

## APPENDIX E

### GUIDELINES FOR THE PREPARATION OF A GNSS TRAINING PROGRAMME

#### 1. INTRODUCTION

1.1 The purpose of this document is to establish a training guide on the management and operation of GNSS systems in general, and on SBAS/GBAS in particular. The work and conclusions of the SACCSA Phase II and the experience of the early implementation of the GBAS prototype stations in the Regions were drawn upon in preparing this document. Accordingly, the following items have been established:

- To identify human resource requirements resulting from the implementation of GNSS systems in the CAR/SAM Regions.
- To determine the initial personnel qualification and training level needed in each of the elements in the SBAS/GBAS system.
- To establish a training programme, taking into account the existing training capacity in the region and the training requirements identified.

1.2 This document covers all of the objectives proposed, defining the training requirements for maintenance, supervision, and engineering personnel working in the GNSS system.

1.3 The training design process will consist of four basic phases:

Phase 1: Formulation of the mission and objective of GNSS systems.

Phase 2: Description of functions, which consists of:

- a) Identification of key tasks and activities of the system personnel.
- b) Grouping of tasks and activities in each function, thus establishing the positions required for the fulfilment of these tasks and activities.
- c) Grouping of positions in units and, grouping of units in bigger clusters, i.e. defining the functional structure of the system.

Phase 3: Baseline analysis, or, in other words, training levels to be initially held by technical personnel of the future GNSS augmentation service provider.

Phase 4: Lastly, design of the training activity, based on the functional structure of the SBAS/GBAS system, particularly focusing on:

- a) Tasks to be performed by the individual responsible for a specific position and degree of specialisation required,
- b) Skills and knowledge required to perform the aforementioned tasks,
- c) etc.

1.4 This document proposes a training plan to train the technical personnel on the optimum operation of the systems and tools that make up SBAS/GBAS systems in order to optimise their operation.

## 2. DISCUSSION

### 2.1 DESCRIPTION OF PROCESSES (FUNCTIONS)

2.1.1 GNSS (SBAS/GBAS) systems consist of the following segments:

- **Space Segment:** consists of the global coverage L-band navigation payload of GEO satellites (for SBAS), and will consist of the satellite constellation, providing distance data to aircraft receivers and the GBAS ground station.
- **Ground Segment:** which will control the SBAS and GBAS mission and will provide GPS satellite augmentation information.
- **User Segment:** which will consist of “SBAS standard” receivers or GBAS monitors to be used to verify signal-in-space services.
- **Support Segment:** which will consist of the platforms for the Validation and Qualification of system services.

2.1.2 Training requirements for the operation of the different system elements are mainly focused on the ground and support segments.

2.1.3 Ground Segment: is made up of the following elements:

- Reference Stations.
- Process and Control Centres, which contain:
  - A central processing unit.
  - A central control unit.
- Satellite Access Stations (SBAS).
- Ground Communications Network.

2.1.4 Support Segment: is made up of the following subsystems:

- User-level service analysis subsystem.
- Service analysis subsystem.
- End-to-end and service volume simulation subsystem.
- Filing and data access subsystem.

2.1.5 Each of these elements will require technical and maintenance personnel duly trained to perform a series of activities.

### 2.2 IDENTIFYING TASKS AND ACTIVITIES OF GROUND SEGMENT PERSONNEL

2.2.1 Among other activities this personnel may be called upon to perform are the following:

- Operation of equipment and systems of ground segment stations.
- Maintenance of ground segment equipment.
- Operation of communications between system stations / units.

2.2.2 In addition to these activities, coordination, planning, and management tasks will need to be performed, and this will require a specific position of responsibility.

## 2.3 IDENTIFYING TASKS AND ACTIVITIES OF SUPPORT SEGMENT PERSONNEL

2.3.1 In this case, the following tasks and activities could be considered:

- Training, operational validation, and certification, as necessary, on specific user and system applications.
- Development, maintenance and/or implementation of simulation tools.
- Tasks related to system data filing and analysis.
- Support to the operation and maintenance functions of the ground segment, and, above all, to system engineering and development functions.
- Tasks related to the interoperability between system elements.

## 2.4 MISSION OF WORK POSITIONS

2.4.1 Once the context of the activities involved in GNSS augmentation systems has been established, it will be advisable to determine the structure of the work positions to ensure an optimum performance of the corresponding tasks.

2.4.2 Next, and in very broad terms, is a description of the mission of each work position.

### 2.4.2.1 System Manager

The System Manager will be ultimately responsible for everything done by system personnel. His/her mission is to direct, coordinate, supervise, and establish performance guidelines for the efficient completion of system activities, in accordance with the development plans and the policies established by the service provider.

### 2.4.2.2 Ground Segment Manager

He/she is responsible for the operation of the GNSS system and his/her mission is to plan, control, and standardise CPCS, SAS, and ERS operation.

He/she may have personnel to assist in his/her tasks, thus creating “ground segment technical divisions”.

### 2.4.2.3 Local System Manager

The mission of the Local System Manager is to direct, coordinate, supervise, and establish performance guidelines for the activities of the local system under his/her responsibility, in accordance with the development plans and policies established by the GNSS augmentation service provider. He/she is ultimately responsible for achieving the objectives at the local level, as well as for implementing procedures and other directives issued by the different central units (support segment, quality and safety; and ground segment).

- **Maintenance personnel** → His/her mission is to perform maintenance on the systems installed. This maintenance will be level 0 (equipment reboot, power supply, acclimatisation and level 1 (replacing boards or components identified as defective). Since there is more than one local manager, they will be responsible for the corresponding maintenance area. An assessment will be made of the need to create a maintenance area for the support segment, or perhaps one of the areas located in one of the CPCS can support the support segment engineering area in performing maintenance tasks (based on future decisions as to the physical location of process and control centres).
- **Supervision personnel** → The system control and monitoring (the main functions of the UCC) teams will operate the system on 24H shifts.
- **Engineering personnel** → The mission of the engineering personnel will be, on one hand, the general coordination of maintenance (perform level 2 maintenance of ERS, and support level 0 and 1 maintenance) and operations; and, on the other hand, support the local unit (CPCS n manager).

#### 2.4.2.4 **Support Segment Manager**

His/her mission is to plan, coordinate, and manage the operation of the support segment elements in accordance with the commitments undertaken.

- **Data analysis personnel** → The mission of analysts is to operate all the tools (simulators and other analytical tools) built in the different support segment subsystems (see item 3, Description of Processes (functions) and conduct a first analysis of results and conclusions.
- **Engineering personnel** → The mission of engineering personnel will be to create study scenarios, analyse results obtained, propose modifications and arrive at conclusions related to the areas of action of the support segment. They could also participate in the maintenance of the equipment of the support segment subsystems, since the equipment consist of HW and SW. This area is also responsible for the detailed analysis of the results obtained by the analysis area and generating the action derived from it.

#### 2.4.2.5 **Safety and Quality System Manager**

He/she will be responsible for developing/implementing the Quality and Safety System, in accordance with quality/safety certifications required of the GNSS augmentation service provider, and for coordinating and being accountable for seeing through the objectives established in the quality and safety policies of the service provider.

## 2.5 WORK POSITION PROFILES

2.5.1 Once the functional structure has been defined, and the mission of the person responsible or the personnel in each of the proposed areas is known, it is possible to understand the scope of action of each of the aforementioned work positions and, therefore, to determine the minimum and/or desirable requirements in terms of training, knowledge, and experience for each of the work positions, as reflected in the following tables:

		GES <sup>1</sup>	ING <sup>2</sup>	OPS <sup>3</sup>
	TOPICS	NR <sup>4</sup>	NR	NR
<b>Specific Training</b>				
Legend: 0: No specific training required 1: Basic level required 2: Advanced level required 3: Expert level required	Air Nav. & ATC	2	2	1
	Propagation of electromagnetic waves	1	2	0
	Electrical facilities	1	2	2
	Radar and aids	1	1	0
	Satellite navigation	2	2	1
	Augmentation programmes	2	2	1
	Quality systems	2	0	0
	Safety management systems	2	0	0
	Auditing	2	0	0
	GNSS	0	2	0
	Prevention of labour risks	0	0	1
	Environment	0	0	0
	ATC systems and operations	0	1	2
<b>Prior Technical Experience</b>				
Legend: 0: No specific experience required 1: 1-3 years 2: 3-5 years 3: More than 5 years	In the GNSS field	1	2	1
	In Air. Nav. or ATC	2	0	0
	Level of knowledge of augmentation programmes *	1	0	0
	Quality systems	1	0	0
	Safety systems (implementation and management)	1	1	0
	Experience in performing audits *	1	0	0
	Control and monitoring of operations in the satellite control centres	0	2	0
	Control and monitoring of operations in network infrastructure	0	2	0
	Control and monitoring of operations in fixed and mobile communications	0	2	0
	Control and monitoring of operations in other fields	0	1	0
	Maintenance (preventive and corrective) in the aeronautical field	0	1	2
	Operation of critical systems	0	1	2
	Use of identification, analysis, and retrieval equipment	0	2	2
	Definition/design of technical procedures	0	2	0
	Definition and drafting of technical manuals	0	2	0
Data processing, analyses, drawing of conclusions and def. of work plans	0	2	0	

<sup>1</sup> GES: Management personnel

<sup>2</sup> ING: Engineering personnel

<sup>3</sup> OPS: Operations/ maintenance personnel

<sup>4</sup> NR: Minimum recommended level

\* Apply the legend on the degree of knowledge (From 0:None to 3:Expert)

	Tasks related to the operation and supervision of aeronautical systems and equipment	0	0	2
<b>Prior managerial experience</b>				
Legend: 0: No specific experience required 1: 1-3 years 2: 3-5 years 3: More than 5 years	Equipment management	3	1	0
	Budget management	3	0	0
	Infrastructure management	3	0	0
	Negotiation	3	1	0
	Planning	3	1	0
	National and international coordination	2	1	0
	Technical project management	2	0	0
	Process reengineering	1	0	0
<b>Office software</b>				
Legend: 1: User 2: Advanced	MS Word	1	1	1
	MS Excel	2	1	1
	MS Access	1	1	1
	MS Power Point	1	1	1
	MS Project	2	1	1
	Internet and e-mail	2	1	1
	Database managers	1	2	1
<b>Languages</b>				
Legend: ICAO Level: 2, 3, 4 6 5	Level of English (ICAO)	4	3	2

**Table A1: Requirements for candidates to work positions generated in SBAS/GBAS systems**

Position	Candidate requirements	Level <sup>5</sup>
SBAS/GBAS system manager	Degree in telecommunications or airspace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Satellite navigation	N
	▪ Electromagnetic wave propagation	D
	▪ Electrical facilities	N
	▪ Radar and aids	D
	▪ GNSS	D
	▪ Augmentation programmes	D
	At least 3 years of managerial experience in similar units.	N
	Quality system management experience.	D
	Safety management experience.	N
	At least 3 years of experience in the GNSS field.	D
	Knowledge of office software, database managers, and planning tools.	N
High level of English, both spoken and written. ICAO (operational) level 4 required.	N	

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D: Desirable

N: Required in order to perform the job with sufficient guarantee

Safety and quality system manager	Degree in aerospace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Electromagnetic wave propagation	D
	▪ Electrical facilities	D
	▪ Radar and aids	D
	▪ GNSS	D
	▪ Augmentation programmes	D
	Experience in quality system management	N
	Experience in safety management	N
	At least 3 years of experience in the GNSS field	D
	Knowledge of Office software package	N
High level of English, both spoken and written. ICAO (operational) level 4 required.	N	
Ground segment manager	Degree in telecommunications or aerospace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Electromagnetic wave propagation	N
	▪ Electrical facilities	N
	▪ Radar and aids	N
	▪ GNSS	N
	▪ Augmentation programmes	N
	Experience in the operation of critical systems	N
	At least 3 years of experience in the GNSS field	D
	Knowledge of the Office package and database management tools	N
	High level of English, both spoken and written. ICAO (operational) level 4 required.	N
Support segment manager	Degree in telecommunications or aerospace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Electromagnetic wave propagation	D
	▪ Electrical facilities	D
	▪ Radar and aids	D
	▪ GNSS	N
	▪ Augmentation programmes	N
	Experience in safety management	D
	At least 3 years of experience in the GNSS field	D
	Knowledge of Office software and database management tools.	N
	High level of English, both spoken and written. ICAO (operational) level 4 required.	N
Local system manager	Degree in telecommunications or aerospace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Satellite navigation	N
	▪ Electromagnetic wave propagation	N
	▪ Electrical facilities	N
	▪ Radar and aids	N
	▪ GNSS	N
	▪ Augmentation programmes	N
	At least 3 years of managerial experience in units of similar size	N
Experience in quality system management	D	

	Experience in safety management	D
	At least 3 years of experience in the GNSS field	D
	Knowledge of office software, database managers, and planning tools	N
	High level of English, both spoken and written. ICAO (operational) level 4 required.	N
Data analysis team	Intermediate degree in telecommunications or airspace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Electromagnetic wave propagation	N
	▪ Electrical facilities	D
	▪ Radar and aids	D
	▪ Satellite navigation	D
	▪ Significant knowledge of operational aid tools	N
	Security Management experience.	D
	At least 3 years of experience in the field of GNSS.	D
	Knowledge of Office software, as well as database management tools	N
	High level of English, both spoken and written. ICAO level 3 required.	N
Support segment engineering team	Degree in telecommunications or airspace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Electromagnetic wave propagation	N
	▪ Electrical facilities	D
	▪ Radar and aids	D
	▪ Satellite navigation	N
	Experience in safety management	D
	At least 3 years of experience in the GNSS field	N
	Knowledge of Office software, as well as database management tools	N
	High level of English, both spoken and written. ICAO level 3 required.	N
Maintenance team	Intermediate degree as maintenance technician, with specific training in:	N
	▪ Air navigation	N
	▪ Electromagnetic wave propagation	D
	▪ Electrical facilities	D
	▪ Radar and aids	D
	▪ Satellite navigation	N
	Knowledge of Office software, as well as database management tools	N
	High level of English, both spoken and written. ICAO level 3 required.	N
Supervision team	Intermediate degree in telecommunications or airspace engineering, or equivalent, with specific training in:	N
	▪ Air navigation	N
	▪ Electromagnetic wave propagation	N
	▪ Electrical facilities	D
	▪ Radar and aids	D
	▪ Satellite navigation	N
	Knowledge of Office software, as well as database management tools	N
	Intermediate level of English, both spoken and written. ICAO level 2 required.	N
Ground segment engineering team	Degree in telecommunications or airspace engineering, or any other like degree, with specific training in:	N



	▪ Air navigation	N
	▪ Electromagnetic wave propagation	N
	▪ Electrical facilities	D
	▪ Radar and aids	D
	▪ Satellite navigation	N
	Experience in safety management	D
	At least 3 years of experience in the GNSS field	N
	Knowledge of Office software, as well as database management tools	N
	High level of English, both spoken and written. ICAO level 3 required.	N

**Table A2: Requirements for candidates to work positions generated by SBAS/GBAS systems**

## 2.6 REQUIRED TRAINING CYCLE

2.6.1 The last phase of the process is the description of the training cycle, understood as a series of training activities to be carried out by individuals who, from the three groups analysed, would be the most appropriate candidates for the job positions previously described.

Training activity	Job Position <sup>6</sup>									
	G1	G2	G3	G4	GL	I1	I2	O1	O2	O3
Course on satellite navigation and augmentation programmes	2	2	2	2	2	2	2	1	1	1
Course on the SBAS/GBAS system	2	2	2	2	2	2	2	1	1	1
Satellite communications	1	1	1	1	1	2	2	1	1	1
Operation and maintenance of SBAS/GBAS reference stations	0	0	0	0	0	2	2	2	2	2
Operation and maintenance of satellite access stations (SAS) (SBAS)	0	0	0	0	0	2	2	2	2	2
Operation and maintenance of SBAS/GBAS process and control centres	0	0	0	0	0	2	2	2	2	2
On-the-job safety and health	1	1	1	1	1	1	1	2	2	2
Competency-based management system	2	2	2	2	2	1	1	0	0	0
Course on measuring instruments	0	0	0	0	0	0	0	2	2	2
Course on quality systems	2	2	2	2	2	1	1	0	0	0
Course on safety management	2	2	2	2	2	1	1	0	0	0
2   Advanced Level	1	Basic Level		0	N/A					

**Table A3: Training activities proposed for the different groups**

<sup>6</sup>

G1	→	SBAS/GBAS System Manager
G2	→	Support Segment Manager
G3	→	Ground Segment Manager
G4	→	Quality and Safety System Manager
GL	→	Local Manager
I1	→	Support Segment Engineering Personnel
I2	→	Ground Segment Engineering Personnel
O1	→	Data Analysis Personnel
O2	→	Supervision Personnel
O3	→	Maintenance Personnel

2.6.2 The following possible modalities are proposed for these training activities:

- **On-line or CBT Courses:** These CBTs will be classified according to their duration:
- **In-person P Courses:** These classroom courses can be delivered either in the conventional form, with a teacher and the students in a classroom, or the teacher conducting the course for the students through satellite communication.

2.6.3 Taking into account these modalities, it is proposed that the aforementioned activities be carried out as described in the following tables.

2.6.4 The tables have been divided by training activity, defining the need to carry out the activity in one, two, or three courses (C1, C2 or C3), with different scopes. These courses can be taught on-line, in-person, or a combination of both.

2.6.5 Likewise, different levels of detail have been determined for each course: basic and advanced.

2.6.6 Furthermore, a recurrent element has been identified (at least once a year) to ensure an appropriate level of knowledge throughout the life of the SBAS/GBAS system.

Course on Satellite Navigation and Augmentation Programmes						
Course	C 1		C 2		C 3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	CBT	CBT	CBT	CBT	NA	NA
In-person	P	P	P	P	NA	NA
Recurrent	CBT	CBT	CBT	CBT	NA	NA

**Table B1: Course on Satellite Navigation and Augmentation Programmes**

Course on the SBAS/GBAS System						
Course	C 1		C 2		C 3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	CBT	CBT	NA	NA	NA	NA
In-person	P	P	NA	NA	NA	NA
Recurrent	CBT	CBT	NA	NA	NA	NA

**Table B2: Course on the SBAS/GBAS System**

Satellite Communications						
Course	C 1		C 2		C 3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	CBT	CBT	NA	NA	NA	NA
In-person	P	P	NA	NA	NA	NA
Recurrent	CBT	CBT	NA	NA	NA	NA

**Table B3: Satellite Communications**

Operation and Maintenance of SBAS/GBAS Reference Stations						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	NA	CBT	NA	CBT	NA	NA
In-person	NA	P	NA	P	NA	NA
Recurrent	NA	CBT	NA	CBT	NA	NA

**Table B4: Operation and Maintenance of SBAS/GBAS Reference Stations**

Operation and Maintenance of Satellite Access Stations (SAS)						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	NA	CBT	NA	CBT	NA	NA
In-person	NA	P	NA	P	NA	NA
Recurrent	NA	CBT	NA	CBT	NA	NA

**Table B5: Operation and Maintenance of Satellite Access Stations (SAS)**

Operation and Maintenance of SBAS/GBAS Process and Control Centres						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	NA	CBT	NA	CBT	NA	CBT
In-person	NA	P	NA	P	NA	P
Recurrent	NA	CBT	NA	CBT	NA	CBT

**Table B6: Operation and Maintenance of SBAS/GBAS Process and Control Centres**

On-the-job safety and health						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	CBT	CBT	NA	NA	NA	NA
In-person	NA	NA	NA	NA	NA	NA
Recurrent	CBT	CBT	NA	NA	NA	NA

**Table B7: On-the-job safety and health**

Competency-based management system						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	NA	NA	NA	NA	NA	NA
In-person	P	P	NA	NA	NA	NA
Recurrent	NA	NA	NA	NA	NA	NA

**Table B8: Competency-based management system**

Course on measuring instruments						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	NA	NA	NA	NA	NA	NA
In-person	NA	P	NA	NA	NA	NA
Recurrent	NA	NA	NA	NA	NA	NA

**Table B9: Course on Measuring Instruments**

Course on quality systems						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	NA	NA	NA	NA	NA	NA
In-person	P	P	P	P	NA	NA
Recurrent	P	P	P	P	NA	NA

**Table B10: Course on Quality Systems**

Course on safety management						
Course	C 1		C 2		C3	
Level	Basic	Advanced	Basic	Advanced	Basic	Advanced
CBT	CBT	CBT	CBT	CBT	NA	NA
In-person	P	P	P	P	NA	NA
Recurrent	P	P	P	P	NA	NA

**Table B11: Course on Safety Management**