OFA06.03.01 Remote Tower - Safety Assessment Report for Multiple Remote Tower

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Abstract

This document contains the Specimen Safety Assessment for a typical application of the 06.03.01 OFA 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 06.03.01 OFA OSED (as no SPR is to be developed for this OFA).

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Document History

Edition	Date	Status	Author	Justification
00.00.01	10th March 2015	Initial version		Creation based on the SAR for Single Remote Tower
00.00.02	20th May 2015	Draft version		Update based on results from Trials and Workshops for an interal review.
00.00.03	24th June 2015	Issued version for final review		Update based on internal project review and update of the safety requirements for Single Remote Tower. Final version for for external review.
00.01.00	8th October 2015	Final version for approval		Final delivery including changes from final internal review and latest update of the OSED and safety requirements related to single remote tower concept.
00.01.01	18th November 2015	Final deliverable		Final deliverable taking into account comments from the SESAR Joint Undertaking.

IPR (foreground)

This deliverable consists of SJU foreground.

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Executive summary

This document contains the Specimen Safety Assessment for a typical application of the 06.03.01 OFA Remote Tower for Multiple airports and the same concept as per P06.08.04. The report presents the list of Safety Requirements specifying the Remote Tower system at concept feasibility phase level (i.e. independent from any physical implementation) and the collected evidences on their validity thereby providing all material to adequately inform the 06.03.01 OFA OSED (as no SPR is to be developed for this OFA).

Evidences on the validity of the safety requirements have been mainly obtained from the following validation exercises performed in the frame of WP6.9.3 and P6.8.4:

- EXE-06.09.03-VP-060
- EXE-06.09.03-VP-061
- EXE-06.09.03-VP-063
- EXE-06.08.04-VP-0641

Evidences have also been obtained from several workshops and surveys, in particular or the degraded modes and the communication aspects.

> The safety assessment for Multiple Remote Tower document here is focused on and limited to the provision of ATC service to 2 low density aerodromes.
>
> **Note that this is not a standalone document**. The results contained in the report are only the additional results from this safety assessment with respect to the assessment performed for Single Remote Tower. At the same time, the Safety Assessment Report for Single Remote Tower has been updated in order to be in line with the outcomes from the safety assessment for Multiple Remote Tower.

The latest version of the safety methodology as per P16.6.1 has been applied for developing this safety assessment. But there are no main changes with respect to the approach applied for the safety assessment of Single Remote Tower concept..

1 Introduction

1.1 Background

The aim of the 06.03.01 OFA Remote Tower is to develop and assess an operational concept that enables the cost effective provision of Air Traffic Services (ATS) at one or more airports from a control facility that is not located in the local ATS Tower.

This can be divided into three main application areas:

- Remote and Virtual Tower for Single Aerodrome (named as Single Remote Tower)

- Remote and Virtual Tower for Multiple Aerodrome (named as Multiple Remote Tower)

- Remote and Virtual Tower for Contingency operations (named as Contingency Remote Tower)

The main target for the Single and Multiple Remote Tower Concepts are low to medium density rural airports, which today very much are struggling with low business margins. A very welcome cut in ATS costs for those airports are foreseen by introducing these concepts. The main target for the Contingency Remote Tower solution is medium to high density airports, whereas for most of them no real contingency alternative exits today, if the ordinary tower has to close down for any reason.

For Single and Multiple Remote Tower, the concept will be applied for two different environments:

- Aerodrome Control Service (tower only, tower and approach);

- Aerodrome Flight Information Service (AFIS)

The current document aims at presenting the results of the safety assessment focused on Remote Tower for two low density aerodromes. They lay on the basis of the safety assessment results obtained for Single Remote Tower [18].

1.2 General Approach to Safety Assessment

1.2.1 A Broader approach

This safety assessment is still conducted (as for the Single Remote Tower) as per the SESAR Safety Reference Material (SRM) [1] which itself is based on a two-fold approach:

- a success approach which is concerned with the safety of the Multiple Remote Tower operations in the absence of failure within the end-to-end RVT system

- a conventional failure approach which is concerned with the safety of the Multiple Remote Tower operations in the event of failures within the end-to-end RVT System.

Together, the two approaches lead to Safety Objectives and Safety Requirements which set the minimum positive and maximum negative safety contributions of the RVT System.

1.3 Intended readership

The intended audience for this document are other P06.09.03 and P06.08.04 team members and those in the corresponding technical projects of P12.04.06, P12.04.07 and P12.04.08. Those working on P16.06.0X, P06.09.02 and P12.04.09 may also have an interest.

At a higher project level, P06.02 and WP B are expected to have an interest in this document. External to the SESAR project, other stakeholders are to be found among:

- Appropriate National Safety Authorities (NSA);

- Affected employee unions;

- Air Navigation Service Providers (ANSP);

- Airport owners;

Airspace users.

1.4 Scope of the Safety Assessment

The safety assessment documented here is focused on the following OI step (as per ATM Master Plan Data Set 14):

- **SDM-0205**: Remotely Provided Air Traffic Services for two low density aerodromes

This OI step is described as the provision of an "Air Traffic Service for more than one aerodrome by a single Air Traffic Control Officer (ATCO)/ Aeronautical Flight Information Service Officer (AFISO) from a remote location, i.e. not from a control tower local to any of the aerodromes. The operator in this remote facility provides Air Traffic Service (ATS) for the aerodromes concerned.

Two enablers are supporting this OI step and thus also being considered in the safety assessment:

- **AERODROME-ATC-54**: Provide a Remote Tower Centre (RTC) position that enables one ATCO/AFISO to manage multiple remote towers simultaneously or in sequence
- **CTE-S02d**: Video Surveillance

L001 This Safety Assessment Report (SAR) is focused on the remote provision of ATC and AFIS services using a RVT system. Nevertheless the assessment is mainly done on the ATC services (in particular TWR services), <u>assuming that this service would allow obtaining the most constraining requirements</u> which will allow as well the provision of AFIS. The assessment of the ATC service is presented in the main body of this report. Some results on the AFIS part are included in Appendix F.

L002 The safety assessment of Multiple Remote Tower is to be done in the specific operational environment defined in section 2, i.e. to two low density and low utilisation aerodromes with traffic schedules typically comprising of single operations, rarely exceeding two simultaneous movements per aerodrome (this encompasses simultaneous movements at the two aerodromes, even if it occurs rarely).

L003 The safety assessment is focused on the capability of providing ATC tower services from a remote controller working position. The fact that this CWP is located in a Remote Tower Centre is out of scope of the assessment. Nevertheless, some aspects related to the potential interaction and support between the controller in a MRVT position and the corresponding Supervisor in the RTC have been addressed when considered to have a significant safety impact.

This report is the final version for the Safety Assessment Report, addressing safety related activities as per the SESAR Safety Reference Material.

The safety assessment for Multiple Remote Tower is based on the outcomes from the one for Single Remote Tower. From this assessment only the additional results related to the Multiple RT concept are to be presented in this report, but also the traceability and references to the corresponding results in the <u>S</u>ingle <u>R</u>emote <u>T</u>owers SAR are provided (reference is included as [SRT-SAR]).

Note that additional results are also included in this report based on new available or updated information with respect to the safety methodology applied or the tools used to perform the assessment.

This report includes the additional information with respect to Multiple Remote Tower for the provision of the following results:

Information defined at "OSED level" which includes:
- the Safety Criteria which determine the expected level of safety for Multiple Remote Tower
- the Safety Objectives, which specifies what the Remote and Virtual Tower has to provide in terms of operational service in order to satisfy the Safety Criteria.

Two types of Safety Objectives are provided: the "Functionality" ones, describing the services required from Remote and Virtual Tower, and the "Integrity" ones, specifying the integrity of the Remote and Virtual Tower system to provide those services.

These OSED-level outputs are to be capture in the OSED (through a coordinated process involving safety, performance, validation and concept experts) in addition to the ones for Single Remote Tower.

Information defined at "SPR level" which includes:
- the Safety Requirements specifies how the Remote and Virtual Tower system is to provide the operational services defined by the Safety Objectives mentioned above.

Two types of Safety Requirements are provided as well at this level: the "Functionality" ones and the "Integrity" ones (as for the Safety Objectives).

As no SPR is to be performed in the frame of this OFA, the SPR-level results mentioned above are to be captured as well in the OSED (through the same coordinated process as for the OSED outcomes) also in addition to the ones for Single Remote Tower.

Evidences on the completeness, correctness and realism of these results are provided in this assessment, either directly included in this report or providing the relevant cross-reference to the concerned project document where evidence can be found for a specific subject.

1.5 Layout of the Document

Section 1 is the current introduction to the safety assessment report for Remote Tower for Single aerodrome.

Section 2 documents the safety assessment of the Remote Tower system for Multiple Remote Tower at the service level and provides the additional elements for its specification (with respect to Single Remote Tower) in terms of Safety Objectives

Section 3 documents the safety assessment of the Remote Tower system for Multiple Remote Tower at the design level and provides the corresponding additional elements for its specification (with respect to Single Remote Tower) in terms of Safety Requirements.

Appendix A shows the consolidated list of additional Safety Objectives specifying the Remote Tower system for Multiple Remote Tower at service level.

Appendix B presents the consolidated list of additional Safety Requirements specifying the Remote Tower system for Multiple Remote Tower at design level.

Appendix C lists the assumptions, issues and limitations identified during the safety assessment.

Appendix D shows the outcomes from the safety workshop performed during the assessment

Appendix E presents the safety related validation results from ATC related trials

Appendix F presents some results on the safety assessment of the AFIS

1.6 References

[1]. SESAR P16.06.01, D26 - SESAR Safety Reference Material, Edition 00.03.01, 9th March 2015

[2]. SESAR P16.06.01, D26 - Guidance to Apply the SESAR Safety Reference Material, Edition 00.02.01, 9th March 2015

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[11]. ICAO Annex 11 – Air Traffic Services, 13th Edition, July 2001

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[15]. P6.9.3 – D13 Remotely Provided Air Traffic Service for Two Low Density Aerodromes Validation Report, Edition 00.04.00, 31st August 2015

[16]. P6.9.3 – D28 Remotely provided Air Traffic Services for two low density aerodromes Appendix F: HP Assessment Report, Edition 00.01.01, September 2015

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1.7 Acronyms and terminology

1.7.1 Acronyms

AFIS	Aerodrome Flight Information Service
AIM	Accident Incident Model
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATS	Air Traffic Services
CFIT	Controlled Flight Into Terrain
LVC	Low Visual Conditions
LVP	Low Visual Procedures
OSED	Operational Service and Environment Definition
RTC	Remote Tower Centre
RVT	Remote and Virtual Tower
SAC	SAfety Criteria

SPR   Safety and Performance Requirements

1.7.2 Terminology

MRVT – Multiple Remote and Virtual Tower

It refers to a controller working position from which remote ATC tower services can be provided to multiple aerodromes. This corresponds to a Remote Tower Module in a Remote Tower Centre.

RVT – Remote and Virtual Tower

If refers to a controller working position from which remote ATC tower services can be provided to a single aerodrome. This corresponds to a Remote Tower Module in a Remote Tower Centre.

RTC – Remote Tower Centre

It refers to Remote Tower Centre, in which one or several Remote Tower Modules are located. Each of these modules can be used for providing ATS service to one aerodrome (RVT) or to multiple aerodromes (MRVT).

2   Safety specifications at the OSED Level

2.1 Scope

Based on safety activities defined in the Safety Plan [1]this section addresses the following activities:

‣   description of the key properties of the Operational Environment that are relevant to the safety assessment - section 2.2

‣   derivation of suitable Safety Criteria (from the OFA Safety Plan [1]) – section 2.3 and 2.4.

‣   identification of the pre-existing hazards that affect traffic in the (small) airport surface and vicinity in and the risks of which services provided by the Single Remote Tower may reasonably be expected to mitigate to some degree and extent - section 2.5.

‣   description of the ATS services to be provided by Single Remote Tower and the derivation of Functional Safety Objectives in order to mitigate the pre-existing risks under normal operational conditions - section 2.6

‣   assessment of the adequacy of the services provided by Single Remote Tower under abnormal conditions of the Operational Environment - section 2.7

‣   assessment of the adequacy of the services provided by Single Remote Tower under internal-failure conditions and mitigation of the system-generated hazards – section 2.8

‣   assessment of the impacts of the Single Remote Tower operations on adjacent airspace or on neighbouring ATM systems – section 2.9

‣   achievability of the Safety Criteria – section 2.10

‣   validation & verification of the safety specification – section 2.11

Note that these activities are done on the basis of the results from the safety assessment for Single Remote Tower. **Only additional or modified outputs are included in this report**.

2.2 Multiple Remote Tower - Operational Environment and Key Properties

This section describes the key properties of the Operational Environment that are relevant to the safety assessment of the ATC services provided from a Remote Tower. This information is mainly obtained from the OSED [4], sections 4.1.1 and 4.1.2.and from the Single Remote Tower SAR [ref] section 2.2.

Multiple Remote Tower providing ATC services is assessed (within the scope of this safety assessment) mainly in the same Operational Environment as Single Remote Tower with the exception of the following key properties:

- By its nature, ATC service is provided to several aerodromes, two aerodromes in the frame of this safety assessment

- The service is mainly to be provided on the basis of single operations, rarely exceeding two simultaneous movements per aerodrome. The service is provided to both aerodromes at all times but traffic at one aerodrome may at rare occasions experience delays due traffic at the other aerodrome, if not coordinated.

- The targeted aerodromes are airport below third level node, i.e. low density and low utilisation aerodromes, with only one runway and non-complex layout.

Concerning the other properties of the operational environment they remain the same as for Single Remote Tower:

Airspace Structure, Boundaries and Types of Airspace

Airspace classification: Class C, Class D

Control Zone - CTR: 10-15 NM radius/rectangular, vertical extension up to 3000ft MSL.

Terminal Control Area - TMA: 10-30 NM radius/rectangular, from 1000-2000 MSL to FL095. This area is taken into account when providing APP additionally to TWR services.

Procedures: specific IFR routes and approach procedures and established VFR routes

Airspace Users (Flight Rules), Traffic Levels and complexity

Traffic Type: VFR and IFR, mainly scheduled, charter and General Aviation (GA) flights and Business Aviation (BA).

Aircraft Fleet mix: all type of aircraft

Aerodrome Layout Characteristics

Taxiway and runway entries: 1 to 3, at the end or middle of the runway (or both)

Aprons: 1 to 4

CNS Aids

Communication: ATC voice communication, VHF-transmitters/receivers, Ground radio system, Autonomous VHF-radio, Search and Rescue (SAR) radio, UHF transmitters/receivers. Data link could be implemented.

Navigation: Navigation specifications including ILS and RNAV (using NDB, DME).

Surveillance: Visual information ("Out of the window" view), Surveillance service may be provided above specific altitude, typically 1000-2000ft, mainly radar-based. ADS-B and surface radar could also be available, but this is out of the scope of the safety assessment.

2.3 Airspace Users Requirements

As explained in the Safety Plan [3] the introduction of Remote and Virtual Tower concept is not safety driven, i.e. the purpose is not to improve safety, but mainly to reduce ATS related costs, in particular in the case of Multiple Remote Tower. Based on that, the safety criteria to be applied has to ensure

that the level of safety is at least not reduced due to introduction of the Multiple Remote Tower, so the airspace users are provided with the same service as in current operations.

For Multiple Remote Tower the aim of the safety assessment is then to show that the provision of ATC services to two low density aerodromes by a single ATCO from a remote location, i.e. not from a control tower local to any of the aerodrome, is as safe as current locally provided ATC services by two ATCOs. This applies for both situations: a single ATCO/AFISO providing the service to one airport at the same time or to both of them in parallel.

2.4 SAfety Criteria

In order to perform the safety assessment of the Remote Tower concept, the level of safety mentioned in previous section is to be defined in terms of risk (per flight or per flight hour) associated to the hazardous situations (listed in section 2.5), and defining how the system contributes to them. Based on that, the generic criterion is then refined as shown in section from 2.4.1 to 2.4.6.

Quantification of this risk is to be done based on the Accident-Incident Model (AIM) [7] from WP16.1.1 and from historical data as far as possible. This quantification represents an ECAC wide average of the risk associated to the ATM baseline (i.e. current ATM system before SESAR implementation which in the case of Remote Tower means current service provided from the tower located in the premises of the corresponding airport).

The SAfety Criteria (SAC) presented hereafter are expressed with respect to this baseline. They do not take account for any modification on the capacity, throughput or traffic movements in the airports considered for each application (these parameters are considered to be the same as in today operations). Even if enhanced visualisation features could have an impact on the movement rate during LVC, the safety criteria is considered in equivalent conditions of traffic (in terms of capacity and movements) and operational environment than in current operations. In case there is a change on this traffic related parameters (e.g. based on results obtained during the concept validation process or inputs from others related projects), then the Safety Criteria will be reviewed and adapted to the new situation.

Note: the terms used to describe specific hazardous events (e.g. Imminent Infringement, Runway Conflict, etc.) used in the SAC are directly obtained from specific elements of the Accident Incident Model used to derive them.

2.4.1 SAfety Criteria related to Mid-Air Collision in TMA

SAC-M#1   There shall be no increase of ATC induced tactical conflict in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

SAC-M#2   There shall be no increase of Imminent Infringement in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

  a. as a function of Ineffective ATCO induced conflict management
  b. as a function of Ineffective externally-induced conflict management
  c. as a function of Ineffective plan induced conflict management

SAC-M#3   There shall be no increase of Imminent Collision in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

  a. as a function of Ineffective ATCO Collision prevention

2.4.2 SAfety Criteria related to Controlled Flight Into Terrain

SAC-M#4   There shall be no increase of Flight Towards Terrain commanded by ATC in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

SAC-M#5   There shall be no increase of Imminent Controlled Flight Into Terrain (CFIT) in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Ineffective ATCO warning

2.4.3 SAfety Criteria related to Wake Vortex Induced Accidents

SAC-M#6   There shall be no increase of under-spacing allowing for Wake Vortex Encounter in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Insufficient Wake Turbulence approach spacing imposed by ATC
   b. as a function of Insufficient Separation to prevent Wake Vortex Encounter spacing provided by ATC

2.4.4 SAfety Criteria related to Taxiway Collision

SAC-M#7   There shall be no increase of Taxiway conflicts in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Ineffective ATC taxiway planning
   b. induced by ATCO

SAC-M#8   There shall be no increase of Imminent Taxiway Infringement in the in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Inadequate ATC conflict management

SAC-M#9   There shall be no increase of Imminent Taxiway Collision in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Ineffective ATC collision avoidance

2.4.5 SAfety Criteria related to Runway Collision

SAC-M#10   There shall be no increase of Runway Incursion in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Ineffective ATC runway entry procedures
   b. as a function of Ineffective ATC vigilance to recognise pilot/driver entering
   c. as a function of ineffective landing management
   d. as a function of ineffective take off management

SAC-M#11   There shall be no increase of Runway Conflict in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Ineffective ATC vigilance to detect Aircraft/Vehicle and Animal/Person runway incursions prior to issuing landing/take-off clearance

SAC-M#12   There shall be no increase of Imminent Runway Collision in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Ineffective Runway Collision Avoidance

2.4.6 SAfety Criteria related to "Landing accidents"

SAC-M#13   There shall be no increase of Landing related Accidents (mainly runway excursions) in each aerodrome for which ATS are remotely provided, in sequence or in parallel, using Multiple Remote Tower

   a. as a function of Ineffective weather conditions monitoring affecting arriving/departing aircraft (leading to hard landing or runway excursion)
   b. as a function of Ineffective check or the runway surface (with respect to snow, slush, RWY surface friction, FOD, …) (leading to loss of control on the runway or runway excursion)

c. as a function of Ineffective monitoring of AC trajectory on final approach (leading to undershoot, AC landing in wrong/closed RWY, AC landing with undercarriage retracted)
d. as a function of Ineffective monitoring of potential intrusions inside the landing-aid protection area (affecting landing AC)
e. as a function of Inefficient management of landing-aid lights

2.5 Relevant Pre-existing Hazards

The same hazardous situations and risks to be mitigated as in current operations and in Single Remote Tower are to be considered for Multiple Remote Tower.

The complete list of hazardous situations, called pre-existing hazards, is provided in the [18] section 2.5.

An additional AIM model is being produced in the frame of P16.6.1 concerning the risk of Runway Excursion (ref). Even if the model is still under development, its qualitative part is currently quite stable to be used in this safety assessment.

From this mentioned list, the following pre-existing hazards should then be linked to this AIM Runway Excursion model:

Pre-existing Hazards		AIM Model
Hp#9	Adverse weather conditions like violent winds or severe crosswind	RWY-EXC
Hp#10	Snow/slush on the runway	RWY-EXC
Hp#11	Low runway surface friction	RWY-EXC
Hp#15	Another aircraft or vehicle inside landing-aid protection area during CATII/III instrument approach	RWY-EXC
Hp#16	Foreign Object Debris within the Runway protected area	RWY-EXC
Hp#17	Aircraft attempt to land with undercarriage retracted	RWY-EXC

Table 1: Update of information for some Pre-existing Hazards

Concerning the following pre-existing hazard:

Hp#18 Loss/interruption of ATC services

It needs to be clarified that it can affect to one or both aerodromes at the same time.

2.6 Mitigation of the Pre-existing Risks – Normal Operations

2.6.1 Operational Services to Address the Pre-existing Hazards

The same ATC services as for Single Remote Tower (and thus provided in current operations) are to be provided <u>to each of the aerodromes</u> under the responsibility of the same ATCO in Multiple Remote Tower operations. They address the pre-existing hazards identified above in the same way.

The list of ATC services is provided in the [18] section 2.6.1.

Due to the availability of the Runway Excursion model at the time of this safety assessment, more detailed information is now presented here with respect to the service RVT.ATC-12 included in the list mentioned before:

RVT.ATC-12	ATC detection and recovery of weather affected runways situations (that may potentially lead to a runway excursion)
	ATC detection and recovery of runway infrastructure/suitability issues (that may potentially lead to a runway excursion)
	ATC detection and recovery of unstable approaches (that may potentially lead to a runway excursion)
	ATC prevention of / recovery from **other** events potentially leading to other landing related accidents

Table 2: Update of ATC service RVT.ATC-12

2.6.2 Derivation of Safety Objectives for Normal Operations

The safety objectives describe WHAT the Multiple Remote Tower system has to operationally perform more in detail in order to provide the ATC services mentioned in previous section. The whole set of safety objectives is aiming to achieve the safety criteria defined in section 2.4.

The HOW this is to be done will be described by the safety requirements and recommendations, derived from those safety objectives, in terms of requirements on technical equipment (information to be provided and associated performance characteristics), controller competence/training, and procedures.

Three main phases on a one-day service provision basis for a Remote Tower position were identified in the [**18**]:

- Service Initiation phase

- Service provision phase

- Service termination phase

This section addresses the second one (service provision phase), the two others are assessed in next section 2.6.3.

For this phase the same safety objectives related to ATC service in normal operations as for Single Remote Tower are applicable to Multiple Remote Tower. **This list is provided in the [18]in section 2.6.2.**

It has to be noted that all these safety objectives are applied to the several aerodromes (two in the case of this safety assessment) to which ATC service is being remotely provided. And that taking into account the different situations related to each aerodrome in terms of:

- Type of traffic: aircraft, helicopters, vehicles

- Type of operations and movements: on the air, on the ground

- Operational Environmental Conditions: visibility conditions, time of the day, etc.

- Operational Procedures and rules being applied: IFR/VFR, LVC procedures, etc.

Note: The complete list of safety objectives (see Appendix A) is to be included in the Remote Tower OSED, and added to /combined with the list of operational requirements already available in section 6 of that document.

Two assumptions - related to the rules of the air and the procedures to be applied by the flight crew, were also identified in the SRT SAR in order to ensure the appropriate provision of the services described in previous section. They apply in the same way for Multiple Remote Tower as for Single Remote Tower. **These assumptions are listed in the [18] section 2.6.2.**

The assessment concerning the Safety Objectives related to AFIS is provided in Appendix F.

2.6.3 Analysis of the Concept for typical RVT position in a RTC

As described in previous section, three main phases are considered on a one-day ATC service provision basis for a Remote Tower position. The corresponding safety objectives for phase 2 (Service Provision phase) have been addressed in section 2.6.2.

Concerning the other two phases (Service Initiation and Termination phases) the corresponding safety objectives identified for Single Remote Tower are also applicable for Multiple Remote Tower. **These safety objectives are provided in the [18] section 2.6.3**.

Concerning these safety objectives the following has to be emphasised:

- For SO-040: the assessment of the capabilities of the Remote Tower position needs to be done with respect to both aerodromes to which remote service is to be provided.

- For SO-042: the service has to be appropriately (safely) stopped (for planned termination) for one aerodrome, while continuing the service provision in the other, or both at the same time.

- For SO-041 and SO-043: the notification of the initiation or termination of the service is to be ensured for all the mentioned actors in both aerodromes for which remote tower service is provided.

Apart from the ATC service provision aspects mentioned above, there are as well some Demand and Capacity Balancing (DCB) related tasks at Remote Tower Centre level ensuring that the traffic and capacity conditions are the ones enabling the remote provision of ATC services from a Remote Tower position. This is particularly important in the case of Multiple Remote Tower.

The safety objective related to these RTC aspects and already identified for Single Remote Tower (see [18] section 2.6.3 SO-039), is split and defined in more detail here after in order to better specify the operational needs for Multiple Remote Tower:

SO-039-M01: RTC shall enable strategic and pre-tactical DCB tasks, in particular management of ATC resources (in terms of roasting, staff allocation, modules and clusters definition and planning, etc.), taking account of weather forecast, traffic demand and any other factors impacting the capacity of the centre to provide relevant ATC/AFIS services to concerned aerodromes.

SO-039-M02: RTC shall enable tactical DCB tasks, in particular management of ATC resources (in terms of staff and modules/clusters management, etc.) with respect to weather conditions, traffic overload/peaks and unexpected events.

Note that the traffic management aspects of the DCB tasks are less relevant for the operational environment addressed in the safety assessment as the targeted aerodromes are only those with low density traffic.

A part from this DCB tasks, and depending on the number of aerodromes and the traffic density, the provision of remote tower services for multiple aerodromes may be subject to the availability of a 'common' APP services providing sequenced traffic to those concerned aerodromes for which the same controller is responsible for.

This is not the case for the operational environment addressed in this safety assessment, but needs to be taken into account for other applications of the Multiple Remote Tower concept.

2.7 Multiple Remote Tower Operations under Abnormal Conditions

The purpose of this section is to assess the ability of the Multiple Remote Tower to work through (robustness), or at least recover from (resilience) any abnormal conditions, external to the Remote Tower System, that might be encountered relatively infrequently.

The same abnormal conditions scenarios as per Single Remote Tower are addressed to assess the Multiple Remote Tower concept. They are listed in section §2.7.1 of the **[18].**

The potential operational effects of these abnormal conditions and the potential mitigations of these effects are mainly the same as in the Single Remote Tower. The only difference is that the new **SO-039-M02** identified in section §2.6.3 can also be applied as mitigation means for all the abnormal conditions scenarios except for the first one.

With respect to the safety objectives for Single remote Tower identified in relation to the abnormal conditions, all of them also apply to the Multiple Remote Tower concept. Just a slight clarification needs to be done on the following ones:

- SO-049 and SO-050: They may apply to one of the aerodromes or both of them.

The complete list of safety objectives related to abnormal conditions is presented in [18] section 2.7.2.

Assumption AO-03 is applicable as well to Multiple Remote Tower as it was for Single RT.

2.8 Mitigation of System-generated Risks (failure approach)

This section concerns Multiple Remote Tower operations under internal failure conditions.

The same operational hazards identified for Single Remote Tower are applicable for Multiple Remote Tower. No additional operational hazard has been specifically identified due to the multiple application of remote tower concept.

Concerning the assessment and the assigned severity class for those mentioned operational hazards, several points need to be clarified.

The complete list of hazards and their corresponding analysis is available in the **[18]** section §2.8.1. The list of relevant assumptions stated during the assessment is also included in this section.

Concerning hazards from OH-01 to OH-34:

- With respect to the protecting mitigation means related to those hazards, i.e. reducing their potential consequences: their performance may be reduced by the fact that controller resources (in particular their situational awareness) are used for several aerodromes instead of just one as it was the case for Single Remote Tower. Nevertheless, for the case addressed in the scope of this document - i.e. SD-0205, it is considered that the impact of this reduction is negligible in the considered operational context which is low density traffic. Then the same outcomes in terms of consequences and severity class are kept for each hazard.

  Note (limitation): for any other operational context these hazards and their corresponding mitigation means have to be re-assessed

- With respect to the causes leading to those hazards: a part from the ones already identified for Single Remote Tower, additional causes related to the multiple application of remote tower may lead to those hazards, or even the contribution of the ones already identified may be different..

Concerning hazards from OH-31 to OH-34: due to the availability of the runway excursion model the consequences for these hazards can be defined in some more detail (even if the corresponding severity class is not yet available for this model):

- OH-31: this hazard can lead to two situations: to an unstable approach and thus to a touch down after an unstable approach, or to a touch down on weather affected runways. Both situations can potentially lead to a runway excursion.

- OH-32: this hazard can lead to a touch-down in a runway with suitability issues and thus potentially to a runway excursion.

- OH-33 and OH-34: both hazards can lead to an unstable approach and this to a touch-down after an unstable approach which can potentially lead to a runway excursion.

Concerning OH-35: There is no change in multiple remote tower with respect to single remote tower; it is still covered by the other more detailed hazards.

Concerning OH-36: there are two aspects to be considered:

- In case it is <u>not detected</u> in time the controller would have to manage more traffic than expected, the controller workload could be negatively impacted and so the capability to provide ATC services. In this case this hazard is considered as part of all the other hazards in which controller errors are a potential cause.

- In case it is <u>detected in time</u>, and there is the possibility to either transfer one of the aerodromes to another module / controller (**SO-039M2**), or otherwise to stop the provision of the service in one of the aerodromes (**SO-049**) to focus only on the other. This may require the support of the Supervisor in the corresponding RTC. In this case the impact in safety is quite low but the capacity is then reduced.

Concerning OH-37: this hazard can affect one of the aerodromes or both of them. Two cases are to be considered:

- When 'individuals' failures affects the provision of the remote service. These causes are analysed in sections §3 and corresponding mitigations means are provided for each of them as relevant.

- When the inappropriate capability of the RVT system is more global and detected, and then the provision of the service needs to be stopped (**SO-051** and **SO-052**) or transferred to another RTM. This may require the support of the Supervisor in the corresponding RTC.

The corresponding list of Safety Objectives related to these hazards is then the same as for Single Remote Tower, as well as the list of Assumptions stated for the assessment of these hazards.
<u>Note:</u> the values included in these Safety Objectives are derived based on the maximum tolerable frequency of occurrence of the corresponding severity class in the relevant Risk Classification Scheme proposed in the SESAR Safety Reference Material. These frequencies of occurrence are an ECAC wide average of the baseline risk (related to current operations – before SESAR), not local levels of risk for specific aerodromes. For local implementation, these figures need to be checked and updated to reflect the local associated risk.

The complete list is presented in the **[18]** in section §2.8.2.

As in previous section, these Safety Objectives expresses **WHAT** we expect, in terms of integrity, from the entire Remote & Virtual Tower system as a whole. The safety requirements and recomendations that will be derived from them will cover the HOW these Safety Objectives are to be satisfied, in terms of technical equipment, controller tasks and procedures.

2.9 Impacts of Remote Tower operations for multiple aerodromes on adjacent airspace or on neighbouring ATM Systems

Any potential interaction with adjacent airspace and impact on neighbouring ATM system are already addressed in previous sections.

No additional safety objectives have been identified on that subject apart from the ones already derived from the assessment of the operations at normal conditions.

2.10 Achievability of the SAfety Criteria

As for Single Remote Tower, no quantitative evidence on the achievability of the safety criteria through the specification of the safety objectives have been collected for Multiple Remote Tower.

Issue: evidences collected are mainly subjective feedback from operational people involved in the project and in the validation exercises.

2.11 Validation & Verification of the Safety Specification

The validation exercises performed in the frame of Remote Tower OFA concerning the Multiple Remote Tower concept have been the following ones:

- **Trial 1: EXE-06.09.03-VP-060** - Multiple Remote TWR Simulation addressing ATC tower services

- **Trial 2: EXE-06.09.03-VP-061** - Multiple Remote TWR Live Trial in shadow passive mode addressing ATC tower services, for basic and advanced RVT position

- **Trial 3: EXE-06.09.03-VP-063** - Multiple Remote AFIS Live Trial in shadow passive and active mode addressing AFIS services, for basic and advanced RVT position

- **Trial 4**: EXE-06.08.04-VP-641 – Mulitple Remote TWR simulation addressing ATC tower services, for basic remote tower position.

L004 The results from these trials have allow to obtain some evidence on the validity of the results obtained for normal operations conditions, but limited evidence concerning abnormal conditions operations and degraded modes (related to internal system failure) have been obtained as only passive shadow mode trials have been done concerning ATC services.

The way these situations (abnormal conditions and degraded modes) can be managed is quite dependent to the physical solution used for implementing the concept. This is then an area that needs to be deeper and specifically assessed at the next life cycle phase.

During those trials, some ATC tasks were identified as being more challenging in the multiple remote tower environment than in current operations (i.e. provision of ATC services from a tower located in the premises of the corresponding aerodromes), needing in particular further assessment for the local implementation of the concept. These tasks were 'Identification of an aircraft in the vicinity of the aerodrome', 'Application of reduced separation in the vicinity of the aerodrome', 'Detection of potential flights towards terrain' and 'Appropriately assess weather conditions impacting traffic'

This is afterwards captured in the corresponding safety requirements derived in section 3 for each corresponding safety objective, in particular for the low density operational environment considered in this SAR.

The safety related results on Trial 2 are presented in Appendix E. The complete set of results from the 3 trials mentioned above is provided in the Validation Report [15].

L005 The validity of the evidences collected from the trials is dependent on the characteristics of the aerodrome / operational environment used in those trials (described in the Validation Report [15]), which are a sub-set of the operational environment in which remote tower is aimed to operate (as described in section 2.2). This is particularly true for the traffic density and the number of simultaneous movements.

Apart from the trials results, expert judgement has also been used for validating some results through working meetings, workshops and document reviews.

3 Safe Design at SPR Level

3.1 Scope

Based on the safety assurance activities defined in the Safety Plan [1], this section addresses the following activities:

- description of the Logical Model of the Multiple Remote Tower system – section 3.2

- derivation, from the Functional and Performance Safety objectives of section 2, of the Functional Safety Requirements for the Multiple Remote Tower system previously described – section 3.3

- analysis of the operation of the Multiple Remote Tower system described above under normal operational conditions – section 3.4

- analysis of the operation of the Multiple Remote Tower as described above under abnormal conditions of the operational environment – section 3.5

- assessment of the adequacy of the Multiple Remote Tower as described above under internal-failure conditions and mitigation of the system generated hazards – section 3.6

- satisfaction for the Safety Criteria by the Multiple Remote Tower system– section 3.7

- realism of the Multiple Remote Tower system – section 3.8

- validation and verification of the Multiple Remote Tower system specification – section 3.9

> Note that these activities are to be done on the basis of the results from the safety assessment for Single Remote Tower. **Only additional or modified outputs are included in this report**.

3.2 The SPR-level Model for Single Remote Tower

The SPR-level Model in this context is a high-level architectural representation of the Multiple Remote Tower system design that is entirely independent of the eventual physical implementation of the design (which should be addressed in next phase of the life cycle). The SPR-level Model describes the main human tasks and machine functions as well as their interactions. In order to avoid unnecessary complexity, human-machine interfaces are not shown explicitly on the model – rather they are implicit between human actors and machine-based functions.

Note that two configurations of the Remote Tower system for the multiple application of the concept have been considered in the project:

- The <u>Basic configuration</u>, as presented in section 3.2.1 in which, using the visualisation system, visual information is provided to the controller in the same way as it would be from a real tower located in the aerodrome.

- The <u>Advanced configuration</u>, in which besides all the elements provided in section 3.2.1, additional enhanced visual features are also available on the visualisation system, providing additional information to the controller in order to support him/her to perform the corresponding ATS tasks. These enhanced features are listed in section 3.2.1.2 below, and further described in the OSED [4].

L006: The safety assessment mainly focuses on the basic configuration. Reference to any of these advanced visual features is only made in this report in case there may be an operational need for them to be put in place. Additional assessment of these specific enhanced visual features needs to be performed in particular concerning their integrity and reliability characteristics. Recommendations on the enhanced visual features are provided in this report, but no detailed assessment on their real impact on safety (benefice or degradation) has been provided in the frame of this assessment.

3.2.1 Description of SPR-level Model

The following figure shows the several elements composing the Remote and Virtual Tower (RVT) system for multiple aerodromes, located in a Remote Tower Centre (RTC) providing ATS services. For completeness reasons, external elements interacting with RVT are also shown in this model in order to derive relevant requirements and/or assumptions for the specification of the RVT system.
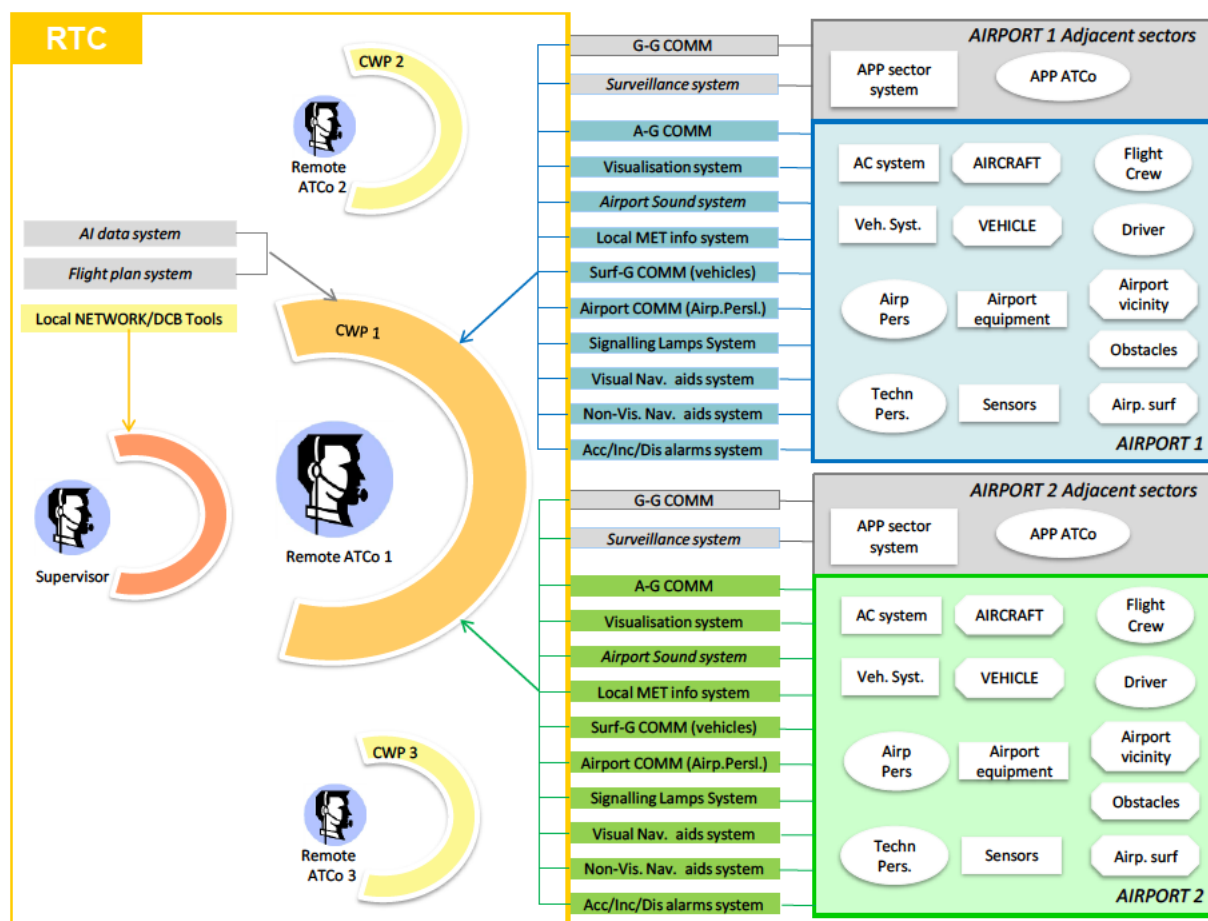
Figure 1: SPR-level Model for Multiple Remote Tower

For each aerodrome the same elements as for the Single Remote Tower are present. Their description is provided in the **[18]** section §3.2.1. Only additional information is provided here with respect to specific elements or information relevant for Multiple Remote Tower.

3.2.1.1 Aircraft elements

The same as for Single Remote Tower

3.2.1.2 Ground Elements

Remote Tower Centre (RTC):

Supporting elements

Note that the SAR is focused on the controller providing ATC services to two low density aerodromes. The supporting elements within the Remote Tower Centre mentioned here after are not mandatory for this concept, but some information is nevertheless provided with respect to them as they may be quite relevant for any evolution of this concept.

- **Local Network/DCB tools**: Provides relevant information and tools for supporting the Supervisor's tasks as managing the allocation of airport/clusters of airports to the RTM in the RTC and the re-staffing resources.

- **Supervisor**: Several tasks have been identified for the role of supervisor in the frame of a RTC. These tasks may need to be put in place or not depending on the number of modules and staff within the RTC, the type of services provided from the RTC, and the levels and

complexity of traffic that the RTC need to deal with. The identified tasks are (not exhaustive list, see detail in section 3.2.2):

- Demand / Capacity Balancing related tasks:
  - Strategic phase: roasting, definition of clusters of airports
  - Pre-tactical: staff allocation, planning of modules/clusters in the RTC
  - Tactical: dynamic DCB, management of modules/clusters in the RTC with respect to unexpected events
- Coordination related tasks:
  - Strategic / pre-tactical: coordination for aerodrome related activities
  - Pre-tactical: coordination for TMA related activities
  - Tactical: coordination for dynamic DCB measures
- Statistics tasks:
  - Post-operations: support to statistical activities on the relevant aerodrome(s)
- Service provision related tasks:
  - Tactical: support to Search And Rescue - SAR service
- Management of degraded modes:
  - Tactical: management of 'operational' and technical alerts in degraded mode situations

Controller Working Position (RVT – RTM)

- The several elements listed here after are available (the associated information they provide is the same as for Single Remote Tower) at the RVT level for each of the aerodromes for which remote services are provided:
- AI data system
- Flight Plan System
- Ground-Ground Communications
- Air-Ground Communications
- Surface-Ground Communications
- Airport Communication
- Surveillance Data (optional)
- Signalling Lamps system
- Visual Nav. Aids system
- Non-visual Nav. Aids system
- Accident, incident and distress alarms
- Airport Sound System (optional)
- Local MET system

- **Visualisation System**: provides the same kind of information but for the several aerodromes for which remote services are to be provided - two low density aerodromes in the scope of this safety assessment. As it was the case for single, additional advanced features may also be available on the visualisation of each aerodrome.
- **CWP HMI**: allows to the controller / operator to get all the information provided by the elements listed above (for the several aerodromes for which remote services are to be provided) and to interact with them as necessary.
- **ATCO**: Provides ATC services to multiple aerodromes (see detail in section 2.6) by using the information provided in the CWP HMI. The related ATCO tasks are described through the Task Analysis activity carried out in the frame of the HP assessment, included in section 3.2.2.

"Technical supervision" related elements

Unchanged with respect to Single Remote Tower, but applicable to each of the airports for which remote services are to be provided in a Multiple Remote Tower mode.

Airport Premises

Elements in this area are unchanged with respect to Single Remote Tower concept.

3.2.1.3 External Entities

Unchanged with respect to Single Remote Tower for:

- "Other ATC Unit" elements
- "E-Network" elements
- "Airport premises" elements

3.2.2 Task Analysis

Two task analyses have been developed in the framework of the HP assessment for Multiple Remote Tower.

- A task analysis providing the detail of the tasks done by the controller for the provision of the ATC services to several aerodromes as described in section 2.6.1.
- A task analysis providing the detail of the supervisor tasks in a Remote Tower Centre.

These tasks analysis are available in the Appendix A of the HP assessment for Multiple Remote Tower [16].

3.2.3 Derivation of Safety Requirements (Functionality and Performance – success approach)

This section provides the additional or modified safety requirements and recommendations (with respect to Single Remote Tower) satisfying the safety objectives (functionality and performance) presented in section 2 for both normal and abnormal conditions. These safety requirements and recommendations are defined at the level of the relevant elements of the SPR-level model shown above.

Most of the safety requirements and recommendations defined for Single remote Tower are also applicable to Multiple Remote Tower concept. This section only presents which of those may be impacted by the provision of remote ATC services to several aerodromes from the same MRVT and in which way, as well as including some additional ones related to MRVT and RTC concepts. The other safety requirements and recommendations obtained from Single Remote Tower and applicable to Multiple Remote Tower are presented in **[18]** section 3.2.3.

The safety requirements and recommendations presented here have been obtained based on:

- *Results from the Single Remote Tower assessment*
- *Results from validation exercises addressing MRVT concept*
- *Results from workshops and discussions with operational and technical experts*

Information concerning the validation of each of these safety requirements is provided in Appendix B.

SR#	Safety Requirement / Recommendations	Derived from
G-G COMM		
SR-06M1	Ground-ground communication with relevant adjacent units (i.e. for each airport within the cluster allocated to the same MRVT position)	SO-001 SO-046

SR#	Safety Requirement / Recommendations	Derived from
	shall be available to the controller in a MRVT position	SO-047
	Note: as per the aeronautical fixed service in accordance with ICAO Annex 11, Chapter 6.2	
SR-06M2	ATCO shall be aware about which adjacent unit a communication (in and out) is related to. Note: in low density aerodromes no additional technical feature may be requested but for more busy aerodromes an indication on the corresponding adjacent unit should be provided to the ATCO.	SO-001 SO-046 SO-047
A-G COMM		
SR-07M01	Air-ground communication with relevant traffic (i.e. for each area of responsibility related to each airport allocated to the same MRVT position) shall be available to the controller in a MRVT position. Note: as per the aeronautical mobile service in accordance with ICAO Annex 11, Chapter 6.1	SO-002 SO-003 SO-004 SO-005 SO-009 SO-010 SO-011 SO-012 SO-013 SO-014 SO-017 SO-019 SO-020 SO-021 SO-024 SO-025 SO-026 SO-027 SO-029 SO-030 SO-031 SO-035 SO-046 SO-050 SO-052
SR-07M02	Controller shall be aware about which airport a communication (in and out) with traffic under his/her responsibility is related to	Same
SR-07M03	Air-ground communication function in the MRVT position shall allow: - to receive communication from all traffic in all the aerodromes at the same time - to transmit to traffic independently for each aerodrome	Same
SRec-07M04	Controller should be able to combine air-ground communication for each aerodrome allocated to the same MRVT position.	Same
Surf-G COMM (airport personnel/vehicles inside manoeuvring area)		
SR-08M01	Communications for the control of relevant vehicles, other than aircraft, on manoeuvring areas (i.e. at each aerodrome under	SO-015 SO-017

SR#	Safety Requirement / Recommendations	Derived from
	control of the same ATCO) shall be available to the controller in a MRTV position. Note: as per the Surface movement control service in accordance with ICAO Annex 11, Chapter 6.3	SO-021 SO-023 SO-026 SO-027 SO-035
SR-08M02	ATCO shall be aware about which airport a communication (in and out) with vehicles under his/her responsibility is related to	Same
SR-08M03	Communication function in the MRTV position shall allow to transmit communication to vehicles independently for each aerodrome	Same
Surf-G COMM (airport personnel/vehicles outside manoeuvring area)		
SR-10M1	Communication with airport personnel in charge of runway inspections shall be available to controller in the MRVT position for the coordination of runway inspections in order to determine runway conditions and detect potential FODs/animals	SO-032
SR-10M2	ATCO shall be aware about which airport a communication (in and out) with airport personnel in charge of runway inspections is related to.	SO-041 SO-043 SO-050 SO-052
Visualisation system		
SR-14M01	Visual presentation of the traffic in the vicinity of each aerodrome under the responsibility of the same controller shall be provided to the controller in the MRVT position. Note: this includes final approach and initial climb areas, and it has to take into account specific traffic evolution for landing and take-off as it is the case for helicopters.	SO-002 SO-003 SO-004 SO-005 SO-006 SO-007 SO-008 SO-009 SO-010 SO-028 SO-029 SO-030 SO-044 SO-045 SO-046 SO-047
SRec-14M02	Visual indication supporting aircraft identification in the vicinity of each aerodrome allocated to the same MRVT position should be provided to the controller Note: from all the advanced visual features tested in this project radar tracking feature would be the best option in this case, noting that the tracking could be done based on other surveillance means than radar, as ADS-B, WAM, etc. Note: this is a recommendation in the operational environment addressed in this assessment. For airports with a higher traffic density and complexity this recommendation is to be considered to be a 'shall' requirement.	SO-002 SO-003 SO-004 SO-005 SO-006 SO-007 SO-008 SO-009 SO-010 SO-028 SO-029 SO-030

SR#	Safety Requirement / Recommendations	Derived from
	Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM. Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01.	SO-044 SO-045 SO-046 SO-047
SRec-14M03	Visual indication supporting the estimation of the position of the aircraft with respect to the terrain in the vicinity of the aerodrome may be provided to the controller Note: from all the advanced visual features tested in this project radar tracking feature would be the best option in this case, noting that the tracking could be done based on other surveillance means than radar, as ADS-B, WAM, etc. Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM. Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01.	SO-28
SR-16M01	Visual presentation of the manoeuvring area for each airport allocated to the same MRVT position and the traffic/vehicles/ personnel on this area shall be provided to controller in the MRVT position Note: this includes runways and the traffic/vehicles/ personnel on or close to it.	SO-014 SO-015 SO-016 SO-017 SO-045 SO-046 SO-047
SRec-16M02	Visual indication supporting aircraft/vehicles identification in the manoeuvring of each aerodrome allocated to the same MRVT position should be provided to the controller Note: from all the advanced visual features tested in this project visual tracking feature would be the best option in this case Note: this is a recommendation in the operational environment addressed in this assessment. For airports with a higher traffic density and complexity this recommendation is to be considered to be a 'shall' requirement. Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM. Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01.	SO-014 SO-015 SO-016 SO-017 SO-045 SO-046 SO-047
SRec-16M03	Visual indication supporting the identification of aircraft/vehicles/obstacles/people entering into or being close to a runway should be provided to the controller Note: from all the advanced features tested in this project visual	Same plus SO-035

SR#	Safety Requirement / Recommendations	Derived from
	tracking feature would be the best option in this case	
	Note: this is a recommendation in the operational environment addressed in this assessment. For airports with a higher traffic and movement density and complexity, this recommendation is to be considered to be a 'shall' requirement (this functionality becoming then a safety net for the prevention of runway incursions).	
	Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM.	
	Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01.	
SR-68M01	Even if controller is able to select different ways of presenting the visual information mentioned in safety requirements SR14-M01 and SR16-M01, visual information for each airport under his/her responsibility shall constantly be presented to the controller in a way allowing the controller to maintain situation awareness in both aerodromes at any time.	SO-007 SO-016 SO-026 SO-028 SO-035
ATCO – ATC service provision		
SR-26M01	Controller shall apply relevant current procedures (as per ICAO PANS ATM [9]) to provide corresponding ATC Tower service to all the aerodromes under his/her responsibility from a same MRVT position. Note: the same examples as per Single RT apply.	SO-001 SO-002 SO-003 SO-004 SO-005 SO-006 SO-007 SO-008 SO-009 SO-010 SO-011 SO-012 SO-013 SO-014 SO-015 SO-016 SO-017 SO-018 SO-019 SO-020 SO-021 SO-022 SO-023 SO-024 SO-025 SO-026 SO-027 SO-028 SO-029 SO-030

SR#	Safety Requirement / Recommendations	Derived from
		SO-031 SO-032 SO-033 SO-034 SO-035 SO-036 SO-037 SO-044 SO-045 SO-046 SO-047
SR-69M01	Controllers shall be provided with a specific training related to local weather conditions of the concerned aerodromes to which remote services are to be provided	SO-028
SR-27M01	Handover procedures shall be applied in a MRVT position (for all the airports allocated to the same MRVT position) as in current operations. Additional information concerning MRVT equipment status shall also be transferred from one controller to the other during this procedure.	SO-038
SR-27M02	Handover procedures between different MRVT positions shall be applied in case one or several airports have to be transferred from one RTM to another within a Remote Tower Centre Note: in the frame of this SAR a cluster is only compose of maximum two airports	SO-038
SR-031M1	In case of unexpected event in one of the airports significantly increasing the workload of the controller affecting the capability of the controller to continue providing safe remote services to all airports under his/her responsibility, the controller shall, in order to be able to manage the abnormal situation either: - Stop the provision of the remote service for the other airport(s) (as per SR-031M2) or - Transfer the provision of the remote service for the airport experiencing the unexpected event or the other airport(s) to another MRVT in the RCT (as per SR-027M1) or - Request another ATCO in the RTC to support him/her on the service provision Note: supervisor in the RTC may support the controller to apply these procedures	SO-049
SRec-031M2	Prior to an unplanned termination of the service provision, controller should ensure that ATC services are safely stopped for the concerned airport. Note: supervisor in the RTC may support the controller on this procedure.	SO-049
RTC level		
SR-33M01	Aerodrome capacity shall be defined not only based on the aerodrome characteristics but also taking account the fact that ATC	SO-039

SR#	Safety Requirement / Recommendations	Derived from
	service is remotely provided by a controller providing service to several airports at the same time. Note: For relevant aerodromes (mainly based on their size) capacity is to be provided to the Network Manager and relevant bodies in charge of Demand & Capacity Balancing activities (locally, regionally) in order to ensure that the traffic on those aerodromes to be controlled from a MRVT position is not exceeding those limits.	
SR-33M02	Clusters of aerodromes to be allocated to a MTRV position shall be defined at local level in order to ensure that the traffic levels and complexity will not exceed low density and rarely two simultaneous movements. <u>Note</u>: other criteria are also to be taken into account, as avoiding similar airport or runways identifiers, or consistency of procedures between clustered aerodromes, but priority is to be given to the traffic levels and complexity.	SO-039
Supervisor *Note that this role is not a mandatory function in the frame of the concept addressed in this SAR, but if implemented, the following requirements apply*		
SR-34M01	If a RTC Supervisor role is implemented - Supervisor in a RTC shall access functions for the planning, coordination and monitoring of the upcoming and present traffic flow, in the purpose of tactical opening and closure of MRVTs and allocation of airports to them taking into account the capacity associated to each cluster of aerodromes.	SO-039M1
SR-34M02	If a RTC Supervisor role is implemented - Supervisor in a RTC shall provide relevant support to controllers in a MRVT position in order to ensure the safe provision of remote ATC services to multiple aerodromes in terms of (as example, not exhaustive): coordination with adjacent sectors and corresponding airports, management of unexpected events or degraded mode situations, transfer of an aerodrome or cluster of aerodrome from one MRVT to another, etc..	SO-039M2
SR-35M01	Supervisor shall access functions for the monitoring of weather for all the aerodromes.	SO-039

Table 3: Derivation of additional SR from normal and abnormal conditions SO

Assumptions from AO-13 to AO-15 stated for Single Remote Tower are also applicable for Multiple Remote Tower. They are presented in **[18]** section 3.2.3.

3.3 Analysis of the SPR-level Model – Normal Operational and Abnormal Conditions

This section aims at ensuring that the SPR-level design is complete, correct and internally coherent with respect to the safety requirements derived for the normal operating conditions that were used to develop the corresponding safety objectives in section 2.6.2.

The analysis necessarily depends on proving the Safety Requirements (Functionality and Performance) from three perspectives:

    a. a static view of the system behaviour using scenarios for normal operations described in section the OSED

    b. check that the system design operates in a way that does not have a negative effect on the operation of related ground-based and airborne safety nets

    c. a dynamic view of the system behaviour using validation exercises.

Concerning **perspective a.** the use cases proposed in the OSED are used as scenarios for Normal operations for assessing the completeness of the safety requirements obtained until now. Those scenarios are listed here after. The analysis of those several scenarios has provided no additional safety requirement.

ID	Scenario	Rationale for the Choice
UC-M1	Transition of Visual Reproduction from Aerodrome A to Aerodrome B	Use case in OSED §5.1.7
UC-M2	Two arriving aircraft to two different aerodromes	Use case in OSED §5.1.8
UC-M3	Runway inspection at multiple aerodromes during the night	Use case in OSED §5.1.9
UC-M4	Control of vehicles in the manoeuvring area	Use case in OSED §5.1.10

Concerning **perspective b.** the potential ground-based safety nets that could be used in a remote tower are the same as in a current tower providing tower service. In both cases the fact of remotely providing the ATC tower services will not have a negative effect on the operation of those related safety nets, in particular for those operated based on surveillance data, which remains unchanged in remote tower with respect to current operations. With respect to the airborne safety nets, there is no change on the way flights operate when they are remotely controlled, so a priori there is no impact on the airborne safety net either.

Concerning **perspective c.** and as mentioned before, several validation exercises have been performed in the frame of Remote Tower project for the multiple application of the concept:

- Trial 1: Simulation addressing ATC tower services being provided to multiple aerodromes also including non-nominal scenarios

- Trail 2: shadow passive mode trial on ATC tower, for basic and advanced configurations of the MRVT position

- Trial 3: shadow passive mode trial on AFIS services, for basic and advanced configurations of the MRVT position, with workshops on degraded modes.

The results from these trials have been used for the definition of some of the safety requirements listed in section 3.2.3. They have also allow to obtain some evidence on the validity of the safety requirements mainly for normal operations conditions, but limited evidence on the dynamic aspects of the system as only passive shadow mode trials have been done concerning ATC services.

The safety related results on trial 2 are presented in Appendix E. The complete set of results from the 3 trials mentioned above is provided in the Validation Report [] [15].

Concerning the safety requirements obtained from Single Remote Tower through the same process (**SR-27** and **SR-40**), they are only applicable for Multiple Remote Tower, as for Single, in case the ATC service can be provided from both the tower in the concerned aerodrome and from a MRVT.

3.4 Design Analysis – Case of Internal System Failures

This part of the safety assessment focuses on the causes of the hazards identified in section 2.8.
The steps concerning this assessment of these causes are the following ones:

  a. *for each system-generated hazard, top-down identification of internal system failures that could cause the hazard*
  b. *derivation of mitigations to reduce the likelihood that specific failures would propagate up to the Hazard (i.e. operational level) - these mitigations are then captured as additional Safety Requirements (Functionality and Performance)*
  c. *Setting of Safety Requirements to limit the frequency with which each identified system failure could be allowed to occur, taking account of the above mitigations.*
  d. *show that the Safety Requirements are achievable - i.e. can be satisfied in a typical physical implementation*

With respect to steps a. and b.:

The same causes for Single Remote Tower identified for the several hazards identified in section 2.8 apply to Multiple Remote Tower, but taking into account that most of the causes can occur in relation to each of the concerned aerodromes.

There are some additional failure modes that need to be considered in multiple remote tower, in particular with respect to the communication system and the visualisation reproduction system (as they support the provision of the remote ATC TWR service to multiple aerodromes). The assessment of these failure modes is provided in Appendix D and the relevant outputs from it, in particular with respect to mitigation means to be applied, have been directly taken into account in the definition of the corresponding safety requirements (see below).

Any common cause introduced by the physical design of the MRVT is to be addressed in the specific safety assessment for the corresponding implementation taking into account acceptable levels of safety as per applicable regulation.

For some causes related to human errors or failure to perform a specific task, additional requirements/recommendations have already been identified in section 3.2.3 based on results from validation exercises and workshops.

With respect to step c.:

The safety requirements derived for Single Remote Tower are also applicable to Multiple Remote Tower as follows:

From SR-42 to SR-60: the integrity requirements are unchanged. Note that, as mentioned before in section 2, they are derived based on ECAC wide average values of baseline risk (related to current operations) and not local levels of risk for specific aerodromes. For local implementation, these figures need to be checked and updated to reflect the local associated risk.

Concerning the requirements for the Visualisation System:

- [**SR-52**] the process to allocate SWAL levels to software components is currently being developed in the frame of 16.6.1. This safety requirement from the Single Remote Tower assessment should then be replaced by the one obtained based on this new approach, once it will be available. In the meantime, a generic requirement indicating that integrity and reliability requirements for the Visualisation System need to be defined for a local implementation based on applicable regulation (see SR-52M01).

- [**SR-54**]: this requirement applies in the same way as for Single Remote Tower.

New Safety requirements are presented in next table:

Note: Concerning the requirements presented below: in some cases Supervisor is mentioned in some of them, as a role of supporting the controller in applying specific procedures. The role of the Supervisor is not a mandatory function in the frame of the concept addressed in this SAR, but if implemented, the corresponding requirements apply.

SR#	Safety Requirement	Derived from
Visualisation System		
SR-52M01	For a local implementation, corresponding assurance level for the software development process of the relevant components of the Visualisation System as well as its availability shall be defined based on applicable regulation. Note: as per the results from this safety assessment a SWAL 3 for the critical aerodrome view (including the sensors in the airport premises, the link between them and the RTM and the displays on which the visual presentation is provided to the ATCO) is proposed. Note: as per the results from this safety assessment the likelihood of loss of a critical aerodrome view on the visualisation system is to be no more than 7e-4 per operational hour. Note: critical view refers to parts of the visual representation of the runway, and the initial climb out and final approach areas	VRS-003 VRS-001 VRS-007 VRS-009 VRS-008 VRS-010 VRS-012
ATCO		
SR-61M01	In case of loss or degradation of ground-ground communication with one or several adjacent ATSU units in a MRVT position relevant fallback procedures shall be applied. Note: supervisor in the RTC may support the controller to apply these procedures	G-GCOM-001 SO-051
SR-62M01	In case of failure or degradation of communication with vehicles/personnel operating on the manoeuvring area for one or several airports allocated to a MRVT position relevant fallback procedures shall be applied (e.g. use of flash gun lights). Note: supervisor in the RTC may support the controller to apply these procedures	S-GCOM-001 S-GCOM-002 S-GCOM-003
SR-64M01	In case of loss of information or detected inappropriate information on a critical view of the visualisation (due to a technical failure) a specific procedure shall be applied taking into account the timeframe of the failure mode (e.g. provision of ATC services limiting the simultaneous operations in the area of responsibility, using PTZ camera to get the corresponding lost image, stopping the service for all the concerned aerodromes, transferring some or all of them to another module in the RTC, etc.). Note: critical view is defined in SR52 Note: Supervisor in the RTC my support the controller to apply these procedures.	VRS-003 VRS-001 VRS-007 VRS-009 VRS-008 VRS-010 VRS-012

SR#	Safety Requirement	Derived from
SR-66M01	In case of failure or degradation of air-ground communication with traffic in a MRVT position, relevant procedures from PANS ATM [9] shall be applied (e.g. issuing clearances though the relevant APP controller). Note: supervisor in the RTC may support the controller to apply these procedures.	A-GCOM-001
SR-67M01	In case incorrect MET/Weather information is provided and detected in a MRVT position, or not information at all is provided, controller shall contact relevant personnel in the airport in order to obtain this information and any relevant update, if not possible to obtain such information from any other source (e.g. pilots, visual inputs from the visual presentation, MET-office, internet, etc.). Note: Supervisor may support the controller to apply this procedure.	MET-001
SR-70M01	In case of failure or degradation of some system/functions of the MRVT position having an impact on the controller workload or affecting the capability of the controller to continue providing safe remote services to all airports under his/her responsibility, the controller shall, in order to be able to manage the degraded mode situation: - Stop the provision of the remote service for the some or all airports - Transfer the provision of the remote service for some or all airports to another MRVT in the RCT (as per SR-027M1) Note: supervisor in the RTC may support the controller to apply these procedures	All above

Table 4: List of safety requirements related to failure conditions for Multiple Remote Tower

Note: Safety requirements related to the controller performing the corresponding ATC tasks from a MRVT position are to be included as relevant based on the results from the Human Performance Assessment [16].

3.5 Validation & Verification of the Safe Design at SPR Level

As explained in section 2.11, a certain number of validation exercises were performed in the frame of Remote Tower OFA for multiple aerodromes. The results from these trials have allow to obtain some evidence on the validity of certain safety requirements concerning normal operations conditions, but limited ones concerning abnormal conditions operations. The main reason is that only passive shadow mode trials have been done concerning ATC services (see L004).

They have not allowed collecting enough evidence on the achievability of safety requirements concerning the degraded mode conditions. Only some expert feed-back on some fall back procedures in case of internal system failure were collected during the trials.

The corresponding evidence for each safety requirement identified in this section 3 is provided in Appendix B (see L005 on the evidence validity). Specific results on proposed procedures for degraded mode conditions are presented in the Rules and Regulation report [14]. The overall results from the trials are provided in the Validation Report [15].

Appendix A   Consolidated List of Safety Objectives

A.1 Safety Objectives (Functionality and Performance)

Only two safety objectives were defined specifically for Multiple Remote Tower with respect to Single Remote Tower. They are listed here after.

The other safety objectives derived for Single Remote Tower, also applicable to Multiple Remote Tower, are provided in the Appendix A.1 of the **[18]**].

SO#	Safety Objective
SO-039-M01	RTC shall enable strategic and pre-tactical management of ATC resources (in terms of roasting, staff allocation, modules and clusters definition and planning, etc.), taking account of weather forecast, traffic demand and any other factors impacting the capacity of the centre to provide relevant ATC/AFIS services to concerned aerodromes
SO-039-M02	RTC shall enable tactical management of ATC resources (in terms of staff and modules/clusters management, etc.) with respect to weather conditions, traffic overload/peaks and unexpected events

Safety Objectives (Integrity)

Any additional safety objective on integrity has been identified for Multiple Remote Tower with respect to the ones already identified for Single Remote Tower (they are provided in Appendix A.2 of the **[18]**).

Appendix B   Consolidated List of Safety Requirements and Recommendations

This appendix presents the list of safety requirements and recommendations for Multiple Remote Tower obtained from the safety assessment presented in this report. As mentioned before, this is not the complete list of requirements but only the ones specific to Multiple Remote Tower. They need to be added to the list of requirements for Single Remote Tower in order to obtain the complete list of requirements specifying Multiple Remote Tower.

Some additional explanation on each requirement as well as evidence (or reference to detailed evidence) on their validity obtained from the validation exercises and other project activities are also provided. In addition and based on those evidence, the corresponding maturity level is defined and some activities are recommended to be done (for the corresponding next phase).

The reference to the corresponding OSED requirements is also included in the table.

B.1 Safety Requirements (Functionality and Performance)

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	G-G COMM				
SR-06M1 [REQ-06.09.03-OSED-MC04.2004]	Ground-ground communication with relevant adjacent units (i.e. for each airport within the cluster allocated to the same RTM position) shall be available to the controller in a MRVT position Note: as per the aeronautical fixed service in accordance with ICAO Annex 11, Chapter 6.2	This information is required, as in current operations, to provide ATC services to the several aerodromes.	Trials 1, 2 and 3, mainly based on debriefings with controllers.	Define in detail the technical support and the way to provide this information to the controller	SO-001 SO-046 SO-047
SR-06M2 [REQ-06.09.03-OSED-MC04.2004]	ATCO shall be aware about which adjacent unit a communication (in and out) is related to. Note: in low density aerodromes no additional technical feature may be requested but for more busy aerodromes an indication on the corresponding adjacent unit should	Controller needs to know how to communicate with a specific adjacent unit and to identify from which adjacent unit a communication comes from This information is	Trials 1, 2 and 3, mainly based on debriefings with controllers.	Define in detail the technical support and the way to provide this information to the controller	SO-001 SO-046 SO-047

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	be provided to the ATCO.	required, as in current operations, to provide ATC services to the appropriate aerodromes.			
	A-G COMM				
SR-07M01 [REQ-06.09.03-OSED-MC04.2001 REQ-06.09.03-OSED-MC04.2002 REQ-06.09.03-OSED-MC04.2003]	Air-ground communication with relevant traffic (i.e. for each area of responsibility related to each airport allocated to the same MRVT position) shall be available to the controller in a MRVT position. Note: as per the aeronautical mobile service in accordance with ICAO Annex 11, Chapter 6.1	This service is required, as in current operations, to provide ATC services.	Trials 1, 2, 3 and 4 and in particular from the COMM survey.	**Define in detail the technical support and the way to make this service available.** **Assess the impact of RT on communication load**	SO-002 SO-003 SO-004 SO-005 SO-009 SO-010 SO-011 SO-012 SO-013 SO-014 SO-017 SO-019 SO-020 SO-021 SO-024 SO-025 SO-026 SO-027 SO-029 SO-030 SO-031 SO-035 SO-046 SO-050 SO-052

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
SR-07M02 [REQ-06.09.03-OSED-MC04.2001 REQ-06.09.03-OSED-MC04.2002 REQ-06.09.03-OSED-MC04.2003]	Controller shall be aware about which airport a communication (in and out) with traffic under his/her responsibility is related to	This service is required, to provide ATC services to the appropriate vehicles / traffic. In case of similar call signs, Call sign similarity solution from EUROCONTROL call sign similarity service should be applied as per MRT_REC_PR3 in [16]. A potential way of doing so is considering MRT_REC_PR10 in the HP assessment [16] proposing to include the airport call-sign for each pilot transmission.	Trials 1, 2, 3 and 4 and in particular from the COMM survey.	**REC**: For the type of aerodrome addressed in this safety report (i.e. low density aerodromes) the controller seems to be able to do that without any technical support. For aerodromes with a different operational environment this capability needs to be reassessed and potentially a technical support should be provided to the controller. Assess the impact of RT on communication load.	SO-002 SO-003 SO-004 SO-005 SO-009 SO-010 SO-011 SO-012 SO-013 SO-014 SO-017 SO-019 SO-020 SO-021 SO-024 SO-025 SO-026 SO-027 SO-029 SO-030 SO-031 SO-035 SO-046 SO-050 SO-052
SR-07M03 [REQ-06.09.03-OSED-MC04.2001 REQ-06.09.03-OSED-MC04.2002]	Air-ground communication function in the MRTV position shall allow: - to receive communication from all traffic in all the aerodromes at the same time - to transmit to traffic independently	This service is required, to provide ATC services to the appropriate vehicles / traffic.	Trials 1, 2, 3 and 4 and in particular from the COMM survey.	Define in detail the technical support and the way to make this service available.	SO-002 SO-003 SO-004 SO-005 SO-009 SO-010 SO-011

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	for each aerodrome			Assess the impact of RT on communication load This is also recommended by MRT_REC_TS9 and MRT_REC_TS10 in the HP assessment [16].	SO-012 SO-013 SO-014 SO-017 SO-019 SO-020 SO-021 SO-024 SO-025 SO-026 SO-027 SO-029 SO-030 SO-031 SO-035 SO-046 SO-050SO-052
	Surf-G COMM (airport personnel/vehicles inside manoeuvring area)				
SR-08M01 [REQ-06.09.03-OSED-MC04.2005 REQ-06.09.03-OSED-MC04.2006]	Communications for the control of relevant vehicles, other than aircraft, on manoeuvring areas (i.e. at each aerodrome under control of the same ATCO) shall be available to the controller in a MRTV position. Note: as per the Surface movement control service in accordance with ICAO Annex 11, Chapter 6.3	This service is required, to provide ATC services to the relevant vehicles in the appropriate aerodrome.	Trials 1, 2 3 and 4, mainly based on debriefings with controllers and also from the COMM survey.	Define in detail the technical support and the way to make this service available.	SO-015 SO-017 SO-021 SO-023 SO-026 SO-027 SO-035

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
SR-08M02 [REQ-06.09.03-OSED-MC04.2005 REQ-06.09.03-OSED-MC04.2006]	ATCO shall be aware about which airport a communication (in and out) with vehicles under his/her responsibility is related to	This service is required, to provide ATC services to the appropriate vehicles / traffic. A potential way of doing so is considering MRT_REC_PR11 in the HP assessment [16] proposing to include the airport call-sign for each vehicle transmission.	Trials 1, 2, 3 and 4 and in particular from the COMM survey.	**REC**: For the type of aerodrome addressed in this safety report (i.e. low density aerodromes) the controller seems to be able to do this task without any technical support. But for aerodromes with a different operational environment this capability needs to be reassessed and potentially a technical support should be provided to the controller. Assess the impact of RT on communication load	SO-015 SO-017 SO-021 SO-023 SO-026 SO-027 SO-035
SR-08M03 [REQ-06.09.03-OSED-MC04.2006]	Communication function in the MRTV position shall allow to transmit communication to vehicles independently for each aerodrome.	This service is required, to provide ATC services to the appropriate vehicles / traffic.	Trials 1, 2, 3 and in particular from the COMM survey.	Define in detail the technical support and the way to make this service available. Assess the impact of RT on communication load	SO-015 SO-017 SO-021 SO-023 SO-026 SO-027 SO-035

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	Surf-G COMM (airport personnel/vehicles outside manoeuvring area)				
SR-10M1 [REQ-06.09.03-OSED-MC04.2005 REQ-06.09.03-OSED-MC04.2006]	Communication with airport personnel in charge of runway inspections shall be available to controller in the MRVT position for the coordination of runway inspections in order to determine runway conditions and detect potential FODs/animals	This service is required, to provide ATC services to the relevant vehicles in the appropriate aerodrome.	Trials 1, 2 3 and 4, mainly based on debriefings with controllers and also from the COMM survey.	Define in detail the technical support and the way to make this service available.	SO-032
SR-10M2 [REQ-06.09.03-OSED-MC04.2005 REQ-06.09.03-OSED-MC04.2006]	ATCO shall be aware about which airport a communication (in and out) with airport personnel in charge of runway inspections is related to.	This service is required, to provide ATC services to the appropriate vehicles / traffic. A potential way of doing so is considering MRT_REC_PR11 in the HP assessment [16] proposing to include the airport call-sign for each transmission.	Trials 1, 2, 3 and 4 and in particular from the COMM survey.	**REC:** For the type of aerodrome addressed in this safety report (i.e. low density aerodromes) the controller seems to be able to do this task without any technical support. But for aerodromes with a different operational environment this capability needs to be reassessed and potentially a technical support should be provided to the controller. Assess the impact of RT on	SO-041 SO-043 SO-050SO-052

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
				communication load	
	Visualisation system				
SR-14M01 [REQ-06.09.03-OSED-VG03.1001]	Visual presentation of the traffic in the vicinity of each aerodrome under the responsibility of the same controller shall be provided to the controller in the MRVT position. Note: this includes final approach and initial climb areas, and it has to take into account specific traffic evolution for landing and take-off as it is the case for helicopters.	This service is required, as in current operations, to provide ATC services. *This requirement is also an output from the HP assessment.*	Trials 1, 2, 3 and 4 Some evidence has been collected on the capability of the visualisation system to provide information to be used for the provision of ATC services. Some items are still to be further assessed as it is explained for SR-26 (in particular for supporting the controller to judge distances and separation between traffic and to identify aircraft on the vicinity of the aerodrome).	**REC:** for busiest aerodromes the need of advanced features supporting / improving the information provided in the visualisation system should be evaluated in more detail in order to ensure that tasks as per requirement SR-26 can be performed properly, in particular to ensure detection of relevant objects and continuously monitoring them. Specify the technical characteristics of the Visualisation System in terms of accuracy, resolution, refreshment rate, etc. based on the characteristics of the RVT platform used during the	SO-002 SO-003 SO-004 SO-005 SO-006 SO-007 SO-008 SO-009 SO-010 SO-028 SO-029 SO-030 SO-044 SO-045 SO-046 SO-047

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
				validation exercises.	
SR-16M01 [REQ-06.09.03-OSED-VG03.1001]	Visual presentation of the manoeuvring area for each airport allocated to the same MRVT position and the traffic/vehicles/personnel on this area shall be provided to controller in the MRVT position Note: this includes runways and the traffic/vehicles/personnel on or close to it.	This service is required, as in current operations, to provide ATC services. *This requirement is also an output from the HP assessment.*	Trials 1, 2, 3 and 4	**REC:** for busiest aerodromes the need of advanced features supporting / improving the information provided in the visualisation system should be evaluated in more detail in order to ensure that tasks as per requirement SR-26 can be performed properly, in particular to ensure detection of relevant objects and continuously monitoring them. Specify the technical characteristics of the Visualisation System in terms of accuracy, resolution, refreshment rate, etc. based on the characteristics of the MRVT platform used during the validation exercises. To assess the need	SO-014 SO-015 SO-016 SO-017 SO-045 SO-046 SO-047

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
				of advanced features as overlays as recommended by MRT_REC_DS3 from the HP assessment [16]	
SR-68M01 [REQ-06.09.03-OSED-VG03.1001]	Even if controller is able to select different ways of presenting the visual information mentioned in safety requirements SR14-M01 and SR16-M01, visual information for each airport under his/her responsibility shall constantly be presented to the controller in a way allowing the controller to maintain situation awareness in both aerodromes at any time.	In order to ensure that situational awareness is maintained for all the aerodromes controlled from the same MRVT and that hazardous situations are properly detected this requirement is needed. *This requirement is also an output from the HP assessment.*	Trials 1, 2, 3 and 4	Specify the technical characteristics of the Visualisation System in terms of layout, accuracy and resolution as well as usability of this functionality. Recommendation from the HP assessment [16] MRT_REC_PR1 also needs to be considered in case 'compressed' images are used in the physical implementation of the visualisation system.	SO-007 SO-016 SO-026 SO-028 SO-035
	ATCO – ATC service provision				
SR-26M01 [REQ-06.09.03-OSED-CM04.0001]	Controller shall apply relevant current procedures (as per ICAO PANS ATM [9]) to provide corresponding ATC Tower service	This requirement encompasses the procedures to be applied for the provision	Appropriate separation between traffic shall be applied and handled	**REC:** Items to be further evaluated in	SO-001 SO-002 SO-003 SO-004

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	to all the aerodromes under his/her responsibility from a same MRVT position. Note: the same examples as per Single RT apply.	of ATC service as per PANS ATM as it is done in current operations when providing Tower controller services. This is to be applied for the several aerodromes in the same MRVT. Any additional procedures related to the fact that the ATC service is provided to several aerodromes from a Remote location have been captured in separated requirements (see below).	by controller from a MRTV position except for reduced visual separation. AS for the Single Remote Tower, validation exercises where done in passive shadow mode for the ATC services, so none additional evidence have been collected with respect to this requirement. Evidence collected for the moment show that the capability of performing the following tasks from a Multiple Remote Tower is lower than in current operations (the same as for Single Remote Tower): * aircraft identification * ensuring appropriate separation between traffic (in particular concerning the	particular when considering busiest or more aerodromes: - Further evaluate the different enhanced visual features for improving the capability of identifying aircraft. - Further assess the capability of evaluation distances / judge separation for the provision of reduced separation (and the potential need for enhanced visual features or for changing procedures). - Evaluate the capability of the ATCO to perform ATC related tasks in a timely manner (active mode validation exercise). - Assess capability of ATC provision under abnormal and degraded modes of operations.	SO-005 SO-006 SO-007 SO-008 SO-009 SO-010 SO-011 SO-012 SO-013 SO-014 SO-015 SO-016 SO-017 SO-018 SO-019 SO-020 SO-021 SO-022 SO-023 SO-024 SO-025 SO-026 SO-027 SO-028 SO-029 SO-030 SO-031 SO-032 SO-033 SO-034 SO-035 SO-036 SO-037

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
			application of reduced separation). * Detection of potential flights towards terrain * Appropriately assess weather conditions impacting traffic For some other ATC tasks any evidence was collected as they were not addressed during the trials (for example ensuring appropriate separation with restricted areas or managing emergency situations). See more detail on the validation results in Appendix E of Trial 2. Nevertheless, due to the restricted scope of the Operational Improved addressed in this SAR, it is concluded that, on the basis of the collected evidences,	To specifically test all the corresponding procedures in an active way. This is also recommended by MRT_REC_TS1 from the HP assessment [16]. Initial results on these items as well as some other items are included in the validation results report in Appendix E, trial 2. *Some additional items related to further validation activities for this safety requirement have also been identified in the HP assessment report [16]:* *MRT_REC_TS2,* *MRT_REC_TS3,* *MRT_REC_TS4* *MRT_REC_TS5*	SO-044 SO-045 SO-046 SO-047

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
			remote tower services can be provided to 2 small low density aerodromes in a safe way.		
SR-69M01 [REQ-06.09.03-OSED-RTC3.0020]	Controllers shall be provided with a specific training related to local weather conditions of the concerned aerodromes to which remote services are to be provided	To better keep the 'local' knowledge of the operational environment even if the service is provided remotely. This is supported by MRT_REC_TR4 from the HP assessment [16].	Mainly from the safety questionnaire used in Trial 2, trial 4 and debriefings with controllers	To specifically define the content of this training as well as the periodicity for it to be performed for each relevant controller.	SO-028
SR-27M01 [REQ-06.09.03-OSED-CM04.0001	Handover procedures shall be applied in a MRVT position (for all the airports allocated to the same MRVT position) as in current operations. Additional information concerning MRVT equipment status shall also be transferred from one controller to the other during this procedure	Handover procedures are currently applied. They need to take into account status of the equipment in the MRVT as well as the status of the traffic in each of the concerned aerodromes.	Not addressed during the trials but during internal discussions with operational experts.	To define the type of information concerning the RVT equipment (in particular Visualisation System) to be included in the handover procedures.	SO-038
SR-27M02 [REQ-06.09.03-OSED-RTC3.0006 REQ-06.09.03-OSED-RTC3.0007 REQ-06.09.03-OSED-RTC3.0008]	Handover procedures between different MRTV positions shall be applied in case one or several airports have to be transferred from one RTM to another within a Remote Tower Centre	They need to take into account status of the traffic in each of the concerned aerodromes.	Not addressed during the trials but during internal discussions with operational experts.	To be defined at the level of the RTC taking into account the defined clusters, the role of the controllers and potentially the role of the supervisor to	SO-038

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
				support this procedure.	
SR-031M1 [REQ-06.09.03-OSED-MP04.0001]	In case of unexpected event in one of the airports significantly increasing the workload of the controller affecting the capability of the controller to continue providing safe remote services to all airports under his/her responsibility, the controller shall, in order to be able to manage the abnormal situation either: - Stop the provision of the remote service for the other airport(s) (as per SRc-031M2) or - Transfer the provision of the remote service for the airport experiencing the unexpected event or the other airport(s) to another MRVT in the RCT (as per SR-027M1) or - Request another ATCO in the RTC to support him/her on the service provision Note: supervisor in the RTC, if implemented, may support the controller to apply these procedures	The capability of the controller to properly provide TWR services is close dependent to the workload generated to do so. In case of unexpected event, more attention must be needed to handle the situation, while traffic still needs to be managed in the other aerodromes the controller is providing service too. Thus, it may be needed to reduce the amount of 'responsibilities' from the controller in order to better and safely manage the various situations in the several aerodromes.	Not addressed during the trials but during internal discussions with operational experts.	Specifically identify the situations in which a specific procedure needs to be applied and defined those procedures taking into account the several actors in the RTC. This is also a recommendation from the HP assessment [16].	SO-049
	RTC level				

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
SR-33M01 [REQ-06.09.03-OSED-CM04.0001]	Aerodrome capacity shall be defined not only based on the aerodrome characteristics but also taking account the fact that ATC service is remotely provided by a controller providing service to several airports at the same time. Note: For relevant aerodromes (mainly based on their size) capacity is to be provided to the Network Manager and relevant bodies in charge of Demand & Capacity Balancing activities (locally, regionally) in order to ensure that the traffic on those aerodromes to be controlled from a MRVT position is not exceeding those limits.	In order to ensure that TWR service can be safely provided to several aerodromes, it is necessary to define the set of aerodromes in a way that the levels of traffic can be managed by the controller from the MRVT. Eventually this information is to be provided to the relevant DCB bodies in order to ensure that these levels are maintained. This is also supported by MRT_REC_PR5 in the HP assessment [16].	Mainly addressed in trial 4 and during internal discussions and a dedicated workshop with operational experts.	For small aerodromes with low density traffic the definition of the corresponding capacity is less relevant. Nevertheless, for more busy aerodromes or in case of providing service to more than 2 aerodromes from the same MRTV the overall capacity of the corresponding cluster needs to be assessed and all possible mechanism to ensure they are maintained put in place (e.g. tactical DCB performed by the supervisor within the RTC, etc.). At the level of the RTC the cluster of aerodromes to be allocated to a specific and its corresponding capacity have to be defined and tested.	SO-039

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
SR-33M02 [REQ-06.09.03-OSED-MP04.0002]	Clusters of aerodromes to be allocated to a MTRV position shall be defined at local level in order to ensure that the traffic levels and complexity will not exceed low density and rarely two simultaneous movements. Note: other criteria are also to be taken into account, as avoiding similar airport or runways identifiers, or consistency of procedures between clustered aerodromes, but priority is to be given to the traffic levels and complexity..	The same rational as for the previous one SR-33M1. Cluster of aerodromes needs to be defined in a way that allow the controller to safely provide the corresponding TWR service to each of the aerodromes. This is also supported by MRT_REC_PR6 in the HP assessment [16]. Other criteria also need also to be taken into account, for example: * avoiding similar airport or runways identified as per MRT_REC_PR1 and MRT_REC_PR2 in the HP assessment [16]. This criteria needs to be further assessed in particular once the communication aspects will be further defined. * ensuring consistency of procedures between clustered aerodromes as per MRT_REC_PR4 in the HP assessment [16].	Not addressed during the trials but during internal discussions and a dedicated workshop with operational experts.	At the level of the RTC the cluster of aerodromes to be allocated to a specific and its corresponding capacity have to be defined and tested	SO-039

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	Supervisor				
SR-34M01 [REQ-06.09.03-OSED-SUP3.0010]	If a RTC Supervisor role is implemented - Supervisor in a RTC shall access functions for the planning, coordination and monitoring of the upcoming and present traffic flow, in the purpose of tactical opening and closure of MRVTs and allocation of airports to them taking into account the capacity associated to each cluster of aerodromes.	Capacity of the aerodrome is done in current operations taking into account the capability to provide ATC services. This capacity needs also to take into account the fact that the services are remotely provided and to several aerodromes. In case this role is implemented, the supervisor has to ensure the appropriate allocation of staff and aerodromes to the several RMT in order to ensure a safe provision of the service. The staff allocation and the definition of shifts patterns should be done as per MRT_REC_PR7 in the HP assessment [16].	Not addressed during the trials but during internal discussions and a dedicated workshop with operational experts.	To define the specific procedures and information needed for the supervisor to manage the allocation of clusters, RTM and staff within the RTC.	SO-039M1
SR-34M02 [REQ-06.09.03-OSED-SUP3.0011]	If a RTC Supervisor role is implemented - Supervisor in a RTC shall provide relevant support to controllers in a MRVT position in order to ensure the safe provision	One of the roles of the supervisor is to support controllers in their tasks as necessary.	Not addressed during the trials but during internal discussions and a dedicated workshop with	To define in which situations, and which are the tasks (and the information needed) the	SO-039M2

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	of remote ATC services to multiple aerodromes in terms of (as example, not exhaustive): coordination with adjacent sectors and corresponding airports, management of unexpected events or degraded mode situations, transfer of an aerodrome or cluster of aerodrome from one MRVT to another, etc..		operational experts.	supervisor would be able to perform in order to support the controller to safety provide the TWR service.	
SR-35M01 [REQ-06.09.03-OSED-SUP3.0010 REQ-06.09.03-OSED-SUP3.0012 REQ-06.09.03-OSED-SUP3.0013]	Supervisor shall access functions for the monitoring of weather for all the aerodromes.		Not addressed during the trials but during internal discussions and a dedicated workshop with operational experts.	To specifically define the type of information the Supervisor may need to perform its assigned tasks in terms of staffing and RTM allocation with respect to the traffic to be managed from the RTC.	SO-039

REC	Description	Additional Explanation	Supporting
	Visualisation System		
SRec-07M04 [REQ-06.09.03-OSED-	Controller should be able to combine air-ground communication for	This service is required, to provide ATC services to the relevant traffic in the	SO-002 SO-003

REC	Description	Additional Explanation	Supporting
MC04.2003]	each aerodrome allocated to the same MRVT position.	appropriate aerodrome. Define in detail the technical support and the way to make this service available. Assess the impact of RT on communication load	SO-004 SO-005 SO-009 SO-010 SO-011 SO-012 SO-013 SO-014 SO-017 SO-019 SO-020 SO-021 SO-024 SO-025 SO-026 SO-027 SO-029 SO-030 SO-031 SO-035 SO-046 SO-050 SO-052
SRec-14M02 [REQ-06.09.03-OSED-MA04.3101]	Visual indication supporting aircraft identification in the vicinity of each aerodrome allocated to the same MRVT position should be provided to the controller	Note: from all the advanced visual features tested in this project radar tracking feature would be the best option in this case, noting that the tracking could be done based on other surveillance means than radar, as ADS-B, WAM, etc. Note: this is a recommendation in the operational environment addressed in this assessment. For airports with a higher traffic density and complexity this recommendation is to be considered to be a "shall"	SO-002 SO-003 SO-004 SO-005 SO-006 SO-007 SO-008 SO-009 SO-010 SO-028 SO-029

REC	Description	Additional Explanation	Supporting
		requirement. Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM. Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01. This is supported by MRT_REC_DS1, MRT_REC_DS2 and MRT_REC_DS3 from the HP assessment [16].	SO-030 SO-044 SO-045 SO-046 SO-047
SRec-14M03 [REQ-06.09.03-OSED-MA04.3101]	Visual indication supporting the estimation of the position of the aircraft with respect to the terrain in the vicinity of the aerodrome may be provided to the controller	Note: from all the advanced visual features tested in this project radar tracking feature would be the best option in this case, noting that the tracking could be done based on other surveillance means than radar, as ADS-B, WAM, etc. Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01.	SO-28

REC	Description	Additional Explanation	Supporting
		This is supported by MRT_REC_DS1, MRT_REC_DS2 and MRT_REC_DS3 from the HP assessment [16].	
SRec-16M02 [REQ-06.09.03-OSED-MA04.3101]	Visual indication supporting aircraft/vehicles identification in the manoeuvring of each aerodrome allocated to the same MRVT position should be provided to the controller	Note: from all the advanced visual features tested in this project visual tracking feature would be the best option in this case Note: this is a recommendation in the operational environment addressed in this assessment. For airports with a higher traffic density and complexity this recommendation is to be considered to be a shall requirement. Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM. Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01. This is supported by MRT_REC_DS1, MRT_REC_DS2 and MRT_REC_DS3 from the HP assessment [16].	SO-014 SO-015 SO-016 SO-017 SO-045 SO-046 SO-047
SRec-16M03 [REQ-06.09.03-OSED-MA04.3101]	Visual indication supporting the identification of aircraft/vehicles/obstacles/people entering into or being close to a runway should be provided to the controller	Note: from all the advanced features tested in this project visual tracking feature would be the best option in this case Note: this is a recommendation in the operational environment addressed in this assessment. For airports with a higher traffic and movement density and complexity, this	Same SO-035

REC	Description	Additional Explanation	Supporting
		recommendation is to be considered to be a shall requirement (this functionality becoming then a safety net for the prevention of runway incursions). Note: as per L006, no assessment on the proposed advanced feature has been performed in the frame of this Safety Assessment. This need to be done for a specific implementation in case an advanced feature is to be used in the RTM. Note: This recommendation may be significantly relevant for certain physical implementation of the visualisation system. It also needs to be considered as a support to SR-68M01. This is supported by MRT_REC_DS1, MRT_REC_DS2 and MRT_REC_DS3 from the HP assessment [16].	
	ATCO – ATC service		
SRec-031M2 [REQ-06.09.03-OSED-CM04.0001]	Prior to an unplanned termination of the service provision, controller should ensure that ATC services are safely stopped for the concerned airport.	Note: supervisor in the RTC may support the controller on this procedure.	SO-049

B.2 Safety Requirements (Integrity)

Note that all figures provided in these requirements are derived based on ECAC wide average values of baseline risk (related to current operations) and not local levels of risk for specific aerodromes. For local implementation, these figures need to be checked and updated to reflect the local associated risk

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	Visualisation System				
SR-52M01 [REQ-06.09.03-OSED-RI03.6002]	For a local implementation, corresponding assurance level for the software development process of the relevant components of the Visualisation System as well as its availability shall be defined based on applicable regulation. Note: as per the results from this safety assessment a SWAL 3 for the critical aerodrome view (including the sensors in the airport premises, the link between them and the RTM and the displays on which the visual presentation is provided to the ATCO) is proposed. Note: as per the results from this safety assessment the likelihood of loss of a critical aerodrome view on the visualisation system is to be no more than 7e-4 per operational hour. Note: critical view refers to parts of the visual representation of the runway, and the initial climb out and final approach areas	Specific software assurance level (SWAL) is to be defined for the new Visualisation System based on the potential associated risk in case of failure of this equipment. The same for the availability of this system.	Analytical assessment based on expert judgement and project reviews as well as during discussions related to Trial 4.	To define the assurance level and the availability and to apply the corresponding assurance activities in order to satisfy them.	SO-102 SO-103 SO-104 SO-105 SO-106 SO-107 SO-108 SO-109 SO-110 SO-111 SO-114 SO-115 SO-116 SO-117 SO-119 SO-120 SO-121 SO-123 SO-124 SO-125 SO-126 SO-127 SO-128 SO-129 SO-130 SO-131 SO-132 SO-134

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	ATCO				
SR-61M01 [REQ-06.09.03-OSED-CM04.0001]	In case of loss or degradation of ground-ground communication with one or several adjacent ATSU units in a MRVT position relevant fall-back procedures shall be applied. Note: supervisor in the RTC may support the controller to apply these procedures	Mitigation mean identified from the hazard assessment.	Assessment based on expert judgement and project reviews as well as during discussions related to Trial 4. Not tested during simulations.	To define the procedure to be applied, the potential several actors involved in in such situation (ATCO, Supervisor, etc.), and to test its efficiency.	SO-101
SR-62M01 [REQ-06.09.03-OSED-CM04.0001]	In case of failure or degradation of communication with vehicles/personnel operating on the manoeuvring area for one or several airports allocated to a MRVT position relevant fall-back procedures shall be applied (e.g. use of flash gun lights). Note: supervisor in the RTC may support the controller to apply these procedures	Mitigation mean identified from the hazard assessment.	Assessment based on expert judgement and project reviews as well as during discussions related to Trial 4. Not tested during simulations.	To define the procedure to be applied, the potential several actors involved in in such situation (ATCO, Supervisor, etc.), and to test its efficiency.	SO-113 SO-115 SO-117 SO-120 SO-121 SO-123 SO-127 SO-132 SO-134
SR-64M01 [REQ-06.09.03-OSED-RTC3.0019]	In case of loss of information or detected inappropriate information on a critical view of the visualisation(due to a technical failure) a specific	Mitigation mean identified from the hazard assessment.	Assessment based on expert judgement and project reviews as well as during discussions related to Trial 4.	To define the procedure to be applied, the potential several actors involved in in such situation (ATCO, Supervisor, etc.), and to	SO-102 SO-103 SO-104 SO-105 SO-106

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	procedure shall be applied taking into account the timeframe of the failure mode (e.g. provision of ATC services limiting the simultaneous operations in the area of responsibility, using PTZ camera to get the corresponding lost image, stopping the service for all the concerned aerodromes, transferring some or all of them to another module in the RTC, etc.). Note: critical view is defined in SR52 Note: Supervisor in the RTC my support the controller to apply these procedures.		Not tested during simulations.	test its efficiency.	SO-107 SO-108 SO-109 SO-110 SO-111 SO-114 SO-115 SO-116 SO-117 SO-119 SO-120 SO-121 SO-123 SO-124 SO-125 SO-126 SO-127 SO-128 SO-129 SO-130 SO-131 SO-132 SO-134
SR-66M01 [REQ-06.09.03-OSED-CM04.0001]	In case of failure or degradation of air-ground communication with traffic in a MRVT position, relevant procedures from PANS ATM [9] shall be applied (e.g. issuing clearances though the relevant APP controller) Note: supervisor in the RTC may support the controller to apply these procedures.	Mitigation mean identified from the hazard assessment.	Assessment based on expert judgement and project reviews as well as during discussions related to Trial 4. Not tested during simulations.	To define the procedure to be applied, the potential several actors involved in in such situation (ATCO, Supervisor, etc.), and to test its efficiency.	SO-102 SO-103 SO-104 SO-105 SO-106 SO-107 SO-108 SO-109 SO-110 SO-111 SO-114 SO-115

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
					SO-116 SO-117 SO-119 SO-120 SO-121 SO-123 SO-124 SO-125 SO-126 SO-127 SO-128 SO-129 SO-130 SO-131 SO-132 SO-134
SR-67M01 [REQ-06.09.03-OSED-RTC3.0019]	In case incorrect MET/Weather information is provided and detected in a MRVT position, or not information at all is provided, controller shall contact relevant personnel in the airport in order to obtain this information and any relevant update, if not possible to obtain such information from any other source (e.g. pilots, visual inputs from the visual presentation, MET-office, internet, etc.). Note: Supervisor may support the controller to apply this procedure.	Mitigation mean identified from the hazard assessment.	Assessment based on expert judgement and project reviews as well as during discussions related to Trial 4. Not tested during simulations.	To define the procedure to be applied, the potential several actors involved in in such situation (ATCO, Supervisor, airport personnel, etc.), and to test its efficiency.	SO-103 SO-104 SO-112 SO-131

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
SR-70M01 [REQ-06.09.03-OSED-CM04.0001]	In case of failure or degradation of some system/functions of the MRVT position having an impact on the controller workload or affecting the capability of the controller to continue providing safe remote services to all airports under his/her responsibility, the controller shall, in order to be able to manage the degraded mode situation: - Stop the provision of the remote service for the some or all airports - Transfer the provision of the remote service for some or all airports to another MRVT in the RCT (as per SR-027M1) Note: supervisor in the RTC may support the controller to apply these procedures	Mitigation mean identified from the hazard assessment.	Assessment based on expert judgement and project reviews as well as during discussions related to Trial 4. Not tested during simulations.	Specifically identify the situations in which a specific procedure needs to be applied and defined those procedures taking into account the several actors in the RTC.	All SO-1xx

Appendix C   Assumptions, Safety Issues & Limitations

C.1 Assumptions log

No *additional assumptions have been stated in the safety assessment for Multiple Remote Tower with respect to Single Remote Tower safety assessment.*

C.2 Safety Issues log

The several safety issues raised during the safety assessment have been identified at the level of each safety requirement. They are mainly related to elements to be further assessed in order to get the corresponding maturity level. They are described in Appendix B for each safety requirement.

C.3 Operational Limitations log

Ref	Operational Limitations	Resolution
L001	This Safety Assessment Report (SAR) is focused on the remote provision of ATC and AFIS services using a RVT system. Nevertheless the assessment is mainly done on the ATC services (in particular TWR services), <u>assuming that this service would allow obtaining the most constraining requirements</u> which will allow as well the provision of AFIS. The assessment of the ATC service is presented in the main body of this report. Some results on the AFIS part are included in Appendix F	A complete assessment of the use of Remote Tower for the provision of AFIS service to multiple aerodromes needs to be done. This assessment can be done based on the results obtained from the assessment of ATC services (in particular concerning the information to be provided to the AFISo) but the specific AFIS procedures needs to be specifically addressed.
L002	The safety assessment of Multiple Remote Tower is to be done in the specific operational environment defined in section 2, i.e. to two low density and low utilisation aerodromes with traffic schedules typically comprising of single operations, rarely exceeding two simultaneous movements per aerodrome (this encompasses simultaneous movements at the two aerodromes, even if it occurs rarely).	For any implementation of this concept to provide ATC services to other types of aerodromes with different traffic densities, complexities and with different operational environments than the ones described section 2, the results needs presented in this report need to be reviewed and assessed again.
L003	The safety assessment is focused on the capability of providing ATC tower services from a remote controller working position. The fact that this CWP is located in a Remote Tower Centre is out of scope of the assessment. Nevertheless, some aspects related to the potential interaction and support between the controller in a MRVT position and the corresponding Supervisor in the RTC have been addressed when considered to have a significant safety impact	When implementing multiple remote tower in a specific Remote Tower Centre the corresponding assessment needs to be performed taking into account the specific configuration of the RTC (i.e. staff, Remote Tower Modules, procedures already put in place, etc.).
L004	The results from these trials have allow to obtain some evidence on the validity of the results obtained for normal operations conditions, but limited evidence concerning abnormal conditions operations and degraded modes (related to internal system failure) have been obtained as only passive shadow mode trials have been done	Additional trials (active ones) are to be performed in active mode or even in simulations in order to better assess the abnormal situations and potentially the procedures and means defined to mitigate the degraded modes of

	concerning ATC services	operations.
L005	The validity of the evidences collected from the trials is dependent on the characteristics of the aerodrome / operational environment used in those trials (described in the Validation Report [15]), which are a sub-set of the operational environment in which remote tower is aimed to operate (as described in section 2.2). This is particularly true for the traffic density and the number of simultaneous movements.	Other types of airport should be used for additional trials in order to obtain evidences covering a larger range of operational environment characteristics.
L006	The safety assessment mainly focuses on the basic configuration. Reference to any of these advanced visual features is only made in this report in case there may be an operational need for them to be put in place. Additional assessment of these specific enhanced visual features needs to be performed in particular concerning their integrity and reliability characteristics. Recommendations on the enhanced visual features are provided in this report, but no detailed assessment on their real impact on safety (benefice or degradation) has been provided in the frame of this assessment	In case of a local implementation, the safety assessment may consider additional enhanced features in order to ensure a safety provision of the TWR service to the several aerodromes.

Appendix D   Safety Workshop on Multiple Remote Tower

The information provided in this appendix is part of the results from the Safety Workshop held in Stockholm on the 17th – 19th September 2015 concerning the assessment of failure modes for several elements in the MRVT:

-     Communication related systems

-     Visualisation reproduction system

Degraded Modes
(technical failures) fo

Appendix E   Safety related validation results from ATC trial 2

This appendix includes the results from the safety questionnaire used to collect information during the Trial 2 for Multiple Remote Tower. These results are used for the definition of the safety requirements presented in this report.

"6.9.3_Results from Safety Questionnaire_Trial 2 MRT_20141010.doc"

6.9.3_Results from
Safety Questionnaire

The complete set of results from all the trials is provided in the Validation Report [15].

Appendix F Assessment of AFIS provided from a Remote Tower.

As mentioned in section 1.4, and as it was the case for Single Remote Tower, even if Multiple Remote Tower can be used for remotely providing ATS services, the safety assessment documented in this safety assessment report is mainly focused on the ATC service. This strategy was applied assuming that the most constraining results specifying Remote Tower system would be derived from ATC services.

The same initial results obtained for Single Remote Tower are applicable for Multiple Remote Tower.

They are presented in the [18] Appendix E. *This appendix provides an initial insight on how the results obtained from the assessment of Remote Tower for the ATC service also allow to satisfy the corresponding operational requirements for the provision of AFIS. But it needs to be noted that the assessment for AFIS is still to be completed.*

A part from what is presented in the above mentioned appendix, results from the trial 3 are presented in the attached report:

6.9.3_Results from
Safety Questionnaire

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