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EUROCONTROL Specification for Area Proximity Warning

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Abstract

This document specifies the minimum requirements for the development, configuration and use of Area Proximity Warning (APW) in the ECAC area.

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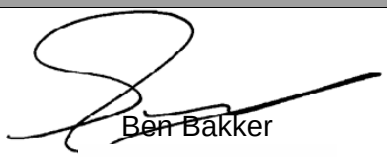
Technical Manager	 Ben Bakker	19-5-2009
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CONTENTS

1. INTRODUCTION

This document is aimed at all Air Navigation Service Providers (ANSPs) in the European Civil Aviation Conference (ECAC) area. It specifies the minimum requirements for the development, configuration and use of Area Proximity Warning (APW). APW is a ground-based safety net intended to warn the controller about unauthorised penetration of an airspace volume by generating, in a timely manner, an alert of a potential or actual infringement of the required spacing to that airspace volume.

The European Convergence and Implementation Plan (ECIP) contains an Objective (ATC02.5) for ECAC-wide standardisation of APW in accordance with the EUROCONTROL Specification for Area Proximity Warning (this document). This document specifies, in qualitative terms, the common performance characteristics of APW as well as the prerequisites for achieving these performance characteristics.

It should also be noted that Regulation (EC) No 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation) contains, *inter alia,* the following essential requirements:

- "*Systems and operations of the EATMN shall achieve agreed high levels of safety. Agreed safety management and reporting methodologies shall be established to achieve this.*"
- "*In respect of appropriate ground-based systems, or parts thereof, these high levels of safety shall be enhanced by safety nets which shall be subject to agreed common performance characteristics.*"

The present document facilitates harmonization of the APW elements of the ground based safety nets and sets up the prerequisites for the refinement, in quantitative terms, of the common performance characteristics which might be developed in a further step in response to the requirements of the SES interoperability Regulation.

This document is targeted at stakeholders identified in ECIP ATC02.5, and the requirements are placed on ANSPs. The document is structured as follows:

- Chapter 1 describes the purpose, scope and structure of the document.
- Chapter 2 lists reference documents, explains terms and contains a list of abbreviations.
- Chapter 3 describes the APW concept of operations. It provides the contextual information for interpretation of the requirements contained in Chapter 4.
- Chapter 4 specifies the minimum qualitative requirements that are regarded as necessary for effective APW. It does not prescribe implementation aspects. Only the ***minimum*** requirements that are

considered essential for ensuring the effectiveness of APW in the ECAC area are specified. These requirements are necessarily of a qualitative nature considering the implications of local factors that need to be considered. The requirements in this chapter are normative in the sense that:

- Requirements using the operative verb ***"shall"*** are mandatory to claim compliance with the Specification. Mandatory requirements are explicitly numbered with the prefix "APW-".
- Requirements using the operative verb ***"should"*** are recommended.
- Requirements using the operative verb ***"may"*** are optional.
- Requirements using the operative verb ***"will"*** denote a statement of intent.

- Chapter 5 identifies the comprehensive guidance material available to assist in implementing this Specification.

Use of the word "shall" is avoided in Chapter 3 of this Specification and in the guidance material in order to emphasise the introductory and explanatory rather than normative nature of the information provided.

Some of the terms in section 2.2 and the requirements on procedures in section 4.2 are derived from paragraph 15.7.4 of ICAO Doc 4444. Any differences in formulation are intended to remove ambiguity and not to imply deviation from ICAO provisions.

2. CONVENTIONS REGARDING TERMS

2.1 Reference Documents

[EURO-HRS]	Guidelines for Trust in Future ATM Systems: Principles, HRS/HSP-005-GUI-03, Edition 1.0, May 2003
[SRC-ESARR4]	ESARR 4: Risk Assessment and Mitigation in ATM, Edition 1.0, 05-04-2001

2.2 Explanation of Terms

alert	Indication of an actual or potential hazardous situation that requires particular attention or action.
area proximity warning	A ground-based safety net intended to warn the controller about unauthorised penetration of an airspace volume by generating, in a timely manner, an alert of a potential or actual infringement of the required spacing to that airspace volume.
ATS surveillance service	Term used to indicate a service provided directly by means of an ATS surveillance system.
false alert	Alert which does not correspond to a situation requiring particular attention or action (e.g. caused by split tracks and radar reflections).
ground-based safety net	A ground-based safety net is functionality within the ATM system that is assigned by the ANSP with the sole purpose of monitoring the environment of operations in order to provide timely alerts of an increased risk to flight safety which may include resolution advice.
human performance	Human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations.
nuisance alert	Alert which is correctly generated according to the rule set but is considered operationally inappropriate.

warning time	The amount of time between the first indication of an alert to the controller and the predicted hazardous situation. *Note.– The achieved warning time depends on the geometry of the situation.* *Note.– The maximum warning time may be constrained in order to keep the number of nuisance alerts below an acceptable threshold.*

2.3 Abbreviations and Acronyms

ADS	Automatic Dependent Surveillance
AGDL	Air-Ground Data Link
ANSP	Air Navigation Service Provider
APW	Area Proximity Warning
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATS	Air Traffic Service
EATMN	European Air Traffic Management Network
EC	European Commission
ECAC	European Civil Aviation Conference
ECIP	European Convergence and Implementation Plan
ESARR	EUROCONTROL Safety Regulatory Requirement
FUA	Flexible Use of Airspace
GAT	General Air Traffic
HMI	Human Machine Interface
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
OAT	Operational Air Traffic
RVSM	Reduced Vertical Separation Minima
SES	Single European Sky
SRC	Safety Regulatory Commission
VFR	Visual Flight Rules

3. APW CONCEPT OF OPERATIONS

3.1 Purpose of APW

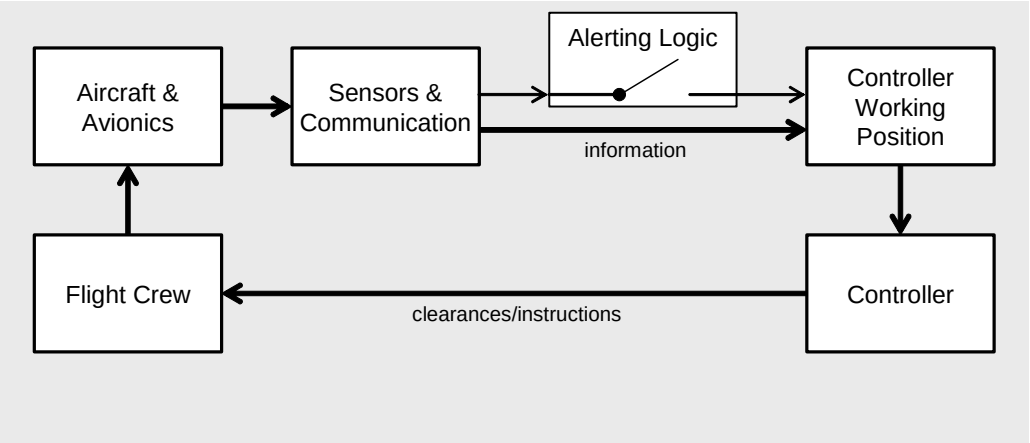

Fig. 1: Simplified ATC Control Loop

As illustrated in Fig. 1, today's ATS system is human centred; based on processing of a continuous stream of information, the controller issues clearances and instructions to prevent or resolve conflicts.

However, the drive for consistency in cognitive information processing tasks leads to selective perception/exposure, selective attention and selective interpretation. As a result, actual or potential hazardous situations related to aircraft position can remain unnoticed.

APW adds independent alerting logic to the control loop in order to warn the controller about unauthorised penetration of an airspace volume by generating alerts of existing or pending situations, related to the position and speed of an aircraft relative to that airspace volume, which require attention/action. APW can have one or more roles, such as:

- Warn the controller about unauthorised penetration of controlled flights into restricted airspace.
- Warn the controller about unauthorised penetration of uncontrolled flights into controlled airspace.

APW is intended to function in the short term, if applicable providing warning times of up to 2 minutes.

3.2 Operational Context

When APW was first introduced, ATS surveillance services were in most cases provided using mixed (raw radar data supplemented with computer-

generated synthetic data) situation displays. In the meantime, the norm for provision of ATS surveillance services has become full-synthetic situation displays in most ECAC States. Decision support tools are gradually being introduced to enable the controller to handle more traffic in order to cope with the ever increasing demand. At the same time, automated support systems have become more robust and trustworthy but also more complex and interdependent. These changes imply a different operational context for APW.

It is essential that individual ANSPs establish a clear APW policy for their particular operational context to avoid ambiguity about the role and use of APW using the following generic policy statements as a starting point:

APW IS A GROUND-BASED SAFETY NET; ITS SOLE PURPOSE IS TO ENHANCE SAFETY AND ITS PRESENCE IS IGNORED WHEN CALCULATING SECTOR CAPACITY.

APW IS DESIGNED, CONFIGURED AND USED TO MAKE A SIGNIFICANT POSITIVE CONTRIBUTION TO PREVENTION OF ACCIDENTS ARISING FROM UNAUTHORISED PENETRATION OF AN AIRSPACE VOLUME.

APW is only effective if the number of nuisance alerts remains below an acceptable threshold according to local requirements and if it provides sufficient warning time to resolve hazardous situations, governed by the inherent characteristics of the human centred system.

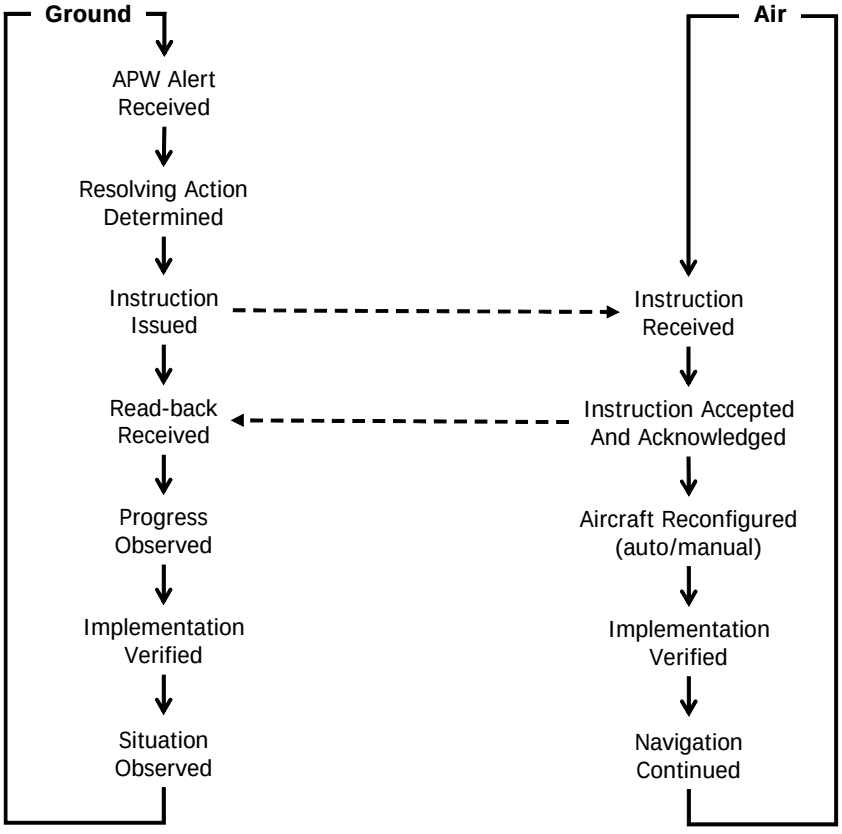

Fig. 2: Expanded ATC Control Loop (triggered by APW)

Fig. 2 illustrates the nominal sequence of events to resolve a particular situation as two loosely coupled loops. Being a human centred system, the Ground loop reflects the states of the controller and the Air loop reflects the states of the flight crew. For each state transition to occur certain preconditions have to be met and actions performed, complicated by many fixed or variable delays and anomalous cases.

3.3 Operational Concept

3.3.1 Human Performance Considerations

In order to be able to process all available information, the controller must acquire situational awareness and build a mental model of the airspace and traffic pattern. To control the situation and make decisions, the controller has to establish strategies and tactics to handle the traffic flows and conflicts.

The use of APW will depend on the controller's trust. Trust is a result of many factors such as reliability and transparency. Neither mistrust nor complacency is desirable; training and experience is needed to develop trust at the appropriate level (see [EURO-HRS]).

For APW to be effective, the controller must have a positive attitude towards APW. This requires that the following aspects are addressed:

- **Appropriateness and timeliness**
  The rule set for generating alerts should be appropriate; dissonance with normal control practices should be avoided.
- **Effectiveness**
  The controller in charge may not notice or recognise the reason for an alert for the same reasons that left the potentially hazardous situation undetected. This should be addressed in HMI design.
- **Comprehensibility and performance monitoring**
  The increasing complexity of APW and the environment in which it is used should be addressed through appropriate training and competency assessment. Practices and controller perception of the effectiveness of APW should be evaluated periodically and following changes to APW. Lessons from particular situations or incidents in which APW was involved should be shared through appropriate mechanisms.

3.3.2 Design Considerations

APW should perform in concert with the airspace design and classification, variety of airspace users, Flexible Use of Airspace (FUA) and the applicable procedures for air navigation services.

Special consideration should be given to making all ground-based safety nets and controller tools perform in concert.

Dependent on the diversity of these aspects, APW should be capable of using different parameters for generation of alerts. Different parameters may be applied in the case of system degradation (e.g. unavailability of one or more radar stations).

Local instructions concerning the use of APW should be established to ensure that APW is used in a safe and effective manner. Pertinent data should be regularly analysed in order to monitor and optimise the performance of APW.

3.3.3 Technical Aspects

APW is suitable for use in any airspace covered by adequate surveillance.

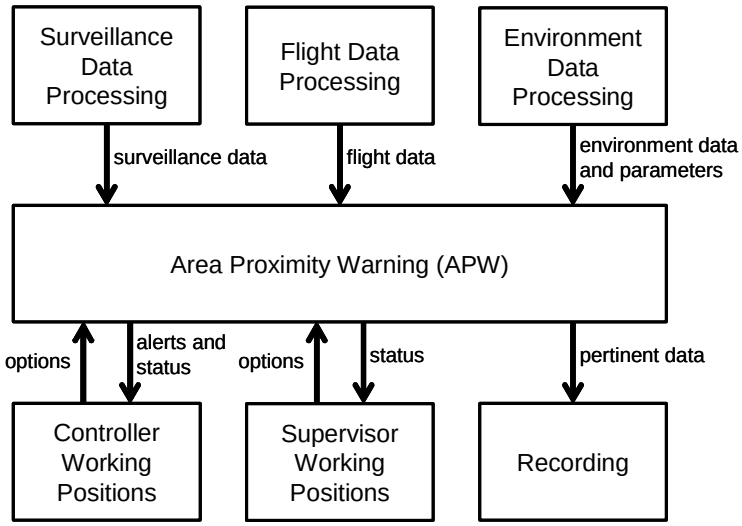

Fig. 3: APW Context Diagram

As illustrated in Fig. 3, APW should obtain information from Surveillance Data Processing, from Environment Data Processing and possibly from Flight Data Processing in order to generate alerts:

- Surveillance data including tracked pressure altitude information should be used to predict hazardous situations
- Flight data should be used as follows:
    - Type/category of flight: to determine the eligibility for alert generation and possibly also the parameters applied
    - Concerned sector(s): to address alerts
    - Cleared/Block Flight Levels: to increase the relevance of alert generation
    - Manually entered Flight Levels: to compensate for missing pressure altitude information
    - RVSM status of aircraft to determine appropriate spacing from the volume of airspace

- Environment data and parameters should include:
    - Airspace volumes
    - Alerting parameters

Alerts should be generated at least at a Controller Working Position of the control sector responsible for the infringing aircraft and/or for the airspace subject to unauthorised penetration. Status information regarding the technical availability of APW is to be provided to all Working Positions. Selectable options of APW related to eligibility, configuration and technical availability may be available at Controller and Supervisor Working Positions.

All pertinent APW data should be recorded for offline analysis.

3.4 Safety Aspects

It is assumed that EUROCONTROL Safety Regulatory Requirements are effectively implemented. It is recommended to put emphasis on [SRC-ESARR4] and its guidance material for the implementation of, and changes to, APW applications.

3.5 Future Directions and Need for Change

APW will have to meet future demands imposed by, amongst other things, further traffic increase, changing traffic patterns, FUA, changing aircraft characteristics, further automation in the air and on the ground and, potentially, the introduction of new concepts.

The compatibility of APW and other ground-based and airborne safety nets needs to be maximised.

Availability of improved or new aircraft information through Mode S, ADS and AGDL will offer new opportunities to improve APW.

This could, amongst others, lead to changes in the following aspects of APW:

- Correlation of ATC constraints with aircraft intent in order to further reduce the number of nuisance alerts;
- Increased look ahead time and multi-level or different types of alerts;
- Correlation of alerts from multiple sources (on the ground and in the air) to generate combined alerts.

4. SPECIFIC REQUIREMENTS

4.1 Policy, Organisational Clarity and Training Requirements

4.1.1 Policy

APW-01 The ANSP ***shall*** have a formal policy on the use of APW consistent with the operational concept and safety management system applied to avoid ambiguity about the role and purpose of APW.

The policy ***should*** be consistent with the generic policy statements in section 3.2 of this Specification but ***may*** contain more detail or additional aspects called for by local factors.

The policy ***should*** be communicated to all relevant staff in order to ensure consistency of all design, configuration, operational use and monitoring activities in compliance with the intended use of APW.

4.1.2 Responsibility for Management of APW

APW-02 The ANSP ***shall*** assign to one or more staff, as appropriate, the responsibility for overall management of APW.

It ***should*** be possible for other staff in the organisation to identify the assigned staff. The assigned staff ***should*** seek advice from the APW manufacturer, as appropriate.

4.1.3 Training and Competence

APW-03 The ANSP ***shall*** ensure that all controllers concerned are given specific APW training and are assessed as competent for the use of the relevant APW system.

Note.– The primary goal of the training is to develop and maintain an appropriate level of trust in APW, i.e. to make controllers aware of the likely situations where APW will be effective and, more importantly, situations in which APW will not be so effective (e.g. sudden, unexpected manoeuvres).

4.2 Requirements on Procedures

4.2.1 Local Instructions

APW-04 Local instructions concerning use of APW ***shall*** specify, *inter alia*:

a) the types of flight (GAT/OAT, IFR/VFR, etc.) which are eligible for generation of alerts;

b) the volumes of airspace within which APW is implemented;

c) the method of displaying the APW to the controller;

d) in general terms, the parameters for generation of alerts as well as alert warning time;

e) procedures for and methods of defining and activating/deactivating volumes of airspace;

f) the volumes of airspace within which APW can be selectively inhibited and the conditions under which this will be permitted;

g) conditions under which specific alerts may be inhibited for individual flights; and

h) procedures applicable in respect of volumes of airspace or flights for which APW or specific alerts have been inhibited.

4.2.2 Controller Actions

APW-05 In the event an alert is generated in respect of a controlled flight, the controller ***shall*** without delay assess the situation and if necessary take action to ensure that the required spacing to that airspace volume will not be infringed or will be restored. If that is not possible the controller ***shall*** take action to mitigate the consequences of the unauthorised penetration.

4.2.3 APW Performance Analyses

APW-06 APW performance ***shall*** be analysed regularly to identify possible shortcomings related to APW.

4.2.4 Statistical Analyses

The appropriate ATS authority ***should*** retain electronic records of all alerts generated. The data and circumstances pertaining to each alert ***should*** be analysed to determine whether an alert was justified or not. Non-justified alerts ***should*** be ignored. A statistical analysis ***should*** be made of justified alerts in order to identify possible shortcomings in airspace design and ATC procedures as well as to monitor overall safety levels.

4.3 Requirements on APW Capabilities

4.3.1 Alerting Performance

APW-07 APW ***shall*** detect and alert operationally relevant situations for eligible aircraft.

APW-08 APW ***shall*** provide alerts for operationally relevant situations.

Note.– Situations are operationally relevant when covered by the adopted rule set and optimisation strategy. The rule set and optimisation strategy

should be determined taking into account the relevant local factors. APW should not be expected to alert all operationally relevant situations.

APW-09 APW alerts ***shall*** attract the controller's attention and identify the aircraft involved in the situation; APW alerts ***shall*** be at least visual.

An airspace volume identification element ***may*** be included to improve the controller's ability to assess the situation.

An audible element ***may*** be included to improve the system's ability to draw the controller's attention to the alert. If a continuous audible element is included, an acknowledgement mechanism ***may*** be provided to silence an alert.

APW-10 The number of nuisance alerts produced by APW ***shall*** be kept to an effective minimum.

Note.– Human factors and local circumstances determine what constitutes an effective minimum.

APW-11 The number of false alerts produced by APW ***shall*** be kept to an effective minimum.

Note.– Local circumstances determine what constitutes an effective minimum.

4.3.2 Warning Time

APW-12 When the geometry of the situation permits, the warning time ***shall*** be sufficient for all necessary steps to be taken from the controller recognising the alert to the concerned aircraft successfully executing an appropriate manoeuvre.

Note.– Warning time may be insufficient in cases of sudden, unexpected manoeuvres.

APW-13 APW ***shall*** continue to provide alert(s) as long as the alert conditions exist.

4.3.3 Alert Inhibition

APW-14 APW ***shall*** provide the possibility to inhibit alerts for predefined volumes of airspace and for individual flights.

Note.– It may be necessary to inhibit alerts for predefined volumes of airspace to suppress unnecessary alerts. It may be necessary to inhibit alerts for specific flights to suppress unnecessary alerts.

APW-15 Alert inhibitions ***shall*** be made known to all controllers concerned.

4.3.4 Status Information

APW-16 Status information ***shall*** be presented to supervisor and controller working positions in case APW is not available.

4.3.5 Adaptability

APW ***should*** be adaptable for the procedures in use in all distinct volumes of airspace.

APW ***may*** need to take into account the type of flight as well as the specific volume of airspace in which the aircraft is flying, in order to apply appropriate parameters or trajectory estimation. Different parameters ***may*** be applied in the case of system degradation (e.g. unavailability of one or more radar stations).

Where appropriate, APW ***should*** be adaptable to alert situations as, for example:

- Uncontrolled flights penetrating controlled airspace without ATC clearance; and
- Military flights leaving exercise areas.

4.3.6 Data Recording

APW-17 All pertinent APW data ***shall*** be made available for off-line analysis.

Note.– Off-line analysis may need access to other data sources as well (surveillance data and voice recordings) for complete analysis.

5. GUIDANCE MATERIAL

5.1 Structure of the Guidance Material

Comprehensive guidance material to assist in implementing this specification covers the full APW lifecycle:

- Definition of objectives
- Implementation or change
- Tuning and validation
- Operating and monitoring

The guidance material consists of a document titled **EUROCONTROL Guidance Material for Area Proximity Warning** with several appendices. Most appendices can be used as stand-alone documents for particular purposes. Table 1 shows the structure of the guidance material.

Title	**Purpose**
EUROCONTROL Guidance Material for Area Proximity Warning	General description of the full APW lifecycle, aimed at staff with responsibility for overall management of APW.
Appendix A: Reference APW System	Detailed technical explanation of typical implementation details of APW with emphasis on parameterisation and performance optimisation. Optimisation concepts are also covered in detail.
Appendix B: Safety Assurance	A set of three documents that can be used as starting point for APW safety assurance work in a particular local context.
Appendix B-1: Initial Safety Argument for APW System	ANSPs may find it convenient to present the safety argument as a stand-alone document initially, as is the case with this document. However, the argument will ultimately become part of the safety case document and the stand-alone version will then become defunct.
Appendix B-2: Generic Safety Plan for APW Implementation	Describes what safety assurance activities should be considered at each lifecycle phase, who should do them, and what the criteria for success are.

Appendix B-3: Outline Safety Case for APW System	Addresses in detail the assurance and evidence from the System Definition stage and outlines the likely assurance and evidence for the later stages.
Appendix C: Cost Framework for the Standardisation of APW	Assists in identifying potential financial implications of standardisation of APW in compliance with the EUROCONTROL Specification for Area Proximity Warning.
Appendix D: Optimisation of APW for ATCC Semmerzake	Describes the (partial) application of the guidance material in a demanding environment.
Appendix D-1: Enhancement of APW for ATCC Semmerzake	Identifies potential solutions for a number of issues.

Table 1: Structure of the guidance material

5.2 Availability and Feedback

The guidance material is freely available at www.eurocontrol.int/safety-nets and regularly updated based on feedback received.

Feedback and questions can be addressed to the contact listed in each document and to safety-nets@eurocontrol.int .

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