	2	Analogue (2, 4, 6 and 8 wires), digital (ISDN; 64 Kb, 2 Mb)
2.1.2	Explain the advantages and disadvantages of each type.	2	Analogue (2, 4, 6 and 8 wires), digital (ISDN; 64 Kb, 2 Mb)
2.1.3	Operate measuring equipment.	3	e.g. dB meters, level meters, generators, sniffer

SUB-TOPIC 2.2: Protocols

2.2.1	Operate standard protocol analyzers.	3	e.g. MFC R2 and/or ATS QSIG (rerouting), impulse dialing and DTMF dialing, ISDN

2.2.2	Analyze communication protocol with appropriate tools and documentation.	4	e.g. MFC R2 , ATS QSIG (rerouting), impulse dialing and DTMF dialing, ISDN, national protocols

SUB-TOPIC 2.3: Switch

2.3.1	State the similarities between ground-ground and air-ground switches.	1	Switching techniques
2.3.2	Describe the most commonly used functionality of PABX.	2	General architecture, digital, analogue, multiplex types, PCM30
2.3.3	Analyze conversion analogue-digital, digital-analogue.	4	General architecture, analogue-digital-analogue

SUB-TOPIC 2.4: Communication chain

2.4.1	Appreciate the replacement of components in a communication chain in a safe way.	3	Continuity of service, communication chain integrity

SUB-TOPIC 2.5: Controller working position

2.5.1	Describe the most common features of a controller working position and the HMI.	2	—

SUBJECT 2: DATA

TOPIC 1: INTRODUCTION TO NETWORKS

SUB-TOPIC 1.1: Types

1.1.1	State the evolution of network topologies.	1	LAN, WAN e.g. architectures, size of the segments, length of the systems, quality of service
1.1.2	Explain how networks meet requirements.	2	Redundancy, bandwidth, BER, time delay, network security

SUB-TOPIC 1.2: Networks

1.2.1	Analyze the features of a network.	4	Routing scheme, rate, internal networking, routers, bridges, gateways, modems, switches, firewalls e.g. wireless networks
1.2.2	Describe network standards and devices.	2	Ethernet, fiber optic, wireless

1.2.3	Appreciate the replacement of components in a network in a safe way.	3	Continuity of service, network integrity

SUB-TOPIC 1.3: External network services

1.3.1	Define aspects of external network services.	1	Provided QoS e.g. SLAs

SUB-TOPIC 1.4: Measuring tools

1.4.1	Operate the usual set of network measuring or monitoring tools to find the values of the main parameters.	3	Data analyzer (sniffer) e.g.net scout
1.4.2	Perform analysis to support fault-finding for correction.	3	Data analyzer (sniffer) e.g.net scout

SUB-TOPIC 1.5: Troubleshooting

1.5.1	Appreciate how to troubleshoot a network.	3	e.g. broken lines, unusable network components, overload, integrity problems

TOPIC 2: PROTOCOLS

SUB-TOPIC 2.1: Fundamental theory

2.1.1	Apply the principles of layers.	3	Differences between layers e.g. layer(s) of sniffer information
2.1.2	Apply the principles of addressing strategy.	3	Masks, subnets, IP addressing, MAC addressing e.g. same logical network computers and systems
2.1.3	Apply the principles of routing strategy.	3	Routing tables, priorities, fault tolerance, management of routing strategy, static and dynamic routing e.g. unicast, multicast, broadcast

SUB-TOPIC 2.2: General protocols

2.2.1	Describe the general protocols.	2	TCP/IP (segments, packets, addressing) e.g. X25, LAPB, pdH, sdH
2.2.2	Analyze the general protocols using the appropriate tools and	4	TCP/IP e.g. X25, LAPB

SUB-TOPIC 2.3: Specific protocols

2.3.1	Describe the specific protocols.	2	e.g. BATAP — ARINC 620, FMTP

TOPIC 3: NATIONAL NETWORKS

SUB-TOPIC 3.1: National networks

3.1.1	Name the national networks to which the organization is connected.	1	e.g. ANSP, MET, military, PTT, airlines, national network(s)
3.1.2	Describe the interfaces between national and global networks.	2	—

TOPIC 4: NETWORKS

SUB-TOPIC 4.1: Network technologies

4.1.1	State emerging network technologies.	1	e.g.as used in EAN, NEAN, AMHS, PENS
4.1.2	Describe the characteristics of current networks.	2	Surveillance data, flight plan data and AIS networks e.g. CIDIN, , quality of service, architecture, AMHS

TOPIC 5: GLOBAL NETWORKS

SUB-TOPIC 5.1: Networks and standards

5.1.1	List the global networks and the standards on which they are based.	1	e.g. ICAO for AFTN/CIDIN/AMHS, ICAO for ATN, FANS 1 and FANS A for ACARS applications (SITA and ARINC)

SUB-TOPIC 5.2: Description

5.2.1	Describe the characteristics of the AFTN networks.	2	Users and data, architectures, quality of service

SUB-TOPIC 5.3: Global architecture

5.3.1	Describe the architecture of the ATN.	2	Air-ground subnetworks, ground-ground subnetworks, airborne networks

SUB-TOPIC 5.4: Air-ground subnetworks

5.4.1	Describe the air-ground subnetworks.	2	VDL (mode 2), HFDL, AMSS, SATCOM

SUB-TOPIC 5.5: Ground-ground subnetworks

5.5.1	Describe the composition of ground-ground subnetworks.	2	PTT, commercial telecom providers, ARINC, SITA

SUB-TOPIC 5.6: Networks on board of the aircraft

5.6.1	State the existence of subnetworks inside the aircraft relevant for ATM communications.	1	e.g. AFDX — ARINC 429

SUB-TOPIC 5.7: Air-ground applications

5.7.1	State the main communication applications using data link systems.	1	e.g. CPDLC, DLIC/AFN, ATIS, DCL

SUBJECT 3: TRANSMISSION PATH

TOPIC 1: LINES

SUB-TOPIC 1.1: Lines theory

1.1.1	Calculate parameters of a line.	3	e.g. equation, attenuation, impedance, S-parameters, Smith chart, bandwidth, HF specifics (dipoles, multipoles), SWR

SUB-TOPIC 1.2: Digital transmission

1.2.1	Calculate parameters for digital transmission.	3	e.g. signal definition, Fourier Theory, signal processing (sampling, etc.), bandwidth, carrier, modulation, noises, S/N, delays, group delay, line quality (signal distortion, rate of failure), transmission speed

SUB-TOPIC 1.3: Types of lines

1.3.1	Describe the different types of lines and their physical characteristics.	2	e.g. copper wires (twisted pairs, symmetrical cables), optic fibers (monomodes or multimodes, connectors, splicer), coaxial attenuation, losses, bending, characteristic impedance, EMC and noise immunity
1.3.2	Appreciate the appropriate type of line for a given specific application.	3	e.g. bandwidth, noise immunity
1.3.3	Check the typical parameters of lines.	3	e.g. impedance, insulation, signal level, time delay

TOPIC 2: SPECIFIC LINKS

SUB-TOPIC 2.1: Microwave link

2.1.1	Describe a microwave link.	2	e.g. carrier frequency, type of modulation, Fresnel Theory, loss, atmospheric influences

SUB-TOPIC 2.2: Satellite

2.2.1	Describe the parameters of a satellite link.	2	Uplinks, downlinks, antennas, footprint, delays, atmospheric influences

SUBJECT 4: RECORDERS

TOPIC 1: LEGAL RECORDERS

SUB-TOPIC 1.1: Regulations

1.1.1	Explain the international regulations.	2	ICAO (recording and reproducing)
1.1.2	Explain national regulations.	2	Appropriate national regulations
1.1.3	Explain how service providers comply with the regulations.	2	e.g. confidentiality when handling recorders, procedures for access to recorders, storage media, access to recording and reproducing room, time to store information (overwrite/erase voice or data),

SUB-TOPIC 1.2: Principles

1.2.1	Explain the principles of recording and reproducing.	2	e.g. storage media (tape, optical and magnetic disc, hard disk, USB media), A/D-D/A converters, frequency range (300 to 3 400 Hz), channel capacity, time synchronization, connection to a network, synchronization of radar and voice recording, replay limitations

SUBJECT 5: FUNCTIONAL SAFETY

TOPIC 1: SAFETY ATTITUDE

SUB-TOPIC 1.1: Safety attitude

1.1.1	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

TOPIC 2: FUNCTIONAL SAFETY

SUB-TOPIC 2.1: Functional safety

2.1.1	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.: safety policy and implementation

A 3 - Training Objectives for a Qualification Training Course on Navigation

SUBJECT 1: PERFORMANCE-BASED NAVIGATION

TOPIC 1: NAV CONCEPTS

SUB-TOPIC 1.1: Operational requirements

1.1.1	Explain the main performance characteristics of a navigation system.	2	Accuracy, precision, stability, integrity, availability, continuity of service, coverage, robustness e.g. Time To First Fix
1.1.2	Explain the relationship between performance measures and the phases of flight.	2	ICAO Doc 9613

SUB-TOPIC 1.2: Performance-based navigation

1.2.1	Describe the PBN concept.	2	ICAO documents, airspace concept, application supported by navigation infrastructure and navigation specifications, functionality of the avionics
1.2.2	Differentiate between an RNAV and an RNP navigation specification.	2	On-Board Performance Monitoring and Alerting
1.2.3	State which navigation applications support the different phases of flight.	1	ICAO Doc 9613

SUB-TOPIC 1.3 Area navigation concept (RNAV)

1.3.1	Differentiate between conventional navigation and area navigation.	2	Fixed route vs flexible route structure

SUB-TOPIC 1.4: NOTAM

1.4.1	Explain the need for NOTAMs.	2	—

SUBJECT 2 GROUND-BASED SYSEMS — NDB

TOPIC 1: NDB/LOCATOR

SUB-TOPIC 1.1: Use of the system

1.1.1	Appreciate the principles of NDB.	3	Relative bearing, measuring method
1.1.2	Describe the overall performance.	2	Coverage, accuracy, availability of the system, integrity, continuity
1.1.3	Explain the technical limitations of NDB.	2	Lack of accuracy, lack of integrity, sensitivity to interference

1.1.4	Describe the current situation.	2	e.g. number, type, users, user groups, regional context

SUB-TOPIC 1.2: Ground station architecture

1.2.1	Describe the main components of an NDB ground station.	2	Electronic cabinet, antennas, power supply, remote controls and monitoring e.g. auto-tune antenna units
1.2.2	Relate NDB station design to operational requirements.	4	Coverage, ID code, VOR backup, double beacon approach, siting

SUB-TOPIC 1.3: Transmitter subsystem

1.3.1	Characterize the main NDB signal parameters.	2	Carrier and ident frequency, output power, depth of modulation
1.3.2	Perform typical measurements on the main NDB signal parameters.	3	e.g. carrier and ident frequency, power measurements, depth of modulation, audio distortion, antenna current, spectrum measurements, ID code

SUB-TOPIC 1.4: Antenna subsystem

1.4.1	Explain NDB antenna characteristics.	2	Impedance, polar diagram, polarization, ground reflections
1.4.2	Appreciate the interface between power stage and the antenna.	3	SWR, radiated power

SUB-TOPIC 1.5: Monitoring and control subsystems

1.5.1	Describe the purpose of monitoring.	2	Integrity, continuity of service, availability
1.5.2	Describe which parameters are used for the monitoring.	2	Antenna current, ID code, depth of modulation
1.5.3	Appreciate how the operational status of the NDB monitoring	3	System status
1.5.4	Describe the issues associated with NDB obstacle limitations and obstacle removal.	2	Siting

SUB-TOPIC 1.6: On-board equipment

1.6.1	Describe the on-board equipment (ADF).	2	Receiver, antenna, displays
1.6.2	Describe how NDB information is used on board.	2	ADF indicator, RMI, HSI, ND

SUB-TOPIC 1.7: System check and maintenance

1.7.1	Appreciate the conformity to international and national regulations.	3	ITU regulations (EMC + SAR), ICAO Annex 10
1.7.2	Appreciate calibration tasks and flight inspection results.	3	e.g. maintenance and flight inspection manuals, procedures and reports
1.7.3	Appreciate troubleshooting of an NDB.	3	e.g. maintenance and flight inspection manuals, procedures and reports
1.7.4	Appreciate the origins of NDB errors.	3	e.g. multipath, EMC, interference with radio broadcast transmissions

SUBJECT 3: GROUND-BASED SYSTEMS — DFI

TOPIC 1: DF

SUB-TOPIC 1.1: Use of the system

1.1.1	State the different types of DF.	1	VDF, DDF, IDF
1.1.2	Describe the user HMI.	2	Indication on radar picture, DF indicator
1.1.3	Appreciate the principles of DF.	3	Bearing, measuring method (standard, Doppler, interferometry)
1.1.4	Describe the overall performance.	2	Coverage, accuracy, availability of the system, integrity, continuity
1.1.5	Explain the technical limitations of DF.	2	Sensitivity to interference
1.1.6	Describe the current situation.	2	e.g. number, type, users, national context

SUB-TOPIC 1.2: VDF/DDF equipment architecture

1.2.1	Describe the main components of DF equipment.	2	Electronic cabinet, antennas, power supply, remote controls and monitoring

SUB-TOPIC 1.3: Receiver subsystem

1.3.1	Explain the main signal parameters.	2	Frequency band (UHF, VHF)

SUB-TOPIC 1.4: Antenna subsystem

1.4.1	Explain DF antenna characteristics.	2	Impedance, polar diagram, polarization, types of antennas
1.4.2	Appreciate protection areas.	3	Obstacles, ICAO Annex 10 e.g. manufacturers manuals

SUB-TOPIC 1.5: Monitoring and control subsystems

1.5.1	Describe the purpose of monitoring.	2	Integrity, continuity of service, availability
1.5.2	Describe which parameters are used for the monitoring.	2	Noise figure, stability of measurement
1.5.3	Appreciate how the operational status of the DF monitoring system is checked.	3	System status
1.5.4	Describe the issues associated with DF obstacle limitations and obstacle removal.	2	Surrounding environment, protection of bearing accuracy

SUB-TOPIC 1.6: System check and maintenance

1.6.1	Appreciate the conformity to international and national regulations.	3	ITU regulations (EMV + SAR), ICAO Annex 10
1.6.2	Perform typical measurements on a DF system.	3	Frequency, channel spacing, sensitivity, selectivity, bearing accuracy
1.6.3	Appreciate calibration tasks and flight inspection results.	3	Ground-based bearing checks, test oscillator e.g. North setting, range, multipath Maintenance and flight inspection manuals, procedures and reports
1.6.4	Appreciate troubleshooting of DF.	3	e.g. sensitivity, local oscillator level Maintenance and flight inspection manuals, procedures and reports
1.6.5	Appreciate the origin of DF errors.	3	e.g. multipath, EMC, interference with radio broadcast transmissions

SUBJECT 4: GROUND-BASED SYSTEMS — VOR

TOPIC 1: VOR

SUB-TOPIC 1.1: Use of the system

1.1.1	State the types of VOR Systems.	1	Conventional, Doppler
1.1.2	Describe the overall performance.	2	Coverage, accuracy, availability of the system, integrity, continuity
1.1.3	Explain the technical limitations of CVOR.	2	Type of information (azimuth), accuracy, integrity, suitable for a network of fixed routes
1.1.4	Appreciate the differences between CVOR and DVOR.	3	Signal broadcast differences, bearing information robustness
1.1.5	Describe the current situation.	2	e.g. number, type, users, user groups, national context, regional context

SUB-TOPIC 1.2: Fundamentals of CVOR and/or DVOR

1.2.1	Appreciate the mathematical signal description.	3	Declination, equations of CVOR and/or DVOR, reference and variable signals
1.2.2	Appreciate the principles for generating the variable signal.	3	CVOR Rotating antenna principle Generating a rotating radiation pattern with static antennas and/or DVOR Frequency modulation through switching antenna

SUB-TOPIC 1.3: Ground station architecture

1.3.1	Describe the main components of a CVOR and/or DVOR ground station.	2	Electronic cabinet, antenna system, power supply, remote controls and monitoring
1.3.2	Relate VOR station design to operational requirements.	4	Siting, coverage, ID code, NDB backup

SUB-TOPIC 1.4: Transmitter subsystem

1.4.1	Characterize main signal parameters for a CVOR and/or DVOR.	2	Carrier frequency stability, output power, signals generated
1.4.2	Perform typical transmitter measurements on VOR signals.	3	Radiation pattern accuracy, power and modulation measurements, spectrum measurements, ID coding

SUB-TOPIC 1.5: Antenna subsystem

1.5.1	Explain VOR antenna characteristics.	2	Impedance, polar diagram, polarization, types of antennas
1.5.2	Appreciate the interface between power stage and the antenna.	3	SWR, radiated power
1.5.3	Appreciate protection areas.	3	Obstacles, ICAO Annex 10 e.g. manufacturers manuals

SUB-TOPIC 1.6: Monitoring and control subsystem

1.6.1	Describe the purpose of monitoring.	2	Integrity, continuity of service, availability
1.6.2	Describe which VOR parameters are monitored.	2	ICAO and RTCA/EUROCAE requirements e.g. NSA requirements
1.6.3	Describe the principles of the CVOR and/or DVOR monitoring systems.	2	Near field sensors, far field sensors, recombination Local and remote monitoring
1.6.4	Appreciate how the operational status of the CVOR and/or DVOR monitoring systems are checked.	3	Near field sensors, far field sensors, recombination Local and remote monitoring e.g. BITE, Watchdog
1.6.5	Describe the issues associated with VOR obstacle limitations and obstacle removal.	2	Surrounding environment, multipath prevention
1.6.6	Explain the optional ILS interface.	2	—

SUB-TOPIC 1.7: On-board equipment

1.7.1	Describe the on-board equipment.	2	Antenna, receiver HMI e.g. CDI, RMI, HSI, ND, PFD
1.7.2	Describe how the VOR information is used on board.	2	e.g. single VOR, VOR-VOR, approach procedures, manual mode, automatic mode

SUB-TOPIC 1.8: System check and maintenance

1.8.1	Appreciate the conformity to international and national regulations.	3	ITU regulations (EMC + SAR), ICAO Annex 10
1.8.2	Perform typical system measurements.	3	In space modulation, phase sideband/carrier, ground check for bearing errors
1.8.3	Appreciate calibration tasks and flight inspection results.	3	Flight inspection (coverage, flight check for bearing errors and modulation) e.g. maintenance manuals, procedures and reports

1.8.4	Appreciate troubleshooting of a CVOR and/or DVOR.	3	Carrier frequency deviation, depth of modulation, lack of power, harmonics ratio e.g. maintenance and flight inspection manuals, procedures and reports
1.8.5	Analyze the origins of CVOR and/or DVOR errors.	4	CVOR System-dependent, adjustments, drifts, multipath, onboard errors and/or DVOR North Adjustment e.g. DVOR: antenna feeding DVOR and CVOR: multipath, EMC, interference with radio broadcast transmissions

SUBJECT 5: GROUND-BASED SYSTEMS — DME

TOPIC 1: DME

SUB-TOPIC 1.1: Use of the system

1.1.1	Describe the overall performances for DME.	2	Coverage, accuracy, availability of the system, integrity, continuity, number of users
1.1.2	Explain the limitations of DME.	2	Accuracy, integrity, capacity
1.1.3	Describe the current situation.	2	e.g. number, types, users, user groups, national context, regional context
1.1.4	State the role of the DME infrastructure in the future navigation applications.	1	PBN
1.1.5	Explain the differences between DME and TACAN for civilian use.	2	e.g. azimuth and range

SUB-TOPIC 1.2: Fundamentals of DME

1.2.1	Describe the key elements of DME system operation.	2	Two-way ranging technique, slant range, time measurement A/c interrogation, pulse pairs, ground reply, fixed time delay, interrogation stagger, 'X' and 'Y' channels
1.2.2	Explain the frequency spectrum and the channel spacing allocated.	2	ICAO Annex 10, L-band

SUB-TOPIC 1.3: Ground station architecture

1.3.1	Describe the main components of a DME ground station.	2	Electronic cabinet, antenna system, power supply, remote controls and monitoring
1.3.2	Relate DME station design to operational requirements.	4	Coverage, ID code, siting

SUB-TOPIC 1.4: Receiver subsystem

1.4.1	Explain the main receiver parameters for a DME.	2	Sensitivity, selectivity, dynamic range, jamming immunity
1.4.2	Perform the typical measurements on the interrogation signals.	3	Sensitivity, selectivity, dynamic range, jamming immunity

SUB-TOPIC 1.5: Signal processing

1.5.1	Explain the functions performed by a DME/N signal processor.	2	Decode, Reply Delay, Automatic Reply Rate Control, Encode, priority (Ident, DME signal, Squitter)
1.5.2	Perform the typical measurement on the DME/N transponder signals.	3	Reply delay, Reply delay offset, decode parameters, rate of replies

SUB-TOPIC 1.6: Transmitter subsystem

1.6.1	Characterize the main signal parameters from the ground station.	2	Carrier frequency, output power, pulse shape, pulse spacing, pulse repetition frequency, main delay, ID code
1.6.2	Perform the typical measurements on a DME.	3	Power and pulse measurements, spectrum measurements, modulation measurements

SUB-TOPIC 1.7: Antenna subsystem

1.7.1	Explain DME antenna characteristics.	2	Patterns, antennas
1.7.2	Appreciate the interface between power stage and the antenna.	3	SWR, radiated power, propagation delay, distribution circuit (e.g. duplexer, circulator)
1.7.3	Appreciate protection areas.	3	ICAO Annex 10, protection area criteria and enforcement e.g. manufacturers manuals

SUB-TOPIC 1.8: Monitoring and control subsystem

1.8.1	Describe the purpose of monitoring.	2	Integrity, continuity of service
1.8.2	Describe which DME parameters are monitored.	2	ICAO and RTCA/EUROCAE requirements e.g. regional and national requirements
1.8.3	Appreciate how the operational status of the DME monitoring system is checked.	3	
1.8.4	Describe the issues associated with DME obstacle limitations and obstacle removal.	2	Multipath, blanking

SUB-TOPIC 1.9: On-board equipment

1.9.1	Describe the on-board equipment.	2	Transmitter, antenna, receiver, HMI e.g. HSI, DME range indication, ND
1.9.2	Describe how the DME information is used on board.	2	e.g. single DME, multi-DME navigation (rho rho), approach procedures, manual mode, automatic mode

SUB-TOPIC 1.10: System check and maintenance

1.10.1	Appreciate the conformity to international and national regulations.	3	ITU regulations (EMC + SAR), ICAO Annex 10
1.10.2	Appreciate calibration tasks and flight inspection results.	3	e.g. maintenance and flight inspection manuals, procedures and reports
1.10.3	Appreciate troubleshooting of a DME.	3	Carrier frequency deviation, depth of modulation, lack of power, harmonics ratio e.g. main delay and monitor shutdown errors, interference Maintenance and flight inspection manuals, procedures and reports
1.10.4	Appreciate the origin of DME errors.	3	e.g. Multipath, EMC, interference with radio broadcast transmissions (harmonics)

SUBJECT 6: GROUND-BASED SYSTEMS — ILS

TOPIC 1: ILS

SUB-TOPIC 1.1: Use of the system

1.1.1	Describe the overall performance for ILS.	2	ICAO Annexes 10 and 14 Coverage, accuracy, availability of the system, integrity, continuity, number of users
1.1.2	Explain the limitations of ILS.	2	ICAO Annexes 10 and 14 Only 40 channels, no segmented paths of approach, beam corruption due to multipath
1.1.3	Interpret ILS facility performance categories.	5	ICAO Annexes 10 and 14, CAT I, CAT II, CAT III Different operational category depending on operational minima, equipment and airport facilities
1.1.4	Define obstacle-free zones for ILS components.	1	ICAO Annexes 10 and 14 Dimensions e.g. regional and national regulations
1.1.5	Explain the importance and need for ILS obstacle-free zones.	2	ILS beam protection, increased significance during LVP conditions

1.1.6	Explain the current situation.	2	e.g. number, type, users, national context
1.1.7	Consider the need for ATC ILS status indications.	2	No continuous monitoring by ATSEP

SUB-TOPIC 1.2: Fundamentals of ILS

1.2.1	Explain how to obtain a change in depth of modulation of an amplitude modulated signal as a function of angular position.	2	Addition of a carrier signal and a side band signal in space
1.2.2	Characterize the signals to be radiated.	2	Amplitude and phase relationship, antenna systems
1.2.3	Relate the adjustment of signals generated to the resulting beam patterns and standards.	4	Phases and amplitudes in antenna array, modulations on carrier signal, phase and amplitude of side band
1.2.4	Describe the required performance of an antenna array.	2	Beam bend potential, coverage, impact on location of critical and sensitive area

SUB-TOPIC 1.3: 2F-Systems

1.3.1	Explain the limitations of a 1F system.	2	Multipath in adverse environment and terrain
1.3.2	Describe the capture effect.	2	Capture effect in receiver circuits
1.3.3	Describe radiation parameters for 2FLOC and 2F-GP.	2	Types of antenna arrays, patterns, coverage, signal distribution, radiated power

SUB-TOPIC 1.4: Ground station architecture

1.4.1	Describe the layout of an ILS.	2	—
1.4.2	Describe the main components of the LOC (1F and 2F), GP (1F and 2F), markers and field monitors.	2	Electronic cabinet, antennas, power supply, remote controls and monitoring, tower indication e.g. DME
1.4.3	Relate ILS station design to operational requirements.	4	Coverage, ID code, siting

SUB-TOPIC 1.5: Transmitter subsystem

1.5.2	Describe the main components of the LOC (1F and 2F), GP (1F and 2F), markers and field monitors.	2	Electronic cabinet, antennas, power supply, remote controls and monitoring, tower indication e.g. DME
1.5.3	Relate ILS station design to operational requirements.	4	Coverage, ID code, siting

SUB-TOPIC 1.6: Antenna subsystem

1.6.1	Explain ILS antenna characteristics: LOC, GP and Marker Beacons.	2	Types, position, polarization, patterns, coverage, antenna matching, distribution circuits, radiated power, ground reflection

SUB-TOPIC 1.7: Monitoring and control subsystem

1.7.1	Describe the purpose of monitoring.	2	Integrity, continuity of service
1.7.2	Describe the parameters for the monitoring according to ICAO Annex 10: LOC, GP and Marker Beacons.	2	RF level, DDM, SDM on position and width
1.7.3	Explain the key additional required monitoring: LOC and GP.	2	External, internal and integral monitoring
1.7.4	Explain the purpose, advantages and disadvantages of the FFM system.	2	e.g. content position, width, requirement for Cat III operations (some States)
1.7.5	Draw a diagram of the monitoring system: LOC, GP, FFM and Marker Beacons.	1	Near-field, integral network, internal network, monitor signal processor e.g. DME
1.7.6	Explain the optional DME interface.	2	Identity coding ratio

SUB-TOPIC 1.8: On-board equipment

1.8.1	Describe the on-board equipment associated with LOC, GP and Marker Beacon.	2	Antennas, receiver, pilot interface (cross pointer) e.g. FMS
1.8.2	Describe how ILS information is used on board.	2	e.g. approach procedures, landing, roll-out, manual, automatic mode (auto-pilot)

SUB-TOPIC 1.9: System check and maintenance

1.9.1	Appreciate the conformity of LOC, GP and marker beacons to international and national regulations.	3	ITU regulations (EMC + SAR), ICAO Annex 10
1.9.2	Justify the occasions when it is necessary to downgrade an ILS facility performance category.	4	e.g. system failures, environmental changes/disturbance
1.9.3	Explain the implications of ILS facility performance categories to the pilot.	2	Link with prevailing Instrument RVR, weather dictating decision height
1.9.4	Perform some typical measurements.	3	Output power, spectrum analysis, modulation, ID code
1.9.5	Appreciate calibration tasks and flight inspection results.	3	LOC, GP and marker beacons Flight inspection and ground calibration results, LOC Centerline measurement, width and centerline field measurements e.g. RF interference monitoring maintenance and flight inspection manuals, procedures and reports
1.9.6	Appreciate troubleshooting of ILS LOC, GP and marker beacons.	3	DDM and SDM misalignment, coverage pilot reported errors, field checks, monitor checks e.g. lack of power, carrier frequency deviation, harmonic ratio, depth of modulation maintenance and flight inspection manuals, procedures and reports
1.9.7	Appreciate the origin of ILS errors.	3	e.g. Multipath, EMC, interference with radio broadcast transmissions (harmonics)

SUBJECT 7: GNSS

TOPIC 1: GNSS

SUB-TOPIC 1.1: General view

1.1.1	Explain the importance and continuing development of GNSS.	2	FANS CNS/ATM concept, ICAO Doc 9849, Navigation Application & NAVAID Infrastructure Strategy
1.1.2	Describe the elements of GNSS.	2	Core constellations, ABAS, SBAS (EGNOS) e.g. GBAS, SCAT 1, APV, ICAO Annex 10
1.1.3	Appreciate the sources of interference to GNSS signals.	3	Intentional, unintentional, ionospheric interference, solar activity
1.1.4	Explain who has responsibility for GNSS oversight in your State and how it is carried out.	2	e.g. RSOO, GSA, National regulator

1.1.5	Appreciate the impact of the modernization of GNSS on the ARNS bands.	3	Introduction of L5, E5A, E5B e.g. COMPASS
1.1.6	Explain the need for a minimum number of visible satellites needed to provide integrity monitoring.	2	e.g. AUGUR
1.1.7	Describe the purpose of the GNSS NOTAM.	2	ICAO Annex 10, Volume 1

SUBJECT 8: ON-BOARD EQUIPMENT

TOPIC 1: ON-BOARD SYSTEMS

SUB-TOPIC 1.1: On-board systems

1.1.1	Explain the purpose and use of a navigation computer.	2	Sensors, navigation database
1.1.2	Explain the purpose and use of an FMS.	2	Sensors, navigation database, path steering, displays

TOPIC 2: AUTONOMOUS NAVIGATION

SUB-TOPIC 2.1: Inertial navigation

2.1.1	Describe the principles and key features of INS/IRS navigation.	2	Gyros, accelerometer, accuracy, drift, updating

TOPIC 3: VERTICAL NAVIGATION

SUB-TOPIC 3.1: Vertical navigation

3.1.1	Describe the different types of vertical sensors and their limitations.	2	Barometric, radio altimetry, geodetic e.g. air data computers, manual intervention, dynamic information (AGL), undulation (WGS84)

SUBJECT 9: FUNCTIONAL SAFETY

TOPIC 1: SAFETY ATTITUDE

SUB-TOPIC 1.1: Safety attitude

1.1.1	State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to navigation systems, safety monitoring

TOPIC 2: FUNCTIONAL SAFETY

SUB-TOPIC 2.1: Functional safety

2.1.1	Describe in terms of exposure time, environment, effect on controller and effect on pilot, the types of functional failures.	2	Total or partial, premature or delayed operation, spurious, intermittent, loss or corruption of data, missing or incorrect input or output Ref.: Safety policy and implementation

A 4 – Training Objectives for a Qualification Training Course on Surveillance

SUBJECT 1: PRIMARY SURVEILLANCE RADAR

TOPIC 1: ATC SURVEILLANCE

SUB-TOPIC 1.1: Use of PSR for Air Traffic Services

1.1.1	Describe the operational requirements of an en-route or an approach PSR.	2	Range, resolution, coverage, availability
1.1.2	Relate key parameters of PSR to system performance.	4	Key parameters: PRF, signal energy, frequency diversity, antenna gain, update rate, polarization, receiver MDS, beam width Performance: range, accuracy, resolution, extractor minimum target threshold, weather influence, PD, blind speed, ambiguities, capacity e.g. weather channel

SUB-TOPIC 1.2: Antenna (PSR)

1.2.1	Describe antenna types, accuracy and problems.	2	Antenna beam(s), side lobes, reflector antenna, active (phased array) antenna, rotating joints, waveguide interface, pressurization, dehumidification, polarization, azimuth encoding, drive systems

SUB-TOPIC 1.3: Transmitters

1.3.1	Describe the basic characteristics of a transmitter.	2	Supply, EHT, RF source (appropriate to type chosen), modulation, interlocks
1.3.2	Describe the signals at all key points.	2	Supply, EHT, RF source (appropriate to type chosen), modulation, interlocks
1.3.3	Describe a generic transmitter block diagram for both compressed and non-compressed system.	2	e.g. solid state, klystron, magnetron, travelling wave tube
1.3.4	State possible failures and where they can occur in the transmitter system.	1	e.g. solid state modules, arcing, corona discharge, component stress, control loops, isolation
1.3.5	State constraints and problems on the high voltage circuitry.	1	e.g. corona discharge, dielectric stress, isolation, arcing, ageing, interlocks, stability (including control loop)

SUB-TOPIC 1.4: Characteristics of primary targets

1.4.1	Appreciate the characteristics of targets detected by PSR.	3	Backscatter, radar cross section (such as reflectivity, stealth technologies, aspect), Doppler shift, ground speed, wind turbines e.g. Swirling Case

SUB-TOPIC: 1.5: Receivers

1.5.1	Describe the basic characteristics of a receiver.	2	Low noise, high dynamic range, bandwidth, detection, frequency, sensitivity, selectivity
1.5.2	Describe the basic elements of a generic receiver.	2	LNA, local oscillator, coherent oscillator, downconverter, filtering, rejection, IF, PSD, AGC, STC, beam switching
1.5.3	Appreciate the importance of STC.	3	Saturation, RF-IF dynamic range

SUB-TOPIC 1.6: Signal processing and plot extraction

1.6.1	Describe the basic function of data processing.	2	Plot extraction (range bin reports, range correlation, azimuth correlation), target reports, sliding window, weighted centre, local tracking
1.6.2	Appreciate the basic functions of a current radar signal processor.	3	A/D conversion, I/Q matching, target detection, detection criteria (fixed, adaptive), MTD and clutter maps
1.6.3	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

SUB-TOPIC 1.7: Plot combining

1.7.1	Describe the basic function of plot combining.	2	Secondary/primary combining, secondary/primary assigning, prime target, range and azimuth collimation
1.7.2	Describe the basic functions of a current radar plot combiner.	2	Scan-to-scan correlation, angel filtering, vehicle filtering, output format

SUB-TOPIC 1.8: Characteristics of primary radar

1.8.1	Explain the basic principles of electromagnetism, propagation, signal detection, RF power generation and distribution.	2	Frequency and phase, electromagnetic radiation, spectrum and bandwidth, noise, HPA, waveguide problems

TOPIC 2: SMR

SUB-TOPIC 2.1: Use of SMR for Air Traffic Services

2.1.1	Describe the operational requirements of SMR.	2	Range, resolution, coverage, MTBF, availability

2.1.2	Relate key parameters and necessity to achieve performances.	4	Specific equations for ranging and power budget, PRF, frequency with respect to range and accuracy, PD, frequency diversity, range with respect to TX power, antenna gain, receiver MDS, update rate, beam width, extractor minimum target threshold, polarization, influence to meteorology

SUB-TOPIC 2.2: Radar sensor

2.2.1	Explain the layout of the SMR.	2	Dual system, service display
2.2.2	Describe the basic functions of the receiver/transmitter unit.	2	Hardware/function overview
2.2.3	Describe how to operate a sensor.	2	e.g. block diagram, timing relations, video path, frequency diversity, polarization, controller structure
2.2.4	Describe the basic functions of the antenna unit.	2	e.g. hardware function overview, control/switch unit, external interface, azimuth encoding, monopulse techniques

TOPIC 3: TEST AND MEASUREMENT

SUB-TOPIC 3.1: Test and measurement

3.1.1	Appreciate how measurements can be made on PSR and SMR.	3	e.g. spectrum analyzer, vector voltmeter, oscilloscope, SWR meter, sensor analysis tools

SUBJECT 2: SECONDARY SURVEILLANCE RADAR (SSR)

TOPIC 1: SSR AND MSSR

SUB-TOPIC 1.1: Use of SSR for Air Traffic Services

1.1.1	Describe the operational requirements of an en-route or an approach SSR.	2	Range, coverage, resolution, performance, update rate ICAO Doc 9924
1.1.2	Relate key parameters of SSR to system performance.	4	Key parameters: rotation rate, PRF, interlaced modes, capacity, frequencies, power budget (uplink, downlink), monopulse techniques Consequences: FRUIT, garbling, side lobes reception and transmission, transponder availability, PD, 2nd recurrence replies

SUB-TOPIC 1.2: Antenna (SSR)

1.2.1	Describe the principles of SSR/MSSR antenna.	2	Monopulse antenna techniques, coaxial connection, sum, difference and control pattern, error angle measurement, azimuth encoding, beam sharpening, side lobes

SUB-TOPIC 1.3: Interrogator

1.3.1	Describe the characteristics of an interrogator.	2	Frequency, spectrum, interrogation modes, duty cycle, ISLS, IISLS, staggering
1.3.2	Explain a generic interrogator.	2	Timing, interface, modulator, BITE
1.3.3	Explain the need for integrity monitoring.	2	Safeguards against erroneous transmission, BITE

SUB-TOPIC 1.4: Transponder

1.4.1	Explain the operational use of the transponder.	2	Diagram of interaction between transponder and airplane
1.4.2	Define the global performances.	1	Range, accuracy, fixed delay to respond
1.4.3	Describe the basic characteristics of a transponder.	2	Transceiver, aerial location, switching and polar diagram, size ACAS Mode S and ADS compatibility, maximum reply rate, ISLS compatibility
1.4.4	Explain the advantages of the transponder.	2	Longer range, more information
1.4.5	Explain the limitations of the transponder.	2	Hundreds of feet precision, 3A limited codes
1.4.6	Describe the conformity to regulations.	2	Equipage obligations, ICAO Annex 10
1.4.7	Describe the data format of the received transponder messages.	2	P1, P2, P3, P4, P5, P6 signals and DPSK modulation (P6)
1.4.8	Describe the data format of the transmitted transponder messages.	2	Field lengths, data bits, Gray code, unused bits, Mode S reply (preamble and data)
1.4.9	Describe the basic characteristics of a transmitter.	2	Timing, modulation, pulse width, power output
1.4.10	Describe the use of the transponder as a field monitor	2	—

SUB-TOPIC 1.5: Receivers

1.5.1	Describe the basic characteristics of an SSR receiver.	2	Standard/MSSR receiver, sensibility, bandwidth, dynamic range, GTC (normal, sectorized), monopulse processor, RSLS, multi-path and interferences

SUB-TOPIC 1.6: Signal processing and plot extraction

1.6.1	Describe monopulse extraction.	2	Phase and amplitude modulation, off boresight angle calculation, azimuth encoding
1.6.2	Describe sliding window SSR extraction.	2	Leading edge, trailing edge, azimuth accuracy, azimuth encoding
1.6.3	Describe the signal processing.	2	Video digitizer, pulse processor, reply decoder (bracket pair detector), synchronous reply correlator
1.6.4	Decode a transponder message.	3	Standard message with SPI set e.g. Mode S
1.6.5	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
1.6.6	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

SUB-TOPIC 1.7: Plot combining

1.7.1	Describe the basic function of plot combining.	2	Secondary/primary combining, secondary/primary assigning, prime target, range and azimuth collimation
1.7.2	Describe the basic functions of a current radar plot combiner.	2	_

SUB-TOPIC 1.8: Test and measurement

1.8.1	Appreciate how measurements can be made on SSR.	3	e.g. spectrum analyzer, vector voltmeter, oscilloscope, SWR meter, sensor analysis tools

TOPIC 2: MODE S

SUB-TOPIC 2.1: Introduction to Mode S

2.1.1	Explain the need for and benefits of Mode S.	2	Classical SSR limitations, resolution, accuracy, integrity, enhanced data (e.g. 25 ft resolution, aircraft ID, BDS information)
2.1.2	Explain the working principles of Mode S.	2	Mode S interrogation, Mode S reply, Mode S uplink and downlink capability, Mode S formats/protocols, ELS, EHS
2.1.3	Explain the complementary use of Mode S and conventional SSR.	2	Mode interlace pattern, operational use of all-call, roll-call
2.1.4	Explain Mode S implementation.	2	Elementary and enhanced surveillance, II and SI codes, use of BDS

SUB-TOPIC 2.2: Mode S system

2.2.1	Describe the theory of operation of Mode S hardware and software.	2	Performance of the system, theory of operation of the system, interfaces to customer equipment
2.2.2	Describe testing possibilities for Mode S.	2	e.g. SASS-C

TOPIC 3: MULTILATERATION

SUB-TOPIC 3.1: MLAT in use

3.1.1	Explain how pilot and controller operations are impacted by the use of an MLAT system.	2	Mode A assigned at gate, coverage of MLAT
3.1.2	Describe the ground mode of transponders.	2	Aircraft interrogations, squitter, change of transponder mode

SUB-TOPIC 3.2: MLAT principles

3.2.1	Explain the MLAT system architecture.	2	Standards, transmitters and receivers, data processing/fusion, redundancy, performance, costs, timing solutions, etc.
3.2.2	Appreciate the principles of MLAT system.	3	Triangulation, coverage, position calculation e.g. SCAS
3.2.3	Describe how to operate the system.	2	Tracking, map creation and blanking
3.2.4	Describe testing possibilities for MLAT.	2	e.g. SASS-C

TOPIC 4: SSR ENVIRONMENT

SUB-TOPIC 4.1: SSR Environment

4.1.1	Explain the operational use of ACAS and implications for pilots and controllers.	2	Traffic Advisories, Resolution Advisories, pilot responses and controller information
4.1.2	Describe the users of the 1 030 MHz 1 090 MHz channels.	2	Modes 1, 3, A, C and S, military, Mode S uplink and downlink capability, ACAS (TCAS), acquisition and extended squitter, PRF-FRUIT ratios, DME and other interferences

SUBJECT 3: AUTOMATIC DEPENDENT SURVEILLANCE (ADS)

TOPIC 1: GENERAL VIEW ON ADS

SUB-TOPIC 1.1: Definition of ADS

1.1.1	Describe the basic characteristics of a ADS.	2	Performance, integrity, latency, QoS, implementation options (e.g. ATN/FANS)
1.1.2	List the types of navigation sensors.	1	GNSS, INS, radio NAVAIDs, navigation solutions from FMS, FoM
1.1.3	State the latest developments, implementation plans and projects.	1	e.g. current and recent test and trials, ICAO status, EUROCONTROL, FAA and other authorities' positions, airline and equipment manufacturer positions, ATC procedures, time scales

TOPIC 2: ADS-B

SUB-TOPIC 2.1: Introduction to ADS-B

2.1.1	Explain the basic principles of ADS-B.	2	Autonomous operation, navigation solutions, link options, aircraft situation awareness
2.1.2	Identify the major elements of ADS-B.	3	e.g. ADS-B global chain (from the aircraft to the controller HMI), GNSS, FMS, encoding, scheduling, link

SUB-TOPIC 2.2: Techniques of ADS-B

2.2.1	Explain the characteristics of the data links used in ADS B.	2	VDL Mode 4, Mode S extended squitter, UAT
2.2.2	Describe the major ADS-B applications.	2	e.g. ADS-B-NRA, ADS-B-RAD, ASAS

SUB-TOPIC 2.3: VDL Mode 4 (STDMA)

2.3.1	Describe the use of VDL Mode 4.	2	High-level description

SUB-TOPIC 2.4: Mode S extended squitter

2.4.1	Describe the use of the Mode S extended squitter.	2	High-level description
2.4.2	Explain the principles related to signals in space.	2	Modulation scheme, signal structure, key data and frequency
2.4.3	Explain the principles related to random access technology.	2	Consequences on the RF environment (1 090 MHz)
2.4.4	Explain the relevant messages.	2	Information in each field, information encoding and decoding
2.4.5	Recognize the structure of a Mode S extended squitter signal.	1	Signal timing and sequencing, data encoding
2.4.6	Explain the interface between the BDS and the extended squitter message.	2	—

SUB-TOPIC 2.5: UAT

2.5.1	State the use of the UAT.	1	High-level description

SUB-TOPIC 2.6: ASTERIX

2.6.1	Decode and analyze a signal coded according to the ASTERIX category 21 standard.	3	Reference to ASTERIX standard. Decode position, call sign, Mode S address, etc.

TOPIC 3: ADS-C

SUB-TOPIC 3.1: Introduction to ADS-C

3.1.1	Explain the basic principles of ADS-C.	2	Contract, multi-contract, time, event triggering
3.1.2	Identify the major elements of the ADS-C system.	3	ADS-C global chain (from the aircraft to the controller HMI), GNSS, processor, link, ground station

SUB-TOPIC 3.2: Techniques in ADS-C

3.2.1	Explain the characteristics of the data links used in ADS-C.	2	e.g. subnetworks (VDLs, AMSS, HFDL)

SUBJECT 4: HUMAN MACHINE INTERFACE (HMI)

TOPIC 1: HMI

SUB-TOPIC 1.1: ATCO HMI

1.1.1	Describe the display types available.	2	Video, synthetic, mixed
1.1.2	State the type of selections available.	1	Source, range, maps, filters
1.1.3	Describe the advantages of different display types.	2	Clarity, configurability, fallback, data integration

SUB-TOPIC 1.2: ATSEP HMI

1.2.1	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
1.2.2	Describe the analytical and status data available to the users.	2	Radar video, front panel and CMS data, HMI on each subsystem

SUB-TOPIC 1.3: Pilot HMI

1.3.1	Describe the transponder interface.	2	Mode A, change procedure, SPI, Mode C, deselection, hijack
1.3.2	Be aware of the ACAS/TCAS display and future potential developments.	0	Characteristics, accuracy, alerts, ADS B, CDTI
1.3.3	Be aware of the EGPWS display and of future potential developments.	0	—

SUB-TOPIC 1.4: Displays

1.4.1	Describe the display types available and their advantages and disadvantages.	2	Raster/rotating, raw/synthetic, monochrome/color, CRT/LCD, performances (cost, availability, maintainability, ergonomics)

SUBJECT 5: SURVEILLANCE DATA TRANSMISSION

TOPIC 1: SURVEILLANCE DATA TRANSMISSION

SUB-TOPIC 1.1: Technology and protocols

1.1.1	Describe the implementation of formats and protocols.	2	Network protocols, Surveillance Data Networks e.g. RADNET, messages CAT 1+
1.1.2	Decode ASTERIX messages.	3	e.g. categories 1, 2, 20, 21, 34, 48, 62
1.1.3	Identify the data transmission architecture in a multisensor environment.	3	Fault tolerance, redundancy of line equipment e.g. software fallback capability, contingency of service, RADNET
1.1.4	Characterize the degradations of the surveillance transmission network.	2	e.g. saturation, excess latency

SUB-TOPIC 1.2: Verification methods

1.2.1	Identify the causes of a fault, based on test tool measurements.	3	e.g. data analyzer, line analyzer

SUBJECT 6: FUNCTIONAL SAFETY

TOPIC 1: SAFETY ATTITUDE

SUB-TOPIC 1.1: Safety attitude

1.1.1	State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to the surveillance systems, safety reports and occurrences, safety monitoring

TOPIC 2: FUNCTIONAL SAFETY

SUB-TOPIC 2.1: Functional safety

2.1.1	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.: Safety policy and implementation

SUBJECT 7: DATA PROCESSING SYSTEMS

TOPIC 2: SYSTEM COMPONENTS

SUB-TOPIC 1.1: Surveillance data processing systems

1.1.1	Identify all functions of an SDP system.	3	Plot processing, tracking, single-sensor and multi sensors tracker, e.g. radar, ADS, MLAT, estimating limits and accuracy of multi sensor tracker, recording e.g. ARTAS tracker
1.1.2	Describe all major components of an SDP.	2	Functional architecture, technical architecture
1.1.3	Differentiate SDP features in the ATS units.	2	Area control centers, Approach control units, Aerodrome control towers
1.1.4	Appreciate how to operate the system.	3	e.g. configuration, adjust parameters, start up and shut down, monitoring
1.1.5	Explain the principles of emergency switching.	2	—

A 5 – Training Objectives for a Qualification Training Course on Data processing/Automation

SUBJECT 1: COMMUNICATION DATA

TOPIC 1: INTRODUCTION TO NETWORKS

SUB-TOPIC: 1.1 Types

1.1.1	State the evolution of network topologies.	1	LAN, WAN, e.g. architectures, size of the segments, length of the systems, quality of service
1.1.2	Explain how networks meet requirements.	2	Redundancy, bandwidth, BER, time delay, network security

SUB-TOPIC 1.2: Networks

1.2.1	Analyze the features of a network.	4	Routing scheme, rate, internal networking, routers, bridges, gateways, modems, switches, firewalls e.g. wireless networks
1.2.2	Describe network standards and devices.	2	Ethernet, fibre optic, wireless
1.2.3	Appreciate the replacement of components in a network in a safe way.	3	Continuity of service, network integrity

SUB-TOPIC 1.3: External network services

1.3.1	Define aspects of external network services.	1	Provided QoS, e.g. SLAs

SUB-TOPIC 1.4: Measuring tools

1.4.1	Operate the usual set of network measuring or monitoring tools to find the values of the main parameters.	3	Data analyser (sniffer) e.g. net scout
1.4.2	Perform analysis to support faultfinding for correction	3	Data analyser (sniffer) e.g. net scout

SUB-TOPIC 1.5: Troubleshooting

1.5.1	Appreciate how to troubleshoot a network.	3	e.g. broken lines, unusable network components, overload, integrity problems

TOPIC 2: PROTOCOLS

SUB-TOPIC 2.1: Fundamental theory

2.1.1	Apply the principles of layers.	3	Differences between layers e.g. layer(s) of sniffer information
2.1.2	Apply the principles of the addressing strategy.	3	Masks, subnets, P addressing, MAC addressing e.g. same logical network computers and systems
2.1.3	Apply the principles of the routing strategy.	3	Routing tables, priorities, fault tolerance, management of routing strategy, static and dynamic routing e.g. unicast, multicast, broadcast

SUB-TOPIC 2.2: General protocols

2.2.1	Describe the general protocols.	2	TCP/IP (segments, packets, addressing), e.g. X25, LAPB, pdH, sdH
2.2.2	Analyze the general protocols using the appropriate tools and documentation.	4	TCP/IP, e.g. X25, LAPB

SUB-TOPIC 2.3: Specific protocols

2.3.1	Describe the specific protocols.	2	e.g. BATAP — ARINC 620, FMTP

TOPIC 3: NATIONAL NETWORKS

SUB-TOPIC 3.1: National networks

3.1.1	Name the national networks to which the organization is connected.	1	e.g. ANSP, MET, military, PTT, airlines, national network(s)
3.1.2	Describe the interfaces between national and global networks.	2	—

SUBJECT 2: SURVEILLANCE PRIMARY

TOPIC 1: ATC SURVEILLANCE

SUB-TOPIC 1.1: Use of PSR for Air Traffic Services

1.1.1	Describe the operational requirements of an en-route or an approach PSR.	2	Range, resolution, coverage, availability

SUBJECT 3: SURVEILLANCE SECONDARY

TOPIC 1: SSR AND MSSR

SUB-TOPIC 1.1: Use of SSR for Air Traffic Services

1.1.1	Describe the operational requirements of an en-route or an approach SSR.	2	Range, coverage, resolution, performance, update rate ICAO Doc9924

TOPIC 2: MODE S

SUB-TOPIC 2.1: Introduction to Mode S

2.1.1	Explain the need for and benefits of Mode S.	2	Classical SSR limitations, resolution, accuracy, integrity, enhanced data (e.g. 25 ft resolution, aircraft ID, BDS information)
2.1.2	Explain the working principles of Mode S.	2	Mode S interrogation, Mode S reply, Mode S uplink and downlink capability, Mode S formats/protocols, ELS, EHS
2.1.3	Explain the complementary use of Mode S and conventional SSR.	2	Mode interlace pattern, operational use of all-call, roll-call
2.1.4	Explain Mode S implementation.	2	Elementary and enhanced surveillance, II and SI codes, use of BDS

TOPIC 3: MULTILATERATION

SUB-TOPIC 3.1: MLAT principles

3.1.1	Explain the MLAT system architecture.	2	Standards, transmitters and receivers, data processing/fusion, redundancy, performance, costs, timing solutions, etc.
3.1.2	Appreciate the principles of MLAT system.	3	Triangulation, coverage, position calculation e.g. SCAS
3.1.3	Describe how to operate the system.	2	Tracking, map creation and blanking
3.1.4	Describe testing possibilities for MLAT.	2	e.g. SASS-C

SUBJECT 4: SURVEILLANCE — HMI

TOPIC 3: HMI

SUB-TOPIC 1.1: ATCO HMI

1.1.1	Describe the display types available.	2	Video, synthetic, mixed
1.1.2	State the type of selections available.	1	Source, range, maps, filters
1.1.3	Describe the advantages of different display types.	2	Clarity, configurability, fallback, data integration

SUBJECT 5: SURVEILLANCE DATA TRANSMISSION

TOPIC 1: SURVEILLANCE DATA TRANSMISSION

SUB-TOPIC 1.1: Technology and protocols

1.1.1	Describe the implementation of formats and protocols.	2	Network protocols, surveillance data networks (e.g. RADNET), messages CAT 1+
1.1.2	Decode ASTERIX messages.	3	e.g. categories 1, 2, 20, 21, 34, 48, 62
1.1.3	Identify the data transmission architecture in a multi sensor environment.	3	Fault tolerance, redundancy of line equipment e.g. software fallback capability, contingency of service, RADNET
1.1.4	Characterize the degradations of the surveillance transmission network.	2	e.g. saturation, excess latency

SUBJECT 6: FUNCTIONAL SAFETY

TOPIC 1: FUNCTIONAL SAFETY

SUB-TOPIC 1.1: Functional safety

1.1.1	Describe the implications of functional failure 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.: Safety policy and implementation

SUB-TOPIC 1.2: Software integrity and security

1.2.1	Appreciate how a system can be defended against potential hostile intent via the data processing systems.	3	Input verification, secure sources e.g. leased lines, private networks, eligibility
1.2.2	Explain how the normal output of a system could be used by unauthorized persons with hostile intent.	2	e.g. terrorists using radar data to coordinate an attack
1.2.3	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 of system, results in capacity reductions and safety consequences
1.2.4	Appreciate error detection and handling in data, hardware and process.	3	Identification, consequence, scope, reporting, fault tolerance, soft fail, failsafe, monitoring, fallback

TOPIC 2: SAFETY ATTITUDE

SUB-TOPIC 2.1: Safety attitude

2.1.1	State the role of ATSEP in safety management routines and in reporting processes.	1	Safety assessment documentation related to data processing systems, safety monitoring

SUBJECT 7: DATA PROCESSING SYSTEMS

TOPIC 1: USER REQUIREMENTS

SUB-TOPIC 1.1: Controller requirements

1.1.1	Explain ATCO missions and services needed in an area control center.	2	Operational requirements e.g. separation, flight progress monitoring and coordination, trajectory prediction, coordination with adjacent centers
1.1.2	Explain ATCO missions and services needed in an approach control unit	2	Operational requirements e.g. vectoring, sequencing, AMAN, CDM
1.1.3	Explain ATCO missions and services needed in an aerodrome control tower.	2	Operational requirements e.g. runway management, DMAN

SUB-TOPIC 1.2: Trajectories, prediction and calculation

1.2.1	State different types of trajectories.	1	e.g. FPL-based, surveillance data-based, FMS-based
1.2.2	Explain the main processes for trajectory prediction.	2	SDP trajectory, FPL trajectory, merged trajectory, predicted trajectory

SUB-TOPIC 1.3: Ground safety nets

1.3.1	Describe the function of safety nets and their legal status.	2	STCA, APW, MSAW, ASMGCS-based safety nets

SUB-TOPIC 1.4: Decision support

1.4.1	Explain the major steps in the air traffic planning process.	2	ATFCM with strategic, pre-tactical and tactical, ATC sector planning, tactical control
1.4.2	Explain the principles of trajectory prediction, conformance monitoring and medium-term conflict detection processes.	2	Route adherence monitoring e.g. CORA, MTCD, CLAM, Level adherence monitoring
1.4.3	Explain the benefit of these tools for safety and efficiency.	2	—

TOPIC 2: SYSTEM COMPONENTS

SUB-TOPIC 2.1: Processing systems

2.1.1	Describe all major components of a data processing system.	2	Functional architecture, technical architecture, supervision

SUB-TOPIC 2.2: Flight data processing systems

2.2.1	Identify all functions of an FDP system.	3	FDPS reference model, message handling, initial flight data handling, relationship with other functions, air ground data link processing, trajectory prediction, flight data management and distribution, SSR Mode A code assignment and management, correlation, coordination and transfer
2.2.2	Describe all major components of an FDP.	2	Functional architecture, technical architecture e.g. HMI, ATC tools, support tools (technical supervision, QoS monitors and logging)
2.2.3	Differentiate FDP features in the ATS units.	2	Area control centers, Approach control units, Aerodrome control towers
2.2.4	Appreciate how to operate the system.	3	e.g. configuration, adjust parameters, start up and shut down, monitoring
2.2.5	Explain the principles of emergency switching.	2	—

SUB-TOPIC 2.3: Surveillance data processing systems

2.3.1	Identify all functions of an SDP system.	3	Plot processing, tracking, single sensor and multi sensor tracker (e.g. radar, ADS, MLAT), estimating limits and accuracy of multi sensor tracker, recording e.g. ARTAS tracker
2.3.2	Describe all major components of an SDP.	2	Functional architecture, technical architecture
2.3.3	Differentiate SDP features in the ATS units.	2	Area control centers, Approach control units, Aerodrome control towers
2.3.4	Appreciate how to operate the system.	3	e.g. configuration, adjust parameters, start up and shut down, monitoring
2.3.5	Explain the principles of emergency switching.	2	—

SUBJECT 8: DATA PROCESS

TOPIC 1: SOFTWARE PROCESS

SUB-TOPIC 1.1: Middleware

1.1.1	Define middleware.	1	Additional specialized functional built on the OS
1.1.2	List the middleware used on the national major systems.	1	e.g. CORBA, UBSS, OTM, EJB
1.1.3	Demonstrate the use of a middleware in an ATM environment.	2	Dual processing system

SUB-TOPIC 1.2: Operating systems

1.2.1	Describe the major aspects of a relevant operating system.	2	e.g. design, start-up, configuration, back-up and restore
1.2.2	Perform relevant operating system commands.	3	—
1.2.3	Characterize typical consequences of an OS upgrade.	2	Some possible implications on HW (performance, memory), middleware (compatibility) and SW components
1.2.4	Explain downward compatibility.	2	Checks on embedded SW modules ability to run under new OS version
1.2.5	Take account of hardware/software compatibility.	2	Examples of HW requirements of specific SW implementations
1.2.6	Describe interactions between application and OS.	2	Examples of OS calls by the application software if no middleware is in use
1.2.7	Describe the life cycle management of an operating system.	2	e.g. versions, releases, patches, migration

SUB-TOPIC 1.3: Configuration control

1.3.1	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

SUB-TOPIC 1.4: Software development process

1.4.1	State the main software development processes.	1	SWALs e.g. life cycle, waterfall model, RUP
1.4.2	List the main steps of two of the main software development processes.	1	—
1.4.3	Explain the main differences between two software development processes.	2	e.g. advantages/disadvantages

TOPIC 2: HARDWARE PLATFORM

SUB-TOPIC 2.1: Equipment upgrade

2.1.1	Explain the key factors that have to be considered when data processing equipment is upgraded or changed.	2	Specification, compatibility, 'proven' or 'state-of-the art' technology, maintenance and operating consequence (e.g. personnel, training, spares, procedures), environmental requirements (e.g. size, power requirements, temperature, interfaces), testing

SUB-TOPIC 2.2: COTS

2.2.1	Explain the advantages and disadvantages of commercial off-the-shelf equipment.	2	Cost, multiplicity of suppliers, quality, maintainability, life cycle, liability

SUB-TOPIC 2.3: Interdependence

2.3.1	Describe the technical issues regarding the interdependence of various equipment and systems.	2	Interface requirements, common point of failure, data conditioning, response time

SUB-TOPIC 2.4: Maintainability

2.4.1	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

TOPIC 3: TESTING

SUB-TOPIC 3.1: Testing

3.1.1	Appreciate the techniques available for system and performance requirements testing.	3	e.g. code walkthrough, modelling, simulation real time and fast time, black box testing, formal methods, use of independent test personnel, data corruption simulation, hardware failure simulation
3.1.2	Appreciate the techniques available for system testing and integration.	3	e.g. system integration testing, load testing, regression testing

SUBJECT 9: — DATA

TOPIC 1: DATA ESSENTIALS FEATURES

SUB-TOPIC 1.1: Data significance

1.1.1	Explain the significance of data.	2	Criticality (critical/non-critical), legality (ICAO, CAA, organization), use (advisory, control)

SUB-TOPIC 1.2: Data configuration control

1.2.1	Explain the control procedures for changes to operational data.	2	Designated roles/persons for authorizing changes and verifying/checking changes

SUB-TOPIC 1.3 Data Standards

1.3.1	Name the authority responsible for standards.	1	e.g. ICAO, ISO, RSOO, national authority
1.3.2	State the standards related to ATM data, their sources and their status.	1	e.g. ASTERIX, WGS84, OLDI, FMTP, AMHS, ADEX-P, FPL
1.3.3	Decode a typical OLDI message.	3	e.g. ACT, PAC
1.3.4	State the nature of ATM processing requirements.	1	Data volatility (e.g. radar), system integrity, consequence of failure

TOPIC 2: ATM DATA DETAILED STRUCTURE

SUB-TOPIC 2.1: System area

2.1.1	Describe how a system area is defined.	2	e.g. size, system center (reference point)

2.1.2	Describe the data related to the system area.	2	e.g. radar data, flight plan data, maps, coordinates

SUB-TOPIC 2.2: Characteristic points

2.2.1	State types of characteristic points used in an ATM system and their structure.	1	Geographic, routing, sector, e.g. Geographic: airports and runways, ILS, radar, limit points. Routing and sectors: coded routes, SID allocation parameters, area navigation waypoints, adjacent FIRs, holding, sectors
2.2.2	Explain the importance of characteristic points in the correct presentation of data.	2	—
2.2.3	Describe the process by which amended adaptation files are introduced.	2	—

SUB-TOPIC 2.3: Aircraft performances

2.3.1	List the performance data used in FDPS.	1	Example of data from in-house system
2.3.2	Describe the structure of aircraft performance data.	2	—
2.3.3	Define speeds, rates and levels.	1	—
2.3.4	Explain the consequences of the use of the wrong type of aircraft.	2	—

SUB-TOPIC 2.4: Screen manager

2.4.1	Describe how the screen manager is used to set up the ATC HMI.	2	—

SUB-TOPIC 2.5: Auto-coordination messages

2.5.1	Describe the meaning of coordination messages in the control process.	2	Coordination parameters, conditions groups, OLDI conditions groups, characteristics of remote centers
2.5.2	Describe the characteristics of the remote centers relevant to OLDI.	2	Civil and military

SUB-TOPIC 2.6: Configuration control data

2.6.1	Explain the structure of the configuration data.	2	Sector CSU link, sectorization plan, control parameters

SUB-TOPIC 2.7: Physical configuration data.

2.7.1	Explain the structure of the physical configuration data.	2	External configuration, device configuration

SUB-TOPIC 2.8: Relevant meteorology data

2.8.1	Explain the organization of the data related to meteorology.	2	Meteorology, QNH TL areas, CB activity

SUB-TOPIC 2.9: Alert and error messages to ATSEP

2.9.1	Explain the importance of alert and error messages.	2	—
2.9.2	Describe different categories of two alert and error messages.	2	—

SUB-TOPIC 2.10 Alert and error messages to ATCO

2.10.1	Describe the structure of the data used in these types of message.	2	MSAW, conflict alert parameters
2.10.2	Explain alerts and error messages, and their importance from an ATCO point of view.	2	e.g. MSAW, conflict alert, MTCD

A 6 – Training Objectives for a Qualification Training Course on System Monitoring & Control

SUBJECT 1: COMMUNICATION VOICE

TOPIC 1: AIR-GROUND

SUB-TOPIC 1.1: Controller working position

1.1.1	Describe the most common features of a controller working position.	2	Frequency selection, emergency, station selection, coupling, headset, loudspeaker, footswitch, push to talk, e.g. microphone (noise cancelling), short time recording

TOPIC 2: GROUND-GROUND

SUB-TOPIC 2.1: Interfaces

2.1.1	Describe the different types of interfaces.	2	Analogue (2, 4, 6 and 8 wires), digital ISDN (64 Kb, 2 Mb)

SUB-TOPIC 2.2: Switch

2.2.1	State the similarities between ground-ground and air-ground switches.	1	Switching techniques
2.2.2	Describe the most commonly used functionality of PABX.	2	General architecture, digital, analogue, multiplex types, PCM30
2.2.3	Analyze conversion analogue-digital, digital-analogue.	4	General architecture, analogue-digital-analogue

SUB-TOPIC 2.3: Controller working position

2.3.1	Describe the two most common features of a controller working position and the HMI.	2	—

SUBJECT 2: COMMUNICATION DATA

TOPIC 1: NETWORKS

SUB-TOPIC 1.1: Network technologies

1.1.1	State emerging network technologies.	1	e.g. as used in EAN, NEAN, AMHS, PENS
1.1.2	Describe the characteristics of the current networks.	2	Surveillance data, flight plan data and AIS networks e.g. CIDIN, , quality of service, architecture, , AMHS

TOPIC 2: GLOBAL NETWORKS

SUB-TOPIC 2.1: Networks and standards

2.1.1	List the global networks and the standards on which they are based.	1	e.g. ICAO for AFTN/CIDIN/AMHS, ICAO for ATN, FANS 1 and FANS A for ACARS applications (SITA and ARINC)

SUB-TOPIC 2.2: Description

2.2.1	Describe the characteristics of the AFTN networks.	2	Users and data, architectures, quality of service

SUB-TOPIC 2.3: Global architecture

2.3.1	Describe the architecture of the ATN.	2	Air-ground subnetworks, ground-ground subnetworks, airborne networks

SUB-TOPIC 2.4: Air-ground subnetworks

2.4.1	Describe air-ground subnetworks.	2	VDL (Mode 2), HFDL, AMSS, SATCOM

SUB-TOPIC 2.5: Ground-ground subnetworks

2.5.1	Describe the composition of ground-ground subnetworks.	2	PTT, commercial telecom providers, ARINC, SITA

SUB-TOPIC 2.6: Air-ground applications

2.6.1	State the main communication applications using data link systems.	1	e.g. CPDLC, DLIC/AFN, ATIS, DCL

SUBJECT 3: COMMUNICATION RECORDERS

TOPIC 1: LEGAL RECORDERS

SUB-TOPIC 1.1: Regulations

1.1.1	Explain international regulations.	2	ICAO (recording and reproducing)
1.1.2	Explain national regulations.	2	Appropriate national regulations
1.1.3	Explain how the service provider complies with the regulations.	2	e.g. storage media, access to recording and reproducing room, time to store information (overwrite/erase voice or data), procedure to reproduce information

SUB-TOPIC 1.2: Principles

1.2.1	Explain the principles of recording and reproducing.	2	e.g. storage media (tape, optical and magnetic disc), A/D-D/A converters, frequency range (300 to 3 400 Hz), channel capacity, time synchronization, connection to a network, synchronization of radar and voice recording, replay limitations

SUBJECT 4: NAVIGATION — PBN

TOPIC 1: NAV CONCEPTS

SUB-TOPIC 1.1: NOTAM

1.1.1	Explain the need for NOTAMs.	2	—

SUBJECT 5: NAVIGATION — GROUND-BASED SYSTEMS-NDB

TOPIC 1: NDB LOCATOR

SUB-TOPIC 1.1: Use of the system

1.1.1	Appreciate the principles of NDB.	3	Relative bearing, measuring method
1.1.2	Describe the overall performance.	2	Coverage, accuracy, availability of the system, integrity, continuity
1.1.3	Explain the technical limitations of NDB.	2	Lack of accuracy, lack of integrity, sensitivity to interference
1.1.4	Describe the current situation.	2	e.g. number, type, users, user groups, regional context

SUBJECT 6: NAVIGATION — GROUND-BASED SYSTEMS-DF

TOPIC 1: DF

SUB-TOPIC 1.1: Use of the system

1.1.1	State the different types of DF.	1	VDF, DDF, IDF
1.1.2	Describe the user HMI.	2	Indication on radar picture, DF indicator
1.1.3	Appreciate the principles of DF.	3	Bearing, measuring method (standard, Doppler, interferometry)
1.1.4	Describe the overall performance.	2	Coverage, accuracy, availability of the system, integrity, continuity

1.1.5	Explain the technical limitations of DF.	2	Sensitivity to interference
1.1.6	Describe the current situation.	2	e.g. number, type, users, national context

SUBJECT 7: NAVIGATION — GROUND-BASED SYSTEMS-VOR

TOPIC 1 VOR

SUB-TOPIC 1.1: Use of the system

1.1.1	State the types of VOR Systems.	1	Conventional, doppler
1.1.2	Describe the overall performance.	2	Coverage, accuracy, availability of the system, integrity, continuity
1.1.3	Explain the technical limitations of CVOR.	2	Type of information (azimuth), accuracy, integrity, suitable for a network of fixed routes
1.1.4	Appreciate the differences between CVOR and DVOR.	3	Signal broadcast differences, bearing information robustness
1.1.5	Describe the current situation.	2	e.g. number, type, users, user groups, national context, regional context

SUBJECT 8: NAVIGATION — GROUND-BASED SYSTEMS-DME

TOPIC 1: DME

SUB-TOPIC 1.1: Use of the system

1.1.1	Describe the overall performances for DME.	2	Coverage, accuracy, availability of the system, integrity, continuity, number of users
1.1.2	Explain the limitations of DME.	2	Accuracy, integrity, capacity
1.1.3	Describe the current situation.	2	e.g. number, types, users, user groups, national context, regional context
1.1.4	State the role of the DME infrastructure in the future navigation applications.	1	PBN
1.1.5	Explain the differences between DME and TACAN for civilian use.	2	e.g. azimuth and range

SUBJECT 9: NAVIGATION — GROUND-BASED SYSTEMS-ILS

TOPIC 1: ILS

SUB-TOPIC 1.1: Use of the system

1.1.1	Describe the overall performances for ILS.	2	ICAO Annexes 10 and 14 Coverage, accuracy, availability of the system, integrity, continuity, number of users
1.1.2	Explain the technical limitations of ILS.	2	ICAO Annexes 10 and 14 Only 40 channels, no segmented paths of approach, beam corruption due to multi-path
1.1.3	Interpret ILS Facility Performance Categories.	5	ICAO Annexes 10 and 14 CAT I, CAT II, CAT III Different operational category depending on operational minima, equipment and airport facilities
1.1.4	Define obstacle free zones for ILS components.	1	ICAO Annexes 10 and 14 Dimensions e.g. national regulations
1.1.5	Explain the importance and need for ILS obstacle free zones.	2	ILS beam protection, increased significance during LVP conditions
1.1.6	Explain the current situation	2	e.g. number, type, users, national context
1.1.7	Consider the need for ATC ILS status indications.	2	No continuous monitoring by ATSEP

SUBJECT 10: SURVEILLANCE — PRIMARY

TOPIC 1: ATC SURVEILLANCE

SUB-TOPIC 1.1: Use of PSR for Air Traffic Services

1.1.1	Describe the operational requirements of an en-route or an approach PSR	2	Range, resolution, coverage, availability

SUBJECT 11: SECONDARY SURVEILLANCE

TOPIC 1: SSR AND MSSR

SUB-TOPIC 1.1: Use of SSR for Air Traffic Services

1.1.1	Describe the operational requirements of an en-route or an approach SSR.	2	Range, coverage, resolution, performance, update rate ICAO Doc 9924

TOPIC 2: MODE S

SUB-TOPIC 2.1: Introduction to Mode S

2.1.1	Explain the need for and benefits of Mode S.	2	Classical SSR limitations, resolution, accuracy, integrity, enhanced data (e.g. 25 ft resolution, aircraft ID, BDS information)
2.1.2	Explain the working principles of Mode S.	2	Mode S interrogation, Mode S reply, Mode S uplink and downlink capability, Mode S formats/protocols, ELS, EHS
2.1.3	Explain the complementary use of Mode S and conventional SSR.	2	Mode interlace pattern, operational use of all-call, roll-call
2.1.4	Explain Mode S implementation.	2	Elementary and enhanced surveillance, II and SI codes, use of BDS

TOPIC 3: MULTILATERATION

SUB-TOPIC 3.1: MLAT principles

3.1.1	Explain the MLAT system architecture.	2	Standards, transmitters and receivers, data processing/fusion, redundancy, performance, costs, timing solutions, etc.
3.1.2	Appreciate the principles of MLAT system.	3	Triangulation, coverage, position calculation e.g. SCAS
3.1.3	Describe how to operate the system.	2	Tracking, map creation and blanking
3.1.4	Describe testing possibilities for MLAT.	2	e.g. SASS-C

SUBJECT 12: SURVEILLANCE — HMI

TOPIC 1: HMI

SUB-TOPIC 1.1: ATCO HMI

1.1.1	Describe the display types available.	2	Video, synthetic, mixed
1.1.2	State the type of selections available.	1	Source, range, maps, filters
1.1.3	Describe the advantages of different display types.	2	Clarity, configurability, fallback, data integration

SUBJECT 13: SURVEILLANCE — DATA TRANSMISSION

TOPIC 1: SURVEILLANCE DATA TRANSMISSION

SUB-TOPIC 1.1: Technology and protocols

1.1.1	Describe the implementation of formats and protocols.	2	Network protocols, surveillance data networks e.g. RADNET, messages CAT 1+
1.1.2	Decode ASTERIX messages.	3	e.g. categories 1, 2, 20, 21, 34, 48, and 62
1.1.3	Identify the data transmission architecture in a multi sensor environment.	3	Fault tolerance, redundancy of line equipment e.g. software fallback capability, contingency of service, RADNET
1.1.4	Characterize the degradations of the surveillance transmission network.	2	e.g. saturation, excess latency

SUBJECT 14: DATA PROCESSING — DPS SYSTEMS

TOPIC 1: USER REQUIREMENTS

SUB-TOPIC 1.1: Controller requirements

1.1.1	Explain ATCO missions and services needed in an area control center.	2	Operational requirements e.g. separation, flight progress monitoring and coordination, trajectory prediction, coordination with adjacent centers
1.1.2	Explain ATCO missions and services needed in an approach control unit.	2	Operational requirements e.g. vectoring, sequencing, AMAN, CDM
1.1.3	Explain ATCO missions and services needed in an aerodrome control tower.	2	Operational requirements e.g. runway management, DMAN

SUB-TOPIC 1.2: Trajectories, prediction and calculation

1.2.1	State different types of trajectories.	1	e.g. FPL-based, surveillance data-based, FMS-based
1.2.2	Explain the main processes for trajectory prediction.	2	SDP trajectory, FPL trajectory, merged trajectory, predicted trajectory

SUB-TOPIC 1.3: Ground safety nets

1.3.1	Describe the function of safety nets and their legal status.	2	STCA, APW, MSAW, ASMGCS-based safety nets

SUB-TOPIC 1.4: Decision support

1.4.1	Explain the major steps in the air traffic planning process.	2	ATFCM with strategic, pre-tactical and tactical, ATC sector planning, tactical control
1.4.2	Explain the principles of trajectory prediction, conformance monitoring and medium-term conflict detection processes.	2	Route adherence monitoring e.g. CORA, MTCD, CLAM, level adherence monitoring
1.4.3	Explain the benefit of these tools for safety and efficiency.	2	—

SUBJECT 15: DATA PROCESSING — DATA PROCESS

TOPIC 1: HARDWARE PLATFORM

SUB-TOPIC 1.1: Equipment upgrade

1.1.1	Explain the key factors that have to be considered when data processing equipment is upgraded or changed.	2	Specification, compatibility, 'proven' or 'state-of-the art' technology, maintenance and operating consequence (e.g. personnel, training, spares, procedures), environmental requirements (e.g. size, power requirements, temperature, interfaces), testing

SUB-TOPIC 2.2: COTS

2.2.1	Explain the advantages and disadvantages of commercial off-the-shelf equipment.	2	Cost, multiplicity of suppliers, quality, maintainability, life cycle, liability

SUB-TOPIC 2.3: Interdependence

2.3.1	Describe the technical issues regarding the interdependence of various equipment and systems.	2	Interface requirements, common point of failure, data conditioning, response time

SUBJECT 16: DATA PROCESSING — DATA

TOPIC 1: DATA ESSENTIALS FEATURES

SUB-TOPIC 1.1: Data significance

1.1.1	Explain the significance of data.	2	Criticality (critical/non-critical), legality (ICAO, CAA, organizations), use (advisory, control)

SUB-TOPIC 1.2: Data configuration control

1.2.1	Explain the control procedures for changes to operational data.	2	Designated roles/persons for authorizing changes and verifying/checking changes

SUB-TOPIC 1.3: Data standards

1.3.1	Name the authority responsible for standards.	1	
1.3.2	State the standards related to ATM data, their sources and their status.	1	e.g. ASTERIX, WGS84, OLDI, FMTP, AMHS, ADEX-P, FPL,
1.3.3	Decode a typical OLDI message.	3	e.g. ACT, PAC
1.3.4	State the nature of ATM processing requirements.	1	Data volatility (e.g. radar), system integrity consequence of failure

SUBJECT 17: SMC — ANS STRUCTURE

TOPIC 1: ANSP ORGANIZATION AND OPERATION

SUB-TOPIC 1.1: ANSP organization and operation

1.1.1	Describe the SMC function within the organization.	2	What the SMC does, interfaces with other functions, similarities and major differences between SMC function at different sites
1.1.2	Describe the structure, roles and responsibilities of the SMC team and any direct interfaces.	2	—
1.1.3	Explain the duties of the ATC supervisor.	2	—

TOPIC 2: ANSP MAINTENANCE PROGRAMME

SUB-TOPIC 2.1: Policy

2.1.1	Describe, in general terms, the ANSP maintenance policy.	2	—
2.1.2	Describe the aspects of the maintenance policy that apply specifically to SMC.	2	—

TOPIC 3: ATM CONTEXT SUB-

SUB-TOPIC 3.1: ATM Context

3.1.1	Describe the ATM requirements and the related services provided by the SMC.	2	Service level agreements, working arrangements e.g. ASM, ATFCM

TOPIC 4: ANSP ADMINISTRATIVE PRACTICES

SUB-TOPIC 4.1: Administration

4.1.1	Describe any ANSP administrative procedures, specifically applicable to SMC.	2	Any non-technical practices e.g. security, access control (building and platform), safety, fire

SUBJECT 18: SMC — ANS SYSTEM/EQUIPMENT

TOPIC 1: OPERATIONAL IMPACTS

SUB-TOPIC 1.1: Degradation or loss of system/equipment services

1.1.1	Describe the importance of monitoring system performance.	2	—
1.1.2	Describe possible ways in which the SMC may become aware of degradation of services and/or systems.	2	e.g. monitoring systems, telephone calls, aural alerts, user complaint
1.1.3	Take account of the end users/customers affected.	2	e.g. ATC Units, airports, airlines
1.1.4	Appreciate the implications for end users/customers.	3	—
1.1.5	Appreciate the appropriate actions to restore service.	3	e.g. switching, replacing, reconfiguration, calling external service provider
1.1.6	Appreciate the need for appropriate communication before and after restoring	3	e.g. users, customers, external and internal providers
1.1.5	Appreciate the appropriate actions to restore service.	3	e.g. switching, replacing, reconfiguration, calling external service provider
1.1.6	Appreciate the need for appropriate communication before and after restoring	3	e.g. users, customers, external and internal providers

TOPIC 2: USER POSITION FUNCTIONALITY AND OPERATION

SUB-TOPIC 2.1 User working position

2.1.1	Appreciate working position performance to agreed parameters.	3	e.g. ATCO, Met, ATSEP, airport positions

SUB-TOPIC 2.2: SMC working position

2.2.1	Appreciate SMC working position performance to agreed parameters.	3	—

SUBJECT 19: SMC — TOOLS, PROCESSES AND PROCEDURES

TOPIC 1: REQUIREMENTS

SUB-TOPIC 1.1: SMS

1.1.1	Describe the ICAO and regional requirements and the national and ATSP SMS.	2	ICAO Annex 19, regional requirements

SUB-TOPIC 1.2: QMS

1.2.1	Describe the quality management system requirements	2	e.g. ISO, EFQM

SUB-TOPIC 1.3: SMS application in the working environment

1.3.1	Describe the relationship between the SMS and the application of SMC.	2	Reporting procedures
1.3.2	Explain which occurrences require incident reporting and follow-up action(s).	2	e.g. national categories for reporting, safety event processing
1.3.3	Apply incident reporting procedures to example occurrence(s).	3	e.g. safety event procedure

TOPIC 2: MAINTENANCE AGREEMENTS WITH OUTSIDE AGENCIES REQUIREMENTS

SUB-TOPIC 2.1: Principles of agreements

2.1.1	Describe the principles and need for maintenance agreements.	2	e.g. types of service level provided

2.1.2	Describe within which functional areas maintenance agreements	2	e.g. network providers, facilities management, communications
2.1.3	Describe where in the SMS manual these agreements are included or referenced.	2	—

TOPIC 3: SMC GENERAL PROCESSES

SUB-TOPIC 3.1: Roles and responsibilities

3.1.1	Describe the role and general method of operations of the SMC.	2	—
3.1.2	Describe the need to monitor service conditions and the way to take appropriate action to ensure service performance.	2	e.g. process to interrupt services for planned maintenance purposes, management of service provision during corrective maintenance, continuity of service, availability
3.1.3	Describe the coordination role of the SMC.	2	e.g. ATSEP, ATCOs, external service providers, ATM stakeholders
3.1.4	Describe how risk analysis can contribute towards decision-making.	2	e.g. assessing risk, handling of service interventions

TOPIC 4: MAINTENANCE MANAGEMENT SYSTEMS

SUB-TOPIC 4.1: Reporting

4.1.1	Describe how maintenance activities and SMC events/actions are recorded.	2	e.g. procedures to follow, terminology to use, record keeping for traceability
4.1.2	Explain the importance of accurate record keeping and dissemination for handover and quality management purposes.	2	e.g. information is logged in database or report is generated and distributed according to defined procedures

SUBJECT 20: SMC — TECHNOLOGY

TOPIC 1: TECHNOLOGIES AND PRINCIPLES SUB-

TOPIC 1.1: General

1.1.1	Describe the principles of control and monitoring systems used.	2	e.g. national basis, colour codes, ergonomics

SUB-TOPIC 1.2: Communication

1.2.1	Describe the key aspects of control and monitoring system capability.	2	e.g. parameters presented to the SMC and types of actions that can be taken
1.2.2	Appreciate the impact of the replacement of components in a communication chain.	3	Continuity of service, communication chain integrity

SUB-TOPIC 1.3: Navigation

1.3.1	Describe the key aspects of control and monitoring system capability.	2	e.g. parameters presented to the SMC and types of actions that can be taken
1.3.2	Appreciate the impact of the replacement of components in navigation equipment.	3	Continuity of service, navigation aid integrity

SUB-TOPIC 1.4 Surveillance

1.4.1	Describe the key aspects of control and monitoring system capability.	2	e.g. parameters presented to the SMC and types of actions that can be taken
1.4.2	Appreciate the impact of the replacement of components in a surveillance chain.	3	Continuity of service, surveillance chain integrity

SUB-TOPIC 1.5: Data processing

1.5.1	Describe the key aspects of control and monitoring system capability.	2	e.g. parameters presented to the SMC and types of actions that can be taken
1.5.2	Appreciate the impact of the replacement of components in data processing chain	3	Continuity of service, data processing, chain integrity

SUB-TOPIC 1.6: Facilities

1.6.1	Describe the key aspects of system management capability.	2	e.g. parameters presented to the SMC and types of actions that can be taken
1.6.2	Appreciate the impact of the loss of supply and/or replacement of components in facility equipment.	3	Continuity of service, integrity

A 7 – Training Objectives for a Qualification Training Course on Infrastructure

SUBJECT 1: POWER SUPPLY

TOPIC 1: POWER DISTRIBUTION

SUB-TOPIC 1.1: Introduction

1.1.1	Describe the power distribution system at a typical site.	2	Commercial net, UPS, engine generator set, battery stations, redundancy, solar systems.
1.1.2	Design the block diagram of the power distribution system at a	4	Components.

SUB-TOPIC 1.2: Safety

1.2.1	Explain any appropriate local and ICAO regulation in force.	2	Company rules.
1.2.2	Discuss the precautions to be taken when working on power equipment.	5	High voltage, earthling techniques, personal safety, precaution to take to handle batteries.

TOPIC 2: UPS (Uninterruptible Power Supply)

SUB-TOPIC 2.1: Design and operational requirements

2.1.1	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.
2.1.2	Design a block diagram of a UPS.	4	Inputs/outputs, rectifier, inverter, converter, static switch, control panel, filters, bypass, batteries.
2.1.3	Analyze and interpret the components and performances of a UPS.	4	Inputs/outputs, rectifier, inverter, converter, static switch, control panel, filters, bypass, batteries.
2.1.4	Check and troubleshoot an existing UPS.	3	Monitoring, maintenance, periodic testing.

TOPIC 3: ENGINE GENERATOR SET (Genset)

SUB-TOPIC 3.1: Design and operational requirements

3.1.1	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.
3.1.2	Design a block diagram of Genset system.	4	Engines, generator, control panel, power transfer switch, bypass, fuel system, air supply system and filters.
3.1.3	Analyze and interpret the components and performances of GenSet.	4	Engines, generator, control panel, power transfer switch, bypass, fuel system, air supply system and filters.

3.1.4	Check and troubleshoot an existing Genset.	3	Monitoring, maintenance, periodic testing.

TOPIC 4: BATTERIES AND BATTERY STATIONS

SUB-TOPIC 4.1: Design and operational requirements

4.1.1	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.
4.1.2	Design a block diagram of a battery station.	4	Batteries, connections (parallel, serial), chargers, types, characteristics.
4.1.3	Explain and analyze the main components and performances of batteries and battery station.	2	Batteries, connections (parallel, serial), chargers, types, characteristics.
4.1.4	Check and troubleshoot an existing battery station.	3	Monitoring, maintenance, periodic testing.

TOPIC 5: POWER SUPPLY NETWORK

SUB-TOPIC 5.1: Design and Operational Requirement

5.1.1	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.
5.1.2	Design a block diagram of a power supply network for a CNS/ATM system.	4	Fuses, circuit breakers, contactors, relays, measuring and protection devices, distribution boards.
5.1.3	Check and troubleshoot a power supply network.	3	Monitoring, maintenance, periodic testing.

TOPIC 6: SAFETY ATTITUDE AND FUNCTIONAL SAFETY

SUB-TOPIC 6.1: Safety attitude

6.1.1	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.

SUB-TOPIC 6.2: Functional safety

6.2.1	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 policy.

TOPIC 7: HEALTH AND SAFETY

SUB-TOPIC 7.1: Hazard awareness

7.1.1	Be aware of potential hazards to health and safety generated by power supply equipment.	0	Mechanical hazards, electrical hazards (HV/LV, EMI), chemical hazards.

SUB-TOPIC 7.2: Rules and procedures

7.2.1	State applicable international requirement.	1	Relevant international documents.
7.2.2	State any applicable legal national requirement.	1	Relevant national documents.
7.2.3	State safety procedure for the persons working on or near power supply equipment.	1	Isolation (clothing, tools), fire extinction types, safety manual presence, safety interlocks, isolating switches, security of the site, climbing procedures.

SUB-TOPIC 7.3: Practical situation

7.3.1	In a practical situation, apply and demonstrate the procedures and techniques to be followed.	2	e.g. Replacing fuses or boards, startup/shut down a station, climbing procedures.

SUB-TOPIC 7.4: Resuscitation techniques

7.3.1	Apply and demonstrate resuscitation techniques.	2	First aid, rescue procedures, resuscitation.

TOPIC 8: Air Conditioning

SUB-TOPIC 8.1: Cooling

8.1.1	Explain the importance of cooling for CNS/ATM system.	1	Operational and technical point of view.
8.1.2	Check and troubleshoot a cooling system.	3	Monitoring, maintenance, periodic testing.

SUB-TOPIC 8.2: Heating

8.2.1	Explain the importance of heating for air conditioning systems.	1	Operational and technical point of view.
8.2.2	Check and troubleshoot a heating system.	3	Monitoring, maintenance, periodic testing.

SUB-TOPIC 8.3: Fresh Air Supply

8.3.1	Explain the importance of fresh air supply for air conditioning systems.	1	Operational and technical point of view.
8.3.2	Check and troubleshoot a cooling system.	3	Monitoring, maintenance, periodic testing.

A 8 – Training Objectives for a Qualification Training Course on Engineering

SUBJECT 1: ENGINEERING

TOPIC 1: INTRODUCTION

SUB-TOPIC 1.1: Needs for Engineering

1.1.1	Define the role of engineering in an ANSP.	1	—

SUB-TOPIC 1.2: Engineering basics

1.2.1	Describe the importance of engineering standards and procedures.	2	—
1.2.2	Describe Engineering Quality Management.	2	—
1.2.3	Describe Engineering Standards.	2	—
1.2.4	Describe the Equipment Life Cycle.	2	—

TOPIC 2: SAFETY

SUB-TOPIC 2.1: Lab Safety Procedures

2.1.1	Describe Safety procedures	2	—

SUB-TOPIC 2.2: Personnel/Equipment Safety Procedures

2.2.1	Describe personnel safety.	2	—

SUB-TOPIC 2.3: Electrostatic Discharge Precautions

2.3.1	Describe safety equipment.	2	—
2.3.2	Describe fire and emergency procedures.	2	—

SUB-TOPIC 2.4: Fire and Emergency Procedures

2.4.1	Describe electrostatic discharge.	2	—
2.4.2	Describe fire and emergency procedures.	2	—

TOPIC 3: RESILIENCE

SUB-TOPIC 3.1: Resilience and safety

3.1.1	Take account of modelling state of the art approaches.	2	—

SUB-TOPIC 3.2: Applicable models

3.2.1	Take account of modelling state of the art approaches.	2	—

SUB-TOPIC 1.3: STAMP – Accident causation model

1.3.1	Take account of design and implement state of the art approaches.	2	—

SUB-TOPIC 3.4: Audit resilience in risk control and safety management systems

3.4.1	Take account of following resilient engineering concepts; Take account of modelling state of the art approaches of design and implement.	2	—
3.4.2	Take account of following resilient engineering concepts.	2	—

SUBJECT 2: REQUIREMENTS AND SPECIFICATIONS

TOPIC 1: DEFINING

SUB-TOPIC 1.1: Regulations

1.1.1	Describe the purpose of regulations.	2	—
1.1.2	Define regulations	1	—

SUB-TOPIC 1.2: Performance

1.2.1	Define specifications.	1	—
1.2.2	Balance / assess technical solutions.	5	—
1.2.3	Analyze requirements and project the utilization into operational environment.	4	—
1.2.4	Interpret needs and translate into specifications.	5	—

SUB-TOPIC 1.3: Maintenance

1.3.1	Define maintenance objectives.	1	—
1.3.2	Define maintenance requirement.	1	—
1.3.3	Define maintenance procedures.	1	—

SUB-TOPIC 1.4: Training

1.4.1	Define training requirement.	1	—
1.4.2	Organize training programs.	4	—
1.4.3	Organize training courses.	4	—
1.4.4	Assess training results.	5	—

TOPIC 2: INSTALLATION REQUIREMENTS

SUB-TOPIC 2.1: Human resources

2.1.1	Manage teams.	4	—

TOPIC 3: TRACE

SUB-TOPIC 3.1: Monitor evolution

3.1.1	Take account of legislation updates impacting mandatory.	2	—

SUBJECT 3: DESIGN

TOPIC 1: PROJECT MANAGEMENT

SUB-TOPIC 1.1: Design and planning

1.1.1	Demonstrate performing project management and estimate cost.	2	—
1.1.2	Describe design and planning.	2	—
1.1.3	Describe implementation phase.	2	—
1.1.4	State the various phases of an installation project.	1	—
1.1.5	Describe the Project Brief.	2	—

SUB-TOPIC 1.2: Problem reporting and change request

1.2.1	Describe problem reporting and change request.	2	—

SUB-TOPIC 1.3: Cost

1.3.1	Describe budgetary concerns.	2	—

SUB-TOPIC 1.4: Conception

1.4.1	Apply project management approaches.	3	Agile project management, Critical chain project management (CCPM), Event chain methodology, Extreme project management (XPM), Lean project management, PRINCE2, Process-based

SUB-TOPIC 1.5: Risk analysis

1.5.1	Identify risks.	3	—
1.5.2	Analyze risks.	4	—
1.5.3	Prevent and manage risks.	4	—

SUBJECT 4: VALIDATION AND TESTING

TOPIC 1: PERFORMANCE VALIDATION

SUB-TOPIC 1.1: Testing standards and frameworks

1.1.1	Apply standards and adapt frameworks.	3	—

SUB-TOPIC 1.2: Unit testing

1.2.1	Apply unit test plan.	3	—

SUB-TOPIC 1.3: Integration testing

1.3.1	Apply integration test plan.	3	—

SUB-TOPIC 1.4: System testing

1.4.1	Apply system test plan.	3	—

TOPIC 2: OPERATIONAL VALIDATION

SUB-TOPIC 2.1: Requirements compliance

2.1.1	Comply User requirements/system requirements/test results traceability.	4	—
2.1.2	Appreciate results.	3	—
2.1.3	Solve in line with state-of-the-art approaches.	5	—

SUBJECT 5: INSTALLATION

TOPIC 1: PLANIFICATION

SUB-TOPIC 1.1: 1) Describe Installation Preparation Activities

1.1.1	Describe how to configure installation items.	2	—
1.1.2	Describe installation instructions.	2	—
1.1.3	Describe installation standards & practices.	2	—
1.1.4	Describe spares and special tools.	2	—
1.1.5	Describe NOTAM.	2	—
1.1.6	Describe impact assessment	2	—

SUB-TOPIC 1.2: Explain the procurement process

1.2.1	Describe the requisition on supply.	2	—
1.2.2	Describe purchasing methods.	2	—
1.2.3	Describe budgetary concerns.	2	—

TOPIC 2: PHYSICAL INSTALLATION

SUB-TOPIC 2.1: Explain panel assembly

2.1.1	Describe AC power distribution.	2	—
2.1.2	Describe DC power distribution.	2	—
2.1.3	Describe AC ground.	2	—
2.1.4	Describe signal grounding.	2	—
2.1.5	Describe protective devices.	2	—
2.1.6	Describe RF cables and systems.	2	—
2.1.7	Describe antennas & structures.	2	—
2.1.8	Describe Control cables.	2	—
2.1.9	Describe Cross connections	2	—

SUB-TOPIC 2.2: Explain Rack Mechanical Assembly

2.2.1	Describe AC power distribution.	2	—
2.2.2	Describe DC power distribution.	2	—
2.2.3	Describe AC ground.	2	—
2.2.4	Describe signal grounding.	2	—
2.2.5	Describe protective devices.	2	—
2.2.6	Describe RF cables and systems.	2	—
2.2.7	Describe antennas & structures.	2	—
2.2.8	Describe Control cables.	2	—
2.2.9	Describe Cross connections.	2	—

SUB-TOPIC 2.3: Explain Rack Electrical Assembly

2.3.1	Describe AC power distribution.	2	—
2.3.2	Describe DC power distribution.	2	—
2.3.3	Describe AC ground.	2	—
2.3.4	Describe signal grounding.	2	—
2.3.5	Describe protective devices.	2	—
2.3.6	Describe RF cables and systems.	2	—

2.3.7	Describe antennas & structures.	2	—
2.3.8	Describe Control cables.	2	—
2.3.9	Describe Cross connections.	2	—

APPENDIX B

TRAINING OBJECTIVES TAXONOMY

B 1 – 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 shall 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
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

Verb	Definition	Example	Level
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
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

Verb	Definition	Example	Level
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
Analyze	Examine minutely the constitution of	Analyze the coverage of the radio system.	4
Assign	Allot as a share, make over	Assign take off number.	4
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

Verb	Definition	Example	Level
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 analyze 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
Discuss	Investigate by reasoning or argument	Discuss the distribution of integrity information through GALILEO.	5
Evaluate	Ascertain amount of, find numerical	Evaluate workload.	5
Extemporize	Produce without preparation, improvise	Extemporize phraseology in abnormal situations.	5

Verb	Definition	Example	Level
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

B 2 – Classes of skills

Skill	Examples
Intellectual skills	
Classifying Rule-using Discriminating Problem-solving	Distinguishes between average flight distance and average stage length. Identifies different classes of aircraft. Defines the concept of insurance. 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.