



# Final Project Report

## Document information

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|------------------|------------------------|
| Project Title    | Remote & Virtual Tower |
| Project Number   | 06.09.03               |
| Project Manager  | NORACON                |
| Deliverable Name | Final Project Report   |
| Deliverable ID   | D17                    |
| Edition          | 00.01.02               |
| Template Version | 03.00.00               |

## Task contributors

NORACON

## Abstract

*The project contributed with the Research and Innovation work for the operational concept of the Remotely provided Air Traffic Services for Single, Contingency and Multiple applications. All three solutions, Remotely Provided Air Traffic Service for Single Aerodrome, Remotely Provided Air Traffic Service for Contingency Situations at Small to Medium Aerodromes and Remotely Provided Air Traffic Services for Two Low-density Aerodromes have reached maturity level of V3. Methods used for development included real time simulations, live passive shadow mode trials of Air Traffic Service (both Aerodrome Control Service, TWR, and Aerodrome Flight Information Service, AFIS) and stakeholder workshops. The primary key performance area (KPA) targeted by the concept is cost effectiveness, with benefits gained by increasing the efficiency of aerodromes (often in rural regions). The concept enables the full range of ATS to be provided whilst maintaining safety, capacity, human performance and overall level of service to the same high standard as in current operations.*

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| Rational for rejection |
|------------------------|
| None.                  |

## Document History

| Edition  | Date       | Status | Author     | Justification           |
|----------|------------|--------|------------|-------------------------|
| 00.00.04 | 15/09/2015 | Draft  | ██████████ | New Document for review |
| 00.01.00 | 30/09/2015 | Final  |            |                         |

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|          |            |       |  |                                                |
| 00.01.01 | 2015/11/11 | Final |  | Updates after SJU assessment.<br>New template. |
| 00.01.02 | 2016/01/19 | Final |  | Update after closure gate comments.            |

## Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

## Acronyms

| Acronym  | Definition                                                           |
|----------|----------------------------------------------------------------------|
| AFIS     | Aerodrome Flight Information Service                                 |
| AFISO    | Aerodrome Flight Information Service Officer                         |
| ASM      | Advanced Shadow Mode                                                 |
| ATC      | Air Traffic Control                                                  |
| ATCO     | Air Traffic Control Officer                                          |
| ATM      | Air Traffic Management                                               |
| ATS      | Air Traffic Service                                                  |
| CBA      | Cost benefit Analysis                                                |
| HP       | Human Performance                                                    |
| IBP      | Industrial Based Platform                                            |
| NASA-TLX | NASA Taskload Index. A subjective workload assessment tool           |
| OSD      | Operational Service and Environment Definition                       |
| PSM      | Passive Shadow Mode                                                  |
| SASHA    | SHAPE measurement technique for Situational Awareness in ATM systems |
| SATI     | SHAPE Automation Trust Index                                         |
| SPR      | Safety and Performance Requirement                                   |

# 1 Project Overview

The main objectives of the Remote Tower concept, as described in the OSED [5], is to provide Air Traffic Services (ATS) from a remote location. The main change to operating methods between the current and proposed concept is that the ATCO or AFISO will no longer provide ATS from a local aerodrome control tower and will not necessarily be located at the aerodrome.

## 1.1 Project progress and contribution to the Master Plan

To meet the objective of the project, to develop the concept of remote tower services, several methods were used to mature the concept. The most important tool for the development was different kinds of validations using a technical validation platform, NORACON IBP SAAB. The validation platform was developed together with SESAR projects P12.04.06, P12.04.07, P12.04.8 and P12.04.09. The operative and technical scope was developed through the validations. Different methods were used to reach the goal for every validation, such as, real time simulation, advanced shadow mode<sup>1</sup> or passive shadow mode. Evaluations were made after every trial to mature both the technical and operational concept side by side which made it possible to mature the platform to a high level early in the project. Different kinds of workshops and questionnaires were used to mature the concept further and receive more feedback from participants. The primary purpose of the workshops was to examine and evaluate conditions which are not possible to validate in operational environment, on a high level, for instance non-nominal and abnormal events such as go-arounds and different kinds of emergency situations. Questionnaires were used to gather evidences, for example situational awareness (SASHA), work load (Bedford and NASA TLX) and trust (SATI). More specific assessment of the human performance used the SESAR HP assessment process uses an 'argument' and 'evidence' approach. The safety assessments are conducted as per the SESAR Safety Reference Material (SRM).

| Code                | Name                                                                                                                        | Project contribution                                                                                                                                                                                                                                                                                                                                                               | Maturity at project start | Maturity at project end |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------------------------|
| SDM-0201<br>(DS 14) | Remotely Provided Air Traffic Service for Single Aerodrome.                                                                 | Through all three validations using both PSM, and ASM and several workshops contributed to mature the concept to exit V3 for low density aerodromes. P06.08.04 will develop the concept further towards medium sized aerodromes.                                                                                                                                                   | V2                        | V3                      |
| SDM-0204<br>(DS 14) | Remotely Provided Air Traffic Service for Contingency Situations at Small to Medium Aerodromes (with a Single Main Runway). | Using results from single remote towers as baseline, the project started on a V2 level and performed two validations as well as workshops to contribute to mature the concept to V3. P06.08.04 will make additional validations to mature the concept further to reach full V3 for more operative concepts such as airports with more VFR traffic and no ground radar environment. | V2                        | V3                      |
| SDM-0205<br>(DS 14) | Remotely Provided Air Traffic Services for Two Low-density                                                                  | Through three validations, using Real Time Simulations PSM trials and several workshops, the project                                                                                                                                                                                                                                                                               | V2                        | V3                      |

<sup>1</sup> The reason to use the name Advanced Shadow Mode instead of Active Shadow Mode was due to the heliport (aerodrome) used in the trial does not have AFIS service normally; i.e. there is no local tower. During the trial, AFIS was offered to the heliport (aerodrome) from the remote tower site Bodö, with support from the national authority.

|  |             |                                                   |  |  |
|--|-------------|---------------------------------------------------|--|--|
|  | Aerodromes. | has contributed to mature the concept to exit V3. |  |  |
|--|-------------|---------------------------------------------------|--|--|

The main contributions to the ATM Master Plan are the two solutions: ATC and AFIS service in a single low density aerodrome from a remote CWP and Remote Tower for two low density aerodromes. The project has also contributed to the solution Remote Provision of ATS during contingency situations, which will be concluded by Project 06.08.04 during 2016.] ]

## 1.2 Project achievements

The project initiated and developed the European Operational concept for Remote Tower Services. All project activities have produced operational and functional concept requirements as well as validation results relating to Remote Tower. Some of these outputs have already been used. Single Remote Tower is already released as a solution for low density aerodromes and has been used as a base line for the world's first operational implementation of the Remote Tower concept, the Air Traffic Control Service (TWR) for Örnköldsvik Airport (ESNO), Sweden is since April 21<sup>st</sup> 2015 provided from the Remote Tower Centre (RTC) at Sundsvall Airport, Sweden. Moreover, the concept application of Single Remote Tower is now a subject of implementation in Europe and knowledge of the concept is spread in Europe and beyond.

One of the first questions for Single Remote Towers was to assess if it was feasible to provide ATS to an aerodrome from a remote location. SDM-0201 shows that it is possible to provide ATS (ATC and AFIS) from a remote location. Results from SDM-0201 have been improved in SDM-0204 revealing the possibility to use the remote concept as a contingency solution in case of problems in the ordinary tower. Results proved that it was feasible to apply the concept to an environment with increased traffic density as well as complexity.

A reproduced view has made it possible to enhance the image for an operator compared to current operations by adding technical features such as additional HMI information from a variety of sensors, and information presented as overlays, on the visual presentation. Once the concept of providing a Remote Air Traffic Service to a single aerodrome was sufficiently mature the next step in development was to add views from two separate low density aerodromes in one controller working position (SDM-0205). Several trials showed that it was feasible for one controller to provide ATS to two different low density aerodromes simultaneously with the same level of safety or higher.

Results show that the amount of traffic determines the requirement for technical features and tools to support the ATCO/AFISOs. Two low density aerodromes is feasible with a basic set up, where tools and features just adds an extra value and increased automation provides more available time. More traffic will surely lead a greater importance of increased automation to ensure spare capacity for non-nominal events. Advanced visual improvements such as object tracking and radar on screen must in both cases be reliable if introduced. Their impact is deemed to increase with more traffic even though they only were seen as a help while controlling two low density aerodromes simultaneously.

The main driver for Remote Provision of ATS is Cost Effectiveness. However, this is not proved through the validation activities. Rather the validation activities are used to validate the assumption in the business case i.e. that it is operationally feasible to provide ATS from a remote location. However the project has contributed with an estimation of decrease of the net reduction in operating cost, to be used in the CBA performed by WP16.

## 1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

| Reference | Title      | Description                                                                                                                                                                                                                                                                                                |
|-----------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D35       | Final OSED | This document is the Operational Services and Environment Description (OSED) relating to the Remote and Virtual Towers (RVT) element of the SESAR operational concept. This document covers the remote provision of Air Traffic Services (ATS):<br><br>To single aerodromes - in a one to one relationship |

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|               |                                                                     | <p>of one airport to one remote working position;</p> <p>To multiple aerodromes simultaneously - in a one to many relationship of more than one airport to one remote working position;</p> <p>As a Contingency solution when the local Tower is not available, the ATCO cannot be located at the local Tower and the service is relocated to a remote contingency facility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>D08-02</b> | Remotely Provided Air Traffic Service for Single Aerodrome VALR     | <p>This document is the Validation Report for the V2 and V3 Single Remote Tower validation activities of P06.09.03. It describes the results from three activities that contribute to the validation of the Single Remote Tower application:</p> <p>Single TWR Trial 1 – a V2 Passive Shadow Mode (PSM) trial establishing a technical and operational prototype for Remote Provision of ATS to a single aerodrome;</p> <p>Single TWR Trial 2 – a V3 PSM trial progressing the technical and operational capability;</p> <p>Single AFIS Trial 1 – a V3 PSM and Advanced Shadow Mode (ASM) trial, assessing the Remote Provision of ATS to a single AFIS aerodrome in a range of operational conditions.</p>                                                                                                                                                                                                                                                                                     |
| <b>D14</b>    | Safety Assessment Report Single TWR                                 | <p>This document contains the Specimen Safety Assessment for a typical application of the Remote Tower for Single airport on a high level. The report presents the list of Safety Requirements specifying the Remote Tower system at V2 phase level and the collected evidences on their validity thereby providing all material to adequately inform the OSED (as no SPR is to be developed).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>D15</b>    | HF case-report for Single TWR & AFIS applications                   | <p>This document contains the Human Performance (HP) assessment report for the P06.09.03 Remote Provision of ATS to a Single Aerodrome only. The HP assessment report describes the changes resulting from the introduction of the Remote Tower concept from a human performance perspective and identifies the potential human performance issues and benefits associated with those changes. A description of the HP related activities conducted to date to address the potential HP issues and benefits identified is provided. The results and HP recommendations &amp; requirements generated from these activities are then presented. The recommendations and requirements resulting from the HP assessment will be used to help the design and development of the Remote Tower concept for single aerodromes. In addition recommendations are made with regards to future activities that need to be performed in the next stages of concept development for single Remote Towers.</p> |
| <b>D13</b>    | Remotely provided Air Traffic Services for multiple aerodromes VALR | <p>This validation report describes the results from activities conducted to assess Remotely Provided ATS for two low density aerodromes</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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|     |                                                     | <p>simultaneously:</p> <p>Multiple TWR Simulation – a real time simulation assessing the feasibility and refining the concept from V2 to V3. Assessment using three aerodrome environments in Sweden: Ångelholm (ESTA), Halmstad (ESMT) and Kristianstad (ESMK);</p> <p>Multiple TWR Trial – a live PSM trial, progress the technical and operational capability for the concept at V3 level. Assessment used two aerodrome environments in Sweden: Sundsvall (ESNN) and Örnsköldsvik (ESNO);</p> <p>Multiple AFIS Trial – a passive shadow mode trial, building upon the work from previous exercises further refines the concept at V3 level in an AFIS environment. Assessed using two aerodrome environments in Norway: Værøy heliport (ENVR) and Røst aerodrome (ENRS).</p>                                                                                              |
| D28 | HF case-report for Multiple TWR & AFIS applications | This document contains the Human Performance (HP) assessment report for the P06.09.03 Remotely provided Air Traffic Services for two low density aerodromes and consists of the HP assessment plan; the results of the HP activities conducted according to the HP assessment process, newly identified issues and the HP recommendations & requirements for the next step, implementation projects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| D32 | Safety Assessment Report Multiple TWR               | This document contains the Specimen Safety Assessment for a typical application of the Remote Tower for Multiple airports. The report presents the list of the additional Safety Requirements with respect to Single Remote Tower specifying the Remote Tower system for Multiple application and the collected evidences on their validity thereby providing all material to adequately inform the OSED (as no SPR is to be developed).                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| D12 | Contingency remote TWR Live Trial 2                 | <p>This Validation Report describes the results following the two validation exercises contributing to the validation of - the Remote Provision of Air Traffic Services (ATS) during Contingency Situations at Small to Medium Aerodromes (with a Single Main Runway) within P06.09.03:</p> <p>- A Live Passive Shadow Mode (PSM) Trial at Gothenburg Airport. The overall aim of this exercise was to assess the technical and operational capability of an initial prototype at medium density aerodrome during contingency situations, at a V2 concept maturity.</p> <p>A Live PSM Trial at Gothenburg Airport. The aim of this exercise was to mature the concept and contribute to the transition towards V4 concept maturity by building on the earlier the exercise. Additional advanced technical enablers as well as amendments and improvements to the baseline</p> |

|            |                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|            |                                                 | functionalities were introduced to mature the prototype platform while using operational lessons learned from single exercises.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>D27</b> | HF case-report for Contingency TWR applications | This document contains the Human Performance (HP) assessment report for the P06.09.03 OI step Remotely Provided Air Traffic Service for Contingency Situations at Aerodromes with a single main Runway concept. The HP assessment report describes the changed results from introduction of the concept out of a HP perspective and identifies the potential human performance issues and benefits associated with those changes. A description of the HP related activities was conducted to address the potential HP issues and benefits. The results and HP recommendations & requirements generated from these activities are then presented. The HP recommendations and requirements resulting from the HP assessment will be used to mature the concept further in validation performed by P06.08.04. In addition, recommendations are made with regards to future activities that need to be performed in the next stages of concept development for the remote contingency tower concept. |
| <b>D31</b> | Safety Assessment Report Contingency TWR        | This document contains the Specimen Safety Assessment for a typical application of the Remote Contingency Tower. The report presents a list of Safety Requirements, in addition to the ones for Single Remote Tower, specifying the Remote Contingency Tower system level and the collected evidences on their validity thereby providing all material to adequately inform the OSED (as no SPR is to be developed).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## 1.4 Contribution to Standardisation

### 1.4.1 Contribution to EASA ED Decisions and Rule Making Tasks

Deliverables from P06.09.03 have contributed to the development of Acceptable Means of Compliance (AMC) and guidance materials “on the implementation of the Remote Tower concept for single mode of operation” produced by EASA in July 2015 under ED Decision 2015-014-R,[4]. These guidance materials are based on the concept developed under this SESAR project. See further EASA web page “<https://easa.europa.eu/document-library/acceptable-means-of-compliance-and-guidance-materials>”.

Due to the ongoing development work of P06.09.03, P06.08.04 and implementation projects outside of SESAR, EASA also produced requirements on Air Traffic Controller licensing in July 2015 under ED 2015-015-R.

### 1.4.2 Contribution to EUROCAE

EUROCAE Working Group (WG) 100 is tasked to develop standards for remote and virtual towers (RVT). For this work have deliverables from P06.09.03 and P06.08.04 been used. The primary input is the P06.09.03/P06.08.04 Final OSED (D35). OSED requirements (regulatory, operational, functional, performance, security, safety and human performance requirements) are, where applicable, being used as an input into the development of Minimum Aviation System Performance (MASP) specifications for Remote and Virtual Tower Visual Surveillance systems.

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## 1.5 Project Conclusion and Recommendations

The overall conclusion by the project is that the Remote Provision of ATS to single aerodrome is acceptable to the controllers and is operationally feasible. This has also been proved by the operational implementation in Sundsvall, Sweden, which follows the ATM master plan schedule.

The project has concluded that the Remote Provision of ATS to two low density aerodromes by a single ATCO/AFISO is acceptable to the operator and is operationally feasible.

Furthermore, the project has contributed to mature the concept of Remote Provision of ATS to an aerodrome during contingency situations at Small to Medium Aerodromes (with a single main runway). The controllers assess the concept to be acceptable and operationally feasible. P06.08.04 will make additional validations to mature the operative concept to reach full V3.

The above results will be used as basis for further developments in more complex environments and higher density aerodromes (single and contingency). The result will also be used as foundation for further development of the remote provision of ATS for multiple aerodromes, to increase the number and complexity of aerodromes. The results can also be used as input to development of remote tower centres (RTC) to optimize the use of remote tower modules (RTM) and other planning tools and functions required when several aerodromes are grouped within the same remote tower centre for improved efficiency without constraints on capacity or safety.

## 2 References

- [1] SESAR Programme Management Plan, Edition 03.00.01
- [2] [European ATM Master Plan](#)
- [3] Multilateral Framework Agreement (“MFA”) signed between the SJU, EUROCONTROL and its 15 selected members on August 11, 2009, amended on 14 June 2010, 19 October 2010 and 2 July 2012
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