Remote Provision of ATS to a Single Aerodrome VALR Annex

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Abstract

This document contains appendices to the P06.09.03 Validation Report (VALR) for Single Remote Tower. These appendices present the feedback obtained from validation exercises EXE-06.09.03-VP-056, EXE-06.09.03-VP-057 and EXE-06.09.03-VP-058. Contributors to feedback detailed herein includes stakeholders to the Single Remote Tower project primarily experts and airspace users who observed and had involvement with the validation exercises of Single Remote Tower. This document has been collated in a separate annex document due to the length and level of detail of the feedback received. Further to this a Human performance assessment and Safety assessment has been undertaken under P06.09.03 for the Single Remote Tower project, each being produced under separate annex documents as individual deliverables.

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Appendix A Rules and Regulations Transversal Area Supporting Material

The Rules and Regulations results from the trials are based on issues collected as part of the HP and Safety assessments. They are therefore not separately reported in this document. A separate project deliverable for Rules and Regulations covering more high level results (not limited to those collected during validation) will be issued by the Rules and Regulations team.

With regards trial specific results, VP-057 produced an Appendix to the Operational Manual and a Checklist for procedures in degraded mode situations. This checklist and Manual are included below.

Checklist A1 – Screen failure

Unreliable screen	ex. non-critical screens frozen or black
	• If there is traffic planned within next 10 minutes revert to one movement mode. • Alert APP *"VR unreliable"*. • Alert technical assistance. • Put on runway lights and stop bars
Frozen screen	
	• If any critical screen(s) are frozen revert immediately to one movement mode. Use the phrase *"due to system failure"* when instructing aircraft. • Alert APP *"VR out of service"*. • Alert technical assistance. • Put on runway lights and stop bars
Black screen	
	• If any critical screen(s) go black revert immediately to one movement mode. Use the phrase *"due to system failure"* when instructing aircraft. • Alert APP *"VR out of service"*. • Alert technical assistance. • Put on runway lights and stop bars
Contingency mode	
	• One movement at the time until VR is tested and back in full operation
Recovering mode	
	• Alert APP that VR is in function again. • Gradually step up amount of simultaneous traffic • Keep lights on for 30 minutes

Checklist A2 – Loss of visual contact

B1 AIRBORNE ARRIVALS

If reported position is outside 8 NM from the runway:

- Check against radar position if available
- Wait 30 seconds in order to achieve visual contact

- If still no visual contact assume the visual reproduction is unreliable or frozen
- Follow checklist A1

If reported position is between 8 NM and 4 NM and there is more than one movement

- Ask flight crew for reconfirmation of position
- Check visual screen status
- Otherwise confirm radar position by contacting APP
- Abort the approach and order a go-around
- VFR can continue towards or remain in published VFR-holding
- Follow checklist A1

If reported position is inside 4 NM and there is more than one movement

- Abort the approach
- VFR shall go back to published holding
- Follow checklist A1

B2 AIRBORNE DEPARTURES

If there is more than one movement

- IFR-Continue as normal
- Coordinate with APP
- VFR-Proceed to holding and thereafter exit point
- Follow checklist A1

B3 LOCAL TRAFFIC IN THE CIRCUIT

If there is more than one movement

IFR

Coordinate with APP
Climb and transfer to APP

VFR

Go back to published holding
Follow checklist A1

B4 TRAFFIC ON GROUND

If there is more than one movement/vehicle

- Follow checklist A1

Checklist A3 – FOD on manoeuvring area

When wild life or FOD is reported by either flight crew or authorised airport staff at the manoeuvring area or in the vicinity

FOD on manoeuvring area	
	• Ask flight crew if the flight can proceed normally. • Check the reported location of the object by using PTZ-camera and if appropriate IR-camera. • If the animal or object can not be detected, ask for more precise report. • Call runway maintenance for appropriate action (bird protection, runway check, etc). •

Checklist A4 – Met info unreliable

Met info unreliable	
	• Call local met-observer or other authorised local staff in ordet to verify current weather conditions.

Checklist A5 - Camera failure

No camera tracking	
	• Confirm position visually. • Ask for position report if needed. • Call maintenance
No IR-camera	
	• Call maintenance
No Zoom camera-PZT	
	• Call maintenance
No alternative camera	
	• Call maintenance

Checklist A6 – e-strip failure

e-strip system u/s	
	Report to APP Start recording on paper Call maintenance

Checklist A7 - Radio failure

No radio	
	• Use back-up system • Report to APP • Call maintenance

Checklist A8 - Radar failure

Radar u/s	
	• Report to APP • Call maintenance

Checklist A9 - VCS failure

VCS-panel u/s	
	• Use back-up system (mobile phone) • Report to APP • Report to airport • Call maintenance

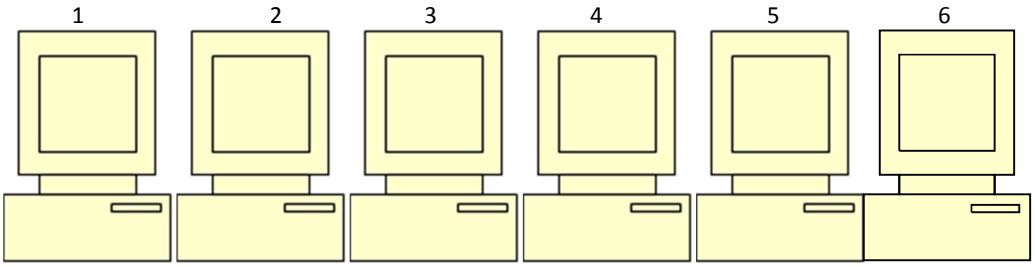
Checklist A10 – Airport sound failure

Airport sound u/s	
	• Call maintenance

Appendix B Appendix to ATS Operational Manual RTC sector ÄNGELHOLM

B.1 RTC sector Ängelholm

Screen number in RTC:



Definition: Critical screens - the screens that cover the short final and the entire path of the runway

Critical screens RWY 14: 2, 3, 4 and 5

Critical screens RWY 32: No. 5, 4, 3 and 2

1.Start-up - RTC

Control of screens

Request ”runway inspection”(should be standard procedure). Ask the vehicle to stop at predetermined positions and report by radio. Check the positions on the screen.

Soundcheck – airport sound

Listen to the car that makes ”runway inspection”. Ask the driver to sound the horn.

2.Contact with the airport

Airport manager

0431 – xx xx xx

Met-obs

0431 – xx xx xx

Report of FOD (Foreign Object Damage)

When pilot report on objects, obstacles, animals on the runway or its vicinity:

- During daytime and VMC
- Check with PTZ camera and possible IR camera
- If you can´t see the object - ask the pilot to report the position of the object
- Is the aircraft able to move on or is other action required – decision together with the pilot
- Call the airport staff for a ”runway inspection” and possible action 0431 - xx xx xx

3.Separations - deviations

Reduced runway separation

Reduced runway separation may **not** be exercised by the RTC.

Reduced separation in the vicinity of the airport

Visual separation as described in Doc 4444 chapter 6 may **not** be exercised by the RTC, with following exception:

Departing aircraft with diverging tracks after take-off

- During daytime and VMC
- All cameras and displays shall be working

4.IR-Camera

Checking the runway or other parts of the manoeuvring area, in order to identify the position of animals or FOD, based on a report. Reporting may be received from a pilot, vehicle driver or other person located on the manoeuvring area.

Use the IR camera with caution. Remember when you are using infrared camera you can have a better picture of the situation on the manoeuvring area than the individual situated there.

5.LVP

During LVP, two simultaneous movements may be allowed (two departures, two landings, a departing and a landing or an aircraft and a vehicle) on the manoeuvring area if the IR camera is used to verify the reports.

- A report "runway free" of aircraft or vehicles.
- Report of being at the ”holding point" of aircraft or vehicles

6.One Movement mode

A reduced mode when the visual presentation is not available.

Provided that no vehicle or aircraft are reported on the manoeuvring area, you can allow an aircraft to land.

The mode may not be used directly after start-up of RTC. RTC have to have had visual control of the airport before using this mode.

Weather Requirements: CAVOK? visibility and cloud base?

7.Abnormal occurrences

Aircraft which are not visible for RTC-controller (Checklist B)

AIRBORNE ARRIVALS
If reported position is outside 8 NM from the runway:

- Check against radar position if available
- Wait 30 seconds in order to achieve visual contact
- If still no visual contact assume the visual reproduction is unreliable or frozen
- Follow checklist A1

If reported position is between 8 NM and 4 NM and there is more than one movement

- Ask flight crew for reconfirmation of position

- Check visual screen status
- Otherwise confirm radar position by contacting APP
- Abort the approach and order a go-around
- VFR can continue towards or remain in published VFR-holding
- Follow checklist A1

If reported position is inside 4 NM and there is more than one movement

- Abort the approach
- VFR shall go back to published holding
- Follow checklist A1

AIRBORNE DEPARTURES

If there is more than one movement

- IFR-Continue as normal
- Coordinate with APP
- VFR-Proceed to holding and thereafter exit point
- Follow checklist A1

LOCAL TRAFFIC IN THE CIRCUIT

If there is more than one movement

IFR

- Coordinate with APP
- Climb and transfer to APP

VFR

- Go back to published holding
- Follow checklist A1

TRAFFIC ON GROUND

If there is more than one movement/vehicle

- Follow checklist A1

Weather information

Loss of Met-report

Call the Met-obs in Ängelholm 0431 - xx xx xx and requests Met-report - notes on paper. Request transmission by fax until the the connection is ok.

Call maintenance 0431 - xx xx xx

When you perceive the weather different from the report.

Call Met-Obs in Ängelholm 0431 - xx xx xx for verification.

Loss of airport sound

Loss of local airport sound - required? Is it acceptable to work without airport sound? Switched off for RTC?

Appendix C Feedback from SJU IVT Experts

C.1 VP-057

C.1.1 Summary

Having made some changes from the 1st validation trial conclusions, (for instance: the general set up, new enhanced visual features, new CWP and mainly the new tracking tools have been included), the first impression was that the concept has stepped forward.

The validation trial was split into two different modes: Basic and Advanced. Under Basic mode only visual reproduction and a PTZ (Pan, Tilt, Zoom) camera are used to providing ATS. Advanced is comprised of radar and visual tracking, infrared camera, alternative cameras covering hotspots on the manoeuvring area, aircraft label overlays, e-Strip system as well as the visual reproduction. These changes showed that the project has made a progress and has become a bit more mature.

The weather was always good, and we only had the opportunity to test the system in either darkness or foggy conditions by using some recorded scenarios, always run in Basic mode thus having no possibility to handle any new and advanced feature to check how the new tools could help the controller under those poor conditions. We were able just to imagine how to work during those conditions. At night time and/or in fog circumstances the Basic Mode is weak and not reliable enough, as a consequence the level of service decreases compared to the local tower service provision.

The question that firstly rises is if this concept is the new way to handle the traffic at the airport and in the vicinity. And our answer is: it depends on a lot of things.

1 Which mode are we talking about?

2 During all weather conditions/seasons, daytime/night time?

3 Scheduled traffic, IFR, VFR or a mix, civil/military traffic, crossings?

4 Airspace classification? Who will be responsible for the separation? Will the RVT only handle the traffic on the manoeuvring area and/or traffic circuit, or in CTR?

At this early stage it is difficult to judge and to answer questions regarding the whole concept when there are so many things to sort out before we know how the platform will be constructed.

On the one hand the Basic Mode seems more restrictive hence it could be used to controlling the manoeuvring area and the traffic circuits under good meteorological conditions and day light, but not beyond VFR traffic patterns because light traffic cannot be constantly watched further than 2NM out, and a medium one at around 4NM; both during CAVOK. Or maybe even only the runway and taxiways?

On the other hand when Advanced Mode is in action the system provides the controller wider and more reliable information, as a consequence the controller feels more confident with the system and the situational awareness could be maintained. Hence Advanced Mode is one way to compensate the lack of perception/information that occurs when providing ATC remotely.

The number of simultaneous movements should be limited to no more than 3 at the same time (in advanced mode, it needs to be more restrictive in basic), and certainly not 3 IFR at the same time. Otherwise the situational awareness could be reduced. Also a possible visual failure can occur and too much traffic would be difficult to handle safely.

The differences between the service provided from a Local and a Remote Tower are mainly based on what you see from RT is limited by the system, the ATCO cannot do anything to improve the quality or accuracy of the image when he/she feels more accurate information is needed. What the controller sees is not the real picture, there are plenty of systems between what the ATCO is seeing and what is actually happening. The new enhanced visual features for Advanced are helpful and useful to provide separation in the area of jurisdiction, although they sometimes get controller's attention. Handling the Zoom camera for instance, is not as easy and quick as using binoculars at Local towers and the picture is not as accurate (indeed, the registration plate on aircraft cannot be read on the

manoeuvring area). The PTZ didn´t work during the whole trial and the technicians had to restart it several times during two-shift time.

ATCO's role and responsibilities may change, since he/she has to constantly judge and test what is the system and subsystems status. Also more coordination is needed in degraded conditions.

There is also a risk for complacency. The systems are reliable but it might increase the risk of feeling too safe?

We suggest those limitations for each mode must be addressed in the 06.09.03 OSED.

C.1.2 Concept Overview

The concept element under validation was "Single Remote Tower".

The Validation objectives were:

- Assess the level of service that can be supplied under a range of technical configuration options;
- Develop of working methods & procedures for normal, abnormal and degraded situations (emergency situations in an aircraft, communication failure, screen black-out, etc…) related to Visual Separation application, use of Infra-red, and weather observations;
- Develop of working methods & procedures for normal situations related to Visual Separation application, use of Infra-red, and weather observations;
- Assess, from a safety viewpoint, the impact of the ATCO Situations Awareness;
- Assess the utility of enhanced visual features;
- Assess the impact of the Remote Tower Concept on TWR ATCO Human Performance under good and limited visibility conditions and during the day and night;
- Assess the acceptability of single remote tower operations for ATCOs, in terms of the concept in general and the HMI (visual reproduction, Advanced Visual Features, CWP and working environment).

C.1.3 Conduct of Validation Exercises

The concept being addressed is the Remote Provision of ATS to a Single Aerodrome.

The validation technique used was "Shadow Mode Live Trial" for single concept, during which the new system (Malmö TACC) is given live feeds in the operational environment and runs in parallel to the operational system (from Ängelholm airport, 100 Kilometres away). The new system will be non-interfering and will not play an active part in the ATM system.

The controller will follow the Ängelholm traffic from the RTC CWP at Malmö TACC.

Nine cameras were placed on top of the local tower (Ängelholm), with each having a 40° visual view, which was presented on LCD monitors in the RTC in Malmö.

View and sound from the local tower were captured with digital video cameras and microphones.

Instead of a single, constant technical configuration, different configurations were used:

- **Basic Configuration** – only basic visual reproduction included and no radar surveillance included;
- **Advanced Configuration** – all technical enablers included.

The Validation Scenario is the same as for VP-056. A small VFR aircraft (Cherokee) from the local flying school was hired to perform specific manoeuvres.

The trial was run from 7th May 2012 to 25th May 2012.

During low activity time some previously recorded scenarios were played in order to "simulate" different cases (departing helicopter, night time, fog, etc.) run in Basic mode.

Each controller had the opportunity to sit at the remote CWP during two days. Several questionnaires and interviews were held by the Validation staff as means of gathering as much feedback as possible from the operational operators. In addition two debriefings were attended in order to draw early conclusions.

See the time schedule:

Day 1	
10:30	Introduction
11:30	Lunch
12:15	HF/Safety/Rules
13:00	Practice in RTC ATCO1 + ATCO 2
14:30	Validation ATCO 1
15:30	Validation ATCO 2
16:30	Validation ATCO 1
17:30	Validation ATCO 2
18:00	Validation ATCO 1
18:30	Validation ATCO 2
19:00	Debrief
20:00	End of day

Day 2	
06:15	Daily Briefing
06:30	Validation ATCO 1 + ATCO 2
07:30	Validation ATCO 1
08:30	Validation ATCO 2
09:30	Validation ATCO 1
10:00	Validation ATCO 2
10:30	Validation ATCO 1
11:00	Validation ATCO 2
11:30	Lunch
12:30	Validation ATCO 1 + ATCO 2
13:00	End of Trial Questionnaire
15:00	Debrief
16:00	End of day

C.1.4 Conclusions and Recommendations

In terms of Safety, Capacity, Predictability and Flight Efficiency performance areas there are no foreseen improvements to come from this concept when compared to the local service provision. The only benefit seems to come from the cost effectiveness. But the advanced mode is the set up that is more capable to provide the nearest level of service in remote towers.

The full advanced mode and its subsystems and/or equipment are necessary for the solution to become operationally deployed, although some basic mode could be used under the appropriate conditions mentioned (day time, good visibility, no more than two movements at a time, and restricted to no more than 2NM away).

The added value of the concept tested, in comparison to the existing local service provided, could be regarded in terms of cost effectiveness.

There could be some consequences, to be identified and properly assessed, regarding the effects the new concept may cause in ATCOs health mainly throw the use of screens and fuzzy pictures. Performing remotely is more tiring than the locally. The eyes suffer from some strain after some time.

Flight crew should be well informed when operating in remotely controlled airports.

Controllers' roles would become more technicians related, since he/she should be able to troubleshoot or check the system status at any time. The ATCO would need some additional technical training regarding how equipment works so as to permit the controller getting more aware of what

he/she can expect or how they can make the better use of it to provide a safe and good level of service.

The advanced mode is necessary if the main target is to implement the new concept.

The technical systems need to be more reliable.

The sounds from the fans, screens and computers in the facility were exhausting and also the eyes were dry and tired after one hour.

Where to place the cameras at the airport is essential.

The ATCOs taking part in the validations should be operational controllers and it is of huge importance that Ängelholm rated ATCOs are in the validation team.

The workload will increase with so many new technical working tools.

C.1 VP-058

C.2.1 Summary

First of all, the overall “visual image” displayed at the Remote Tower Module was really excellent. The quality and accuracy of the visual view was good enough to spot and track any target within the AOR. This aspect of the concept has improved significantly from the former platforms previously tested.

According to the VALP (P060903-D051-VALP-00.02.02), the CWP in the RTC will include all presentation of all necessary systems; but in the case of the flight plan data system it didn´t work during the trial. It was substituted by a PC presentation.

The voice control system (radio and telephone) didn’t work properly to perform due ATS service since the AFISO needed total silence around him/her in order not to interrupt the communication.

The due correlation between radar and visual information was impossible to be achieved whenever any aircraft was approaching the heliport closer than 6NM. From heliport site up to 6NM out the correspondent radar symbol and label were displaced from the visual object on the screens. As a consequence the radar target/label was detached from its visual view. Although it was not complicated for the AFISO to keep visual screen-contact with the visual reproduction of one helicopter at a time it would have been confusing and risky in the decision making based on this corrupted information if more than one movement had occurred simultaneously.

PTZ camera continues, as in former trials, being not easy to be operated. In addition it was demonstrated during the trial that the PTZ window appeared and disappeared unintentionally when it was supposedly to be tracking the traffic.

The camera-solar-protection panel didn´t work the day of the visit, thus some glare was influencing the visual view during the trial.

The compressed air system that prevents droplets to stick to the camera lenses didn´t work. This circumstance together with the fact that it rained and snowed during some parts of the trial demonstrated the need of some procedures to be followed when the system is degraded. I would suggest there should be not only some operating-status indications of these subsystems in the CWP, but also it is necessary the AFISO was able to operate them at his/her need.

There were constant messages (“image is corrupt”) popping in and out on the whole set of screens. This means the image was unreliable at some point, but there was no procedure to follow. I suggest some procedures in regards of “corruption” (for instance: which screens are critical or not) should be addressed.

C.2.2 Concept Overview

The concept being addressed is the Remote Provision of ATS to a Single Aerodrome, as described in the OSED for Remote Provision of ATS, Section 3.1: the full range of AFIS defined by the EUROCONTROL Guidelines for AFIS will be provided. The airspace users are expected to be provided with the appropriate level of services as if the AFIS were provided locally at Værøy. The AFISO is not located at the aerodrome. They are located at the Remote Tower Centre in Bodø. Both in Norway.

The Remote AFIS performed AFIS tasks using the CWP in the Bodø Remote Tower facility. The visual surveillance was provided by a reproduction of the OTW view, by using visual information capture.

On top of a strategically placed mast at the Heliport (Værøy) 14 cameras were placed, having a 360° visual view, which was presented on 55 inch LCD monitors in the RTC.

View and sound from the Heliport were captured with digital video cameras and microphones. The actual airport systems, e.g. runway and taxi lights, were connected to the network with relevant data displayed in the RTC.

The CWP in the RTC included all presentation of all necessary systems e.g. flight plan, Met, airport lights, navaids, alarms, with interfaces to the airport.

The exact range of operational tasks and procedures to be addressed is a focus of the trial and the aim is to include as many as possible.

Brief summary of Validation Objectives:

Gain feedback on the technical capability of the Remote AFIS. Assess the range of AFIS functions that could be performed. To gather AFISO opinion on the level of service that can be provided under the current technical configuration to a single aerodrome. Support the development of working methods & procedures related to Visual Separation application, use of Infra-Red, and weather observations. Support the development of working methods & procedures for abnormal situations potentially experienced during the trial (e.g. emergency situations in an aircraft, communication failure with one aircraft). Support the development of working methods & procedures in degraded mode situations related to the failure of the visualisation system (black-out, frozen, corrupted information). Assess the utility of the Remote AFIS Concept. To assess the impact of the Remote AFIS Concept on AFISO Human Performance in all weather and visibility (including daylight and darkness) conditions. Assess the acceptability of the Remote AFIS prototype for AFISO. Gain feedback into the impact of the Remote Provision of AFIS on AFISO roles tasks & responsibilities. Assess the Communication facility utility, usability and acceptability in the Remote Tower platform. Assess the confidence the AFISO has in the accuracy of the MET observation.

C.2.3 Conduct of Validation Exercises

The Remote Provision of Aerodrome Flight Information Services (AFIS) to a Single Aerodrome, assessed firstly through Passive Shadow Mode and secondly in Advanced Shadow Mode. The Passive Mode part entails the AFIS Officer (AFISO) observing live traffic in a non-intrusive manner and not interacting with the aircraft or providing any service. The Advanced Mode will require the AFISO to provide the full AFIS service to the aircraft as the ATCO-in-the-loop using the prototype system. The purpose of the first, Passive Shadow Mode element of the exercise is to assess confidence and assurance among stakeholders that the system can be used for provision of ATS in live traffic during the second part of the trial. Because the Advanced Shadow Mode will follow after the Passive Shadow Mode, there will be an opportunity to familiarise the AFISO with the platform and indicate the confidence in providing AFIS from a Remote Tower and meet the regulator requirements in order to start providing AFIS in Advanced Mode.

C.2.4 Conclusions and Recommendations

The main expected benefit is foreseen as in terms of Cost Benefit, but only in the event the concept is brought to the multiple mode operation. Although the rest of the performance indicators (Safety, Capacity, Predictability, Flight efficiency) could be improved under the Remote Tower Concept, the thorough and appropriate assessments need to be done on each area.

Obviously, new systems and equipment are necessary on ground for the new concept to become operationally deployed, compared to the present provision at the local Tower. There is also a need to assess the new roles and responsibilities derived from the new concept (new actors are set in place between the “reality” and the “relayed” view displayed at the CWP module). In addition, new procedures should be considered when this concept is in operation, (for instance: what if procedures, degraded modes, system and subsystems failures, check lists, troubleshooting, etc..).

The infrared camera as well as some of the “advanced mode features” (such as radar and visual tracking) offer extra tools that would help the AFISO in performing a more safe and efficient provision of ATS.

There is a need in identifying and developing new standards of training and recruitment, especially for those potential “contingency” situations in the remote module. Besides this, new roles, responsibilities and clear procedures for the Controller, the Pilot as well as the ATSEP should be assessed.

The interaction between the Human and the System entails another new challenge. Among others, lack of depth perception as well as fatigue (caused by attending system alerts, by operating new technical features, etc…) are new characteristics that will play a roll between the system and the operator.

Although the proposed solution was not yet completely mature, it is close to be feasible enough for the intended service to be provided, which was AFIS.

Appendix D NSA Expert Review

D.1 VP-056

D.1.1 Introduction

On 10 and 11 November 2011 the Dutch expert attended the live trial for Single Remote Tower, performed by a team with Thomas Svensson, LFV, as validation leader.

This is one of the first validation steps to be taken.

In the end the main expected benefit of the Remote and Virtual Towers is cost effectiveness and efficiency.
ATS facilities cheaper to maintain, able to operate for longer periods and enabling lower staffing costs through centralised resource pools. It will reduce the requirement to operate and maintain actual control tower buildings and infrastructure, leading to further cost savings, while maintain safety/economical benefits by not skipping the ATC service at remote or less dense locations at all.

Main areas of possible constraints are safety, capacity, flexibility and access and equity.

D.1.2 Presentation of the System

A briefing on the trial started 10 November10.30 o'clock, chaired by Thomas Svensson, attended by several (former) ATCo's, representatives of SAAB, ETF, LFV and Finavia. This briefing addressed all relevant issues.

Validation leaders were Thomas Svensson and Jan Bengtsson.

The task contributers are NORACON (LFV, AVINOR, FINAVIA, EANS), NATMIG (Saab), Eurocontrol, ETF, ATCEUC and IFATCA.

The Live trial validation trial 1 consists of a shadow mode trial establishing a technical and operational baseline for Remote Provision of ATS to a single aerodrome.

The total validation trial 1 has a 3 week duration. For this particular live trial two shifts were used:

The afternoon shift of 10 November (10.30 - 20.00) and the morning shift of 11 November (06.15 - 14.00),l offering daylight operations (with sunny conditions at Ängelholm) and operations during the twilight period.

The validation set-up was located at Malmö Airport, performing distance TWR for Ängelholm airport (located t a distance of appr. 100 km), using its real live traffic, including local VFR traffic.

This set-up at Malmö Airport attracted quite some interest, several groups were about to visit the test-location during the visitors days 15-16 November.

All participants in the trial had to declare they were well prepared and briefed to participate in this trial before starting the trial itself.

During and after the shifts questionnaires were to be completed, some in writing, some behind a computer.
The involved ATCo's indicated the questions in these questionnaires were relevant, and all questionnaires included a field to bring up additional issues that draw attention during the trial.

During this Validation Trial 1 the focus was on

- Situation Awareness
- Visibility
- CWP (incl. HMI)
- Safety

- Human factors
- Specific focus also an new Infrared functionality

Thereby establishing 'fitness for purpose'.

D.1.3 Current Status

The set-up of the system at Malmö Airport included a 360° view, enabled by 9 Samsung 50" LCD monitors showing the views of 9 cameras at Ängelholm airport with each a 40° field of view.

It is important to realize that each camera runs its own settings, the difference in view from one camera to neighbouring cameras will differ in most occasions.

Elevation of the fixed cameras resulted in screen views of appr. 40% ground and 60% sky. This introduced the issue of differences in brightness between ground and sky, not easy to overcome by one single camera.

The most important area of Ängelholm aerodrome was covered by 5 new camera's with a higher resolution than the former ones.

The 9 screens were placed in a circle around the Controller Working Position, giving a diameter of almost 4 meters. See for pictures of the set-up at Malmö Airport the Appendix to this report.

For some ATCo's this could give a feeling that the screens are too close for comfort. This could be overcome by using larger LCD screens. Another solution could be not to place the 9 screens in a circle, but in a half-circle, thereby still covering the 360° view, but traffic 'leaving at the right hand side of this set-up would pop-up on the far left hand side and vice versa.

The total delay between the camera recording at Ängelholm and the presentation on the screens at Malmö was less than 1 sec.

The validation trial assumed situations with never more than 3 aircraft at the same time.

Ängelholm aerodrome was a good choice for this first validation trial. It offered a mix of IFR and VFR traffic for this validation trial, but had never more than one aircraft at the same time on 10-11 November 2011.

D.1.4 Observations

D.1.4.1 Safety

- The signal light gun issue (to warn pilots in case of a total loss of communication and video-data) was raised by me, but was apparently not a part of this trial. Nevertheless, it should be included somewhere. The staff involved couldn't give clarity on this subject. One of the ideas is to connect such a signal light gun to the PTZ camera, and/or install lights close to the thresholds.
- Questionnaires based on Validation Objectives:
  - Situation awareness
  - Functional requirements
  - Safety
  - Scenario Based Observations
  - End of trial questionnaires
    - Trust
    - HMI
    - CWP
    - Service Provision
    - Roles and Responsibilities
    - Risks
  - End of day/ trial debriefing

  were filled in by the ATCo's, allowing them to include all their ideas, suggestions and concerns.

- Cameras and sunlight
  It turned out that in a situation with the sun low above the horizon, the views on the one linked LCD screen showed a white rectangular area. Whenever traffic would fly in that specific direction, visual detection on the LCD screens would not be possible.
  It may well be that solving this issue would require specific video knowledge, maybe in combination with automatic filtering.

- Using the PTZ camera (intended as replacement of the binoculars) and the infrared camera required too much time of the controller, when he/she had to make use of the mouse to turn the camera in the desired direction. Presets helped, but solutions like pointing at a location after which the camera would automatically rotate, tilt to the desired elevation angle and focus at the indicated distance seems possible.

D.1.4.2 Capacity

- The ATCo's mentioned they found it quite difficult to find a GA aircraft on the screen. This raised the question how easy of difficult it would be to guarantee visual separation in a situation with more than one GA aircraft near the field.
  - The performance of the human eye is sometimes hard to match, requiring adjustable focus, adjustable aperture, but also the fact that on the screens everything is equally sharp or equally out of focus.
  - Especially finding and following (read: finding again) two different GA aircraft in or near the circuit area was considered an area of further attention: how to detect more easily GA aircraft (maybe even more important in winter time with snow covered fields, knowing that most GA aircraft are white). Technical ways to further assist the ATCo in finding and tracking aircraft may be possible later on, but were not used during the first trial.
  - It helps that in Sweden, at least in this area of Sweden, GA traffic had to make use of Transponders, so the use of the radar screen by the ATCo's was possible.
  - There may be a relation to capacity, especially of VFR GA traffic, maybe a procedural solution.
- The multiple aerodrome concept was not part of this first trial. However, it was already discussed that in the possible future switching over from one aerodrome to another would be easier when making use of electronic strips instead of paper strips. But again, not part of this trial.

D.1.4.3 Other Areas

- Circuit areas:

  The VFR circuits in Sweden are usually flown in such a way that the pilots following such a VFR circuit always has to make a left hand turn to turn to cross wind leg, downwind leg, base leg and final.

  This means that the VFR circuit traffic, depending on the runway direction in use, would fly in front of the 'tower' of behind the 'tower' when on base leg.

  In The Netherlands however VFR circuit areas are usually located on only one side of the runway. This means that the pilot, depending on the runway direction in use, would have to make either right hand turns or left hand turns to stay within the VFR circuit area. This means that all base leg movements are located in the same direction in relating to the tower.

  This idea may help the ATCo in easier locating the GA aircraft and could be of interest for the Remote and Virtual Tower concept.

- The contrast of the 9 screens with the background was not adjusted the first day. This raised some remarks, since the screens became darker and darker in time, the background stayed bright, reducing detection of visual clues on the screens.

  Easy to solve, but nevertheless an issue to pay attention to.

- One idea to overcome the sometimes big contrast differences between ground and air could be the use of 2 layers of cameras, one layer for the ground and one for the air, each optimized on the required contrast. Maybe such an solution could be used only on the most interesting part of the total view.

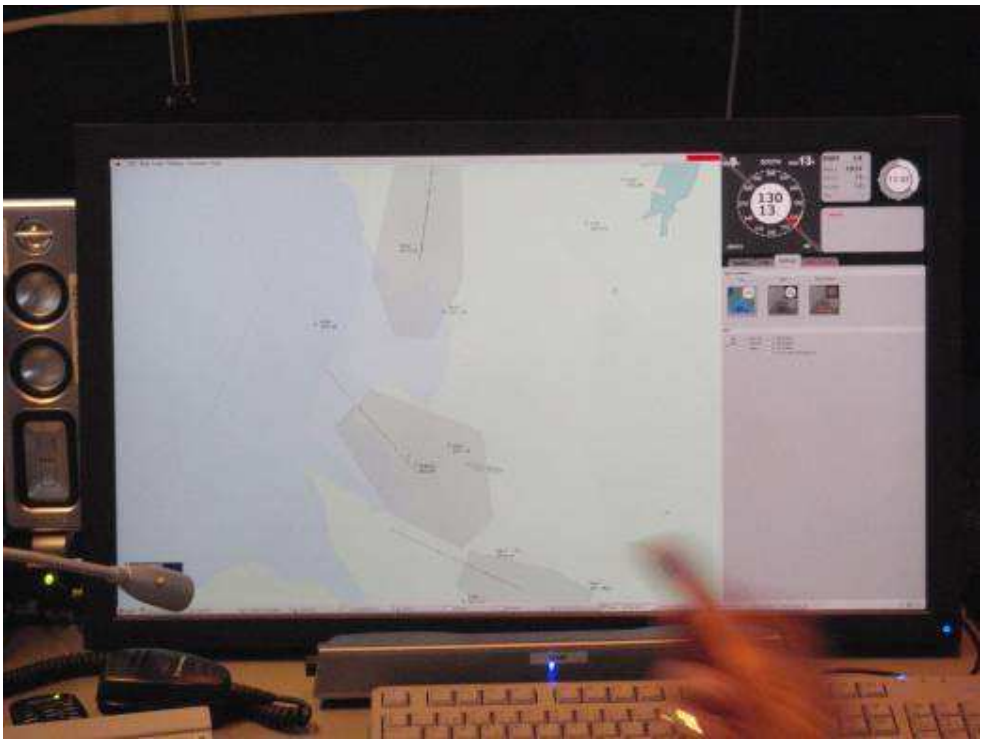
- An optimized use of adjustable white balance might be helpful to make longer use of visual coloured cues under marginal light circumstances.

D.1.5 Pictures of Live Trial 1

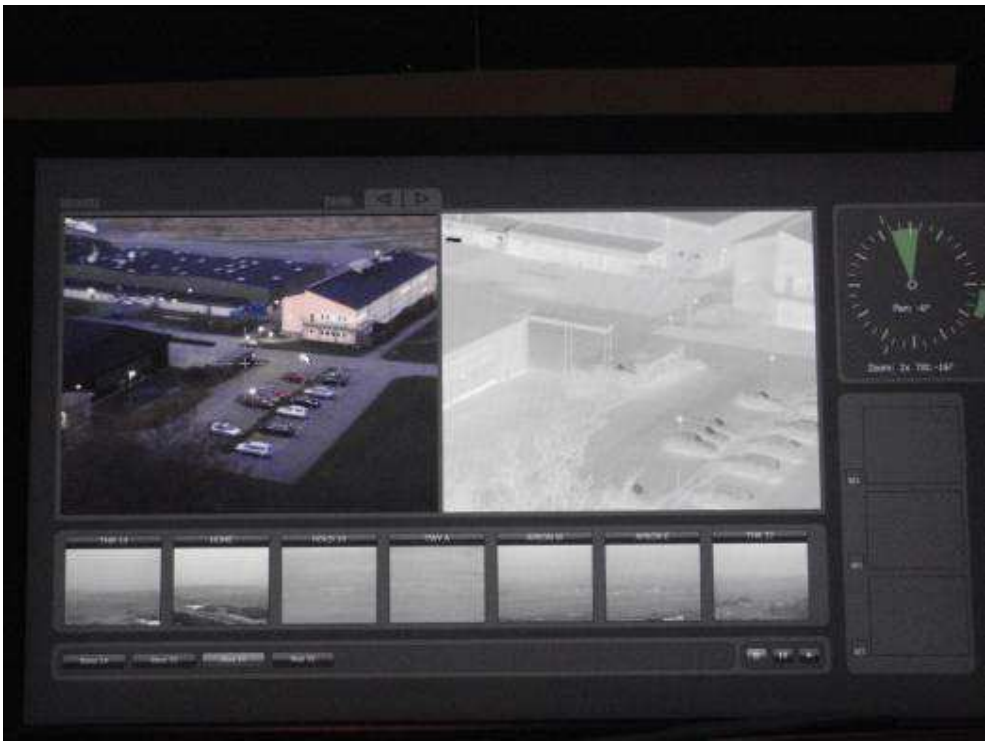
Set-up at Malmö Airport

Part of the 360° display and the Controller Working Station.

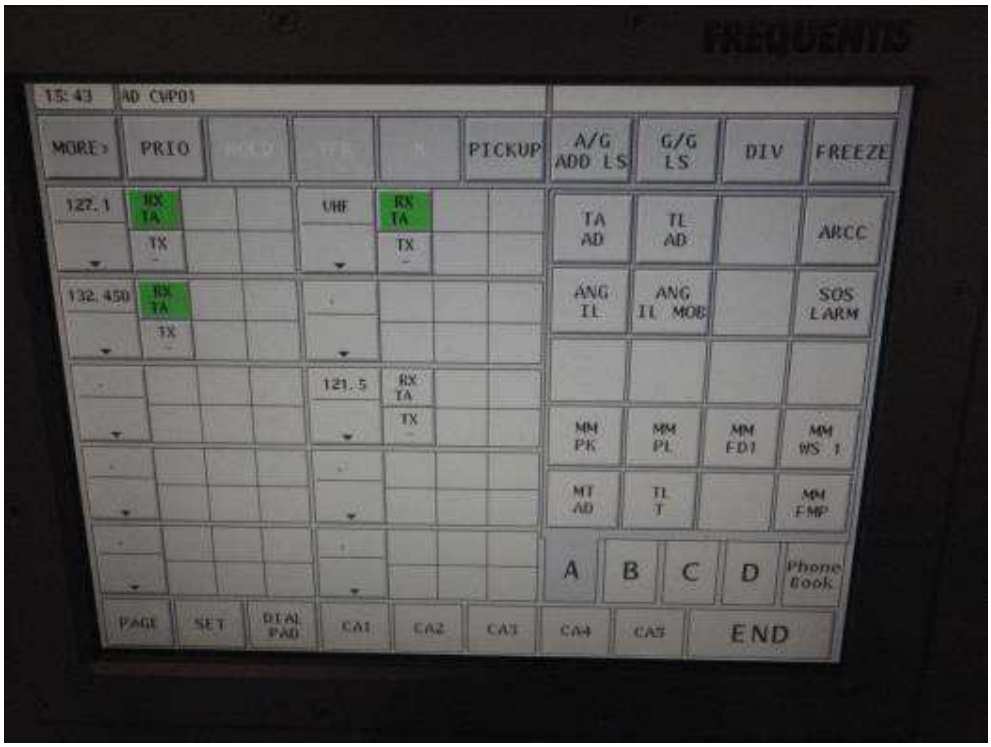
The ATCo could make use of a radar display,



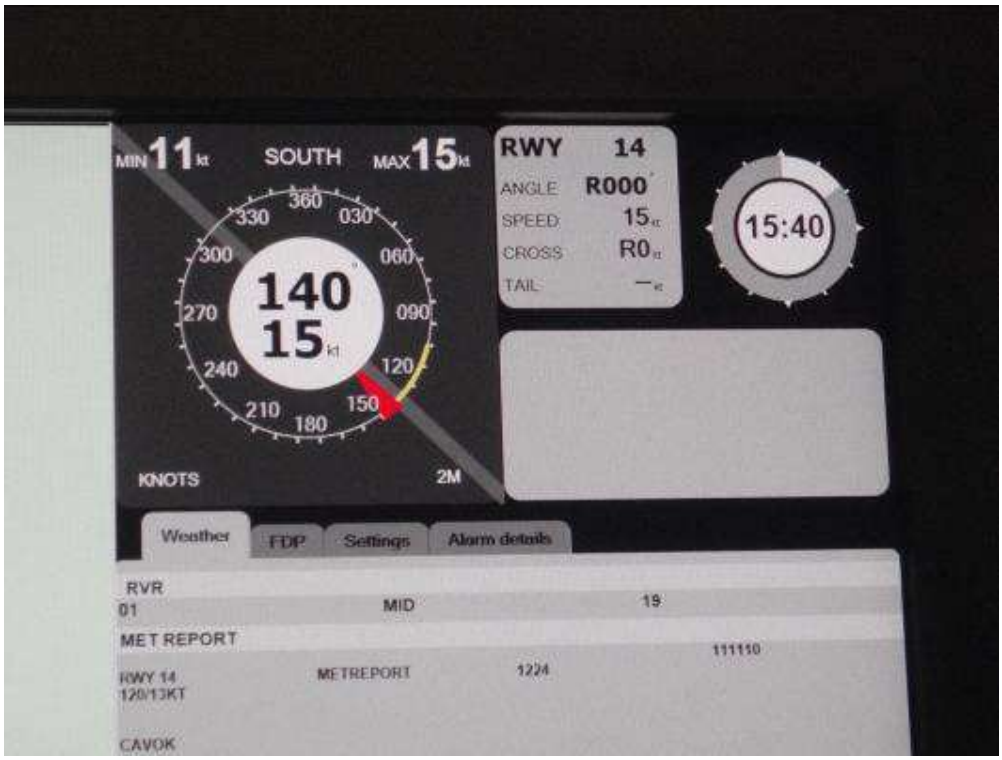
as well as a PTZ camera with adjustable zoom and tilt, and an infrared camera.



Live audio from Ängelholm TWR was delivered, so both pilots contacting Ängelholm TWR and ATCo's (because of the shadow mode) of Ängelholm TWR could be heard in the Malmö set-up.



Meteo information of Ängelholm was also available and presented.



Paper strips of all Ängelholm traffic were printed in the Malmö set-up.

D.2 VP-057

Review by: Jos Wilbrink

Live trial date: 21 and 22 May 2012

Dispatch Date: 24 May 2012

D.2.1 Introduction

On 21 and 22 May 2012 the Dutch expert attended the second live trial for Single Remote Tower, performed by a team with Martin Emson and Thomas Svensson, LFV, as validation leaders.

In the end, the main expected benefit of the Remote and Virtual Towers is cost effectiveness and efficiency.

ATS facilities are cheaper to maintain, able to operate for longer periods and enable lower staffing costs through centralised resource pools. It will reduce the requirement to operate and maintain actual control tower buildings and infrastructure, leading to further cost savings, while maintaining safety/economic benefits by not skipping the ATC service at remote or less dense locations at all.

Main areas of possible constraints are safety, capacity, flexibility and access and equity.

D.2.2 Presentation of the System

A briefing on the trial started 21 May 2012 at 10.30, chaired by Martin Emson, attended by Stein Nielsen (a former Norwegian ATCO) and Ann Mari Hilstad (Norwegian AFISO), the ATCOs for this second trial. Also attending was Bengt-Arne Skoog of SAAB and an observer of SAAB, Anna Wennerberg of Eurocontrol Bretigny. Part of the briefing was attended by Göran Linqvist and Roland Johansson. This briefing addressed all relevant issues. Validation leaders were Martin Emson (and Thomas Svensson). The task contributors are NORACON (LFV, Avinor, Finavia, Estonia), NATMIG (Saab), Eurocontrol.

Another briefing was given by Roland Johansson, LFV, introducing procedures based on earlier live trials, dealing with situations like screen failure, loss of visual contact, camera failure and so on. These procedures had been developed in close co-operation with Eurocontrol, Bretigny. The ATCOs were requested to provide their first impression of these procedures.

The live trial validation trial 2 consisted of a shadow mode trial for Remote Provision of ATS to a single aerodrome.

The total validation trial 2 had a 3 week duration. For the attendance of this particular live trial two shifts were used: The afternoon shift of 21 May (10.30 - 20.00) and the morning shift of 22 May (06.30 - 14.00), offering daylight operations (with sunny conditions at Ängelholm) and operations during the twilight period.

The validation set-up again was located at Malmö Airport, performing remote TWR for Ängelholm airport (located at a distance of approximately 100 km), using its real live traffic, including local VFR traffic.

The new set-up at Malmö Airport attracted quite some interest; several groups visited the test-location.

All participants in the trial were briefed before the start of the trial and had to fill in a questionnaire on their experience and background. The reason for this questionnaire was because of a possible link between the amount of experience with working without radar and the feeling of comfort during the basic mode. During this 2nd live trial representatives of Eurocontrol Bretigny took special interest in Human Factors and Human Behaviour; Anna Wennerberg attended both 21 and 22 May, addressing especially on safety and procedures.

Also attending the trial was Billy Josefsson, focussing on evaluation of the Human Performance aspects whilst Thomas Svensson was the validation leader during the first live trial, November 2011.

In order to improve, the Plan-Do-Check-Act cycle (Deming circle) has been used.

The ATCOs were requested to think out loud, in order to make best use of their experience and impressions. Maybe due to the presence of only Scandinavian people, except but me, sometimes discussions took place in Norwegian/Swedish language, which unfortunately was not understandable for me.

During this Validation Trial 2 the focus was on:

- Acceptability
  - Visual representation
  - CWP (including HMI)
  - Additional ATCO tools
- Human performance
  - Situation awareness
  - Trust
- Safety
- Ability to provide service in two different equipage modes: BASIC mode (without radar, only PTZ as an additional tool) and ADVANCED mode (with all additional visual features available, including radar, tracking, Infrared camera and a few hot spot cameras).

Thereby establishing 'fitness for purpose'. The participating ATCOs were supposed to act as if they were actually controlling the traffic at Ängelholm Airport and compare if they could act as the ATCO at Ängelholm TWR, regarding the application of separation and capacity.

During and after the shifts, questionnaires were to be completed, some in writing, some behind a computer.
The involved ATCOs indicated the questions in these questionnaires were relevant, and all questionnaires included a field to bring up additional issues that draw attention during the trial.

- Questionnaires based on Validation Objectives:
- Situation awareness
- Functional requirements
- Safety
- Scenario Based Observations
- End of trial quest.
  - Trust
  - HMI
  - CWP
  - Service Provision
  - Roles and Responsibilities
  - Risks
  - End of day/ trial debriefing

Questionnaires to be filled in by use of computer or by hand.

D.2.3 Current Status

The set-up of the system at Malmö Airport included a 360° view, enabled by 9 Sony flat wide monitors, each covering 40°. The most important area of Ängelholm aerodrome was covered by 6 new full HD camera's, with a higher resolution than the former ones.

6 LCD screens (full HD) are placed in half a circle around the Controller Working Position, covering 240°, showing the runway and the areas nearby the runway with a frame rate of 30 frames/second.

Behind the CWP three screens (HD ready) provide views of the remaining 120°, but only at a frame rate of 20 frames per second. See for pictures of the set-up at Malmö Airport the Appendix to this report.

This trial also available were a few additional cameras, placed more near to the areas of Ängelholm airport considered most important for the ATCOs. With the option of 'Picture in Picture (PiP)' the ATCO could add more visual clues. Question is where to put these PiPs on the screens, knowing that when you place them in the sky, that PiP could block an approaching aircraft, invisible behind that PiP. Maybe areas at the bottom of the screen, outside the runway area and the approach areas might be helpful.

There was some discussion on the "cone of silence" where aircraft flew too high too close to be visible on the screens. One camera looking vertical could help, but could create confusion as well. Ambient sound could be sufficient as well. An issue for further investigation.

Bengt-Arne Skoog of SAAB indicated there are plans of using 14 cameras and 14 screens (placed vertically) in order to increase the vertical coverage in one of their national projects. This could be useful, especially when the cameras are located more close to the runway.

The next live trial, in Norway, is expected to make use of 14 cameras as well, including options like using filters and better option to keep a clear view.

Anyway, the new setting created more space, solving a feeling expressed the first trial in which some ATCOs indicated the screens were too close for comfort.

The total delay between the camera recording at Ängelholm and the presentation on the screens at Malmö was still less than 1 sec, which is considered very good compared to the delays that come with radar information (appr. 6 sec).

The validation trial assumed situations with never more than 3 aircraft at the same time.

Ängelholm aerodrome again turned out to be a good choice for this second validation trial. It offered a mix of IFR and VFR traffic for this validation trial. Where during the first trial during my attendance there was never more than one aircraft at the same time, during this second trial there were situations with 3 aircraft and a car at the same time in 'basic mode' operation, so without radar to check the comfort level of the ATCO.

D.2.4 Observations

D.2.4.1 Safety

- The signal light gun issue (to warn pilots in case of a total loss of communication and video-data) was raised by me, but like in the first trial was apparently not a part of this second trial neither. A proposed solution is to put the signal gun on the PTZ, to be manoeuvred on the IDP.
- Many questionnaires were to be filled in by the ATCOs, before their first 'shift' and immediately after their shift. The questionnaires allowed the ATCOs to include all their ideas, suggestions and concerns.
- Separate bilateral meetings were held between Anna Wennerberg and an ATCO, going into more details of safety and procedures.

  Both days a plenary end of day debriefing was held and taken notes of
- Cameras and sunlight

  Compared to the first trial improvements have been realised, although the above mentioned filters for the next phase still are considered necessary to really tackle this problem (see pictures in the appendix to this report, with the remark that the 'blocking of the screen with a white rectangle' occurred less long than in the first trial).

- Using the PTZ camera (intended as replacement of the binoculars) and the infrared camera required less time of the controller compared to live trial 1. Now operation is done with a pen, much faster than trial 1. Again, the use of presets helped, but SAAB indicated they are still looking for improvement of its use.

Presets helped, but solutions like pointing at a location after which the camera would automatically rotate, tilt to the desired elevation angle and focus at the indicated distance seems desirable.

The ATCOs found the PTZ hard to control, resulting in nervous movements, especially when zoomed in.

D.2.4.2 Capacity

- In basic mode no radar can be used, nor additional ATCO features, only the PTZ camera.
- One moment a small GA aircraft made a left turn to final RWY 14 and was hard to distinguish while turning.

  A possible solution could be to make it mandatory for aircraft to have their lights on in the CTR.
- At Ängelholm there are entry/exit points at the CTR for VFR traffic. The routes to/from these points could be considered as VFR routes, which could help to spot an aircraft in basic mode conditions. At least one of the involved ATCOs was not aware of these points.
- With the new cameras and screens aircraft were easier to distinguish when on one of the 6 'front HD screens'.

  Nevertheless, the tracking possibility in the advanced mode really helped a lot to overcome the issue of the first trial in which ATCOs mentioned they found it quite difficult to find a GA aircraft on the screen. This raised the question how easy or difficult it would be in the basic mode to monitor visual separation in a situation with more than one GA aircraft near the field and to inform the pilots adequately.

  Again, during this second trial, the ATCOs indicated they sometimes lost track of a small aircraft, but only when working in the basic mode.
- This new tracking facility can work in three modes: cameras, radar and fused. The ATCO can make the selection. The type of box around the aircraft on the screens indicated the mode of tracking. In case radar tracking was possible, a label became visible on the screens, indicating the squawk code of the aircraft or its call sign, the distance in miles (e.g. D12), the altitude in hundred feet (e.g. A11) or the Flight level (e.g. 142) and sometimes the ICAO code of the airport of origin of destination.

  Due to obstacles tracking is possible up to a distance of 25 km down to ground level. Between 25 and 75 km tracking was possible above an altitude set this trial at 1500 ft (this minimum altitude is an issue for further evaluation).

  - It was noted that also birds were tracked by cameras, provided they were not too far away (then too small) and not too close (then too fast to track). It was also nice to note that even smoke was tracked for a while by cameras after the bird watch had to fire his gun to clear the runway of birds.
- It helps that in a large part of Sweden, like in this area of Sweden, GA traffic has to make use of Transponders, so the use of the radar screen by the ATCOs was possible, but only in the advanced mode (in basic mode radar information was set at 'not available').
- Where at Ängelholm the ATCO could accept reduced separation, this is not (yet) allowed from the remote tower. So it can happen that the real controller at Ängelholm accepts reduced separation, in which case the ATCOs at Malmö in their shadow mode were requested to indicate how they should have acted if they would have been in control themselves from the remote control position; would they feel comfortable to allow reduced separation or not. If not, why not?

- The multiple aerodrome concept was not part of this second trial. Also the third trial in November in Norway will use a single aerodrome concept.

  The next phase will be a multiple aerodrome concept to be controlled for a remote control position. However, it was already discussed that in the possible future switching over from one aerodrome to another would be easier when making use of electronic strips instead of paper strips. In this second trial the ATCOs could make use of e-strips with all the features that came with it.

  Preliminary discussions have started for the preparation of this next step: the multiple aerodrome concept.

D.2.4.3 Other Issues

- In order to make best use of the presence of ATCOs and other people this second trial LFV made use of previously recorded situations during periods of low traffic at Ängelholm.

  A very good idea, also demonstrating the possibility to store recordings for study afterwards as part of an investigation in case an incident occurred.

  However, these recorded scenarios only made use of the 6 screens in front of the ATCO.

  E-strips, radar and ambient sound were not included in the recordings.

  The option of using tracking in recorded scenarios was only temporarily not available.

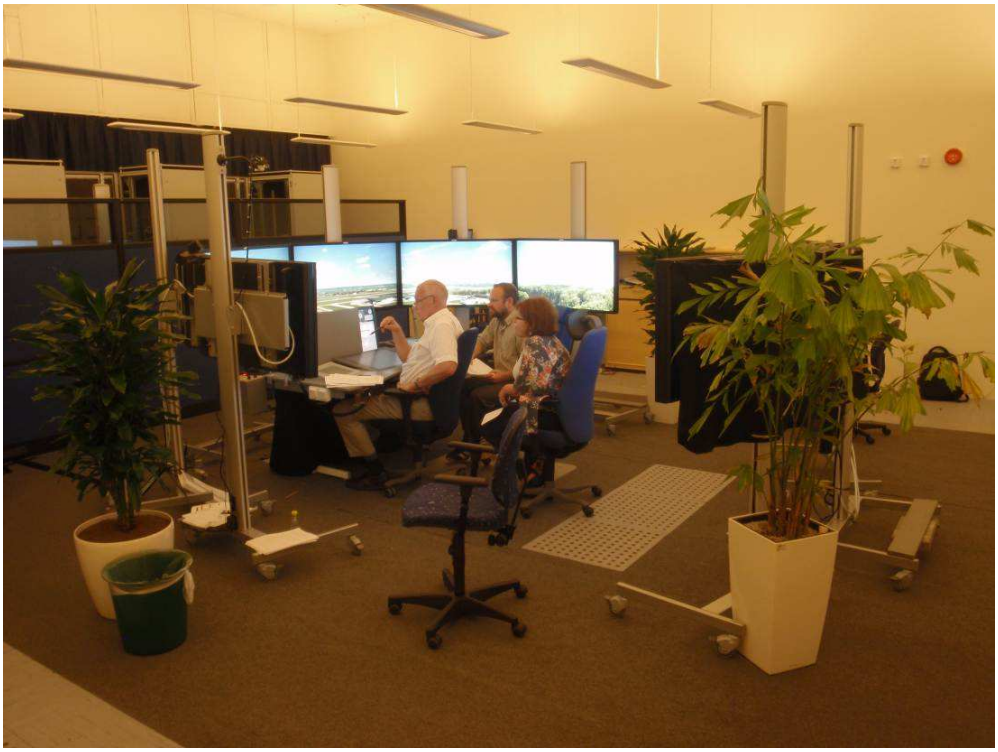
- Another improvement, compared to the first trial, was the possibility to dim the lights in the background.

- One issue left was the request to be able to dim also the intensity of the radar display and the list of aircraft movements to be expected, in order to have a better night vision when it's dark outside.

D.2.5 Pictures of Live Trial 2, 21-22 May 2012

Set-up at Malmö Airport

Six main screens in front, covering 240° and the three screens covering 120° at the back of the ATCOs (in the bottom of this picture), with a gap between the two groups.

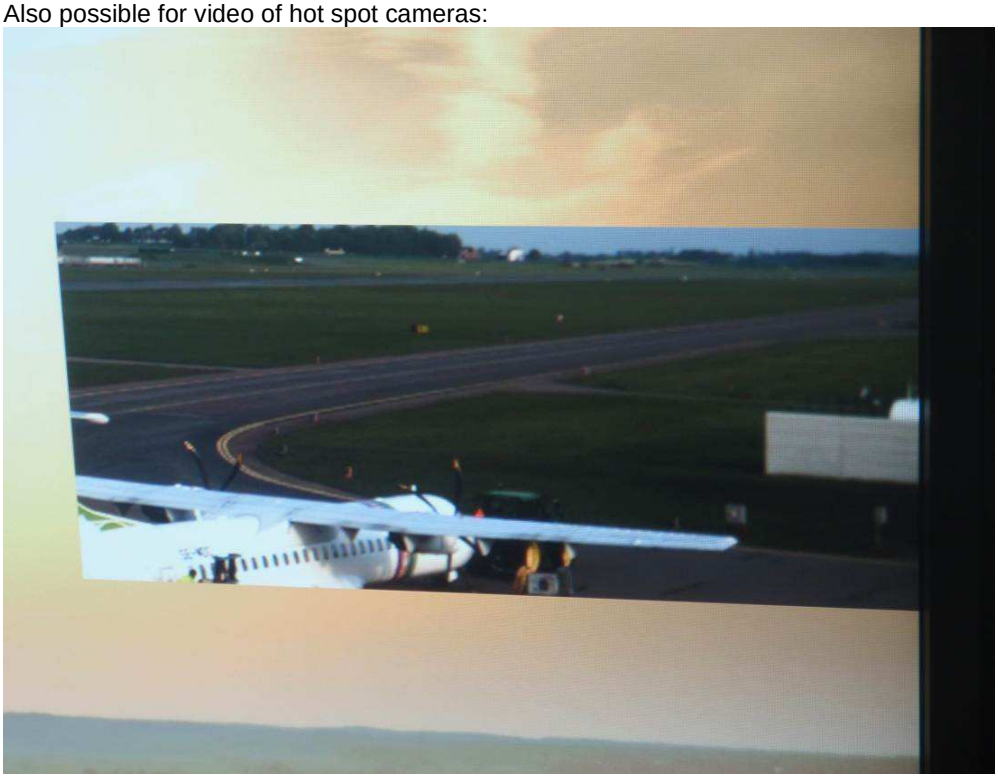


The three monitors ‘in the back’ covering 120°

Picture-in-Picture

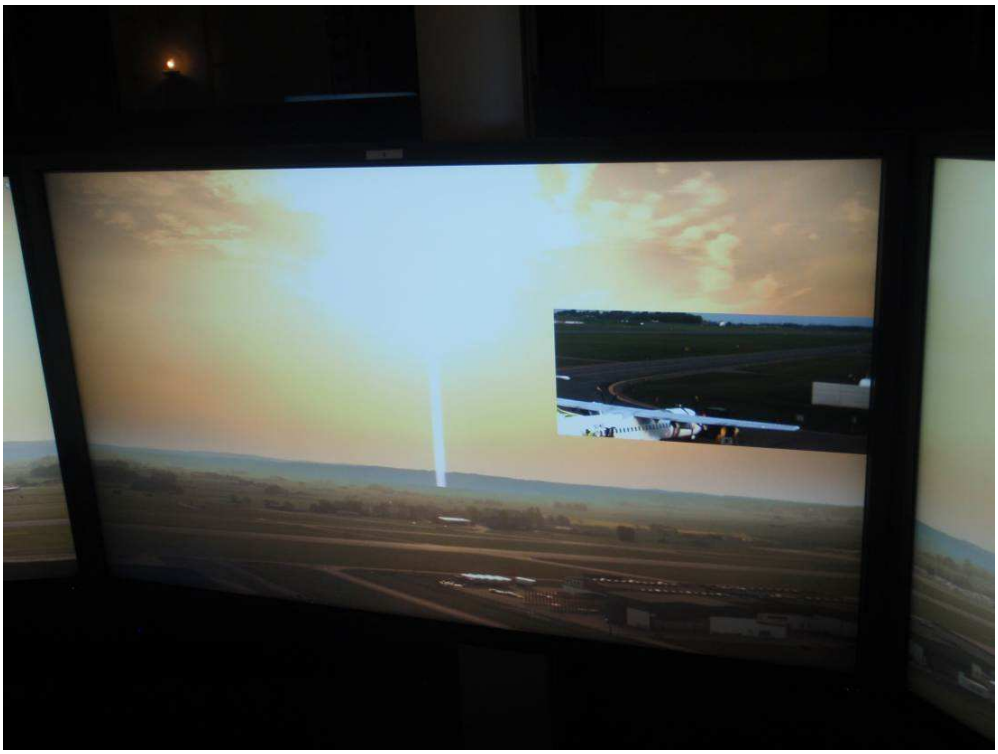
The position of the PiP is subject of further investigation.

Also possible for video of hot spot cameras:



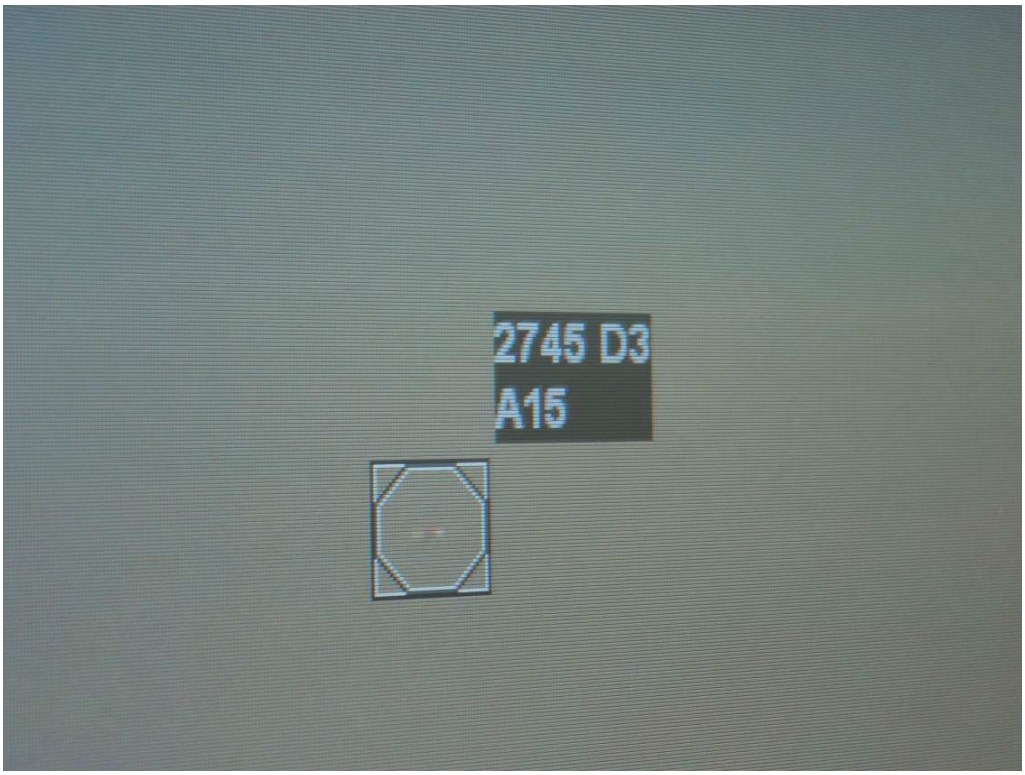
Cameras and sunlight

Quite and improvement compared to the first live trial

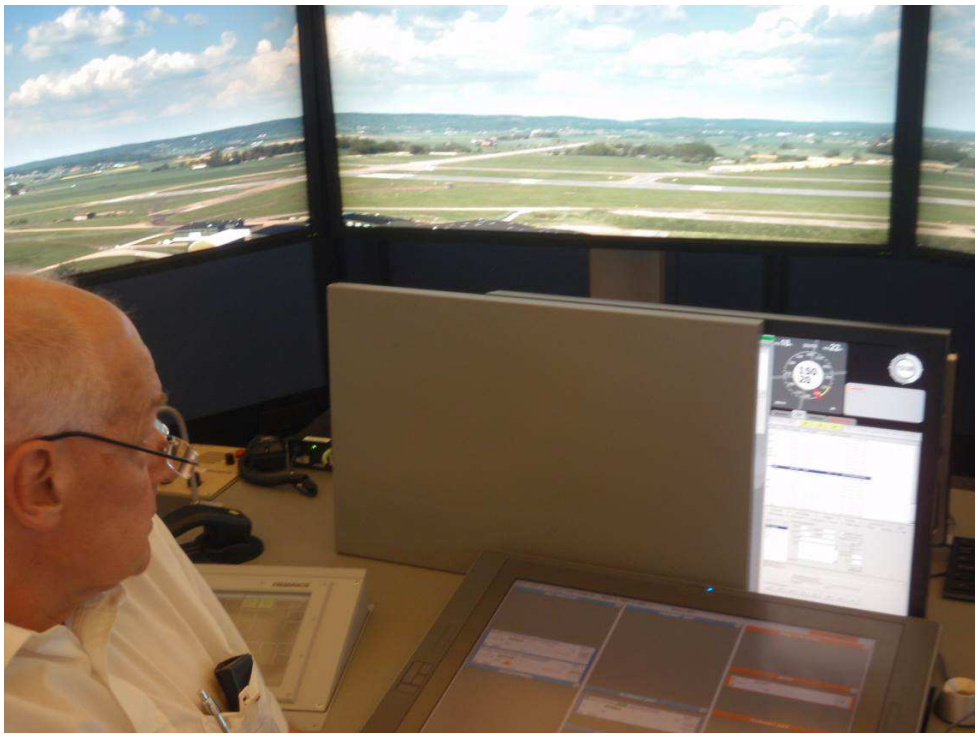


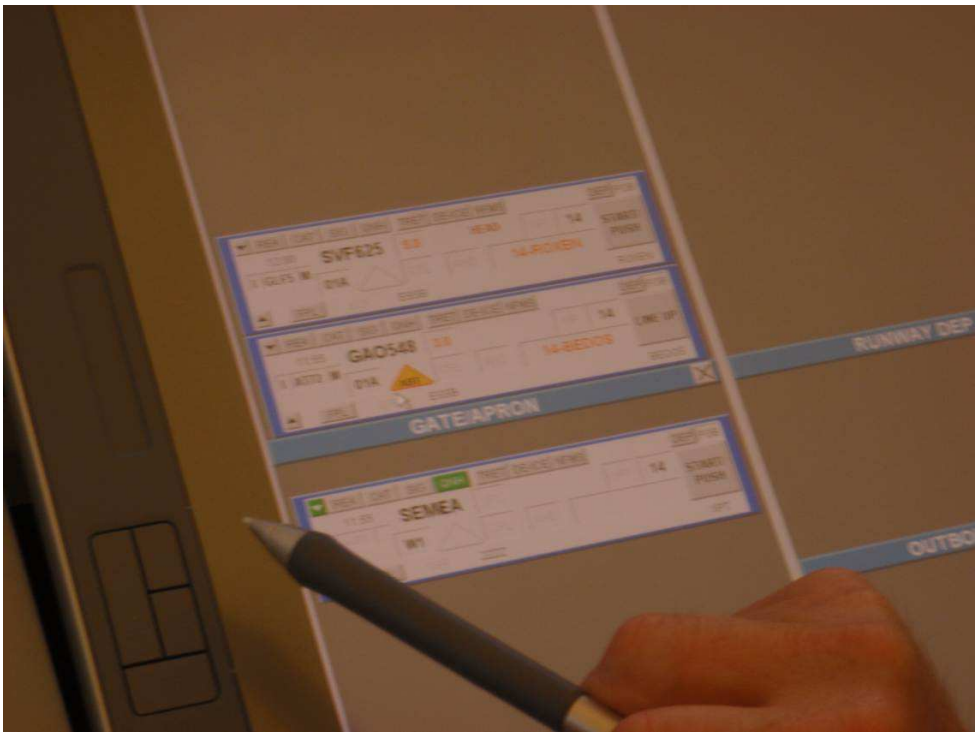
Labels of aircraft in advanced mode

In these pictures the pictogram is indicating that the aircraft is tracked by both radar and cameras. The first picture also shows how easy an aircraft can be detected in advanced mode.



E-strips in front of the ATCO.
(This picture has been taken during 'basic mode', so no radar data can be used by the ATCO, therefore the radar screen has been blocked)





D.3 VP-058

D.3.1 Introduction

On 7 and 8 March 2013 the Dutch expert attended the live trial for Single Remote Tower, performed by a team with Stein Nielsen, Ole Petter Nordnes, Ann Mari Hilstad and Ida Alexandra Johansen as participants.

In the end the main expected benefit of the Remote and Virtual Towers is cost effectiveness and efficiency.

ATS facilities cheaper to maintain, able to operate for longer periods and enabling lower staffing costs through centralised resource pools. It will reduce the requirement to operate and maintain actual control tower buildings and infrastructure, leading to further cost savings, while maintain safety/economical benefits by not skipping the ATC service at remote or less dense locations at all.

Main areas of possible constraints are safety, capacity, flexibility and access and equity.

D.3.2 Presentation of the System

A briefing on the trial was given by Ann Mari Hilstad on 7 March 2013, also attended by Ida Alexandra Johansen. This briefing addressed all relevant issues.

The task contributors are NORACON (LFV, Avinor, Finavia, Estonia), NATMIG (Saab), Eurocontrol, ETF, ATCEUC en IFATCA.

This validation exercise consists of an advanced shadow mode trial for Remote Provision of AFIS to a single aerodrome/heliport.

The total validation trial has a 3 week duration. For the attendance of this particular validation exercise two shifts were used: The afternoon operation on 7 March (16.45-17.20) and the morning operation on 8 March (09.20-10.00). Due to wind conditions the operation on the afternoon on 7 March was cancelled at a very late stage.

The validation set-up is located at Bodø Airport, providing distant AFIS for Værøy heliport (located at a distance of appr. 43 NM), with its real live traffic.

The validation set-up at Bodø Airport attracted quite some interest, several groups visited the test-location.

The participants in this validation exercise were briefed before the start of the exercise.

During this Validation exercise the focus was on the assessment of human performance (including usability), safety, capacity and cost effectiveness.

The AFISOs were requested to fill in their feelings and experiences in a feedback form immediately after the helicopter operation, in order to make best use of their experience and impressions. Such a feedback form allowed also to make any comment considered useful.

D.3.3 Current Status

The set-up of the system at Bodø Airport included a 360° view, enabled this time by 14 NEC LCD flat monitors in portrait position.

10 screens (full HD) are placed in half a circle around the Controller Working Position, covering appr. 257°, showing the runway and the areas nearby the runway with a frame rate of 30 frames/second.

Behind the CWP four screens provide views of the remaining 103°.

This trial there were no additional camera's for areas considered most important for the AFISO's. With the option of 'Picture in Picture (PiP)' the ATCO could add more visual clues. Question is where to put these PiPs on the screens, knowing that when you place them in the sky, that PiP could block an approaching aircraft, invisible behind that PiP. Maybe areas at the bottom of the screen, outside the runway area and the approach areas might be helpful.

There was some discussion on the “cone of silence” where aircraft flew too high too close to be visible on the screens. Especially for the helicopter operation at Værøy. It is important for the AFISO to be able to see the departing helicopter while climbing to 70 ft but quite close to the cameras. At that point the pilot decides whether to continue the departure or not. At this moment the AFISO could not see the helicopter at that particular but important moment. One camera looking vertical could help, but could create confusion as well. Ambient sound could be sufficient as well. An issue for further investigation.

The total delay between the camera recording at Værøy and the presentation on the screens at Bodø was still less than 1 sec, which is considered very good and could be much better than the delays that come with radar information.

This validation exercise allowed for situations with never more than 1 helicopter in the area, as agreed with CAA Norway.

D.3.4 Observations

D.3.4.1 Safety

- Questionnaires were to be filled in by the AFISOs immediately after their shift. The questionnaires allowed the AFISOs to include all their ideas, suggestions and concerns.
- Cameras and sunlight

  Compared to the first two trials improvements have been realised. The rising sun did not block a screen or a rectangle part of a screen anymore.
- Using the PTZ camera and the infrared camera required less time of the AFISO compared to live trial 1 and 2. Now operation is done with a pen or a mouse, much faster than trial 1. This exercise there were no presets used because of the size of the heliport, but that is still an option for future use. Presets could help, but solutions like pointing at a location after which the camera would automatically rotate, tilt to the desired elevation angle and focus at the indicated distance seems desirable.

D.3.4.2 Capacity

- Radar could be used at any time.
- The multiple aerodrome concept was not part of this validation exercise, although it was mentioned that preparation for such a multiple aerodrome/heliport will start in April 2013. Already the AFISOs could make use of e-strips (which will be necessary in a multiple aerodrome concept). For such a multiple aerodrome trial many technical problems that were encountered in this validation exercise will have to be solved. Also much attention has to be given to the information to the AFISO/ATCO in order to avoid confusion on which field he/she is working with. In that respect it is was discussed not to use paper charts because when changing to the other field these papers could easily be forgotten and create confusion later on.

D.3.4.3 Technical Issues Requiring Attention

- The Voice Communication System was not functioning properly. The AFISO had to make use of a separate microphone and an old fashioned telephone earphone to listen. While using this combination audibility was reduced because of a strong echo. Also any sound in the exercise room at Bodø Airport was amplified and caused too much background noise in the loudspeakers. Sometimes the AFISO and Bodø Ctrl Sector North were hardly able to understand each other, sometimes even worse!!
- Listening out of frequency 126.45 (Bodø Ctrl Sector North) was not possible, reducing considerably the situational awareness of the AFISO.
- New equipment was supplied 6 March 2013 for flight plans. This new equipment worked well with the FDR, but not with the e-strips. The AFISO had to fill in all the necessary details on

the e-strips themselves. This issue has to be solved before allowing more traffic and before starting in the multi aerodrome mode.

- The AFISO is supplied with the actual wind information, but also with the 10 minutes average wind speed and direction. The AFISO would like to make use of a 2 minute average instead of the 10 minute average, but it was not possible yet to provide this data.
- Visibility at Værøy was measured with dedicated equipment located very close to the sea. However, because of seawater splash this equipment could not be used anymore. The request to put the equipment on top of the roof of a nearby building was not realised yet.
- The generator at Værøy was broken down. This caused limited views because automatic cleaning of the windows protecting the camera's was no longer done automatically, requiring manual cleaning. Until such manual cleaning was done, falling snow sticking on the windows partially blocked the views on some screens.
- In the very beginning the same windows protecting the camera's were getting dirty and it took a while to find out this was caused by the exhaust of the generator, putting an oil film on some of the windows. An additional filter in the exhaust system of the generator solved this problem.
- The setup of the exercise in Bodø included a camera and microphones allowing to capture the screens and the actions of the AFISO and project them in a adjacent room. Thereby offering the possibility to monitor the trial by more people without disturbing the AFISO too much.
- Procedures have to be developed how to make best use of the e-strips, especially the layout of the strip and how to deal with the information in the first call and in the last call.
- There is a weather radar located at the nearby Rust Airport. This information could be useful for the AFISO while working with Værøy heliport. This weather data is not provided to the AFISO yet. For the time being the AFISO make use of their own private laptop or iPad in order to see this useful weather information.
  A good development is that the AFISO can use the IR/PTZ camera to look in more details to clouds approaching the heliport. After some training they could distinguish Cb clouds and other relevant clouds, enabling them to inform the pilots in more detail.
  Also the information on the screens behind the AFISO turned out to be useful for the AFISOs, enabling them to determine cloud base and visibility using visual reference points. Such a 360 degree view helps the AFISO. For people at the Værøy heliport themselves such a 360 degree view is not possible without leaving the building, so this can be considered an improvement for safety.
- The AFISOs are also offered wind information for Værøy heliport including detailed information on the relative wind direction and the crosswind component. This detailed information is projected on one of the screens but is not used by the AFISOs (yet?).
- There were some doubts whether the construction for the cameras at Værøy heliport was stiff enough to resist hard and gusty winds. So far it seems to be adequate, although on 2 of the 14 screens some shaking of the presented picture could be seen. Fortunately these 2 screens were behind the AFISOs and given the fact that the other screens have a steady picture the problem seems to be the attachment of the related cameras.
- Within 10 NM of V heliport a confusing mismatch was visible between the actual position of the helicopter/airplane and the position indicated on the screens related to a label.
- The working position for the AFISO was too crowded with equipment. There was simple no room left for paper or a work pad to make notes on (let alone right and left handed people). One AFISO indicated the need for an iPad in order to be able to find required information on the internet. This issue requires attention.
- It was noted that on screen 9 (most RH front screen) the blinking beacon light should be visible all the time on the screen. However, for an unknown reason, this blinking light was not shown on the screen at all, or only now and then. In one case the AFISO reported the

helicopter pilot the beacon light at Værøy heliport was not working. The pilot replied he could see the beacon light working well!!!

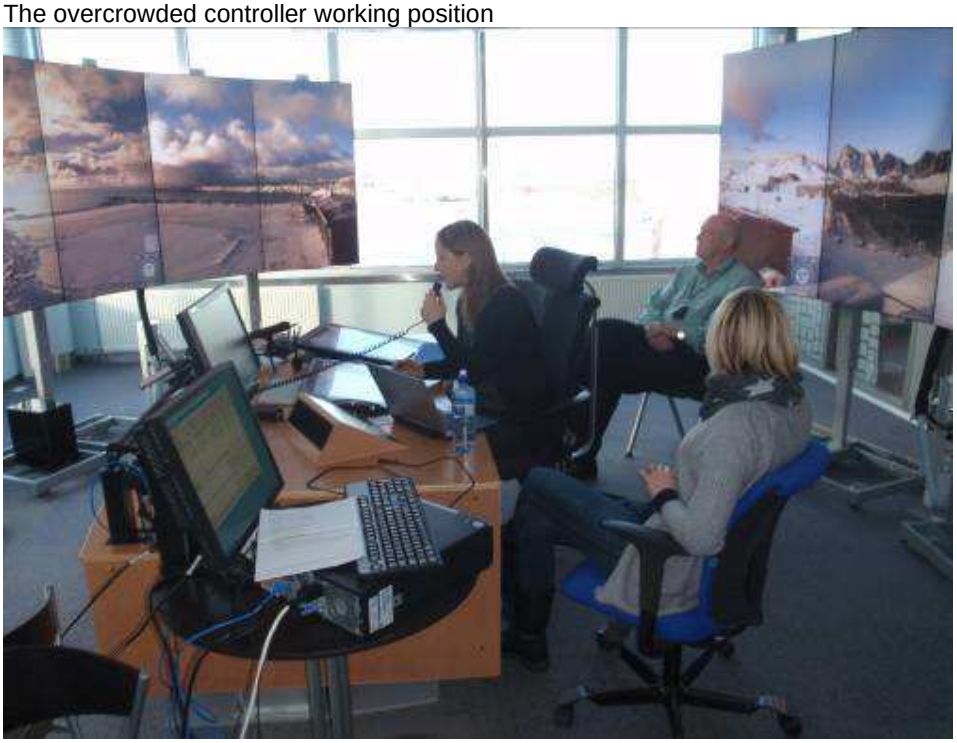
D.3.4.4 Other Issues

- The option of making use of previously recorded situations was available and demonstrated, but there was no recording of sounds.
- Nevertheless, it is still a very good idea, also demonstrating the possibility to store recordings for study afterwards as part of an investigation in case an incident occurred.

D.3.5 Pictures from Remote Tower Live Trial 3, 7-8 March 2013

Setup of the 14 screens, 10 in the front, 4 in the back.

The overcrowded controller working position



Appendix E Feedback from Airspace Users (VP-057)

The following feedback was taken from the Airspace Users following the observation of the single RVT trial 2 on the 15th and 16th May 2012.

E.1 Airspace User Representative 1: IAOPA

E.1.1 General

Environment and scenarios during this 2-day-trial cycle

- Traffic situation: Amount of traffic was low: 0 to 10 movements/hr, both IFR plus VFR. No incident happened, neither real nor simulated.
- MET: Actual visibility ranged from good visibility with low clouds and rain to CAVOK. Mostly winds > 15kt from SE. Only recorded traffic at night and in fog was demonstrated.

The trial setup was very similar to a tower simulator as it is widely used for training of tower controllers. In particular unusual situations which some day will occur in a remote tower environment could be much better tested in a simulator than in this shadow trial. Therefore the validation efforts in WP 6.9.3 could be enhanced by some simulator trials, which include - but not limited to - aircraft in distress or without radio contact, go-arounds, unidentified aircraft in the traffic pattern, animals or vehicles on the runway, but this should be subject of tower controller's training anyway.

As airspace users we are not really interested in where the tower controller is located, as long as he/she can carry out his/her duties.

E.1.2 Basic Mode

Computer systems, screens and cameras were good, but not sufficiently reliable; this was true in particular for the infra-red and PTZ cameras, which remained inoperative during many hours.

E.1.3 Advanced Mode

Both, the video and the radar tracking capabilities in advanced mode seem to be a striking step into the future. They will not only help in the virtual remote tower environment, they should become available for real towers as well by some kind of "head up" display on the tower's windows, as it is often difficult to impossible to identify aircraft "in the grey" by just looking into the right direction.

As relatively cheap A-SMGCS are on the horizon even for low traffic airfields, such displays should be included in the validation trials, may be in the next round.

E.2 Airspace User Representative 2: SAS

E.2.1 General

Contingency methods must be more realistic, the checklist in trial #2 was definitely too restrictive meaning that no traffic should be accepted even during VMC. Pilot must have the last say when equipment in RTC or cameras goes down. If the runway is free and the pilot can confirm that, he/she could be cleared to land/take-off at own discretion.

In general, this concept is very promising and could also transform into a system for bigger airports.

E.2.2 Basic Mode

The new screens are much better in this trial#2, resolution is high as in normal life. You still don´t have the 3D effect as you have in real TWR and that is more obvious in darkness. Controller had one point in saying "what do I really need to see in darkness?" One solution could be to have IR function on those cameras that cover the manoeuvre area.

[However] SAS: In this task the controller during my visit have the opinion that they can do as today apply self-separation if needed. If you have IFR involved the problem could be solved with local methods in addition to the general handbook.

E.2.3 Advanced Mode

When RTC are serving more than one airport at the same time NO DLA must be the rule for IFR traffic. This task is possible to solve by methods and to act as the airports are in IMC conditions even if VMC are at hand. VMC can then make it smoother for the controller.

Video and Radar tracking was definitely helpful and made it possible to handle several IFR and VFR at the same time. Under my 2 days both Controller were comfortable with 2-3 movements at the same time.

The customisable filter on the Radar tracking could be modified.

E.3 Airspace User Representative 3: EBAA

E.3.1 General

The objective is keeping an airfield open, even far off the traffic peak time, e.g. at midnight. The technical/maintenance/organisational problems of the setup have to be resolved, hopefully in a way that keeps the price tag for a remote tower installation below the cost for the operation of a traditional tower. If this goal is not reached, we should aim for changing the rules and allow even commercial IFR traffic at uncontrolled airports, as it is common practice in the US. I know, this is not exactly within the scope of WP 6.9.3, however, it should not be forgotten. With a reliable TIS-B, also on the ground with vehicles on the runway visible, safety should be even better than today with control towers.

E.3.2 Basic Mode

The comfort has been improved.

Supervision of the runway condition seems satisfactory (comparable to the real tower conditions).

One of the proposed procedures to test the reliability of the RVT (e.g. first use of the day) is to have an on-site physical actor (e.g. an airport service actor drives around the airport to test all the cameras). The RVT concept is to limit the number of on-site physical actors, and, if needed for regulatory purposes, an independent mechanism should be developed to test the reliability of the cameras that do not require the help of an on-site physical actor (e.g. an independent/redundant Built In Test).

The ATC task of visual separation of in-flight traffic seems to hit the same limits as with the trial #1 (to be confirmed from the evaluation exercises)

E.3.3 Advanced Mode

Video tracking enables (under certain conditions) to supervise an in-flight traffic established on a visual VFR pattern (conditions may be: in fair weather conditions / to be evaluated with a mountainous background in respect to a sky background).

Radar tracking enables to supervise transponder equipped aircrafts easily.

Video tracking (~2 NM range) + Radar tracking holds the potential to enable ATC with multiple mixed VFR/IFR traffic, which is encouraging

In the perspective of the use of RVT in medium traffic complexity, maybe a customisable filter on the Radar tracking would be necessary to display only relevant in-flight traffic (e.g. 30 NM range + inbound traffic in accordance with the flight plan + two in-flight traffics coming close to another)

Augmented reality possibilities could be envisaged to display relevant reference points (e.g. the position on the Out The Window (OTW) view of the VFR entry points / the VFR base turn / the North,

East, South & West / the IFR Final Approach Fix (FAF) / etc…). This might be necessary in the multiple RVT concept when one controller will swap environment frequently.