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EVALUATION REPORT ITWP SESSION 3

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Abstract:

The project ITWP launched at EUROCONTROL Experimental Centre aims at studying the integration of the various ATC Systems and the development of the Advanced Surface Movement and Guidance Control System (A-SMGCS). This report describes the third ITWP evaluation session which took place in IANS Luxembourg in November 2008. The evaluation focused on the impact of the ITWP safety support tools on controller situation awareness when used with the external tower view of the airport; the utility and usability of ITWP and the improvements made to ITWP since the second evaluation.

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EXECUTIVE SUMMARY

The Integrated Tower Working Position (ITWP) project was launched in 2006 at the EUROCONTROL Experimental Centre (EEC) to study the integration of the various Airport Airside System Components. **The third ITWP evaluation took place at IANS EUROCONTROL (Luxembourg) between the 25-28th November 2008** where a realistic operational setting with an external tower view of the Paris CDG airport was tested, and the main objectives were to assess:

1. The impact of the ITWP safety support tools on controller situation awareness when used with external tower view of the airport;
2. The utility and usability of ITWP with particular attention on the improvements made to ITWP since the second evaluation in November 2007;
3. The impact of the ITWP on controller working method when integrated into an operational setting with the external tower view of the airport.

Five controllers from different ANSPs (DSNA France, ENAV Italy, DFS Germany, NAV Portugal and Austro Control Austria) participated in 12 simulation exercises. The Runway and Ground control positions were studied. Exercises with and without the safety support tools were run to enable the controllers to assess the impact of the new features, while working with the external view. The **main constraints** were the limited time available for training the controllers in a new airport environment and on new equipment; the impossibility to split the view between the GND and RWY positions, which meant that the same generic view was seen on all the control positions.

The results are based on the controllers' subjective opinions expressed during the simulation through interviews, questionnaires and the observations made by human performance specialists during the simulation exercises. The results indicate that the ITWP environment was well appreciated by all of the controllers.

The training of the controllers, even though it was limited in time, was considered to be just sufficient. After a period of adaptation taking into account the generic HMI and unfamiliar airport layout, the **controllers were able to use the outside view with the ITWP including the new safety tools, the routing function and the stripless environment to perform their day to day controlling tasks**.

The outside view reportedly improved the realism of the simulation compared with the previous ITWP evaluations. Working on one screen was considered to be comfortable but in some situations it was difficult to find the optimum configuration depending on the individual controller's working practices. Further, the controllers felt that the ITWP HMI could be improved by reducing the amount of non-relevant information displayed. Several issues were raised that required further study and improvement, such as label and EFS layout and management, **display of alerts on the different control positions** and stop bar management.

The new safety support tools were accepted and several refinements suggested in order to improve their functionality. The same can be said for the Routing function whose limited features were considered to be very useful for the Ground controller in particular, but further improvements are required to realise its full potential.

The controllers did not detect any major limitation using ITWP. However, they accepted that ITWP was a generic tool that would need to be tailored to the environment in which it will be implemented, in order to meet current operational needs and working methods.

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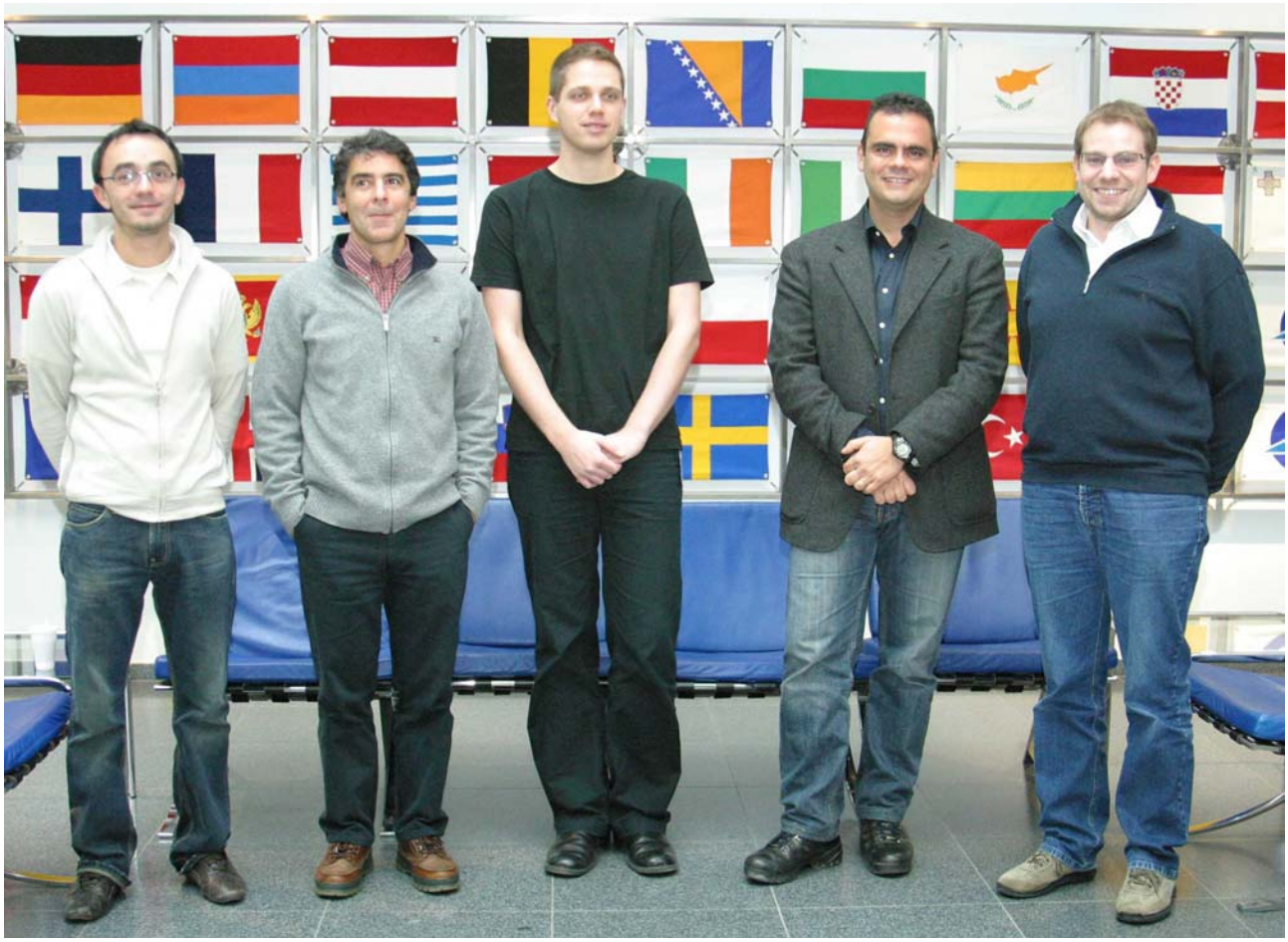
ACKNOWLEDGEMENTS

The Project Team would like to thank the controllers who participated in the simulation. They all showed a high level of professionalism and enthusiasm. It would not have been possible to achieve the results presented in this report without their input.



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1. INTRODUCTION

1.1. BACKGROUND

Information management and system integration are key enablers for the development of airports in the future. The Air Traffic Control (ATC) tower environment is often characterised by a number of individual systems all having their own interface, without any common information management. It is anticipated that in the near future a greater number of systems will provide even more information to the controller. The possibility that controllers will have to interact with a greater number of different systems and integrate more information from additional sources has implications for both system safety and efficiency.

Therefore, in 2006, as part of the Medium Term Validation (MTV) Airport Work Program, the Integrated Tower Working Position (ITWP) project was launched to study the integration of the various Airport Airside System Components into an Integrated Tower Working Position. The aim of the ITWP [Ref. 1] is to:

1. Reduce the number of screens, displays and peripherals in order to reduce information fragmentation and induced scanning effects, diverted attention and visual difficulties;
2. Facilitate the coordination between control positions;
3. Remove unnecessary flight data entries and duplication of information;
4. Provide a physical controller environment that is independent of the controller role.
5. Increase safety through the use of integrated safety support tools.

In order to achieve the above aims the following project activities were defined:

1. Develop commonly agreed functional specifications and associated requirements that cover operational, technical, human factors, and safety aspects to be supported by the ITWP;
2. Develop a possible Human-Machine Interface (HMI) solution for the EUROCONTROL Experimental Centre (EEC ITWP);
3. Develop a prototype to demonstrate the EEC ITWP (using the Early Demonstration and Evaluation Platform – eDEP);
4. Perform simulations to evaluate the functional specifications, the human factors and safety requirements, and the HMI solution.
5. Study Human Factors and Safety elements associated with the development of an Integrated Controller Working Position

1.2. THE INTEGRATED TOWER WORKING POSITION

A description of the current version of the EUROCONTROL ITWP prototype is provided below:

1. All necessary information is displayed to the controller on the same HMI display. A single 30inch screen is provided to each RWY[1] and GND[2] controller. The controllers currently interact with the ITWP HMI display using a mouse. It is anticipated in the future that a 30inch tactile screen will be used.
2. ITWP provides a common environment independent of the controller role (display, interaction means), therefore the CWP parameters can be adapted by each controller.
3. To improve the integration of information, ITWP provides controllers with an air/ground composite radar image, multiple windows management which aims to display the most important information on the foreground, and improved information linking between applications in terms of communication of information.

[1] RWY (Runway) controller, in the ITWP, is a controller who handles arriving, departure and crossing traffic on the runway. He also handles traffic on taxiways before or after the GND controller.

[2] GND (Ground) controller, in the ITWP, is a controller who manages traffic on the apron, parking stands and on taxiways before and after the RWY controller' transfer.

4. Electronic strips and bays are used to improve coordination between ATC controllers, facilitate the circulation of flight strips between controller positions (compared to standing away from their position and transferring it manually), and to provide the ability to share a unique (virtual) object amongst tower controllers. Controllers can interact with flights through both the electronic strips and radar labels.

5. Safety support tools which detect potential and actual hazardous situations are implemented in the ITWP. The ITWP provides alerts related to the non conformance detection, inconsistent clearances, runway conflicts, alerts linked to the controllers' input error related to the airport layout and several other alerts (e.g. red stop bar crossed, stationary aircraft etc.)

1.3. PREVIOUS ITWP ACTIVITIES

The ITWP project has adopted a participatory design in which current tower controllers are involved as far as possible in the design and development process. Involving the potential end users in the design and development of a concept is important as their expertise and experience increases the likelihood that the developed concept will be useful, useable and acceptable to the end users.

On this basis, three stakeholder workshops and three ITWP prototype evaluation sessions involving current controllers from a number of different European Air Navigation Service Provides (ANSP) have been conducted to date. Each evaluation is preceded by a stakeholder workshop. The aim of the workshops is to present controllers with the latest version of the ITWP prototype and gain preliminary feedback on the HMI solution. The workshops are also used to brainstorm ideas with the controllers and identify ways in which the ITWP can be improved.
The evaluation sessions enable the ATC tower controllers to interact with and perform their operational tasks using the ITWP prototype under various different scenarios. Feedback from the controllers regarding the ITWP prototype is then gathered from the controllers using questionnaires and interviews.

The first two ITWP prototyping evaluation sessions were performed in the Human Factors laboratory at the EUROCONTROL Experimental Centre (EEC) in Bretigny France using just the Stockholm Arlanda airport environment on the eDEP platform. However, there was no external view of the airport available and Stockholm airport has no runway crossing points for aircraft.

The first evaluation session of the initial ITWP prototype took place in April 2007. The aim of this first evaluation was to investigate whether the integration of tools such as Advanced Surface Management and Guidance & Control System (A-SMGCS), Electronic Flight Strips, meteorological information and air traffic monitoring equipment onto one screen could support tower controllers in their daily tasks. Overall, the controllers were found to be very positive and enthusiastic about the ITWP concept. The findings from this evaluation allowed the ITWP to be updated and improved.

The second evaluation session, took place in November 2007 using an improved ITWP prototype based on feedback from the initial evaluation session and also updated to include the integration of vehicle management and new safety support tools. The main objective of the second evaluation was to test the utility and usability of these additional functions as well as the improvements made to the ITWP prototype. Once again feedback from controllers regarding the ITWP was very positive and the feedback gain from controllers allowed for the ITWP prototype to be further developed and improved.

The third ITWP prototype evaluation session took place between the 25-28th November 2008. For this third evaluation session the ITWP prototype was assessed using a new airport environment – Paris Charles de Gaulle (CDG). In addition, this evaluation included the visual tower simulator at the EUROCONTROL Institute of Air Navigation Service (IANS) facility in Luxembourg

which provides a 3D outside view of the airport. Therefore, this third evaluation session was the first opportunity to evaluate the ITWP prototype in a realistic operational environment which included an outside tower view of the airport. The aim of this third ITWP prototype evaluation was threefold:

4. To assess the impact of the ITWP safety support tools on controller situation awareness when utilised in a realistic operational setting with external view of the airport.
5. To assess the utility and usability of ITWP and the improvements made to ITWP since the second evaluation in November 2007, focusing specifically on the safety support tools and routing functions, when integrated into a realistic operational setting with external tower view of airport
6. To assess the impact of the ITWP on controller working method when integrated into a realistic operational setting with external tower view of airport.

1.4. FUTURE ITWP ACTIVITIES

The research conducted in the ITWP project to date has been recognized as being of great importance that could lead to a major improvement of Airport Operations where controllers will have to manage an increased number of information sources in order to give additional safety and efficiency to the whole ATC system.

The ITWP project objectives are in line with the SESAR concept and therefore the “continuation” project of ITWP has been defined in the SESAR WP6 Airport Operations and more specifically the sub-work package 6.9 “Tower Management & CWP” with a project called “A-iCWP” -Advanced Integrated Controller Working Position.

ITWP activities will therefore continue as part of the MTV work program until the SESAR Joint Undertaking program effectively starts its activities in September 2009.

1.5. DOCUMENT SCOPE

The evaluation report describes the ITWP evaluation from the context and the objectives of the simulation, to the results, i.e. the data collected and the analysis of these data.

1.6. STRUCTURE OF THE DOCUMENT

The document is structured as it follows:

Chapter 1 - Introduction
This section describes the purpose of this document, its structure, the reference documents and glossary of terms used throughout the document.

Chapter 2 - Evaluation Objectives
Chapter 2 describes the high level and low level objectives of the evaluation.

Chapter 3 - Evaluation Environment
Chapter 3 globally describes the evaluation platform, operational environment, traffic samples.

Chapter 4 – Simulation conduct
Chapter 4 gives the main information about the evaluation conduct in terms of participants, experimental design, data collection.

Chapter 5 – Results
Chapter 5 addresses the evaluation results including the initial system safety analysis

Chapter 6 – Conclusion
The conclusion presents a synthesis of results and the way forward (recommendations).

1.7. ACRONYMS

A-iCWP	**A**dvance **I**ntegrated **C**ontroller **W**orking **P**osition
ANSP	**A**ir **N**avigation **S**ervice **P**rovider
ATC	**A**ir **T**raffic **C**ontrol
ATCO	**A**ir **T**raffic **C**ontrol **O**fficer
ATM	**A**ir **T**raffic **M**anagement
A-SMGCS	**A**dvanced **S**urface **M**ovement **G**uidance & **C**ontrol **S**ystem
CDG	**C**harles **D**e **G**aulle airport
CLD	**Cl**earance **D**elivery
CWP	**C**ontrollers **W**orking **P**osition
eDEP	**E**arly **D**emonstration and **E**valuation **P**latform
EFS	**E**lectronic **F**light **S**trip
E-OCVM	**E**urocontrol **O**perational **C**oncept **V**alidation Strategy
FAA	**F**ederal **A**viation **A**gency
GND	**G**round
HAZOP	**Haz**ard and **Op**erability Analysis
HF	**H**uman **F**actors
HMI	**H**uman **M**achine **I**nterface
IANS	**I**nstitute of **A**ir **N**avigation **S**ervices
ITWP	**I**ntegrated **T**ower **W**orking **P**osition
LAN	**L**ocal **A**rea **N**etwork
LCD	**L**iquid **C**ristal **D**isplay
MTV	**M**edium **T**erm **V**alidation
OED	**O**xford **E**nglish **D**ictionary
RWY	**R**un**w**a**y**
TWR	**T**o**W**e**R**
TOWSIM	**TOW**er **SIM**ulator
SESAR	**S**ingle **E**uropean **S**ky **A**TM **R**esearch
WP	**W**ork **P**ackage

1.8. GLOSSARY

The following terms are used in the document to describe the third evaluation simulation and results:

Term	Description
Baseline	The benchmark against which the organisations will be measured in the course of a validation; in ATC terms, a defined set of tools, procedures and airspace design **Source**: E-OCVM, Version 2
Comprehensibility	Refers to clear meaning: understanding and interpretation (text or symbol coding, sound)
Effectiveness *Criteria of usability*	The accuracy and completeness with which users achieve specified goals **Source**: Gate to Gate, Indicators and Metrics, §6.1.3, 2008
Efficiency *Criteria of usability*	The relation between the resources expended in relation to the accuracy and the completeness with which users achieve specified goals **Source**: based on definition from Gate to Gate, Indicators and Metrics, §6.1.3, 2008
Event	An event can be either: a) a nominal but not frequent traffic situation or b) a non-nominal traffic situation that may deteriorate in unsafe situation / accident if not resolved on time.
Hypothesis	"A supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation (OED). A hypothesis is stated so that it may be tested. Consequently it is important that the hypothesis is expressed in a testable form." **Source**: E-OCVM, Glossary, Version 2, 2007
Perceptibility	Refers to : - characteristic of sound that makes it easy to hear in any surrounding context (or environment?), - colour, size and position on the screen that makes it visible in any surrounding context
Potential hazardous / critical safety situation	A non-nominal traffic situation that may deteriorate (result) in unsafe situation / accident if not resolved on time.
Safety	"Freedom from unacceptable risk". **Source**: EUROCONTROL SRC RTF10
Safety occurrence	"Accidents, serious incidents and incidents as well as other defects or malfunctioning of an aircraft, its equipment and any element of the Air Navigation System which is used or intended to be used for the purpose or in connection with the operation of an aircraft or with the provision of an air traffic management service or navigational aid to an aircraft." ESARR glossary
Satisfaction	Freedom from discomfort, and positive attitudes to the use of the product
Scenario (validation scenario)	Representation of an operational situation. A scenario description should cover location, ATM environment, together with the time order and of occurrence of specific events.
Suitability	Suitability is to ensure that the proposed concepts and new tools provided are really "fit for purpose" and also integrates well into the existing system / environment. **Source**: based on definition in Gate to Gate, Indicators and Metrics, §6.1.2, 2008
Utility *(Usefulness)*	The quality of being of practical use, i.e. useful from an operational point of view. The ability to be used to achieve the intended goal, which means that the tools are able to give exactly the right *kind* of service, i.e. what is expected from them.
Usability	Refers to the effectiveness and efficiency with which controllers can achieve a specified goal. Usability relating to the interpretation of information refers to intelligibility (i.e. comprehensibility and readability), visibility and perceptibility aspects. The usability of dialogs refers efficiency, comfort of use (minimising cognitive effort) and safety aspects.

1.9. REFERENCE DOCUMENTS

1. [Ref. 1] ITWP – Initial study report, August 2006, v1.0, EUROCONTROL.
2. [Ref. 2] E-OCVM – European Operational Concept Validation Methodology, Version 2, EUROCONTROL - EEC, March 2007.
3. [Ref. 3] ITWP – Evaluation report, Session 2, November 2007, v1.0, 11.02.2008.
4. [Ref. 4] ITWP – Evaluation plan, Session 3, November 2008, v1.0, 12.02.2008.
5. [Ref. 5] MM081127– ITWP evaluation report meeting-v2.0.

2. EVALUATION OBJECTIVES

The high level and low level objectives for ITWP evaluation session 3 are given below, see Table 2-1. Related hypotheses are in annex 1. A cross reference matrix Requirements x Objectives is in annex 3.

Table 2-1: High level objectives (HLO) and low level objectives (LL) for ITWP evaluation 3

HLO 1.	**Assess whether ITWP helps the controller to manage his/her traffic in an efficient and safe manner when integrated into a realistic operational tower environment with outside view.**	
	LL1.1	To assess the impact of the ITWP safety support tools on ATCO situation awareness when integrated into a realistic operational setting with external airport view
HLO 2.	**Assess the utility and usability of ITWP tools and functions, (including information displayed, HMI, control devices etc.)**	
	LL 2.1	Assess the utility and usability of the ITWP safety support tool visual alert messages with and without audio signal when integrated into an realistic operational environment with external tower view compared to when no alerts are available
	LL 2.2	Assess the utility and usability of improvements made to ITWP safety support tools in a realistic operational setting with external tower view
	LL 2.3	Assess the utility and usability of improvements to the routing function in a realistic operational setting with external tower view.
	LL 2.4	Assess the utility and usability of the data link equipped aircraft identifier
	LL 2.5	Assess the utility of the automated stop bars in a realistic operational setting with external tower view
	LL 2.6	Re-assess the utility and usability of the Electronic Flight Strips, Label Management and Vehicle Management in a realistic operational setting with external tower view. (i.e. functions that did not rate highly in terms of utility and usability in the previous ITWP evaluation 2)
HL03	**Assess the impact of the ITWP on controller's working method**	
	LL03.1	Assess the impact of ITWP on head-up/head-down time when integrated in a realistic operational setting with external tower view

Although an Initial Safety Analysis was not part of the original objectives, the EEC safety specialist took the opportunity to conduct a one hour SWIFT analysis in order to identify potential safety related issues relating to ITWP for future study.

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3. EVALUATION ENVIRONMENT

3.1. EVALUATION PLATFORMS

Two simulation platforms were used for the evaluation:

- **ITWP/eDEP platform** for the display radar screen: the ITWP application has been developed to run on eDEP platform, to replicate the TWR controller's environment without external airport view.
- **3D Airport TOWSIM Simulator**: the EUROCONTROL Institute of Air Navigation Services in Luxembourg is equipped with simulation/training platform TOWSIM that replicates various controllers' environment (e.g. tower, en route, approach etc.). The simulator provided integrated out of the window views of Paris CDG airport as well as two pilot positions.

3.2. OPERATIONAL ENVIRONMENT

The evaluation environment (see Figure 3-1) was detailed in the Evaluation Plan [4].

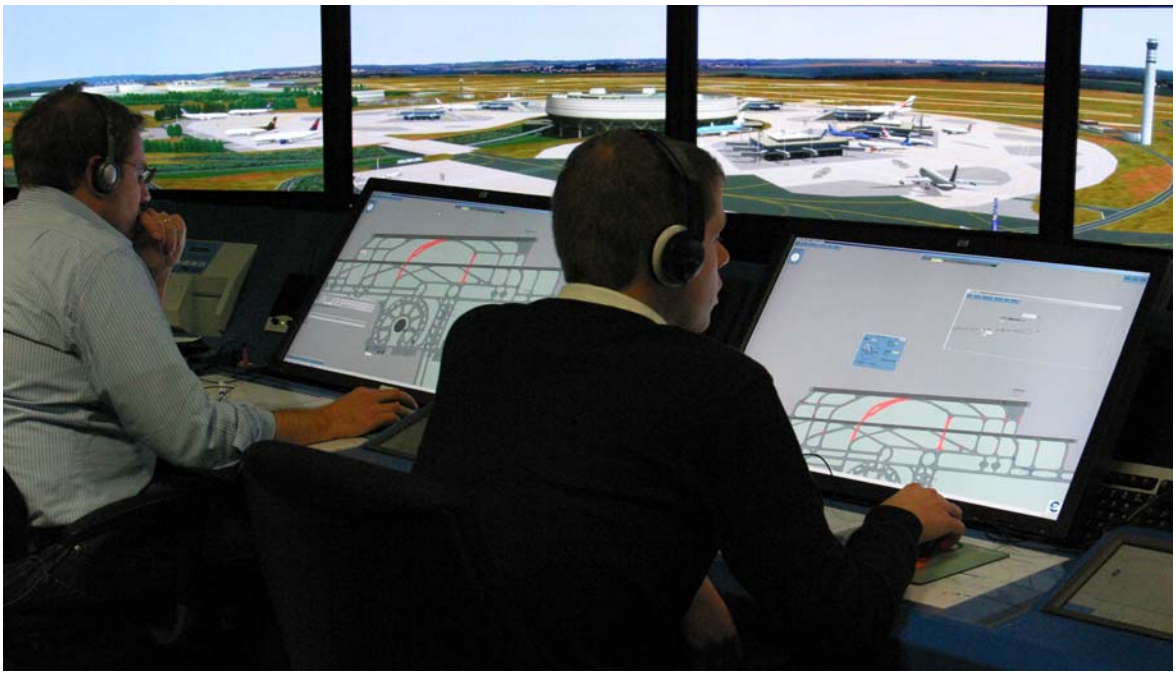

Figure 3-1: ITWP GND and RWY Positions

Main characteristics of the evaluation environment were:

- **Platform**: experimental facilities, three control positions (i.e. CLD, GND and RWY control positions) and two pseudo-pilot positions.
- **Operational environment**: one airport environment (Paris CDG airport) was used during the experimental session;

The operational environment used for the simulation was based on the northern part of the Paris-Charles de Gaulle (LFPG) airport lay-out. This included the 2 northern runways (09R-27L and 09L-27R), taxiways to/from these runways, gates at Terminal 1 and remote parking areas, especially stands S6 till S31, R1 to R14, Q1 to Q21, (in ellipse on Figure 3-2).

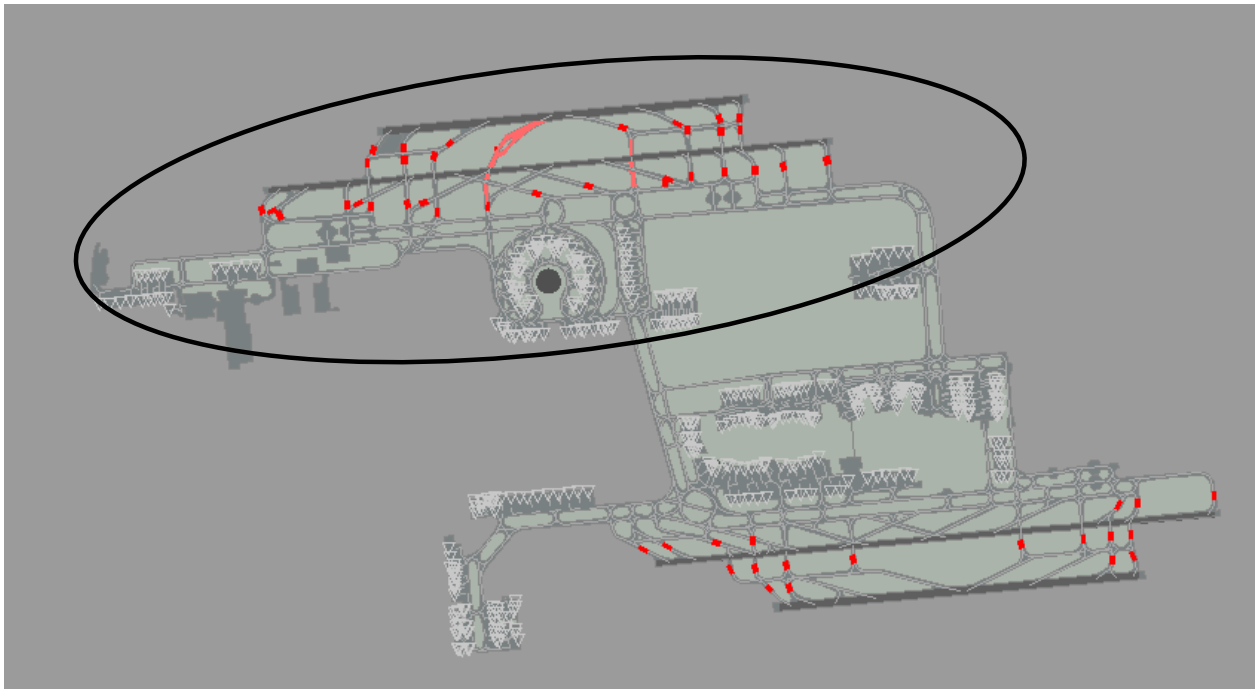

Figure 3-2: ITWP Operational Environment (CDG airport)

3.3. TRAFFIC SAMPLE AND SCENARIOS

Two traffic samples built from real data sources from Paris CDG airport were used in the evaluation (detailed description in [4]):

- One 20 minute training traffic sample with a low traffic load to facilitate learning;
- One low traffic load sample lasting 50 minutes was used during the evaluation exercises. In order to increase controllers' workload, a peak of traffic was included in the traffic sample.

At certain times pilots performed actions corresponding to planned events that could trigger alerts on controllers' position (section 0 provides in annex the list of potential events). Two scenarios defined two sets of events. When possible, each type of alert was shown at least once to every controller.

4. SIMULATION CONDUCT

4.1. EVALUATION SESSION

Different exercises were elaborated to cover simulation needs and to cope with the different phases of the project, encompassing tests, ATCOs' training and exercises.

Evaluation Session 3 was split into a:

- **Training phase**: this phase aimed at briefing and familiarising participants with project objectives, scope and HMI functionalities. Rotations between ATCOs were organised to train them on GND and RWY positions;
- **Evaluation session**: twelve exercises were run, each of them having a 50 minute planned duration. The exercises took place in two conditions: half of them in "with alerts" condition and the other half in "without alerts" condition. The "with alerts" condition included information alerts (yellow) and alarms with auditory signals (red).

No technical problems affected the session schedule. However, due to technical considerations, the data link symbol could not be evaluated in the simulation runs. Therefore two additional demonstration exercises were performed on eDEP (with the training sample) to show the data link identifier and the RWY INCURSION alert.

4.2. PARTICIPANTS

Five ATC controllers – Italian (ENAV-Napoli), Portuguese (NAV Portugal), Austrian (Austro Control), German (DFS Frankfurt) and French (DSNA-Paris CDG) participated in the third evaluation phase of ITWP. Their experience as qualified tower controller ranged from 4 to 11 years. Two of them had not been involved in previous ITWP activities (Austro Control and DSNA).

The Human factor team (two EEC HF specialists and exterior HF support) conducted data gathering from the controllers. The EEC project manager conducted intermediate and final debriefings. One EEC safety specialist conducted safety activities. EUROCONTROL experts played the supervisor and pseudo-pilot roles. Figure 4-1: is a picture of the evaluation team.

Figure 4-1: ITWP-3 Evaluation Team

4.3. ORGANISATION

Training phase:

Four training exercises were run (TE1 to TE4). Controllers who were not involved in a training simulation exercise observed (Obs) their colleagues' activity. Time constraints meant that those controllers that were very familiar with ITWP participated in fewer training exercises.

Table 4-1: Training exercises organisation for ITWP evaluation 3

Date	Tuesday 25th Nov 08			
Training Exercises	*TE1*	*TE2*	*TE3*	*TE4*
Condition	AL (with alerts)			
DFS	GND	Obs	CLD	Obs
ENAV	Obs	Obs	RWY	CLD
DSNA	RWY	CLD	GND	Obs
Nav Portugal	CLD	GND	Obs	RWY
Austro Control	Obs	RWY	Obs	GND

Evaluation session:

Twelve evaluation exercises (EX1 to EX12) were run to cover the evaluation needs.
An adapted rotation ensured that each of participants in the evaluation was able to operate both a ground and runway controller for each of the alert conditions (i.e. no alerts and alerts). The alert conditions were counter-balanced to mitigate any practice effects which could have strongly biased the results obtained. When a controller was involved neither in a simulation, nor in an interview, he participated as an observer so as to help further familiarisation with the ITWP platform, as well as refining his opinion.

Table 4-2: Evaluation exercises organisation for ITWP evaluation 3

Date	Tuesday 25th		Wednesday 26th				Thursday 27th				Friday 28th	
Evaluation Exercise	*EX1*	*EX2*	*EX3*	*EX4*	*EX5*	*EX6*	*EX7*	*EX8*	*EX9*	*EX10*	*EX11*	*EX12*
Cond : With alerts / No alert	NOAL	AL	AL	NOAL	NOAL	AL	AL	NOAL	NOAL	AL	AL	NOAL
Scenario	S1	S2	S1	S2	S2	S2	S2	S2	S1	S1	S1	S1
DFS	GND		GND			RWY	CLD	RWY		CLD	CLD	CLD
ENAV	RWY		CLD	CLD	RWY		RWY		CLD	GND		GND
DSNA		CLD	RWY		GND		GND			RWY		RWY
Nav Portugal	CLD	RWY		RWY		CLD		GND	GND		GND	
Austro Control		GND		GND	CLD	GND		CLD	RWY		RWY	

The annex 5 provides the planning actually completed.

4.4. DATA COLLECTION AND PROCESSING

1.1.1 Data Collection

The ITWP evaluation was made through several kinds of collected data:

- An Entry Questionnaire was completed to gather information about participants;
- A Post-Training Questionnaire was dedicated to training organisation and effectiveness;
- Observations of controllers while working with ITWP were made by the HF team, the safety expert and the project manager;
- One-to-one Interviews were conducted at the end of each exercise by the HF team;
- A Post-Exercise Questionnaire was dedicated to situation awareness assessment;
- A Final Questionnaire was mainly oriented to the utility and usability of HMI.

The questionnaires and the templates for observations and interviews are available in the evaluation plan [4].

In addition, the safety specialist conducted an initial safety analysis of ITWP. This included observations during the evaluation exercises, asking safety related questions in the interviews and conducting a one hour SWIFT safety analysis.

Debriefings conducted by the project manager allowed the project team to have additional feedback from the controllers (technical debriefings, training debriefing, intermediate and final debriefings).

A video device recorded controllers working on ITWP. Although it was initially planned to use video recording to identify changes in controllers' working method in terms of head up / head down 'time', it was decided given resource limitations and the quality of data produced from the video recordings that direct observation and controller subjective feedback would provide sufficient data given the evaluation objectives.

The questionnaires were based on qualitative scales; the arithmetic mean of the answers was used for global results while the median of the answers was used for detailed results.

The questionnaires' results were linked to qualitative data gathered from the controllers.

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5. RESULTS

The results for ITWP session 3 are presented within 5 main sections:

- Training effectiveness;
- Situation awareness;
- HMI utility and usability;
- Working methods (head-up/head-down);
- ITWP Initial System Safety Analysis.

5.1. TRAINING EFFECTIVENESS

The effectiveness of the training was assessed by analysing the responses given in a post training questionnaire together with observations made during the simulation exercises and feedback from controllers.

The responses to the questionnaire were relatively mixed and depended to some extent on whether or not controllers had participated in ITWP activities. The two controllers that had not previously participated in previous ITWP evaluations indicated that they had not received enough training to get familiar with the ITWP functionalities: in particular the routing function and positioning of the strip bays (on RWY position) were considered as not easy to learn.

Two of the five controllers answers indicated that they did not have enough training to get familiar using with the external view: Observations made throughout the simulation exercises supported by controller feedback showed that in the early simulation exercises none of the controllers really used the external view (see section 5.4). Feedback from controllers suggests that was because some of them were not familiar enough with the ITWP HMI and functionalities and others were not familiar with the CDG airport environment so had to often look for the names of intersection and holding stands. However, as the week progressed and controllers became more familiar with the ITWP and the CDG airport environment the controllers working method changed and they started to use the outside view much as they would in their normal operational environment.

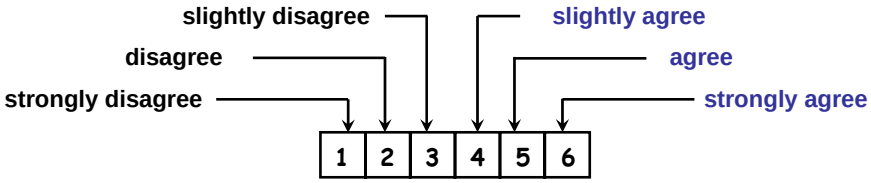
All controllers either commented that more training was necessary or the training phase gave the minimum amount of training required. Controllers also suggested that they needed to have more advice on how best to set up the layout of the screen.

However, the learning effect that took place during the simulation did not compromise the results obtained as the experimental design used counter-balancing to mitigate its impact and the usability/utility questionnaire was administered at the end of the evaluation.

5.2. SITUATION AWARENESS

After each exercise, controllers were given a questionnaire to complete, which was based on the EC SASHA questionnaire. The main objective was to collect data to assess the affect of alerts on controllers' perceived situation awareness compared to having no alerts.

The following rating scale was used:



The mean and median values for the ratings obtained for each question were calculated (using ratings obtained from both the RWY and GND positions) to give an overview of the overall results obtained for the ALERT and NO ALERT condition. A Wilcoxon test was then performed to determine whether there were significant differences in the ratings obtained between the ALERT and NO ALERT conditions for each question.

The ratings obtained for the GND and RWY positions were then looked at separately and these are represented in the following graphs. The mean and median ratings obtained for each position were also calculated to investigate whether controller position had an impact on the ratings obtained for the ALERT and NON-ALERT conditions

It should be noted that only the relevant mean values are reported in the following section, see Annex 6 for all the results of all the statistical analyses performed.

Q1: I was ahead of the traffic at all times.

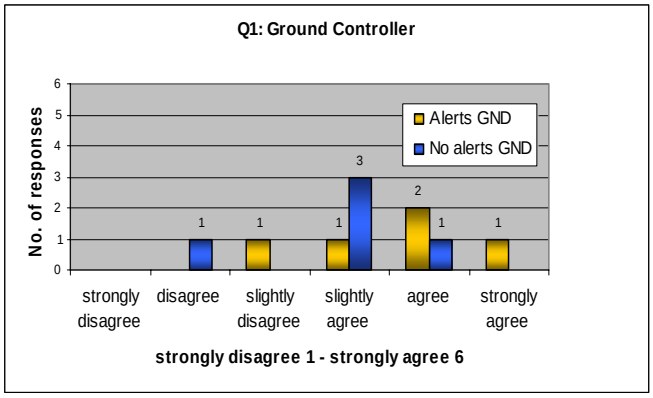


Figure 5-1: SA results for GND

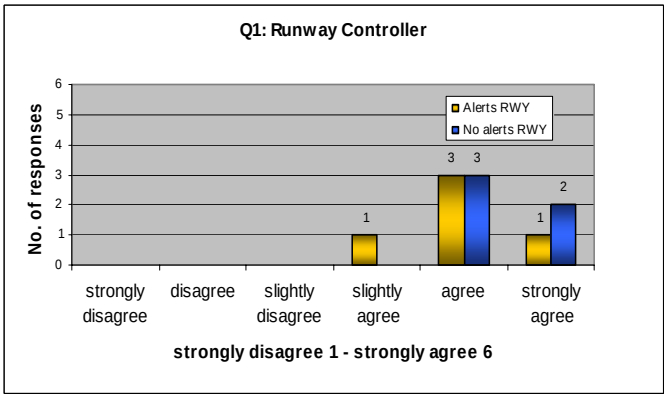


Figure 5-2: SA results for RWY

No significant difference was found between the ratings obtained for the NO ALERT and ALERT conditions. The mean ratings for NO ALERTS and ALERTS being 4.8 and 4.6 respectively.

When looking at the GND and RWY ratings separately again no real difference was found between the ratings obtained for the NO ALERT and ALERT conditions.

The results suggest that the alerts did not help controllers feel more ahead of the traffic compared to when there were no alerts.

Overall controller ratings were positive and controllers in both conditions tended to agree they felt ahead of the traffic most of the time. However, the ratings obtained for the GND controller were

more varied than the RWY controller. It should be noted that the GND who disagreed that he was ahead of the traffic at all times stressed that this was due to problems encountered with the routing function.

Q2. I felt comfortable with organising and planning my tasks.

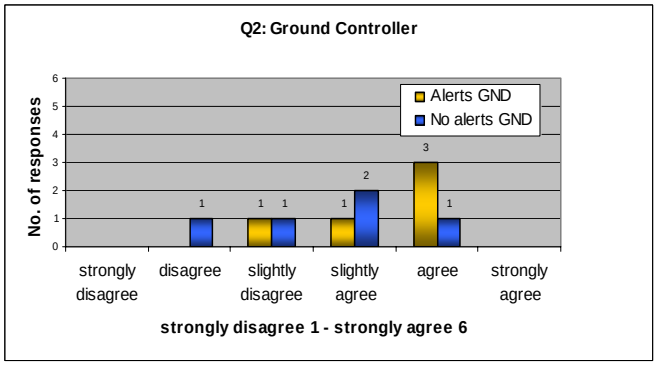


Figure 5-3: SA results for GND

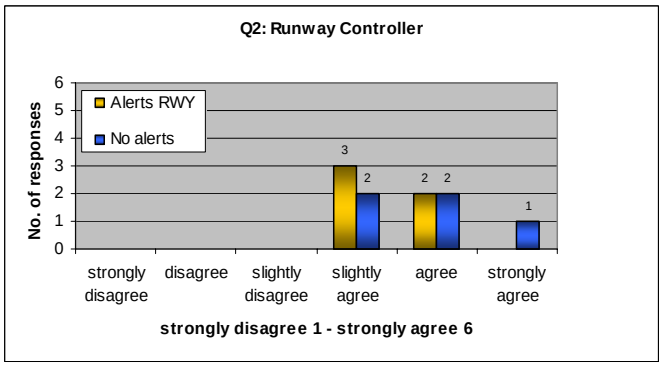


Figure 5-4: SA results for RWY

There was no significant difference found between the ratings obtained for ALERTS compared to NO ALERTS for this question. The means ratings for NO ALERTS and ALERTS was 4.2 and 4.4 respectively. This suggests that the alerts do not appear to affect controller organising and planning their tasks compared to when there are no alerts.

The RWY controllers tended to agree more strongly with the statement that they were comfortable planning and organising their tasks than the GND controllers. The ratings from the GND controllers were more varied. Feedback from GND controllers who disagreed or slightly disagreed with the statement indicated they were concerned about the current layout of the Electronic Flight Strips and the fact that they couldn't move a strip from one bay to another themselves. They said they found it confusing that when doing certain inputs, the EFS would then move automatically to another bay, especially for aircraft landing and taking off. It was also mentioned that many mistakes were made by the pilot responsible for the GND position aircraft.

Q3: I had difficulty in finding information.

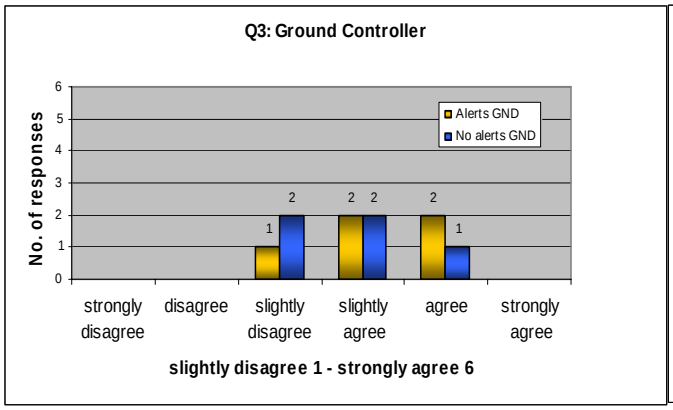


Figure 5-5: SA results for GND

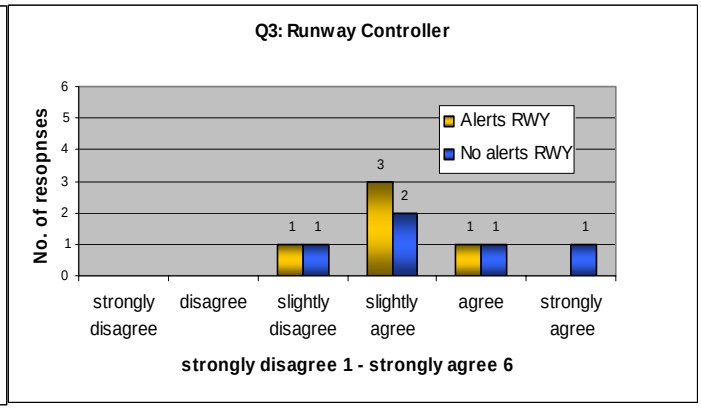


Figure 5-6: SA results for RWY

No significant difference was found between the ratings obtained for the NO ALERT and ALERT conditions. The mean ratings for both NO ALERTS and ALERTS being 4.1.

The separate mean ratings for the GND and RWY positions also indicates there was no real differences in the ratings obtained for the ALERT and NO ALERT conditions. This suggest the ALERTS did not affect (either positively or negatively) the perceived difficulty of finding information.

However, it should be noted that the ratings obtained for this question were quite varied for both GND and RWY positions. Feedback from controllers suggests that the reported difficulties in findings information were caused by the label overlap and the EFS which were said to cause clutter on the HMI.

Q4: All the information I needed for performing my tasks was available.

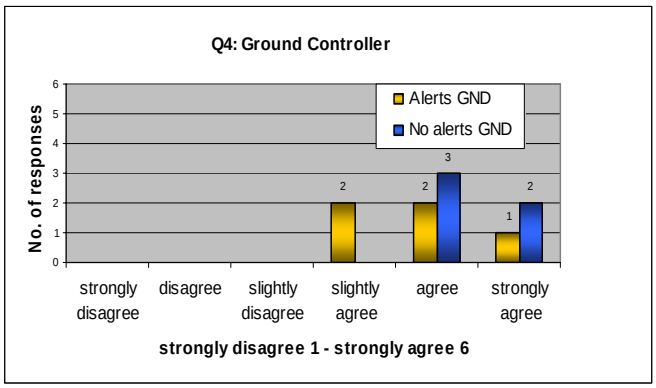


Figure 5-7: SA results for GND

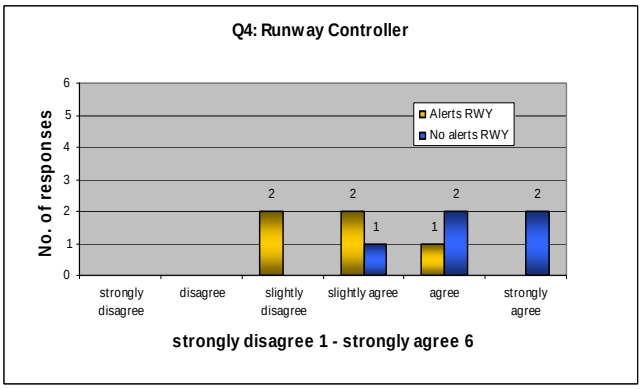


Figure 5-8: SA results for RWY

A significant difference ($p<0.05$) was found between the ratings obtained for ALERT condition compared to the NO ALERT condition, with controllers agreeing more strongly that the NO ALERT conditions provided all the information for the performing the tasks than the ALERT condition. The mean obtained from the ratings obtained was 4.3 for the ALERT condition compared to 5.3 for the NO ALERT condition. The ratings obtained for the NO ALERT condition were very positive as controllers generally either agreed or strongly agreed that they had all the information required to perform their tasks.

The separate means for the RWY and GND position showed that the RWY position with ALERTS agreed less that they had all the information necessary to perform their tasks than the NO ALERT condition. The mean ratings obtained for the RWY was 5.2 for NO ALERTS and 3.8 for ALERTS. (A similar trend was found for the GND position but the difference between the mean ratings obtained was much smaller e.g. the mean for GND was 5.4 with NO ALERTS and 4.8 ALERTS).

Feedback from the controllers suggests that the ALERT condition was not rated as highly as the NO ALERT condition could be because the controllers felt there too many alerts were displayed that were not necessary in particular those alerts that did not concern them (such as the route deviation which is not useful for the runway controller).

Q5: There was a risk of forgetting something important.

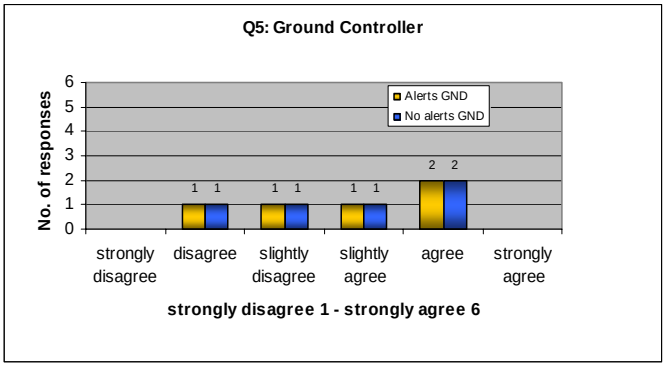


Figure 5-9: SA results for GND

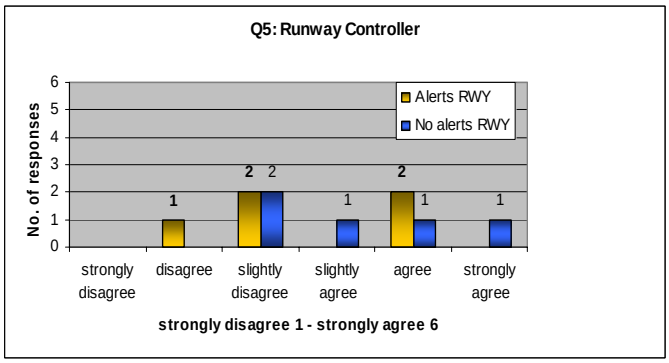


Figure 5-10: SA results for RWY

There was no significant different between the ratings obtained for the ALERT and NO ALERT conditions. The mean rating obtained for the ALERT condition was 3.7 compared to 4 for the No ALERT condition.

However, when looking at the ratings obtained for the RWY and GND position separately it looks as if although there is no difference between the ratings obtained for the GND position for both the NO ALERT and ALERT conditions, the RWY position had a slight tendency to agree more strongly with the statement 'that there was a risk of forgetting something important' in the No ALERT condition (mean rating 4.2) compared to the ALERT condition (mean rating 3.6). This suggests that controllers felt 'there less the risk of them forgetting to do something important' with ALERTS compared to No ALERTS were present.

Q6: I was surprised by an event I did not expect.

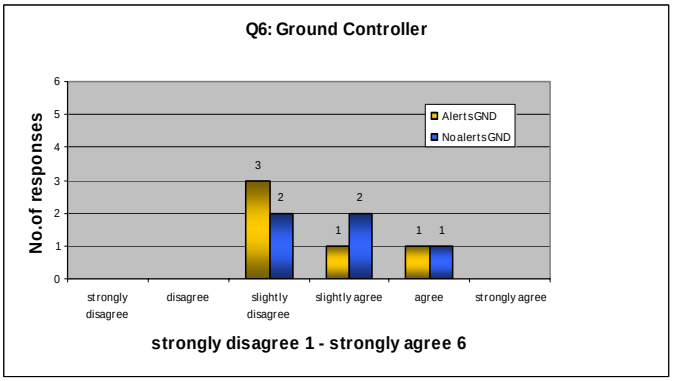


Figure 5-11: SA results for GND

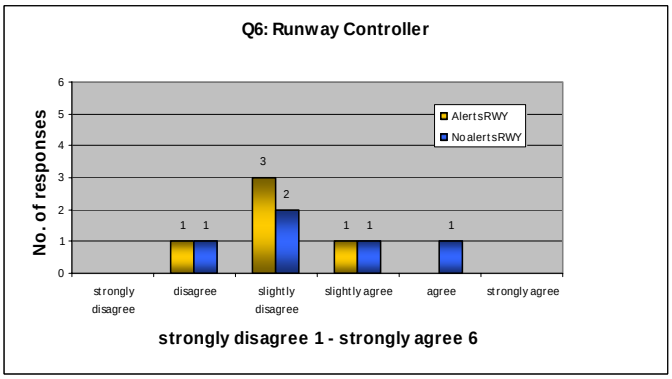


Figure 5-12: SA results for RWY

No significant difference was found between the ratings obtained for the ALERT and NO ALERT condition. The mean rating was 3.3 for ALERTS compared to 3.6 for NO ALERTS.

The separate means for the GND and RWY positions also showed there was no real difference between ratings obtained for the ALERT and NO ALERT condition which suggests the alerts did not affect detection of unexpected results compared to when there were no alerts.

Responses for both the ALERT and NO ALERT condition were relatively varied although generally most controllers reported they either disagreed or slightly disagreed with the statement that they were often surprised by an event they did not expect for both the GND and RWY positions.

Q7: I started to focus on a single problem or a specific area under my responsibility.

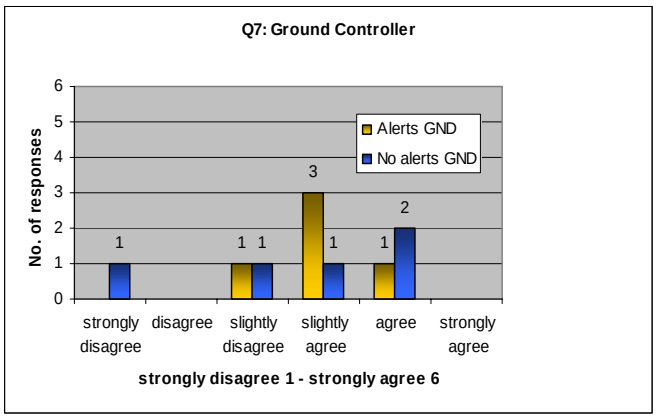


Figure 5-13: SA results for GND

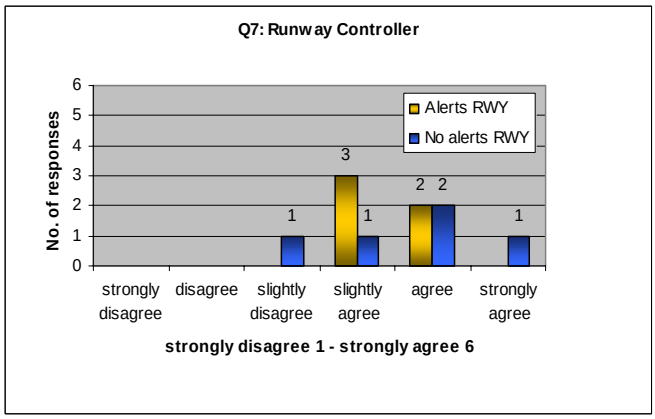


Figure 5-14: SA results for RWY

The controller rating obtained for this statement were rather varied. No significant difference was found between the ratings obtained for the ALERT and NO ALERT condition. The mean rating for this question was 4.2 for the alert condition, compared to 4.1 for the non alert condition.

The separate means for the RWY and GND positions also shows there is no real difference in ratings obtained between the ALERT and NO ALERT conditions.

The results indicates that the alert did not appear to affect the extent to which controllers felt they focused on a single problem or specific area of responsibility compared to when there were no alerts.

Q8: Using the information from the integrated screen gave me a good understanding of the traffic.

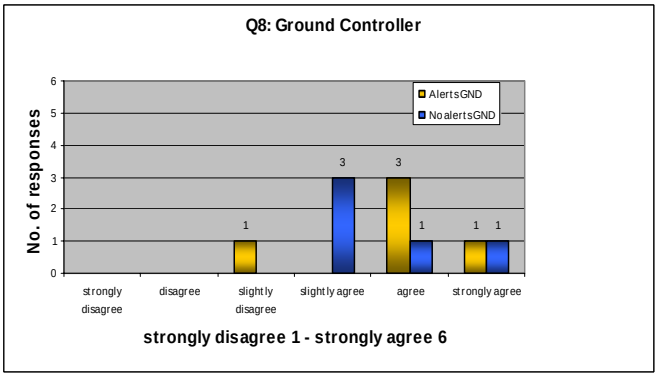


Figure 5-15: SA results for GND

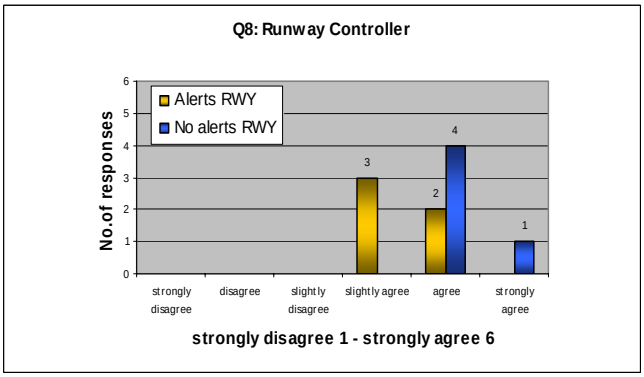


Figure 5-16: SA results for RWY

No significant difference was found between the ratings obtained for the ALERT and No ALERT conditions. The mean ratings obtained were 4.6 for the ALERT condition compared to 4.9 for the NO ALERT condition.

However, the ratings for the separate positions indicated that for the RWY position controllers more strongly agreed that the information presented gave them a good understanding of the traffic in the NO ALERT condition compared to the ALERTS condition with the mean ratings being 5.2 and 4.4 respectively. Feedback from the controllers suggest that as described previously in Q4 this may

be due to too much non-relevant information being presented to the RWY controllers in the ALERT condition, i.e. alerts that are of not concern to the RWY position.

Overall the controller ratings obtained were generally positive and indicate that overall they felt the information presented on the ITWP HMI gave them a good understanding of the traffic. The one controller who rated 'slightly' disagree' for the ALERT condition on the GND position commented that as it was one of the first exercises he was not familiar with the Charles the Gaulle airport Environment and also he had trouble with the labels overlapping.

Q9: The workload was acceptable in order for me to carry out my required tasks adequately.

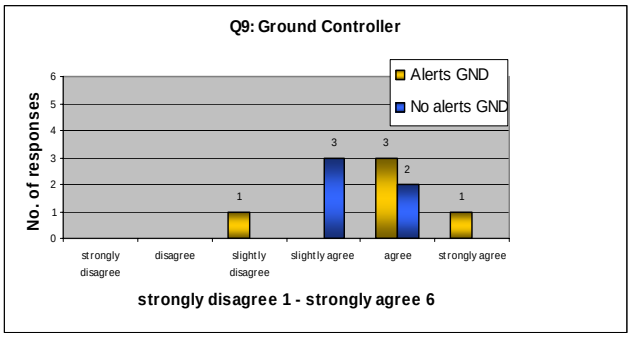


Figure 5-17: SA results for GND

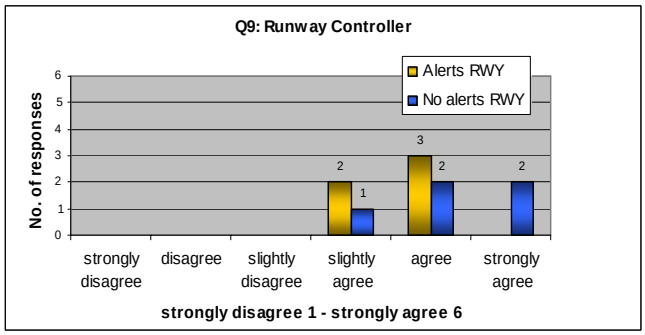


Figure 5-18: SA results for RWY

No significant difference was found between the ratings obtained between the ALERT and No ALERT conditions. Controllers generally agreed that the workload was acceptable to carry out their tasks in both conditions. The mean rating was 4.7 for the ALERT condition and 4.8 for the No ALERT condition.

The separate means for GND and RWY positions showed no particular trend specific to the GND or RWY positions in terms of workload acceptability.

Most of the controllers tended to agree that the workload was acceptable for the GND and RWY controllers in both the ALERT and NO ALERT conditions. It should be noted that the controller in the GND position that slightly disagreed that workload was acceptable for the ALERT condition commented that he felt the acknowledgement button for alerts resulted in an extra unnecessary action.

Q10: I was able to easily identify hazardous situations.

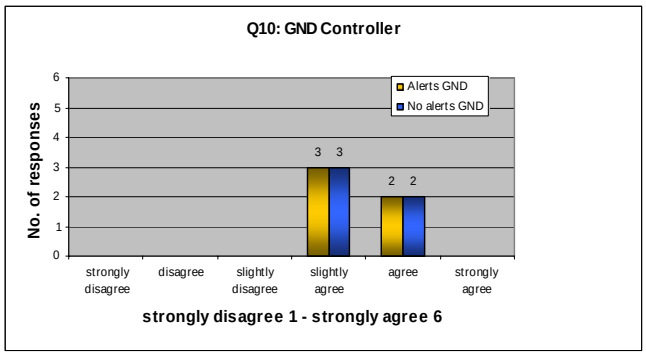


Figure 5-19: SA results for GND

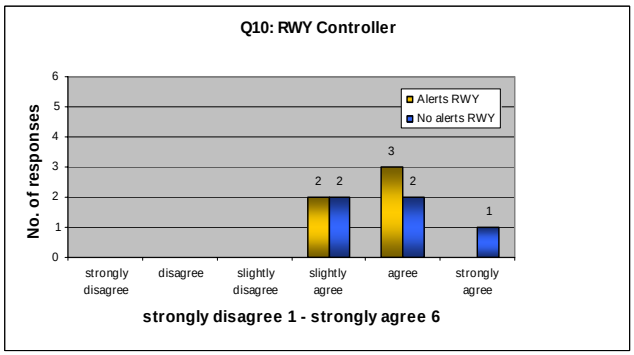


Figure 5-20: SA results for RWY

No significant difference was found between the ratings obtained between the ALERT and No ALERT conditions. The mean rating was 4.5 for the ALERT condition and 4.6 for the No ALERT condition.

The separate means for the GND and RWY position also showed no real differences between ratings obtained for ALERT and NO ALERT conditions. Therefore the alerts did not affect identification of hazardous situations in any way compared to when there were no alerts.

Controller controllers generally agreed that they were able to easily identify hazardous situations in both the ALERT and NO ALERT conditions with all responses spread over ‘’slightly agree” to ‘’strongly agree’’.

Q11: I was able to easily and quickly rectify hazardous situations.

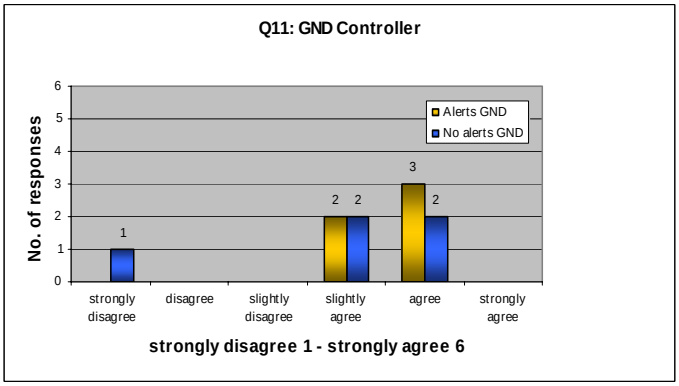


Figure 5-21: SA results for GND

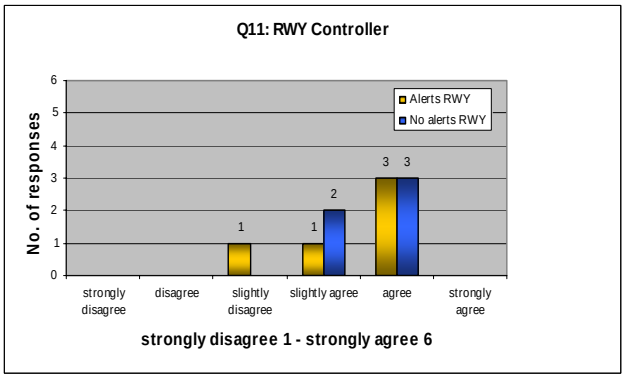


Figure 5-22: SA results for RWY

No significant difference was found between the ratings obtained between the ALERT and NO ALERT conditions. The mean rating was 4.5 for the ALERT condition and 4.2 for the NO ALERT condition.

However, the separate GND and RWY position mean ratings show that the GND position agreed more strongly with the statement that they were likely to more easily and quickly resolve hazards in the ALERT condition compared to the NO ALERT condition with means of 4.6 and 3.8 respectively. The ratings obtained (see figure 24) show that for the GND position one controller strongly disagreed with the statement that he was able to quickly and easily rectify hazards and this resulted in the lower mean as the other controllers either slightly agreed or agreed with this statement. The controller that strongly disagreed commented that the reason he did not feel it was

easy and quick to rectify hazards was due to the fact that he was still familiarising himself with his environment and concentrating on trying to update the EFS.

These results therefore suggest that the alerts did not affect controllers' perceived ability to rectify hazardous situations quickly and easily compared to when there were no alerts.

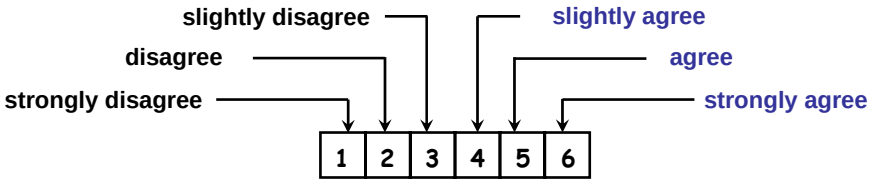
Summary of results for situation awareness

The situation awareness results were overall positive, controllers perceived themselves to have relatively good level of situation awareness when working with ITWP for both the alert and no alert conditions. However, the questionnaire results suggest that the alerts do not generally improve controller situation awareness compared to when there are no alerts on the ITWP. (There was an indication that when in the RWY position controllers felt the alerts helped to reduce the risk of them forgetting something important compared to when there were no alerts. However, subjective ratings from only five RWY controllers were used in this analysis so it's not feasible to draw any concrete conclusions from this result).

However, the results did indicate that controllers tended to agreed less with the statement that 'all the information needed to perform the tasks was available' with alerts compared to when there were no alerts. The RWY controllers were also less likely to agree that the information presented gave a good understanding of the traffic situation in the alert condition compared to the non alert condition. Feedback from the controllers suggests that they felt that there was far too much non-relevant information with the alerts caused by alerts being presented that did not concern them. This was particularly the case for the RWY controller.

5.3. UTILITY AND USABILITY

All of the controllers completed the final questionnaire whose purpose was to assess the utility and usability of the ITWP in general, and the new and improved functions in particular. For each of the 110 statements, the ATC controllers were asked how much they agreed or disagreed with each statement.



The final questionnaire gave a very high rate of answers: only 1% of the answers were missing. The utility and usability was assessed by calculating the median value of the ratings obtained for each statement. The mean rating and the standard deviation (SD)[3] were only calculated to give an overview of the results for alerts (see 5.3.2.1). Subjective feedback gained from both the controller comments written on the questionnaire and the individual interviews were used to explain and interpret the results obtained.

5.3.1. ITWP Environment

5.3.1.1. General questions on the ITWP environment

		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
01	The ITWP environment allows controllers to perform their day-to-day tasks					**5**	
	Median = 5					▲	
02	The ITWP environment allows easy access to data				**1**	**4**	
	Median = 5					▲	
03	The Towsim outside view was realistic and usable				**1**	**2**	**2**
	Median = 5					▲	
04	I was able to perform my normal controlling tasks using the outside view plus ITWP					**5**	
	Median = 5					▲	

All the controllers agreed that the ITWP allowed them to perform their day to day tasks. They all agreed that they were able to perform their normal controlling tasks using the outside view plus ITWP. The TOWSIM outside view was judged realistic and usable. Those controllers that had previously participated in ITWP evaluations all commented that the outside view was beneficial and increased the realism of the evaluations compared to when no external view was used. Only one controller slightly agreed with the statement on the outside view: he was not used to work with runways so far from the tower.

[3] The standard deviation (SD) measures the dispersion of a collection of numbers.

For the GND position, controllers considered that having all the information on the same screen was comfortable. However, the screen, despite its size, was considered to be overloaded with secondary information.

On the RWY position, the screen was judged too small to display both ground and air radar in good conditions. The controllers stated that more room was needed to display the strips (for controllers using strips).

Moreover, some controllers stated that they are used to working with a zoom function or an extra window focused on a specific part of the airport (e.g. during night time). One controller commented that one disadvantage of having only one screen could be the lack of a backup in the case of system failure.

Although some controllers did not use the labels to input data, all of them found that functionality easy to use. However, transfer via the label was judged as being too complicated (whether controllers used paper strip or not in their real environment). The main problem with labels was overlapping and labels not following the target. As a result some controllers considered that it was difficult to distinguish targets under their responsibility, and sometimes it was difficult to link alerts with the corresponding label.

For **most** of the tasks, there was no difference in the number of actions the controllers had to do during the simulation compared to their usual operational environment. However, in the “with alerts” condition; some controllers found that there were too many clicks to perform. Some controllers stated that they had to input too much information. For example, they considered that they should not have to input a “vacate” instruction when an aircraft crosses a runway. They also considered that they sometimes had to perform too many additional actions to avoid an alert.

Even though the controllers were at ease with the use of the mouse all the controllers agreed with the idea of using a touch input device instead of the mouse in the future ITWP environment, provided that the screen would be horizontal and the buttons would be enlarged to facilitate the access to the commands.

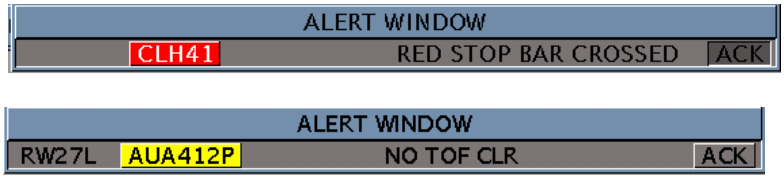
5.3.1.2. Alert description and audio signal

		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
	 						
05	The auditory alert for the red alarm is useful					**4**	**1**
	Median = 5					▲	
06	The auditory alert for the red alarm is suitable			**1**	**2**	**2**	
	Median = 4				▲		
07	For yellow information alerts, it is useful to have the alert description above the callsign in the radar label			**1**		**3**	**1**
	Median = 5					▲	
08	For red alarms, it is useful to have the alert description above the callsign in the radar label			**1**		**3**	**1**
	Median = 5					▲	
09	The alert description above the callsign in the radar label is suitable for yellow information alerts				**1**	**4**	
	Median = 5					▲	
10	The alert description above the callsign in the radar label is suitable for red alarms				**1**	**4**	
	Median = 5					▲	

The responses indicate that overall the controllers either agreed or slightly agreed that the auditory signal for red alarms, and the alert description was useful and suitable. Feedback from the controllers suggests the slightly agreed and slightly disagreed ratings were obtained because controllers felt: the signal was too long; the information above the labels was often obvious when the analysis of the situation was clear; the alert description for the yellow alerts and red alarms should only be displayed on the concerned position.

Generally, all the controllers found that the auditory signal should be less strong (decrease the intensity) and/or set off on one position only. One controller commented that 'the auditory signal is not necessary on the GND position'. Another controller suggested that 'the alarm could be red first without audio, then shortly after the audio signal should be set off. In the meantime the controller could input the information in case he had forgotten it'.

5.3.1.3. Acknowledgment button



		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
11	It is useful to have an acknowledgement button for the yellow alert to remove the yellow alert text from the screen			1		2	2
	Median = 5					▲	
12	It is useful to have an acknowledgement button for the red warning alarm in order to cancel the audible alert		1	1			3
	Median = 6						▲
13	The acknowledgement button is easy to use for the yellow alert				1	3	1
	Median = 5					▲	
14	The acknowledgement button is easy to use for the red alarm	1			1	2	1
	Median = 5					▲	

The responses regarding the acknowledgement button were mixed. Most of the controllers seem to indicate that the acknowledgement button was useful and easy to use. However, some controllers found limitations with the acknowledgement button, commenting: '..considering the yellow alerts and red alarms should remain until the situation is solved, the acknowledgement button is not useful.'; '..in red alarm situations immediate action is required and there is no time to acknowledge the alarm.' and; 'with a shorter buzzer the acknowledgement button would not be necessary;

In both cases (yellow alerts and buzzer for red alarms), all controllers agreed that if there is an acknowledgement button, only the person who is responsible for resolving the situation should be able to switch it off.

5.3.1.4. Red circle for red alarms

			1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
35	*When I was **GND controller**, the red circle* helped me to identify the mobile associated with the alarm				1	2	2	
	Median = 4					▲		
36	*When I was **RWY controller**, the red circle* helped me to identify the mobile associated with the alarm				1	1	2	1
	Median = 4					▲		
37	*The red circle* around the radar position symbol was useful				1	1	3	
	Median = 5						▲	
38	*The red circle* was suitable				1	1	3	
	Median = 5						▲	
39	It was useful to have the red circle displayed on my screen even if I was not concerned with it			1		1	2	
	Median (4 values) = 4,5						▲	

Most of the controllers either agreed or slightly agreed on the usefulness and suitability of the red circle around the radar position for the red alarms on both GND and RWY positions. However, the simulations did not really provide good conditions to test its usefulness: there were too many false alarms according to certain local working methods (for example, give clearances in sequence on parallel twin runways) and some controllers were too consumed by their difficulties to manage the labels. Only one controller disagreed with the display of the red circle when the controller is not concerned.

5.3.2. Utility and usability of Alerts

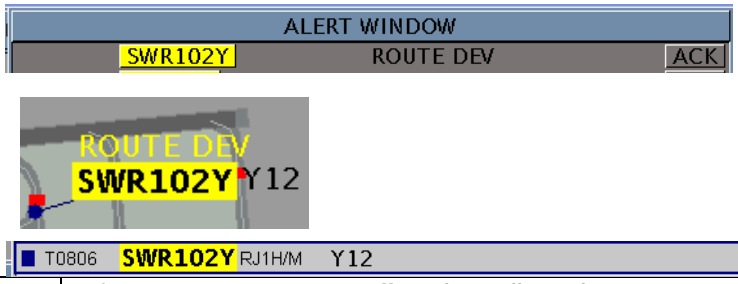
5.3.2.1. Overview of the results

Table 5-1: Average and standard deviation for utility and usability questions on alerts

	Yellow alerts			Red alarms		
	Number of answers	Average score	SD	Number of answers	Average score	SD
Utility	79	**4,012**	**1,214**	205	**4,385**	**1,117**
Usability	33	**4,757**	**0,561**	95	**4,389**	**1,014**

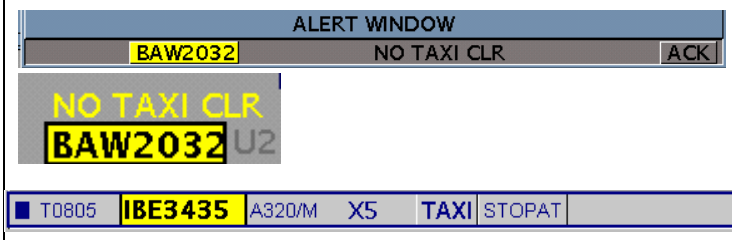
Considering that all the statements in the final questionnaire were positive, the yellow alerts and red alarms were on average well appreciated by the controllers (between 4 and 5). The dispersion was globally small (around one).
The yellow alerts were on average much better rated for usability than for utility and the dispersion for the usability was small. It was much bigger for the utility. Therefore, the controllers agreed with the usability statements but gave less homogeneous answers for the questions related to utility.
The average of the answer to the questions related to the red alarms fits in between the average of the answers for the yellow alerts in terms of utility and usability.
A more detailed analysis, leading to more complete conclusions, is presented in the following sections.

5.3.2.2. Yellow alerts mostly used on the GND position

ROUTE DEV		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
15	When I was ***GND controller***, *the yellow alert ROUTE DEV* helped me to identify an aircraft deviating from a cleared route on a taxiway				**1**	**4**	
	Median = 5					▲	
16	*The yellow alert ROUTE DEV* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)		**1**	**1**	**1**	**2**	
	Median = 4				▲		
17	*The yellow alert ROUTE DEV* was suitable i.e. easy to interpret				**1**	**4**	
	Median = 5					▲	
18	It was useful to have *the yellow alert ROUTE DEV* displayed on my screen even if I was not concerned with it	**1**	**1**	**2**	**1**		
	Median = 3			▲			

All the controllers either agreed or slightly agreed that the yellow alert ROUTE DEV helped the GND controller and was easy to interpret.
It was beneficial because it attracted the controller's attention to an aircraft evolution. This alert was useful to detect when pilots did not follow the cleared route. It was particularly helpful when the controllers were concentrating on another situation
Nevertheless, all the controllers criticised the ROUTE DEV false alerts triggered when using the "push back", or "stop at" functions.

All the controllers clearly stated that the alert function was very useful on the GND position but not on the RWY position. They explained that the alerts were disturbing for the RWY controller. They overloaded the screen with unnecessary information. This is consistent with the low rates of statements 16 and 18.

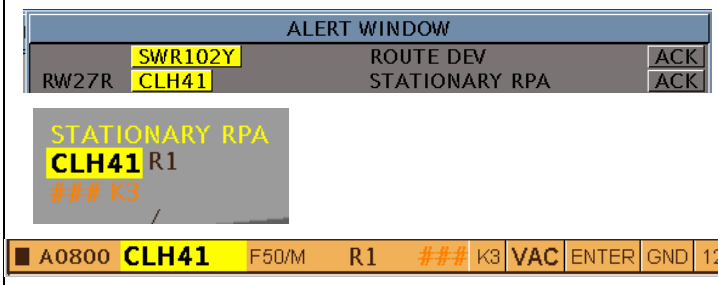
No TAXI CLR		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
19	When I was ***GND controller***, *the yellow alert No TAXI CLR* helped me to identify an aircraft taxiing without clearance				**1**	**4**	
	Median = 5					▲	
20	*The yellow alert NO TAXI CLR* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)		**1**	**1**		**3**	
	Median = 5					▲	
21	*The yellow alert NO TAXI CLR* was suitable i.e. easy to interpret				**1**	**4**	
	Median = 5					▲	
22	It was useful to have *the yellow alert NO TAXI CLR* displayed on my screen even if I was not concerned with it	**2**		**3**			
	Median = 3			▲			

Most of the controllers agreed that the yellow alert NO TAXI CLR helped the GND controller to identify an aircraft taxiing without clearance and was easy to interpret.

Some controllers pointed out that false alerts were triggered during push back. They also considered that alarms triggered because of a late input were inappropriate. A modification in the trigger delay (5 s) of the NO TAXI CLR alert, applied in the middle of the week, notably improved the system performance and the controllers' judgment.

All controllers disagreed to some extent that the NO TAXI CLR alert should be displayed on the RWY position.

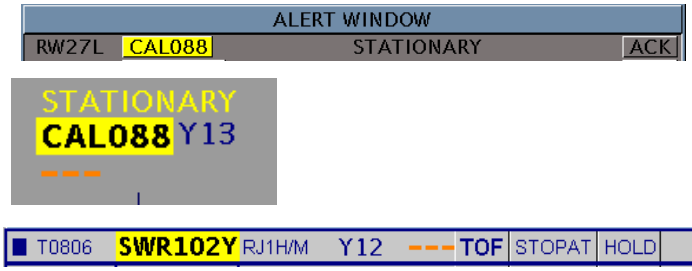
5.3.2.3. Yellow alerts mostly used on the RWY position

STATIONARY IN RPA		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
23	When I was ***RWY controller***, *the yellow alert STATIONARY in RPA* helped me to identify an aircraft stationary in RPA with no other mobile involved			**1**	**2**	**1**	
	Median (4 values) = 4				▲		
24	*The yellow alert STATIONARY in RPA* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)			**1**	**3**		
	Median (4 values) = 4				▲		
25	*The yellow alert STATIONARY in RPA* was suitable i.e. easy to interpret				**1**	**3**	
	Median (4 values) = 5					▲	
26	It was useful to have *the yellow alert STATIONARY in RPA* displayed on my screen even if I was not concerned with it			**1**	**2**	**1**	
	Median (4 values) = 4				▲		

The STATIONARY RPA alert did not occur often enough during the simulation due to the difficulty to simulate it without the controllers noticing what was happening. Therefore, the results of the questionnaire on that alert are not significant enough to draw clear conclusions. . However, it can be stated that although the alert was considered easy to interpret, only one controller agreed on its usefulness for the RWY controller. The other controllers considered that it would be important to distinguish aircraft stopping after landing, crossing and lining up. They also noted that they would have normally detected the stationary aircraft before the alert was triggered.

Only one controller clearly commented that the alert would be relevant information only for the GND controller.

STATIONARY

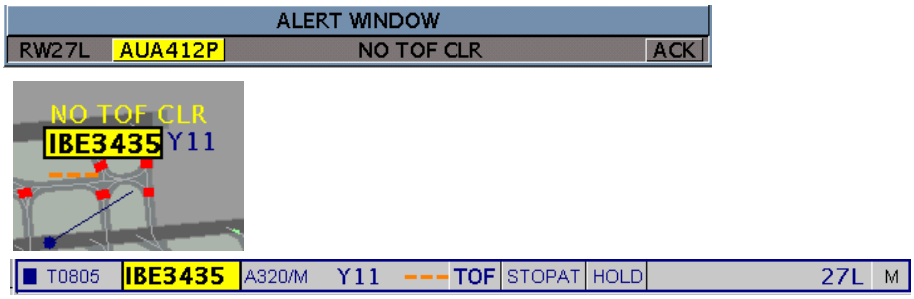


		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
27	When I was ***RWY controller***, *the yellow alert STATIONARY* helped me to identify an aircraft stationary in RPA with no other mobile involved			**1**	**3**		
	Median (4 values) = 4				▲		
28	*The yellow alert STATIONARY* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)			**1**	**3**		
	Median (4 values) = 4				▲		
29	*The yellow alert STATIONARY* was suitable i.e. easy to interpret				**3**	**1**	
	Median (4 values) = 4				▲		
30	It was useful to have *the yellow alert STATIONARY* displayed on my screen even if I was not concerned with it	**1**		**1**	**1**	**1**	
	Median (4 values) = 3,5			▲			

The STATIONARY alert did not occur often enough during the simulation due to the difficulty to simulate it without the controllers noticing what was happening. Therefore, the results of the questionnaire on that alert are not significant enough to draw clear conclusions.

The controllers gave lower rates for statements on suitability (easy to interpret) and usefulness for the RWY controller regarding the STATIONARY alert than the equivalent statements regarding the STATIONARY RPA alert. One controller said that this alert was not needed because the RWY controller always checks the effectiveness of the take-off clearance.

The controllers also gave lower rates when they assessed the interest to have the STATIONARY alert on their screen, even when they were not concerned with it.

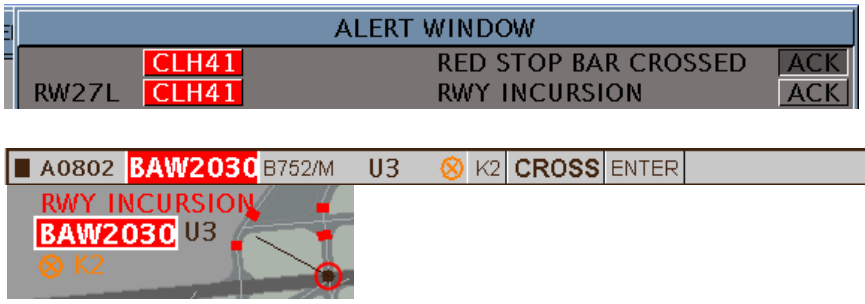
NO TOF CLR		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
31	When I was ***RWY controller***, *the yellow alert NO TOF CLR* helped me to identify an aircraft taking off without take-off clearance				**2**	**2**	**1**
	Median = 5					▲	
32	The yellow alert *NO TOF CLR* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)				**2**	**2**	**1**
	Median = 5					▲	
33	The yellow alert *NO TOF CLR* was suitable i.e. easy to interpret				**2**	**2**	**1**
	Median = 5					▲	
34	It was useful to have the yellow alert *NO TOF CLR* displayed on my screen even if I was not concerned with it		**1**	**1**	**1**	**2**	
	Median = 4				▲		

Most of the controllers agreed or strongly agreed with the statement “the yellow alert NO TOF CLR helped the RWY controller to identify an aircraft taking off without clearance”. Controllers considered that the alert helped them to detect an event that could be a dangerous situation.

Most of the controllers considered that the alert was displayed and switched at the correct time. They found the information easy to interpret.

The controllers’ comments differed when they considered the positions to be informed: some stated that since it is a big safety issue, the alert should be displayed on every position so that even if the RWY controller does not notice it, the other controllers are warned. One controller stated that ‘the NO TOF CLR should be a red alarm because it concerns the runways’. Others stated that if the controller is not concerned with the alert, there is no reason to display it on his screen.

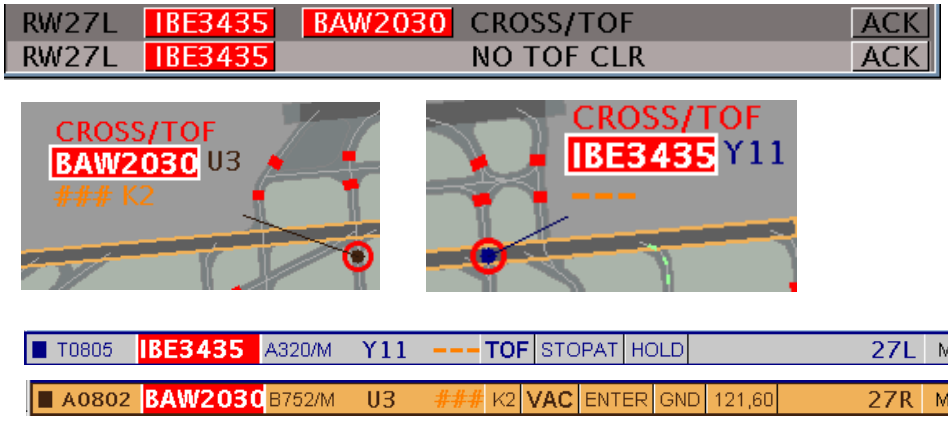
5.3.2.4. Red alarms used on the GND and RWY positions

RUNWAY INCURSION		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
40	When I was ***GND controller***, *the red alarm RWY INCURSION with audio signal* was useful i.e. enabled sufficient detection of a mobile entering the Runway Protection Area without a clearance				**1**	**3**	**1**
	Median = 5					▲	
41	When I was ***RWY controller***, *the red alarm RWY INCURSION with audio signal* enabled sufficient detection of a mobile entering the Runway Protection Area without a clearance					**3**	**2**
	Median = 5					▲	
42	The *red alarm RWY INCURSION with audio signal* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)				**2**	**2**	**1**
	Median = 5					▲	
43	The *red alarm RWY INCURSION with audio signal* was easy to interpret				**2**	**1**	**2**
	Median = 5					▲	
44	The auditory alert for *red alarm RWY INCURSION* is useful				**1**	**2**	**2**
	Median = 5					▲	
45	The auditory alert for *red alarm RWY INCURSION* is suitable			**1**	**1**	**1**	**2**
	Median = 5					▲	
46	It was useful to have *the red alarm RWY INCURSION with audio signal* displayed on my screen even if I was not concerned with it			**2**	**1**	**2**	
	Median = 4				▲		

The RWY INCURSION alarm was not triggered during the simulation due to the difficulty to simulate it without the controllers noticing what was happening. It was only shown to the controllers during the training and evaluation phases.

Despite this, the controllers rated the RWY INCURSION red alarm highly. It confirms its utility for both GND and RWY controllers. The controllers slightly agreed, agreed or strongly agreed with the fact that the time the alarm was triggered and switched off was correct. They slightly agreed, agreed or strongly agreed with the statement on the usability of the RWY INCURSION alarm.

The controllers' answers on the audio signal were consistent with the general results on alert description and audio signal 5.3.1.2:. Four of the five controllers either agreed or strongly agreed that the audio signal was useful. Three of the five controllers agreed or strongly agreed that the alarm was suitable. The controllers that slightly disagreed and slightly agreed felt that the audio signal should be triggered on the RWY position only and could be decreased in volume.

CONFLICT red alarm for No TOF CLR vs CROSS		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
47	When I was ***GND controller***, *the CONFLICT red alarm for No TOF CLR vs CROSS* helped me to identify a mobile crossing the runway against an aircraft taking-off with no clearance			**1**		**3**	**1**
	Median = 5					▲	
48	When I was ***RWY controller***, *the CONFLICT red alarm for No TOF CLR vs CROSS* helped me to identify a mobile crossing the runway against an aircraft taking-off with no clearance			**1**		**3**	**1**
	Median = 5					▲	
49	The *CONFLICT red alarm for No TOF CLR vs CROSS* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)				**2**	**2**	**1**
	Median = 5					▲	
50	*The CONFLICT red alarm for No TOF CLR vs CROSS with audio signal* was easy to interpret				**1**	**4**	
	Median = 5					▲	
51	The auditory alert for *the CONFLICT red alarm for No TOF CLR vs CROSS* is useful					**3**	**2**
	Median = 5					▲	
52	The auditory alert for *the CONFLICT red alarm for No TOF CLR vs CROSS* is suitable			**1**		**3**	**1**
	Median = 5					▲	
53	It was useful to have *the CONFLICT alert for No TOF CLR vs CROSS* displayed on my screen even if I was not concerned with it			**1**		**3**	**1**
	Median = 5					▲	

Most of the controllers strongly agreed or agreed that the CONFLICT red alarm helped both GND and RWY controllers to identify an aircraft taking off without clearance while a mobile was crossing the same runway. In that situation, the controllers are probably focusing on the crossing mobile. There is a risk to miss the aircraft infringement. The controller who slightly agreed with the statement considered that he did not need the alarm description (above the callsign) since the hazardous situation can clearly be identified and understood.

The controllers slightly agreed, agreed or strongly agreed that the time the alarm was triggered and switched off was correct, and most of them agreed that the alarm was easy to interpret.

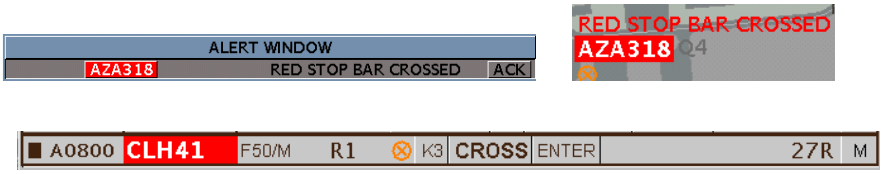
Some alarms were considered as false when the controllers were intentionally giving sequences of take off clearances mixed with holding clearances to optimise the runway throughput. False alarms were also identified when a take off was aborted and the alarm did not go off.

The controllers' answers on the audio signal were consistent with the general results on alert description and audio signal 5.3.1.2: All controllers agreed the auditory signal was useful and four of the five controllers strongly agreed or agreed that the auditory alert was suitable.

Most of the controllers agreed or strongly agreed with the fact to display the alarm on both positions because several controllers are often involved in the management of runway crossings.

Orange bar around runway

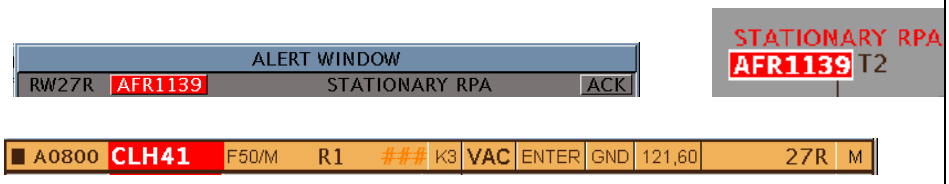
The orange bar around a runway when an aircraft has been cleared to cross should be linked to the aircraft position and not with who is in charge of the aircraft: the bar should stay orange while the aircraft is crossing the runway, even if it has been transferred to the GND controller. This could have an impact on the CONFLICT alarm

RED STOP BAR CROSSED 		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
54	When I was ***GND controller***, *the red alarm RED STOP BAR CROSSED with audio signal* enabled sufficient detection of a aircraft crossing the red stop bar				**3**	**1**	
	Median (4 values) = 4				▲		
55	When I was ***RWY controller***, *the red alarm RED STOP BAR CROSSED with audio signal* enabled sufficient detection of a mobile crossing the red stop bar				**1**	**3**	
	Median (4 values) = 5					▲	
56	The *red alarm RED STOP BAR CROSSED with audio signal* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)				**2**	**2**	
	Median (4 values) = 4,5				▲		
57	The *red alarm RED STOP BAR CROSSED with audio signal* was easy to interpret				**2**	**2**	
	Median (4 values) = 4,5				▲		
58	The auditory alert for *the red alarm RED STOP BAR CROSSED* is useful				**1**	**3**	
	Median (4 values) = 5					▲	
59	The auditory alert for *the red alarm RED STOP BAR CROSSED* is suitable			**1**	**1**	**2**	
	Median (4 values) = 4,5				▲		
60	It was useful to have *the red alarm RED STOP BAR CROSSED with audio signal* displayed on my screen even if I was not concerned with it			**3**	**1**	**1**	
	Median = 3			▲			

All of the controllers either slightly agreed or agreed that the RED STOP BAR CROSSED red alarm enabled sufficient detection of an aircraft crossing the red stop bar, both on the GND and RWY positions. They also slightly agreed or agreed that the time the alarm was triggered and switched off was correct and that the alarm was easy to interpret.

The controllers' answers on the audio signal were consistent with the general results on alert description and audio signal 5.3.1.2:

Three controllers slightly disagreed with the fact that it was useful to have the alarm displayed on their screen if they were not concerned with it.

STATIONARY in RPA 		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
61	When I was ***GND controller***, *the red alarm STATIONARY IN RPA with audio signal* enabled sufficient detection of a mobile stationary in the RPA				**2**	**2**	
	Median (4 values) = 4,5						
62	When I was ***RWY controller***, *the red alarm STATIONARY IN RPA with audio signal* enabled sufficient detection of a mobile stationary in the RPA				**1**	**3**	
	Median (4 values) = 5						
63	*The red alarm STATIONARY IN RPA with audio signal* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)				**2**	**2**	
	Median (4 values) = 4,5						
64	*The red alarm STATIONARY IN RPA with audio signal* was easy to interpret				**1**	**3**	
	Median (4 values) = 5						
65	The auditory alert for *the red alarm STATIONARY IN RPA* is useful	**1**			**2**	**2**	
	Median = 4						
66	The auditory alert for *the red alarm STATIONARY IN RPA* is suitable		**1**	**1**	**2**	**1**	
	Median = 4						
67	It was useful to have *the red alarm STATIONARY IN RPA* with audio signal displayed on my screen even if I was not concerned with it		**1**	**1**	**2**		**1**
	Median = 4						

All the controllers who gave an answer slightly agreed or agreed that the STATIONARY IN RPA red alarm enabled sufficient detection of a mobile stationary in the RPA, both on the GND and RWY positions. They also slightly agreed or agreed with the fact that the time the alarm was triggered and switched off was correct and that the alarm was easy to interpret and useful.

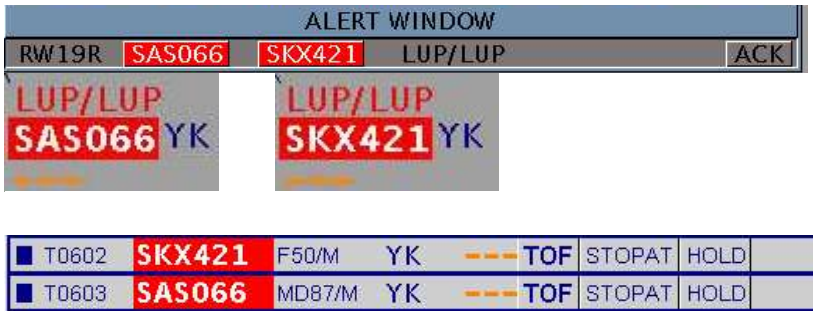
One controller disagreed with the statement on the usefulness of the alarm because he considered that there was no need to trigger the alarm if there is non occupancy hazard on the runway.

The controllers' answers on the suitability of the auditory alert for the STATIONARY IN RPA alarm signal were mixed.

Controllers' comments also differed when they considered the positions to be informed: one strongly agreed and two slightly agreed with the fact that the alarm was displayed on both positions, the others disagreed with the statement.

5.3.2.5. Red alarms mostly used on the RWY position

LUP/LUP



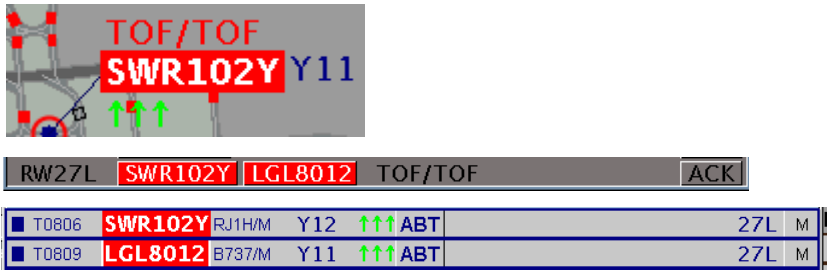
		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
68	When I was ***RWY controller***, *the red alarm LUP vs LUP with audio signal* enabled sufficient detection of line up clearances error		**1**		**1**	**2**	
	Median (4 values) = 4,5				▲		
69	*The red alarm LUP vs LUP with audio signal* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)		**1**		**2**	**1**	
	Median (4 values) = 4				▲		
70	*The red alarm LUP vs LUP with audio signal* was easy to interpret		**1**		**1**	**2**	
	Median (4 values) = 4,5				▲		
71	The auditory alert for *the red alarm LUP vs LUP* is useful	**1**			**3**	**1**	
	Median = 4				▲		
72	The auditory alert for *the red alarm LUP vs LUP* is suitable	**1**		**1**	**2**	**1**	
	Median = 4				▲		
73	It was useful to have *the red alarm LUP vs LUP with audio signal* displayed on my screen even if I was not concerned with it	**1**	**1**	**1**	**1**	**1**	
	Median = 3			▲			

Most of the controllers slightly agreed or agreed with the fact that the LUP vs LUP red alarm enabled sufficient detection of line up clearances error, on the RWY positions. They also slightly agreed or agreed that the time the alarm was triggered and switched off was correct and that the alarm was easy to interpret and useful.

One controller was not satisfied with this alarm because, in his operational environment, he often gives Line Up clearances in sequence on the same runway. So he considered many alarms as false regarding this local working method (note Conditional Line Up - CLU is available on the EFS as an option for multiple lines) and commented that he would like multiple LUPs to be made possible.

The controllers' answers on the audio signal were consistent with the general results on alert description and audio signal 5.3.1.2:

Most of the controllers disagreed with the fact that the alarm was displayed on both position.

TOF/TOF 		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
74	When I was ***RWY controller***, *the red alarm Take-off vs Take-off with audio signal* enabled sufficient detection of take-off clearances input error				**2**	**3**	
	Median = 5					▲	
75	*The red alarm Take-off vs Take-off with audio signal* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)			**1**	**1**	**3**	
	Median = 5					▲	
76	*The red alarm Take-off vs Take-off with audio signal* was easy to interpret			**1**	**1**	**3**	
	Median = 5					▲	
77	The auditory alert for *the red alarm Take-off vs Take-off* is useful				**2**	**3**	
	Median = 5					▲	
78	The auditory alert for *the red alarm Take-off vs Take-off* is suitable			**1**	**1**	**2**	
	Median (4 values) = 4,5				▲		
79	It was useful to have *the red alarm Take-off vs Take-off with audio signal* displayed on my screen even if I was not concerned with it	**1**	**1**	**1**	**1**		**1**
	Median = 3			▲			

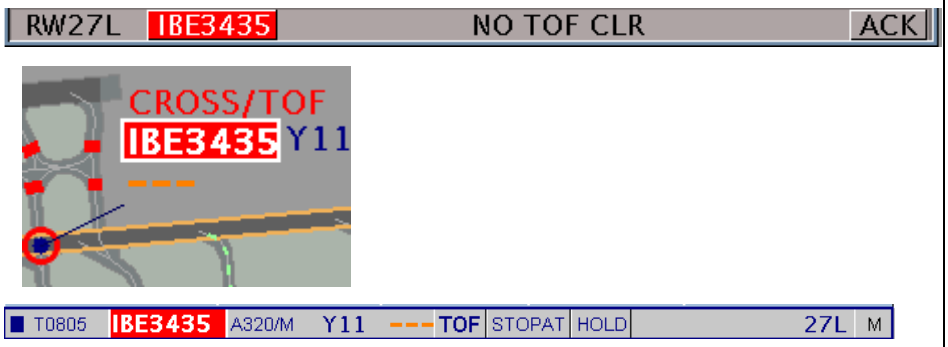
Most of the controllers slightly agreed or agreed with the fact that the red alarm TOF vs TOF enabled sufficient detection of take-off clearances error for the RWY controller.
One controller considered that the alarm did not take reduced separation into account, which was leading to false alarms.

Most of the controllers slightly agreed or agreed with the fact that the time the alarm was triggered and switched off was correct and that the alarm was easy to interpret. All controllers reported that the alarm was useful, one controller commented that 'When there are landing and departing aircraft at the same time, the alarm allows the controller to focus on one area at a time'.

The controllers' answers on the audio signal were once again consistent with the general results on alert description and audio signal 5.3.1.2:

Most of the controllers disagreed with display of the alarm on both GND and RWY positions.

NO TOF CLR



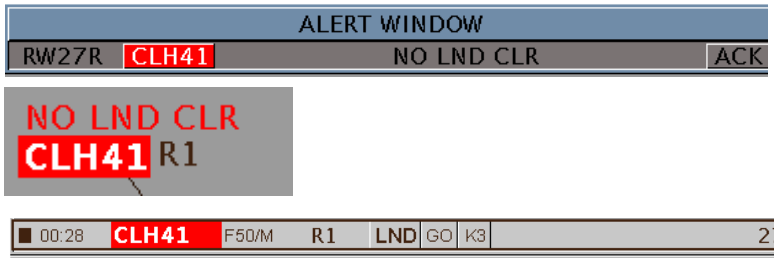
		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
80	When I was ***RWY controller***, *the red alarm NO TOF CLR with audio signal* helped me to identify an aircraft taking off and another mobile was cleared on the same RWY				**1**	**2**	**2**
	Median = 5					▲	
81	*The red alarm NO TOF CLR with audio signal* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)				**2**	**3**	
	Median = 5					▲	
82	*The red alarm NO TOF CLR with audio signal* was easy to interpret				**1**	**3**	**1**
	Median = 5					▲	
83	The auditory alert for *the red alarm NO TOF CLR* is useful				**1**	**3**	**1**
	Median = 5					▲	
84	The auditory alert for *the red alarm NO TOF CLR* is suitable			**1**	**2**	**2**	
	Median = 4				▲		
85	It was useful to have *the red alarm NO TOF CLR* displayed on my screen even if I was not concerned with it		**1**	**1**	**2**		**1**
	Median = 4				▲		

Most of the controllers strongly agreed or agreed with the fact that the NO TOF CLR red alarm helped the RWY controller to identify that an aircraft was taking off and another mobile was cleared on the same runway.

The controllers slightly agreed or agreed with the fact that the time the alarm was triggered and switched off was correct. All of them agreed that the alarm was easy to interpret and useful.

The controllers' answers on the audio signal were consistent with the general results on alert description and audio signal 5.3.1.2.

The controllers' comments differed when they considered the positions to be informed: one strongly agreed and two slightly agreed with the display of the alarm on both the GND and RWY positions. The others disagreed with that statement.

NO LND CLR		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
86	When I was ***RWY controller***, *the red alarm No Landing Clearance with audio signal* enabled sufficient detection of an aircraft landing without landing clearance				**2**	**3**	
	Median = 5					▲	
87	*The red alarm No Landing Clearance with audio signal* was displayed at the correct time (I had time to handle potential hazardous situation) and it was switched off at the correct time (I did not need this information any more)			**2**	**3**		
	Median = 4				▲		
88	*The red alarm No landing Clearance with audio signal* was easy to interpret				**1**	**4**	
	Median = 5					▲	
89	The auditory alert for *the red alarm No Landing Clearance* is useful			**1**	**4**		
	Median = 4				▲		
90	The auditory alert for *the red alarm No landing Clearance* is suitable			**2**	**3**		
	Median = 4				▲		
91	It was useful to have *the red alarm No Landing Clearance with audio signal* displayed on my screen even if I was not concerned with it	**1**	**1**	**1**	**2**		
	Median = 3			▲			

Most of the controllers slightly agreed or agreed with the fact that the NO LND CLR red alarm enabled sufficient detection of an aircraft landing without landing clearance.

Two controllers slightly disagreed with the fact that the time the alarm was triggered and switched off was correct. A modification in the delay (10s instead of 30s), applied in the middle of the week, notably improved the controllers' opinion.

Two controllers considered that this alarm could be a yellow alert and not a red alarm with audio signal: when there is no obstacle on the runway, if an aircraft is on final without landing clearance or if an aircraft is vacating the runway there is no need for a red alarm. One controller was not satisfied with this alarm because, in his operational environment, he often gives landing clearances in sequence. So he considered that many alarms were false regarding this local working method. Also sometimes the controllers did not mark the "hold at", which set off the alarm. One controller commented that his kept him from doing other tasks which a higher priority.

The controllers considered that the alarm was easy to interpret.

The controllers' answers on the audio signal were consistent with the general results on alert description and audio signal 5.3.1.2.

Three of them disagreed with the display of the alarm on both the GND and RWY positions.

5.3.3. Summary of results for alerts

To summarize the obtained results, controllers' assessment of global utility and usability of the alerts implemented in the ITWP3 is given Figure 5-23 (yellow alerts) and Figure 5-24 (red alarms).[4] The global score of utility and usability for a given alert was calculated as it follows:

- all of the answers to the questions on utility were grouped and the median was calculated from that distribution;
- Idem for questions on usability.

The table below explains how the diagram can be understood:

Table 5-2: Usability and utility diagram interpretation

When…	…then the HMI function is considered:
1<*utility* ≤ 3.5 and 1<*usability* ≤ 3.5	Useless and unusable
1<*utility* ≤ 3.5 and *usability*>3.5	No real operational utility but is usable
utility>3.5 and 1<*usability* ≤ 3.5	Useful but the HMI must be redone
utility >3.5 and *usability* >3.5	*Useful and usable*
utility ≥ 5 and 3.5 <*usability*<5	*Four sub-cases can be identified:*
3.5 <*utility*<5 and *usability* ≥ 5	Useful but HMI should be improved
3.5<*utility*<5 and 3.5<*usability*<5	Usable but the functionality should be consolidated
utility ≥ 5 and *usability* ≥ 5	Functionality and HMI should be improved
	Useful and usable

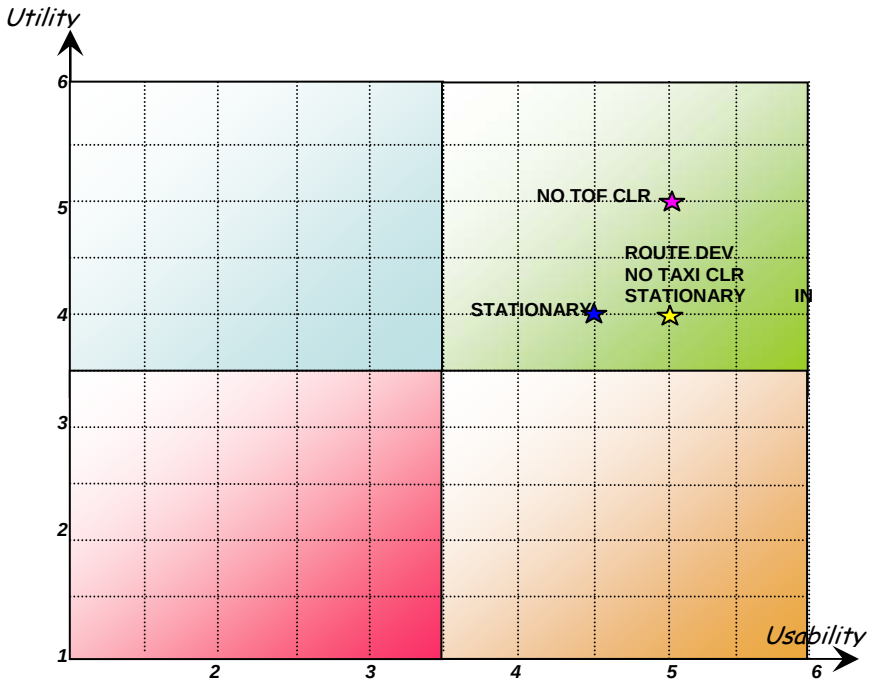


Figure 5-23: Utility and usability diagram for yellow alerts

In summary, all the yellow alerts were evaluated useful and/or usable by the controllers, on different levels:

- The NO TOF CLR alert is useful and usable.
- The ROUTE DEV, TAXI CLR and STATIONARY alerts are usable but the operational need should be reviewed (review the specifications or the definition of the parameters).

[4] The calculation mode and diagram presentation are those already used in the evaluation report ITWP session2. Definition has been slightly modified for *utility*>3.5 and 1<*usability* ≤ 3.5 (*redone* instead of *improved*)

- The STATIONARY alert should be improved in terms of HMI and functionality in order to increase its level of utility and usability.

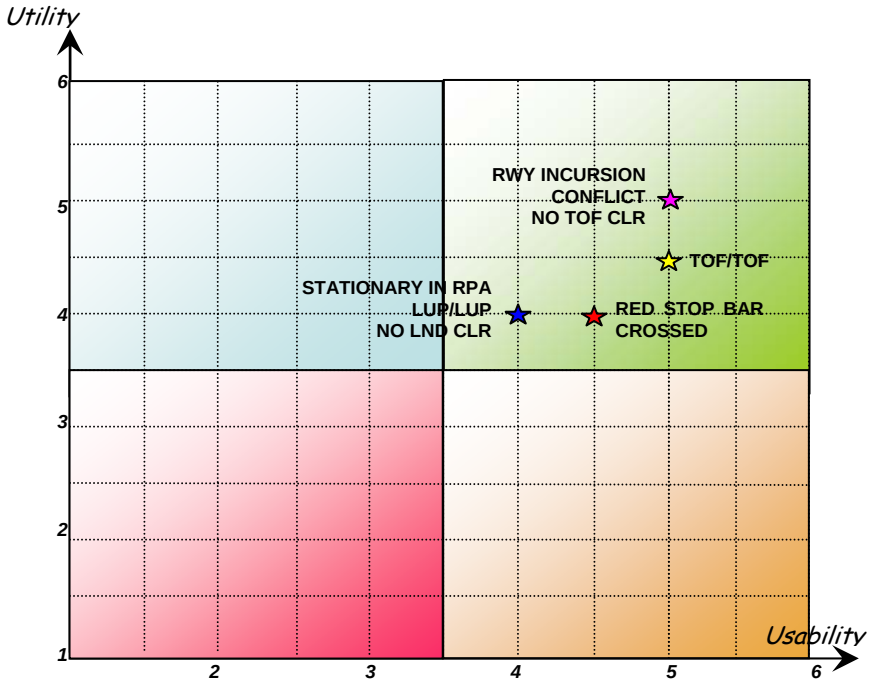
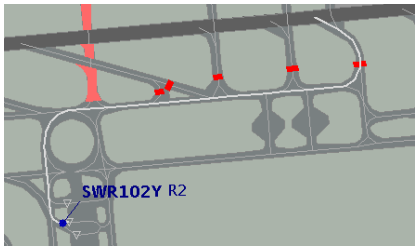


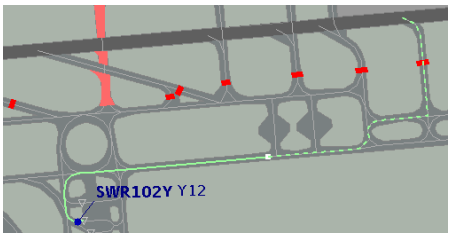
Figure 5-24: Utility and usability diagram for red alarms

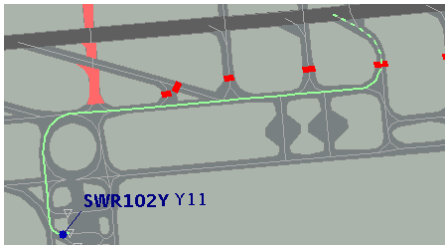
In summary, all the red alarms were evaluated useful and/or usable by the controllers, on different levels:

- The RWY INCURSION, CONFLICT and NO TOF CLR alerts are useful and usable.
- The TOF/TOF alert is usable but the operational need should be reviewed (review the specifications or the definition of the parameters).
- The RED STOP BAR CROSSED, STATIONARY IN RPA, LUP/LUP and NO LND CLR alert should be improved in terms of HMI and functionality in order to increase its level of utility and usability.

5.3.4. Routing Function







		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
92	The display of the planned route (white) with *the routing function* is useful				**2**	**2**	**1**
	Median = 5					▲	
93	The display of the planned route with *the routing function* is easy to use and to interpret (by scrolling on the radar symbol)				**1**	**3**	**1**
	Median = 5					▲	
94	The display of the cleared route (solid green) with *the routing function* is useful				**2**	**3**	
	Median = 5					▲	
95	The display of the cleared route (solid green) with *the routing function* is easy to use and to interpret				**1**	**4**	
	Median = 5					▲	
96	The display of the route that has not yet been cleared (dashed green line) with the routing function is useful				**1**	**3**	**1**
	Median = 5					▲	
97	The display of the route that has not yet been cleared (dashed green line) with the routing function is easy to use and to interpret				**1**	**4**	
	Median = 5					▲	
98	The update of a route with *the routing function* is useful					**4**	**1**
	Median = 5					▲	
99	The update of route with *the routing function* is easy to use	**1**			**3**	**1**	
	Median = 4				▲		

The controllers became more comfortable with the routing function during the week. The function was mainly used by the GND controller. Three controllers stated that they never used it when they were on the RWY position.
All the controllers appreciated the function. They considered that it was an improvement compared to their current working environment. Unfortunately, some malfunctions prevented them from taking full advantage of the services (sometimes the wrong routes were allocated, some portions of the routes were not good, the controllers could sometimes unintentionally open the function, etc.) Due to the misinterpretation of some clearances and delays in the execution of some instructions by the pilots, the routing function was often used to check the aircraft position rather than for re-routing purposes.

All the controllers considered that the display of the planned routes was useful and usable. For example they used it:

- For planning tasks: the function helped them to prioritise the tasks they had to perform for a given aircraft;
- To communicate with the RWY controller about a holding point;
- To see Y11, Y12 for an aircraft going to 27R;
- To identify potential conflicts: it helped them to prevent a potential safety critical situation for incoming or outgoing flights (in particular for the arrivals: conflict detection of an aircraft taxiing to the stands);
- To see the distance to the crossing point. It helped them to solve conflicts; …

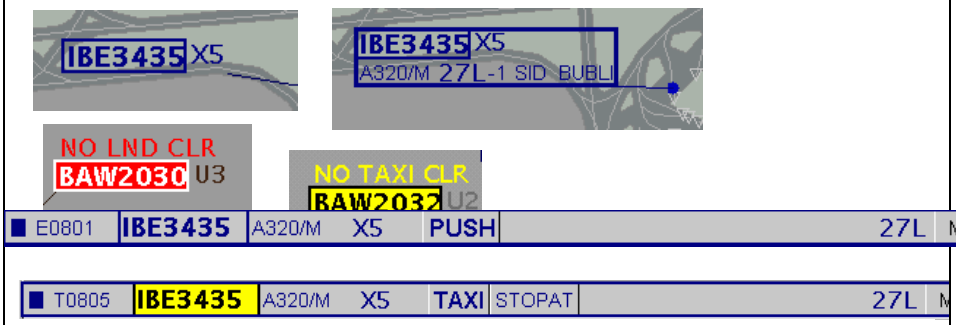
Nevertheless, some controllers admitted that the planned route was particularly beneficial as they were not familiar with the airport layout, although one controller commented that 'The routing functionality could be useful even when the layout of the airport is known: when the controller often moves between working positions, he can forget which are the best routes.'

The opinions on the display of the cleared routes were less positive. There are several reasons for that, including the following ones: too many clicks were required to modify a route; it was particularly difficult to do a re-routing close to terminal 1 because there were lots of points and route segments (more than close to the runway); it was difficult to use the routing function to change the exit point K1-2-3.

All the controllers considered that the display of the routes that had not yet been cleared was useful and usable.
All the controllers considered that the update of the routes was useful and usable. Although there were a couple of problems reported that could be improved for example the solid trajectory stayed on the screen without any reason after the controller gave the taxi instruction and When the aircraft had started to move, the proposition of routes was not good as it still took into account the starting point of the aircraft.

One controller strongly disagreed with the fact that the routing function was easy to use, because it demanded too many clicks and caused errors. It was suggested that one potential solution for this was that commonly used routes should be inputted automatically with one click on the destination point.

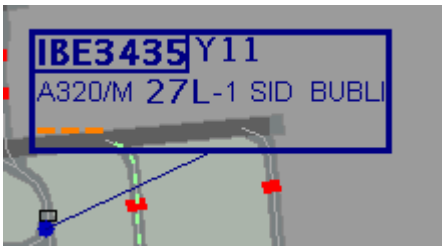
5.3.5. Data Link equipped identifier

Data Link EQUIPPED IDENTIFIER		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
100	*The data link equipped identifier* on the radar label helped to quickly identify data-linked aircraft	**1**			**3**	**1**	
	Median = 4				▲		
101	*The data link equipped identifier* on the EFS helped to quickly identify data-linked aircraft				**3**	**2**	
	Median = 4				▲		
102	*The data link equipped identifier* is clearly visible on the radar label			**1**	**2**	**2**	
	Median = 4				▲		
103	I find *the data link equipped identifier* on the radar label is suitable			**1**	**2**	**2**	
	Median = 4				▲		
104	*The data link equipped identifier* is clearly visible on the EFS			**1**	**3**	**1**	
	Median = 4				▲		
105	*The data link equipped identifier* on the EFS is suitable			**1**	**2**	**2**	
	Median = 4				▲		

The Data Link equipped identifier was not used during the simulation. However, it was shown to controllers during training and evaluation phases. Consequently, the controllers only gave their opinion on the identifier without operational use.

Most of the controllers agreed on the statements concerning the Data Link equipped identifier.

5.3.6. Automatic Stop Bar Management



		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
106	*The Automatic Stop Bar management* is useful for ***GND controller***		**1**	**1**	**2**	**1**	
	Median = 4				▲		
107	*The Automatic Stop Bar management* is useful for ***RWY controller***				**3**	**2**	
	Median = 4				▲		
108	*The Automatic Stop Bar management* dropped at the correct time (e.g. if a clearance is given early then the stop bar dropping is delayed until the mobile approaches it)		**1**		**3**	**1**	
	Median = 4				▲		

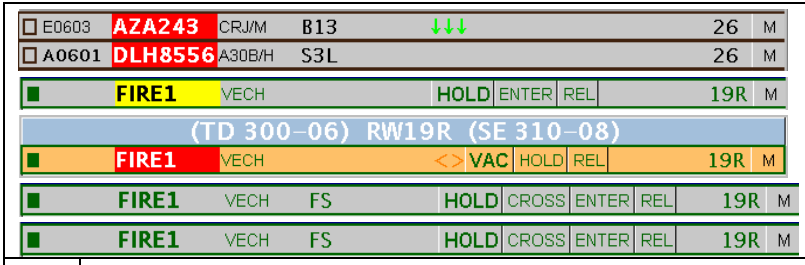
All the controllers considered that the automatic stop bar management was useful for the RWY controller but two of them disagreed with the fact that it was useful on the GND position.
Nevertheless, in the interviews the controllers gave comments showing that improvements are needed:

- On conditional line-up, the controller did not like when the automatic stop-bar switched off automatically: it should be linked to the clearance and the traffic situation *(see note below)*
- The link between the stop bar and the take off clearance should be removed as it could lead to potentially dangerous situations
- The buttons are too small. It is a potential cause of mistakes

Most of the controllers slightly agreed or agreed with the fact that the red stop bar dropped at the correct time. Two controllers said that the time parameter was not always correct.

Note: The controllers were briefed not to use the Conditional Line Up clearance as the corresponding functionality linking the stop bar and the location of the other mobile had not been programmed resulting in the stop bar dropping too early

5.3.7. Flight Strip Function

		1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Slightly agree	5-Agree	6-Strongly agree
							
109	ITWP EFS functionality is useful				**3**	**1**	**1**
	Median = 4				▲		
110	ITWP EFS is easy to use and to interpret			**2**	**2**	**1**	
	Median = 4				▲		

All the controllers agreed that the EFS functionality was useful. However, the controllers put into practise their operational habits, so some of them did not use EFS at all, especially when they were on the RWY position.

The controllers appreciated that ITWP gives the possibility to work either with labels, either with EFS or with both of them.
Consequently, many EFS display configurations were observed, as controllers tried to found out the best way to use it by themselves. The controllers who preferred working with the labels often pushed the pending arrivals and pending departures (plus airborne) bays to the side and so they were not all visible.

The controllers who used paper strips in their usual working environment found that the electronic strips were a good tool: for example, the pending arrival bay in ITWP allows the controller to have information on the incoming traffic without having to wait for the strip to be printed. Input data and access data in the EFS was easy to learn and easy to do.

Finally, the controllers agreed that EFS would probably have to be adapted to each local airport and working method.

Only two controllers slightly disagreed with the fact that the EFS were easy to use. However, during the interviews, all the controllers made comments that showed that improvements on the bays are needed:

- The controller needs to group/ungroup the EFS list to better organise his work;
- The layout of the 27R and 27L e-bays is not well composed and logical;
- The controller needs to make a group with the possibility to change the position of each window;
- The controller needs to join a strip to another group when the strips are grouped (for example when both runways can be used for LND);
- The controller needs to modify the order of the sequence on the holding point, in order to increase the departure flow;
- When a controller aborted take-off, the traffic was instructed to contact and he had problems to move the strip again to the GND controller;
- As the strip automatically moved to another bay when the controller made an input, sometimes he was confused not being aware of where it went;
- For holding point between runways it would be better to have the strips with Hold Short in a separate bay instead of mixing them with the Taxi In strips;
- It was difficult to move a strip inside a bay (rarely successful at first time);
- The name of the bay is not self explaining;
- The order of strips in the RWY bay is not correct (times are not correct);

- The grouping bays take a lot of space on the screen.

Fewer comments were made on the electronic strips themselves:

- Difficult to distinguish the colours for departing and arriving traffic;
- The strip is too narrow (decreases visibility);
- For the planning purpose, it would be useful to have information about standard instrumental departure (SID) routes in the EFS;
- A controller would like to have the possibility to indicate that an aircraft has been delayed (in a remark box);
- Strips should be shorter.

5.4. WORKING METHODS

This section concerns the impact of the ITWP on controller head-up/head-down time when integrated into a realistic operational setting with external tower view of airport.

The controllers, especially on the GND position, did not really use the external view during the first exercises of the simulation. They were concentrated on the HMI (mainly because labels overlapping). Same focus on HMI can also happen in real environment, when working by night in the tower or working under poor visibility conditions (thick fog).
However, as the simulation week progressed and the controllers they became more familiar working with the ITWP and the airport environment they began to use the external view more as they would in the real world. **They all found that the external view was realistic, usable and beneficial.** The controllers involved in the previous simulation sessions considered that the outside view improved the conditions of the simulation. Nevertheless, for one controller, the lack of knowledge of the airport layout was a limitation to the use of the external view.

The RWY and GND controllers looked outside mainly to:
- Check the real speed of the traffic;
- Check the movement of aircraft to be sure that it followed the given instructions;
- Check the movement of the aircraft in order to decide on the relevance of an alert;
- Identify potential hazardous situations (detected before the alert was triggered);
- Evaluate the aircraft separation.

The RWY controllers looked outside mainly to:
- Evaluate the distance of the arrival traffic on final (distance from touch down);
- Make a visual separation;
- Make a decision on how to manage a situation (when a NO TOF CLR alert was triggered, the controller looked outside to decide if he had to abort or if he could lets the aircraft continue);
- Monitor take off because it was not clearly visible on the radar.

Like in their operational environment, controllers concentrated on the radar more when the traffic was growing.

5.5. ITWP INITIAL SYSTEM SAFETY ANALYSIS

Three safety analysis methods were used during the RTS to gain safety insights into ITWP system safety. These were,

(i) Observation of controller interaction with the system during the exercises,
(ii) Safety focused questions put to controllers during interviews, and
(iii) A SWIFT[5] hazard identification session.

The purpose of the safety analysis was to gain insight into potential hazards related to the ITWP as a system. Individual controller performance and system bugs were not taken into account.

5.5.1. Observation of simulation exercises

The controllers work at airports with different operating environments, working methods, and varying traffic levels. They all adapted to the ITWP according to their experience and were competent in performing their functions.

As is normal with an experimental platform there were system bugs. These were identified and noted for correction. However some situations were observed which could be considered as inherent to the ITWP system and as being potentially hazardous if not corrected. These were:

- When a runway controller transferred control of an aircraft crossing the active runway to the ground controller before the aircraft had cleared the physical limits of the runway, the runway crossing indicator was switched off.[6]
- There were occurrences of safety net alerts on certain safe situations[7];
  - aircraft taking off and airborne in conflict with landing aircraft
  - landed aircraft clear of runway in conflict with landing aircraft

5.5.2. Safety focused questions

The following safety focused questions were put to controllers during post-exercise interviews in an attempt to establish if there were potential system safety issues. These questions were supplementary to the formal Human Factors questionnaire.

- did the system confuse you?
- was the system contradictory to the outside view?
- did the system information contradict your perception of the current traffic situation?
- did the system reduce your effectiveness in managing any situation?
- did the alerts ever seem illogical?

The responses to the above questions did not provide any beneficial insight into potential system safety issues.

5.5.3. The SWIFT process

As no formal Hazard and Operability Analysis (HAZOP) or other comprehensive safety analysis methodology had been applied to the ITWP system design prior to now, it was considered most beneficial at this stage of development to attempt to elicit system safety insights in the most efficient way possible, given the resources available; hence the SWIFT methodology. The SWIFT

5 SWIFT - Structured what-if checklist technique – is a trademark of DNV

6 This situation happens due to the programming of the alert based on EFS position rather than aircraft position and can easily be adjusted.

7 These situations happen due to the programming of the alert based on the current A-SMGCS Level 2 Conflict alert rules which we know are normally fine tuned at each airport.

was not exhaustive and was limited in scope due to the time constraints. The one hour session took place at the end of the simulation runs on Wednesday 26th November 2008.

The SWIFT was organised around 'Steps' which were a selected number of standard controller instructions that would be given to flight crew, and which would require a controller input to the system. The categories of 'events' were 'Operating error or human factors' and 'Equipment failure' The what-if questions centred on controller or flight crew/vehicle driver error, and on un-detected equipment failure.

The following is a summary of the significant output from the session (the full swift table can be found in Annex 2).

Equipment failure - undetected failure of system to update input

- the worst credible outcome was considered to be increased workload
- responses regarding likely consequences of an event ranged from 'no consequences', to 'wrong' or 'missing' alerts
- mitigations included the A-SMGCS surveillance function; subsequent alerts - either the correct one or one generated erroneously by the system working in a 'confused' state; and a function (to be developed) to force the next clearance or action

Operating error or human factors – input not made by controller

- the worst credible outcome was considered to be increased workload
- responses regarding likely consequences of an event ranged from 'no consequences', to 'missing alerts' and 'no subsequent alerts'

One specific remark should be noted

- Failure to input a line-up clearance could result in a 'CONFLICT' alert between a departing and a landing aircraft being triggered at a later moment than the foreseen LUP vs LND alert resulting in a possible go around or abort take off or in the worse case collision.
- mitigations included the A-SMGCS surveillance function and alerts (as for equipment failure above)

Operating error or human factors – flight crew or vehicle driver deviation

The worst credible outcome identified for this event was 'collision'. However deviations by flight crew / vehicle drivers may be discounted as not being system related. On the other hand, system safety nets play an important role in mitigating against the effects of deviation

General conclusions and recommendations

- ITWP system errors, whether human or equipment centred are likely to cause increased workload (the effects of increased workload have not been considered in this assessment)

- the system safety nets have been effective in simulation

- The behaviour of the system in the event of missed inputs should be investigated. The system specifications should be capable of ensuring that the system logic can cope with a breakdown of input sequence

- the interaction of safety nets should to be investigated at system level under success and failure cases
- A recurring point raised by controllers has been single screen failure. The requirements for Controller Working Positions should be taken into account for the ITWP, especially Hardware Acceptance Levels (HAL) and Software Acceptance Levels (SWL)

- the system should not generate alerts on safe situations
- the system should **not** allow controllers to cancel an alert generated for another controller position or function
- the system safety nets have been effective in simulation

6. CONCLUSIONS

6.1. EVALUATION ORGANISATION AND CONDUCT

Overall the controllers considered the training to be just sufficient although most agreed that it could have been longer.

The counter-balancing of the 'with and without alert' conditions was found to be effective and helped to mitigate the practice affects that were evident during the simulation exercise. Further after an exercise without alerts, the controllers were better able to point out which alerts would be essential and were more comfortable assessing the utility of the alerts.

A variety of subjective data collection methods were used including questionnaires, observation individual interviews and group debriefings which provided the evaluation team with a rich amount of data / information. This allowed the evaluation team to build a very interesting and relevant amount of information regarding the evaluation objectives.

Some controllers did mention that several difficulties were encountered during the simulation due to pilot error. The pseudo-pilots also pointed out that their workload was very high and it was not made easier by the quality of the transmissions or difficulties making the necessary inputs into the pilot CWP HMI. In addition the pseudo-pilots also felt that simulation schedule was very intense for them.

Recommendations:

- In future evaluations the training duration should be longer so that controllers have more time to become familiar with the ITWP HMI, functionality as well as the airport environment. The training content should include advice to controllers on working method and also how best to set up / layout the ITWP HMI. Special attention should be paid to controllers who have to manage a new airport environment and a new HMI
- Only subjective data was collected during the evaluation. Ideally objective data should be analysed as well. The eDEP platform should be developed to enable objective data to be collected and analysed.
- An extra pilot position should be used to reduce the workload on the GND pilot position and a spare pilot should be used to rotate the pilots roster. The pilot's HMI should also be improved regarding the evaluation requirements
- The audiolan quality should be improved in case of communication analysis and also to enable observers to listen to the pilot / controller communications.
- Several traffic samples should be used to ensure controllers do not become over familiar or bored during the evaluation exercises.

6.2. ITWP IN GENERAL

Overall controllers were very positive about the ITWP and felt the ITWP functionality was very useful. The controllers did not note any strong limitation using ITWP.

Working with only one screen was considered comfortable, in particular on the GND position. Although, controllers generally felt that more room was needed on the RWY position to display the electronic strips. In fact most of the controllers commented that the HMI were generally overcrowded and said the EFS took up a lot of room on the HMI plus there was a lot of secondary information displayed that was not necessary, e.g. alerts that were not considered relevant. This finding is strongly supported by the results obtained from the situation awareness questionnaire.

The controllers main concern about working with only one screen was single screen failure. This was a recurrent theme brought up by controllers and they stated that the requirements for

Controller Working Positions should be taken into account for the ITWP, especially Hardware Acceptance Levels (HAL) and Software Acceptance Levels (SWL).

Inputting data into the system was considered as extra actions to perform compared to real life operations especially for the alert condition. However, for all of the exercises (both with or without alerts), the controllers stated that their workload was acceptable and manageable.

It was generally agreed that ITWP is a generic tool that needs to be tailored to the environment in which it will be implemented, in order to fit to the real tower environment, operations and working methods. This should help to reduce non-relevant information being displayed and unnecessary actions being performed.

Touch screens properly positioned should be well received in a future ITWP environment as long as the input field are made sufficiently large.

Recommendations:

- The ITWP HMI needs to be reviewed and where possible the amount of 'clutter' and non-relevant information reduced to ensure the HMI is less crowded. Enabling controllers to better tailor the ITWP HMI to the airport environment and working methods may help to achieve this (this could also help reduce the number of input actions required). Improvements could also be made to the EFS which was seen to take a lot of room on the HMI (see section 6.7). Further where possible, non-relevant alerts could not be displayed, see section 6.3.
- The requirements for Controller Working Positions should be taken into account for the ITWP, especially Hardware Acceptance Levels (HAL) and Software Acceptance Levels (SWL).
- The use of touch screens should be investigated. However, with touch screen the ITWP HMI must be adapted in that the input field must be enlarged to help prevent erroneous inputs

6.3. ITWP 3 SAFETY TOOLS

Although no benefits in terms of situation awareness with the alerts compared to the no alerts was found from the questionnaires, controllers were generally very positive about the safety support tools. In summary they found the safety support tools to be suitable and useful and reportedly helped controllers to perform their day-to-day tasks. Controllers also reported that for unexpected events such as an aircraft crossing the stop bar, having an alert made them detect the situation earlier (although no objective data is available to support this).

However, controllers generally agreed that not all the alerts were required on both positions if the alert did not concern them. This very much depended on the type of alert and seemed to be particularly true for the RWY position. This finding was strongly supported by the results of the situation awareness questionnaires

Overall controllers considered the auditory signal of the alerts to be useful and suitable, although controllers suggested it could be improved by either reducing the volume and ensuring it only sounds on the position that can rectify the situation.

Mixed responses were received with regards to the acknowledgement button as some controllers felt it wasn't necessary and only added to the number of inputs that were required. However, controllers **agreed unanimously that only the person responsible for resolving the situation should be able to acknowledge the alert** – this is in line with good HF practice and design.

It was also reported that the orange bar around a runway when an aircraft has been cleared to cross should be linked to the aircraft position and not with who is in charge of the aircraft: the bar

should stay orange while the aircraft is crossing the runway, even if it has been transferred to the GND controller. This could have an impact on the CONFLICT alarm

It should be noted that some alerts and alarms were difficult to trigger as controllers were asked to work safely. Thus the RWY INCURSION alert was not triggered during the simulation.

Recommendations:

- Need to investigate the need for an acknowledge button, it may be that the rectifying the situation alone is sufficient and an acknowledge button is not necessary.
- If there is an acknowledgment button it should impact individual screens only, i.e. only the person responsible for resolving the situation should be able to acknowledge the alert
- Auditory alert could be improved: The auditory alert should only be triggered on position that can resolve the situation. Controllers also suggested the intensity of the auditory signal could be decreased; another suggestion was that the auditory signal should be triggered shortly after the alarm is visually displayed to allow controllers to react to visual alarm before auditory signal is triggered.
- The display of yellow alerts and red alarms on non concerned positions should be re-examined (maybe only some of them could be displayed on both positions)
- The NO LND CLR colour should be re-examined. Some controllers commented this should be a yellow information alert instead of red alarm)
- Inconsistent Clearances alarms should take into account the local working methods (reduced separation due to sequences of clearances and operations on twin parallel runways) in order to reduce the number of alarms interpreted as false by the controllers
- The red alarms linked to the controller's input should be re-examined in order to reduce the number of alarms interpreted as false by the controllers
- The orange bar around a runway when an aircraft has been cleared to cross should be linked to the aircraft position and not with who is in charge of the aircraft: the bar should stay orange while the aircraft is crossing the runway, even if it has been transferred to the GND controller.
- The alerts and alarms that could not be triggered during the investigation should be examined in future evaluations.

6.4. ROUTING FUNCTION

The routing function was thought to be very useful and well appreciated by controllers, although it does need some improvement as controllers reported that it was not always easy to use e.g. they felt too many inputs were required to modify a route. Further the HOLD AT and STOP AT functions need to be improved.

Recommendations:

- The route modification functionality should be improved to make the input of route changes easier.
- The STOP AT and HOLD at functions need to be improved and re-evaluated.

6.5. DATA LINK

Controllers were generally positive about the data link identifier although this needs more evaluation as it was not possible to assess it in an operational context in this evaluation.

Recommendations:

- Further evaluation(s) need to be conducted to fully investigate the suitability of the data link identifier.

6.6. AUTOMATIC STOP BAR

The automatic stop bar was generally considered useful especially for the RWY position, although improvements were recommended, for example controllers felt the automatic stop bar should be linked to the clearance and the traffic situation *and* the link between the stop bar and the take off clearance should be removed as it could lead to potentially dangerous situations. Controllers also commented that the input buttons needed to be enlarged to avoid erroneous inputs.

Recommendations:

- The automatic stop bar should be linked to the clearance and the traffic situation *and* the link between the stop bar and the take off clearance should be removed as it could lead to potentially dangerous situations.
- The input buttons on the automatic stop bar need to be made bigger.

6.7. EFS

As mentioned in previous evaluations the EFS could be improved. Controllers commented they took up a lot of room on the ITWP HMI as there were many data fields displayed. They also reportedly that it was difficult to move and organise the strips within the bays as they wanted and that the strips would automatically move from one bay to another which could cause confusion. It was suggested that the EFS should be adapted to the local airport and environment and working method.

Recommendations:

- The size of the EFS could be reduced by reducing the number of data fields on EFS. This could be achieved by displaying only the subsequent action(s) permitted on the EFS. This will help to reduce overcrowding on the ITWP HMI.
- EFS management should be improved so controllers can more easily move and organise the strips within the bays.

6.8. LABEL MANAGEMENT

The controllers reported that the labels were generally easy to use but again as in previous evaluations the anti overlap function needs to be improved and sometimes the label did not follow the target aircraft.

Recommendations:

- The label management needs to be improved to ensure the label follows the target aircraft and also to ensure labels do not overlap.

6.9. OUTSIDE VIEW OF AIRPORT AND WORKING METHOD

The outside view was found to be realistic and improved the realism of the environment compared with the previous evaluation sessions. With practice, controllers were able to use the outside view more than at the beginning of the evaluation. They were able to work as they normally do, scanning the situation and updating their mental picture using the outside view.

Recommendations:

- TowSim could be further developed to enable different configuration of the outside view e.g. to provide the possibility to split the outside view between the RWY and GND positions.
- Future studies need to investigate the impact of ITWP on controller working method and human performance / error compared to current day (i.e. non-ITWP) operations.

ANNEXES

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Annex 1 - Hypotheses

HLO 1.	**Assess whether ITWP helps the controller to manage his/her traffic in an efficient and safe manner when integrated into a realistic operational tower environment with outside view.**		
	LL1.1	**To assess the impact of the ITWP safety support tools on ATCO situation awareness when integrated into a realistic operational setting with external airport view**	
		H1.1.1	*The visual information alert messages enhance controllers awareness of potential hazardous situations,(i.e. help the controllers to identify events that may compromise safety compared to when no alert messages are available)*
		H1.1.2	*The visual red warning alarms with audio signal enhance controllers awareness of potential hazardous situations, (i.e. help the controllers identify events that may compromise safety compared to when no alert message is available)*
HLO 2.	**Assess the utility and usability of ITWP tools and functions, (including information displayed, HMI, control devices etc.)**		
	LL 2.1	**Assess the utility and usability of the ITWP safety support tool visual alert messages with and without audio signal when integrated into an realistic operational environment with external tower view compared to when no alerts are available**	
		H.2.1.1	*The visual information alert messages are useful and suitable*
		H.2.1.2	*The visual red warning alarms with audio signal are useful and suitable*
		H2.1.3	*The audio signal that accompanies the visual red warning alarm messages is useful and suitable*
	LL 2.2	**Assess the utility and usability of improvements made to ITWP safety support tools in a realistic operational setting with external tower view**	
		H2.2.1	*The red circle around the radar position symbol to signify an alert is useful and suitable*
		H2.2.2	*The alert description displayed above the callsign in the radar label is useful and suitable*
		H2.2.3	*The' information alert' status for a runway incursion with a single mobile is useful and suitable*
		H2.2.4	*The red alarm status 'CONFLICT' for "No TOF CLR vs CROSS" is useful and suitable*
		H2.2.5	*The red alarm status for red stop crossed bar is useful and suitable*
		H2.2.6	*The red alert for a mobile stationary in the RPA is useful and suitable*
		H2.2.7	*It is useful and suitable to display triggered Alerts on the RWY and GND position*
		H2.2.8	*The acknowledgement button in the alert window is useful and usable*
		H2.2.9	*The LUP/LUP alert is useful and suitable*
		H2.2.10	*The TOF/TOF is useful and suitable*
		H2.2.11	*The NO LND CLR is useful and suitable*
		H2.2.12	*The NO TOF CLR is useful and suitable*
	LL 2.3	**Assess the utility and usability of improvements to the routing function in a realistic operational setting with external tower view.**	
		H2.3.1	*The routing function to display planned routes on ITWP is useful i.e. helps the controller in his work*
		H2.3.2	*The routing function to display planned routes on ITWP is usable i.e. intuitive and easy to interpret*
		H2.3.3	*The routing function to display cleared routes on ITWP is useful i.e. helps the controller in his work*
		H2.3.4	*The routing function to display cleared routes on ITWP is usable, i.e. intuitive and easy to interpret*
		H2.3.5	*The routing function to update routes on ITWP is useful*
		H2.3.6	*The routing function to update routes is usable i.e. intuitive and easy to use*
	LL 2.4	**Assess the utility and usability of the data link equipped aircraft identifier**	
		H2.4.1	*The data link equipped aircraft identifier on ITWP is useful for the controller i.e. facilitates controller in identifying data link equipped aircraft*

		H2.4.2	*The data link equipped aircraft identifier is sufficient and suitable (radar label and EFS)*
	LL 2.5	**Assess the utility of the automated stop bars in a realistic operational setting with external tower view**	
		H2.5.1	*The automatic stop bars in ITWP are useful i.e. help controllers in their work*
	LL 2.6	**Re-assess the utility and usability of the Electronic Flight Strips, Label Management and Vehicle Management in a realistic operational setting with external tower view. (i.e. functions that did not rate highly in terms of utility and usability in the previous ITWP evaluation 2)**	
		H2.6.1	*ITWP EFS functionality is useful, i.e. support controllers in his day to day tasks*
		H2.6.2	*The automatic opening/closing of EFS bays depending on the state of a flight is useful*
		H2.6.3	*ITWP EFS are usable, i.e. intuitive, easy to use, easy to read and interpret*
		H2.6.4	*ITWP label management is useful, i.e. supports controllers in their day to day task*
		H2.6.5	*ITWP label management is suitable*
		H2.6.6	*ITWP vehicle management is useful*
		H2.6.7	*ITWP vehicle management is usable*
		H2.6.8	*Vehicle clearances are suitable*
		H2.6.9	*ITWP access to data (via EFS, labels, alert messages) is efficient and easy to use*
		H2.6.10	*ITWP input of data in EFS (clearances, modifications of holding point, rwy, parking position) is efficient and easy to perform*
HL03	**Assess the impact of the ITWP on controller's working method**		
	LL03.1	**Assess the impact of ITWP on head-up/head-down time when integrated in a realistic operational setting with external tower view**	
		H3.1.1	*ITWP result in more head down time*
		H3.1.2	*ITWP result in less head up time*

Annex 2 - The SWIFT table

Note: text between [ ] are my notes added subsequently for clarification.

STEP	CATEGORY	WHAT-IF?	CAUSES	CONSEQUENCES	MITIGATIONS
Give taxi clearance	Equipment failure	Undetected failure of system to update input	Software/hardware failure	Wrong alert Missing alert Strip not in correct bay HMI does not reflect route status Worst credible outcome Vis1 – increased workload Vis2 - same	A-SMGCS Function to force next clearance/action
	Operating error or human factors	Input not made by controller	High Workload, prioritisation issues, distraction	'No taxi clearance' alert is triggered HMI does not reflect route status Strip not in correct bay No subsequent alerts Worst credible outcome Vis1 – increased workload Vis2 - same	'No taxi clearance' alert [this alert may be the only mitigation against the '' No subsequent alerts'' consequence; dependance on alerts as a working method may be a HF/safety issue –to be investigated - also interaction of alerts and system confusion following missed input]
		pilot deviates	distraction	Worst credible outcome Collision [this not different from current operations – ITWP/A-SMGCS bring safety enhancement to this type of situation]	''Route deviation alert'' is triggered

STEP	CATEGORY	WHAT-IF?	CAUSES	CONSEQUENCES	MITIGATIONS
Give hold short instruction	Operating error or human factors	Input not made by controller	High Workload, prioritisation issues, Distraction	none	
		Pilot/driver deviates	distraction	Collision [this not different from current operations – ITWP/A-SMGCS bring safety enhancement to this type of situation]	alert
	Equipment failure	Undetected failure of system to update input	Software/hardware failure	none	
Give stop/hold instruction	Operating error or human factors	Input not made by controller		Same as previous	
		Pilot/driver doesn't stop		Collision [this not different from current operations – ITWP/A-SMGCS bring safety enhancement to this type of situation]	
	Equipment failure	Undetected failure of system to update input	Software/hardware failure	Same as previous	
Give lineup clearance	Operating error or human factors	Input not made by controller	Distraction, workload	Aircraft lines up Aircraft does not line up, controller does not notice, gives take-off clearance, conflict with landing aircraft [this depends on why aircraft	Alert because the system believes no line-up clearance Stop bars won't drop [crew may query why] A-SMGCS Controller surveillance ''no landing clearance" alert

STEP	CATEGORY	WHAT-IF?	CAUSES	CONSEQUENCES	MITIGATIONS
				doesn't lineup, if it is because stop bars stay up – system issue – if it is due to crew being late in moving – not a system issue;	
	Equipment failure	Undetected failure of system to update input	Software/hardware failure	No specific comments	
Give takeoff clearance	Operating error or human factors	Input not made by controller	distraction	''no TOF clearance alert'' is triggered safety net preventing inconsistent clearances removed (landing clearance given, controller forgets, gives TOF as system not updated, no alert "landing/take-off conflict"	The 'no TOF clearance alert'' is triggered [the ''no TOF clearance'' alert should be a sufficient mitigation]
	Equipment failure	Undetected failure of system to update input	Software/hardware failure	''no TOF clearance alert'' is triggered see above	
Give landing clearance	Operating error or human factors	Input not made by controller	distraction	''No landing clearance'' alert triggered [the consequence here could be ''none'']	''No landing alert'' triggered
	Equipment failure	Undetected failure of system to update input	Software/hardware failure	On landing, strip will update [the consequence here could be ''none'']	On landing, strip will update
Change taxi route	Operating error or human factors	Input not made by controller	distraction	Route deviation alert [the consequence here could be ''none'']	Route deviation alert
	Equipment failure	Undetected failure of system to update input	Software/hardware failure	Route deviation alert [the consequence here could be ''none'']	Route deviation alert

Annex 3 - Cross Reference Matrix Requirements x Objectives

Note: the requirements referenced in this document are link to the requirements given in the D1 ITWP Functional requirements V1.0 (12th Dec. 2008). The references in grey are the former requirements references.

	NOAL - no alerts AL - with alerts and audio signal for alarm			Requirements	
				Functional	**HMI**
HLO 1.	**Assess whether ITWP helps the controller to manage his/her traffic in an efficient and safe manner.**				
	LL1.1	**To assess the impact of the ITWP safety support tools on ATCO situation awareness**			
		H1.1.1	*The visual information alert messages enhance controllers awareness of potential hazardous situations,(i.e. help the controllers to identify events that may compromise safety compared to when no alert messages are available)*	*F.SN.PROC1 (F.SN.CNF.1) Display non conformance to ATC instructions (route deviation for a/c or assumed vehicle, mobile (a/c or assumed vehicle taxi without clearance - no taxi clearance, an a/c stationary)*	
		H1.1.2	*The visual red warning alarms with audio signal enhance controllers awareness of potential hazardous situations, (i.e. help the controllers identify events that may compromise safety compared to when no alert message is available)*	*F.SN.GEN.1 Display of alert* *F.SN.GEN.2 Visual display of alerts* *F.SN.GEN.3 Use of audio signal* *F.SN.GEN.4 Alert displayed on RWY and GND position*	*H.SN.GEN.1 Clear indication of the cause for the alert* *H.SN.GEN.2 Visual display (label, EFS, A-SMGCS display, around the track symbol)* *H.SN.GEN.3 Support for alert identification* *H.SN.GEN.4 Same coding and display on RWY and GND position*
HLO 2.	**Assess the utility and usability of ITWP tools and functions, (including information displayed, HMI, control devices etc.)**				
	LL 2.1	**Assess the utility and usability of the ITWP safety support tool visual alert messages with an audio signal when integrated into an realistic operational environment with external tower view compared to when no alerts are available**			
		H.2.1.2	*The visual information alert messages are appropriate (yellow)*		*H.SN.GEN.1Unambiguous cause for the alert* *H.SN.GEN.2 Visual display in label EFS, A-SMGCS display, around the track symbol*

	NOAL - no alerts AL - with alerts and audio signal for alarm			Requirements	
				Functional	**HMI**
		H2.1.2	*The visual red warning alarms with audio signal are useful and appropriate*	*F.SN.GEN.1 Display of alert* *F.SN.GEN.2 Visual display of alerts* *F.SN.GEN.4 Alert displayed on RWY and GND position*	*H.SN.GEN.1 Unambiguous cause for the alert* *H.SN.GEN.2 Visual display in label EFS, A-SMGCS display, around the track symbol* *H.SN.GEN.3 Audio signal to support an alarm identification* *H.SN.GEN.4 Same coding of alerts on RWY and GND position*
		H2.1.3	*The audio signal that accompanies the visual red warning alarm messages is useful and appropriate*	*F.SN.GEN.3 Use of audio signal* *F.SN.GEN.4 Alert displayed on RWY and GND position*	*H.SN.GEN.1 Display of alerts* *H.SN.GEN.3 Audio signal with alarms*
	LL 2.2	**Assess the utility and usability of improvements made to ITWP safety support tools in a realistic operational setting with external tower view**			
		H2.2.1	*The red circle around the radar position symbol to signify an alert is useful and appropriate*	*F.SN.GEN.2 Visual display of alerts*	*H.SN.GEN.2 Visual display in the label, in the EFS, A-SMGCS display,* ***around the track symbol***
		H2.2.2	*The alert description displayed above the callsign in the radar label is useful and appropriate*	*F.SN.GEN.2 Visual display of alerts*	*H.SN.GEN.2 Visual display in* ***label,*** *EFS, A-SMGCS display, around the track symbol*
		H2.2.3	*The' information alert' status for a runway incursion with a single mobile is useful and appropriate*	*F.SN.AREA.1 (F.SN.RCA.1) Display RWY conflict (cause)* *F.SN.AREA.2 (F.SN.RCA.2) Display RWY conflict (level of severenity)* *F.SN.AREA.4 (F.SN.RCA.3) Duration of display*	*H.SN.AREA.1 (H.SN.RCA.1) Unambiguous alert presentation* *H.SN.AREA.2 (H.SN.RCA.2) Adequate time*
		H2.2.4	***The red alarm status 'CONFLICT' for "No TOF CLR vs CROSS" is useful and appropriate***	*F.SN.CLRS.1 (F.SN.CLR.1) Display inconsistent clearances* *F.SN.GEN.7 End alert display*	*H.SN.CLRS.1 (H.SN.CLR.1) Display of conflicting ATC clearances* *H.SN.CLRS.2 (H.SN.CLR.2) Level of severity for alert (ALARM)* *H.SN.CLRS.3 (H.SN.CLR.3) End of alert for inconsistent clearances* *H.SN.GEN.7 End of alert*
		H2.2.5	***The red alarm status for red stop crossed bar is useful and appropriate***	*F.SN.PROC.6 (F.SN.CNF.6) Display red stop bar crossed*	*H.SN.PROC.14 (H.SN.CNF.14) Clear identification* *H.SN.PROC.15 (H.SN.CNF.15) Level of alert (ALARM)*

	NOAL - no alerts AL - with alerts and audio signal for alarm			Requirements	
				Functional	HMI
		H2.2.6	***The red alert for a mobile stationary in the RPA is useful and appropriate***	*F.SN.PROC.3 (F.SN.CNF.3) Display stationary arrival aircraft in the RWY protection area* *F.SN.AREA.3 (F.SN.RCA.3) Display RWY conflict (step 1 alert) | Display RWY conflict (step 2 alert)* *all F.SN.GEN.YY*	*H.SN.GEN.1 Clear display of cause for alert* *H.SN.PROC.7 (H.SN.CNF.7) Display alert* *H.SN.PROC.8 (H.SN.CNF.8) Level of severity for alert (ALARM)* *H.SN.PROC.9 (H.SN.CNF.9) Level of severity for alert (INFORMATION)*
		H2.2.7	*It is useful and appropriate to display triggered Alerts on the RWY and GND position (for each alert in the evaluation ask if it useful to be displayed on two positions)*	*F.SN.GEN.4 Display of alert on RWY and GND position*	*H.SN.GEN.4 Alert coding on both position the same*
		H2.2.8	*The acknowledgement button in the alert window is useful and usable*	*F.SN.GEN.5 Acknowledge button*	*H.SN.GEN.5 Means to acknowledge the alert* *H.SN.GEN.6 Who should acknowledge the alert*
		H2.2.9	*The LUP/LUP alert is useful and appropriate*	*F.SN.CLRS.1 (F.SN.CLR.1) Display inconsistent clearances* *all F.SN.GEN.YY*	*H.SN.CLRS.1 (H.SN.CLR.1) Display of conflicting ATC clearances* *H.SN.CLRS.2 (H.SN.CLR.2) Level of severity for alert (ALARM)* *H.SN.CLRS.3 (H.SN.CLR.3) End of alert for inconsistent clearances* *H.SN.GEN.7 End of alert*
		H2.2.10	*The TOF/TOF is useful and appropriate*	*F.SN.CLRS.1 (F.SN.CLR.1) Display inconsistent clearances* *all F.SN.GEN.YY*	*H.SN.CLRS.1 (H.SN.CLR.1) Display of conflicting ATC clearances* *H.SN.CLRS.2 (H.SN.CLR.2) Level of severity for alert (ALARM)* *H.SN.CLRS.3 (H.SN.CLR.3) End of alert for inconsistent clearances* *H.SN.GEN.7 End of alert*
		H2.2.11	*The NO LND CLR is useful and appropriate*	*F.SN.PROC.5 (F.SN.CNF.5) Display a/c "clear to land" omission* *all F.SN.GEN.YY*	*H.SN.PROC.12 (H.SN.CNF.12) Clear and visible display of the alert* *H.SN.PROC.13 (H.SN.CNF.13) Level of severity (ALARM)* *all given under H.SN.GEN.YY*

	NOAL - no alerts AL - with alerts and audio signal for alarm			Requirements	
				Functional	HMI
		H2.2.12	*The NO TOF CLR is useful and appropriate*	*F.SN.PROC.7 (F.SN.CNF.7) No take off instruction*	*H.SN.PROC.16 (H.SN.CNF.16) Clear indication* *H.SN.PROC.17 (H.SN.CNF.17) Level of severity (INFORMATION)* *H.SN.PROC.18 (H.SN.CNF.18) Level of severity (ALARM)* *all given under H.SN.GEN.YY*
	LL 2.3	**Assess the utility and usability of improvements to the routing function in a realistic operational setting with external tower view.**			
		H2.3.1	*The routing function to display planned routes on ITWP is useful i.e. helps the controller in his work*	*F.ROUTE.DIS.3 Display initial planned route*	
		H2.3.2	*The routing function to display planned routes on ITWP is usable i.e. intuitive and easy to interpret*		*H.ROUTE.DIS.1 Display of planned route*
		H2.3.3	*The routing function to display cleared routes on ITWP is useful i.e. helps the controller in his work*	*F.ROUTE.DIS.2 Display cleared / not cleared route* *F.ROUTE.CLR.1 Clear assigned route*	
		H2.3.4	*The routing function to display cleared routes on ITWP is usable, i.e. intuitive and easy to interpret*		*H.ROUTE.DIS.2 Display of cleared route* *H.ROUTE.CLR.1 Validate cleared route*
		H2.3.5	***The routing function to update routes on ITWP is useful***	*F.ROUTE.CHG.1 Modify initial route* *F.ROUTE.CHG.2 Cancel / Change initial route* *F.ROUTE.CHG.3 Input new route* *F.ROUTE.CHG.4 Propose new route*	
		H2.3.6	*The routing function to update routes is usable i.e. intuitive and easy to use*		*H.ROUTE.CHG.1 Change / Input route* *H.ROUTE.CLR.1 Clear assigned route*
	LL 2.4	**Assess the utility and usability of the data link equipped aircraft identifier**			
		H2.4.1	*The data link equipped aircraft identifier on ITWP is useful for the controller i.e. facilitates controller in identifying data link equipped aircraft*	*F.DL.IDF.1 Aircraft equipped for data-link com*	
		H2.4.2	*The data link equipped aircraft identifier is sufficient and suitable (radar label and EFS)*		*H.DL.IDF.1 - Display of aircraft equipped for data link com*
	LL 2.5	**Assess the utility of the automated stop bars in a realistic operational setting with external tower view**			

	NOAL - no alerts AL - with alerts and audio signal for alarm			Requirements	
				Functional	HMI
		H2.5.1	*The automatic stop bars in ITWP are useful i.e. help controllers in their work*	*F.SN.PTD.1 Display stop bars status* *F.SN.PTD.5 Automatically switch protection devices*	*H.SN.PTD.2 Visible status of stop bars* *H.SN.PTD.5 Change of the stop bar status*
	LL 2.6	**Re-assess the utility and usability of the Electronic Flight Strips, Label Management and Vehicle Management in a realistic operational setting with external tower view. (i.e. functions that did not rate highly in terms of utility and usability in the previous ITWP evaluation 2)**			
		H2.6.1	*ITWP EFS functionality is useful, i.e. support controllers in his day to day tasks*	*all FS linked to input instructions (F.BL.ORD.2, .4, .6, .8, .9, .10, .11, .12, .15, .16, .17, F.SN.RWY.1,.2), to display a/c type, parking position , runway, time (estimated, actual, target), transfer etc. (e.g. F.BL.TRAF.2 - traffic display; F.BL.FPL.4; F.FD.TRSF.1; .2; .3), to update information (F.BL.UPD.1, .2)*	
		H2.6.2	*The automatic opening/closing of EFS bays depending on the state of a flight is useful*	*F.BL.TRAF.2 Display traffic* *F.FD.RUL.1 Display of pending traffic RWY* *F.FD.RUL.2 Display pending traffic GND - arrival traffic* *F.FD.RUL.3 Display pending traffic GND - departures*	
		H2.6.3	*ITWP EFS are usable, i.e. intuitive, easy to use, easy to read and interpret*		*H.BL.ORD.2, .4, .6, .8, .9, .10, .11, .12, .15, .16, .17, Easy to input instructions* *H.SN.RWY.1; .2 Input cross and enter runway* *H.BL.TRAF.1 Display of traffic* *H.BL.UPD5 Update the system traffic data* *H.FD.TRSF.1,.2;.3; .4; .5 Transfer of traffic*
		H2.6.4	*ITWP label management is useful, i.e. supports controllers in their day to day task*	*all FS linked to input instructions (F.BL.ORD.2, .4, .6, .8, .9, .10, .11, .12, .15, .16, .17, F.SN.RWY.1,.2, F.VEH.ORD.1,2), to display a/c type, parking position, runway, time (estimated, actual, target), transfer etc. (e.g. F.BL.TRAF.2; .3; F.BL.FPL.4; F.FD.TRSF.1; .2; .3)*	

	NOAL - no alerts AL - with alerts and audio signal for alarm			Requirements	
				Functional	HMI
		H2.6.5	*ITWP label management is appropriate*		*H.BL.LBL.1 Configure radar label* *H.BL.LBL.3 Colour of the labels depending on the traffic* *H.BL.POS.1, 4, 5, 6, 7, 8 Managing the position of the radar labels* *H.BL.UPD.5 Update traffic data* *H.FD.TRSF.1; .2; .3; .4; .5 (automatic deconflict is not implemented);* *H.SN.RWY.1; .2 Input orders to cross and enter runway* *H.BL.ORD..2, .4, .6, .8, .9, .10, .11, .12, .15, .16, .17,* *H.SN.RWY.1,.2 Cross and enter runway* *H.VEH.ORD.1,2 Tow and release vehicle*
		H2.6.6	*ITWP vehicle management is useful*	*F.BL.TRAF.2 Display traffic* *F.BL.TRAF.3 Traffic entering his area of responsibility* *F.BL.ORD.4; 9; 17 Orders possible to give to a mobile* *F.VEH.DIS.1, 2 Hide /display vehicles* *F.VEH.ORD.2; .3 Orders for vehicle / towed a/c (others than BL.ORD)* *F.SN.RWY.1; 2 Cross / enter runway* *F.FD.TRSF.1; .4 Transfer of mobile* *F.SN.AREA. (F.SN.RCA.) 1; .2; .3; .4; .5; .6; .7 Display of runway conflict* *F.SN.PROC. (F.SN.CNF.) 1; .4; Display of alert for non conformance to ATCO instructions* *F.SN.CLRS.1 (F.SN.CLR.1) Inconsistent clearances cross and enter vs. take-off, landing*	

	NOAL - no alerts AL - with alerts and audio signal for alarm			Requirements	
				Functional	HMI
		H2.6.7	*ITWP vehicle management is usable*		*H.BL.TRAF.1; .3 Display of traffic* *H.BL.ORD.4, .5, .6, 9,.15, .17 Giving instructions* *H.VEH.DIS.1; .2 Display /Hide vehicles* *H.VEH.ORD.1; .2 Input Tow and Release instruction* *H.SN.RWY.1; .2 Instruction to cross and enter runway* *H.FD.TRSF.4 Transfer of vehicle* *H.SN.AREA. (H.SN.RCA.) 1; .2; .3; .4 Display of runway conflict* *H.SN.PROC. (H.SN.CNF.) 1; .4; Display of alert for non conformance to ATCO instructions* *H.SN.CLRS. (H.SN.CLR.) 1; 2 Display of alert for inconsistent clearances*
		H2.6.8	*Vehicle clearances are appropriate*	*F.BL.ORD.4; 6; 9; 17 for a vehicle* *F.VEH.ORD.1; 2 Instructions tow and realise* *F.SN.RWY. 1; 2 Instructions to cross and enter runway*	*H.BL.ORD.4; 6; 9; 17 linked to instructions to vehicle / towed a/c* *H.SN.RWY.1; 2 Cross and enter runway instructions* *H.VEH.ORD.1; 2 Input Tow and Release*
		H2.6.9	*ITWP access to data (via EFS, labels, alert messages) is efficient and easy to use*	*all F. related to EFS, Labels and alert messages (to many to list them all) refere to D1 ITWP Functional requirements V1.0*	*all H. related to EFS, Labels and alert messages (to many to list them all) refere to D1 ITWP Functional requirements V1.0*
		H2.6.10	*ITWP input of data in EFS (clearances, modifications of holding point, rwy, parking position) is efficient and easy to perform*	*all FS linked to input instructions (F.BL.ORD 3-19); F.BL.UPD.1;.2; F.VEH.ORD.YY; F.SN.RWY.YY*	*H.BL.ORD.YY;* *H.VEH.ORD.YY;* *H.RWY.ORD.YY*
HL03	**Assess the impact of the ITWP on controller's working method**				
	LL03.1	**Assess the impact of ITWP on head-up/head-down time when integrated in a realistic operational setting with external tower view**			
		H3.1.1	*ITWP result in more head down time*	*No req*	*No req*
		H3.1.2	*ITWP result in less head up time*	*No req*	*No req*

Annex 4 - List of events

Information alert:

1.	**ROUTE DEV**	An aircraft deviates from cleared route on a taxiway
2.	**NO TAXI CLR**	Aircraft taxi without clearance from ATC
3.	**STATIONARY**	Aircraft stationary
4.	**NO TOF CLR**	Aircraft cleared to line-up and it takes-off without TOF clearance, no other mobile involved
5.	**STATIONARY RPA**	Aircraft stationary in RPA with no other mobile involved

Alarm:

1.	**TOF/TOF**	Two aircraft with TOF clearance
2.	**LUP/LUP**	Two aircraft are cleared to line-up **from the same or adjacent holding points on the same runway**
3.	**RWY INCURSION**	Aircraft on the Runway protection area
4.	**RED STOP BAR CROSSED**	An aircraft does not stop at the holding point i.e. red stop bar
5.	**STATIONARY RPA**	Aircraft that has landed and is within RPA for 30seconds or more without moving
6.	**NO LND CLR**	Aircraft close to runway without a Landing clearance
7.	**CONFLICT (CROSS/TOF)**	Two mobiles involved, CROSS vs. NO TOF CLR
8.	**NO TOF CLR**	Aircraft cleared to line-up and it takes-off without TOF clearance

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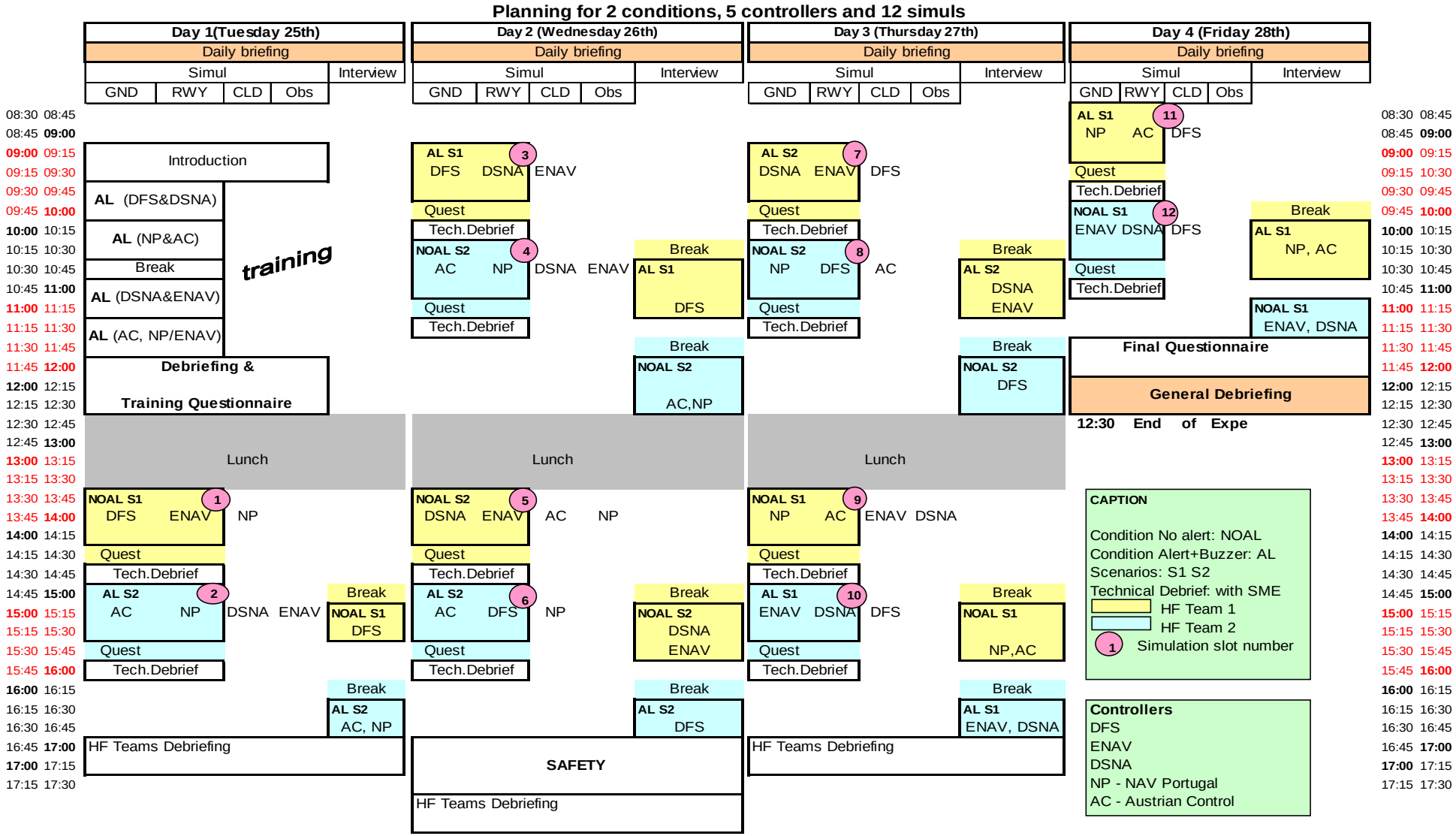
Annex 5 – ITWP session 3 planning



Annex 6 – Situation Awareness statistical analyses

1. Mean and Median ratings for ALERTS and NO ALERT conditions (Ground and Runway Controllers ratings), for each question non the post exercise questionnaire.

		Q1	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*
Alert	**Mean**	4,8	4,4	4,1	4,3	3,7	3,3	4,2	4,6	4,7	4,5	4,5
	Median	5	4,5	4	4,5	3,5	3	4	4,5	5	4,5	5
No Alert	**Mean**	4,6	4,2	4,1	5,3	4	3,6	4,1	4,9	4,8	4,6	4,2
	Median	4,5	4,5	4	5	4	3	4,5	4,5	4,5	4,5	4,5

Annex 7 – Wilcoxon test

This test determines whether there were significant differences in the ratings obtained between the ALERT and NO ALERT conditions for each question.

		Wilcoxon Matched Pairs Signed Rand Test											
		Parameters	**Qu1**	**Qu2**	**Qu3**	**Qu4**	**Qu5**	**Qu6**	**Qu7**	**Qu8**	**Qu9**	**Qu10**	**Qu11**
		N	6	7	7	8	3	4	7	7	7	5	8
		T	8,5	12	13,5	3	3	3	12	9	12,5	6	16
		p *	0,67	0,74	0,93	0,04	1	0,47	0,74	0,4	0,8	0,69	0,78
		* if less than <=0.05, then statistically significant											
	Conclusion												
	Only for question 4 does there seem to be a statistically significant difference 'at the 5% level' using Wilcoxon's Matched Pairs Signed Rank Test.												

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