RWSL final OSED

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Abstract

This document provides an Operational Service and Environment Definition (OSED) for the SESAR Solution #1, Runway Status Lights (RWSL) application, following the V3 activities performed at Paris Charles-de-Gaulle airport.

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This deliverable consists of SJU foreground.

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Executive summary

This Operational Service and Environment Definition (OSED) details the operational concept for the SESAR Solution #1 “Runway Status Lights” (RWSL), which is part of the Operational Focus Area (OFA) 01.02.01 (Airport Safety Nets),

It defines the SESAR Step 1 - Operational Service, environment, use cases and requirements for RWSL.

The Runway Status Lights system addresses the Operational Improvement AO-0209 "Enhanced Runway Usage Awareness to reduce hazardous situations on the RWY".

This OSED was developed to remain as close as possible the FAA works on RWSL and to the U.S. definition for homogeneity and consistency purposes (e.g. target U.S. / Europe common operational procedures for flight crews).

Runway Status Lights (RWSL) system is a fully automatic system based on aerodrome core surveillance that can be used on airports to increase safety by preventing runway incursions. The information on runway usage is directly made available to the vehicle drivers and flight crews through new airfield lights, which can be composed of:

- Runway Entrance Lights (REL): sets of red lights illuminating runway entrances when it is not safe to enter or cross the runway;
- Take-off Hold Lights (THL): sets of red lights illuminating along the axis of a runway in front of a departing aircraft when it is unsafe to take-off from that runway due to an obstacle (vehicle or aircraft) already occupying or entering the runway ahead;
- Runway Intersection Lights (RIL): sets of red lights illuminating along the axis of a runway near the intersection with another runway (crossing runways only) when it is not safe to go through the intersection.

As the validation environment didn’t permit addressing and assessing RIL, the choice was made to not include them in this final version of the OSED.

Even if specific RIL requirements have not been validated during the V3 validations, the corresponding part has been moved to this document’s appendices.

The FAROS application (Final Approach Runway Occupancy Signal), which is intended for landing aircraft, is not in the scope of this OSED (consistent with the PIR).

Some new operating methods have been defined for vehicle drivers and flight crews. The system is meant to be compatible with airport operations and independent of ATC clearances delivery, even if tower runway controllers will have access to the status of the REL and THL on the A-CWP, with no change in their operating methods, except in case of flight crew request on the radio frequency or failure of the system.

This OSED is consolidated into a final version after the Step 1 V3 validation trials at CDG, on the basis of the 06.07.01-D07 [7].

1 Introduction

1.1 Purpose of the document

The Operational Service and Environment Definition (OSED) describes the operational concept defined in the Detailed Operational Description (DOD) [13] in the scope of Operational Focus Area (OFA) 01.02.01.

It defines the operational services, their environment, use cases and requirements.

The OSED is used as the basis for assessing and establishing operational, safety, performance and interoperability requirements for the related systems further detailed in the Safety and Performance Requirements (SPR) document. The OSED identifies the operational services supported by several entities within the ATM community and includes the operational expectations of the related systems.

This OSED is a top-down refinement of the Step 1 DOD [13] produced by the federating OPS P06.02 project. Its contents should be consolidated back into the higher level SESAR concepts using a "bottom up" approach.

The figure below presents the location of the OSED within the hierarchy of SESAR concept documents, together with the SESAR Work Package or Project responsible for their maintenance.

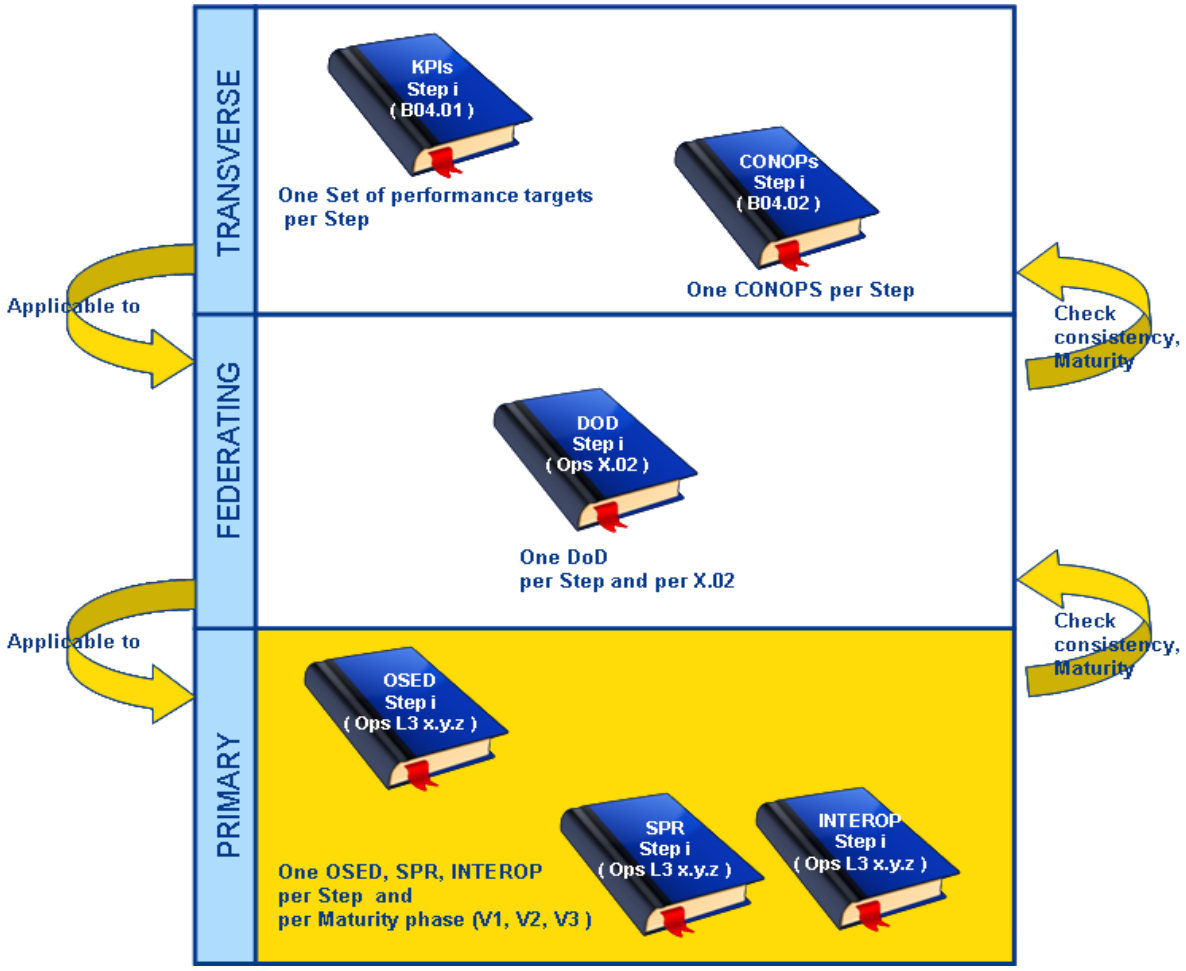

Figure 1: OSED document with regards to other SESAR deliverables

In Figure 1, the steps are driven by the OI steps addressed by the project in the Integrated Roadmap document [12].

1.2 Scope

This OSED details the operational concept for the SESAR Solution #1 “Runway Status Lights”, which is part of the Operational Focus Area (OFA) 01.02.01 (Airport Safety Nets).

The concept developed in this document shows traceability to the higher level DOD [13], written by P06.02, for the Concept Storyboard Step 1.

1.3 Intended readership

The main audience for this OSED is:

- Partners contributing to other tasks within project 06.07.01 using the OSED as input, e.g. SPR for RWSL and OCD
- The project 06.09.02 that develops the “A-CWP”, future Controller Working Position Requirements
- The technical project 12.03.01 developing multi-sensor data fusion, which provides surveillance data for RWSL
- The technical project 12.03.02 developing safety nets prototypes
- The transverse project 06.02 (Coordination and consolidation of operational concept definition and validation) to ensure a bottom-up approach is consistent with their vision of airport movement.

1.4 Structure of the document

This document is structured in several chapters, based on the OSED template 03.00.00 [3].

Chapter 1 introduces the document and defines the scope and the background.

Chapter 2 presents the link with what has been defined in higher level DOD document from P06.02 and identifies the relevant OIs, scenarios and use cases.

In chapter 3, a description of current and new operating methods related to the implementation of the RWSL system is provided to highlight the resulting changes and improvements.

The next chapter, chapter 4, presents in which context the RWSL system is working and provides details about the different lighting functions of the system, i.e. in what they consist of and when / in which cases they are triggered. Roles and responsibilities of the relevant actors as they are confronted to the system are also described.

Chapter 5 then details each possible operational situation in which a function of the RWSL system can be triggered. It is structured to match with the scenarios defined in the Airport DOD [13] by P06.02.

Chapter 6 gathers all the requirements that can be deduced from the previous descriptions. They are organized in 3 categories that are operational requirements, functional requirements and training requirements.

Finally, chapter 7 lists all the relevant documents used as inputs to establish this OSED.

1.5 Background

Runway incursions are one of the most serious safety issues for ATM. In 2005, there were more than 600 runway incursions reported, this means that there were two incursions every day in the ECAC region.

A runway incursion is defined by ICAO as: "*any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft*". Runway incursions are the major concern for the safety on the airport surface. This issue concerns all mobiles on the airport, i.e. both aircraft and vehicles.

In July 2001 a joint runway safety initiative was launched by GASR (Group of Aerodrome Safety Regulators), JAA, ICAO and EUROCONTROL to investigate specific runway safety issues and to identify preventative actions. The main result was the development of the "European Action Plan for the Prevention of Runway Incursions" (EAPPRI) that was first distributed in April 2003 and approved by the EUROCONTROL Provisional Council in April 2004. The second version (EAPPRI V2.0) [15] has been published in May 2011 (mentioning RWSL without detailing them further), while the development for the third edition has started in summer 2016.

Although a number of actions have been taken in the past to reduce their number (e.g. better airfield signage), and some safety nets have been introduced for tower controllers (A-SMGCS Level II), runway incursions are still happening quite frequently.

Further improvements are therefore needed to broaden the scope of applicability of safety nets preventing runway incursions to all the actors (ATC, vehicle drivers and flight crews). One of these improvements is to reduce the number and the severity of runway incursions (and thus the number of runway accidents) by warning directly flight crews and vehicle drivers about the potential danger of their situation.

Indeed, it is worth noticing that vehicle drivers and flight crew represent a significant origin for runway incursions. The EUROCONTROL portal provides (based on limited sample) the percentage of people in different professional groups having been involved in a runway incursion.

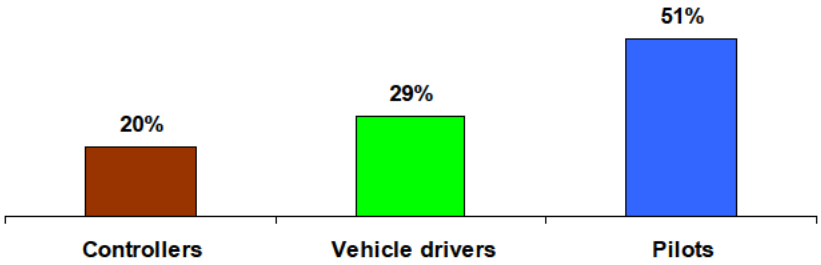

Figure 2: Actors involved in a sample of runway incursions

RWSL have been trialled operationally at a few US airports since 2004 and are being operationally deployed at 17 airports.

Given the concluding results observed in USA, and Roissy-Charles De Gaulle (CDG) airport offering an opportunity to perform V3 on-site validations, this subject has been included in the scope of the project 06.07.01 for Step 1. The objective that guided the OSED development was to conform as much as possible to the systems already installed in the USA for harmonization purposes for pilots.

One key difference in Europe, and in particular at CDG, is the combination of RWSL field lighting with stop bars. As yet there is no operational experience of RWSL and stop bars being used together, although MITRE have evaluated the combination and produced a report entitled "Results from a Human-In-The-Loop Simulation exploring the Concurrent Use of Runway Entrance Lights and Stop Bars" [17].

1.6 Glossary of terms

Term	Definition
THL safety region	The "THL safety region" area is associated to a THL. It is defined from the next intersection (included) after the runway entrance point to the end of the runway. It is activated when there is a mobile inside this area. See section 4.1.2.2 for further details.
Closed runway	The runway is not available for aircraft operations.

Term	Definition
Occupied runway	At some airports, an intermediate runway status between “open” and “closed” may be available for controllers: the “occupied” runway is temporarily unavailable for aircraft operations (e.g. a runway inspection is in progress) but can be reopened at any time with a very short notice.
Track report	“Track report” is used to define all surveillance data sent by the airport core surveillance system to symbolize an obstacle or a mobile located in the coverage of this surveillance system.

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1.7 Acronyms and Terminology

Term	Definition
A-CWP	Advanced Controller Working Position
ADD	Architecture Definition Document
AGL	Aerodrome Ground Lighting
AIP	Aeronautical Information Publication
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air traffic control
ATIS	Automated Terminal Information Service
ATM	Air Traffic Management
CAT	Category (of an approach or a holding point)
CDG	Paris Charles de Gaulle airport
CONOPS	Concept of Operations
CWP	Controller Working Position
DOD	Detailed Operational Description
DSNA	Direction des Services de la Navigation Aérienne
E-ATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
ECTL	EUROCONTROL (European Organisation for the Safety of Air Navigation)
FAA	Federal Aviation Administration
FAROS	Final Approach Runway Occupancy Signal
FLS	Field Lighting System

Term	Definition
GPS	Global Positioning System
HMI	Human Machine Interface
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
INTEROP	Interoperability Requirements
IRS	Interface Requirements Specification
LED	Light Emitting Diode
LVC	Low Visibility Conditions
LVP	Low Visibility Procedures
MET	Meteorological
MITRE	Massachusetts Institute for Technology, Research and Engineering
MLAT	Multilateration
NOTAM	Notice To Airmen
OCD	Operational Concept Description
OFA	Operational Focus Areas
OSED	Operational Service and Environment Definition
REL	Runway Entrance Lights
RET	Rapid Exit Taxiway
RFFS	Rescue and Fire Fighting Services
RI	Runway Incursion
RIL	Runway Intersection Lights
RIMS	Runway Incursion Monitoring System (Replaced by RMCA)
RMCA	Runway Monitoring and Conflict Alert
RWSL	Runway Status Lights
RWY	Runway
SESAR	Single European Sky ATM Research Programme

Term	Definition
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SMR	Surface Movement Radar
SPR	Safety and Performance Requirements
THL	Take-off Hold Lights
THR	Threshold
TWR	Tower
TWY	Taxiway
US(A)	United States (of America)

2 Summary of Operational Concept from DOD

2.1 Mapping tables

This section contains the link with the relevant DOD [13] (06.02-D122 Step 1 Airport DOD 2014 Update, dated 31/03/2015), scenarios and use cases, environment, processes and services relevant for this particular OSED.

Relevant OI Steps ref. (coming from the Integrated Roadmap)	Operational Focus Area name / identifier	Story Board Step	Master or Contributing (M or C)	Contribution to the OIs short description
AO-0209 – Enhanced Runway Usage Awareness to reduce hazardous situations on the RWY	Airport Safety Nets	Step 1	M	The runway usage awareness is enhanced thanks to implementation of the Runway Status Light (RWSL) system.

Table 1: List of relevant OIs within the OFA

Table 2 identifies the link with the applicable scenarios and use cases of the DOD.

Scenario identification	Use Case Identification	Reference to DOD section where it is described
Landing	UC 6 15	4.2.5.2.2
Taxi-in	UC 6 21	4.2.5.2.3
Taxi Out	UC 6 79	4.2.7.2.1.1
Take Off	UC 6 86	4.2.7.2.1.2

Table 2: List of relevant DOD Scenarios and Use Cases

As there is no explicit reference to RWSL applicable environments in the DOD, the table identifying the link with the applicable environments of the DOD has been removed.

Table 3 identifies the link with the applicable Operational Processes defined in the DOD. The service identification was not started at the moment of writing the DOD.

DOD Process / Service Title	Process/ Service identification	Process/ Service short description	Reference to DOD section where it is described
Manage Safety at Airport	Perform RWSL operations	Provide RWSL lights, Manage RWSL issues, Disable RWSL, Manage clearance conflicting with RWSL lights	5.2.5

Table 3: List of the relevant DOD Processes and Services

Table 4 summarizes the requirements including performance (KPA related) requirements relevant of the OSED. This table supports defining the performance objectives in the scope of OFA 01.02.01.

The DOD performance requirements are structured to respond to Key Performance Indicators (KPI) targets / decomposed PIs, so this table will support traceability to the performance framework.

DOD Requirement Identification	DOD requirement title	Reference to DOD section where it is described
REQ-06.02-DOD-6200.0014	Advanced Information Management and System Integration in the ATC Tower	6.2
REQ-06.02-DOD-6200.0067	Enhanced Runway Usage Awareness	6.2

Table 4: List of the relevant DOD Requirements

2.2 Operational Concept Description

The runway usage awareness is enhanced thanks to implementation of the Runway Status Lights (RWSL) system (which covers both new procedures and new airfield lights). RWSL is a surveillance driven automatic system that visually indicates to flight crews and vehicle drivers when it is unsafe to enter, use or cross a runway, through new airfield lights which can be composed of Runway Entrance Lights (REL) and Take-off Hold Lights (THL). [AO-0209]

2.3 Processes and Services (P&S)

The operational process ("Perform RWSL Operations") can be found on the EATMA portal (https://www.atmmasterplan.eu/architecture/).

2.3.1 Perform RWSL Operations

The following figure presents the process "Perform RWSL Operations", based on dataset 16, EATMA version 7.0 - 13 July 2016:

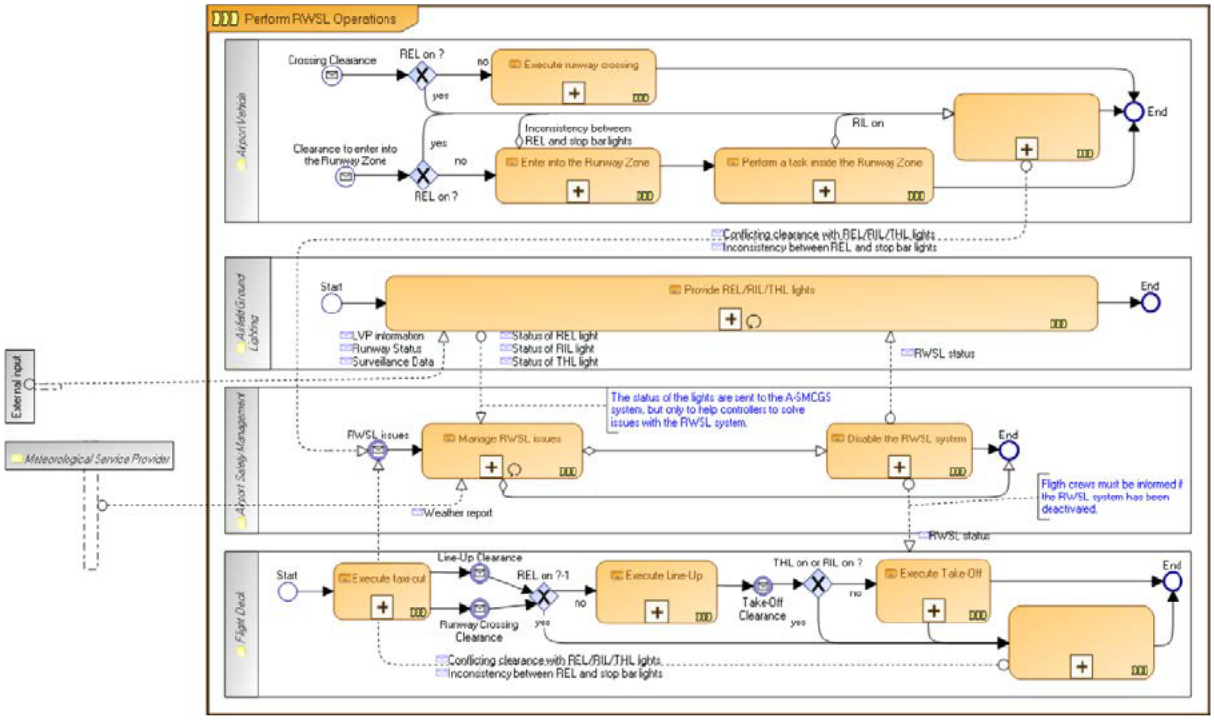

Figure 3: Process "Perform RWSL Operations"

The flight crew requests the taxi clearance from the tower ground controller.

The flight crew acknowledges[1] the taxi clearance and related routing may be depicted on the cockpit display system superimposed with airport moving map [AUO-0603-A]. This visual help for the flight crew can be combined with enhanced external out of the window vision system [AUO-0403].

Once acknowledged, the related routing is updated on the aircraft HMI as well as within the local ground system.

The flight crew manoeuvres the aircraft looking out and guided by visual aids e.g. taxiway markings and airfield ground lighting such as “Follow-the-Greens” with Taxiway Centreline Lights [AO-0222A] or Runway Intersection Lights, Runway Entrance Lights and Take-Off Hold Lights [AO-0209].

The aircraft reaches departure runway holding position.

The flight crew initiates the take-off roll and the aircraft is airborne.

The main BPMN (Business Process Model and Notation) elements used in the operational models are presented in Appendix B of the DOD [13].

2.3.2 Services

Operational services are not part of the DOD.

2.3.3 Mapping to Service portfolio and Systems

This information is not available in the DOD.

[1] Each clearance/instruction related to runway operations requires an acknowledgment from the flight crew.

3 Detailed Operating Method

3.1 Previous Operating Method

In a joint effort to prevent runway incursions, flight crews, vehicle drivers and tower runway controllers operate under the following standards:

Flight crews need an ATC clearance to line-up, to take-off, to land and to cross a runway.

To help, ground lighting and markings are implemented in accordance with international standards in the vicinity of runways. Runway intersections have been built as perpendicular to the runway as possible (AO-0209).

The airfield is equipped with both permanent and controllable stop-bars on every entry to a runway, which are either used only during Low Visibility Procedures (LVP) usually at the CAT II/III position or 24 hours a day (maybe with the exception of the line-up taxiway). Flight crews will never get cleared to cross a lit stop bar.

Aircraft must squawk while taxing so as to be identified by the aerodrome core surveillance, which is itself equipped with the visual and/or aural runway incursion monitoring and collision avoidance system (RMCA, AO-0102). However, the latter gives only information to ATC and not directly to the flight crew, meaning the controller must warn the pilot by radio, commanding (depending on the case) a rejected take-off or a go-around.

Vehicles operating on the manoeuvring area are as well equipped with a system transmitting their own position and identification which has to be switched ON before any use of the vehicle. They are then detected as such by the aerodrome core surveillance which feeds the RMCA system.

Vehicle drivers, including Rescue and Fire Fighting Services (RFFS), need a clearance from the tower runway controller to enter the runway area, independently of weather conditions.

Not all vehicles are allowed to operate on the manoeuvring area under LVP but those who can, may need to contact the tower ground controller. RFFS in emergency may be exempt from ground contact and from abiding to usual local rules.

Vehicle drivers will never get a clearance to cross a lit stop bar. Only RFFS in action are allowed at some airports to cross a lit stop bar.

Tower runway controllers: beyond specific methods to manage traffic visually (with support of an approach radar and the flight strips), ATC uses the A-SMGCS (AO-0201), including RMCA. It raises warnings to ATC – not to the flight crew or vehicle driver – which then has to trigger action.

To reduce the risk of runway incursions, airports have implemented Improved Procedures and Best Practices on the Ground (AO-0101). For example at CDG, tower runway controllers will bring traffic for departure onto as less intersections as reasonably possible, usually two. Multiple line-ups are allowed between close intersections as long as the holding point is visible from the tower controller in charge.

ATC operates controllable stop bars as described above (either only during LVP or 24h a day depending on airports). If any control of a permanent stop bar fails it turns red, whereas a controllable stop bar deactivates[2]. As a consequence vehicles and aircraft will be rerouted towards another intersection.

Aeronautical Information (ATIS, NOTAMs and AIP) supports this work. Notably, the ATIS message advises to hold short of the inner active runway if landing on the outer. The airfield AIP advises so, as well as it shows hot spots on the ground charts.

These operating methods shall remain unchanged with the RWSL operative.

[2] Unless a fail-safe system is implemented, in which case controllable stop bars turn red as well.

3.2 New SESAR Operating Method

The purpose of the RWSL system is to reduce the number of runway incursions (RI) without interfering with normal runway operations.

RWSL does not generate any alerts with respect to runway conflicts or controller clearances. The system automatically activates airfield lights to indicate to flight crew and vehicle drivers when it is unsafe to use the runway; there is no action from ATC to activate RWSL functions. Lights statuses are displayed on the tower runway controller's A-CWP only for information.

RWSL is driven by surveillance system that provides position and other information (speed, acceleration, identification…) for all aircraft and vehicles on or near the airport surface. RWSL commands the field lighting system to turn ON and OFF the lights of each RWSL function independently in accordance with its safety logic.

There are three types of runway status lights: Runway Entrance Lights (REL), Take-off Hold Lights (THL), and Runway Intersection Lights (RIL), that operate largely independently of each other, with their own sets of triggering criteria.

RWSL analyses the motion and trends of aircraft and vehicles on or near the runways, illuminates runway entrance lights (REL) if the runway is unsafe for entering or crossing, illuminates take-off hold lights (THL) if the runway is unsafe for take-off with a lined-up aircraft, illuminates runway intersection lights (RIL) if the runway is unsafe for entering or crossing from another runway.

As stated before, RIL are not covered in this document, which concentrates on REL and THL, so they are just cited here as a reminder.

3.2.1 Operating method for tower runway controller and tower supervisor

An important factor of RWSL operations is that it is completely independent of ATC actions. The system parameters must therefore be sufficiently tuned to support ground movement procedures without causing unnecessary delay or confusion by contradicting appropriate clearances.

Even if the system is independent of ATC actions, there are some new operational methods to define in case there is some malfunctioning. Those methods are defined through the following requirements, reported from chapter 6.1.1:

- REQ-06.07.01-OSED-RWSL.1101
- REQ-06.07.01-OSED-RWSL.1102
- REQ-06.07.01-OSED-RWSL.1103
- REQ-06.07.01-OSED-RWSL.1104
- REQ-06.07.01-OSED-RWSL.1105
- REQ-06.07.01-OSED-RWSL.1106

3.2.2 Operating method for flight crews

The RWSL system is a support tool for flight crews and vehicle drivers.

RWSL is an independent surveillance driven system that automatically indicates to flight crews and vehicle drivers when it is unsafe to enter, use or cross a runway.

The following requirements define how flight crews should react depending on the encountered situation, and are reported from section 6.1.2:

- REQ-06.07.01-OSED-RWSL.1201
- REQ-06.07.01-OSED-RWSL.1202
- REQ-06.07.01-OSED-RWSL.1203

- REQ-06.07.01-OSED-RWSL.1204
- REQ-06.07.01-OSED-RWSL.1205
- REQ-06.07.01-OSED-RWSL.1206
- REQ-06.07.01-OSED-RWSL.1207
- REQ-06.07.01-OSED-RWSL.1208
- REQ-06.07.01-OSED-RWSL.1209
- REQ-06.07.01-OSED-RWSL.1210

3.2.3 Operating Method for vehicle drivers

The RWSL system is a support tool for flight crews and vehicle drivers.

RWSL is an independent surveillance driven system that automatically indicates to flight crews and vehicle drivers when it is unsafe to enter, use or cross a runway.

The following requirements define how vehicle drivers should react depending on the encountered situation, and are reported from section 6.1.3:

- REQ-06.07.01-OSED-RWSL.1301
- REQ-06.07.01-OSED-RWSL.1302
- REQ-06.07.01-OSED-RWSL.1303
- REQ-06.07.01-OSED-RWSL.1304
- REQ-06.07.01-OSED-RWSL.1305
- REQ-06.07.01-OSED-RWSL.1306

3.3 Differences between new and previous Operating Methods

The purpose of the RWSL system is to reduce the number of runway incursions (RI) without interfering with normal airport operations; previous operating methods are still applicable (flight crews and vehicle drivers shall continue to comply with ATC clearances.) and additional methods required by the use of RWSL system are indicated in the above section.

4 Detailed Operational Environment

4.1 Operational Characteristics

4.1.1 REL and THL lights

RWSL is a fully automated system that processes information from aerodrome core surveillance system and activates different sets of field lighting to inform flight crews and vehicle drivers about the unsafe status of the runway they are about to use or cross.

The RWSL overall concept usually embeds three kinds of field lighting sets, which are:

- Runway Entrance Lights (REL) for mobiles (vehicles or aircraft) about to cross or enter the runway,
- Take-off Hold Lights (THL) for aircraft about to take off on the runway,
- Runway Intersection Lights (RIL) for mobile taxiing or aircraft about to take off on a crossing runway,

REL, THL and RIL consist of surface red lights that are directly visible to flight crews and surface vehicle drivers.

To avoid flight crews' confusion, the lights only have two states: either OFF (extinguished), either ON (lit) with bright red color.

The RWSL lighting system is implemented in addition to existing airfield lighting, meaning that the functioning of the system has to be defined with the use of existing stop bars for instance and that the layout of the RWSL lights has to take into account existing lighting fixtures.

Note: In the following schemas, individual lights are figured with small triangles oriented towards the potential viewer (aircraft or vehicle), as they are implemented in the runway or taxiway pavement. Red triangles mean lit lights (ON) and white triangles mean unlit lights (OFF).

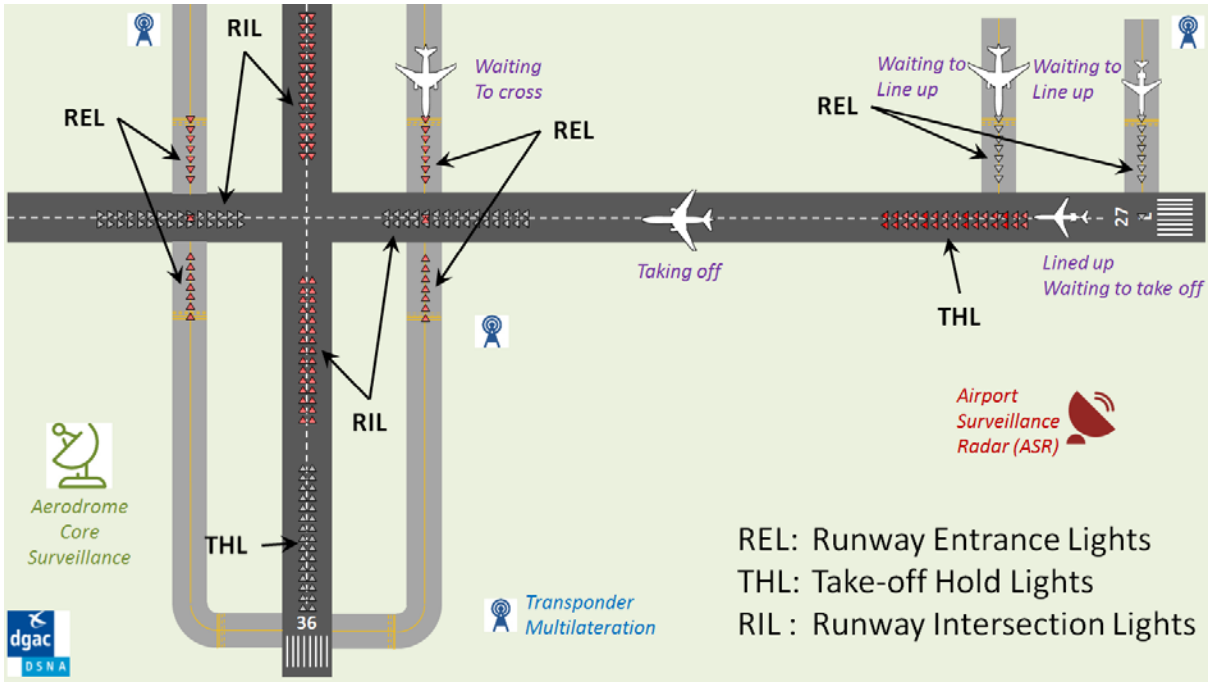

Figure 4: Different sets of lights part of the RWSL concept

As stated before, within the scope of this OSED, only REL and THL are fully described since no validation activities have been performed yet on RIL within the scope of SESAR.

Runway Entrance Lights (REL): The REL system is composed of unidirectional lights that are implemented along the taxiway centreline and showing red towards the mobile at the holding point. An array of REL includes the first light prior to the holding point followed by a series of evenly spaced lights to the runway edge. One additional light to the side of the runway centreline lights toward the intersecting taxiway is in line with the last two lights before the runway edge.

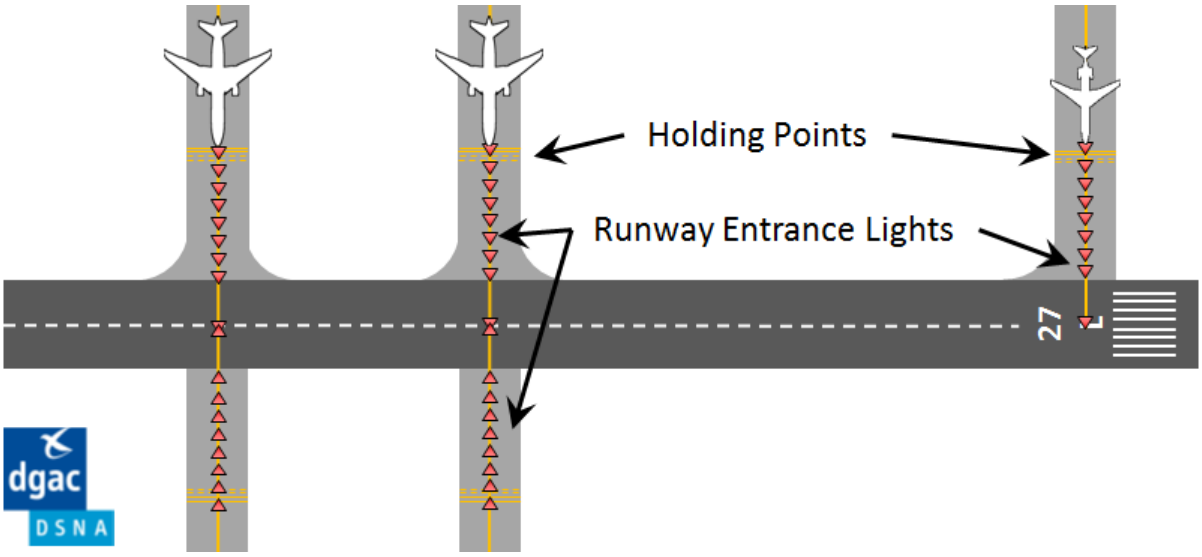

Figure 5: REL implementation

When taxiway centreline is not perpendicular to the runway, unidirectional lights are still directed to the holding point and remain visible when aircraft proceed on the line. This case can happen when taxiways are oblique (compared to the runway), or also when the taxiway centreline is curved in order to follow the line-up path.

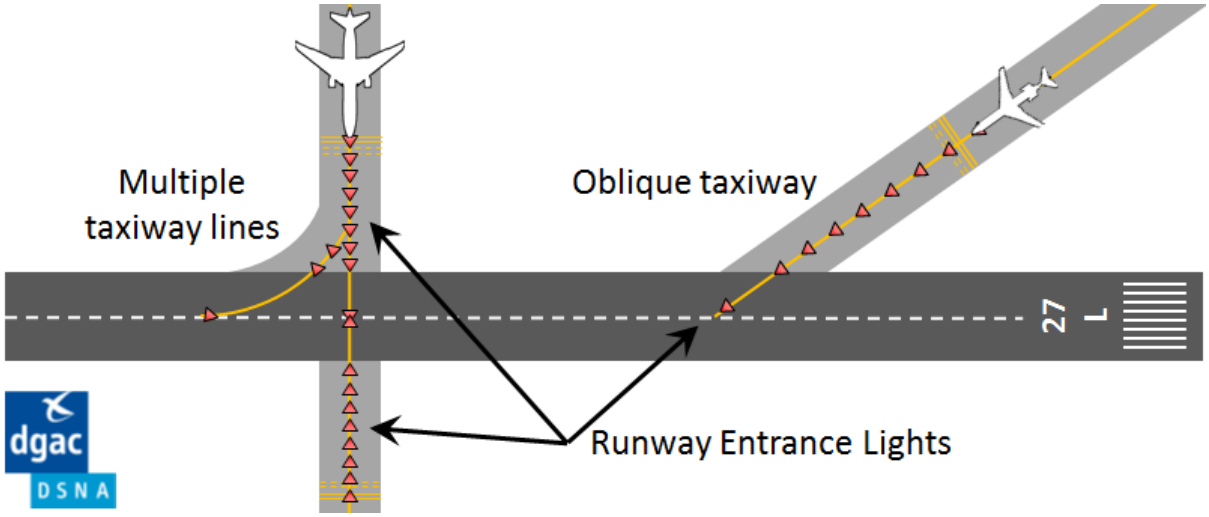

Figure 6: REL implementation (taxiway not perpendicular to the runway)

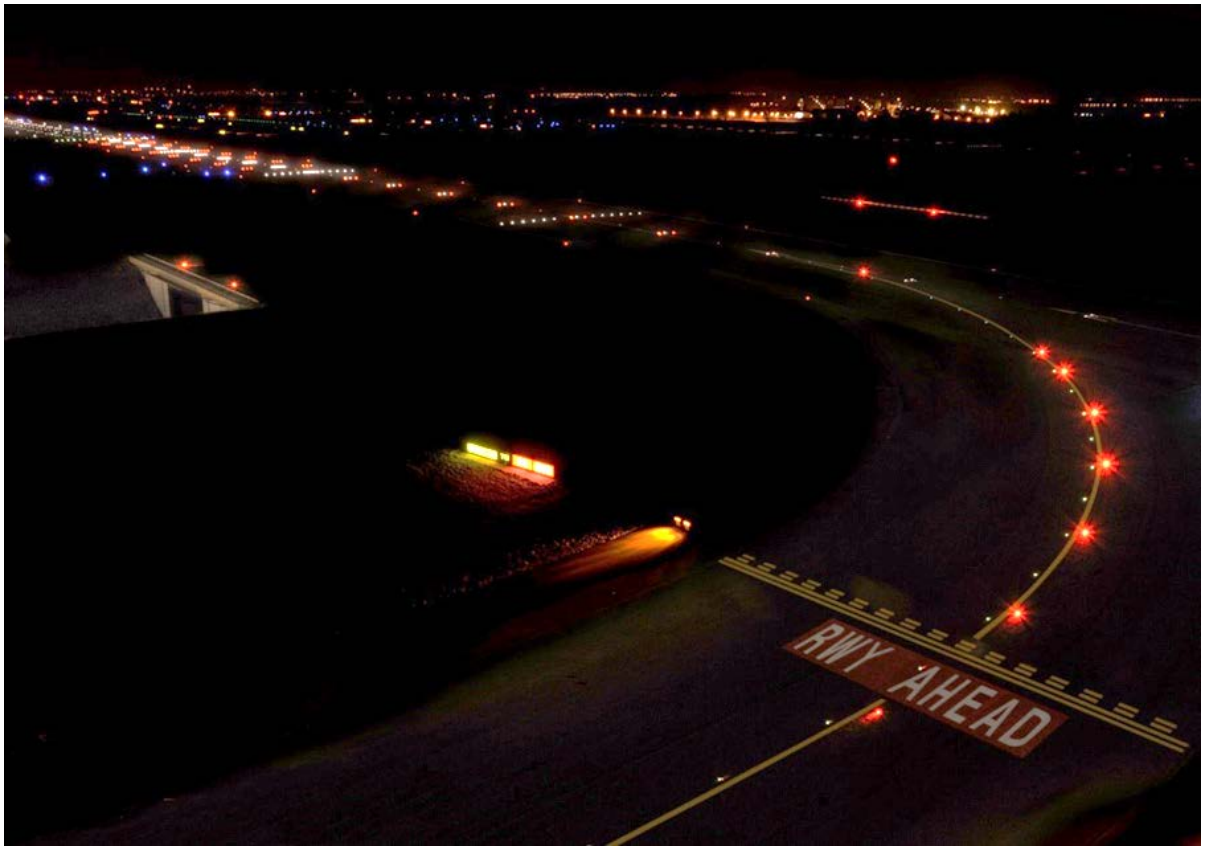

Figure 7: Picture of a REL at CDG

When several holding points are implemented on a taxiway, REL may go till the farthest holding point from the runway centreline (i.e. the CAT III holding point). It is then possible to dissociate the switching ON/OFF of the REL lights located between the runway centreline and the CAT I holding point from the switching ON/OFF from the REL lights located between the later holding point and the CAT III holding point. This extension, when implemented, will be used in LVP conditions.

Take-off Hold Lights (THL): The THL system is composed of unidirectional lights showing red towards the respective departure threshold in a double longitudinal row aligned either side of the runway centreline lighting. Lights extend for about 450 meters (1500ft) starting at the beginning of the entry taxiway or about 115m from the departure threshold.

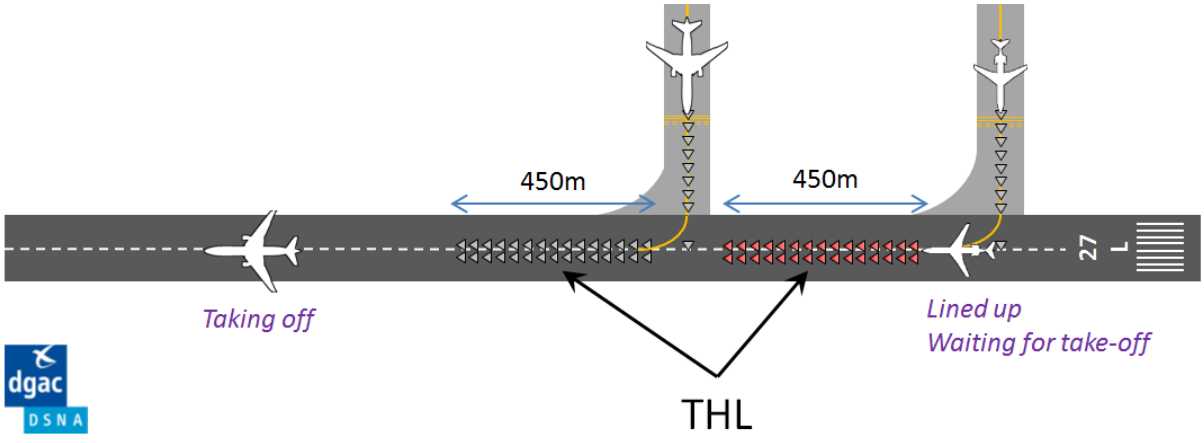

Figure 8: THL implementation

The distance over which THL extends has to be fitted with the runway and taxiway layout. It can also be implemented in several segments in order to allow multiple line-ups without inducing any confusion to flight crews. In the figure below, segments 1+2 and segments 2+3 provide 450m of red lights and both groups constitute the two THL associated to the two holding points.

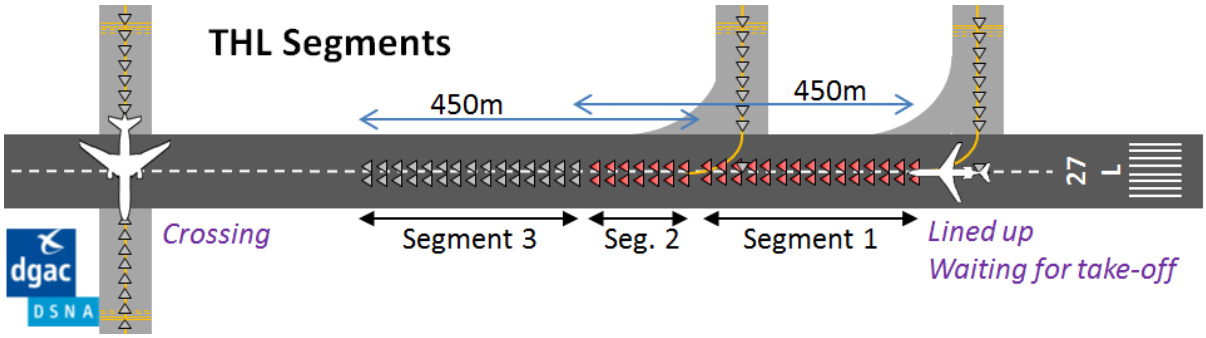

Figure 9: THL implementation with segmentation (1)

If the Runway has several consecutive line-up entry taxiways, the addition of all segments can produce a long THL line (e.g. more than 1000m), but for a specific entry taxiway, and a departing aircraft from this taxiway, only dedicated segments will be lit (corresponding to ~450m downstream the intersection).

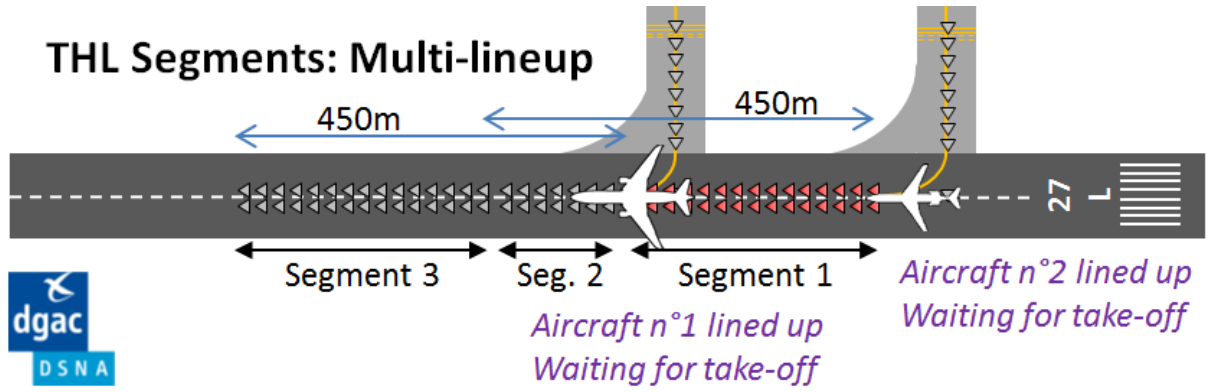

Figure 10: THL implementation with segmentation (2)

Figure 11: Picture of a THL at CDG

4.1.2 System Characteristics

4.1.2.1 REL switch ON / OFF principles

As stated before, RWSL shall have no impact on the tower runway controller work procedures in a nominal situation. Otherwise, specific cases have been identified where new procedures should be defined:

- Error from ATC: e.g. the tower runway controller issued an erroneous clearance.
- Error from pilot/driver: e.g. a mobile entered the runway without clearance.
- RWSL system is malfunctioning.

Normally, no clearance should be given with REL lights ON, because it may trigger radio communications and generate delays in flight operations. This means that REL rules should be specified and tuned taking into account local methods and procedures so that this principle is respected.

A possibility is to specify REL functions with a set of rules: some rules will command to switch ON REL and others will command to switch them OFF. Rules can be generic or specified for each REL and can be defined with several parameters. The tuning of these parameters is important to find the balance between the two imperatives:

- REL shall be OFF when a valid clearance is issued.
- REL should be ON when the situation is considered as dangerous

This balance may be difficult to find, as the tower runway controller can anticipate on dynamic situations in order to optimize runway throughput. Practically, it means that parameters are tuned to

offer the maximum of protection, lights being switched OFF as soon as they could interfere with a correct controller's decision or clearance.

Regarding safety, operational situations can be qualified according to two different objectives:

- **Anti-collision**: Parameters are tuned in order to avoid situations where 2 mobiles could physically collide.
- **Anti-incursion**: Parameters are tuned in order to comply with local ATC ground procedures.

REL can be switched ON by aircraft and vehicles in motion on the runway or aircraft on approach. In the following paragraphs, the word "mobile" will designate either an aircraft or a vehicle.

Several generic rules can be identified. Use cases will describe the sequence of triggered rules in operational situations. The general principle with the rules is to switch ON a REL when at least one rule considers a mobile as a potential threat to a pilot or driver waiting to enter the runway at the corresponding intersection. Switching OFF occurs when no more rule considers any mobile as a potential threat for this particular intersection.

Mobile Moving on the Runway

When a mobile (aircraft or vehicle) is moving on the runway, and is close to an intersection, the corresponding REL should be ON, as long as the mobile represents a direct risk of collision. RWSL should be tuned so as to apply different rules to aircraft and vehicles, as they usually don't have the same kinematics and maneuverability.

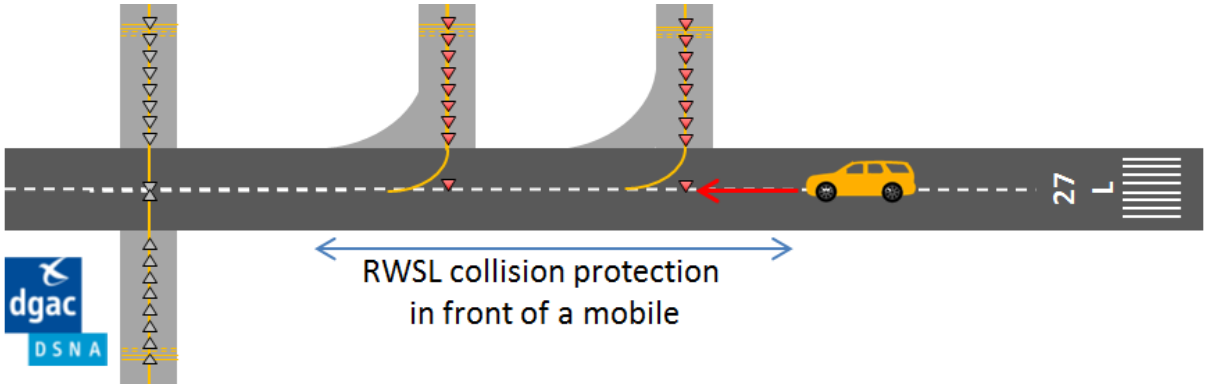

Figure 12: REL: Mobile moving on the runway

A mobile at slow speed may be considered as not dangerous anymore.

In some cases, ATCO may anticipate and give a clearance to enter the runway before the mobile has actually passed the intersection. RWSL should be tuned to take this practice into account (REL at this intersection should be OFF when the clearance is issued).

Aircraft taking off

When an aircraft is taking off, and has reached a considerable speed, REL in front of it should be switched ON. According to the airport runway procedures, All REL may be lit or only those within a certain distance from the line-up taxiway[3].

[3] This could be useful on certain airports with a very long runway and light aircraft at take-off for example. However, this case is only cited here as a reminder, and will not be further developed throughout the document.

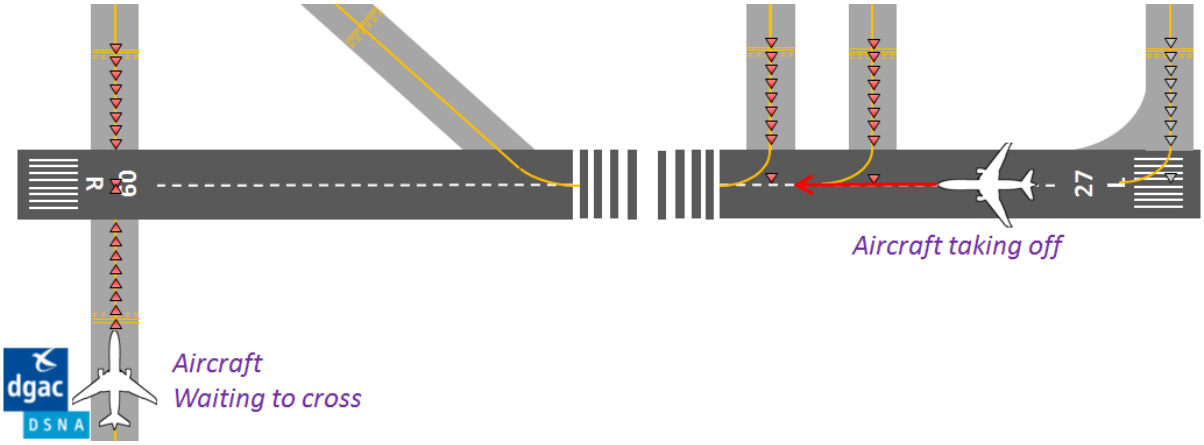

Figure 13: REL: Aircraft taking off

REL in front of the departing aircraft should be switched OFF in a timely manner, in order to avoid any delays in the runway operations. For example, on the previous figure, the departure will be airborne far before reaching the end of the runway, where an aircraft is waiting to cross: REL should be OFF when the controller issues the crossing clearance.

In case of a rejected take-off, distant REL in front of the decelerating aircraft should be switched OFF in a timely manner, in order to avoid any delays in the runway crossing operations.

Aircraft on approach

REL at an intersection should be switched ON by an aircraft on approach when it is close to the intersection. Criteria triggering the lights to switch ON are multiple, and should be tuned according to local procedures. For example:

- Some REL may be lit to avoid a line-up (potentially a non-authorized line-up) if there is not enough time for the departing aircraft to line-up and take-off within the airport runway separation rules.
- Some REL may be lit to avoid a crossing (potentially a non-authorized crossing) if there is not enough time to cross the runway.
- In case of go-around, REL should be extinguished in a timely manner, in order to avoid any delays in the runway crossing operations.

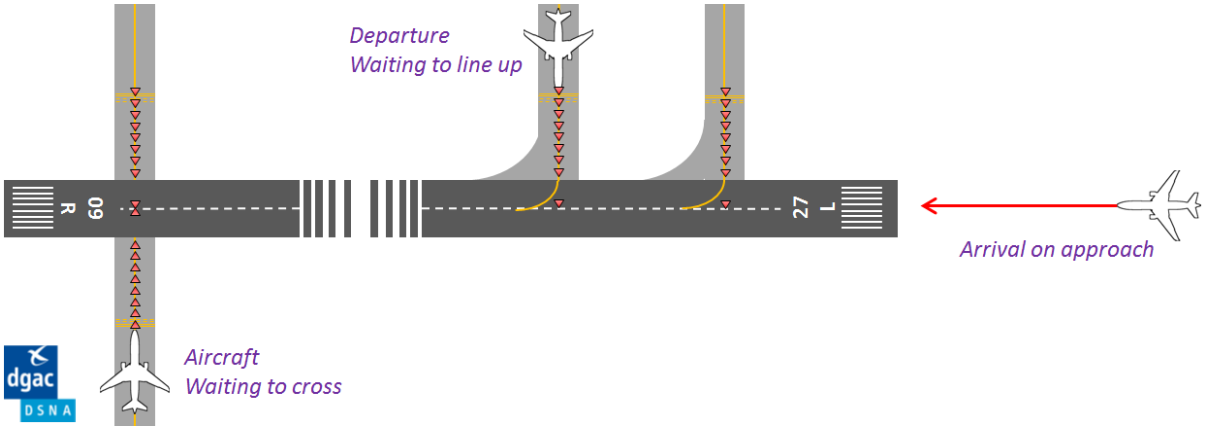

Figure 14: REL: Aircraft on approach

Landing aircraft

When an aircraft is landing, and has still a considerable speed, REL in front of it should be ON. According to the airport runway procedures, All REL can be lit or only those within a certain distance from the threshold.

REL in front of the landing aircraft should be switched OFF in a timely manner, in order to avoid any delays in the runway operations. For example, when the landing aircraft has decelerated, or when it is vacating via a rapid exit taxiway, REL should be OFF when the controller issues the crossing clearance to another aircraft.

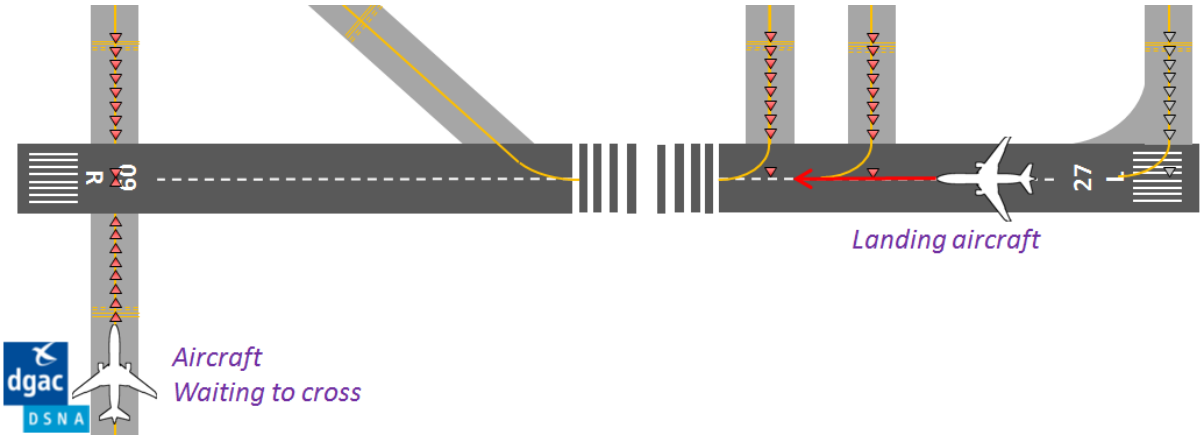

Figure 15: REL: Landing aircraft

Blinking phenomena

In some specific operational situations, REL can be seen as 'blinking' by vehicle drivers or pilots. RWSL is designed to mitigate the perception of lights as blinking.

A REL is considered as blinking when:

- a REL is switched ON, then OFF, then ON again on a short time duration,
- a REL is switched OFF, then ON, then OFF again on a short time duration.

Two main reasons can explain blinks:

- The air and ground situations are dynamic and in constant evolution,
- Input data quality: evaluation of distances and speeds in particular can be noised.

Within the specification and implementation of REL rules, blinks have been minimized through several practices:

- Input data preprocessing (e.g. smoothing of initial rate of climb of aircraft)
- Prediction: the extinction rule applies only if there is no prediction of switching ON again in the next seconds.
- Timer: the rule must be valid for a certain time before the REL is switched ON or OFF.
- Hysteresis: triggering thresholds based on hysteresis curves or cycles can be introduced in order to avoid threshold effects on certain rules. For example, if a "switch ON" rule is triggered with a condition on Speed, S>30kts, the "switch OFF" condition should not be S<30kts but S<20kts if a hysteresis of 10kts is retained. The introduction of hysteresis shall be taken into account and specified at the system's design phase.

4.1.2.2 THL – switch ON / OFF principles

THL should be provided for each line-up area on the departure side of a runway. When there are several consecutive entrance points on the runway, the total available THL line in front of a departure

can exceed 450m, but for safety reasons the THL are only lit for the respective distance of about 450 meters.

When two consecutive line-up entry points are spaced by a distance inferior to 450m, a system of segmentation is implemented: a same segment can be used by several THL, i.e. within the first 450m of several line-up entrances. On the following figure, segment n°2 is used for D2 (case A) and D1 (case B). Segmentation is also necessary to implement multi-line-up operations (case C).

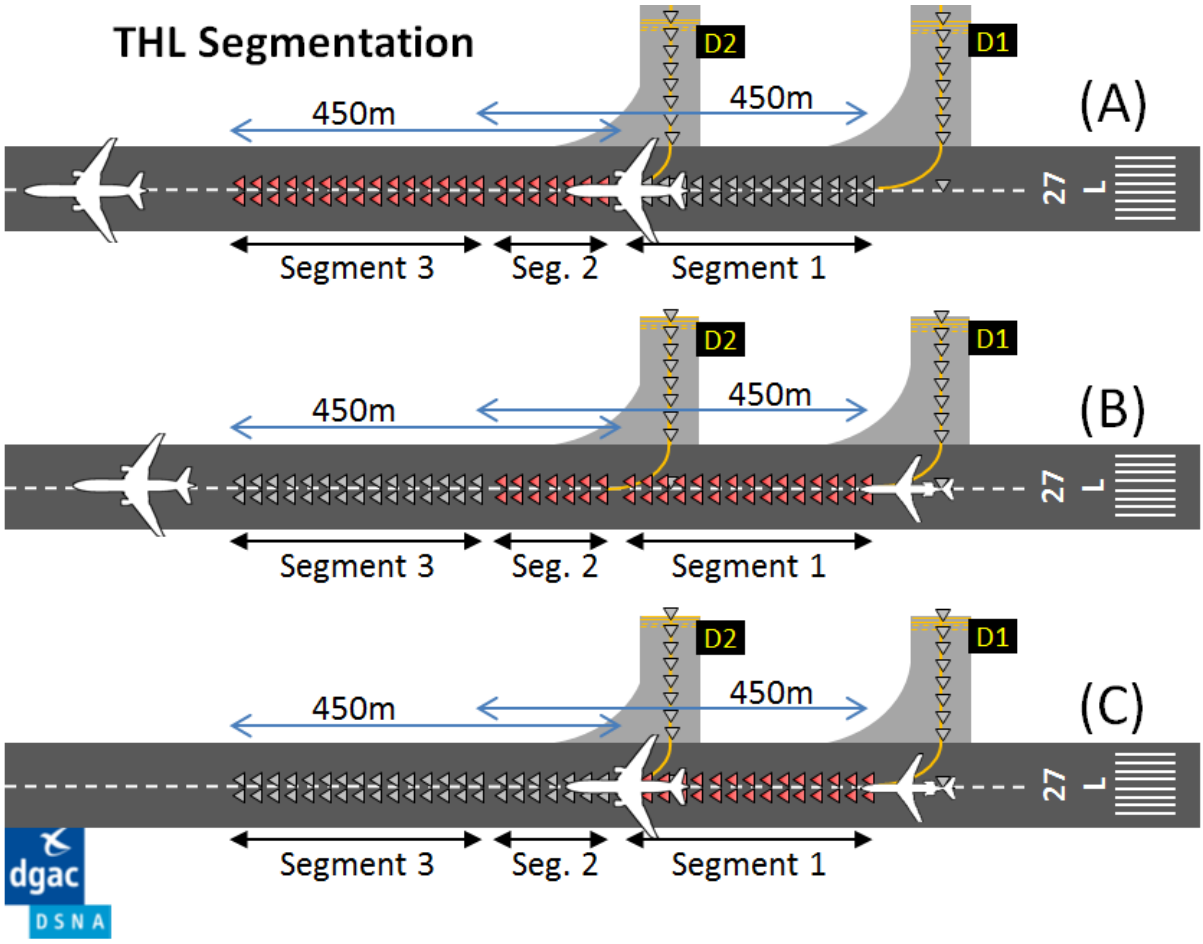

Figure 16: THL: Segmentation principle

Line-up detection

THL service is dedicated to departing aircraft: There are two necessary conditions to switch ON a THL:

- An aircraft shall be lining up or lined up for departure,
- A conflicting mobile shall be present (moving or not) on the runway or in the safety region (see below) in front of it.

RWSL should determine if a mobile on the runway is a departing aircraft, lining-up or already lined-up. This detection may depend on the implementing airport, runways, procedures, QFUs in use, etc. As the aerodrome core surveillance provides the aircraft identification, thus making the distinction between aircraft and vehicles (no vehicle being considered as capable to “line up”) the two following rules can be used:

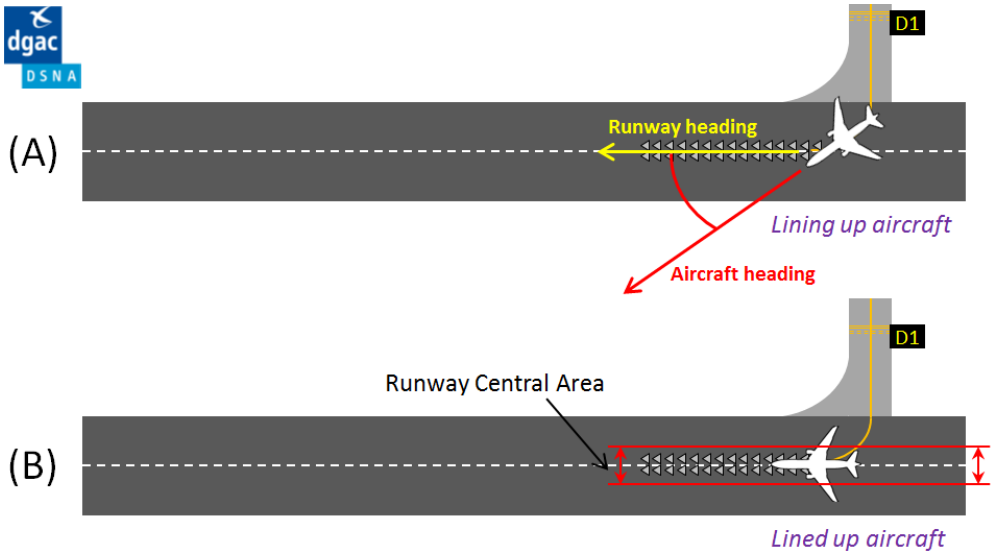

Figure 17: THL: Line-up detection

The first rule (A) detects that an aircraft is penetrating the runway via D1, and monitor the aircraft's heading. When the aircraft heading is close to the runway heading, the aircraft is considered as lining-up.

The second rule (B) is used primarily when heading data is not reliable (e.g. if the aircraft speed is too low). A distance from the runway centreline is defined to determine if the aircraft is in the runway central area. The second rule detects that the aircraft is penetrating the runway via D1, and monitor if the aircraft is in the runway central area. When the aircraft has been in the central area for some time, it is considered as lined-up.

Safety Region

When an aircraft on departure enters the runway via a given taxiway, RWSL detects this entry taxiway and the line-up sequence. Once the detection is performed, the THL service can be provided to the aircraft: RWSL monitors if there is a mobile in front of it. Practically, a dedicated area is defined for each entry taxiway, and is called the "safety region".

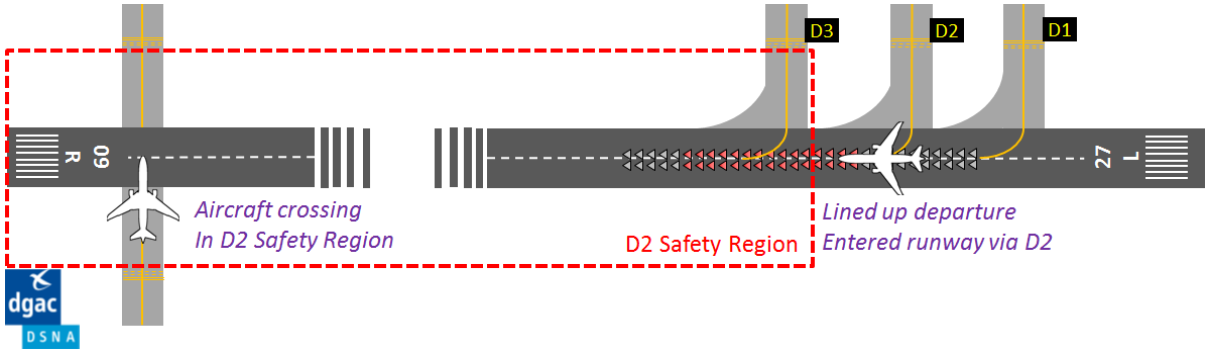

Figure 18: THL: Safety region

The safety region is the area in front of the line-up taxiway entry where the mobile detection is performed. When a mobile is in this area, and if a departure is lined up, THL is switched ON until the mobile exits the area. A safety region is defined for each taxiway entry used for line-up.

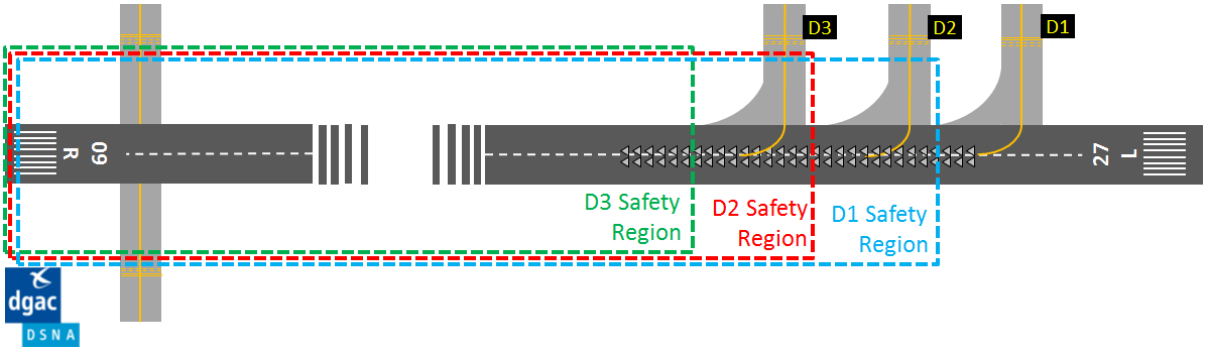

Figure 19: THL: Safety regions overlap

Several safety regions may overlap, and in the previous figure they have been slightly offset for clarity reasons, even if they are all aligned on the runway centreline and have the same width.

THL in front of a departing aircraft should be switched OFF in a timely manner, in order to avoid any delays in the runway operations, and in particular, they should be OFF when the controller gives the take-off clearance.

The first manner to switch THL OFF is to monitor when all conflicting mobiles exit the safety region. However, on some airports, it may be too late according to tower controller procedures, and two additional possibilities are introduced:

- For mobiles on ground: an anticipation of the safety region exit can be implemented (based on a position prediction)
- For taking off aircraft: THL behind them may be switched OFF when the aircraft is no more considered as a potential danger.

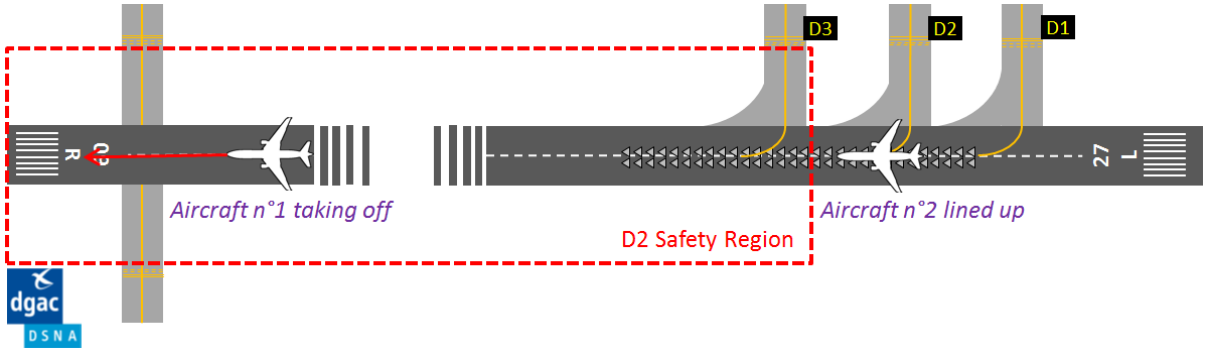

Figure 20: THL: Multiple line-ups extinction

At least two conditions can be implemented to switch OFF THL in case of two consecutive departing aircraft:

- Aircraft n°1 is at a sufficient distance from aircraft n°2
- Or aircraft n°1 is airborne

With these two conditions, THL will be switched OFF before the aircraft n°2 take-off clearance is given by the tower runway controller.

Rejected take-off

In case of two consecutive aircraft on departure, if aircraft n°1 performs a rejected take-off, THL shall be switched ON for aircraft n°2 with the following rules:

- If THL were already ON, they shall remain ON
- If THL were switched OFF (e.g. by the previous rules), they shall be switched ON again.

LVP / Non-LVP Conditions

RWSL behaviour shall comply with local procedures and not interfere with normal operations. It results that the RWSL system should embed different set of parameters to adapt its logic to exploitation procedures in use, i.e. to the aerodrome LVP or Non-LVP exploitation rules. In particular, the safety region can be extended to wider boundaries.

Blinking phenomena

As for REL, THL may be prone to blinking phenomena, which have the same causes than REL's, and their occurrence have been reduced with the same methods (see REL blinking phenomena).

4.1.2.3 Aerodrome Surveillance

On the airport operator side:

- The airfield ground lighting system will need to be upgraded to provide RWSL functions (i.e. REL and THL).
- The lighting system should have the necessary performance in terms of lighting and extinction times: RWSL switching ON and OFF orders should be executed in a timely manner.

On the airport operator or ATC side (depending on local context):

- An RWSL management processor will be needed to implement the RWSL safety logic, using the aerodrome core surveillance data as input to switch ON and OFF the lights accordingly.
- The aerodrome surveillance system should provide RWSL processor with targets' information, such as identification, position, altitude and their respective trends.
- Surveillance system provides targets as a result of multi-sensor fusion. Target reports are single "points" whereas they represent physical objects with length, wingspan, height… That fact should be taken into account, at least during the RWSL tuning phase.

On the ATC side:

- The aerodrome core surveillancesystem will need to be upgraded to interface the RWSL management processor to display RWSL status information to the tower runway controller and to allow RWSL deactivation by the tower supervisor.
- An enhanced aerodrome core surveillancesystem may be required to ensure that the RWSL are switched ON / OFF at the right time, without downgrading the runway capacity (cf. RWSL V3 Validation Report; 06.07.01-D09, [8]).

4.1.2.4 A-CWP

ATC operations will be changed very little by RWSL system implementation. The only situations when ATC should need to refer to RWSL information would be in response to a query from a flight crew or vehicle driver concerning RWSL lights contradicting a clearance or being inconsistent with visible traffic. The only ATC need is then to have RWSL information displayed on the tower runway controller A-CWP.

The whole RWSL system shall also be able to be deactivated from the control tower if required (for instance, in case of heavy rain, the system will have to be deactivated if surface movement radars performances are strongly degraded).

4.1.3 Weather Characteristics

RWSL will be used in good visibility and in low visibility conditions.

During LVP operations, the system will be used in conjunction with stop bars. If the airport is equipped with REL extensions to CAT III holding points, the system shall manage the two segments (segment 1 from the CAT I holding point till the runway centreline and segment 2 from the CAT III holding point till CAT I holding point) as a unique REL in LVP.

If there is a risk that aerodrome core surveillance performances could be impacted by adverse weather, local procedures and/or RWSL system shall prevent any performance deviations in REL and THL behaviour.

4.1.4 Traffic Characteristics

RWSL functions shall be applied to all mobiles that are moving on and around the equipped runways of an airport.

THL service is provided to departing aircraft. If a mobile is detected in front of the departing aircraft, (i.e. in the safety region), the THL objective is to prevent the take-off run, or to command a rejected take-off at the beginning of the take-off run. It is a local decision to choose the required level of detection for a target to be considered as “in the safety region”: from the most reliable situation (e.g. cooperative target, detected by MLAT and several primary radars), to the least reliable situation (e.g. non-cooperative target, detected by only one sensor, reputed as a potential source of false tracks).

REL service is provided to all mobiles: REL are lit even if no mobile is present on the taxiway. REL are switched ON/OFF according to mobile in motion on the runway. As for THL, it is a local decision to choose the required level of detection for a target to be considered as “in motion on the runway”.

Tower and ground controllers have to manage aerodrome core surveillance detection problems such as false tracks. In the case of RWSL, there is no more “man in the loop” to prevent or correct detection errors. It is the responsibility of the local management team to assess the level of performance of its aerodrome core surveillance, to decide the required level of detection for a target to be taken into account by REL and THL functions, and, possibly, to undertake improvements works (aerodrome core surveillance upgrade, definition of target filters…).

4.2 Roles and Responsibilities

The actors whose roles and responsibilities that are described below are based on the list of actors identified in the latest draft of the deliverable entitled “Actors – Roles and Responsibilities” issued by WPB.04.02. At the time the present document was finalized, the latest version made available by WPB.04.02 was version 5 issued in May 2011 [10].

When no appropriate actor was identified in WPB.04.02 document, an additional actor is defined.

The roles and responsibilities defined below are restricted to the additional roles and responsibilities that actors are in charge of due to the implementation of the RWSL system. Standard and permanent roles and responsibilities are not repeated in here.

The actors whose roles and responsibilities are described below are those who are involved during daily operations or are associated to actors who use the RWSL system. Actors that have been involved in the design of the system, in the training of flight crews and drivers or in the description of the system as permanent aeronautical information publication are not addressed here.

4.2.1 Roles and Responsibilities of the tower runway controller and tower supervisor

The tower runway controller needs to deal with both RWSL functions: REL and THL.

RWSL service has no impact on tower runway controller clearances: the system shall be tuned according to local practices and light extinction should not be late compared to the clearances.

If a flight crew or vehicle driver advises the tower runway controller of an inconsistency between a clearance given and the status of the REL or THL (clearance given while RWSL are ON), the tower runway controller has to make sure the runway can be used safely by this aircraft, then ask the tower

supervisor for manual switching OFF in case of malfunctioning, and then issue the clearance again. No mobile is allowed to pass over activated RWSL lights.

If a tower runway controller is informed of any malfunctioning of one or all of the RWSL functions that could interfere with safe operations, the tower supervisor shall switch OFF this (these) function(s).

Information regarding unserviceable RWSL functions shall be transmitted to flight crews and vehicle drivers using the appropriate means. Additionally, the airport duty officer and/or AGL maintenance department may be informed, so that the problem can be fixed as soon as possible.

4.2.2 Roles and Responsibilities of the flight crew

The flight crew needs to deal with both RWSL functions: REL and THL.

Pilots should maintain an awareness of the Runway Status Lights. They should keep in mind:

- REL that are ON indicate that the runway ahead is not safe to enter or cross.
- THL that are ON indicate that the runway is not safe for take-off.
- REL or THL that are OFF have no meaning.

It has to be clear for pilots that red lights (lights switched ON) mean “STOP!” Pilots should remain clear of a runway when an REL along their taxi route is illuminated. Pilots shall not take off when a THL on the runway ahead is illuminated.

It should be clear for pilots that lights that are switched OFF convey no meaning. The system is not, at any time, intended to convey approval or clearance to proceed onto a runway or to take off from a runway. Pilots remain obligated to comply with all ATC clearances, except when compliance would require crossing an illuminated REL or THL.

In such a case, the crews should hold short of the runway for REL or reject take-off for THL (if possible), report to ATC, and await further instructions.

If the pilots notice illuminated REL and remaining clear of the runway is impractical for safety reasons, then they should proceed according to their best judgment of safety (understanding that the illuminated REL indicates the runway is unsafe to cross or enter) and contact ATC at the earliest opportunity.

If the pilots notice illuminated THL and aborting take-off from the runway is impractical for safety reasons, then they should proceed according to their best judgment of safety (understanding that the illuminated THL indicate the runway is unsafe for take-off) and contact ATC at the earliest opportunity.

THL are intended for pilots on departure, but if pilots on short final notice an illuminated THL, then they should inform ATC they are going around because of red lights on the runway.

Stop bars should not be mistaken for REL: stop bars are operated by the tower runway controller and their switching OFF should always be associated with an ATC clearance, whereas REL are fully automated, and are an additional safety measure.

In case of an inconsistency between the stop bar lights (OFF, with lead on segment ON) and the REL (ON), flight crew shall stop and contact tower runway controller for further instructions.

Pilots are requested, when taxiing on the runway, to limit taxi speed to below a reasonable limit (to be defined locally) so as not to unnecessarily turn on the REL, except when directed otherwise by ATC.

The flight crew is still responsible for evaluating the safety of an action it has been cleared to do, even when RWSL lights are OFF.

The flight crew is always responsible for manoeuvring the aircraft on the airport surface and for taking the ultimate decision according to their best judgement whether it is safe to comply with an ATC instruction or to stop ahead red lights.

4.2.3 Roles and Responsibilities of the vehicle driver

The vehicle driver needs to deal with REL function only.

A vehicle driver is still responsible for evaluating the safety of an action it has been cleared to do, even when RWSL functions are not activated (lights are OFF).

If REL are activated and is in contradiction with the clearance received from the tower runway controller, the vehicle driver shall either hold if not yet on the runway, or vacate the runway immediately if already on it, and ask the tower runway controller for further instructions: vehicle driver shall not cross or enter a runway when REL are switched ON.

A switched OFF REL shall have no particular meaning for a vehicle driver.

A switched ON THL shall have no particular meaning for a vehicle driver.

A switched OFF THL shall have no particular meaning for a vehicle driver.

The vehicle driver is always responsible for manoeuvring the vehicle on the airport surface and for taking the ultimate decision according to their best judgement whether it is safe to comply with an ATC instruction or to stop ahead red lights.

In case of inconsistency between the stop bar lights (OFF, with lead on segment ON) and the REL (ON), the vehicle driver shall stop and contact the tower runway controller for further instructions.

4.2.4 Roles and Responsibilities of the ground lighting maintenance service

The airfield ground lighting maintenance service informs the tower supervisor of any planned unavailability of one or several parts of the RWSL system.

The airport services inform the tower supervisor whenever they notice any malfunction or failure of one or several functions of the RWSL system by any means.

The airfield ground lighting maintenance service informs the tower supervisor when a stopped function (due to maintenance, malfunction, etc.) of the RWSL system is put into service again.

The airfield ground lighting maintenance service switches OFF a RWSL function when the supervisory panel or an on-site visit proves it is malfunctioning with risks of causing misinterpretation by flight crews or vehicle drivers. He immediately informs the tower supervisor who may relay that information to the tower runway controller.

4.3 Constraints

RWSL system requires the availability of the aerodrome core surveillance data.

In order to support aerodrome core surveillance performances, vehicle positioning systems and aircraft transponders shall be turned ON and kept ON while on the manoeuvring area.

The accuracy of horizontal and vertical positions and trends information from the airport core surveillance system together with its integrity shall be adequate for RWSL.

The RWSL processor shall receive aerodrome core surveillance data in a timely manner.

All future deployment should consider the following elements as local constraints:

- **Nature of the mobiles (aircraft and vehicles, cooperative or not):** should the system detect all mobiles? What are the local regulations about these mobiles equipment level (Mode S, reported Mode C accuracy, vehicle positioning system for airside vehicles, etc.?)
- **Nature and performances of the surveillance:** what are the sensors feeding the aerodrome core surveillance, their coverage and performances, their contribution to the overall surveillance performances?
    - As a generic example of the way to proceed, about altitude, it should be clarified what sensors provide Mode C data, at what update rate, is it a raw, smoothed, or extrapolated aircraft data, what is the time offset between reality and data collection, etc. and what are the consequences on other subsequent data such as vertical velocity?

926 • It should also be highlighted that the expected needs about aircraft vertical position
927 information differs from one sub-system to another (REL, THL, RMCA, A-CWP
928 display, etc.)

929 • In the same way, RWSL provides indications about runway usage directly to pilots
930 and vehicle drivers, without any human-in-the-loop to detect inconsistencies with real
931 situation.

932 - **Characteristics of the runway layout and operations:** parallel dependent runways,
933 hotspots positions, local procedures (multiple line-ups, etc.). RWSL is a new system that has
934 to deal with the existing operational methods without degrading the airport capacity or
935 interfering with normal operations. Thus, RWSL has to take as a constraint the need to avoid
936 inconsistencies between operational clearances and its own lights statuses so that these
937 lights are never ON when a valid (not erroneous) clearance is issued by the controller.

938 - **Physical characteristics of the lights and their infrastructure:** latencies (both ways),
939 lighting and brightness level, orientation and aperture of lights, composition with pre-existing
940 infrastructure and lights, and their supervision have to be studied carefully.

5 Use Cases

Use cases for Runway Intersection Lights can be found in 06.07.01-D07: RWSL initial OSED [7].

5.1 Use case 1 – REL – Departure Aircraft

5.1.1 General Conditions

Scope and Summary

This use case describes how RWSL system switches ON and OFF REL when an aircraft is taking off and how it will be presented on tower runway controller's A-CWP and tower supervisor's HMI.

Pre Conditions

The airport is equipped with REL and aerodrome core surveillance.

The status of REL is made available on tower runway controller's A-CWP and tower supervisor's HMI.

REL are OFF for all the entrance taxiways of the runway.

Post Conditions

REL are OFF for all the entrance taxiways of the runway.

Actors

Tower runway controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

An aircraft enters the runway and lines-up.

5.1.2 Main Flow

Use case steps:

1. Aircraft is lined up and stopped: no REL is switched ON.

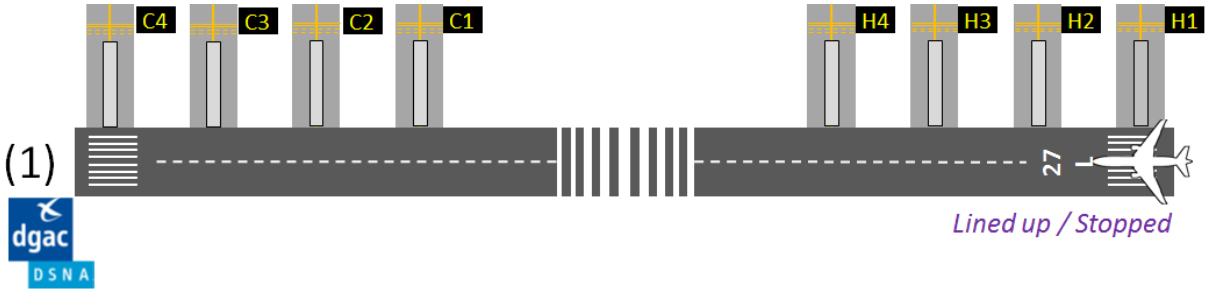

Figure 21: REL: UC1: Departure aircraft (1)

2. Aircraft has some speed, and is close to H2 and H3: they are switched ON.

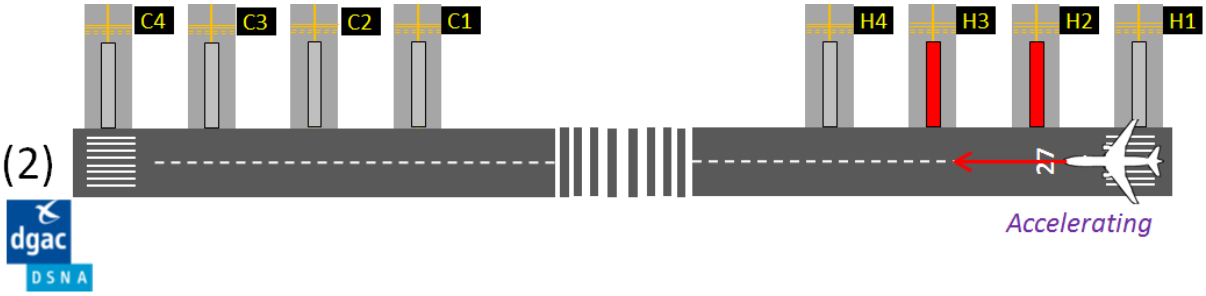

Figure 22: REL: UC1: Departure aircraft (2)

3. Aircraft is passing next to H2 and then next to H3: H2 and H3 are switched OFF. Note that some anticipation can be introduced: H2 and H3 can be switched OFF before the aircraft actually crosses the intersection.

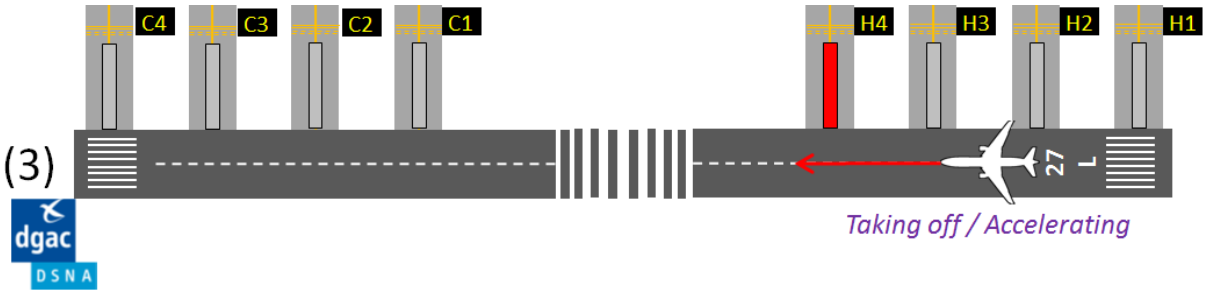

Figure 23: REL: UC1: Departure aircraft (3)

4. Aircraft has a considerable speed (and acceleration): it is detected as a take-off run. All REL in front are switched ON (H4, C1, C2, C3 and C4).

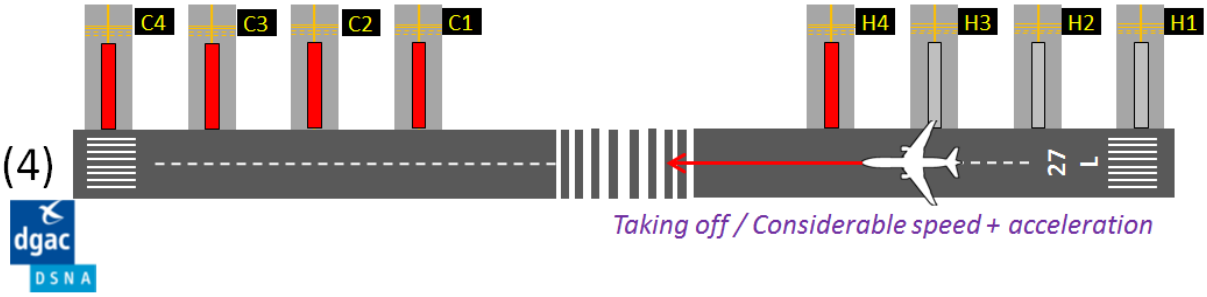

Figure 24: REL: UC1: Departure aircraft (4)

5. Aircraft is passing next to H4 and then next to C1: H4 and C1 are switched OFF.

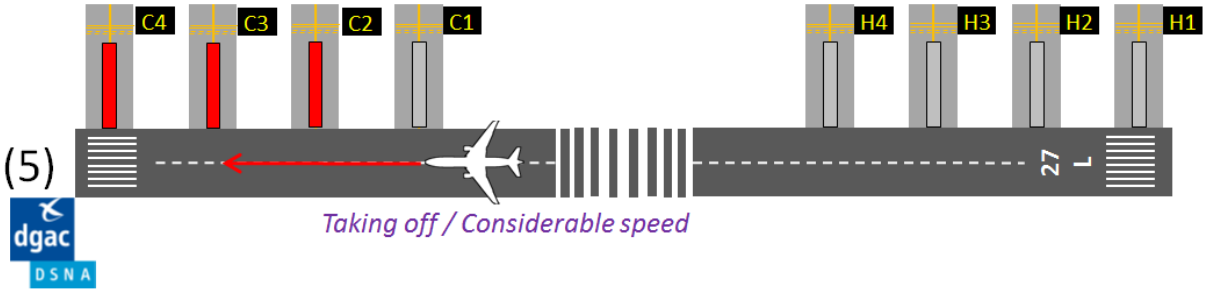

Figure 25: REL: UC1: Departure aircraft (5)

6. Aircraft is airborne: all REL in front are switched OFF.

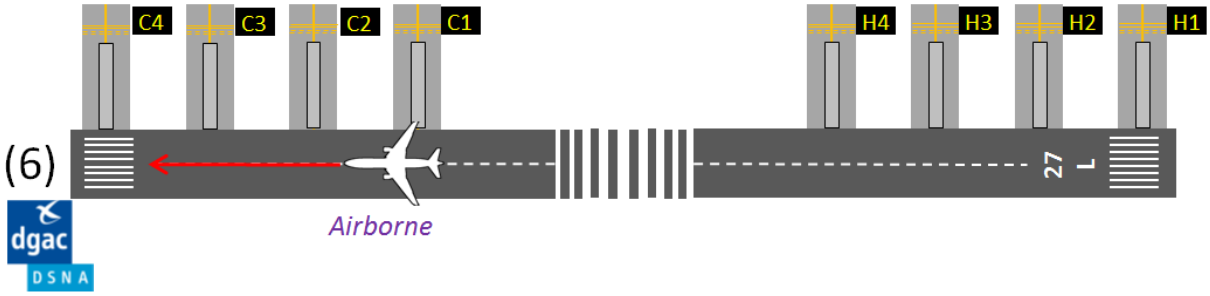

Figure 26: REL: UC1: Departure aircraft (6)

5.1.3 Alternative Flow 1: Rejected take-off

In this alternative flow, a rejected take-off (RTO) occurs after RWSL has detected the departure as being in its take-off run. It corresponds to a high-speed RTO, and can be triggered either by a tower runway controller order or by a pilot decision.

Use case steps:

Steps 1 to 4 are identical to main flow steps.

5. Aircraft is passing next to H4: H4 is switched OFF.

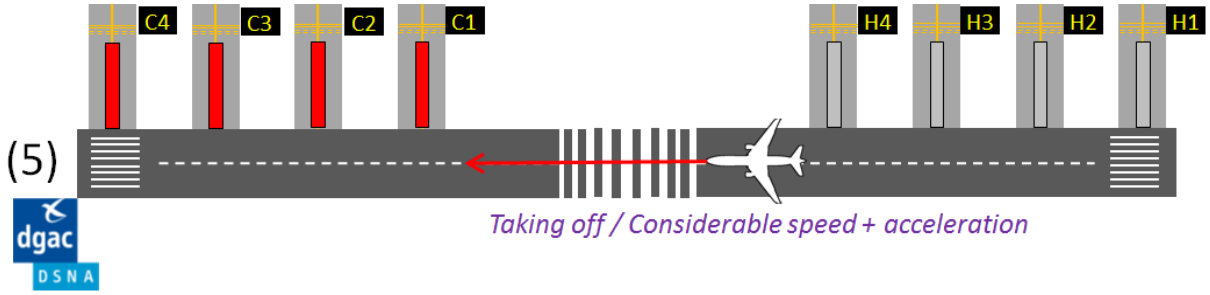

Figure 27: REL: UC1: Rejected take-off (1)

6. Aircraft is performing a rejected take-off. When it has sufficiently decelerated, distant REL are switched OFF: C3 and C4 are switched OFF.

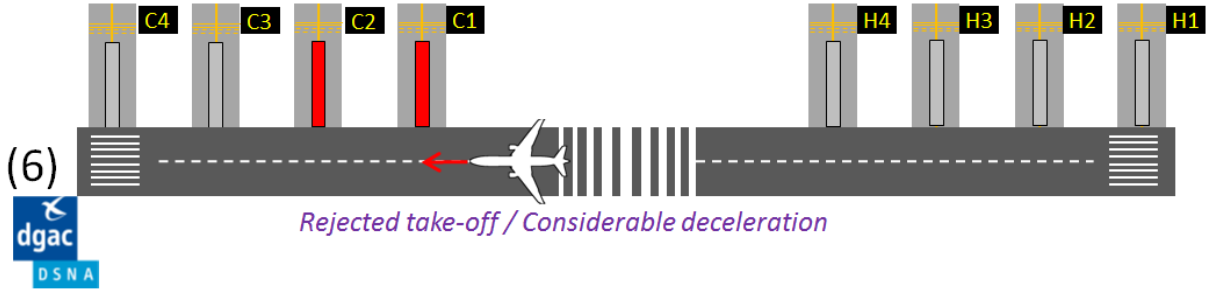

Figure 28: REL: UC1: Rejected take-off (2)

7. Aircraft has stopped and is about to vacate the runway: all REL are switched OFF: C1 and C2 are switched OFF.

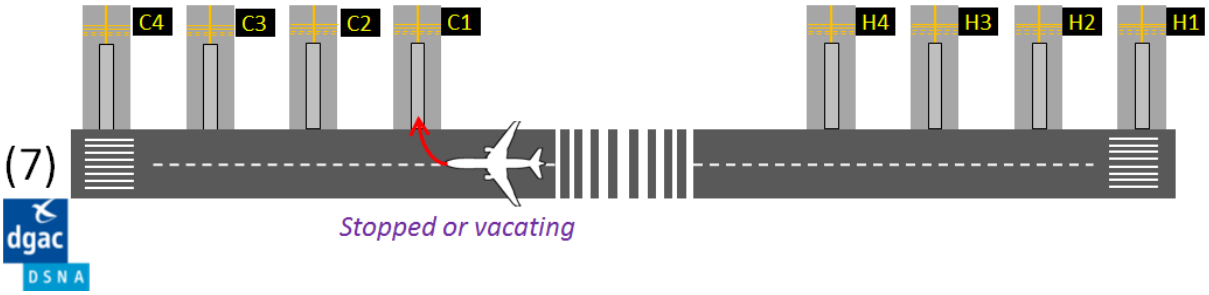

Figure 29: REL: UC1: Rejected take-off (3)

5.1.4 Alternative Flow 2: LVP conditions

RWSL processor receives the information that the runway is used in LVP conditions. Rationale and logic remain unchanged from the main flow. Local implementation can decide to modify RWSL tuning or behaviour to increase protection: for example, REL could be maintained ON until the aircraft crosses the intersection, even if it is airborne.

5.1.5 Failure Flow 1: Erroneous crossing clearance

Aircraft AC1 is taking off as in the main flow sequence; a second aircraft AC2 is taxiing on a taxiway equipped with REL, in order to cross the runway. Two different scenarios have to be distinguished, depending on the REL status by the time AC2 receives the clearance to cross the runway.

First scenario: REL ON

The second aircraft AC2 receives the erroneous clearance after the REL are switched ON.

Use case steps:

Steps 1 to 4 are identical to main flow steps for AC1.

5. Aircraft AC2 receives the erroneous clearance to cross.
6. The pilot of AC2, as the REL in front is ON, holds short of runway and replies to the tower runway controller that there is a problem with the clearance and the REL state.

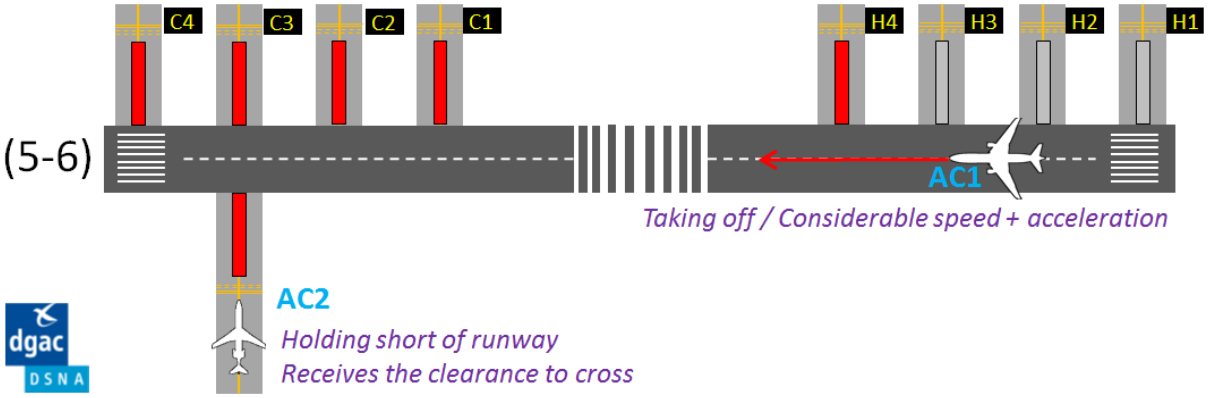

Figure 30: REL: UC1: Erroneous clearance – REL ON (1)

7. The tower runway controller analyses the situation (with the help of A-CWP, showing REL light status) and cancels the clearance.

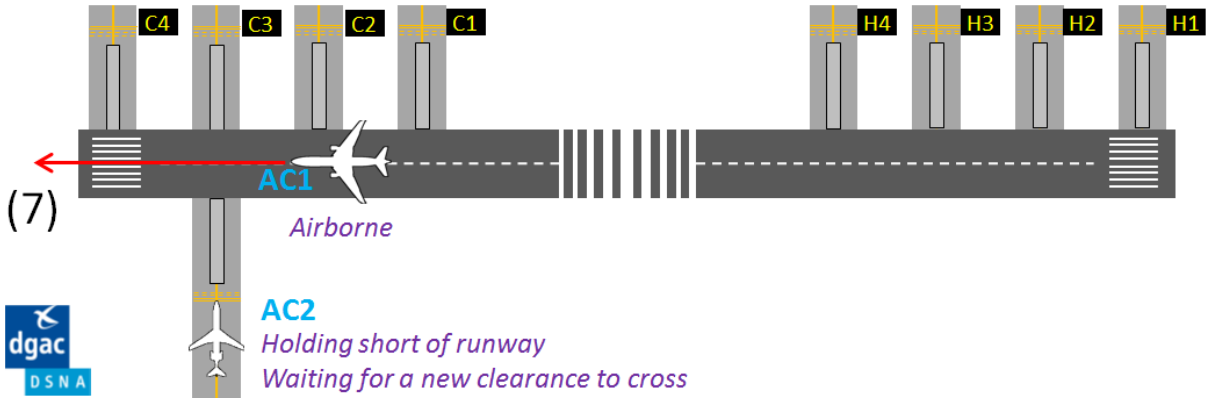

Figure 31: REL: UC1: Erroneous clearance – REL ON (2)

Second scenario: REL OFF

The second aircraft AC2 receives the erroneous clearance before the REL is switched ON.

Use case steps:

1. Aircraft AC1 is lined-up and stopped: no REL is switched ON.
2. Aircraft AC1 has some speed, and is close to H2 and H3: they are switched ON.
3. Aircraft AC1 is passing next to H2 and then next to H3: H2 and H3 are switched OFF. REL at the end of the runway are not switched ON yet.
4. Aircraft AC2 is taxing and receives the crossing clearance: it does not stop at the holding point and enters the runway.

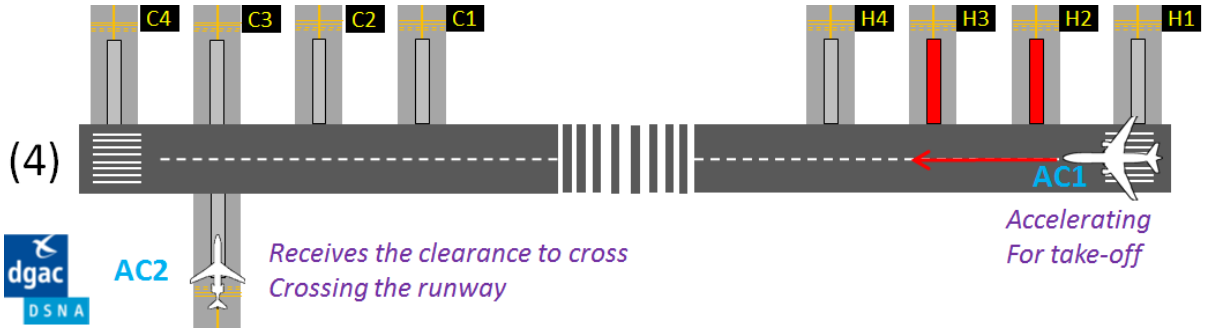

Figure 32: REL: UC1: Erroneous clearance – REL OFF (1)

5. Aircraft AC1 has a considerable speed (and acceleration): it is detected as a take-off run. All REL in front are switched ON (H4, C1, C2, C3 and C4).
6. The pilot of AC2 sees the last lights of the REL as they are switched ON. He decides, on his best judgement, to expedite the crossing: this decision can be based on different factors, e.g. the aircraft is already engaged on the runway, the good visibility and the absence of immediate danger in front. He warns the tower runway controller as soon as possible.

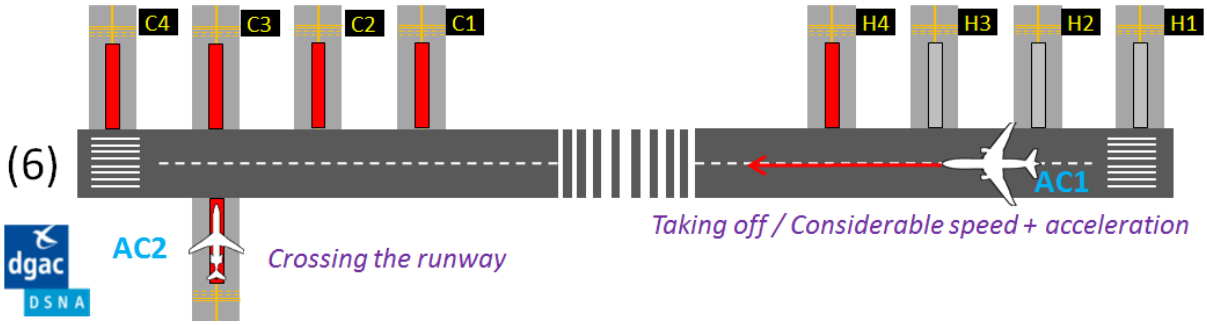

Figure 33: REL: UC1: Erroneous clearance – REL OFF (2)

7. The pilot of AC1 is commanded a rejected take-off, either via THL switching ON, or by tower runway controller on RMCA alert, or by tower runway controller on AC2 pilot report.
8. Aircraft AC1 has stopped and is about to vacate the runway via C1.

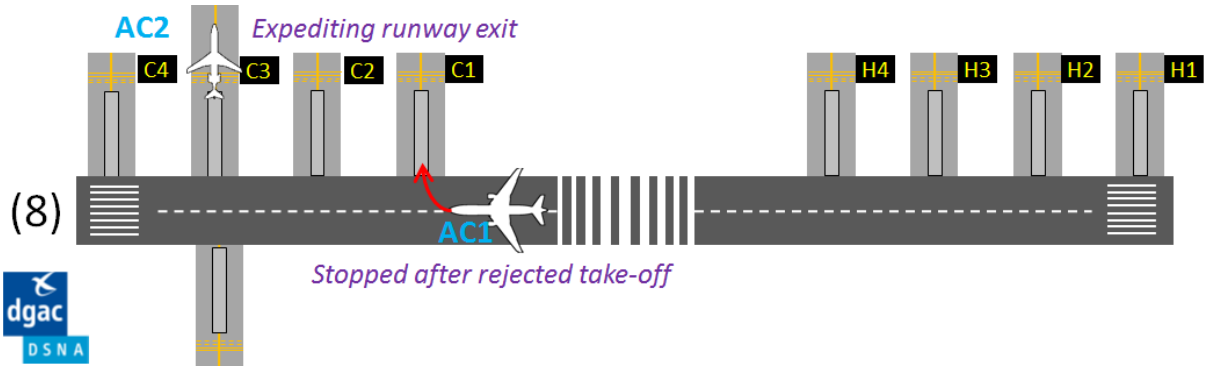

Figure 34: REL: UC1: Erroneous clearance – REL OFF (3)

5.1.6 Failure Flow 2: RWSL malfunction

Aircraft AC1 is taking off as in the main flow. Again two different scenarios have to be distinguished, depending on the malfunction symptoms.

First scenario: REL OFF instead of ON

An observer (pilot, vehicle driver or anyone else) reports to the tower runway controller or tower supervisor that a REL has not been switched ON as expected.

Depending on the problem analysis, the tower supervisor can decide:

- To continue operations with RWSL (e.g. if the problem is located only on a single REL). Some restrictions may be introduced (e.g. taxiway usage). If necessary, the tower runway controller should provide information to end users via all appropriate means (e.g. ATIS / NOTAM).
- To deactivate RWSL. The tower runway controller should provide information to end users via all appropriate means (e.g. ATIS / NOTAM).

Second scenario: REL ON instead of OFF

A pilot or a vehicle driver reports to the tower runway controller or supervisor that a REL is still ON when he receives the clearance to enter the runway. The clearance was valid but the REL has not been switched OFF in a timely manner.

The tower supervisor can decide to deactivate RWSL. In this case, he should provide information to end users via all appropriate means (e.g. ATIS / NOTAM).

5.2 Use case 2 – REL – Aircraft approaching and landing

5.2.1 General Conditions

Scope and Summary

This use case describes how RWSL system switches ON and OFF REL when an aircraft is approaching the runway and how it will be presented on tower runway controller's A-CWP and tower supervisor's HMI.

Pre Conditions

The airport is equipped with REL and aerodrome core surveillance.

The status of REL is made available on tower runway controller's A-CWP and tower supervisor's HMI.

REL are OFF for all the entrance taxiways of the runway.

Post Conditions

REL are OFF for all the entrance taxiways of the runway.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

The aircraft approaching is responsible for the switching ON REL. RWSL system shall trigger preventive information, warning flight crews and vehicle drivers who may be present on REL equipped intersections that a conflict situation could happen if they enter the runway.

5.2.2 Main Flow

Use case steps:

1. Aircraft is on approach. REL at the beginning of the runway are progressively switched ON as the aircraft is getting closer[4]: H1, then H2, H3 and H4.

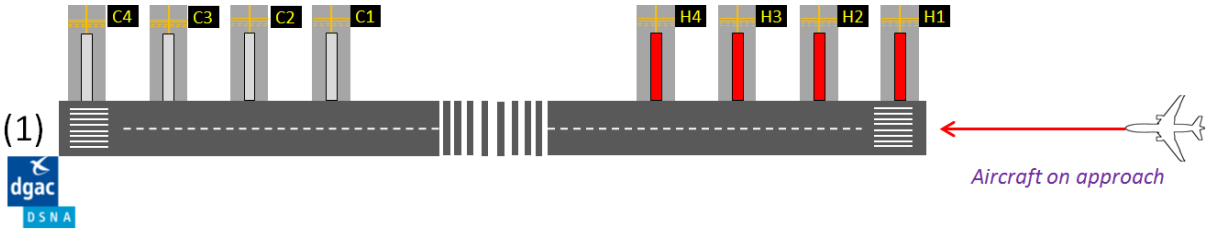

Figure 35: REL: UC2: Approach phase (1)

2. Aircraft is on short final and now close to the runway threshold. REL at the end of the runway are switched ON: C1, C2, C3 and C4.

[4] A crossing at the far end of the runway will take less time than a line-up and take-off from the nearest holding point to the threshold. RWSL shall allow the far-end crossings until the last limit (e.g. 2 NM on final), but prevent line-ups a bit before, as those nearest-end line-ups might be dangerous if done at the last legal limit for runway occupation.

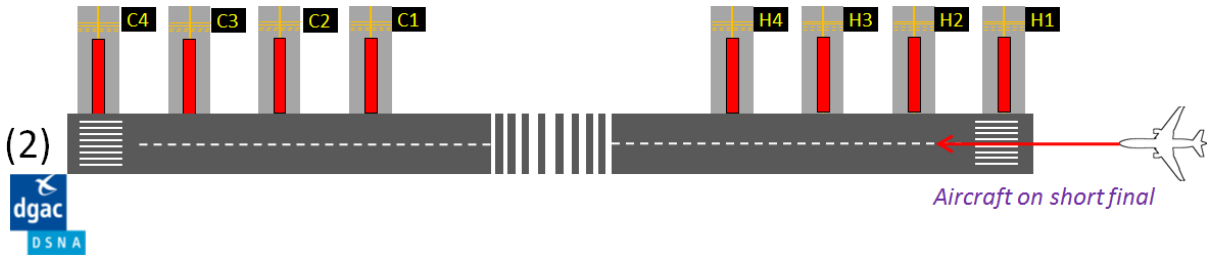

Figure 36: REL: UC2: Approach phase (2)

3. Aircraft is passing next to H1: H1 is switched OFF.
4. Aircraft touches down and starts decelerating.
5. Aircraft is passing next to H2: H2 is switched OFF.

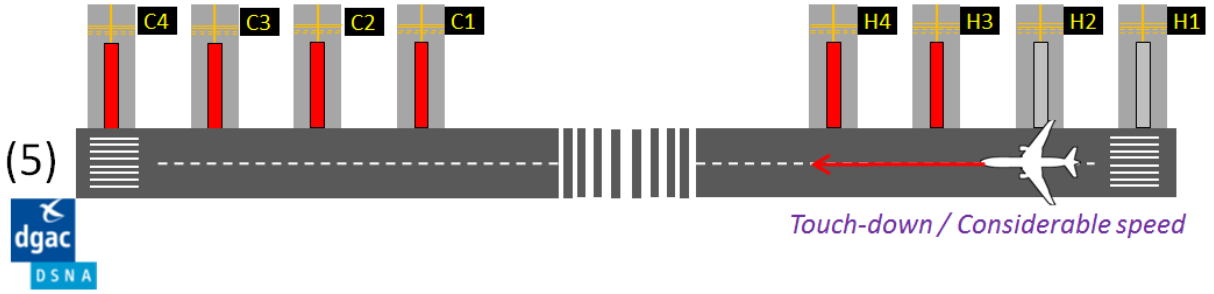

Figure 37: REL: UC2: Landing phase (1)

6. Aircraft decelerates under a controlled speed. Distant REL are switched OFF: C3 and C4.

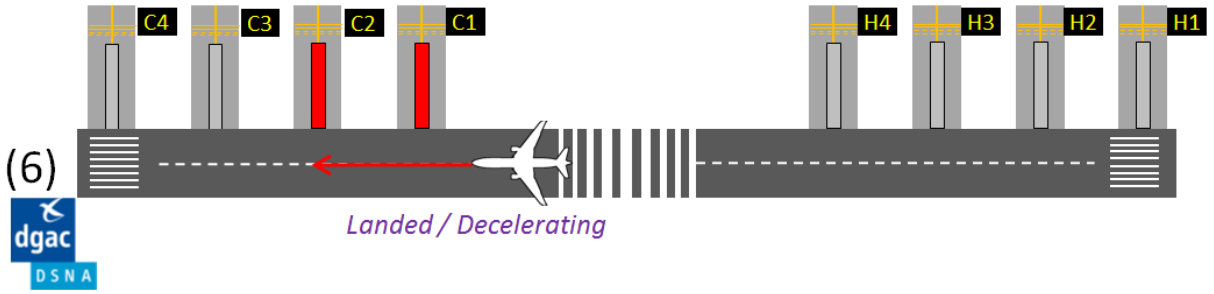

Figure 38: REL: UC2: Landing phase (2)

7. Aircraft is passing next to C1 and then C2: C1 and then C2 are switched OFF.
8. Aircraft has speed, and is close to C3: C3 is switched ON.

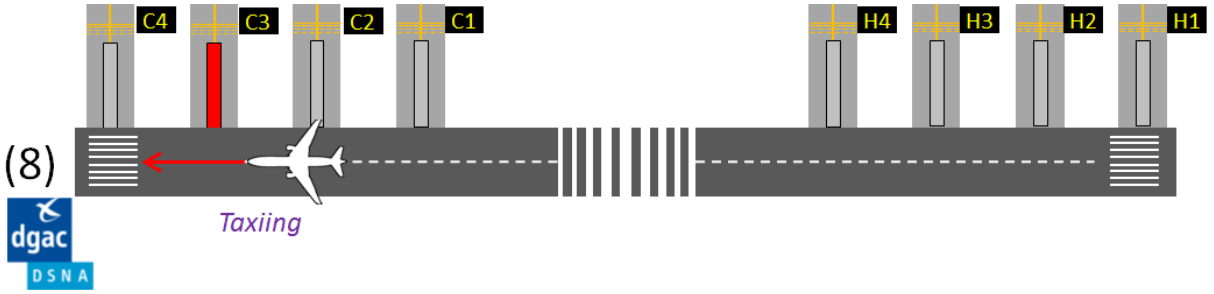

Figure 39: REL: UC2: Taxiing phase (1)

9. Aircraft is passing next to C3: C3 is switched OFF.
10. Aircraft has speed, and is close to C4: C4 is switched ON.

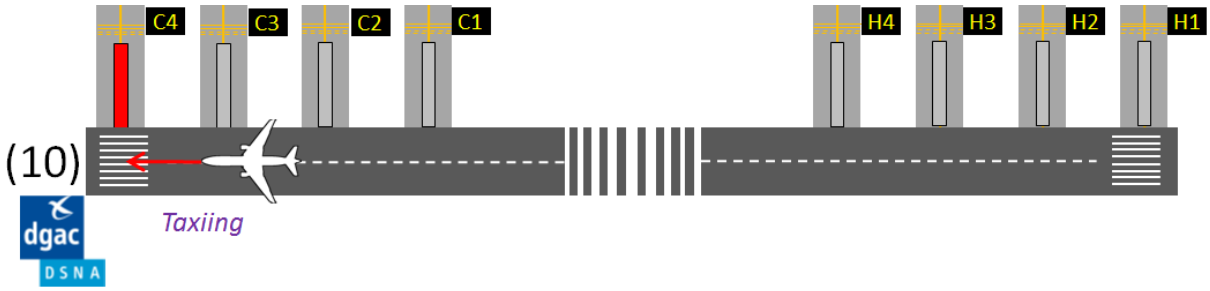

Figure 40: REL: UC2: Taxiing phase (2)

11. Aircraft has decelerated under a low speed; all REL in front are switched OFF: C4 is switched OFF.

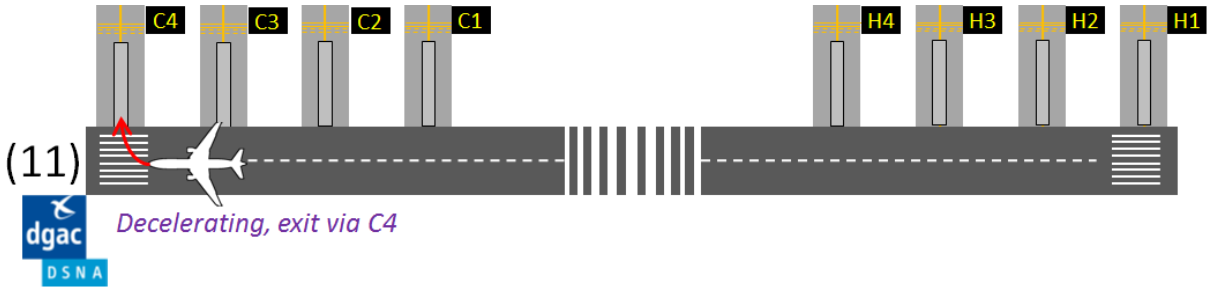

Figure 41: REL: UC2: Runway exit phase

Note: In the previous steps, when the aircraft is moving forward and is "passing next to an intersection", the corresponding REL is switched OFF. Some anticipation can be introduced in RWSL (depending on local tuning), and the REL can be switched OFF before the aircraft actually crosses the intersection.

5.2.3 Alternative Flow 1: Rapid exit taxiway

Use case steps:

Steps 1 to 5 are identical to main flow steps.

6. Aircraft decelerates under a controlled speed. Distant REL are switched OFF: C3 and C4.

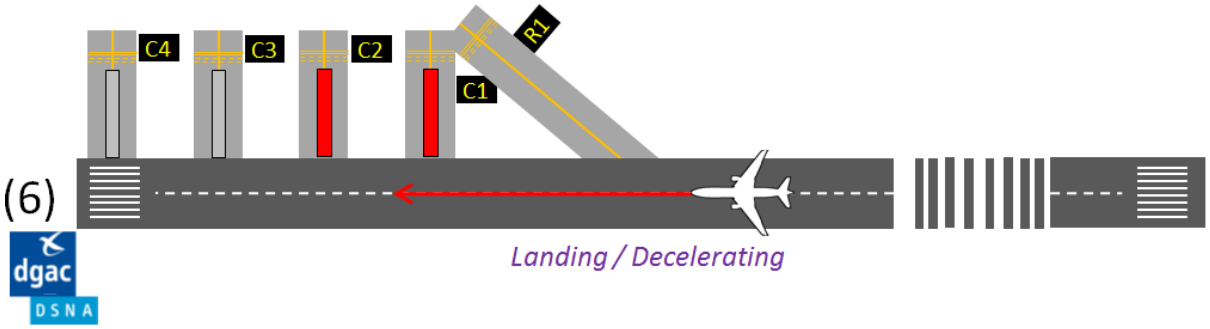

Figure 42: REL: UC2: Rapid exit taxiway (1)

7. Aircraft turns and exits via R1 rapid exit taxiway. As soon as RWSL detects the use of R1, all REL in front are switched OFF: C1 and then C2 are switched OFF.

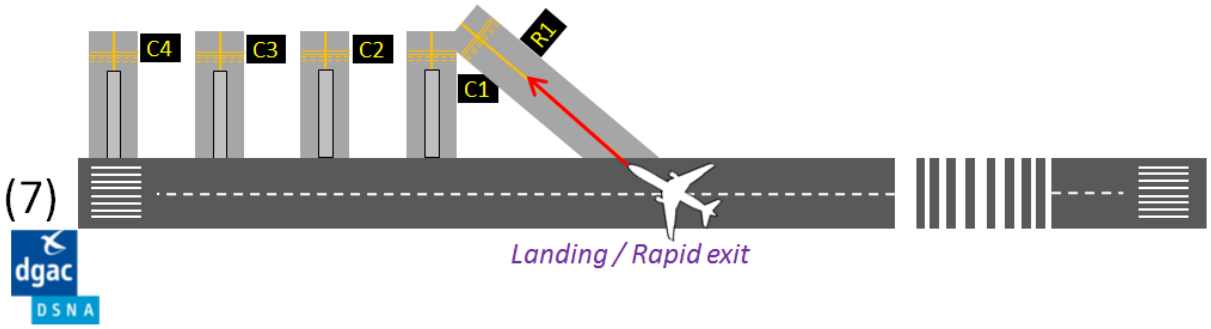

Figure 43: REL: UC2: Rapid exit taxiway (2)

5.2.4 Alternative Flow 2: Go around

Two different scenarios have to be distinguished, depending on the going-around aircraft trajectory.

First scenario: aircraft changes heading (and start to climb)

Use case steps:

1. Aircraft is on approach. REL at the beginning of the runway are progressively switched ON as the aircraft is getting close: H1, then H2 and H3.

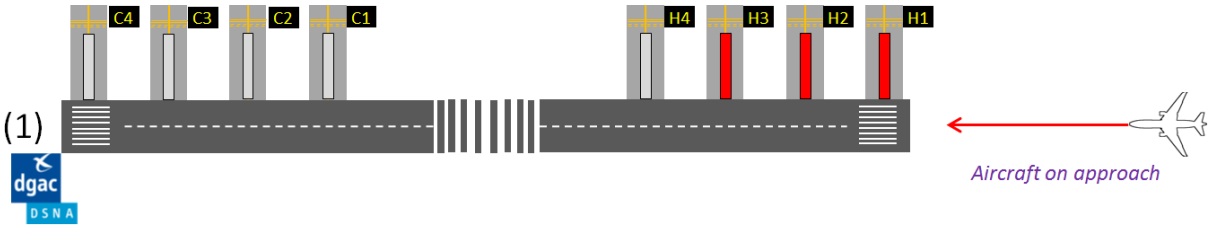

Figure 44: REL: UC2: Go around with heading change (1)

2. A go around is performed, either by pilot decision or by ATC request. All REL of the runway are switched OFF as soon as the GA is detected: H1, H2 and H3 are switched OFF.

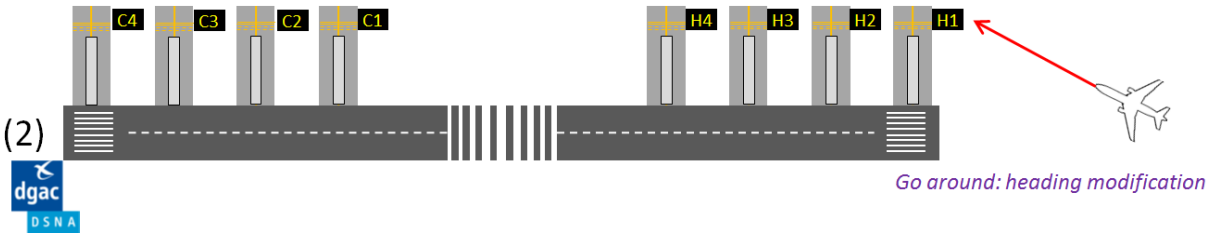

Figure 45: REL: UC2: Go around with heading change (2)

Second scenario: aircraft stays along the runway axis but starts to climb.

Use case steps:

1. Aircraft is on approach. REL at the beginning of the runway are progressively switched ON as the aircraft is getting close: H1, then H2 and H3 (see above).
2. A go-around is performed, either by pilot decision or by ATC request. All REL of the runway are switched OFF as soon as the GA is detected: H1, H2 and H3 are switched OFF.

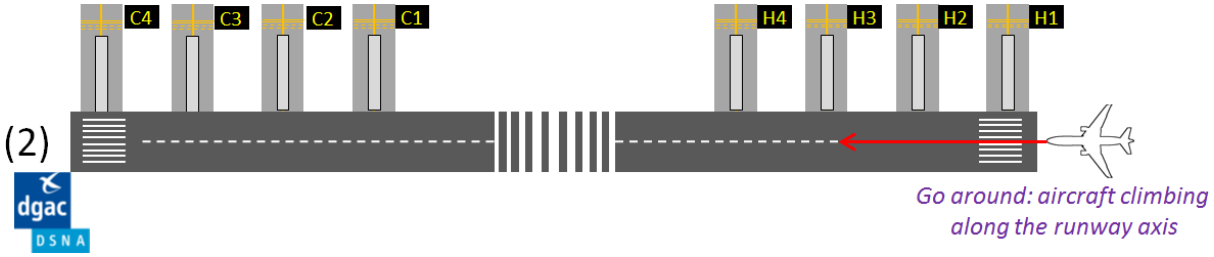

Figure 46: REL: UC2: Go around without heading change

5.2.5 Alternative Flow 3: LVP conditions

RWSL processor receives the information that the runway is used in LVP conditions. Rationale and logic remain unchanged from the main flow. Locally, it can be decided to modify RWSL tuning to increase protection: for example, REL could be switched ON earlier when the aircraft is on approach because separations are increased.

5.2.6 Failure Flow 1: Erroneous line-up clearance

Aircraft AC1 is approaching cleared to land. Aircraft AC2 is waiting to line-up from H3. As for Use case 1, two different scenarios have to be distinguished, depending on REL status by the time AC2 receives the clearance to line-up on the runway.

First scenario: REL ON

H3 REL is switched ON before AC2 receives the line-up clearance (or before the aircraft is actually moving).

Use case steps:

1. AC2 pilot, as the REL in front is ON, holds short of runway and replies to the tower runway controller that there is a problem with the clearance and the REL state.

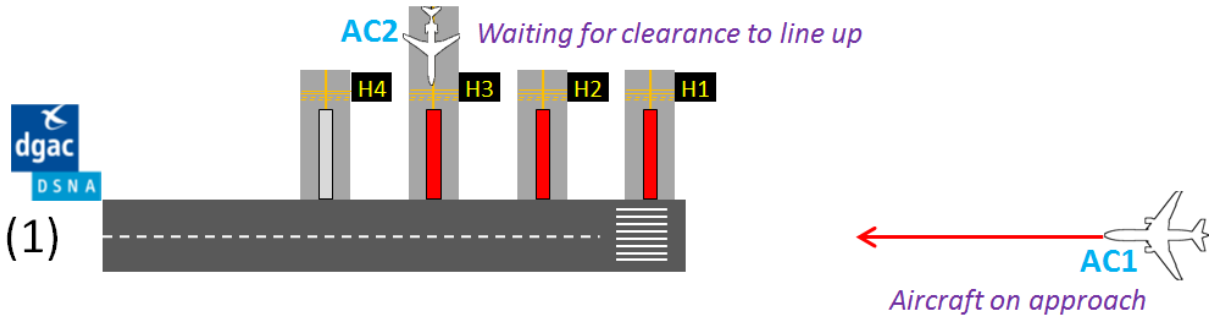

Figure 47: REL: UC2: Erroneous line-up clearance – REL ON

2. The tower runway controller analyses the situation (with the help of A-CWP showing REL status) and cancels the clearance.

Second scenario: REL OFF

H3 REL is switched ON as AC2 has already received the line-up clearance and is moving past the holding point.

Use case steps:

1. AC2 Pilot sees the last lights of the REL as they are switched ON. The aircraft has already passed the Holding Point.

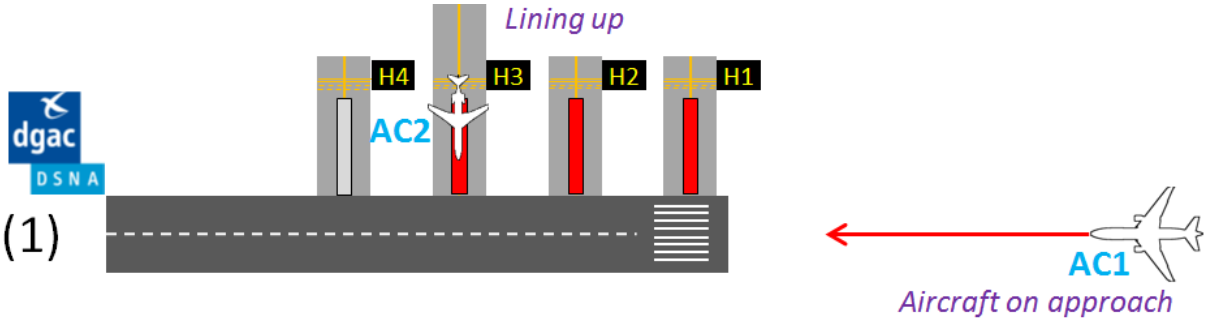

Figure 48: REL: UC2: Erroneous line-up clearance – REL OFF (1)

2. On his best judgement, AC2 pilot stops and warns the tower runway controller.
3. The tower runway controller analyses the situation (with the help of A-CWP showing REL status) and commands AC1 pilot to perform a go-around.
4. A go-around is initiated, either by pilot decision or by tower runway controller request. All REL of the runway are switched OFF as soon as the go-around is detected by the RWSL system: H1, H2 and H3 are switched OFF.
5. AC2 can resume its line-up.

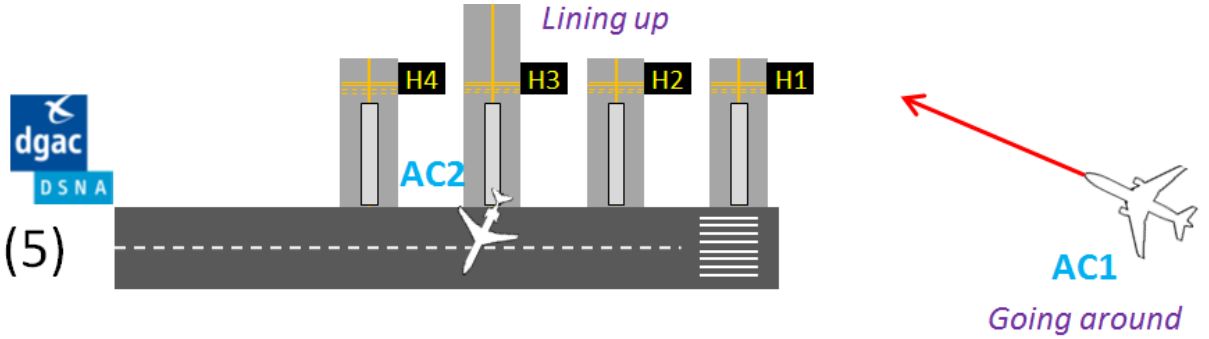

Figure 49: REL: UC2: Erroneous line-up clearance – REL OFF (2)

5.2.7 Failure Flow 2: Erroneous crossing clearance

Aircraft AC1 is approaching and cleared to land. Aircraft AC2 is taxiing in order to cross the runway. Again, two different scenarios have to be distinguished, depending on the REL status by the time AC2 receives the clearance to cross the runway.

First scenario: REL ON

REL is switched ON before AC2 receives the erroneous clearance to cross (or at least before AC2 has passed the holding point).

AC2 holds short of the runway, reports to the controller and the clearance is cancelled.

Second scenario: REL OFF

REL is switched ON after AC2 has passed the holding point.

As in use case 1 (Take-off use case), AC2 pilot stops or expedites the crossing, depending on its best judgement.

AC2 pilot reports to the controller and a go-around is commanded if necessary (provided that AC1 pilot did not initiate a go-around on its own initiative).

5.2.8 Failure Flow 3: RWSL malfunction

See use case 1 corresponding failure flow at section 5.1.6.

As a reminder, if some REL are out of order or malfunctioning, the tower supervisor shall be able to deactivate the RWSL system if he/she considers that performances are so degraded that the service cannot be provided to flight crews and vehicle drivers.

End users will be informed that RWSL system has been deactivated (on a runway or globally) via all appropriate means (e.g. ATIS / NOTAM).

5.3 Use case 3 – REL – Non cooperative target moving on the runway

5.3.1 General Conditions

Scope and Summary

This use case describes how the system switches ON and OFF REL when a non-cooperative target is moving on the runway and how it will be presented on tower runway controller's A-CWP and tower supervisor's HMI.

Pre Conditions

The airport is equipped with REL and aerodrome core surveillance.

The status of REL is made available on tower runway controller's A-CWP and tower supervisor's HMI.

REL are OFF for all the entrance taxiways of the runway.

Post Conditions

REL are OFF for all the entrance taxiways of the runway.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

Depending on the performance and characteristics of the local aerodrome core surveillance, it should be determined:

- If aerodrome core surveillance reports a target as a non-cooperative target,
- if track reports correspond to aircraft and/or vehicles,
- if the detection performance is sufficient to RWSL REL service.

RWSL system shall trigger a preventive warning, informing flight crews and vehicle drivers who may be present on REL equipped intersections that a conflict situation could happen if they enter the runway.

5.3.2 Main Flow

REL rules may be set up in order to switch ON REL when a non-cooperative target (or a target reported as non-cooperative by the aerodrome core surveillance) is moving on the runway and is getting close to an intersection (taxiing speed). REL should be switched OFF in a timely manner. Logic is the same as for aircraft or vehicle "proximity" protection (however, tuning may be different).

If there is the possibility to have a situation where a departure aircraft is reported by the aerodrome core surveillance as a non-cooperative target, RWSL should provide the same logic of take-off run detection in order to switch ON all REL in front of the departure, as for the aircraft target case (however, tuning may be different).

If there is the possibility to have a situation where an arriving aircraft is reported by the aerodrome core surveillance as a non-cooperative target, RWSL should provide the same logic of approach detection in order to switch ON all REL in front of the arrival, as for the aircraft target case (however, tuning may be different).

It should be determined if runway operations with a target reported by the aerodrome core surveillance as a non-cooperative target is a nominal situation. In this case REL switching OFF should be tuned, as for “aircraft target”, to happen in a timely manner (e.g. with introduction of anticipations in order to avoid conflicts with tower runway controller clearances).

5.3.3 Alternative Flow: LVP conditions

RWSL processor receives the information that the runway is used in LVP conditions. Rationale and logic remain unchanged from the main flow. Local implementation can decide to modify RWSL tuning to increase protection. As an example, REL could be switched ON earlier or switched OFF later because separations are increased

5.3.4 Failure Flow: RWSL malfunction

If some REL are out of order or malfunctioning, the tower supervisor shall be able to deactivate the RWSL system if he/she considers that performances are so degraded that the service cannot be provided to flight crews and vehicle drivers.

End users will be informed that RWSL system has been deactivated (on a runway or globally) via all appropriate means (e.g. ATIS / NOTAM).

5.4 Use case 4 – REL – Vehicle moving on the runway

5.4.1 General Conditions

Scope and Summary

This use case describes how RWSL system switches ON and OFF REL when a vehicle is moving on the runway and how it will be presented on tower runway controller’s A-CWP and tower supervisor’s HMI.

Pre Conditions

The airport is equipped with REL and aerodrome core surveillance.

The status of REL is made available on tower runway controller’s A-CWP and tower supervisor’s HMI.

REL are switched OFF for all the entrance taxiways of the runway.

Post Conditions

REL are switched OFF for all the entrance taxiways of the runway.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

A vehicle is moving on the runway at a sufficient speed.

5.4.2 Main Flow

Use case steps:

1. Vehicle has entered the runway and is getting close to H3: H3 is switched ON.

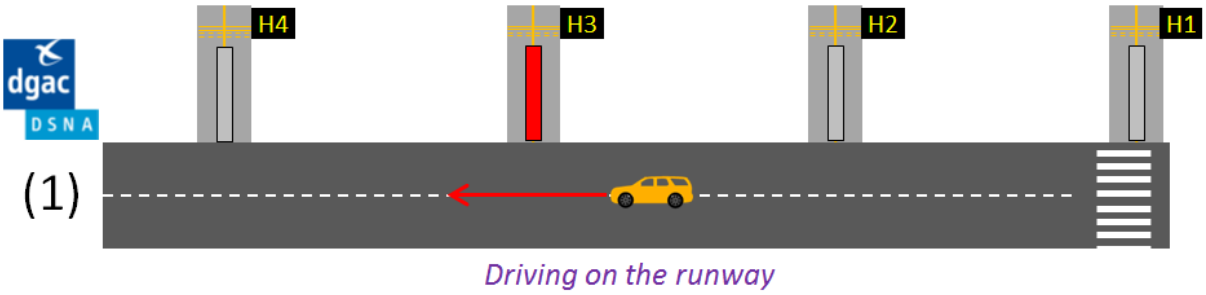

Figure 50: REL: UC4: Vehicle moving on the runway (1)

2. Vehicle is passing next to H3: H3 is switched OFF.
3. Vehicle is getting close to H4: H4 is switched ON.

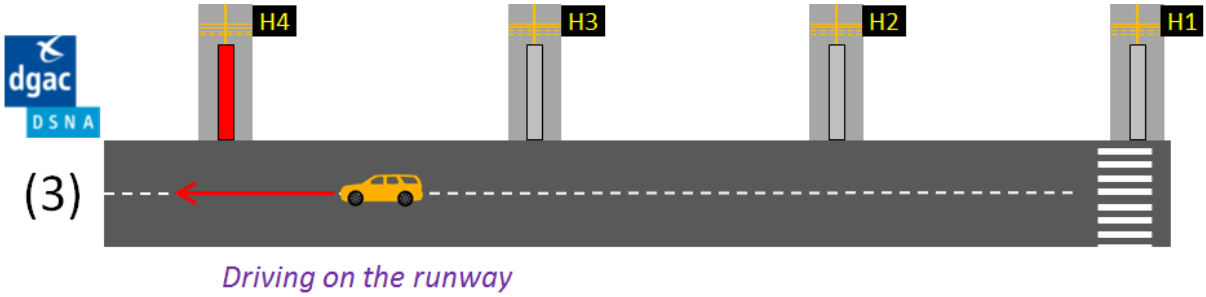

Figure 51: REL: UC4: Vehicle moving on the runway (2)

4. Vehicle has stopped; all REL on front are switched OFF: H4 is switched OFF.

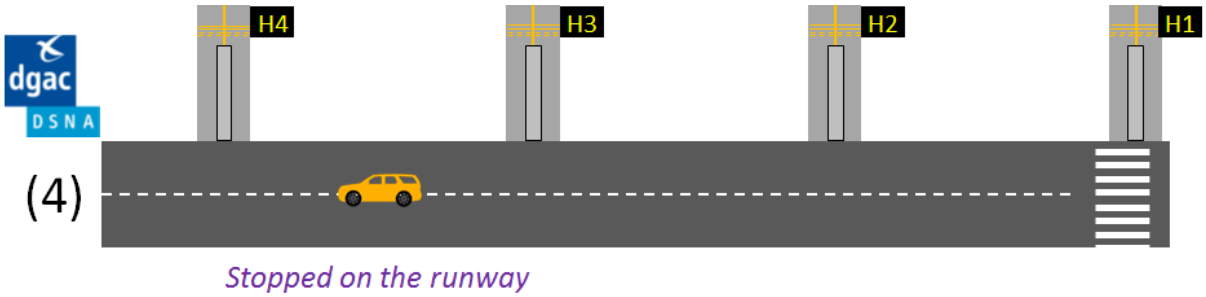

Figure 52: REL: UC4: Vehicle moving on the runway (3)

5. Vehicle performs a U-Turn, accelerates and is getting close to H3: H3 is switched ON.

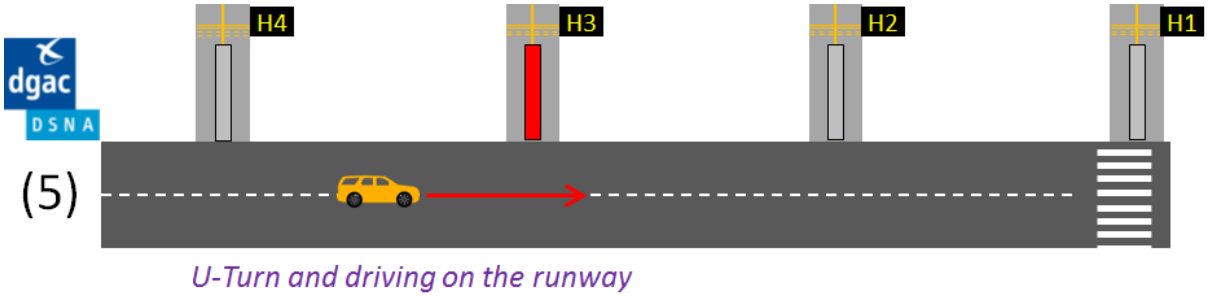

Figure 53: REL: UC4: Vehicle moving on the runway (4)

6. Vehicle exits the runway via H3: H3 is switched OFF.

5.4.3 Alternative Flow: LVP conditions

RWSL processor receives the information that the runway is used in LVP conditions. Rationale and RWSL logic remain unchanged from the Main Flow. Locally, it can be decided to modify RWSL tuning to increase protection: for example, REL could be switched ON earlier or switched OFF later because separations are increased

5.4.4 Failure Flow: RWSL malfunction

If some REL are out of order or malfunctioning, the tower supervisor shall be able to deactivate the RWSL system if he/she considers that performances are so degraded that the service cannot be provided to flight crews and vehicle drivers.

End users will be informed that RWSL system has been deactivated (on a runway or globally) via all appropriate means (e.g. ATIS / NOTAM).

5.5 Use case 5 – REL – Closed runway

5.5.1 General Conditions

Scope and Summary

This use case describes REL behaviour when the runway is closed and how it will be presented on tower runway controller's A-CWP and tower supervisor's HMI. On some airports, an intermediate runway state may be available for controllers: runway occupied.

Pre Conditions

The airport is equipped with REL and aerodrome core surveillance.

The status of REL is made available on tower runway controller's A-CWP and tower supervisor's HMI.

RWSL system receives runway operational status, and the runway is "open".

Post Conditions

REL configured to be forced ON are lit and displayed as such on tower runway controller's A-CWP.

REL configured to be forced OFF are unlit and displayed as such on tower runway controller's A-CWP.

RWSL REL service is still available and running for other (active and not forced) REL.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

The tower runway controller changes the runway status to "closed"/"occupied" via the runway status system.

5.5.2 Main Flow

1. Runway status is shown on the tower runway controller's A-CWP and tower supervisor's HMI.
2. The tower runway controller changes the runway status to "closed"/"occupied" via the runway status system.
3. When the runway is declared as closed (resp. occupied), RWSL system shall:
    - Switch ON REL which have been configured off-line to be ON (lit) when the runway is closed (resp. occupied).

- Switch OFF REL which have been configured off-line to be OFF (unlit) when the runway is closed (resp. occupied).
- Maintain active REL that have been configured off-line to be active when the runway is closed (resp. occupied). Active means that the REL service is provided and is nominal on those intersections [See use cases above].

These configuration alternatives (forced ON, forced OFF or active) on runway “closed” (resp. “occupied”) shall be adapted separately for each REL.

The lighting status triggered by RWSL system, shall be displayed on the tower runway controller’s A-CWP.

Pilots and vehicle drivers can see different RWSL behaviours depending on runway operational status (open, occupied or closed). Should RWSL not be informed of a runway occupied or closed status, it shall keep its behaviour as defined for an open runway.

5.5.3 Failure Flow: RWSL malfunction

If some REL are out of order or malfunctioning, the tower supervisor shall be able to deactivate the RWSL system if he/she considers that performances are so degraded that the service cannot be provided to flight crews and vehicle drivers.

End users will be informed that RWSL system has been deactivated (on a runway or globally) via all appropriate means (e.g. ATIS / NOTAM).

5.6 Use case 6 – REL – Reopened runway

5.6.1 General Conditions

Scope and Summary

This use case describes REL behaviour when the runway is reopened after having been closed and how it will be presented on tower runway controller’s A-CWP and tower supervisor’s HMI.

Pre Conditions

The airport is equipped with REL and aerodrome core surveillance.

The status of REL is made available on tower runway controller’s A-CWP and tower supervisor’s HMI.

RWSL system receives runway status, and the runway is “closed” (resp. “occupied”).

Post Conditions

REL configured to be forced ON or OFF when runway was closed (resp. occupied) are active again.

RWSL REL service is available again on all REL of the runway.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

The tower runway controller changes the runway status to “open” via the runway status system.

5.6.2 Main Flow

1. Runway has been closed / occupied (tower runway controller action) [See use case 5].
2. The tower runway controller reopens the runway via the runway status system.
3. When the runway is reopened, RWSL system shall return to normal mode. All REL of the runway shall return to their normal operation [See use cases 1 to 4].

The lighting triggered by the system, shall be displayed on the tower runway controller's A-CWP and tower supervisor's HMI.

RWSL system shall consider all the runways equipped with RWSL as open in case of loss of runway status information. It shall take into account the runway status when the information will be available again.

5.6.3 Failure Flow: RWSL malfunction

If some REL are out of order or malfunctioning, the tower supervisor shall be able to deactivate the RWSL system if he/she considers that performances are so degraded that the service cannot be provided to flight crews and vehicle drivers.

End users will be informed that RWSL system has been deactivated (on a runway or globally) via all appropriate means (e.g. ATIS / NOTAM).

5.7 Use case 7 – THL – Departure aircraft against mobile

5.7.1 General Conditions

Scope and Summary

This use case describes how the system manages THL segments when there is a departure on the runway and how it will be presented on tower runway controller's A-CWP and tower supervisor's HMI.

Note: In the use case, a mobile is systematically introduced in front of the line-up departure. This condition is necessary to observe THL switching ON. We could have considered a simpler "main flow" scenario with a single departure aircraft on the runway: in this case, there is no RWSL action, i.e. no THL is switched ON.

Pre Conditions

The airport is equipped with THL and aerodrome core surveillance.

The status of THL is made available on tower runway controller's A-CWP and tower supervisor's HMI.

THL are OFF on the whole runway.

Post Conditions

THL are OFF on the whole runway.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

The system shall trigger preventive information, warning flight crews who are ready for take-off or have initiated their take-off that a conflict situation could happen if they initiate their take-off run or continue their acceleration: there is at least one mobile in front of them in the safety region.

5.7.2 Main Flow

Use case steps:

1. Aircraft DEP is lining-up via D2. No mobile inside the corresponding D2 safety region. Consequently, D2 THL remains OFF.

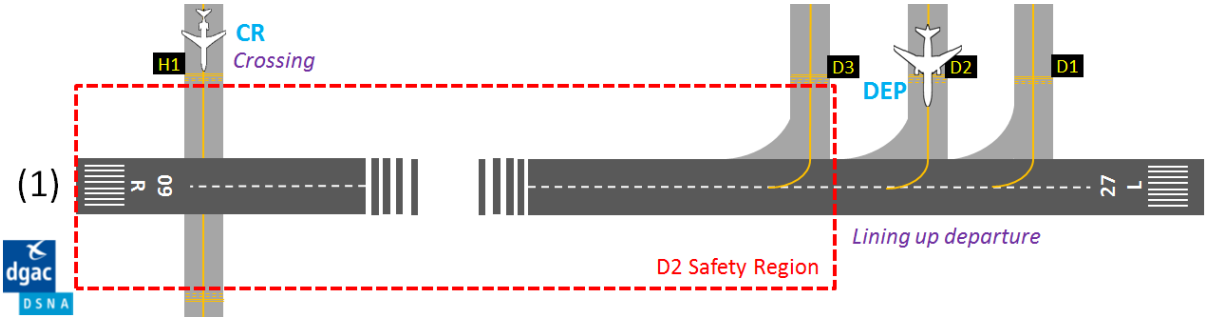

Figure 54: THL: UC7: Aircraft lining up (1)

2. Aircraft CR is crossing the runway; it has entered D2 safety region. Aircraft DEP is still lining-up via D2: the line-up is not yet detected by RWSL. Consequently, D2 THL remains OFF.

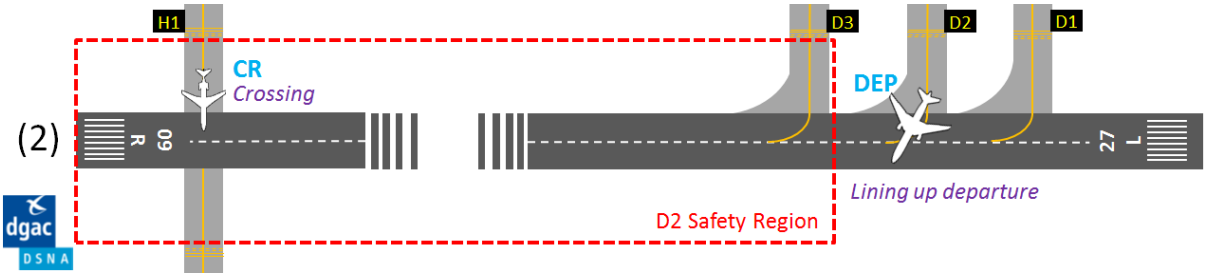

Figure 55: THL: UC7: Aircraft lining up (2)

3. The line-up is detected and aircraft CR is still in D2 safety region: D2 THL segments are switched ON (there are 2 segments in the use-case layout).

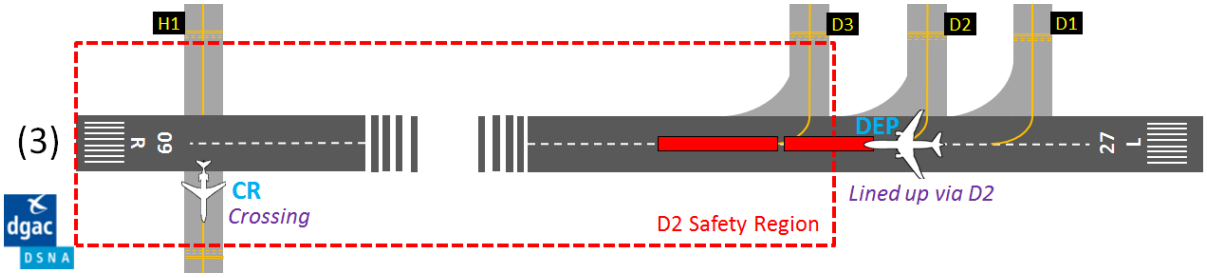

Figure 56: THL: UC7: Aircraft lined up (1)

4. Aircraft CR exits the D2 safety region: D2 THL is switched OFF. Some anticipation may be introduced in the region exit detection.

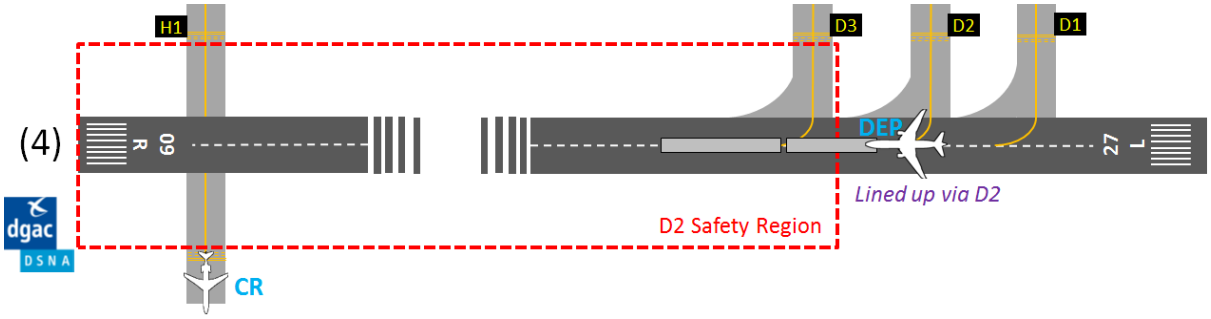

Figure 57: THL: UC7: Aircraft lined up (2)

5. Aircraft DEP receives the take-off clearance from the tower runway controller and starts its take-off run.

5.7.3 Alternative Flow 1: Multiple line-ups

In case two aircraft are cleared to line-up consecutively from different holding points, two different scenarios have to be distinguished, depending on the first one to physically line up (leading or trailing one):

First scenario: trailing aircraft lining up first, then leading aircraft

Two departure aircraft are cleared to line-up: DEP1 via D1 and then DEP2 via D2.

A crossing aircraft CR is added to the scenario, to command some THL switching ON.

Use case steps:

1. Aircraft CR is crossing the runway; it has entered D1 and D2 safety regions
2. Aircraft DEP1 is detected as lined-up via D1. Aircraft CR is inside D1 safety region: D1 THL segments are switched ON (the first two segments for this use case layout).

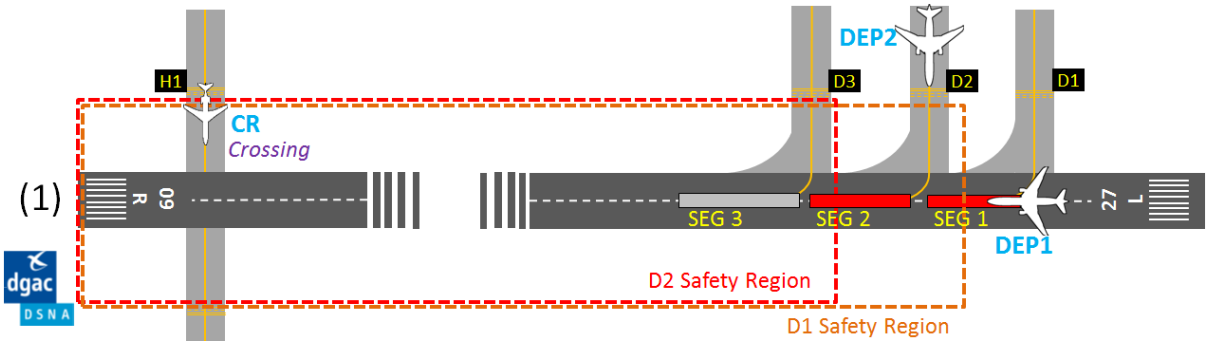

Figure 58: THL: UC7: Multiple line-ups, trailing first (1)

3. Aircraft DEP2 enters the runway to line-up via D2

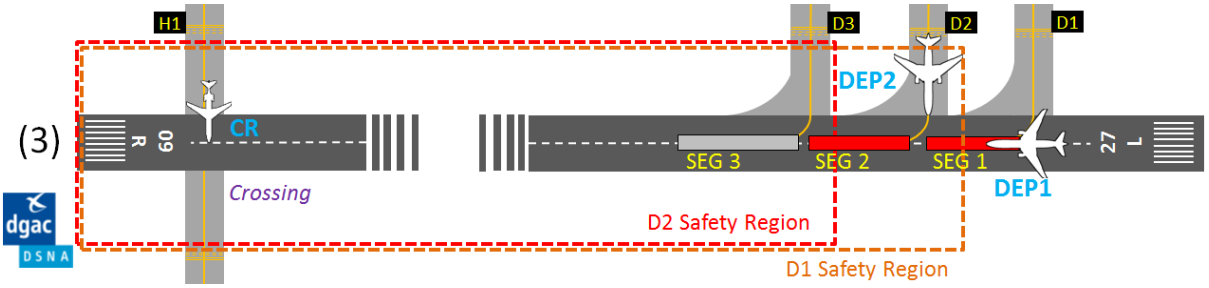

Figure 59: THL: UC7: Multiple line-ups, trailing first (2)

4. When aircraft DEP2 is detected as lined-up via D2, THL segments n°2 (already lit) and n°3 are switched ON (because of CR aircraft in D2 safety region).

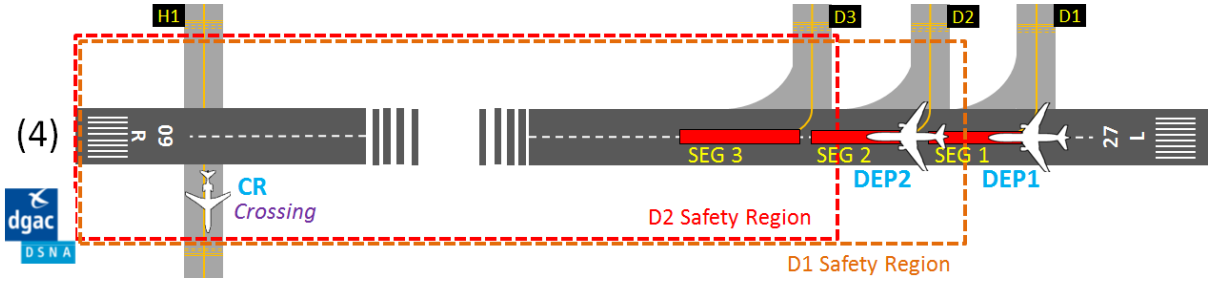

Figure 60: THL: UC7: Multiple line-ups, trailing first (3)

5. When aircraft CR exits D2 safety region: D2 THL is switched OFF. Note that some anticipation may be introduced in the region exit detection.

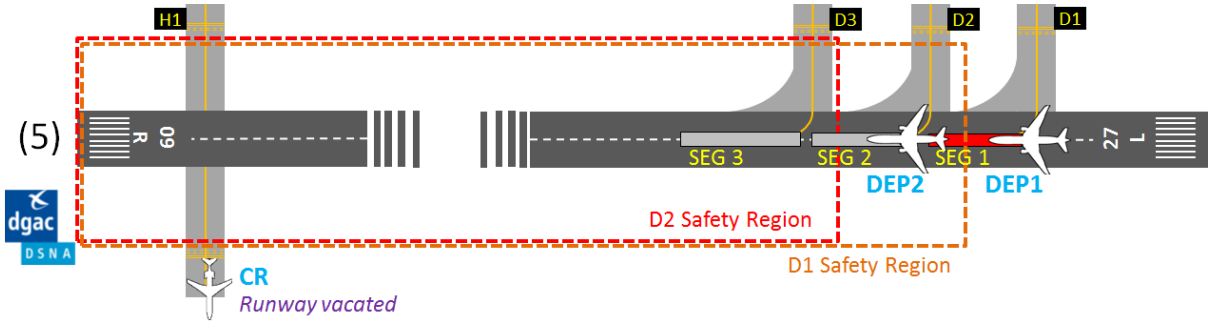

Figure 61: THL: UC7: Multiple line-ups, trailing first (4)

6. Aircraft DEP2 receives the take-off clearance from the tower runway controller and starts its take-off run.
7. When aircraft DEP2 has passed segment n°2, this segment is switched ON again to prevent aircraft DEP1 from taking off by providing him with full THL service as it is now possible.

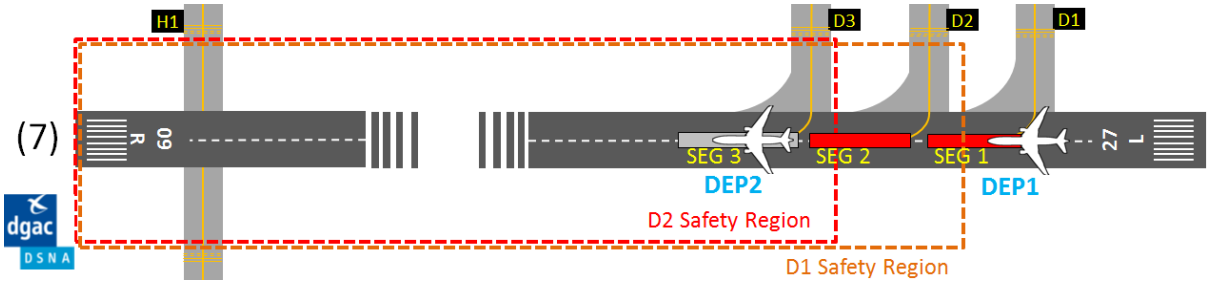

Figure 62: THL: UC7: Multiple line-ups, trailing first (5)

8. When aircraft DEP2 is airborne. RWSL does not consider it as a threat anymore, even if it is still located in D1 safety region. D1 THL segments are switched OFF.

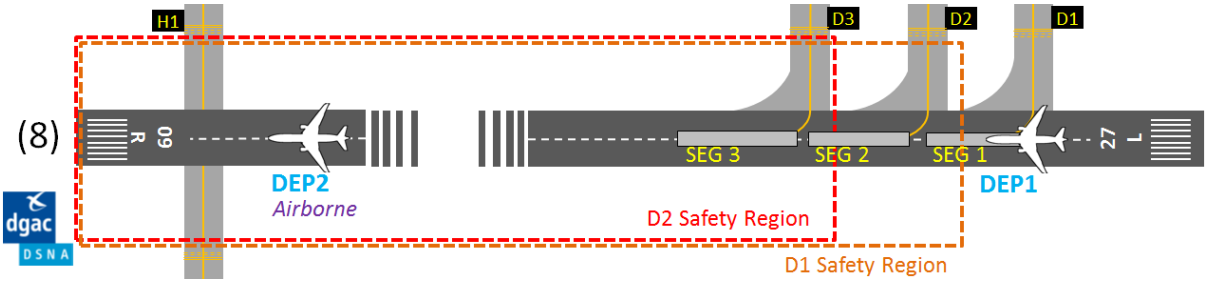

Figure 63: THL: UC7: Multiple line-ups, trailing first (7)

This DEP2 aircraft situation has been configured off-line: RWSL considers that DEP2 does not trigger THL anymore. In this scenario the situation corresponds to an airborne status, which may or not be taken into account to switch OFF THL. Other conditions may also be configured to switch OFF THL by anticipation (e.g. if there is enough distance between DEP1 and DEP2).

Second scenario: leading aircraft lining up first, then trailing aircraft

Two departure aircraft are authorised to line-up: DEP2 via D2 and then DEP1 via D1.

No crossing aircraft CR will be involved in this scenario.

Use case steps:

1. Aircraft DEP2 is detected as lined-up via D2. No mobile is in D2 safety region: D2 THL remains OFF.

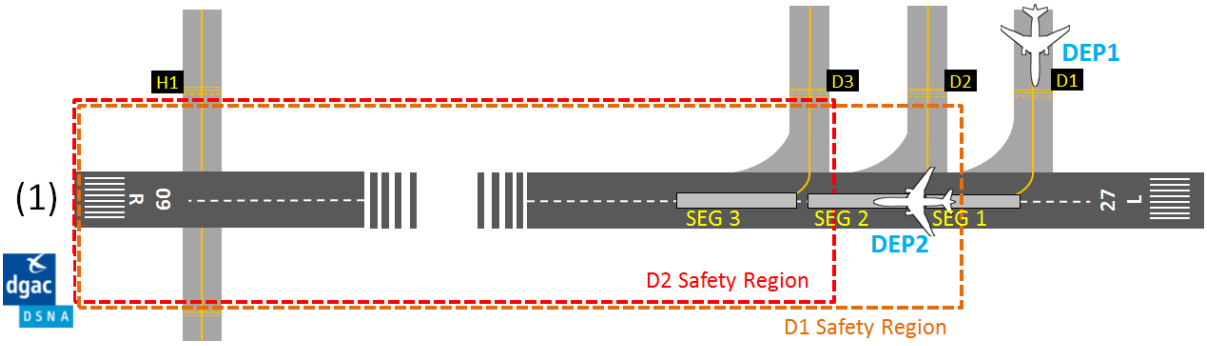

Figure 64: THL: UC7: Multiple line-ups, leading first (1)

2. Aircraft DEP1 enters the runway to line-up via D1. When it is detected as lined-up by RWSL, D1 THL segment n°1 is switched ON. D1 segment n°2 remains OFF because it would interfere with DEP2 operations otherwise.

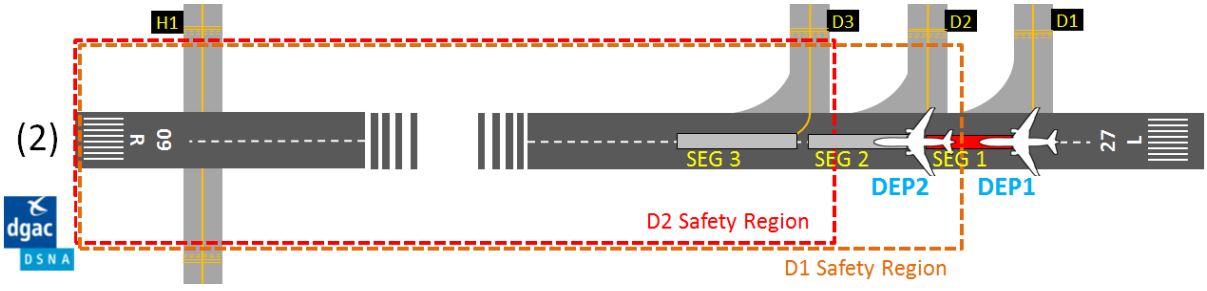

Figure 65: THL: UC7: Multiple line-ups, leading first (2)

3. Aircraft DEP2 receives the take-off clearance from the tower runway controller and starts its take-off run.

4. As in first scenario step 7, when aircraft DEP2 has passed segment n°2, this segment is switched ON.

5. As in first scenario step 8, when RWSL considers that aircraft DEP2 is not a threat to DEP1 anymore, even if it is still located in D1 safety region, D1 THL is switched OFF. Aircraft DEP1 may now take off with a clearance.

5.7.4 Alternative Flow 2: Multiple line-ups and rejected take-off

After a situation of multiple line-ups, aircraft DEP2 is taking off and DEP1 is lined-up from D1.

Use case steps:

1. Aircraft DEP1 is detected as lined-up via D1. Aircraft DEP2 is in D1 safety region: D1 THL (segment n°1 and n°2) is switched ON.

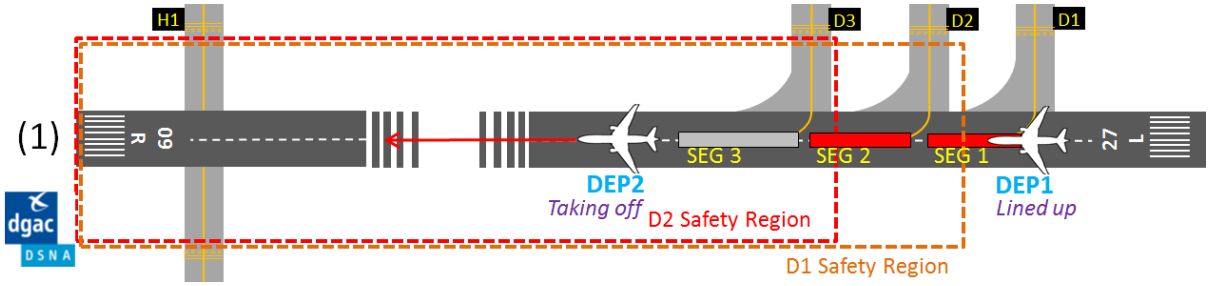

Figure 66: THL: UC7: Multiple line-ups, rejected take-off (1)

2. RWSL considers that Aircraft DEP2 is not a threat to DEP1 anymore, even if it is still located in D1 safety region. D1 THL is switched OFF.

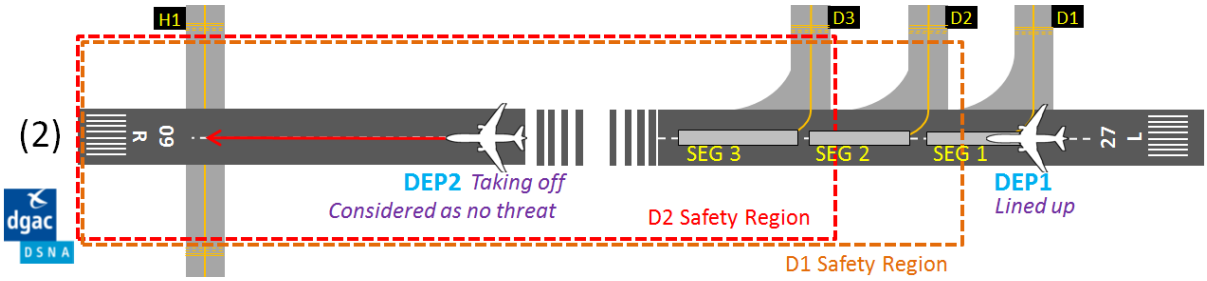

Figure 67: THL: UC7: Multiple line-ups, rejected take-off (2)

3. For whatever reason, DEP2 pilot aborts the take-off. Aircraft DEP2 is decelerating on the runway. As soon as RWSL detects the rejected take-off, aircraft DEP2 is considered as a threat to DEP1 again, and D1 THL is switched ON again.

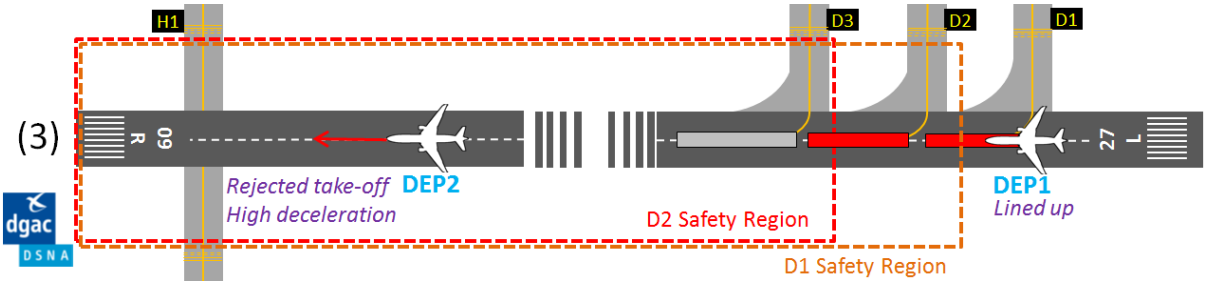

Figure 68: THL: UC7: Multiple line-ups, rejected take-off (3)

4. When aircraft DEP2 exits the runway, and thus D1 safety region, D1 THL is switched OFF again. Aircraft DEP1 may now take off with a clearance.

5.7.5 Alternative Flow 3: LVP conditions

RWSL processor receives the information that the runway is used in LVP conditions. Rationale and logic remain unchanged from the Main Flow. Local implementation can decide to modify RWSL tuning to increase protection: for example, safety regions can be widened (from CAT I holding points to CAT III holding points), or the configured situations where RWSL can switch OFF THL by anticipation (even if mobile is still in safety region) can be hardened.

5.7.6 Failure Flow 1: Runway incursion

The departing aircraft DEP is cleared to take off. A mobile (aircraft or vehicle) enters the safety region in front (with or without a tower runway controller clearance). The THL corresponding to the initial DEP lining-up position is switched ON. Two different scenarios have to be distinguished, depending on the precise timing, and whether the departing aircraft has already started its take-off run or not when the runway incursion happens.

First scenario: departing aircraft has not started its take-off run

Use case steps:

1. DEP aircraft is lined-up for take-off, and receives a take-off clearance. DEP pilot sees the THL ON in front of him.

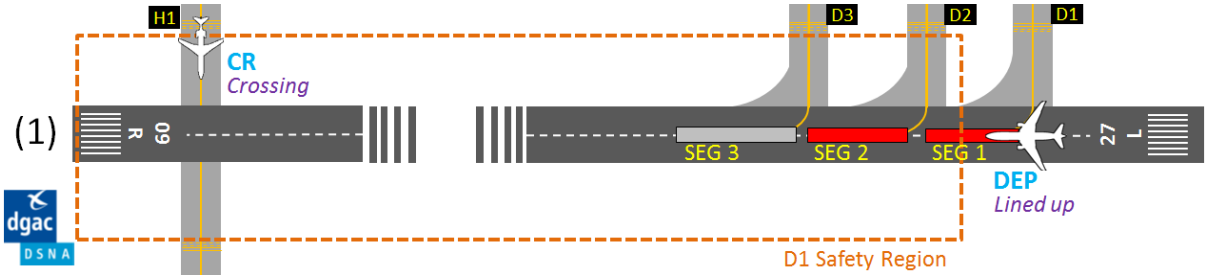

Figure 69: THL: UC7: Runway incursion before the start of the take-off run

2. DEP pilot does not start the take-off run. He reports to tower runway controller the inconsistency between THL switched ON and the received clearance to take off.
3. The tower runway controller analyses the situation (with the help of A-CWP, with THL status) and cancels his take-off clearance.
4. When the mobile CR has exited the runway, the tower runway controller issues a new take-off clearance to the departing aircraft.

Second scenario: departing aircraft has started its take-off run, but has some THL lights still visible

Use case steps:

1. DEP aircraft is taking off. It is accelerating.
2. CR aircraft enters the runway (with or without a tower runway controller clearance).
3. As soon as CR aircraft enters D1 safety region, D1 THL is switched ON. DEP aircraft position is upstream segment n°2 end, and DEP pilot can still see some THL lights in front.

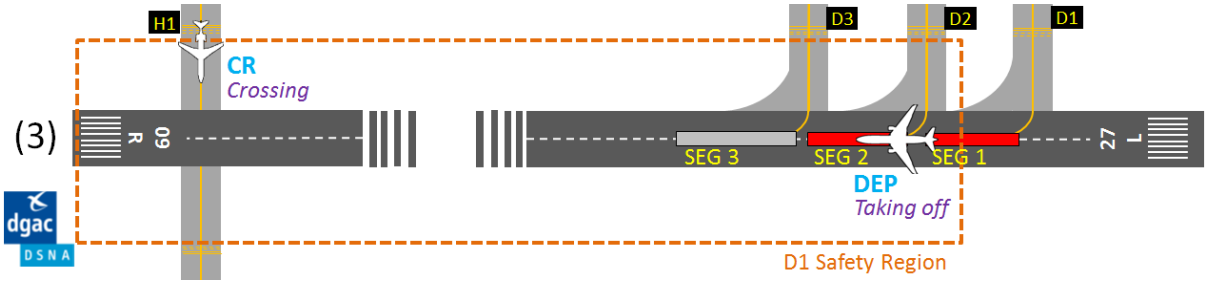

Figure 70: THL: UC7: Runway incursion after the start of the take-off run

4. DEP pilot decides, based on its best judgement, to abort the take-off and performs a rejected take-off. He advises the tower runway controller as soon as possible.
5. The tower runway controller analyses the situation (with the help of A-CWP, with THL status) and manages the new runway situation.

Note 1: This use-case only deals with THL management; REL management in case of a rejected take-off is described in section 5.1.3.

Note 2: In the case where DEP aircraft already has passed the whole THL length at the time of the runway incursion, and thus its pilot cannot see the lights, the working method will remain as the current one when a runway incursion occurs as an aircraft is taking off. Increasing the length of the THL for a given holding point would be dangerous as aircraft can reach a high speed after a 450m take-off run. At that speed, aborting the take-off would be hazardous for some aircraft (depending on their decision speed and how fast they reach it) and THL length shall be compatible with all kind of aircraft using the runway.

5.7.7 Failure Flow 2: THL ON for an approaching arrival aircraft.

Use case steps:

1. An arrival aircraft is on final approach, cleared to land on the runway.
2. The pilot sees THL switched ON in front of him.
3. The pilot performs a go around and as soon as possible reports the fact to the tower runway controller.

In such a case, the pilot should not land on the runway, as it may be unsafe. Several reasons can explain why those THL were ON:

- Runway status is closed or occupied, and RWSL is configured to switch ON THL in such a case.
- A departure aircraft is lined up and a mobile is in front (erroneous landing clearance or wrong landing runway).
- RWSL is malfunctioning.

5.7.8 Failure Flow 3: RWSL malfunction

Two different scenarios have to be distinguished, depending on the malfunction symptoms.

First scenario: THL OFF instead of ON

Use case steps:

1. An aircraft is lined up, ready for departure on the runway.
2. The pilot sees no THL in front of him whereas he should have seen some (multiple line-ups, or a mobile on the runway ahead)

3. The pilot reports to the tower runway controller that THL has not been switched ON as expected
4. Depending on the problem analysis, the tower supervisor can decide:
    - To continue operations with RWSL. Some restrictions may be introduced (e.g. entry taxiway usage). If necessary, the tower runway controller should provide information to end users via all appropriate means (e.g. ATIS/NOTAM).
    - To deactivate RWSL. The tower runway controller should provide information to end users via all appropriate means (e.g. ATIS/NOTAM).

Second scenario: THL ON instead of OFF

Use case steps:

1. An aircraft is lined up, ready for departure on the runway.
2. The tower runway controller issues a take-off clearance to the pilot.
3. The pilot sees a THL ON in front of him whereas he should have seen none (no multiple line-up, and no mobile on the runway ahead)
4. The pilot reports to the tower runway controller that THL has not been switched OFF as expected in a timely manner.
5. The tower supervisor can decide to deactivate RWSL. In this case, he should provide information to end users via all appropriate means (e.g. ATIS/NOTAM).

5.8 Use case 8 – THL – Closed runway

5.8.1 General Conditions

Scope and Summary

This use case describes THL behaviour when the runway is closed and how it will be presented on tower runway controller's A-CWP and tower supervisor's HMI. On some airports, an intermediate runway state may be available for controllers: runway occupied.

Pre Conditions

The airport is equipped with THL and aerodrome core surveillance.

The status of THL is made available on tower runway controller's A-CWP and tower supervisor's HMI.

RWSL system receives runway status, and the runway is "open".

Post Conditions

THL configured to be forced ON are lit and displayed as such on tower runway controller's A-CWP.

THL configured to be forced OFF are unlit and displayed as such on tower runway controller's A-CWP.

RWSL THL service is still available and running for other (active and not forced) THL.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

The tower runway controller changes the runway status to "closed"/"occupied" via the runway status system.

5.8.2 Main Flow

Use case steps:

1. Runway status is shown on the tower runway controller's A-CWP and tower supervisor's HMI.
2. The tower runway controller changes the runway status to "closed"/"occupied" via the runway status system.
3. When the runway is declared as closed (resp. occupied), RWSL system shall:
    - Switch ON THL which have been configured off-line to be ON (lit) when the runway is closed (resp. occupied).
    - Switch OFF THL which have been configured off-line to be OFF (unlit) when the runway is closed (resp. occupied).
    - Maintain active THL that have been configured off-line to be active when the runway is closed (resp. occupied). Active means that the THL service is provided and is nominal on those intersections [See use cases above].

These configuration alternatives (forced ON, forced OFF, or active) on runway "closed" (resp. "occupied") shall be general for every THL.

The lighting status triggered by RWSL system, shall be displayed on the tower runway controller's A-CWP.

Pilots and vehicle drivers can see different RWSL behaviours depending on runway operational status (open, occupied or closed). Should RWSL not be informed of a runway occupied or closed status, it shall keep its behaviour as defined for an open runway.

5.8.3 Failure Flow: RWSL malfunction

If some THL segments are out of order or malfunctioning, the tower supervisor shall be able to deactivate the RWSL system if he/she considers that performances are so degraded that the service cannot be provided to flight crews and vehicle drivers.

Flight crews will be informed that RWSL system has been deactivated (on a runway or globally) via all appropriate means (e.g. ATIS / NOTAM).

5.9 Use case 9 – THL – Reopened runway

5.9.1 General Conditions

Scope and Summary

This use case describes THL behaviour when the runway is reopened after having been closed and how it will be presented on tower runway controller's A-CWP and tower supervisor's HMI.

Pre Conditions

The airport is equipped with THL and aerodrome core surveillance.

The status of THL is made available on tower runway controller's A-CWP and tower supervisor's HMI.

RWSL system receives runway status, and the runway is "closed" (resp. "occupied").

Post Conditions

THL configured to be forced ON or OFF when runway was closed (resp. occupied) are active again.

RWSL THL service is available again on all THL of the runway.

Actors

Tower Runway Controller / Flight crews / Vehicle drivers / Tower supervisor

Trigger

The tower runway controller changes the runway status to "open" via the runway status system.

5.9.2 Main Flow

Use case steps:

1. Runway has been closed / occupied (tower runway controller action) [See use case 8].
2. The tower runway controller reopens the runway via the runway status system.
3. When the runway is reopened, RWSL system shall return to normal mode. All THL of the runway shall return to their normal operation [See use case 7].

The lighting triggered by the system, shall be displayed on the tower runway controller's A-CWP and tower supervisor's HMI.

RWSL system shall consider all the runways equipped with RWSL as open in case of loss of runway status information. It shall take into account the runway status when the information will be available again.

5.9.3 Failure Flow: RWSL malfunction

If some THL segments are out of order or malfunctioning, the tower supervisor shall be able to deactivate the RWSL system if he/she considers that performances are so degraded that the service cannot be provided to flight crews and vehicle drivers.

Flight crews will be informed that RWSL system has been deactivated (on a runway or globally) via all appropriate means (e.g. ATIS / NOTAM).

6 Requirements

As every requirement from the preceding edition of this OSED [7] has been modified, either in its text or title or rationale, it has been decided to completely rewrite this section. The old requirements are thus moved to Appendix C, and new ones are numbered as follows, taking into account their nature:

- Operational requirements:
  - for the tower runway controller or the supervisor: REQ-06.07.01-OSED-RWSL.11XX
  - for flight crews: REQ-06.07.01-OSED-RWSL.12XX
  - for vehicle drivers: REQ-06.07.01-OSED-RWSL.13XX
- Aeronautical Information requirements: REQ-06.07.01-OSED-RWSL.20XX
- Functional requirements REQ-06.07.01-OSED-RWSL.30XX
- Training requirements REQ-06.07.01-OSED-RWSL.40XX

6.1 Operational requirements

6.1.1 Operational requirements for the tower runway controller and the tower supervisor

[REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1101
Requirement	The tower runway controller or the tower supervisor shall deactivate the RWSL in case of a malfunction resulting in red lights in front of a cleared mobile.
Title	RWSL lights conflicting with clearance due to malfunction.
Status	<Validated>
Rationale	The driver or pilot shall never cross red lights even in case of a system's malfunction.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES TO>	<Operational Focus Area>	01.02.01	N/A

[REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1102
Requirement	The tower runway controller shall revise a clearance in case this erroneous clearance, or the operational situation evolution, would have made a driver or a pilot go through red RWSL lights.
Title	RWSL conflicting with clearance.
Status	<Validated>
Rationale	The controller may have made a mistake or the operational situation may have evolved since the clearance delivery.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES TO>	<Operational Focus Area>	01.02.01	N/A

1724

1725 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1103
Requirement	The tower runway controller shall use display of RWSL information only to answer flight crews' or drivers' concerns regarding the status of RWSL lights, and not for traffic control.
Title	Use of RWSL lights status display.
Status	<Validated>
Rationale	Not allow the tower runway controller to use RWSL lights status as information for traffic control.
Category	<HMI>
Validation Method	<Live Trial>
Verification Method	

1726 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1727

1728 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1104
Requirement	The tower supervisor shall have the possibility to deactivate RWSL system if there is a risk of performance deviation (sensors unavailability or malfunction or performance deviation). Local implementations may allow disabling of some specific input sensors only.
Title	Prevention of RWSL performance variability consequences.
Status	<Validated>
Rationale	RWSL performance shall be nominal at all times.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1729 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1730

1731 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1105
Requirement	If the whole system is not operational then pilots and drivers shall be informed.
Title	ATIS/NOTAM notice in case of RWSL service not guaranteed.
Status	<Validated>
Rationale	Introduce a new ATIS/NOTAM message in case of partial or failed service.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1732 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1733

1734 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1106
Requirement	The tower supervisor shall deactivate RWSL if the system is interfering with normal safe operations.
Title	RWSL deactivation in case of interference with normal safe operations.
Status	<Validated>
Rationale	The tower supervisor shall deactivate RWSL if the system is interfering with normal safe operations.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

6.1.2 Operational requirements for flight crews

[REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1201
Requirement	Flight crews shall maintain an awareness of the runway status lights and react in a timely manner so that they: • do not enter on a runway when a REL along their taxi route is illuminated: REL that are ON (illuminated red) indicate that the runway ahead is not safe to enter or cross. • do not take off when a THL on the runway ahead is illuminated: THL that are ON (illuminated red) indicate that the runway is not safe for take-off.
Title	Flight crews' required behaviour in case of RWSL lights ON.
Status	<Validated>
Rationale	Inform flight crews that they shall stop in case of red lights.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

[REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1202
Requirement	Flight crews shall not consider RWSL lights extinction as an approval or a clearance to proceed onto a runway or take off from a runway.
Title	Flight crews' required behaviour in case of RWSL lights OFF.
Status	<Validated>
Rationale	Inform flight crews that they shall not consider lights extinction as an approval or a clearance to proceed onto a runway or take off from a runway.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1744 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1203
Requirement	Flight crews shall comply with the tower runway controller's clearances except when compliance would require crossing an illuminated REL or THL. In such a case the crews shall HOLD SHORT of the runway for REL or STOP the aircraft for THL (if possible), contact the tower runway controller and await further instructions.
Title	Flight crews' compliance with the tower runway controller's clearances except in case of red lights.
Status	<Validated>
Rationale	Inform flight crews that they shall follow tower runway controller's clearances except when they have red lights in front of them.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1745 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1746

1747 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1204
Requirement	If the flight crews notice an illuminated REL and remaining clear of the runway is impractical for safety reasons, then they shall proceed according to their best judgment of safety (understanding that the illuminated REL indicates the runway is unsafe to cross or enter) and contact the tower runway controller at the earliest opportunity.
Title	Flight crews best judgement with REL ON.
Status	<Validated>
Rationale	Inform flight crews that they have to proceed following their best judgement in case of conflict between a clearance and REL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1748 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1749

1750 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1205
Requirement	If the flight crews notice an illuminated THL and aborting take-off from the runway is impractical for safety reasons (for instance, the aircraft has already a high speed), then they shall proceed according to their best judgment of safety (understanding that the illuminated THL indicate the runway is unsafe for take-off) and contact the tower runway controller at the earliest opportunity.
Title	Flight crews best judgement with THL ON.
Status	<Validated>
Rationale	Inform flight crews that they have to proceed following their best judgement in case of conflict between a clearance and THL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1751 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>

<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1752

1753 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1207
Requirement	If flight crews notice an illuminated THL on short final, they shall ask the tower runway controller for instructions if there is sufficient time, or perform a go around and inform the tower runway controller that they are going around because of red lights on the runway. N.B. THL are not operating primarily for the aircraft on short final.
Title	Flight crew procedure on short final.
Status	<Validated>
Rationale	Introduce new flight crew procedure for flight crews on short final if they notice THL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1754 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1755

1756 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1208
Requirement	Flight crews shall switch ON transponders and keep them ON while taxiing so that RWSL detects the mobile as an aircraft without any ambiguity.
Title	Transponders switched ON while taxiing.
Status	<Validated>
Rationale	Remind flight crews that they shall maintain their transponders ON while taxiing, because aerodrome surveillance performances and RWSL are strongly linked to the mobile equipment level.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1757 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1758

1759 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1209
Requirement	Flight crews shall continue to apply existing procedures defined for stop bars. Nevertheless, if flight crews notice an illuminated REL and the stop bar goes OFF and green lead-on lights appear, they shall stop and contact the tower runway controller at the earliest opportunity.
Title	Stop bars / REL procedure – Flight crews.
Status	<Validated>
Rationale	Introduce a new flight crew procedure for simultaneous use of stop bars and REL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1760 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1761

1762 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1210
Requirement	When taxiing on the runway, flight crews should limit taxi speed below a given limit so as not to unnecessarily turn ON the REL, except when directed otherwise.
Title	Taxi speed limitation – Flight crews.
Status	<Validated>
Rationale	Remind flight crews that they should limit their speed when taxiing on runway.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1763 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1764 ### 6.1.3 Operational requirements for vehicle drivers

1765 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1301
Requirement	Vehicle drivers shall maintain an awareness of the runway status lights and react in a timely manner so that they shall not enter on a runway when a REL along their route is illuminated.
Title	Vehicle drivers' required behaviour in case of RWSL lights ON.
Status	<Validated>
Rationale	Inform vehicle drivers that they shall stop in case of red lights.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1766 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1767

1768 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1302
Requirement	Vehicle drivers shall not consider REL extinction as an approval or a clearance to proceed onto a runway.
Title	Vehicle drivers' required behaviour in case of REL OFF.
Status	<Validated>
Rationale	Inform vehicle drivers that they shall not consider lights extinction as an approval or a clearance to proceed onto a runway.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1769 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1770

1771 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1303
Requirement	Vehicle drivers shall comply with tower runway controller's clearances except when compliance would require crossing an illuminated REL. In such a case the drivers shall HOLD SHORT of the runway, contact the tower runway controller and await further instructions.
Title	Vehicle drivers' compliance with tower runway controller's clearances except in case of REL.
Status	<Validated>
Rationale	Inform vehicle drivers that they shall follow the tower runway controller's clearances except when they have red lights in front of them.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1772 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1773

1774 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1304
Requirement	If the vehicle drivers notice an illuminated REL and remaining clear of the runway is impractical for safety reasons, then they shall proceed according to their best judgment of safety (understanding that the illuminated REL indicates the runway is unsafe to cross or enter) and contact the tower runway controller at the earliest opportunity.
Title	Vehicle drivers best judgement with REL ON.
Status	<Validated>
Rationale	Inform vehicle drivers that they have to proceed following their best judgement in case of conflict between a clearance and REL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1775 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1776

1777 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1305
Requirement	If available, vehicle drivers shall switch ON vehicle positioning systems and keep them ON while taxiing so that RWSL detects the mobile as a vehicle without any ambiguity.
Title	Vehicle positioning systems turned ON while taxiing.
Status	<Validated>
Rationale	Remind vehicle drivers that they shall maintain their vehicle positioning systems ON while taxiing, because aerodrome surveillance performances and RWSL are strongly linked to the mobile equipment level.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1778 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1779

1780 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1306
Requirement	Vehicle drivers shall continue to apply existing procedures defined for stop bars. Nevertheless, if vehicle drivers notice an illuminated REL and the stop bar goes OFF and green lead-on lights appear, they shall stop and contact the tower runway controller at the earliest opportunity.
Title	Stop bars / RWSL procedure – Vehicle drivers.
Status	<Validated>
Rationale	Introduce a new driver procedure for simultaneous use of stop bars and REL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1781 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1782

1783 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.1307
Requirement	Vehicle drivers shall proceed as usual, following their clearance, whatever the status of THL as those are not intended to be seen by them.
Title	Vehicle drivers' compliance with tower runway controller's clearances even with THL ON.
Status	<Validated>
Rationale	Inform vehicle drivers that they shall follow the tower runway controller's clearances as usual, taking no account of THL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1784 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1785

1786 6.1.4 Aeronautical Information requirements

1787 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2001
Requirement	Operational use of RWSL shall be published in aeronautical information.
Title	Publication in Aeronautical Information.
Status	<Validated>
Rationale	Inform flight crews of the operational use of RWSL in the AIP, via SUP-AIP and additional awareness campaign material.
Category	<Validated>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1788 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1789

1790 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2002
Requirement	Aeronautical information shall state that flight crews shall maintain an awareness of the runway status lights. • REL that are ON (illuminated red) indicate that the runway ahead is not safe to enter or cross. Flight crews shall remain clear of a runway when an REL along their taxi route is illuminated. • THL that are ON (illuminated red) indicate that the runway is not safe for take-off. Flight crews shall not take off when a THL on the runway ahead is illuminated. • Lights that are OFF have no meaning.
Title	Aeronautical information statement on RWSL principles.
Status	<Validated>
Rationale	To inform flight crews about RWSL principles.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1791 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1792

1793 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2003
Requirement	Aeronautical information shall include that RWSL is never intended to convey approval or clearance to proceed onto a runway or take off from a runway.
Title	Aeronautical Information statement on RWSL extinction meaning.
Status	<Validated>
Rationale	To inform flight crews about RWSL extinction meaning.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1794 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1795

1796 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2004
Requirement	Aeronautical information shall highlight that flight crews remain obliged to comply with the tower runway controller's clearances except when compliance would require crossing an illuminated REL or THL. In such a case the crews shall HOLD SHORT of the runway for REL or STOP the aircraft for THL (if possible), contact the tower runway controller and await further instructions.
Title	Aeronautical Information statement about flight crews expected behaviour in case of conflict between a clearance and RWSL.
Status	<Validated>
Rationale	To inform flight crews about the required behaviour in case of conflict between a clearance and RWSL.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1797 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>

<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1798

1799 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2005
Requirement	Aeronautical information shall describe what flight crews shall do if the actions above are impractical for safety reasons. • If the flight crews notice an illuminated REL and remaining clear of the runway is impractical for safety reasons, then crews shall proceed according to their best judgment of safety (understanding that the illuminated REL indicates the runway is unsafe to cross or enter) and contact the tower runway controller at the earliest opportunity. • If the flight crews notice an illuminated THL and aborting take-off from the runway is impractical for safety reasons, then crews shall proceed according to their best judgment of safety (understanding that the illuminated THL indicate the runway is unsafe for take-off) and contact the tower runway controller at the earliest opportunity.
Title	Aeronautical Information statement about flight crew's best judgement.
Status	<Validated>
Rationale	To inform flight crews that they have to proceed following their best judgement in case of conflict between a clearance and RWSL.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1800 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1801

1802 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2006
Requirement	Aeronautical information shall state what flight crews on short final shall do if they notice an illuminated THL, e.g. inform the tower runway controller that they are going around because of red lights on the runway, or ask the tower runway controller for instructions if there is sufficient time. N.B. It must be clear for flight crews that THL are not operating primarily for the aircraft on short final.
Title	Aeronautical Information statement – Flight crews on short final.
Status	<Validated>
Rationale	To inform flight crews about the new procedure for them on short final if they notice THL.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1803 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1804

1805 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2007
Requirement	Aeronautical information shall include guidance that transponders shall be turned ON and kept ON while taxiing.
Title	Aeronautical Information statement on transponders.
Status	<Validated>
Rationale	To inform flight crews about the need to maintain their transponders on while taxiing.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1806 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1807

1808 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2008
Requirement	Aeronautical information shall describe simultaneous use of REL and stop bars / lead on lights and flight crew procedures to be followed.
Title	Aeronautical Information statement on simultaneous use of stop bars and REL.
Status	<Validated>
Rationale	To inform flight crews about the required behaviour in case of simultaneous use of stop bars and REL.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1809 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1810

1811 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.2009
Requirement	Aeronautical information shall state that when taxiing on the runway, flight crews should limit taxi speed below a given limit so as not to unnecessarily turn ON the REL, except when directed otherwise.
Title	Aeronautical information guidance about taxi speed on runway.
Status	<Validated>
Rationale	To inform flight crews that they should limit their speed when taxiing on runway.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	

1812 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1813 ## 6.2 Functional requirements

1814 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3001
Requirement	The tower runway controller' A-CWP and the tower supervisor HMI shall permit the display of RWSL lights status shown to aircraft and vehicles.
Title	Tower runway controller and tower supervisor display.
Status	<Validated>
Rationale	Inform the tower runway controller and tower supervisor about RWSL lights statuses.
Category	<HMI>
Validation Method	<Live Trial>
Verification Method	<Test>

1815 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1816

1817 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3002
Requirement	RWSL lights status shall be displayed to the tower runway controller's A-CWP and the tower supervisor's HMI in a timely manner.
Title	Timely display of RWSL lights status on CWP.
Status	<Validated>
Rationale	To inform the tower runway controller and tower supervisor about RWSL lights status.
Category	<HMI>
Validation Method	<Live Trial>
Verification Method	<Test>

1818 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1819

1820 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3003
Requirement	RWSL shall be able to be deactivated from the tower supervisor if required.
Title	RWSL deactivation possibility for the tower supervisor.
Status	<Validated>
Rationale	Give the possibility to the tower supervisor to deactivate the whole RWSL system.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

1821 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1822

1823 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3004
Requirement	Inclusion of RWSL ON/OFF switch into the tower runway controller's A-CWP or the tower supervisor's HMI shall take account of ergonomic design.
Title	Ergonomic design of RWSL switch on HMI.
Status	<Validated>
Rationale	Ergonomic RWSL switch on HMI.
Category	<HMI>
Validation Method	<Live Trial>
Verification Method	<Test>

1824 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1825

1826 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3005
Requirement	Inclusion of RWSL ON/OFF status into the tower runway controller's A-CWP or the tower supervisor's HMI shall take account of ergonomic design.
Title	Ergonomic design of REL and THL status on HMI.
Status	<Validated>
Rationale	Display ergonomically REL and THL status on HMI.
Category	<HMI>
Validation Method	<Live Trial>
Verification Method	<Test>

1827 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1828

1829 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3006
Requirement	The tower runway controller and tower supervisor shall be informed about the status of RWSL service.
Title	Display RWSL service status on the tower runway controller's A-CWP and tower supervisor's HMI.
Status	<Validated>
Rationale	The loss of RWSL shall be announced to end users (flight crew and vehicle drivers) by any appropriate means, including R/T, ATIS, NOTAM, etc.
Category	<HMI>
Validation Method	<Live Trial>
Verification Method	<Test>

1830 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1831

1832 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3007
Requirement	RWSL system shall switch ON REL of a runway when there is a take-off on it.
Title	REL switch ON during take-off.
Status	<Validated>
Rationale	Inform flight crews/vehicle drivers that there is a take-off on the runway and it is unsafe to enter the runway.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1833 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1834

1835 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3008
Requirement	RWSL system shall detect when an aircraft has aborted its take-off and switch ON REL according to local parameters.
Title	REL switch ON in case of take-off abortion.
Status	<Validated>
Rationale	Inform flight crews/drivers that it is unsafe to enter the runway.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1836 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1837

1838 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3009
Requirement	RWSL system shall detect when an aircraft on final is approaching the runway and switch ON REL according to local parameters.
Title	REL switch ON in case of an approach.
Status	<Validated>
Rationale	Inform flight crews/vehicle drivers that it is unsafe to enter the runway (final approach).
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1839 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01 N/A	N/A

1840

1841 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3010
Requirement	RWSL system shall detect when a non-cooperative target is moving on the runway and switch ON REL according to local parameters.
Title	REL switch ON during runway occupancy by a non-cooperative target.
Status	<Validated>
Rationale	Inform flight crews/vehicle drivers that it is unsafe to enter the runway (runway occupied by a non-cooperative target moving).
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1842 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1843

1844 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3011
Requirement	RWSL system shall detect when a vehicle is moving on the runway and switch ON REL according to local parameters.
Title	REL switch ON during runway occupancy by a vehicle.
Status	<Validated>
Rationale	Inform flight crews/drivers that it is unsafe to enter the runway (runway occupied by a vehicle moving).
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1845 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1846

1847 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3012
Requirement	RWSL system shall receive runway status: closed, occupied (if defined locally) or opened and adapt its logics in consequence, following rules that may be defined locally.
Title	RWSL management in case of closed/opened/occupied runway.
Status	<Validated>
Rationale	To allow usage of different rules for closed/occupied/opened runway.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1848 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1849

1850 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3013
Requirement	RWSL system shall receive runway operational procedures information (LVP or not) and adapt its logic in consequence.
Title	RWSL logic under LVP conditions.
Status	<Validated>
Rationale	Parameters could be different in LVP, so the system has to take that fact into account.
Category	<Operational>
Validation Method	<Shadow Mode>
Verification Method	<Test>

1851 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1852

1853 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3014
Requirement	RWSL behaviour shall be independent from the stop bars statuses and commands.
Title	Independence between REL and stop bar systems.
Status	<Validated>
Rationale	RWSL is built over existing services and procedures and shall not interfere with them. In particular, no interface is required between REL and stop bars, even if both systems should deliver operationally coherent information.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

1854 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1855

1856 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3015
Requirement	RWSL system shall switch ON THL segments when an aircraft is aligned for take-off or has begun its take-off and a mobile is present in front of it, according to local parameters.
Title	THL management in case of take-off.
Status	<Validated>
Rationale	Inform flight crews that it is unsafe to continue their take-off (another mobile is present on the runway ahead).
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1857 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1858

1859 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3016
Requirement	RWSL system shall switch ON THL segments when there are several aircraft lining-up on the same runway, according to local parameters.
Title	THL management in case of multiple line-ups.
Status	<Validated>
Rationale	Inform flight crews of the trailing aircraft that it is unsafe to initiate their take-off (another aircraft is lining-up or lined-up on the runway ahead), but the leading aircraft shall have no THL ON in front of it because of that fact (regardless of other factors requiring its THL to be ON or OFF).
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

[REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3017
Requirement	RWSL system shall switch OFF REL when, regarding RWSL criteria, the runway is not unsafe anymore to cross or enter (regardless of any given clearance).
Title	REL switch OFF when runway is not unsafe anymore.
Status	<Validated>
Rationale	Indicate to flight crews/drivers that, regarding RWSL criteria, it is not unsafe anymore to cross or enter the runway (regardless of any given clearance).
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

[REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3018
Requirement	RWSL system shall switch OFF THL when, regarding RWSL criteria, the runway is not unsafe anymore to take-off on (regardless of any given clearance).
Title	THL switch OFF when runway is not unsafe anymore.
Status	<Validated>
Rationale	Indicate to flight crews/drivers that, regarding RWSL criteria, it is not unsafe anymore to take-off on the runway (regardless of any given clearance).
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

[REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3019
Requirement	RWSL system should as far as possible avoid flashing or blinking effects for any set of lights (lights going ON for a very short time or OFF for a very short time).
Title	Avoiding flashing or blinking effects.
Status	<Validated>
Rationale	As RWSL should increase flight crews' and vehicle drivers' situational awareness, lights going ON or OFF for a too short period could disorientate them or lessen their trust in the system.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1869 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1870

1871 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3020
Requirement	RWSL system should be deactivated when the MLAT system is unserviceable or in maintenance.
Title	RWSL system deactivating when MLAT is unavailable.
Status	<Validated>
Rationale	RWSL system should have accurate data as input so as to deliver accurate information to pilots and vehicle drivers.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1872 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1873

1874 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3021
Requirement	RWSL system should be deactivated when a critical input source is missing or unreliable.
Title	System deactivation when critical input source is missing or unreliable.
Status	<Validated>
Rationale	It should be possible to deactivate the system (by system design or local procedure) when a critical input source is missing or unreliable in order to prevent any risk of RWSL performance deviation.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1875 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1876

1877 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.3022
Requirement	RWSL shall define its own criteria based on aircraft horizontal and vertical position and trends to switch ON and OFF lights, one set for REL and another one for THL, so as to not interfere with local operational procedures.
Title	Definition of RWSL own sets of criteria for REL and THL.
Status	<Validated>
Rationale	RWSL parameters and setup are very sensitive to aircraft position and behaviour, so their kinematics has to be deeply and accurately observed to properly switch ON and OFF REL and THL.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	<Test>

1878 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES TO>	<Operational Focus Area>	01.02.01	N/A

1879

1880 6.3 Training requirements

1881 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.4001
Requirement	Air Traffic Controllers shall receive a briefing on RWSL system and implementation. This shall include instructions that RWSL is not to be used as a tactical controller tool.
Title	Air Traffic Controllers briefing about RWSL functioning.
Status	<Validated>
Rationale	Inform the tower runway controller and tower supervisor about RWSL system and its implementation.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1882 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES TO>	<Operational Focus Area>	01.02.01	N/A

1883

1884 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.4002
Requirement	Air Traffic Controllers shall be briefed / trained to not clear flight crew/vehicle drivers through RWSL lights once they are made aware by flight crews or vehicle drivers that they are illuminated.
Title	Air Traffic Controllers training about RWSL procedures.
Status	<Validated>
Rationale	Inform the tower runway controller that he shall not clear flight crews/vehicle drivers to go through red lights in any case.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1885 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES TO>	<Operational Focus Area>	01.02.01	N/A

1886

1887 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.4003
Requirement	Flight crews shall be informed on the RWSL system and its implementation.
Title	Flight crews information about RWSL.
Status	<Validated>
Rationale	Inform flight crews about RWSL system and its implementation.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1888 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1889

1890 [REQ]

Identifier	REQ-06.07.01-OSED-RWSL.4004
Requirement	Vehicle drivers shall be informed on the RWSL system and its implementation.
Title	Vehicle drivers' information about RWSL.
Status	<Validated>
Rationale	Inform vehicle drivers about RWSL system and its implementation.
Category	<Operational>
Validation Method	<Live Trial>
Verification Method	

1891 [REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.02-DOD-6200.0067	<Partial>
<APPLIES_TO>	<Operational Focus Area>	01.02.01	N/A

1892

7 References

7.1 Applicable Documents

[1] Template Toolbox 03.01.03
https://extranet.sesarju.eu/Programme%20Library/SESAR%20Template%20Toolbox.dot

[2] Requirements and V&V Guidelines 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Requirements%20and%20VV%20Guidelines.doc

[3] SESAR Operational Service and Environment Definition template, edition 03.00.00

[4] Templates and Toolbox User Manual 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Templates%20and%20Toolbox%20User%20Manual.doc

[5] EUROCONTROL ATM Lexicon
https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR

7.2 Reference Documents

The following documents were used to provide input/guidance/further information/other:

[6] B.04.02 High Level Process Models

[7] P06.07.01 Operational Service and Environment Definition for RWSL, 00.01.03, 19/03/2012

[8] P06.07.01 RWSL V3 Validation Report, 00.01.00, 10/06/2016

[9] OATA Use Case Template; 03.00.00, 08/05/2012

[10]WPB.04.02, SESAR WPB4.2 Actors, Roles and Responsibilities 00.01.05, 12/05/2011

[11]SESAR Safety Reference Material
https://extranet.sesarju.eu/Programme%20Library/Forms/Procedures%20and%20Guidelines.aspx

[12]WPB.01 Integrated Roadmap Latest version

[13]P06.02 Step 1 Airport DOD 2014 Update, D122, 00.01.01, 31/03/2015

[14]WPB.04.02, WPB4.2 – D08 processes and Services, 00.01.00, dated 12/09/2010

[15]EUROCONTROL “European Action Plan for the Prevention of Runway Incursions” – Edition 2.0, April 2011

[16]EUROCONTROL “Safety Assessment of Runway Status Lights (RWSL) System – Generic Guidance” - Edition 1.0, 29/04/2016

[17]MITRE, “Results from a Human-In-The-Loop Simulation Exploring the Concurrent Use of Runway Entrance Lights and Stop Bars”, MTR090404, November 2009

Appendix A Justifications

N/A.

Appendix B New Information Elements

No New Information Elements are defined in this OSED.

Appendix C Deleted requirements

All ancient requirements issued in previous RWSL OSED [7] are deleted.

They were numbered continuously as follows:

REQ-06.07.01-OSED-RWSL.0001

To:

REQ-06.07.01-OSED-RWSL.0059

Appendix D Runway Intersection Lights requirements

Requirements specific to RIL are reported here as a reminder, as they directly come from 06.07.01 D07-Initial OSED for RWSL. However they have not been assessed during SESAR validation process.

REQ-06.07.01-OSED-RWSL.0012
REQ-06.07.01-OSED-RWSL.0049
REQ-06.07.01-OSED-RWSL.0050
REQ-06.07.01-OSED-RWSL.0051
REQ-06.07.01-OSED-RWSL.0052
REQ-06.07.01-OSED-RWSL.0053
REQ-06.07.01-OSED-RWSL.0054
REQ-06.07.01-OSED-RWSL.0055

Note: Some requirements applying to RIL along with REL or THL are not reported here. They are to be read in section 6.

1951 **-END OF DOCUMENT-**

1952