6.8.4 SAR Contingency Tower - Final Update

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Abstract

This document updates the P06.09.03 D31 SAR for Remote Contingency Tower document, with input from EXE-P06.08.04-VP-752 V3 at Girona airport. The document contains the Specimen Safety Assessment for a typical application of the 06.03.01 OFA Remote Contingency Tower. This report presents the list of Safety Requirements, in additional to the ones for Single Remote Tower, specifying the Remote Contingency Tower system level and the collected evidence 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

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00.00.03	25th June 2015	Issued version for review		Update based on internal project review.
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00.01.01	25th November 2015	Final deliverable		Final deliverable taking into account comments from the SESAR Joint Undertaking.
00.01.02	27th April 2016	Initial version	ENAIRE	Update of 6.9.3 D31 from EXE-P06.08.04-VP-752 in OFA 06.03.01 Remote Contingency Tower

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00.02.01	22th August 2016	Final Version	ENAIRE	Update considering SJU request for clarifications

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 Contingency Tower. The report presents the list of Safety Requirements, in additional to the ones for Single and for Mulitple Remote Tower, specifying the Remote Contingency Tower system at concept feasibility phase level and the collected evidence 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).

Evidence on the validity of the safety requirements have been mainly obtained from the following validation exercises performed in the frame of P06.09.03 and P06.08.04:

- EXE-06.09.03-VP-059 :
  life passive shadow mode trial at Gothenburd Airport aiming to assess the technical and operational capability of an initial prototype at medium density aerodromes during contingency situations
- EXE-06.09.03-VP-062 :
  a Life PSM trial at Gothenburg Airport aiming at confirming results from trial 1 and to also assess advanced technical enablers
- EXE-06.08.04-VP-751 :
  a life PSM trial at Girona Airport aiming at assessing in V2 the continuity of operation during contingency situations from a Remote Contingency Tower
- EXE-06.08.04-VP-752:
  a life PSM trial at Girona Airport aiming to assess in V3 the continuity of operations during contingency situations form a Remote Contingency Tower

This document is an update from P06.09.03 D31 SAR which includes additional consideration from EXE-P06.08.04-VP-752 results.

The safety assessment for Remote Contingency Tower document here is focused on and limited to the provision of ATC service to small and medium aerodromes with a single main runway in a contingency situation.

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 [12].

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
- Remote and Virtual Tower for Multiple Aerodrome
- Contingency Tower

In a global manner, the main target for the Single and Multiple R&VT Concepts are low to medium density 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 Tower solution is small to medium density airports with a single main runway (SDM-0204), given that, for most of them, if the ordinary tower had to close down for any reason no real contingency alternative exits today.

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)

Despite the broader possible implementations the current document aims at presenting the results of the safety assessment focused only on Remote Tower for Contingency situations for small / medium aerodromes with a single main runway. They lay on the basis of the safety assessment results obtained for Single and Mulitple Remote Tower. Only additional results with respect to those mentioned assessments were included in P06.09.03 D31 report. This document only updates the previous report with any additional consideration from EXE-P06.08.4.-VP-752 results. Many of these updates come from the inclusion of VFR traffic, and the use of the advanced features (IR camera, flight tracking, etc.)

1.2 General Approach to Safety Assessment

1.2.1 A Broader approach

This safety assessment is conducted 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 Single 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 Single 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.

1.2.2 Approach applied for this safety assessment

The safety assessment for Remote Contingency Tower is mainly based on the outcomes from the assessment performed for Single Remote Tower [SRT-SAR]. From these assessments only the additional results related to the Contingecy RT concept are to be presented in this report, but also the traceability and references to the corresponding results in the Single and Mulitple Remote Towers SAR are provided.

The assessment is done taking current contingency plans as reference and thus the corresponding level of service, capacity and safety they provide.

Several possible implementations can be envisaged for the provision of contingency service from a remote tower. Two of them are addressed here:

- A Remote Contingency Tower located on the aerodrome site.
- A spare Remote Tower Module in a Remote Tower Center maintained for use during contingency events.

In both cases, the module used for providing the remote tower service during a contingency situation is called Remote Contingency Tower. While it could be possible to provide this contigency solution for various airports at the same contigency location, the provision of multiple simultenaous contigencies is not addressed.

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. Those working on P16.06.0X may also have an interest.

At a higher project level, P06.02 is 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 16[12]):

- **SDM-0204**: Remotely Provided Air Traffic Service for Contingency Situations at Small to Medium Aerodromes (with a Single Main Runway)

This OI step is described as the Remote Provision of ATS to an Aerodrome during Contingency Situations, i.e. to provide a Contingency solution when the local Tower is not available, when the ATCO cannot be located at the local Tower and the service is to be relocated to a Remote Contingency Facility.

Three enablers are supporting this OI step and thus also being considered in the safety assessment. ATC-52 and ATC-53 are not directly associated with the OI Step, but were required for the validation of the concept:

- **AERODROME-ATC-52:** Provide Remote Tower Controller position with visual reproduction of both remoted aerodrome views and other sensor data.
- **AERODROME-ATC-51:** Remote Tower Centre (RTC) position that in contingency situation hosts ATCO that will no longer be located at the local Tower.
- **AERODROME-ATC-53:** Remote Tower controller position enhanced with additional sources for low visbility conditions

L001 This Safety Assessment is focused on the remote provision of ATC Tower services from a Remote Tower Module in a contingency situation for small / medium airports with only one runway.

This report is a proposed version for the final SAR, addressing safety related activities of the SESAR Safety Reference Material (SRM).

It includes the provision of the same type of results as for the two previous assessments:

- Information defined at "OSED level" which includes the Safety Criteria and the Safety Objectives
- Information defined at "SPR level" which includes the Safety Requirements

Evidence 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 at the service level and provides its specification in terms of Safety Objectives

Section 3 documents the safety assessment of the Remote Tower system at the design level and provides the corresponding specification in terms of Safety Requirements.

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

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

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

1.6 References

[1]. SESAR P16.06.01, Task T16.06.01-006, SESAR Safety Reference Material, Edition 00.03.01, 9th March 2015

[2]. SESAR P16.06.01, Task T16.06.01-006, Guidance to Apply the SESAR Safety Reference Material, Edition 00.02.01, 9th March 2015

[3]. P6.9.3 – D12 Contingency TWR Trial 1 & 2 Validation Report, Edition 00.03.01, 2nd November 2015

[4]. SESAR P06.08.04 - D111 6.8.4 HP Contingency Tower- Final Update Edition 00.02.00, 30th May 2016

[5]. P6.9.3 – D14 Remote Tower – Safety assessment for single remote tower, Edition 00.01.02, 12th October 2015

[6]. P6.9.3 – D31 OFA06.03.01 Remote Tower - Safety Assessment Report for Remote Contingency Tower, Edition 00.01.01

[7]. P6.8.4 – D94 OSED for Remote Provision of ATS to Aerodromes

[8]. P6.8.4 – D105 Contingency Tower V2 - VALR VP-751

[9]. P6.8.4 – D107 Contingency Tower V3 - VALR VP-752

[10].P6.8.4 – D108 6.8.4 SAR Single Remote - Final Update

[11].ATM Master Plan Integrated Roadmap Dataset 16 - https://www.atmmasterplan.eu/rnd/integrated-roadmap

1.7 Acronyms

AFIS	Aerodrome Flight Information Service
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATS	Air Traffic Services
IFR	Instrumental Flight Rules
NSA	National Safety Authorities
OFA	Operational Focus Area
OSED	Operational Service and Environment Definition
RCT	Remote Contingency Tower
RT	Remote Tower
RTC	Remote Tower Center
RTM	Remote Tower Module
RVT	Remote and Virtual Tower
SAC	SAfety Criteria
SAR	Safety Assessment Report
SMR	Surface Movement Radar
SPR	Safety and Performance Requirements
SRM	Safety Reference Material
VFR	Visual Flight Rules

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
- definition of suitable Safety Criteria (from the OFA Safety Plan [1]) – section 2.3

- assessment and derivation of the corresponding Safety Objectives for the Remote Contingency Tower – section 2.4
- achievability of the Safety Criteria – section 2.5
- validation & verification of the safety specification – section 2.6

2.2 Contingency 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 Tower services provided from a Remote Tower during a contingency situation in the concerned airport. This information is mainly obtained from the and P06.08.04 OSED [7](sections 3.5 and 4.2)

Two types of airports are mainly addressed by the overall remote tower concept:

- Primary target airports: medium sized airports without ground surveillance radar. They are generally considered as being too small to bear the investment of ground surveillance technologies such as A-SMGCS system.
- Secondary target airports: medium to large airports equipped with a ground surveillance system which the visual presentation proposed by Remote Contingency Tower concept would be coupled with.

The environment characteristics of these two types of airports are provided in detail in the OSED section 4.2.1 [7]. Included in this section, is that these airports have specific IFR routes & approach procedures as much as established VFR routes. For primary target airports, the presence of VFR traffic within the airport environment mixed with IFR traffic could be more significant than in secondary target airports.

The specific type of Remote Tower that this document is concerned with, Remote Contingency Tower, is assessed in the operational environment:

- Small / Medium aerodromes with a Single Main Runway
- Concerning the other properties of the operational environment they remain the same as for Single Remote Tower.

2.3 SAfety Criteria

The same SAfety Criteria (SAC) as for Single Remote Tower apply for Remote Contingency Tower.

The difference is that these SACs here are defined with respect to a different baseline, which is the Contingency solution already put in place in the concerned airport for which Remote Service is provided during contingency situations.

Three main types of contingency solutions are described in the OSED as part of the current operating methods (see the detail in OSED section 3.5.2.1 [7]):

1. The aerodrome control tower is closed and the ATS is ceased
2. A surface movement radar coverage and/or multi-lateration technology based solution, provided from a location other than the local ATS tower
3. Basic level of ATS from a location other than the local ATS tower

The purpose of the Remote Contingency Tower is to maintain at least the same level of safety (as in options 2 and 3 where the ATS service is still provided) while keeping the provision of service at the concerned airport during a contingency situation (no service provision then as in option 1).

2.4 Safety Objectives for Remote Contingency Tower

The assessment done in this section is based on the one performed for Single and Mulitple Remote Tower, taking into account the specificity of the Remote Contingency Tower. The assessment is done taking into account the contingency process applying to a local tower in an airport.

2.4.1 Defining a Contingency process

The contingency process is described in several phases. They are defined here from a Local Tower perspective.

- **Normal operations**: provision of normal Tower services from the local control tower
- **Transition into Contingency**: due to a specific event/outage, immediate actions are taken to ensure operations are safe and the corresponding contingency plan is put in place.
- **Contingency situation**: phase in which short / medium term actions are put in place in order to ensure the continuity of the service in a safe way as long as the service cannot be provided in Local Tower.
- **Transition out of Contingency**: once the operations can be re-established its provision is transferred to the local tower againas per the contingency plan.

The several actions / tasks performed in each of these phases may vary depending on the reason and nature of the event triggering the contingency situation.

Two types of Contingency situations are addressed (more information is provided in the OSED):

- **Planned events** : events such as planned maintenance/outage in the control tower
- **Unplanned events**: events which would tend to be emergency situations. These unplanned events can be sudden (unplanned and sudden) or they could be events where staff are alerted beforehand and therefore have time to do some preliminary planning (unplanned but gradual).

2.4.2 Defining the safety objectives related to the Contingency process

The Safety objectives corresponding to each of the phases presented in previous section and for each type of contingency event are presented in the following tables.

Planned contingency event	**Normal operations**	**Transition Into Contingency**	**Contingency Situation**	**Transition out of Contingency**
Local Tower view	Provision of Tower services	Contingency plan for a planned event (**SO-053-C01**)		
Remote Contingency	Plannification of the use of RCT	Initiation of the service provision	Provision of the service from the	Transfer to the local tower and

Tower View	for a specific planned event (**SO-039-C01**)	from the RCT (**SO-40-C01** and **SO-41-C01**)	RCT (SO-01 to SO-38, SO-44 to SO-52, SO-39M02, All SO1xx) *Note 1*	Termination of the service procision from the RCT (**SO-42-C01** and **SO-43-C01**)

The corresponding new safety objectives are defined here after:

SO-053-C01: In case of contingency situation (planned or unplanned), local tower shall apply relevant contingency plan.

SO-039-C01: RTC / RCT shall enable strategic and pre-tactical management of ATC resources (in terms of roasting, staff allocation, modules planning, etc.), taking account of weather forecast, traffic demand and any other factors impacting the capacity of the centre to provide relevant ATS services to concerned aerodromes as well as demand from concerned aerodromes for the provision of planned contingency services.

SO-040-C01: Prior to remotely providing ATC services, RCT capabilities shall be assessed / verified

SO-041-C01: In case of a contingency situation, coordination between concerned tower and RTC/RCT shall be ensured for transferring the service from the local tower to the RCT.

SO-042-C01: Provision of ATC service from RCT shall appropriately (safely) be stopped

SO-043-C01: In case of a contingency situation, coordination between concerned tower and RTC/RCT shall be ensured for transferrinfg the service from the RCT to the local tower.

Note 1: those references refer to safety objectives already defined for Single and for Multiple Remote Tower in their corresponding assessments.

Unplanned contingency event	**Normal operations**	**Transition Into Contingency**	**Contingency Situation**	**Transition out of Contingency**
Local Tower view	Provision of Tower services	Contingecy plan for unplanned events (SO-53-C01)		
Remote Contingency Tower View		*Initiation of the service provision from the RCT (**SO-039-C02**, SO-40-C01 and SO-41-C01)*	*Provision of the service from the RCT (SO-01 to SO-37, SO-44 to SO-52, SO-39M02, All SO1xx)* *Note 1*	*Transfer to the local tower and Termination of the service procision from the RCT (SO-42-C01 and SO-43-C01)*

The additional Safety Objective in unplanned contingency events is the following one:

SO-039-C02: RTC/RCT shall enable enable the provision of ATC service in case of a contingency event in the concerned airports by tactical management of ATC resources (in terms of staff and modules management, etc.).

2.5 Achievability of the Safety Criteria

No quantitative evidence on the achievability of the safety criteria through the specification of the safety objectives have been collected for Remote Contingency Tower. From a qualitative view point, subjective feed back from the operational experts during the trials was provided in the sense that the level of safety seemed to be equivalent to the current contingency solutions used as reference where ATS service is still provided (see section 2.3 regarding options 2 and 3).

2.6 Validation & Verification of the Safety Specification

The validation exercises performed in the frame of Remote Contingeny Tower have been the following ones:

- **EXE-06.09.03 VP-059**: a Life Passive Shadow Mode (PSM) trial at Gothenburd Airport aiming to assess the technical and operational capability of an initial prototype at medium density aerodromes during contingency situations.
- **EXE-06.09.03-VP-062**: a Life PSM trial at Gothenburg Airport aiming at confirming results from trial 1 and to also assess advanced technical enablers.
- **EXE-06.08.04-VP-751**: a life PSM trial at Girona Airport aiming at assessing in V2 the continuity of operation during contingency situations from a Remote Contingency Tower
- **EXE-06-08-04-VP-752**: a life PSM trial at Girona Airport aiming at assessing in V3 the continuity of operation during contingency situations from a Remote Contingency Tower

The results from these trials have allowed to obtain some evidence on the Remote Contingecy Tower with the following limitations:

L002 Concerning the other phases of the contingency process (transition into and out of phases): these phases where in P06.09.03 addressed during the debriefing with the operational expert participating during the trial, and thus the evidence are limited on the specification for these phases. In EXE-P06.08.04-VP751/752 it was assessed that ATCO had to configurate the CWP as if they were coming to RCT from TWR. Therefore, they needed to set the system configuration and confirm that they were ready to provide ATS service before the control was transferred from TWR. As a result of this, the elapsed time was measured until the ATCO in the RCT takes control. On average in V3, where OTW, PTZ and Advanced Visual Features were used, the ATCO needed 18 min to assume the traffic once they were in the RCT. In V2, where only OTW and PTZ were used, the ATCO needed 6.7 min on average to start assuming the traffic in the RCT. While the Advanced Visual Features had the negative impact of longer transition times into RCT, they were found more useful in V3 during night sessions as OTW and PTZ was not seen as sufficient to maintain ATCO situational awareness. A recommendation to reduce this time was that each ATCO have a user-defined RCT configuration. Also from debriefing sessions was the recommendation that two ATCOs are at the start of the RCT transition-in. One ATCO would control the traffic supported by OTW and the system in TWR and the other ATCO supporting all other RCT functionalities (e.g use of PTZ for tracking) Trainning to refresh system functionalities could be also needed to be adequately defined.

L003 Concerning the provision of tower services during the contingency regarding traffic mix, as a result in EXE-P06.08.04-VP-752, there's a need for further research on how to support ATC in RCT regarding separation provision for simultaneous VFR-VFR and VFR-IFR traffic. According to debriefing sessions, ATCOs commented that the distance perception on OTW are different to TWR and reported that feasible simultaneous VFR operations in mixed VFR-IFR will possibly be not more

than 1 or 2. Although the prototype could be improved to increase ATCO trust regarding RCT functionalities and more training could let the ATCO be more familiar with the different perception in RCT, none of these visual functions are directly supporting distance perception for separation provision task for VFR-IFR mix mostly if radar information is not available and the ATCO has to rely on RCT functionalities only. Additionally, the narrower RCT angle of view also impacts the control of simultaneous IFR and VFR traffic and/or changing the approach procedures. This last only applies if there are VFR circuits on each side of the single runway and the RCT does not provide a 360º view.

The complete set of results from the trials mentioned above is provided in the corresponding Validation Reports [5], [7], [10] and [11]. . Apart from the trials' results, expert judgement has also been used for validating some results through working meetings, workshops and document reviews.

evidence.

In any case, the way the above mentioned situations (abnormal conditions and degraded modes as well as transition to and from contingency situations) can be managed is quite dependent to the physical solution used for implementing the concept. During contingency, availability of air situational display/ ground radar/no ground radar in RCT (e.g. to support provision for simultaneous VFR operations in mixed VFR-IFR) and angle of view in RCT. These are then the areas that needs to be deeper and specifically assessed for general applicable implementation in RCT and that might need to be considered for SESAR 2020.

3 Safe Design at SPR Level

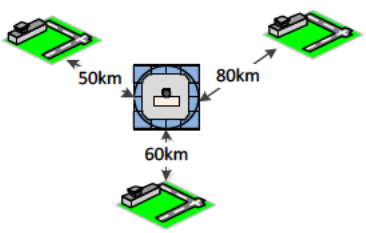
3.1 Scope

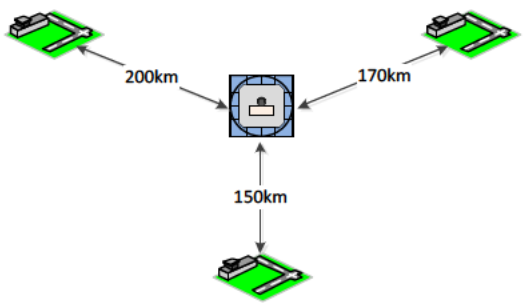
Based on the safety assurance activities defined in the Safety Plan, this section addresses the following activities:

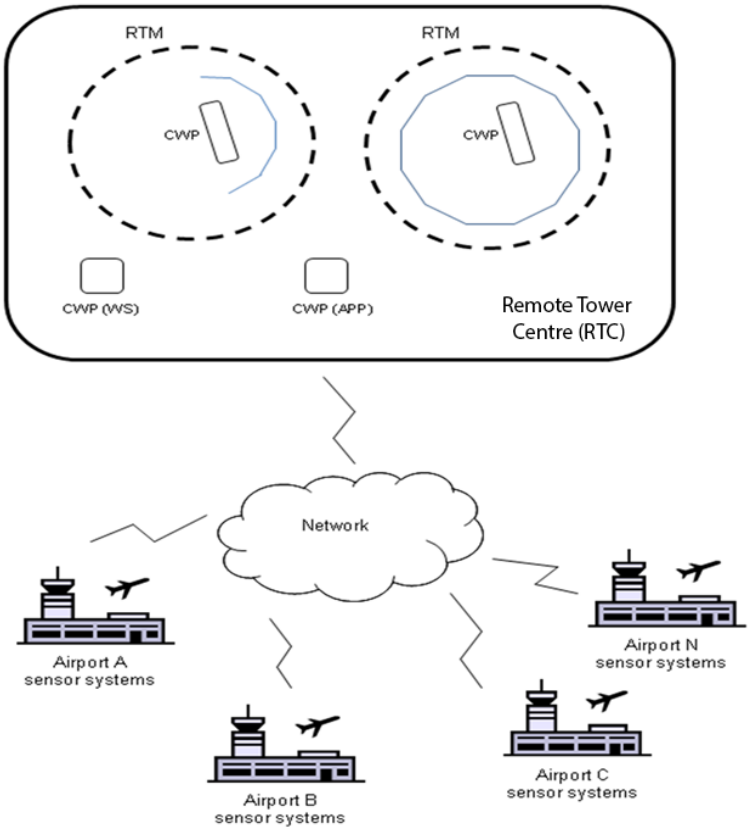
- description of the Logical Model of the Single Remote Tower system – section 3.2
- derivation of the corresponding safety requirements based on the service description defined in section 2 – section 3.3
- validation and verification of the Single Remote Tower system specification – section 3.4

3.2 The SPR-level Model for Single Remote Tower

The SPR-level Model for Remote Contingency Tower is the same as for Single Remote Tower. As explained in section 1.2.2 the corresponding module for providing contingency services can be located in the airport premises or closeby, or as being part of a Remote Tower Center. The schemes below show both possibilities:







Note that, as for Single Remote Tower, two configurations of the Remote Tower system have been considered in the project:

- The Basic configuration, 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 Advanced configuration, in which besides all the elements provided in the Basic configuration, 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 further described in the OSED section 3.2.1.1.4[7].

L005: The safety assessment in the P06.09.03 SAR [8] was mainly focused on the basic configuration. On the other hand, advanced visual features were assessed in EXE-P06.08.04-VP-752 and results (usefulness, situational awareness and support to safe and controllable operations) are included in its VALR [11]. The use of these advanced visual features needs further technical research to increase ATCO trust on system support during contingency in RCT, mostly when these advanced visual features support obstacle detection tasks and because the controller will not have everyday experience using these tools since they are applicable to the contigency tower. There are relevant aspects to consider for technical improvement such as the different use of the available PTZ cameras versus OTW (different zooming or resolution and needs to support ATC on situational awareness of the active/actives ones, etc.) and the integration of information in RCT from different sources (e.g.

flight tag relying on updates of radar information that does not superimpose with flight position in OTW visualization).

3.3 Derivation of Safety Requirements

The following table lists the safety requirements derived from previous table. They are presented per SPR-model elements. A reference to the corresponding Safety objective(s) is also provided. In case an equivalent or similar requirement is already provided in the OSED the corresponding reference has also been provided.

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

SO	Requirement *(forward reference)*	Maps on to
Normal operations		
SO-053-C01	Local tower shall apply the contingency plan in case of planned outage or emergency situation as appropriate [SR-C1].	Local Tower
SO-039-C01	Supervisor in a RTC/RCT shall strategically / pre-tactically plan ATC resources (staffing) taking into account any planned event which would required the provision of ATC services for a concerned aerodromes from a RCT.[SR-C2]	Supervisor
Transition into Contingency – Transfer to RCT from Local Tower		
SO-040-C01	ATCO allocated to a RCT position has to apply the relevant start-up procedure before providing Tower service from that RCT position. A specific start-up checklist to check RCT capabilities shall be used. [SR-C3] Note: this can be done by the ATCO in the RCT in his own or with the support of the supervisor. When defining this procedure, careful consideration regarding setting advanced visual features might be needed (e.g. regarding time required to set these functionalities and training needs to be familiar with them).	ATCO
SO-041-C01	Handover procedures between Local Tower and RCT shall be applied (taking into account time and availability constraints) in order to transfer the service from local tower to the RCT. A specific transfer checklist shall be used [SR-C4] Note: this can be done by the ATCO in the RCT in his own or with the support of the supervisor.	RCT / Local Tower
Transition out of Contingency – Transfer from RCTto Local Tower		
SO-042-C01	ATCO shall transfer Tower control to local tower in a safe way (e.g. following specific procedures included in a LoA).[SR-C5]	ATCO
SO-043-C01	Handover procedures between Local Tower and RCT shall be applied in order to transfer back the service from RCT to Local tower. A specific transfer checklist shall be used. [SR-C6] Note: this can be done bu the ATCO in the RCT in his own or with	RCT / Local Tower

SO	Requirement *(forward reference)*	Maps on to
	the support of the supervisor.	

Concerning the Phase "Provision of Tower service during contingency situation" the same requirements as per Single Remote Tower during Service provisions apply.

3.4 Validation & Verification of the Safe Design at SPR Level

As explained in section 2.6, trials for Remote Contingency Tower have been performed in Passive Shadow Mode and mainly addressing the "Provision of service during Continency phase". Thus the results from these trials have allow to obtain some evidence on the validity of certain safety requirements for this phase concerning normal operations conditions, but limited ones concerning abnormal conditions operations and degraded modes and also concerning the other contingency phases "Transition into" and "Transition out of" (see L002 and L003). The same applies to the "Provision of Tower service during contingency situation" phase.

The concept has been shown to be feasible, but additional activities are still to be done in the frame of a specific implementation as specific aspects are very dependent on the traffic being handled and the concerned operational environment (VFR-IFR, configuration and sequence of the arrivals and departures, etc.). This is particularly true for:

- The capability of the controller to provide ATC services and the potential need for advanced features (for example use of radar, tracking systems, etc) (see SR-26 in the SAR for Single Remote Tower [8]).
- Defining the final airport traffic capacity in remote contingency operations, which depends on the type of traffic as mentioned above, but also on the implemented angle of view of the OTW presentation, the functionalities the controller may have to support her/his tasks, and the role that supervisor may have in supporting the controller.

Evidence:

Results from EXE-06-08-04-VP-752 showed that the controllers felt that traffic levels of 11 movements per hour was the maximum that could be handled safely under contingency remote tower operations.

Additionaly, results from other planned validation trials could potentially be evidence complementary to this safety report. For example this could be the case for EXE-06.08.04-VP-639 and VP-640, which also aim at assessing remote tower for a single medium aerodrome.

The overall results from the trials are provided in the Validation Reports [5], [7], [10] and [11].

Appendix A Consolidated List of Safety Objectives

A.1 Safety Objectives (Functionality and Performance)

Description
Local Tower view
SO-053-C01: In case of contingency situation (planned or unplanned), local tower shall apply relevant contingency plan.
Normal operations
SO-039-C01: RTC / RCT shall enable strategic and pre-tactical management of ATC resources (in terms of staff allocation, modules planning, etc.), taking account of weather forecast, traffic demand and any other factors impacting the capacity of the centre to provide relevant ATS services to concerned aerodromes as well as demand from concerned aerodromes for the provision of planned contingency services.
Transition into contingency
SO-039-C02: RTC/RCT shall enable the provision of ATC service in case of a contingency event in the concerned airports by tactical management of ATC resources (in terms of staff and modules management, etc.).
SO-040-C01: Prior to remotely providing ATC services, RCT capabilities shall be assessed / verified
SO-041-C01: In case of a contingency situation, coordination between concerned tower and RTC/RCT shall be ensured for transferring the service from the local tower to the RCT.
Transition out of contingency
SO-042-C01: Provision of ATC service from RCT shall appropriately (safely) be stopped
SO-043-C01: In case of a contingency situation, coordination between concerned tower and RTC/RCT shall be ensured for transferrinfg the service from the RCT to the local tower.

A.2 Safety Objectives (Integrity)

Any additional safety objective concerning integrity has been identified during the safety assessment.

Appendix B Consolidated List of Safety Requirements

This appendix presents the list of safety requirements obtained from the safety assessment presented in this report. 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 that evidence, some activities are recommended to be done for the next corresponding design phase. Apart from those recommended activities, additional ones are also proposed in the HP assessment for CRT [8]. They all should be considered together in the next Contingency Remote Tower related activities.

The complete list of requirements for Contingency Remote Tower is made of the requirements presented here, plus the ones for Single Remote Tower in the [SRT SAR].

B.1 Safety Requirements (Functionality and Performance)

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	AI data system				
SR-C1 [REQ-06.09.03-OSED-CC05.0001]	Local tower shall apply the contingency plan in case of planned outage or emergency situation as appropriate Note: the specific timing and procedures are to be defined at local level	This is as in current operations. The difference is just that here the contingency plan includes a solution based on a visualisation system (i.e. a Remote Contingency Tower).	Expert judgement based on current operations	To define in detail the contingency procedures to be applied with respect to the local tower in case or planned outage and also in case of emergency situation.	SO-053-C01
SR-C2 [REQ-06.09.03-OSED-CC05.0001]	Supervisor in a RTC/RCT shall strategically / pre-tactically plan ATC resources (staffing) taking into account any planned event which would required the provision of ATC services for a concerned aerodromes from a RCT.	One task allocated to the Supervisor role is to accommodate the planned use of RTC/RCT in terms of module(s) and staff availability.	This has been defined based on expert judgement and on the basis of other Supervisor tasks already defined in the frame of Single Remote Tower and specifically within a	To define the information, timing and procedures to be applied in order to ensure that RTC/RCT and corresponding staff needs will be available during the planed event triggering the contingency	SO-039-C01

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
	Note: the specific timing and procedures are to be defined at local level		Remote Tower Centre.	situation.	
SR-C3 [REQ-06.09.03-OSED-CC05.0001] [REQ-06.09.03-OSED-RTC3.0008]	ATCO allocated to a RCT position has to apply the relevant start-up procedure before providing Tower service from that RCT position. A specific start-up checklist to check RCT capabilities shall be used. Note: this can be done by the ATCO in the RCT in his own or with the support of the supervisor.	This requirement is based on the one from Single Remote Tower SR-28. The difference is for contingency is that the procedure should adapt to the available time before starting to provide the service. That's why the note have been adding, recommending the potential involvement of the supervisor to ensure that the transition to contingency is done in the appropriate delay.	This has been defined based on the requirements from Single Remote Tower plus on the basis of the Supervisor tasks within a Remote Tower Centre.	To define the system checking that need to be done, the timing to do so and by who it needs to be done.	SO-040-C01
SR-C4 [REQ-06.09.03-OSED-CC05.0001] [REQ-06.09.03-OSED-RTC3.00017]	Handover procedures between Local Tower and RCT shall be applied (taking into account time and availability constraints) in order to transfer the service from local tower to the RCT. A specific transfer checklist shall be used [SR-C4] Note: this can be done by the ATCO in the RCT in his own or with the support of the supervisor.	This requirement is based on the one from Single Remote Tower SR-27. Then main difference here is the additional time and information / personnel availability constraint that needs to be taken into account to define these procedures.	Not addressed during the trials but during internal discussions with operational experts.	To define the type of information concerning traffic and operational environment situation to be included in the handover procedures, as well as the timing and the way of obtaining this information.	SO-041-C01

REQ	Description	Additional Explanation	Validation Activity / Evidence	Next activities / recommendations	Satisfies
SR-C5 [REQ-06.09.03-OSED-CC05.0001] [REQ-06.09.03-OSED-RTC3.00017]	ATCO shall transfer Tower control to local tower in a safe way (e.g. following specific procedures included in a LoA).	This requirement allows a safe transfer of the service provision from the RCT to the local tower once the contingency situation is finished.	Not addressed during the trials but during internal discussions with operational experts.	To defined procedures to be applied to traffic in order to ensure this transfer of responsibilities can be done in a safe way	SO-042-C01
SR-C6 [REQ-06.09.03-OSED-CC05.0001] [REQ-06.09.03-OSED-RTC3.00017]	Handover procedures between Local Tower and RCT shall be applied in order to transfer back the service from RCT to Local tower. A specific transfer checklist shall be used. [SR-C6] Note: this can be done by the ATCO in the RCT in his own or with the support of the supervisor.	The same rational as for SR-C4 applies here, unless the time and availability factors are not the main constraints in this case. Equivalent then to SR-27 but from the perspective of the RCT giving back the service provision to the local tower.	Not addressed during the trials but during internal discussions with operational experts.	To define the type of information concerning traffic and operational environment situation to be included in the handover procedures, as well as the timing and the way of obtaining this information.	SO-043-C01

B.2 Safety Requirements (Integrity)

Any additional Safety Requirements concerning integrity aspects have been identified during the assessment.

Appendix C Assumptions, Safety Issues & Limitations

C.1 Assumptions log

No additional assumptions have been stated in the safety assessment for Remote Contingency 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 is focused on the remote provision of ATC Tower services from a Remote Tower Module in a contingency situation for small / medium airports with only one runway.	In case Remote Contingency Tower is to be applied for other type of airports (with multiple runways or/and bigger ones) the safety assessment needs to be revaluated (e.g. only one CWP has been assessed in RCT) .
L003	Concerning the other phases of the contingency process (transition into and out of phases): these phases were addressed during the debriefing with the operationl expert participating during the trial or only limited to assess time elapsed between the start of the run and RCT-ATCO taking over control, and thus the evidence are limited on the specification for these phases	To be tested during dedicated active trials in order to ensure the applicability and need of certain requirements (for instance if ATCO had to control the traffic even if in simulated environment and transition to RCT is not in low complexity period of the single runway airport).
L004	Concerning the provision of tower services during the contingency situation, the results for these trials provide evidence that there are limitations for feasible simultaneous mixed IFR-VFR operations even with the use of Advanced Visual Features.	The needs for changes in training are to be tested (e.g. familiarization with changes on distances perspective), ATC procedures in place (e.g. if VFR circuits are defined at both sides of the runway and angle of view is less than 360º in RCT) and system improvement (e.g. enabling relevant flight plan information accessible on the tag over OTW) to support simultaneous VFR operations in mixed VFR-IFR
L005	The safety assessment is the result of assessments of the basic configuration and additionally of the use of specific enhanced visual features although they were not all ready for implementation. The main limitation was with the obstacle detection functionality.	In case of a local implementation, the safety assessment may consider results for improvement [11] on enhanced features in order to ensure a safety provision of the TWR service to the corresponding aerodrome. (for instance, obstacle

		detection to be possibly filtered, showing only information relevant for ATCO or flight tracking not being lost when flight stops or reduces speed while taxiing)

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