



The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

MINIMUM AVIATION SYSTEM PERFORMANCE SPECIFICATION FOR REMOTE TOWER OPTICAL SYSTEMS

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CHAPTER 1

GENERAL

1.1 INTRODUCTION

ICAO has recommended the development of provisions for remotely-operated Air Traffic Services (ATS), including updating requirements for surveillance and communications, providing requirements for sensors and display technologies to replace visual observation, and providing requirements for personnel licensing and training [1]).

The use of remote tower technology enables the provision of aerodrome ATS as defined in ICAO Document 4444 [2], EUROCONTROL's Manual for Aeronautical Flight Information Service (AFIS) [3] and ICAO Document 9426 [4] from a location from which provision of ATS by direct visual observation is not possible. A remote tower facility could be several hundred kilometres from the aerodrome it is providing service to, or it could be located in a building on or near the aerodrome but without an adequate direct view of the area of control responsibility.

ICAO Document 9426 (Part III) [4] states that an aerodrome tower is required to *"permit the controller to visually survey those portions of the aerodrome and its vicinity over which they exercise control"*. In the switch from a conventional tower to a remote tower facility, the primary change relates to the manner by which the above provision is satisfied. The view from a conventional tower (the "out-of-the-window" (OTW) view) facilitates visual survey in line with the ICAO regulation. When operating from a remote tower facility, visual observation of the aerodrome is no longer carried out by directly observing the OTW view. Instead, a remote tower optical system, comprising cameras at the aerodrome and a display presentation to the remote operator, are provided to enable situational awareness.

The remote tower visual presentation is one of the principle components that enables the provision of ATS from a remote tower facility or from environments where an existing aerodrome tower OTW view is inadequate for providing ATS. An optical sensor presentation is a type of visual presentation that displays video images from cameras, which could be infrared as well as visible spectrum devices.

This Minimum Aviation System Performance Specification (MASPS) document pertains to remote tower optical systems, and is applicable to all optical sensor configurations that could be used to implement remotely-operated ATS for an aerodrome. The specific configuration of the optical system will be a matter for individual implementations.

1.2 DEFINITION OF TERMS

NOTE: *Some terms provided below are taken from ICAO documents, EASA Annex to ED Decision 2015/014/R or SESAR Documents [2][6][11].*

The following defined terms are used within the context of this document.

Air Traffic Services

A generic term meaning variously, flight information service, alerting service, air traffic advisory service, or air traffic control service (area control service, approach control service or aerodrome control service).

Johnson's Criteria Detection

Something in an image that raises an observer's attention.

Johnson's Criteria Military example: "There is something!" [12]

Visual Detection in ATS based on Johnson's Criteria Detection

Johnson's detection criteria applied to images of objects relevant to the provision of ATS displayed in a visual presentation.

Same as for Johnson's criteria detection: "There is something!"

Johnson's Criteria Recognition

Classes of objects can be differentiated.

Johnson's criteria military example: Tank/Armoured Personnel Carrier/Lorry [12].

Visual Recognition in ATS based on Johnson's criteria recognition

Attributes of an object relevant to ATS provision that may be perceived based on Johnson's criteria recognition applied to its display in a visual presentation. Such attributes include the following:

- Class / category / type of aircraft: to be determined based on, for example, one or more of the following:
 - Aircraft size & fuselage configuration
 - Engine configuration (e.g. wing-mounted (below/above) or tail-mounted, number and type of engines)
 - Wing configuration (e.g. wing mounted below or on top of the fuselage)
 - Stabilizer configuration
 - Landing gear configuration
 - Aircraft painting or markings
- Vehicle type / class: e.g. fire truck / car / fuel truck / baggage trailer
- Personnel and obstructions: e.g. person / wildlife / FOD

Visual Presentation

A visual display that shows the areas of responsibility of the remote tower ATS Unit. The term "visual presentation" comprises the following types of presentation (as used in the context of this document):

- a) optical sensor presentation
- b) virtual presentation
- c) augmented presentation

a) Optical Sensor Presentation

Display of images from optical sensors (visible spectrum, thermal, IR, NIR, SWIR ...).

NOTE: *Implementations of the optical sensor presentation at the time of writing of this MASPS typically comprise a wide-angle display ('panorama') that presents a wide field-of-view image derived from one or more fixed-view optical sensors, and a PTZ view.*

Panorama

The term 'panorama' is used in this MASPS to refer to a wide-angle display typically used to show images from fixed-view optical sensors. However, use of this term does not preclude other implementations of the optical sensor presentation.

PTZ

An imaging sensor or sensors with a pan/tilt pointing capability and a narrow, possibly variable, angle of view. The PTZ sensor and view emulate the function of binoculars in a conventional tower, and could also be used to assist light gun operation.

b) Virtual Presentation

A computer-generated synthetic visual representation of the aerodrome operational environment generated using target information derived from surveillance systems (e.g. multilateration, ADS-B, approach radar), static environment information (e.g. aerodrome layout, GIS data) and other sensor information (e.g. meteorological data). The virtual presentation may contain two-dimensional, three-dimensional, pictorial, symbolic or textual representations.

NOTE: *This definition includes two-dimensional plan-position indicator type displays as well as three-dimensional virtual environments.*

c) Augmented Presentation

A mixture of virtual presentation and optical sensor presentation, whereby information associated with real-world objects is presented as 2D/3D graphical elements, image data, symbols or text overlaid onto the optical sensor presentation, either conformably or close to their optical images. Examples include runway/taxiway boundaries and stop bars, and target symbols and labels.

Operator

Throughout this document, the term “operator” is used to refer to the officer providing ATS in the role of ATCO, AFISO or apron controller.

Out-The-Window (OTW) view

The view from a conventional aerodrome tower’s visual control room.

Remote Tower Module (RTM)

A module from which Remote ATS can be provided. It includes one or more controller working positions (CWPs) (including necessary ATS systems such as communications, aerodrome lighting control etc.) and visual presentation display screens, as required.

Remote Tower Centre (RTC)

A facility containing one or more RTMs from which ATS can be provided to one or more aerodromes.

1.3

ABBREVIATIONS

TABLE 1: ABBREVIATIONS

AFISO	Aerodrome Flight Information Service Officer
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATS	Air Traffic Services
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V.
DRRP	Detection and Recognition Range Performance
EUROCAE	European Organisation for Civil Aviation Equipment
FOD	Foreign Object Debris
FTA	Fault Tree Analysis
HMI	Human Machine Interface
ICAO	International Civil Aviation Organisation
IMRT	Integrity Monitor Response Time
MASPS	Minimum Aviation System Performance Specification

MOPS	Minimum Operational Performance Specification
MTBF	Mean Time Between Critical Failures
MTTR	Mean Time To Repair
NTPQ	Network Time Protocol Query
PTZ	Pan Tilt Zoom
RMA	Reliability, Maintainability, Availability
VGA	Video Graphics Array

1.4 PURPOSE AND SCOPE

This document comprises a MASPS for remote tower optical systems including specification of standard system characteristics. It is intended to be used by equipment designers, regulators, manufacturers, installers, aerodrome ATS providers and operators.

The exact operational and technical scope of this MASPS is defined in [TABLE 2](#).

TABLE 2: SCOPE OF THIS MASPS DOCUMENT

Operational Scope	Technical Scope
Remote provision of ATS to a single aerodrome (as defined in 1.5)	Optical sensor presentation (as outlined in section 1.2)

This MASPS was produced with knowledge of existing and proven installations and the latest results from research projects such as SESAR [7][8][9][10][11]. Adherence to this specification is intended to enable the operational implementation of a remote tower optical system for an aerodrome.

The development of remote tower systems is an evolutionary process. As such, this MASPS for remote tower optical systems may be extended in future with additional specifications pertaining to the optical system or with a broadened scope to include additional systems. MASPS may also drive the development of subsequent MOPS by providing a clear allocation of system performances between its various individual components.

Compliance with this MASPS is recommended as one means of assuring that a remote tower optical system and each of its component subsystems will perform its intended function(s) satisfactorily.

1.5 OPERATIONAL CONTEXT

The Remote Provision of ATS to a Single Aerodrome

The remote provision of ATS to a Single Aerodrome (known as *Single Mode of Operations* within EASA guidance material [5] and [6] and commonly referred to as *Single Remote Tower* within SESAR [11]) involves the provision of ATS from a single RTM at a remote location to only one aerodrome at a time.

When providing remote ATS to a single aerodrome, the application of the remote tower concept will vary depending on the operational environment, the individual needs of stakeholders and other parameters. Factors influencing the implementation of the concept include *inter alia*:

- Traffic density;
- Air traffic characteristics;
- Physical orography of the aerodrome;
- Airspace characteristics;
- Aerodrome infrastructure;
- Operator roles and local procedures;

- Required performance.

All of the above have an influence on the most suitable technical implementation (systems, equipment etc.). For a more detailed insight refer to European Aviation Safety Agency (EASA) guidance material [5] and [6].

Use cases which fall under the remit of the remote provision of ATS to a single aerodrome include, but are not limited to, the following:

- The provision of ATS to one aerodrome on a permanent basis;
- The provision of ATS to more than one aerodrome – but only one at a time – for example by “switching” the RTM between aerodromes (however note specific requirements for switching between the services are outside the scope of this MASPS);
- The provision of ATS to an aerodrome on a temporary basis, for example during planned or unplanned contingency situations, or during specific times such as during the night or for specific events;
- The provision of ATS to distant areas of an aerodrome from which the view from an existing aerodrome tower is inadequate or non-existent. Providing a remote tower facility could therefore be in lieu of building a second aerodrome tower;
- The provision of ATS to a specific area of the aerodrome, e.g. apron management (providing an apron control tower function at an aerodrome).

1.6

TECHNICAL CONTEXT

The technical context of this MASPS document consists of the optical sensor presentation. For detailed definition please see section 1.2.

1.7

REFERENCES

- [1] ICAO Working Paper, AN-Conf/12-WP/157 Recommendation 2/2, AN-Conf/12-WP/42
- [2] ICAO Document 4444 “Procedures For Air Navigation Services - Air Traffic Management”, 15th Edition, 2007 (amendment 4, November 2012);
- [3] EUROCONTROL “Manual for Aerodrome Flight Information Service (AFIS)”, Edition, 1.0, June 2010;
- [4] ICAO Document 9426 “Air Traffic Services Planning Manual”, 1st Edition, December 1992;
- [5] EASA, ED Decision 2015/014/R, Remote Tower Operations, July 2015;
- [6] EASA, Annex to ED Decision 2015/014/R, Guidance Material on the implementation of the remote tower concept for single mode of operation, Issue 1, July 2015;
- [7] SESAR DEL-06.09.03-D14-SAR, OFA06.03.01 Remote Tower, SAR for Single Remote Tower, Edition 00.01.02, October 2015;
- [8] SESAR DEL-06.09.03-D15-HP HP Assessment Report for Single Remote Tower, Edition 00.01.01, September 2013;
- [9] SESAR P06.09.03 D08-02 - Remotely Provided Air Traffic Service for Single Aerodrome VALR, Edition 00.05.02, 01/05/2014
- [10] SESAR P06.09.03 D08-02 - Remote Provision of ATS to a Single Aerodrome VALR Annex, Edition 00.05.02, 29/04/2104;
- [11] SESAR DEL-06.09.03-D35-OSD, D35 OSD for Remote Provision of ATS to Aerodrome, Edition 00.06.02, 2015-11-20;
- [12] John Johnson, “Analysis of image forming systems,” in Image Intensifier Symposium, AD 220160 (Warfare Electrical Engineering Department, U.S. Army Research and Development Laboratories, Ft. Belvoir, Va., 1958), pp. 244–273.
- [13] RCA electro-optics handbook [2nd Edition]. Published 1974 by RCA/Commercial Engineering in Harrison, N.J.
- [14] ED-153, Guidelines for ANS Software Safety Assurance, August 2009, EUROCAE ED-153.

CHAPTER 2

SYSTEM DESCRIPTION

2.1 INTRODUCTION

In order to analyse the requirements of a remote tower optical system, it is necessary to split the system into its conceptual building blocks, independent of the technical realisation.

A remote tower optical system is composed of the following building blocks:

- Optical Sensors: capture images and output a video stream
- Encoding/Processing: applies compression and other processing to the video stream
- Network: transmits the compressed video and other signals such as operator control commands between the aerodrome and the remote tower installation
- Decoder/Processing: applies decompression and other processing to the video stream
- Optical Sensor Presentation: displays the video stream to the operator
- Control HMI: interface for remotely operating sensors and other devices at the aerodrome
- PTZ Function: An imaging sensor or sensors with a pan/tilt pointing capability and narrow (i.e. 'magnified'), possibly variable, field-of-view (emulates binoculars)
- Time source: time reference for synchronisation of components

The following **FIGURE 1** illustrates these basic building blocks. (Other items necessary for a typical remote tower system but not within the scope of the remote tower optical system, such as communications and aerodrome lighting controls, are not shown here.)

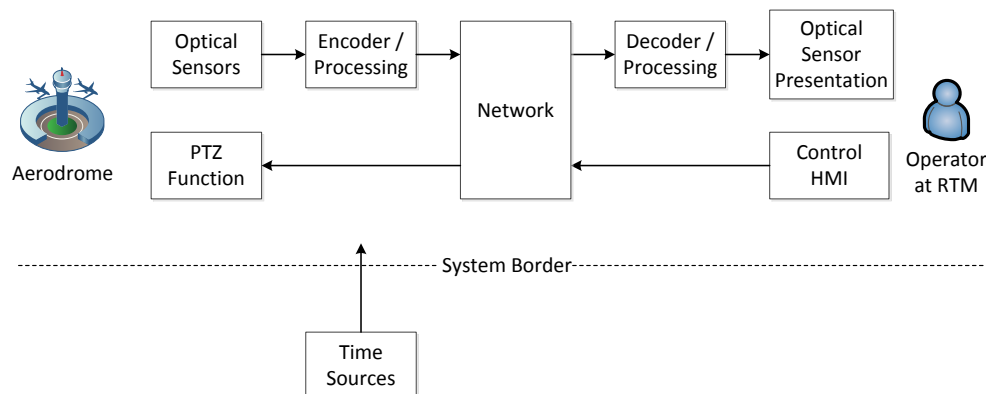


FIGURE 1: REMOTE TOWER OPTICAL SYSTEM CONCEPTUAL BUILDING BLOCKS

In an implementation, one or more of these conceptual building blocks might be integrated into a single physical element.

The following subsections outline each building block in more detail.