Executive summary

This document describes the process and the results of the analysis of a sample of European A and B severity runway incursions incidents that occurred in EUROCONTROL member states in the period 2013 - 2015. The analysis was carried by means of the Safety Functions Maps barrier model.

The purpose of this report is to support the review of the European Action Plan for the Prevention of Runway Incursions.

The analysis was performed using the approach applied by EUROCONTROL for the identification of the Network Manger Top 5 safety priorities. It is based on plotting the incident information onto the Safety Functions Map (SAFMAP) barrier structure that provides defence against runway collision accidents.

This incident analysis provides information about Safety-I (i.e. safety functions that failed) but also about Safety-II (i.e. safety functions that performed well). In particular, at barrier level, the resilience (Safety-II) is addressed by identifying the barrier that stopped the incident from propagating further, while Safety-I is addressed by analysing the previous barriers. With regard to Safety-I, the information regarding the barriers component’s that failed is available in most cases. As regards Safety-II, incidents of lower severity level would need to be analysed in order to build a reliable picture of ‘what worked well’.

The analysed sample includes 126 runway incursion incidents from a total of 270 A and B severity runway incursion incidents that occurred in 2013, 2015 and 2015 and were reported to EUROCONTROL. It can be concluded that the analysed sample of runway incursion incidents is sufficiently representative for the overall population of runway incursion incidents in Europe.
Contents
1. Introduction ................................................................................................................................. 4
   1.1 Incident sample.................................................................................................................... 4
   1.2 Approach ............................................................................................................................. 4
2. General analysis of barriers’ performance ................................................................................... 6
   2.1 Basic barriers’ overall performance ...................................................................................... 6
   2.2 Barriers’ resilience per initiator ............................................................................................. 8
3. Analysis of events with specific context ..................................................................................... 10
   3.1 Sudden High Energy Runway Conflict................................................................................ 10
   3.2 ATC not identifying occupied runway ................................................................................. 11
   3.3 Vehicles participating in the event ...................................................................................... 12
   3.4 Hand-over & take-over of ATC operational positions.......................................................... 13
   3.5 Incidents during LVO.......................................................................................................... 14
   3.6 Crossing lit stop bars.......................................................................................................... 15
   3.7 Use of conditional clearances ............................................................................................ 17
4. Performance of the runway incursion prevention basic barrier .................................................. 19
   4.1 Incorrect entry of taxiing mobile into RWY protected area.................................................. 19
   4.2 Incorrect presence of landing aircraft ................................................................................. 21
   4.3 Incorrect presence of a departing aircraft ........................................................................... 24
   4.4 ATC causing an incorrect entry of a taxiing mobile............................................................. 26
5. Performance of the runway conflict prevention basic barrier ..................................................... 28
   5.1 Runway incursions that turned into runway conflicts .......................................................... 28
   5.2 Initiators of scenarios involving clearance for RWY use already given ............................... 29
   5.3 Initiators of scenarios involving ATCO not recognising and preventing the conflict............. 30
6. Performance of the ATC runway collision avoidance basic barrier .......................................... 31
   6.1 Conflicts not resolved by ATC runway collision avoidance ................................................. 31
   6.2 Initiators of scenarios involving inadequate conflict detection and interpretation by ATCO. 32
Annex 1. SAFMAP Events descriptions......................................................................................... 33
1. INTRODUCTION

1.1 Incident sample

The study used a sample of European A and B severity runway incursions incidents that occurred in EUROCONTROL member states in the years 2013, 2014 and 2015. The source of the data was the “NM collaborative process for identification of operational safety hazards at network level and assessment of the associated risk” agreed by the Network Management Board on 12 April 2016. The process, as approved, defined the data requirements based on the evolution of the NM Top 5 prioritisation process during the years of 2014, 2015 and 2016 and the respective data samples for 2013, 2014 and 2015. It is to be noted that the data sample for 2013 was only available in coded format while the samples for 2014 and 2015 description allowed the extended SAFMAP coding as provided in Annex 1.

The analysed sample, as presented on Figure 1, includes 126 runway incursion incidents, of which 27 were classified as severity A and 99 were classified as severity B incidents. The sample of runway incursions analysed constitutes 47% from all 270 A and B severity runway incursion incidents that occurred in the period 2013 -2015 and were reported to EUROCONTROL. It can be concluded that the analysed sample of runway incursion incidents is sufficiently representative for the overall population of runway incursion incidents in Europe.

![Figure 1: Analysed incident sample](image)

1.2 Approach

The sample of 126 incidents was analysed using the same approach applied by EUROCONTROL for the identification of Network Manager Top 5 safety priorities. It is based on plotting the incident information on the Safety Functions Map (SAFMAP) barrier structure providing defence against runway collision accidents. The used model version is “Safety Functions Map Configuration Description Model” of 18 November 2016.

The SAFMAPs are barrier models based on a structured documentation of the available defences against particular unwanted accident outcomes. These barriers are either part of the ATM system (ground and/or airborne component) or can impact the safety performance of ATM and/or aircraft.
navigation. Each discrete barrier is considered as a safety function. The functions used are rather
generic, for example the function “Pilot/driver detection that RWY protected area entry will be
incorrect” does not specify the actual means to implement this function such as stop-bars, runway
guard lights or runway entry lights.

SAFMAPs are hierarchical structures in which each higher level structure (function) can be
decomposed into several lower level structures (sub-functions). The top levels are called basic safety
functions. The basic safety functions for the prevention of runway collision are presented on Figure 2.

![Figure 2: Basic barriers for runway collision prevention](image-url)
2. GENERAL ANALYSIS OF BARRIERS’ PERFORMANCE

2.1 Basic barriers’ overall performance

The information presented by Figure 3 below provides an indication of the barrier strength, i.e. the basic barriers’ ability to stop an event developing into a more severe outcome and ultimately into a runway collision. An exception is the barrier ‘Runway incursion prevention’ - all the events analyses with the help of the SAFMAP model have been classified as A and B severity events, hence it is obvious that the ‘Runway incursion prevention’ barrier has failed in the vast majority of the analysed cases. Information about the Runway incursion prevention barrier strength could be obtained by analysis of safety occurrences of lower severity, i.e. reported cases when this barrier ‘worked well’.

In the analysed sample the ‘Runway conflict prevention’ barrier was tested 122 times and worked 38 times, i.e. its recorded efficiency is 31%.

The ‘ATC runway collision avoidance’ barrier has been tested 84 times and worked 38 times, i.e. its recorded efficiency is 45%.

The ‘Conflict participant runway collision avoidance’ barrier has been tested 46 times and worked 40 times, i.e. its recorded efficiency is considerably higher reaching 87%.

In 6 cases the conflict geometry (chance) helped avoid the collision, which means that the overall recorded efficiency of the runway conflict prevention and collision avoidance barriers is 95%.

![Figure 3: Basic barriers’ performance](image)

Figure 4 (next page) provides further insight into the barriers’ strength. It identifies the number of incidents stopped by a barrier in terms of absolute number (shown to the left of the barrier bars) and percentage (shown to the right of the barrier bars) of all incidents analysed. It also identifies the number of times the next barrier was not challenged despite the failure of the previous one. For example, in 12 out of 122 cases (10%) there was no need for runway conflict prevention. Such events include infringement of ILS sensitive area by a mobile during Low Visibility Operations (LVO).
### Figure 4: Number of incidents stopped by a barrier

Figure 5 below illustrates the events that were stopped (to develop into a runway collision) by one of the ATC barriers, but where only providence was left as a further barrier had the ATC barrier that stopped them failed.

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Number of Incidents stopped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Providence</td>
<td>6</td>
</tr>
<tr>
<td>Conflict Participant Runway Collision Avoidance</td>
<td>32</td>
</tr>
<tr>
<td>No need for participant RWY collision avoidance</td>
<td>8</td>
</tr>
<tr>
<td>ATC Runway Collision Avoidance</td>
<td>22</td>
</tr>
<tr>
<td>No need for ATC collision avoidance</td>
<td>16</td>
</tr>
<tr>
<td>Runway Conflict Prevention</td>
<td>26</td>
</tr>
<tr>
<td>No need for runway conflict prevention</td>
<td>12</td>
</tr>
<tr>
<td>Runway Incursion Prevention</td>
<td>4</td>
</tr>
</tbody>
</table>

### Figure 5: Events with only providence left as alternative barrier

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents stopped by that barrier with only providence left as alternative barrier.
2.2 Barriers' resilience per initiator

The barriers' resilience per initiator is illustrated on Figure 6 below. The initiators are failures of one of the 6 sub-functions (sub-barriers) of the 'Runway Incursion Prevention' basic safety barrier:

- Prevention of ATC causing incorrect entry of a taxiing mobile into the RWY protected area.
- Prevention of taxiing mobile from incorrectly entering the RWY protected area
- Prevention of incorrect presence of a vacating mobile in the RWY protected area
- Prevention of incorrect presence of a departing aircraft in the RWY protected area
- Prevention of incorrect presence of landing aircraft
- Prevention of incorrect presence of people in the RWY protected area

In addition to the barrier resilience per initiator, Figure 6 illustrates the events that were stopped to develop into runway collision by one of the barriers, but where only providence was left as a further barrier had the barrier that stopped them failed. It is to be noted that such events have various originators; however, the majority is caused by incorrect presence of departing aircraft on the runway protected area and by landing without clearance.

![Figure 6: Barriers' resilience per initiator](image)

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents stopped by that barrier with only providence left as alternative barrier.
Figure 7 below presents the share of the various initiators in the overall sample of events analysed. The incorrect entry of a taxiing mobile into the runway protected area is a clearly outstanding initiator (35% of events analysed).

The share of events of incorrect presence of landing aircraft is also considerable - 25% of all events analysed. Often, the cause is insufficient spacing of aircraft on final approach.

Figure 7: Distribution of events per initiator
3. ANALYSIS OF EVENTS WITH SPECIFIC CONTEXT

3.1 Sudden High Energy Runway Conflict

Figure 8 below illustrates the barrier efficiency in mitigating risk of Sudden High Energy Runway Conflicts (SHERCs), as well as the SHERC events that were stopped by one of the barriers, but where only providence was left as a further barrier had the barrier that stopped them failed. SHERC events account for 10% of the analysed sample.

The main initiator of the SHERC events in the analysed sample is incorrect entry of a taxiing mobile into the runway protected area. This initiator is one of the most safety critical initiators as it initiated the 2 SHERC events stopped by the ‘providence’ barrier and the 2 SHERC events saved by ATC with only providence left as alternative barrier.

![Figure 8: Sudden High Energy Runway Conflict](image)

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of SHERC incidents stopped by that barrier.

Figure 8: Sudden High Energy Runway Conflict
3.2 ATC not identifying occupied runway

The ATC (Tower controller) did not identify that the runway is occupied when issuing a runway use clearance in 33 events, i.e. in 26% of the analysed cases. As illustrated on Figure 9 more than the half these incidents crossed the ATC prevention barriers and were stopped at the top of the barrier model.

The biggest initiator of incidents in which ATC did not identify that the runway is occupied is the incorrect presence of a departing aircraft. In the majority of these events the TWR controller issued a clearance for take-off not identifying or forgetting the presence of a mobile on the runway.

![Figure 9: ATC not identifying occupied runway](image.png)

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents stopped by that barrier in which the TWR controller did not identify that the runway was already occupied when issuing a runway use clearance.
3.3 Vehicles participating in the event

The runway incursion events involving the presence of vehicles on the runway protected area represent 25% of the analysed sample of events. It is to be noted that the ATC conflict prevention and collision avoidance barrier are not particularly efficient in stopping these events – 60% of the events passed through these basic barriers.

It appears that the combination of vehicles participating in the event scenario and the presence of a departing aircraft accounts for a considerable part of the most critical events, i.e. those that were stopped by the top barriers of the model.

![Figure 10: Runway incursions involving vehicles](image)

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents with vehicle participation stopped by that barrier.
3.4 Hand-over & take-over of ATC operational positions

In the analysed sample the TWR position hand-over and take-over is an initiating factor with a quite limited impact – 6 out of 7 events were stopped by the ATC conflict prevention and collision avoidance barriers.

![Figure 11: Hand-over & take-over of operational positions](image)

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents stopped by that barrier in which hand-over / take-over was a factor.
3.5 Incidents during LVO
The ATC conflict prevention and collision avoidance barriers are quite efficient for stopping RI events associated with Low Visibility Operations (LVO). One particular scenario (applicable in 4 events) is the infringement of the ILS protected (sensitive) area, i.e. there is no actual runway conflict.

![Diagram of Incidents during low visibility operations](image)

**Figure 12: Incidents during low visibility operations**

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents that occurred during LVO and were stopped by that barrier.
3.6 Crossing lit stop bars

The events involving crossing of lit red stop bar by the conflict participant represent 6% of the analysed sample, i.e. crossing lit red stop bar is a rather rare event. It is to be noted that the ATC conflict prevention and collision avoidance barriers worked in all cases. In one of these cases the ATC collision avoidance barrier was identified as the last available barrier before ‘providence’.

The initiator of all events was the incorrect entry of a taxiing mobile into the runway protected area.

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents stopped by that barrier in which a red lit stop bar was crossed by a mobile.

In order to better assess the potential of the red stop bars as a RI prevention barrier an additional analysis of the events involving incorrect entry of a taxiing mobile into the runway protected area was done. This analysis is based on the premise that if stop bars existed, the ATCO would have switched them on correctly and the pilot/driver would have stopped upon observing the red light.

Out of the 10 events triggered by “ATC causing an incorrect entry of taxiing mobile” there are 4 cases where there is a reasonable expectation that stop bars could have prevented the runway incursion. Out of the 44 events triggered by “Taxiing mobile incorrect entry” there are 25 events where there is a reasonable expectation that stop bars could have prevented the incursion.

The cases where it was considered that stop bars could have been inefficient to prevent the incursion are two major groups: (1) those involving conditional clearance and (2) those involving a mobile entry not via the designated taxiways.

Figure 13: Incidents involving crossed red lit stop bars

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents stopped by that barrier in which a red lit stop bar was crossed by a mobile.
3.7 Use of conditional clearances

Although the share of events involving use of conditional clearance is relatively low in the analysed sample (8%) the potential for a high severity outcome is considerable. A considerable number of the events (40 %) the events were stopped by the last 2 barriers – collision avoidance by the conflict participant and providence. Another 30 % of the events were stopped by the ATC collision avoidance barrier.

In all but one events the initiator was the incorrect entry of a taxiing mobile into the runway protected area. It should be noted that the conditional clearance in this scenario is not necessarily the cause of the runway incursion.

In five of the analysed cases the incorrect entry into the runway protected area was triggered by an inadequate air-ground communication, in particular inadequate application of read-back/ hear-back procedure.

In three of the analysed cases the incorrect entry into the runway protected area was triggered by an incorrect execution of otherwise correctly read-back conditional clearance. In all of these cases the pilot/driver misunderstood the clearance and entered the runway before the traffic constituting the condition.

In one of the analysed cases the incorrect entry into the runway protected area was triggered after a conditional clearance issued to the second traffic using the runway.

In one of the analysed cases the incorrect entry into the runway protected area was triggered by the insufficient spacing between the departure aircraft and the landing aircraft. It took more time than expected by ATCO for the take-off run to take place.
Figure 14 – Incidents involving conditional clearances

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents stopped by that barrier in which the use of conditional clearance was a factor.
4. PERFORMANCE OF THE RUNWAY INCURSION PREVENTION BASIC BARRIER

4.1 Incorrect entry of taxiing mobile into RWY protected area

The incorrect entry of a taxiing mobile into the RWY protected area is the strongest initiator in the analysed sample of RI events. It accounts for 35% of the sample events. The factors with the highest contribution to the incorrect entry are communication issues (misunderstanding) and incorrect execution of ATC clearance (non-compliance).

Figure 15:
Incorrect entry of a taxiing mobile into the RWY protected area – factors
Incorrect entry due to communication misunderstanding has the potential to pass through the ATC barriers - 40% of these events were stopped by the conflict participant barrier and the providence.

Figure 16:
Incorrect entry of a taxiing mobile into the RWY protected area – barriers’ resilience

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents initiated by an incorrect entry of a taxiing mobile into the runway protected area and stopped by that barrier.
4.2 Incorrect presence of landing aircraft

Incorrect presence of landing aircraft is the second largest initiator for runway incursions in the sample. The 31 events account for 25% of the analysed sample of reported incidents. There were two major groups of factors for the incorrect presence of landing aircraft.

The first group, accounting for 74% (23 incidents) of the incorrect presence of landing aircraft events involved ATC not providing a correct and timely landing clearance, leading to the landing aircraft incorrectly passing beyond the specified spacing limits or entering the RWY protected area.

The second group, accounting for 26% (8 incidents) of the incorrect presence of landing aircraft events involved insufficient spacing between landing aircraft and between landing and departing aircraft that caused landing aircraft to incorrectly pass beyond the specified spacing limits.

**Note:** The spacing limits are locally defined and may vary, for example 4NM, RWY threshold, distance from RWY threshold when the clearance to land is issued, etc.

![Figure 17: Incorrect presence of landing aircraft – factors](image)

- There was insufficient spacing between successive landing a/c and between landing and departing a/c that caused landing aircraft to incorrectly pass beyond the specified spacing limits.
- ATC did not provide a correct and timely landing clearance. This led to the landing aircraft incorrectly passing beyond the specified spacing limits or entering the RWY protected area.
Landing without clearance can be classified as a particular kind of incorrect presence of landing aircraft but it is analysed separately and illustrated on Figure 18 below to provide additional insights. The major factor leading to landing without clearance was communications misunderstanding, followed by deliberate landing without clearance and landing without clearance after loss of communications.

Figure 18: Landing without clearance - factors
The resilience of the basic safety barriers to the initiators “Incorrect presence of landing aircraft” and “Landing without clearance” is shown on Figure 19.

In all but one events initiated by insufficient spacing between successive landing and between landing aircraft and departing there was no need of collision avoidance.

More than one third of the events involving ATC not providing correct and timely landing clearance required collision avoidance either by ATC or the conflict participant.

Figure 19:

Incorrect presence of landing aircraft (including landing without clearance) – barriers’ resilience

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents initiated by incorrect presence of landing aircraft and stopped by that barrier.
4.3 Incorrect presence of a departing aircraft

As in the events involving incorrect presence of landing aircraft, ATC is the main causal factor of this group of events. In 85% of the cases (17 events) involving incorrect presence of a departing aircraft ATC did not ensure that the runway was not going to be occupied during the take-off. This failure could have been corrected by the presence of adequate flight data, visual traffic monitoring, surveillance information, position reports and RWY status information and detection and resolution of clearance non-conformity (e.g. with the help system support) of route deviations, high speed taxiing towards the Holding Point, etc.

Figure 20: Incorrect presence of a departing aircraft – factors
The resilience of the basic safety barriers to the initiator “Incorrect presence of a departing aircraft” is shown on Figure 21.

About half of the events involving incorrect presence of departing aircraft required collision avoidance either by ATC or the conflict participant. In all but one of these events the initiator was ATC who did not ensure that runway is clear during the take-off.

![Figure 21: Incorrect presence of a departing aircraft – barriers’ resilience](image)

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents initiated by incorrect presence of departing aircraft and stopped by that barrier.
4.4 ATC causing an incorrect entry of a taxiing mobile

The two main causes of the 10 events when ATC caused incorrect entry of a taxiing mobile into the runway protected area are incorrect plan of work (5 events) and inadequate detection or interpretation of the potential runway conflict.

![Diagram of factors causing incorrect entry of a taxiing mobile into the runway protected area](image)

**Figure 22:**
ATC causing incorrect presence of a taxiing mobile – factors
With the caveat that the number of events involving ATC causing an incorrect entry of a taxiing mobile in the analysed sample, it is to be noted that those events involving inadequate detection or interpretation of the potential runway conflict by ATC required collision avoidance.

Figure 23:
ATC causing incorrect presence of a taxiing mobile – barriers’ resilience

The number shown to the left of a barrier bar identifies the total number of incidents stopped by that barrier. The number shown to the right of a barrier bar identifies the number of incidents initiated by incorrect presence of a taxiing mobile caused by ATC and stopped by that barrier.
5. PERFORMANCE OF THE RUNWAY CONFLICT PREVENTION BASIC BARRIER

5.1 Runway incursions that turned into runway conflicts

The second basic safety barrier ‘Runway Conflict Prevention’ was challenged 122 times, prevented the runway conflict in 38 of these events (31 % efficiency) and failed 84 times (69% failure rate). In 65 of the cases when the barrier failed the clearance for the intended RWY use has already been given prior to the incorrect entry into the RWY protected area and there was no opportunity for ATC to prevent it.

ATCO conflict prevention barrier was challenged 32 times. When challenged (runway incursion leading to potential conflict), it worked once and failed 31 times. In 18 out of the 31 cases when conflict prevention by the ATCO failed the other conflict participants also failed to identify and prevent the runway conflict.

![Figure 24: Runway incursions that turned into runway conflicts - causes](image)

- Clearance for RWY use has already been given
- Impossible to detect the potential conflict
- Both ATCO and Conflict participants did not recognise and prevent the conflict
5.2 Initiators of scenarios involving clearance for RWY use already given

The “zoom” into the 65 events that involved clearance for RWY use already given (to the other conflicting mobile) shows that the distribution of the initiators in the overall sample of runway incursion events (shown on Figure 7, section 2.2) is very similar to the distribution of the initiators of the runway incursion events that occurred when runway use clearance was already issued to other mobile.

**Figure 25:**

Initiators of scenarios involving ‘clearance for RWY use already given’
5.3 Initiators of scenarios involving ATCO not recognising and preventing the conflict

ATCO conflict prevention barrier was challenged 32 times. When challenged (runway incursion leading to potential conflict), it worked once and failed 31 times.

Same initiators can be seen as in the scenarios when runway use clearance was already issued to another mobile.

It should be noted that the performance of the ‘ATCO barrier’ in runway conflict prevention is rather weak when the initiating factor is a vacating mobile. This may be explained with the limited opportunities for visual acquisition of vehicles due to the combination of environmental factors such as vehicle size, colour, distance from ATC tower, obstructed line of sight, etc.

Figure 26:

Initiators of scenarios involving ‘ATCO not recognising and preventing the conflict’
6. PERFORMANCE OF THE ATC RUNWAY COLLISION AVOIDANCE BASIC BARRIER

6.1 Conflicts not resolved by ATC runway collision avoidance

It should be noted that in the majority of cases when the ATC runway collision avoidance barrier failed to stop the events (67%), ATCO did not detect or did not interpret correctly the runway conflict. In order to improve the overall performance of this barrier means and measures to improve conflict detection by ATCO could be considered.

Figure 27:
Runway conflicts not resolved by ATC runway collision avoidance - causes
6.2 Initiators of scenarios involving inadequate conflict detection and interpretation by ATCO

All types of initiators (except unauthorised presence of person on the RWY protected area) contribute to the scenarios whereupon ATCO failed to detect and/or interpret correctly the runway conflict. The majority of the scenarios are linked to 2 initiators: incorrect entry of a taxiing mobile into, and incorrect presence of departing aircraft on, the RWY protected area.

Figure 28: Initiators of scenarios involving inadequate conflict detection and interpretation by ATCO
## Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

### ANNEX 1. SAFMAP EVENTS DESCRIPTIONS

#### 2015 safety occurrence data

<table>
<thead>
<tr>
<th>Occurrence</th>
<th>Runway Incursion Prevention</th>
<th>Runway Conflict Prevention</th>
<th>ATC Runway Collision Avoidance</th>
<th>Participant Runway Collision Avoidance</th>
<th>Providence</th>
</tr>
</thead>
</table>
| RWY incursion 1 | The situation developed during good visibility.  
  ATCO cleared a crossing aircraft, expecting that the landing one will vacate via a preceding taxiway as this taxiway is used usually by this operator. The procedures for this airport published in AIP require landing aircraft to vacate via the first possible exit.  
  There is ASMGCS Level 1 and no alerts are available.  
  Stop bars are not used during the day and ATCO would have switched them off with the clearance. | No opportunity to prevent the conflict  
  Clearance to land was already given at the time the other aircraft was cleared to cross the RWY | ATCO did not detect the conflict | The rolling aircraft flight crew observed the crossing one and succeeded to stop | Not challenged |
| RWY incursion 2 | The helicopter correctly read-back the clearance. It was a non-commercial operation and the crew was not accustomed with the operations at the international airport.  
  There was no opportunity to detect non-conformity with the clearance before the runway incursion. The TWR position did not allow detection of the potential non-conformity.  
  Both crews were aware of each other and the helicopter crew detected the potential conflict but only after passing the HP.  
  Stop bars not used. | No opportunity to prevent the conflict  
  Clearance to land was given at the time the helicopter passed the HP. | No need for ATC collision avoidance  
  Crew landed and reported seeing a helicopter on the side. | Not challenged | Not challenged |
| RWY incursion 3 | ATCO forgot the presence of the car.  
  The existing procedure for using a runway status memory aid was not followed.  
  No visual detection by ATCO, no ASMGCS or surveillance.  
  The vehicle driver called 30 seconds after the take-off clearance. Although not in English, the message was heard and understood by the aircraft crew when they were ready to push TOGA, brakes were held and crew waited at the RWY threshold. | Not challenged | Not challenged | Not challenged | Not challenged |

---

For EUROCONTROL Page 33
<table>
<thead>
<tr>
<th>RWY incursion 4</th>
<th>RWY incursion 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A taxiing-out aircraft was cleared to cross an active runway</td>
<td>ATCO cleared an aircraft for take-off while vehicle was still on the runway</td>
</tr>
<tr>
<td>• The situation developed during runway configuration change</td>
<td>• ATCO forgot the presence of the car.</td>
</tr>
<tr>
<td>• ATCO intended to stop the aircraft before the active runway and correctly switched on the stop bars.</td>
<td>• There were two cars on the runway and two memory strips were used.</td>
</tr>
<tr>
<td>• The actual taxi clearance cleared the aircraft to cross the active runway. The clearance that was used frequently before the configuration change was delivered again in an “automatism”.</td>
<td>• The working position was changed and only one memory strip was transferred to the new position.</td>
</tr>
<tr>
<td>• No system support provided to ATCO</td>
<td>• A hand-over took place and then one of the vehicles reported vacating which prompted ATCO to remove the only memory strip.</td>
</tr>
<tr>
<td>• Stop bars were used; the taxiing aircraft identified the lit stop bars and stopped</td>
<td>• No visual detection as the visibility from the TWR was not good,</td>
</tr>
<tr>
<td>• Not challenged</td>
<td>• No ASMGCS or surveillance.</td>
</tr>
<tr>
<td>• Not challenged</td>
<td>• The aircraft crew observed visually the car and reported to ATC.</td>
</tr>
<tr>
<td>• Not challenged</td>
<td>• Not challenged</td>
</tr>
<tr>
<td>• Not challenged</td>
<td>• Not challenged</td>
</tr>
<tr>
<td>RWY incursion 6</td>
<td>RWY incursion 7</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>A take-off clearance was given when the runway was still occupied by a vehicle</strong></td>
<td><strong>An aircraft erroneously vacated a runway and entered a parallel one that was occupied by an inspecting vehicle</strong></td>
</tr>
<tr>
<td>- There were two vehicles on the runway – one at the runway end and one half-way the runway.</td>
<td>- An aircraft was cleared to backtrack on the departure runway and turn 180 at the end.</td>
</tr>
<tr>
<td>- Only one electronic memory aid was used. It is possible to use more than one memory aid.</td>
<td>- Flight crew misunderstood the ATC backtrack instruction, provided a wrong read-back to exit the runway that was not heard-back by ATCO.</td>
</tr>
<tr>
<td>- When the aircraft lined up an instruction was given for the vehicle at the runway end to vacate and the presence of the other vehicle was omitted.</td>
<td>- ATCO failed to detect the wrong taxiing of the aircraft and there was no system support for non-conformity detection.</td>
</tr>
<tr>
<td>- A tower roof support pole obscured the line of sight towards the middle of the runway.</td>
<td>- Flight crew and vehicle driver did not detect the potential conflict before the runway incursion.</td>
</tr>
<tr>
<td>- No surveillance available.</td>
<td>- Stop bars were not in use.</td>
</tr>
<tr>
<td>- Flight crew observed the vehicle on the runway and from the position it was seen as if it is at the end of the runway.</td>
<td>- ATCO issued a take-off clearance for the correct runway and this was not identified by flight crew.</td>
</tr>
<tr>
<td>- Flight crew reported to ATC seeing a yellow vehicle at the end of the runway.</td>
<td>- Flight crew did not provide a read-back of the runway designator.</td>
</tr>
<tr>
<td>- ATCO scanned visually the end of the runway, confirmed that the first, also yellow vehicle was vacated and re-cleared again the aircraft for take-off.</td>
<td>- ATCO did not detect the conflict</td>
</tr>
<tr>
<td>- Flight crew did not challenge ATC further.</td>
<td>- Flight crew did not provide a read-back.</td>
</tr>
<tr>
<td>- At the same time the driver of the vehicle on the runway was outside the car with no possibility to listen to the air ground communications.</td>
<td>- ATCO did not detect the conflict</td>
</tr>
<tr>
<td>- No opportunity to prevent the conflict</td>
<td>- The vehicle driver observed visually the conflict, entered the car and vacated on time the runway</td>
</tr>
<tr>
<td>- The vehicle was already given a clearance.</td>
<td>- Flight crew got airborne without visual detection of the conflict by any of the participants</td>
</tr>
<tr>
<td></td>
<td>- Worked</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

<table>
<thead>
<tr>
<th>Runway Incursion</th>
<th>Description</th>
<th>ATCO Response</th>
<th>Challenge Status</th>
</tr>
</thead>
</table>
| **RWY incursion 8**<br>ATCO issued an incorrect RWY clearance | • ATCO issued landing clearance at a time when RWY was occupied by a lined-up aircraft.  <br>• The situation developed during a distraction by a discussion in the TWR.  <br>• ATCO forgot the presence of the departing aircraft.  <br>• ATCO did not update the electronic flight data strip and this prevented the conflict alert. | • No opportunity to prevent the conflict  <br>• The first aircraft was already given a line-up clearance | • ATCO detected the conflict after the lined-up aircraft reported ready for take-off.  <br>• The landing aircraft was instructed to go-around | • Not challenged  
| **RWY incursion 9**<br>An aircraft, cleared to HP on the departure runway, entered the runway and took-off without clearance | • Flight crew read-back correctly the clearance but did not comply afterwards.  <br>• ATCO failed to detect the non-conformity  <br>• There was no other traffic cleared for the runway.  <br>• Stop bars are not in use at the airport | • No challenge for runway conflict prevention  <br>• ATCO identified the incursion during the take-off roll and did not initiate any action as there was no conflicting traffic | • Not challenged | • Not challenged  
| **RWY incursion 10**<br>Incorrect presence of person on the RWY | • An aircraft, before vacating the runway after landing, reported observing a person on the runway | • No opportunity to prevent the conflict  <br>• It was barely possible to observe the person visually but only if it was known to be there.  <br>• ASMGCS was available but did not detect it as well. | • ATCO did not detect the conflict  <br>• It was barely possible to observe the person visually but only if it was known to be there.  <br>• ASMGCS was available but did not detect it as well. | • The flight crew did not detect the person before landing | • worked  
| **RWY incursion 11**<br>Non-conformity with conditional clearance | • An aircraft, received clearance to line-up behind landing aircraft, entered the runway before the landing aircraft  <br>• There was insufficient time available for ATCO to detect the non-conformity and prevent the runway incursion  <br>• Flight crew crossed lit red stop bars. | • No opportunity to prevent the conflict  <br>• The first aircraft was already given a landing clearance. | • ATCO detected the conflict and instructed the landing aircraft to go-around. | • Not challenged | • Not challenged  
| **RWY incursion 12**<br>Non-conformity with conditional clearance | • An aircraft, cleared to line-up behind landing aircraft, lined-up after the earlier departure and before of the landing aircraft  <br>• ATCO cleared flight crew to line-up behind the landing aircraft. The clearance was incorrectly read back as lining-up behind the departing traffic.  <br>• Shortly after the clearance hand-over started and distracted the handing over ATCO from monitoring the RWY and ASTOS alarm that is only visual on ASMGCS.  <br>• ATCO did not detect the visual ASMGCS alert  <br>• The flight crew crossed lit red stop bars. | • No opportunity to prevent the conflict  <br>• The first aircraft was already given a landing clearance. | • ATCO detected the conflict when the landing aircraft had 55 second to THR and provided take-off clearance to the departing aircraft.  <br>• The decision was based on the fact that a rapid vacation of runway was not possible due to closure of taxiway and the expected short run of the departure aircraft.  <br>• Shortly afterwards ATCO changed his plan, cancelled the take-off and instructed the landing aircraft to go-around | • Not challenged  
| | | | | • Not challenged  
| | | | | • Not challenged  

For EUROCONTROL Page 36
### RWY Incursion 13
**Take-off clearance was given on an occupied runway**

- A take-off clearance was given when the runway was still occupied by a vehicle.
- ATCO forgot the previous crossing clearance.
- No memory aid was used for occupied runway.
- ASMGCS was available but ATCO did not scan the surveillance display.

- No opportunity to prevent the conflict
- The crossing aircraft was already given a clearance.
- ATCO did not detect the conflict visually
- There was an ASMGCS alert (visual) but it was not detected by ATCO.

- The departing aircraft flight crew observed the crossing aircraft and challenged the take-off clearance.
- Not challenged

### RWY Incursion 14
**Insufficient spacing of departing and arriving aircraft**

- Tight operations with several departures and a landing from the same runway.
- An aircraft was cleared to taxi across the runway between two departures.
- The crossing, although asked to expedite, took more time than expected.
- The subsequent departure was asked to expedite the take-off but also took more time than expected.
- The landing aircraft passed over the end of the runway, still awaiting the landing clearance, immediately after the departing aircraft got airborne from the same runway.

- ATCO delayed the landing clearance.
- No need for ATC collision avoidance
- Not challenged
- Not challenged

### RWY Incursion 15
**A taxiing-out military aircraft crossed the RWY holding point without clearance**

- A taxiing-out military aircraft crossed the RWY holding point without clearance while another aircraft was approaching to land at the same runway.
- The flight crew was performing a ‘mental rehearsal’ of the departure and omitted the fact that they do not have a line-up clearance.
- ATCO was able to detect the non-conformance but only after the HP crossing.
- Stop bars are not used at the airport

- No opportunity to prevent the conflict
- The landing aircraft was already given the landing clearance.
- ATCO identified the conflict and issued several times a go-around instruction to the landing aircraft.
- The crew reacted to the instruction only at the third time

- The sun was in the eyes of the landing aircraft flight crew and was impairing the possibility for a visual detection of the occupied runway
- The closest point of approach distance was marginal – 15-20 meters vertically and 10-15 meters horizontally

### RWY Incursion 16
**A taxiing-out aircraft crossed the RWY holding point without clearance**

- A taxiing-out aircraft crossed the Runway holding point without clearance in front of another aircraft that was taking-off from the same runway.
- The crossing aircraft was moving slowly and the potential to cross the holding point was difficult to detect.
- The aircraft crossed lid red stop bars

- No opportunity to prevent the conflict
- The departing aircraft was already given a take-off clearance.
- ATCO identified the conflict after RIMCAS alert and issued an avoiding instruction to the departing aircraft – ‘to deviate left’.
- The crew reacted to the instruction and deviated to the left during the take-off roll.

- The crossing aircraft crew did not detect the departing one.
- The departing aircraft PF detected at speed of 100kt and closing to V1 that an aircraft is slowly moving toward the holding point and briefed PM but it was not possible to judge from their position weather the holding point was crossed or not.
- The closest point of approach distance was marginal – 45 meters.
<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>ATCO issued incorrect take-off clearance</th>
<th>ATCO cleared an aircraft for take-off while a vacating aircraft was still on the runway</th>
<th>The preceding landing aircraft was still on the runway.</th>
<th>No system support available and the ATCO did not identify the potential conflict by traffic monitoring.</th>
<th>The take-off instruction was in the native language and was not understood by the other flight crew.</th>
<th>ATCO identified the conflict visually after the pilot initiated avoiding action.</th>
<th>The rolling aircraft flight crew observed the preceding landing aircraft on the runway when at around 80kt and succeeded to stop.</th>
<th>Not challenged</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWY incursion 18</td>
<td>ATCO issued incorrect take-off clearance</td>
<td>The situation developed during OJT and in good visibility.</td>
<td>ATCO cleared an aircraft for take-off while another, crossing and taxiing-in aircraft was still on the runway.</td>
<td>No system support available. ATCO did not identify the potential conflict with traffic monitoring.</td>
<td>Flight crew observed that the runway was still occupied and did not action the take-off clearance.</td>
<td></td>
<td></td>
<td>Not challenged</td>
</tr>
<tr>
<td>RWY incursion 19</td>
<td>A crew took a take-off clearance issued to another aircraft</td>
<td>ATCO cleared an aircraft for take-off from an intermediate taxiway and the clearance was picked up by an aircraft, lined up behind at beginning of the runway. The call signs were not similar.</td>
<td>ATCO did not detect the conflict.</td>
<td>ATCO did not detect the conflict.</td>
<td>The flight crew that the clearance was intended for, identified the conflict by monitoring the communications.</td>
<td>Not challenged</td>
<td>Not challenged</td>
<td>Not challenged</td>
</tr>
<tr>
<td>RWY incursion 20</td>
<td>An aircraft landed while the RWY protected area was occupied</td>
<td>An aircraft landed while the runway protected area was still not free.</td>
<td>No need for runway conflict prevention</td>
<td></td>
<td></td>
<td>Not challenged</td>
<td>Not challenged</td>
<td>Not challenged</td>
</tr>
<tr>
<td>RWY incursion 21</td>
<td>An aircraft landed while the RWY protected area was occupied</td>
<td>An aircraft landed while the runway protected area was still not free.</td>
<td>No need for runway conflict prevention</td>
<td></td>
<td></td>
<td>Not challenged</td>
<td>Not challenged</td>
<td>Not challenged</td>
</tr>
<tr>
<td>RWY incursion</td>
<td>Description</td>
<td>Safety Functions</td>
<td>Prevention</td>
<td>Challenge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------</td>
<td>------------</td>
<td>-----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>An aircraft landed while the runway was still occupied by an aircraft that was testing the engines.</td>
<td>No need for runway conflict prevention</td>
<td>Not challenged</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATCO asked an approaching helicopter if they agree to and after an agreement cleared it to land at the runway threshold</td>
<td></td>
<td>Not challenged</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The aircraft performing an engine test run was at around 60% down the runway length.</td>
<td></td>
<td>Not challenged</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>ATCO cleared the first of two landing aircraft to enter the area between CAT III and CAT I holding positions for the departure runway.</td>
<td>No need for runway conflict prevention</td>
<td>Not challenged</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The pressure came from the need to vacate the ILS critical area for the parallel arriving runway by the second taxiing-out aircraft while a third aircraft was on a short final.</td>
<td></td>
<td>Not challenged</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Both taxiing-out aircraft used one and the same taxiway that made it impossible to protect the ILS CAT III critical area.</td>
<td></td>
<td>Not challenged</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>A taxiing-out aircraft crossed the HP of a RWY while another aircraft was running for take-off.</td>
<td>No opportunity to prevent the conflict</td>
<td>ATCO instructed the taxiing aircraft to stop immediately.</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The aircraft was cleared to taxi to the HP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATCO detected the high taxi speed and potential non-conformance already before the runway incursions and instructed the taxiing aircraft to stop immediately.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Due to inertia of the movement the aircraft stopped after passing the HP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>The situation developed during LVP.</td>
<td>No need for runway conflict prevention</td>
<td>Not challenged</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After short spacing on final, ATCO cleared an aircraft to land while the preceding arriving aircraft was still in the ILS CAT III critical area.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>An aircraft was cleared to taxi to the HP but lined-up and departed without clearance.</td>
<td>No opportunity to prevent the conflict</td>
<td>No need for ATC collision avoidance</td>
<td>Not challenged</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATCO cleared the taxiing-out aircraft to HP and to change to TWR frequency.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The read-back was incorrect – cleared for take-off. The frequency read-back was also incorrect.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>There was no hear-back.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No visual detection by ATCO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The TWR ATCO was focussed on some other part of the movement area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No ASMGCS available.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No stop bars available</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>Description</th>
<th>Countermeasures</th>
<th>Implications</th>
</tr>
</thead>
</table>
| 27 RWY incursion | An aircraft crossed the HP and taxied onto the runway while another aircraft was on short final. | • ATCO issued a conditional clearance to a taxing aircraft to line up after the landing aircraft.  
• The clearance was wrongly read-back as a clearance to line up and wait.  
• There was no hear-back.  
• Incorrect phraseology, accent and pilot expectation (after he was asked if ready for immediate departure) contributed to the misunderstanding.  
• The arriving aircraft was cleared to land in the native language.  
• No visual detection by ATCO  
• No ASMGCS available.  
• No stop bars available | • No opportunity to prevent the conflict  
• The landing clearance had already been given.  
• ATCO did not detect the conflict  
• The flight crew of the landing aircraft saw the aircraft on the runway and initiated a go-around |
| 28 RWY incursion | A taxiing-out aircraft crossed the HP of a RWY while another aircraft was running for take-off. | • The aircraft was cleared to taxi to the HP for ILS CAT III critical area  
• The crew did not see the stop-bar, crossed the HP and stopped before the CAT I HP.  
• ATCO detected the ILS CAT III area penetration after an ASMGCS alert and instructed the taxiing aircraft to stop.  
• The take-off was not cancelled as the departing aircraft was not using the LVP. | • Not challenged  
• Not challenged  
• Not challenged  
• Not challenged |
| 29 RWY incursion | An aircraft was cleared to land and landed while a taking-off one was still on the runway. | • There was insufficient spacing between the landing and departure aircraft.  
• The departure aircraft was asked for an immediate departure and received conditional clearance after the preceding, first landing.  
• It took more than ATCO expected before the take-off run to take place. | • No opportunity to prevent the conflict  
• The clearance to line up and take-off had already been given.  
• No need for ATC collision avoidance  
• Not challenged |
| 30 RWY incursion | An aircraft landed while the runway protected area was still not free. | • The situation developed during LVP.  
• After short spacing on final, ATCO cleared an aircraft to land while the preceding arriving aircraft was still in the ILS CAT III critical area. | • No need for runway conflict prevention  
• Not challenged  
• Not challenged  
• Not challenged |
| 31 RWY incursion | An aircraft landed while the opposite end of the runway was still occupied by a vehicle. | • During vehicle runway inspection ATCO cleared an aircraft to enter the runway and wait for a take-off clearance, and a VFR aircraft to perform a low pass and training go around.  
• Instead of ‘pass and go around’ the VFR aircraft performed a ‘touch and go’. | • No opportunity to prevent the conflict  
• The clearances for the vehicle and for the aircraft to line up and take-off had already been given.  
• ATCO had sufficient time only to instruct the lining-up aircraft to stop.  
• This was a deliberate priority after a prompt risk weighting.  
• No need for participant collision avoidance  
• Not challenged |
<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>Description</th>
<th>Possible Causes</th>
<th>Conflict Prevention</th>
<th>ATCO Challenge</th>
<th>Need for ATC Collision Avoidance</th>
<th>Overall Analysis</th>
</tr>
</thead>
</table>
| 32 incursion  | An aircraft landed while the runway protected area was still occupied | - The situation developed during LVP.  
- After short spacing on final, ATCO cleared an aircraft to land while the preceding arriving aircraft was still in the ILS CAT III critical area.  
- ATCO did not properly detect that the preceding taxiing-out aircraft was still within the ILS critical area. | - No need for runway conflict prevention | - Not challenged | - Not challenged | - Not challenged |
| 33 incursion  | An aircraft landed while the runway protected area was still occupied | - The situation developed during LVP  
- After short spacing on final, ATCO cleared an aircraft to land while the preceding arriving aircraft was still in the ILS CAT III critical area.  
- It took the aircraft an unusual time of 30 seconds after passing the CAT I HP to pass CAT III HP.  
- There was an ASMGCS alert but ATCO cleared the arriving aircraft to land | - No need for runway conflict prevention | - Not challenged | - Not challenged | - Not challenged |
| 34 incursion  | A vehicle crossed the runway while a helicopter was on short final for the same runway and had been already cleared to land | - A vehicle crossed the runway while a helicopter was on short final for the same runway and had been already cleared to land  
- The vehicle was cleared to taxi via the fire fighters taxiway to the RWY HP  
- The pilot read-back was correct.  
- No ASMGCS available.  
- No stop bars available  
- ATCO was able to detect the RWY incursion only when the vehicle was already leaving the runway after the crossing. | - No opportunity to prevent the conflict  
- The landing clearance had already been given. | - Not challenged | - Not challenged | - Not challenged |
| 35 incursion  | An aircraft was cleared to land while preceding landing aircraft was still on the runway | - The situation developed during OJT and APP and TWR position consolidation.  
- During night time and after short spacing on final, ATCO cleared an aircraft to land while the preceding arriving aircraft was still on the runway.  
- The TWR ATCO assistant saw the potential conflict but did not inform the TWR ATCO. | - ATCO had not worked during night for some time and the landing clearance was based on visual observation without checking on the ground radar display  
- The flight crew of the arriving aircraft refused the clearance to land and went-around. | - Not challenged | - Not challenged | - Not challenged |
| 36 incursion  | A vehicle crossed the runway while an aircraft was on short final and was cleared to land | - The vehicle was cleared to taxi to the HP and asked to report when reaching but the vehicle driver incorrectly read-back cleared to cross and report leaving the runway.  
- There was no hear-back. | - No system support available to ATCO  
- ATCO did not identify the potential conflict by means of traffic monitoring.  
- When the aircraft was cleared to land the vehicle was completing the RWY crossing | - No need for ATC collision avoidance | - Not challenged | - Not challenged |
<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>A vehicle did not comply with RWY clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 RWY incursion</td>
<td>A vehicle incorrectly reported that runway is vacated but after a technical problem remained on the runway.</td>
</tr>
<tr>
<td>38 RWY incursion</td>
<td>The situation developed during dawn and high workload.</td>
</tr>
<tr>
<td>39 RWY incursion</td>
<td>A VFR aircraft landed without clearance on a runway already occupied by a vehicle</td>
</tr>
<tr>
<td>40 RWY incursion</td>
<td>A taxing aircraft confused the taxiways, crossed the holding point and crossed an active runway while there was no other traffic for the runway</td>
</tr>
<tr>
<td>41 RWY incursion</td>
<td>A taxing aircraft confused the taxiways, crossed the holding point and crossed an active runway while there was no other traffic for the runway. The flight crew confused two parallel taxiways. The vertical signs for the taxiways were not very clear ASMGCS Level I and also anti-intrusion sensors were available, but the sensors were dis-activated. The aircraft crossed lit red stop bar.</td>
</tr>
</tbody>
</table>

- A vehicle incorrectly reported that runway is vacated but after a technical problem remained on the runway.
- ATCO cleared an aircraft for landing while a vehicle was still on the runway.
- ATCO did not observe that the runway is occupied and cleared the aircraft to land.
- There is ASMGCS Level 1 at this airport.
- The vehicle and aircraft were on separate frequencies.
- ATCO did not detect the conflict. The vehicle observed the landing aircraft and suggested to ATCO a go-around.

- ATCO did not observe that the runway is occupied.
- The flight crew of the arriving aircraft, upon receiving landing clearance, informed ATCO that there is a vehicle on the runway.
- ATCO then instructed the vehicle to vacate the runway.

- ATCO did not detect that the runway is occupied.
- The flight crew of the arriving aircraft, upon receiving landing clearance, informed ATCO that the runway lights are dimmed and that there is a vehicle on the runway.
- ATCO then instructed the vehicle to vacate the runway.

- ATCO did not detect that the runway is occupied.
- The flight crew of the arriving aircraft, upon receiving landing clearance, informed ATCO that there is a vehicle on the runway.
- ATCO then instructed the vehicle to vacate the runway.

- ATCO did not observe that the runway is occupied and cleared the aircraft to land.
- The conflict was not prevented by either participant.

- ATCO did not detect the conflict.
- The landing aircraft observed that the runway is occupied and went around.

- ATCO did not detect the conflict.
- The VFR aircraft landed and stopped short of the vehicle on the runway.

- No need for runway conflict prevention.
- Not challenged
## Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

<table>
<thead>
<tr>
<th>RWY incursion 42</th>
<th>RWY incursion 43</th>
<th>RWY incursion 44</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A taxiing-out aircraft lined-up onto the runway while another aircraft was on short final for the same runway</strong></td>
<td><strong>A taxiing aircraft was cleared to cross the runway while another aircraft was running for take-off.</strong></td>
<td><strong>ATCO cleared an aircraft for take-off while a vehicle was at the edge of the runway.</strong></td>
</tr>
<tr>
<td>ATCO issued a conditional clearance to a taxiing aircraft to line up after the landing aircraft.  The clearance was wrongly read-back as a clearance to line up and wait.  There was no hear-back.  Incorrect phraseology contributed to the misunderstanding.</td>
<td>No opportunity to prevent the conflict  The landing clearance had already been given.</td>
<td>The ATCO cleared an aircraft for take-off while a vehicle was on the runway protected area.  The situation developed during OJT and in good visibility.  A vehicle was cleared on the runway after TWR and GND coordination.  TWR ATCO forgot the presence of the vehicle.  The vehicle was cleared for the runway and the runway engaged lighting system was engaged.  ATCO failed to detect later the red light for occupied runway. The light position and its brightness made it obscure by the daylight.  TWR ATCO cleared an aircraft for take-off at the time when GND ATCO was busy on the phone.  GND ATCO did not detect the take-off clearance.  The vehicle was without transponder. There was primary radar but the vehicle track was intermittent and not detected.  The white colour of the vehicle made little contrast against the colour of the concrete and ATCO did not identify it visually.  The vehicle was on a separate TWR frequency.</td>
</tr>
<tr>
<td>No opportunity to prevent the conflict  The landing clearance had already been given.</td>
<td>The ATCO did not detect the conflict after the take-off clearance and before the take-off run.</td>
<td>ATCO did not detect the conflict</td>
</tr>
</tbody>
</table>
## 2014 safety occurrence data

<table>
<thead>
<tr>
<th>Occurrence</th>
<th>Runway Incursion Prevention</th>
<th>Runway Conflict Prevention</th>
<th>ATC Runway Collision Avoidance</th>
<th>Participant Runway Collision Avoidance</th>
<th>Providence</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWY incursion 1 A vehicle, inspecting a taxiway, misunderstood its clearance and entered the RWY</td>
<td>The vehicle driver was cleared to check and remain on the taxiway but he misunderstood and thought he was cleared to enter RWY after use of non-standard phraseology and communicating on a separate frequency. The clearance was issued based on false ASMGCS target in the runway touchdown zone. The situation developed during CATII weather conditions. The vehicle was on a separate frequency. It was at the far end of the airfield, no use (as usual at this airport) of available binoculars. ASMGCS alerts were turned off after many false alerts had been reported. Stop bars were available, but not used.</td>
<td>No opportunity to prevent the conflict. <strong>Clearance to land was given at the time the vehicle reported that there was no mobile on the runway.</strong></td>
<td>The ATCO detected the conflict on ASMGCS and collision avoidance (go-around) action was taken when the landing aircraft was at 0.5NM.</td>
<td>Not challenged</td>
<td>Not challenged</td>
</tr>
<tr>
<td>RWY incursion 2 Taxiing-out aircraft entered the runway without clearance</td>
<td>A taxiing-out aircraft did not identify the lack of clearance to enter the runway. The taxi clearance was received and acknowledged but without read-back to hold at the HP. Long distance and a wide screening visual field for the ATCO. The situation developed in an area that was very difficult to observe visually. There was an SMR but no warning was available. The aircraft passed red stop bars.</td>
<td>No system support available to ATCO. <strong>ATCO did not identify the potential conflict by traffic monitoring despite the clearance challenge (confirmation asked) by the crew who was already observing the occupied RWY.</strong> Landing confirmation often asked and rarely associated with occupied RWY. The flight crew identified the occupied RWY visually and initiated a go-around.</td>
<td>Not challenged</td>
<td>Not challenged</td>
<td>Not challenged</td>
</tr>
<tr>
<td>RWY incursion 3 Snow removal vehicle entered RWY without clearance</td>
<td>A taxing snow removal vehicle did not identify the lack of clearance to enter the runway.</td>
<td>No opportunity to prevent the conflict. <strong>The landing clearance had already been given.</strong></td>
<td>The ATCO detected the conflict visually and collision avoidance (instruction to vehicle to leave the RWY and a go-around instruction) action was taken.</td>
<td>Not challenged</td>
<td>Not challenged</td>
</tr>
<tr>
<td>RWY incursion 4</td>
<td>ATCO provided incorrect take-off clearance for an occupied RWY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ATCO did not ensure that the RWY is free before giving take-off clearance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No RWY status aid was used,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No visual scan or identification of occupied RWY in another way.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RWY incursion 5</td>
<td>A taxiing aircraft failed to stop at the holding point and entered the active RWY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The aircraft crossed red stop bar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No opportunity to prevent the conflict</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RWY incursion 6</td>
<td>An aircraft did not vacate entirely the RWY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The pilot stopped on the Rapid Exit Taxiway while vacating the RWY.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATCO did not identify the potential incorrect presence of a vacating aircraft.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RWY incursion 7</td>
<td>ATCO issued a landing clearance for an occupied RWY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ATCO issued landing clearance at a time when RWY was occupied by a runway inspection car.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ATCO forgot the car presence on the RWY.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RWY incursion 8</td>
<td>Following position confusion a vehicle entered an active RWY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A vehicle driver confused his/her position and entered the RWY from the grass.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The driver did not build and maintain an accurate situational and positional awareness picture.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The vehicle entered the RWY without communication, without a clearance and with its lights off during dark time. Lights were switched on after entering the RWY. The vehicle was not equipped with XPDR.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ATCO was controlling two runways in different parts of the manoeuvring area and his attention was split.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The potential conflict was neither detected by visual monitoring nor resolved before entering.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The stop bars or RWY guard lights were bypassed due to the vehicle RWY entry from the grass.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The ATCO cleared a departing aircraft for take-off after he had visually scanned the manoeuvring area and the ASMGCS Level 1 screen, and concluded that the RWY was clear.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The vehicle was not equipped with a XPDR and there was no radar track when the aircraft asked for departure.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It was concluded that the primary radar detected the vehicle but ASMGCS did not display it after processing with the other information from the multi-lateration.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No ASMGCS Level 2 provided.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The vehicle lights seen but no action taken by flight crew</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample**
<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>Description</th>
<th>Contributing Factors</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>A helicopter crossed a RWY in non-conformity with the clearance</td>
<td>A military helicopter was cleared to cross RWY at an intersection. This was contrary to the LoA with the military and the helicopter crossed at the RWY threshold as per LoA - expectation bias. Incomplete clearance read-back by the helicopter pilot. Restricted view from the TWR.</td>
<td>Not challenged</td>
</tr>
<tr>
<td>10</td>
<td>ATCO cleared an aircraft to land on a RWY that was still occupied by a vehicle</td>
<td>During work in progress, several vehicles were on the RWY. The ATCO instructed them to vacate, but one erroneously stayed. The vacation instruction to the vehicle was not read back. The ATCO confused a reply from someone else that answered a previously asked question. Workload at the time. There was no a line of sight to the RWY part where the vehicle was positioned (obscured by a building). At the RWY edge the ATCO identified, visually, a vehicle with similar livery and assumed that the RWY was vacated.</td>
<td>Crew landed and stopped the aircraft before the vehicle (in the middle down the RWY).</td>
</tr>
<tr>
<td>11</td>
<td>ATCO cleared a vehicle onto the RWY erroneously assuming it was at another position (i.e. on another taxiway).</td>
<td>The ATCO cleared an aircraft for take-off and then cleared a vehicle - despite its correct position report - to enter RWY after assuming it was on the usual taxiway at the beginning of the RWY. The actual position was not in the ATCO line of sight. ATCO had a poor visual contact as the conflict location was too far away. The vehicle was not equipped with a transponder. The vehicle crossed red stop bar</td>
<td>No opportunity to prevent the conflict</td>
</tr>
<tr>
<td>12</td>
<td>ATCO cleared a taxiing out aircraft to cross an active RWY and into conflict with a landing aircraft</td>
<td>The event occurred during RWY configuration change. The ATCO cleared an aircraft to cross an active runway. The runway was wrongly assumed not to be active as per the previous configuration. There was no visual scanning by ATCO as the RWY was at the back of the visual field. Stop bars were switched off by the ATCO as part of, what was assumed, a legitimate crossing clearance.</td>
<td>The flight crew observed the vehicle and succeeded to stop the take-off</td>
</tr>
</tbody>
</table>

**Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample**
### RWY incursion 13
An aircraft landed without clearance on occupied RWY

- The second of two consecutive aircraft on final landed while the first was still on the runway.
- The ATCO confused the identity and position of the second aircraft assuming it was further away on final and gave traffic information for traffic that was the aircraft to which information was given.
- The lack of landing clearance was omitted by crew.
- No opportunity to prevent the conflict
- The first aircraft was already given a landing clearance.
- ATCO did not detect the conflict
- No need for participant collision avoidance
- Not challenged

### RWY incursion 14
ATCO provided a conflicting landing clearance when the RWY protected area was occupied by a departing aircraft

- The landing aircraft was a second of two landings and its speed restrictions were overridden with the ATCO re-clearing them as number two.
- A departing aircraft attempted to line-up after the first landing, just passed the HP and stopped there.
- The incursion was identified by the crew of the landing aircraft.
- The crew of the landing aircraft advised they could accept a visual landing and were cleared to land.
- No need for runway conflict prevention
- Not challenged
- Not challenged
- Not challenged

### RWY incursion 15
A training aircraft taxied to the RWY using an incorrect taxiway

- The flight crew read-back correctly the clearance but the trainee pilot followed another taxiway that was usually used.
- The ATC tower was far away and the situation was not clearly visible.
- There was no other conflicting aircraft.
- Stop bars are not used at this airport.
- No need for runway conflict prevention – no conflicting traffic
- Not challenged
- Not challenged
- Not challenged

### RWY incursion 16
An aircraft landed without clearance on occupied RWY

- After short spacing on final, the ATCO issued go-around instructions to a VFR flight when it was 30m above the terrain.
- The pilot reported that he considered it was safer to land on an occupied runway than to go-around.
- No opportunity to prevent the conflict
- Clearance had already been given to the first aircraft.
- The flight crew elected not to comply with the ATC go-around instruction.
- The flight crew landed and stopped the aircraft before the previously landed aircraft.
- Not challenged

### RWY incursion 17
A single pilot aircraft took-off without clearance

- After short spacing between arrival and departure aircraft, the ACTO asked the departing aircraft for immediate departure but pilot requested “30 seconds on brakes” for technical reasons.
- The ATCO then instructed the landing aircraft to go-around
- ATCO attempted to cancel the take-off clearance but the frequency was blocked and the aircraft commenced the departure that created conflict with the going-around aircraft.
- No opportunity to prevent the conflict
- There was insufficient time to prevent the conflict
- There was no opportunity for visual collision avoidance action
- worked
### Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>Incident Description</th>
<th>Contributing Factors</th>
<th>System Support &amp; Observations</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>During daylight, a trainee ATCO misunderstood the position of a vehicle (thought to be at another HP) and cleared it for a runway inspection (for FOD). Subsequently ATCO cleared and aircraft to land. No memory aid was used. There was no surveillance equipment.</td>
<td>No opportunity to prevent the conflict. The vehicle had already been given RWY use clearance.</td>
<td>The ATCO identified the conflict and instructed the landing aircraft to go-around. The flight crew did not respond to the instruction.</td>
<td>The vehicle driver identified the conflict and vacated the runway.</td>
</tr>
<tr>
<td>19</td>
<td>An aircraft lined-up without clearance on an active RWY. Subsequently ATCO cleared and aircraft to land.</td>
<td>No opportunity to prevent the conflict. The other aircraft was already given a landing clearance.</td>
<td>The ATCO did not identify the conflict. The situation developed very fast.</td>
<td>The flight crew of the landing aircraft saw the aircraft on the runway and initiated a go-around.</td>
</tr>
<tr>
<td>20</td>
<td>The ATCO issued landing clearance to an aircraft asking the crew &quot;to land at a displaced threshold&quot;. The aircraft was closer than expected by ATCO and there was already a departing aircraft lined-up. There was no surveillance.</td>
<td>No opportunity to prevent the conflict. The other aircraft was already given RWY use clearance.</td>
<td>The decision of the ATCO was to clear the aircraft to land despite the fact that the runway was occupied.</td>
<td>The landing aircraft flew over the lined-up aircraft and landed.</td>
</tr>
<tr>
<td>21</td>
<td>The ATCO cleared intentionally an aircraft to land on an occupied RWY. There was a vehicle at the end of the runway but the ATCO thought it was a safe situation. Performance pressure was reported as a factor.</td>
<td>No opportunity to prevent the conflict. The other aircraft was already given RWY use clearance.</td>
<td>The decision of the ATCO was to clear the aircraft to land despite the fact that the runway was occupied.</td>
<td>The flight crew landed and stopped before the end of the runway.</td>
</tr>
<tr>
<td>22</td>
<td>The ATCO cleared an aircraft to land while the RWY protected area was occupied. There was a vehicle already cleared near the runway. The vehicle was on another frequency.</td>
<td>No opportunity to prevent the conflict. The other aircraft was already given RWY use clearance.</td>
<td>ATCO did not detect the conflict.</td>
<td>No need for participant collision avoidance - the crew landed and reported seeing a vehicle on the side.</td>
</tr>
<tr>
<td>23</td>
<td>A helicopter landed without clearance on occupied RWY. The ATCO cleared the landing helicopter to go-around but the instruction was acknowledged only with a click on the frequency.</td>
<td>No opportunity to prevent the conflict. The vehicle had already been given the clearance.</td>
<td>It was difficult for the ATCO to observe if the helicopter was initiating a go-around or a landing.</td>
<td>It was difficult for the ATCO to observe if the helicopter was initiating a go-around or a landing.</td>
</tr>
</tbody>
</table>
### RWY incursion 24
A taxiing out aircraft crossed an active runway

- The flight crew correctly read-back the hold short instruction but crossed the active runway in front of a departing aircraft.
- No opportunity to prevent the conflict
- The departing aircraft was already given take-off clearance.
- The ATCO observed the crossing aircraft and instructed the departure aircraft to stop.
- The departure aircraft continued the run and took off.
- No need for participant collision avoidance
- Not challenged

### RWY incursion 25
ATCO cleared an aircraft to take-off from an occupied RWY

- The ATCO cleared an aircraft for take-off while another one was still vacating. There was an aircraft on short final and the ATCO was under pressure.
- The take-off clearance did not ensure that the runway was going to be free during the take-off.
- No opportunity to prevent the conflict
- Clearance for RWY use had already been given.
- No need for ATC collision avoidance
- Not challenged

### RWY incursion 26
ATCO cleared an aircraft to take-off from an occupied RWY

- The ATCO cleared an aircraft for take-off while another one was still vacating. There was an aircraft on short final and the ATCO was under pressure.
- The take-off clearance did not ensure that the runway was going to be free during the take-off.
- No opportunity to prevent the conflict
- Clearance for RWY use had already been given.
- No need for ATC collision avoidance
- Not challenged

### RWY incursion 27
An aircraft crossed an occupied RWY

- An aircraft crossed the runway while another one was cleared for take-off.
- The ATCO cleared the aircraft to hold short, the read-back was wrong - “cleared to cross”
- There was no hear-back.
- ATCO did not detect the conflict
- An aircraft asked for, and was given, departure clearance.
- There was ASMGCS Level 1.
- No need for ATC collision avoidance
- Not challenged

### RWY incursion 28
Unauthorised crossing of an active RWY

- An aircraft on short final reported seeing a motorcycle crossing the runway.
- There were no fences at the airport
- No opportunity to prevent the conflict
- Landing clearance had already been given.
- No need for ATC collision avoidance
- Not challenged

### RWY incursion 29
ATCO cleared an aircraft to land on an occupied RWY

- The ATCO cleared an aircraft to land on an occupied RWY.
- There was another already landed aircraft still on the runway.
- The spacing between the successive landing aircraft was insufficient.
- No opportunity to prevent the conflict
- Clearance for RWY use had already been given.
- The decision of the ATCO was to clear the aircraft to land on an occupied runway after the second landing aircraft proposed “to land after”.
- The flight crew landed and stopped before the end of the runway.
- Not challenged

### RWY incursion 30
ATCO cleared an aircraft to land while the while another aircraft was still in the ILS sensitive area

- During low visibility procedures (550 RVR) at ASMGCS Level 2 airport, an aircraft landed while the previous landed aircraft was still in the ILS sensitive area.
- The spacing between two aircraft on final was reduced as the speed restrictions of 160kt were not adhered to.
- The ATCO instructed the second landing aircraft to go-around several times but there was no read-back.
- No need for runway conflict prevention
- Not challenged
- Not challenged
- Not challenged
### RWY incursion 31
**ATCO incorrectly cleared an aircraft for take-off on occupied RWY**
- During CAVOK weather and in normal workload situation, one aircraft lined-up via an intersection taxiway while another one was departing on the same runway.
- The departing aircraft passed the intersection before the one entering the runway.
- The ATCO forgot the presence of the lining-up aircraft and cleared for take-off the other aircraft.
- There was a strip for the occupied runway.
- No opportunity to prevent the conflict.
- Clearance for RWY use had already been given.
- The conflict was not detected.
- ASMGCS Level 2 was available but failed to issue a runway conflict alarm.
- No need for participant collision avoidance.
- The first departing passed the intersection before the second one entered the runway.
- Not challenged.

### RWY incursion 32
**A taxiing aircraft entered occupied RWY due to positional confusion**
- A taxiing aircraft from gas station to a parking position confused the taxiways, crossed the holding point and entered an active runway while another aircraft was on short final.
- The flight crew did not maintain positional awareness.
- No opportunity to prevent the conflict.
- Landing clearance had already been given.
- The ATCO detected the conflict and instructed the landing aircraft to go-around.
- Not challenged.

### RWY incursion 33
**An aircraft was cleared to land and a vehicle driver was cleared to inspect the same runway**
- After hand-over of operational position, the ATCO cleared an aircraft to land on the left of the two parallel runways.
- Usually, landings are on the left runway but just before the hand-over the crew was instructed to expect the right runway.
- The read-back was for the right runway and there was no hear-back.
- The ATCO instructed the landing aircraft to go-around several times but there was no read-back.
- The ATCO cleared a vehicle for right runway inspection.
- On the strip the information was for right runway and this went unnoticed by the ATCO.
- There was AMGCS but the vehicle was not equipped with transponder due to cost.
- The ATCO detected the conflict but the collision avoidance action (go-around) was not implemented by the pilot.
- The vehicle driver, moving in the opposite direction to the landing, saw the landing aircraft and vacated the runway.
- Not challenged.

### RWY incursion 34
**An aircraft was cleared to land while a taking-off one was still on the runway**
- ATCO was aware that there was insufficient spacing between the landing and departure aircraft.
- The risk perception by the ATCO was that it was an acceptable situation.
- The ATCO was not used to single runway operations.
- The departure spent some time on the runway before commencing the departure run.
- No opportunity to prevent the conflict.
- Clearance for RWY use had already been given.
- No need for ATC collision avoidance.
- Not challenged.

### RWY incursion 35
**A taxiing aircraft misunderstood the clearance and entered occupied RWY**
- A trainee pilot (17-years old) was cleared to cross the runway after a landing aircraft.
- The pilot misunderstood the clearance and crossed in front of the landing aircraft.
- The conditional clearance was misunderstood.
- The read-back was incomplete.
- There was no request of a full read-back by the ATCO.
- No opportunity to prevent the conflict.
- Landing clearance had already been given.
- The ATCO did not detect the conflict.
- There was no system support for conflict detections at this airport.
- Flight crew of the landing aircraft detected visually that the runway is occupied and initiated go-around.
- Not challenged.
| RWY incursion 36 | There was work in progress at the airport and single runway operations. | No opportunity to prevent the conflict | Not challenged |
| RWY incursion 36 | There was insufficient spacing between the landing and departure aircraft. | Clearance for RWY use had already been given. | Not challenged |
| RWY incursion 36 | The ATCO was not used to single runway operations. | No need for ATC collision avoidance | Not challenged |
| RWY incursion 37 | There was work in progress at the airport and single runway operations | No opportunity to prevent the conflict | Not challenged |
| RWY incursion 37 | There was insufficient spacing between the landing and departure aircraft. | Clearance for RWY use had already been given. | Not challenged |
| RWY incursion 37 | The ATCO was not used to single runway operations. | No need for ATC collision avoidance | Not challenged |
| RWY incursion 38 | The event occurred during low visibility procedures. | No need for runway conflict prevention | Not challenged |
| RWY incursion 38 | An aircraft was cleared to land while the second of the previous two landings was still in the ILS sensitive area. | Not challenged | Not challenged |
| RWY incursion 38 | The first two landings were vacating via the same taxiway and stopped for intersecting parallel runway. | Not challenged | Not challenged |
| RWY incursion 38 | There was a RIMCAS alert but ATCO cleared the landing. | Not challenged | Not challenged |
| RWY incursion 39 | The event occurred during low visibility procedures. | No need for runway conflict prevention | Not challenged |
| RWY incursion 39 | An aircraft was cleared to land while a previous landing was still in the ILS sensitive area. | Not challenged | Not challenged |
| RWY incursion 39 | The first two landings were vacating via the same taxiway and stopped for intersecting parallel runway. | Not challenged | Not challenged |
| RWY incursion 39 | There was a RIMCAS alert but ATCO cleared the landing. | Not challenged | Not challenged |
| RWY incursion 40 | The event occurred during low visibility procedures. | No need for runway conflict prevention | Not challenged |
| RWY incursion 40 | The spacing between two aircraft on final was reduced. | Not challenged | Not challenged |
| RWY incursion 40 | The ATCO instructed the second landing aircraft to go-around several times but the flight crew landed the aircraft. | Not challenged | Not challenged |
### Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>Description</th>
<th>Causes</th>
<th>Actions</th>
<th>Results</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 41RWY incursion | A taxiing aircraft crossed an active runway in front of a departing aircraft | - The event occurred during daylight and in good visibility conditions.  
- The flight crew did not understand that the crossing clearance was a conditional one.  
- During daylight, stop bars are not used at this airport. | - No opportunity to prevent the conflict  
- Take-off clearance had already been given. | - The ATCO was alerted by RIMCAS alert but there was insufficient time for reaction. | - worked |
| 42RWY incursion | An aircraft was cleared to land while another one was taxiing on the RWY | - The Ground ATCO cleared aircraft to taxi and did not coordinate with the Tower ATCO. | - Neither TWR, nor participants detected the conflict | - ATCO did not detect the conflict | - Not challenged |
| 43RWY incursion | A taxiing aircraft crossed without clearance the HP of an occupied RWY | - An aircraft failed to stop at the HP, crossed it and stopped short of the runway during the departure of another aircraft.  
- The pilot misunderstood the clearance to hold at the HP as a line-up and wait. | - No opportunity to prevent the conflict  
- Take-off clearance had already been given. | - ATCO did not detect the conflict | - Not challenged |
| 44RWY incursion | ATCO cleared an aircraft to land on occupied RWY | - The ATCO cleared an aircraft to land after previously clearing a taxiing aircraft to taxi and line-up on the same runway.  
- There were electronic flight strips but the ATCO did not initially identify the potential conflict. | - The taxiing aircraft was still before the HP when ATCO gave the clearance to land to the other one.  
- After issuing the landing clearance, but before the taxiing aircraft reached the HP, the ATCO identified the potential conflict and stopped the taxiing aircraft. | - Not challenged | - Not challenged |
| 45RWY incursion | ATCO cleared an aircraft to land on occupied RWY | - The ATCO cleared an aircraft to land after previously clearing a taxiing aircraft to taxi and line-up on the same runway.  
- Taxiing aircraft flight crew identified the red stop bars, stopped the taxi and asked ATC for confirmation. | - Not challenged | - Not challenged | - Not challenged |
<table>
<thead>
<tr>
<th>RWY incursion</th>
<th>Event Description</th>
<th>Cause</th>
<th>Resolution</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>ATCO cleared an aircraft for take-off from a runway occupied by a snow removal vehicle.</td>
<td>The ATCO cleared several vehicles in one go to enter the runway for snow removal.</td>
<td>ATCO did not detect the conflict visually.</td>
<td>During the departure run, the flight crew observed the vehicle and succeeded to get airborne and climb above vehicle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One of the vehicles followed the others but forgot to tune to the tower frequency.</td>
<td>No ASMGCS was available at that airport.</td>
<td>It was a small high performance jet.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This vehicle entered via a vehicle road where no stop bars are installed but a sign was present to contact tower frequency.</td>
<td>ATCO did not detect the conflict.</td>
<td>The same performance would not have been possible for a typical commercial jet.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>When ATCO instructed the vehicles to vacate the one without communication remained on the runway.</td>
<td>ATCO did not detect the conflict.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ATCO cleared an aircraft for take-off on the same occupied RWY.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The colour of the vehicle was dark with low conspicuity against the terrain and no light beacon installed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The aircraft succeeded to depart and climb above the vehicle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>ATCO cleared an aircraft for a touch and go on an occupied runway.</td>
<td>It was a single runway airport and the single ATCO on shift in the tower after long shift with no breaks.</td>
<td>No opportunity to prevent the conflict.</td>
<td>Not challenged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The ATCO forgot the presence of some vehicles on the runway. He cleared them on the runway before a comfort break and when he returned he forgot to mark their presence on a strip.</td>
<td>The vehicles were already given clearance to be on the runway.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsequently, the ATCO did not identify the occupied runway when clearing the aircraft for a touch and go.</td>
<td>ATCO did not detect the conflict.</td>
<td>During the approach the flight crew observed the vehicle and went around.</td>
</tr>
<tr>
<td>48</td>
<td>A vehicle entered an occupied runway without clearance.</td>
<td>A vehicle entered an active runway without clearance in front of a landing aircraft.</td>
<td>No opportunity to prevent the conflict.</td>
<td>Not challenged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The read-back was correct but the clearance involved crossing two runways and the vehicle driver got confused.</td>
<td>The landing aircraft had already been given clearance.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ATCO did not detect the conflict.</td>
<td>ATCO did not detect the conflict.</td>
<td>The vehicle driver identified the landing aircraft and moved to the end of the runway.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ATCO did not detect the conflict.</td>
<td></td>
<td>The flight crew of the landing aircraft did not see vehicle as they had suffered a bird- strike during the landing and their attention was focused on the landing itself.</td>
</tr>
<tr>
<td>49</td>
<td>A taxiing aircraft entered an occupied runway without clearance.</td>
<td>A taxiing aircraft picked-up the clearance for another one and entered the runway.</td>
<td>Neither ATCO, nor participant detected the conflict.</td>
<td>Not challenged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The aircraft that confused the call sign read-back the clearance</td>
<td></td>
<td>During the approach the flight crew observed the vehicle and went around.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There was no hear-back by ATCO</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsequently, an approaching aircraft was cleared to land.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is no ASMGCS at the airport.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is SMR but the ATCO failed to identify the potential incorrect RWY entry.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

<table>
<thead>
<tr>
<th>RWY Incursion</th>
<th>Description</th>
<th>Events</th>
<th>Causes</th>
<th>ATCO Actions</th>
<th>Participant Actions</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| RWY Incursion 50 | ATCO cleared an aircraft to land on an occupied runway | • The ATCO cleared an aircraft to land when another one was on the runway protected area.  
• Prior to giving landing clearance a taxiing aircraft was instructed to line-up and wait and soon after to hold short but by that time the aircraft had already passed the holding point. | • No opportunity to prevent the conflict  
• The clearance for RWY use had already been given | • The ATCO did not detect the problem.  
• The taxing aircraft identified it and called the landing one.  
• The flight crew of the landing aircraft, in VMC, decided to continue the approach and land. | • No need for participant collision avoidance | • Not challenged |
| RWY Incursion 51 | A taxiing aircraft entered an occupied runway without clearance | • A taxiing aircraft was instructed to taxi to the holding point and read-back the clearance correctly.  
• Subsequently, the aircraft changed radio channel from Ground to Tower and passed the holding point.  
• Another approaching aircraft on short final went around.  
• The taxiing aircraft took a wrong taxiway – used for exiting the runway. | • Neither ATCO, nor participant detected the conflict | • ATCO did not detect the conflict | • During the approach the flight crew observed the vehicle and went around. | • Not challenged |
| RWY Incursion 52 | An aircraft landed while the preceding one was still on the runway | • Two consecutive landings on the same runway.  
• The second aircraft landed while the preceding one was still on the runway.  
• The first landing aircraft was a radio-navigation check flight and was changing from IFR to VFR and vice-versa.  
• After short spacing on final, the ATCO instructed the second landing aircraft to expect late landing clearance.  
• The flight crew continued approach and landed while the first landing aircraft was still on the runway.  
• The first had difficulties with vacating. | • No opportunity to prevent the conflict  
• The landing aircraft had already been given clearance. | • The ATCO did not instruct the second aircraft to go-around. | • Crew landed and stopped the aircraft before the previously landed aircraft that was already vacating the runway at that time. | • Not challenged |
| RWY Incursion 53 | A taxiing aircraft entered an occupied runway without clearance | • A aircraft was instructed to taxi to the holding point and hold short  
• The pilot read-back the clearance correctly.  
• Subsequently, the aircraft passed the holding point.  
• Another approaching aircraft on short final was instructed to go-around.  
• The taxiing aircraft took a wrong taxiway.  
• The clearance was for an unusual taxiway in order to expedite the departure that was already delayed.  
• The flight crew was not familiar with the cleared taxiway and was busy as the SID had just been altered.  
• No stop bars were installed on this taxiway. | • No opportunity to prevent the conflict  
• The landing aircraft had already been given clearance. | • The ATCO saw the conflict and instructed the landing aircraft that was at 1 NM from touchdown to go-around. | • Not challenged | • Not challenged |
### Runway Incursion Incidents in Europe - Safety Functions Maps analysis of 2013 - 2015 data sample

<table>
<thead>
<tr>
<th>RWY Incursion</th>
<th>Incident Details</th>
<th>Safety Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWY 54</td>
<td>• During dark time a taxiing-in aircraft was instructed by means of a conditional clearance to cross, to taxi to the holding point and hold short. • The correct conditional clearance was misunderstood and read-back incorrectly as “I have traffic in sight – clear to cross”. • Subsequently, the aircraft passed the holding point. • Another approaching aircraft on short final went around. • Stop bars were not used.</td>
<td>• No opportunity to prevent the conflict • The landing clearance had already been given</td>
</tr>
<tr>
<td>RWY 55</td>
<td>• Low visibility procedures were used • A taxiing-out aircraft was instructed by ATC to taxi to the HP for CAT I and by this entered the LOC sensitive area. • An aircraft on final went around. • The ATCO did not realise the need to protect the LOC sensitive area. • ATCO cleared the aircraft.</td>
<td>• The landing aircraft asked if the LOC was protected and when informed that the taxing aircraft was at CAT I HP initiated a go-around.</td>
</tr>
<tr>
<td>RWY 56</td>
<td>• A helicopter crossed the RWY threshold without clearance while an aircraft was on short final. • The ATCO saw the conflict and twice tried to contact the helicopter without success.</td>
<td>• No opportunity to prevent the conflict • The landing clearance had already been given</td>
</tr>
<tr>
<td>RWY 57</td>
<td>• An aircraft was cleared to land while a previously landed one had not vacated completely and had remained within the runway protected area. • The taxiing-out aircraft reached CAT I stop bar and stopped vacating.</td>
<td>• No need for ATC collision avoidance</td>
</tr>
</tbody>
</table>

For EUROCONTROL Page 55