



Flight Operations Briefing Notes

Runway and Surface Operations

Preventing Runway Incursions

I Introduction

One major safety issue of surface operations is the occurrence of runway incursions.

Taxi clearances at some large airports are quite complex and subject to misunderstandings.

The objective of this Flight Operations Briefing Note is to provide awareness of:

- A runway incursion;
- The associated contributing factors; and,
- Related prevention strategies, especially in terms of best practices for flight crew to avoid runway incursions.

II Background Information – Statistical Data

II.1 Definitions

The European JAA defines a runway incursion as the unintended presence of an aircraft, vehicle or person on the runway or runway strip.

The US FAA defines a runway incursion as any occurrence at an airport involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in the loss of separation with an aircraft taking off, intending to take off, landing or intending to land.

In this Flight Operations Briefing Note, the term Runway Incursions includes the European JAA and US FAA definition amongst others and/or additionally the following types of events:

- Inadvertent crossing of a hold-line and/or entry onto an active runway (with or without loss of separation with an aircraft, vehicle or pedestrian),
- Takeoff / landing without clearance,
- Simultaneous takeoff and landing from the same or from intersecting runways, or,
- Takeoff / landing from/onto the wrong runway.

Note:

Experience shows that several cases of takeoff and/or landing did occur from taxiways.

II.2 Operational consequences

The US FAA defines 4 categories of potential hazards associated with an urgency level of reaction required from the flight crew:

- Little or no risk of a collision, no need for corrective action, but this is an incursion or incident nonetheless;
- Decreasing separation, corrective action is advisable and there is time and room for corrective action;
- Separation decreases, time-critical action is essential to avoid a collision; or,
- Extreme danger, instantaneous action required to narrowly avoid catastrophe (near collisions and collisions).

The nature of the reaction from the crew depends upon situations:

- Lateral evasive maneuver in case of potential collision,
- Rejected takeoff, possibly near or above 100 kt, or maximum braking at landing, instructed by Air Traffic Control (ATC) or decided by flight crew,
- Go around at low altitude (DH or below) instructed by ATC or decided by flight crew,
- Emergency evacuation following a collision.

II.3 Statistical data

68% of the accidents involving Air Traffic Management (ATM) occurred during the ground phase of flight. (Source: Review of ATM-related Accidents worldwide from 1980 to 2001 by the National Aerospace Laboratory (NLR) – Netherlands)

There is a runway incursion every 3 or 4 days in Europe. There is a near collision due to runway incursion every 2 or 3 months in Europe. (Source: European JAA - 2002)

Runway incursion is a threat that may occur at any airport in the world (i.e.: any airport having a significant number of ground movements).

Runway incursions do occur in daytime as well as at night, in good as well as in low visibility conditions.

The following drawing synthetizes the major causes leading to runway incursions (Figure 1):

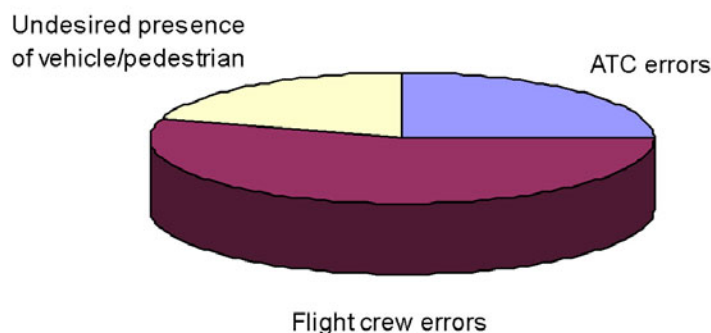


Figure 1

(Source – US FAA– 2001)

III Operational and Human Factors Involved in Runway Incursions

Runway incursions are the consequence of multiple operational and/or environmental factors.

One major contributing factor for runway incursions is the crew lack of situational awareness during airport surface operations, induced by weather considerations, by complex airport factors or by crew technique itself; it is also caused by ATC issues.

III.1 Weather factors

All factors affecting the crew visibility can be considered as potential contributing factors for runway incursions:

- Low visibility conditions (haze, dust (e.g.: from construction works), light or heavy rain),
- Visibility on taxiway lower than expected RVR,
- Position of the sun versus pilot's eyes, reflection of the sun on wet surfaces blinding the pilots (Figure 2),



(Photo credit - US FAA)

Figure 2

Where is the hold position?

- Snow and/or icing over surfaces covering airport surface markings,
- Night time operations.

III.2 Airport factors

Various airport factors may affect pilot situational awareness, distract the crew, or lead to crew confusion:

- Congested airports with many different-sized aircraft, and with many vehicles and pedestrians moving on the airport surface,
- Close-spaced parallel runways, crossing runways, high speed turn-off, complex and confusing intersections, etc ... (Figures 3, 4 and 5),



Figure 3

Taxiway parallel to crossing runways



Figure 4

Complex intersection and short taxiway between two runways

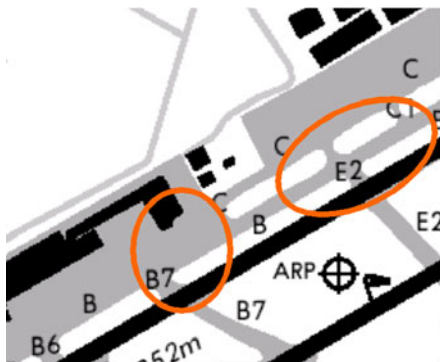


Figure 5

*Direct access to a runway from a parking area,
or access to a runway via a taxiway from another parking area on the same airport*

- Surface ground radar failure (or not at the latest standard) in case of low visibility,
- Substandard (non-ICAO compliant), downgraded (e.g.: poorly illuminated, rubbed out, ...) or missing signs, lights and/or markings,
- Construction works involving people and vehicles on the airport surface,
- Non nominal airport configuration: closed taxiways or runways (Figure 6), runway used as taxiway, partial back-track on a runway, ...



Figure 6

Identification of a closed runway

III.3 ATC factors

Runway incursions may also be due to ATC:

- Controller degraded situational awareness: controller's failure to see and track airport activity from the tower, failure to provide separation on ground, ...
- Incorrect or inadequate clearance (e.g.: improper TWR / GND controllers coordination, use of non-standard phraseology, pilots readback-error not detected by controller, ...).

III.4 Crew technique factors

Many runway incursions are caused by flight crew inability to correctly taxi as per ATC clearance because of:

- Failure to properly visualize the expected or cleared taxi out (in) path,
- Inadequate pre-flight or approach preparation,
- Lack of a proper identification and briefing with the PNF of the taxi clearance both at departure and at arrival,
- Failure to accurately materialize on airport surface charts the expected or cleared taxi routing, with outstanding elements (intersections, holding lines, ...),
- Distraction or poor monitoring of the taxi progress,

- Non-adherence to procedures (e.g.: incomplete read back, ...),
- Unfamiliarity with the airport and failure to advise controller when a loss of position awareness occurs,
- Failure in Crew Resource Management (cross-check / coordination) resulting in inadequate reference to critical data such as heading, raw ILS deviations, airport lights, signs and/or markings,
- Crew complacency when operating at very familiar airport (e.g.: home base),
- Too high taxi speed,
- High pressure on flight crew, in congested airports, so as not to “lose a slot”.

IV Best Practices, Prevention Strategies and Lines-of-defense

The recommendations to avoid runway incursions are manifold:

- Adequate communication technique during taxi,
- Proper knowledge of airport surface markings, lights and signs,
- Proper preparation of expected taxi out/in routing, and adequate taxi technique and operation.

IV.1 Communication guidelines

The following communication guidelines should be implemented to address the factors involved in runway incursions:

- Use of aviation English and language proficiency, and adherence to established standard ICAO phraseologies in order to keep situational awareness for all participants associated with runway operations,
- Use of a common frequency for PF and PNF, when practicable, particularly until all runways have been vacated after landing (i.e.: do not anticipate switching to the ground controller frequency).
- State your position whenever making initial contact with any tower or ground controller, regardless of whether you have previously stated your position to a different controller,
- Acknowledge and read back all the clearances and instructions, including call sign and runway designator, especially full read back of any holding position instructions,
- If clearances are not clearly understood, do not hesitate to request clarification,
- Adopt the sterile cockpit rule (defined in the *Flight Operations Briefing Note **Managing Interruptions and Distractions in the Cockpit***) during taxi phase,
- When cleared to cross a runway, report to ATC, when requested, when the aircraft has vacated the runway,

- Public Address or operational calls on the airline frequency should be avoided while taxiing, particularly when approaching any active runway.
- When temporarily leaving the ATC frequency, notify other flight crew member and request to be briefed of what you may have missed,
- Advise ATC immediately if you are holding for any reason on taxiway or runway because this strongly affects the timing of every controller and pilot who anticipates your action,
- Ask ATC, if the aircraft is holding for a time considered to be an extended holding period, particularly when aircraft is cleared to taxi into position-and-hold onto the departure runway (TIPH clearance),
- Listen to other traffic on the party line frequency to help maintaining awareness of airport activity.

IV.2 Airport knowledge

The following best practices should be implemented to warrant airport knowledge:

- Know standard airport markings, signs, lighting, and understand their meaning and operational consequences (Figure 8): "holding markings area", ... and special markings and lighting to enhance taxiing capabilities in low visibility conditions (e.g.: "stop bars" which prevent lining up or crossing a runway when red lights are illuminated (Figure 7)),



(Photo credit - US FAA - Eurocontrol)


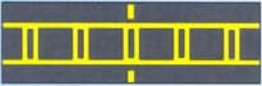


Figure 7

Stop Bar lights fixtures

Airport Signs — Action or Purpose

<p>4-22 TWY/RWY HOLD POSITION: Hold Short of Runway on Taxiway</p> <p>Also . . . RWY/RWY HOLD POSITION: Hold Short of Intersecting Runway</p>	 <p>RUNWAY BOUNDARY: Exit Boundary of Rwy Protected Areas</p>
<p>8-APCH RWY APCH HOLD POSITION: Hold Short for Acft on Approach</p>	 <p>ILS CRITICAL AREA BOUNDARY: Exit Boundary of ILS Critical Area</p>
<p>ILS ILS HOLD POSITION: Hold Short of ILS Critical Area</p>	 <p>RUNWAY EXIT: Defines Direction & Designation of Exit Twy from Rwy</p>
<p> NO ENTRY: Identifies Paved Areas Where <u>Aircraft</u> Entry is Prohibited</p>	<p>Also . . . TWY DIRECTION: Defines Direction & Designation of Intersecting Taxiway(s)</p>
<p> TAXIWAY LOCATION: Identifies Taxiway on Which Aircraft is Located</p>	<p>22↑ OUTBOUND DESTINATION: Defines Directions to Take-Off Runways</p>
<p> RUNWAY LOCATION: Identifies Runway on Which Aircraft is Located</p>	<p> INBOUND DESTINATION: Defines Directions for Arriving Aircraft</p>
<p> RUNWAY DISTANCE REMAINING: Identifies Runway Length Remaining</p>	<p> TAXIWAY ENDING MARKER: Indicates Twy Does Not Continue</p>
	<p> DIRECTION SIGN ARRAY: Identifies Location in Conjunction with Multiple Intersecting Taxiways</p>

Airport Markings

 <p>HOLDING POSITION: Hold Short of Intersecting Rwy Also Land and Hold Short Marking</p>
 <p>ILS CRITICAL AREA: Hold Short During IMC Conditions</p>
 <p>TAXIWAY/TAXIWAY HOLDING POSITION: Hold Short of Intersecting Taxiway When Directed by ATC</p>
 <p>MOVEMENT AREA BOUNDARY: Defines Boundary of Movement Area and Non-Movement Area</p>

(Source - US FAA Aeronautical Information Manual - AIM)

Figure 8

Extract from Pilots Guide to Airport Signs and Markings

- Be able to interpret the relation in between the airport chart schematic and airport signs,
- Systematically review airport layout information which may be reported through NOTAM and ATIS information (recent changes in airport layout, construction works, temporary taxiway / runway closures, ...),
- Share taxi experience at familiar airport between flight crew members (local habits, particulars in taxi routings) and transmit it to airline operations in order to ensure wide dissemination to all flight crew.

IV.3 Cockpit procedures for maintaining situational awareness

The following best practices are presented into three parts to ensure that cockpit procedures will maintain situational awareness throughout ground operations:

- Best practices to prepare/plan ground operations at the gate and prior to starting the descent:
 - Independently verify aircraft parking location (LAT/LONG if necessary),
 - Review the airport layout using adequate airport charts, ATIS and NOTAM information, and share previous experience at this airport, if any, to determine expected taxi routes,
 - Review the designations of the possible/probable exits on the landing runway,
 - Identify any anticipated complex intersections and runway crossings along the expected taxi routes (Figure 9),



Figure 9

Complex taxiways intersection and arrangement of expected signs at intersection

“Black square – You are there!” “Yellow sign – Points the way!”

- Plan timing and execution of check lists to increase attention when approaching intersections and runway crossings, and enhance situational awareness during the taxi phase,
 - Conduct detailed briefing with cross-coordination of both flight crew members, these briefings should take place before push-back or engine start, and during the descent preparation.
- Best practices to conduct taxi operations when taxi clearance is received:
 - Acknowledge received routing and not the expected one,
 - If unexpected clearance is delivered, before taxiing, review the routing on airport diagram and conduct detailed briefing, to ensure both flight crew members have fully understood the instructions,
 - If taxi instructions are complex or at unfamiliar airports, writing down all instructions is desirable, request progressive taxi instructions (i.e.: step by step routing directions) if needed,
 - Before taxiing, clear up any uncertainties with ATC about the routing (Figure 10),



Figure 10

Confusing taxiway crossing of the runway

- Use exterior lights as required by Airbus SOPs,
- One pilot head up at any time to taxi the aircraft and to scan outside for other traffic,
- When taxiing, both flight crew members should be “in the loop” for actively monitoring and updating their progress and location on the airport diagram; this includes knowing the aircraft’s present position and mentally calculating the next location on the route: PF-guided-by-PNF with cross-confirmation should be the operational standard,

- Be alerted by any information not consistent with what is expected (Figure 11),



Figure 11

On a taxiway, which color are you expecting ... for the taxiway edge lights? ... for the taxiway centerline lights, if any?

- Taxi at adequate speed as per taxi/brake policy and avoid high taxi speed when approaching any intersection, for proper signs and markings identification,
- When PF does the flight control check, (s)he must continuously watch outside the aircraft; PNF checks flight control deflections on ECAM System Display,
- If PF needs to watch inside the cockpit, (s)he must stop the aircraft,
- When approaching a runway, alertness to detect the hold-line on the taxiway (Figure 12) is required (e.g.: hold-line may be farther from the runway than expected, particularly when the taxiway is oblique),



(Photo credit - US FAA)

Figure 12

Holding short of a runway

- If you have any doubt at any time of aircraft location, stop and immediately inform ATC: do not hesitate to ask for a "Follow-me" vehicle,
- Before crossing a runway, position the aircraft at a right angle with the runway, when practicable, to better monitor operating environment,
- Before crossing a runway, ensure that the taxi clearance includes an explicit clearance to cross that runway, this requirement also includes crossing of non-active runways,
- Never cross red stop bars without a positive clearance from the ATC,

- Conduct before-takeoff check list when the aircraft is stationary, when practicable,
- Before-takeoff check list completion before moving into the active runway is required to avoid holding time on the active runway,
- Best practices to conduct taxi operations when line up and hold clearance, or line up and takeoff clearance is delivered:
 - Visually scan to the left and to the right and check approach path is clear of traffic,
 - Use the TCAS display, when ATC transponder is switched on, to remain aware of traffic on approach,
 - Light up the aircraft and make it more visible when entering a runway to takeoff or when taxiing into position and holding for takeoff, as required by Airbus SOPs (e.g.: switching on the strobe lights (if installed) when entering the runway to line up clearly shows to other aircraft that an aircraft is about to take off),
 - Perform a line-up check onto the departure runway: identification of runway markings and lights (Figure 13), alignment with correct runway, ILS tuned for this runway if available (e.g.: LOC diamond), correct takeoff position, and orally confirm "active runway check",

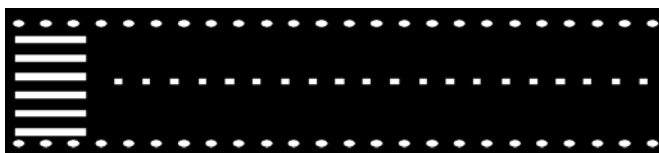


Figure 13

Which color confirms that you are on a runway?

- Be extra vigilant if you are holding on an active runway awaiting for takeoff clearance (e.g.: monitor ATC landing clearance to other aircraft),
- Contact ATC if takeoff is delayed for more than 90s, after ATC takeoff clearance has been received,
- Best practices to adopt during the approach and landing roll, when ATC landing instructions are received:
 - Use exterior lights, as required by Airbus SOPs (e.g.: LAND lights switched on below FL100),

- Verbally coordinate and agree on the assigned runway,
- Check approach charts and nav aids selection for this runway (e.g.: ILS tuned for this runway, if available),
- Identify the required runway and, during final approach, maintain an awareness of this runway (e.g.: LOC diamond (if available), runway heading, runway characteristic (width, length, lighting)), particularly when approaching parallel runways,
- Actively monitor the assigned tower frequency for potential conflicts involving your runway, and visually check - whenever possible - that no aircraft is holding in takeoff position,
- After landing roll, clear the runway once speed is controlled, to reach holding position on the turn off taxiway; never stop on the runway unless instructed to do so (e.g.: Land and Hold Short Operations - LAHSO in practice at several US airports where landing aircraft are ordered to hold before reaching an active runway intersection), pay specific attention when there is closely spaced parallel runways or converging runways (Figure 14),



Figure 14

Close spaced parallel runways and high-speed exit

Note:

Turning off at an outboard parallel high-speed exit (T), you must ensure to hold short of the inboard parallel runway unless specifically issued an ATC clearance to cross.

- When leaving the landing runway, switch off the strobe lights - if installed - to show to other aircraft that you have vacated the runway,
- Perform the after-landing checklist only when the taxi clearance to the gate has been understood by both pilots, or when reaching holding position on the turn off taxiway.

IV.4 Emerging technology

The objective of an overall reduction in Runway Incursions would result from a combination of “improved pilot performance and new system catching errors or providing assistance to pilots”.

Some available enhanced systems for ATC

- Airport Movement Area Safety System (AMASS) is a software package that takes data from the ASDE-3 airport surface movement detection radar (installed at major US airports) and processes it to provide controllers with aural and visual warnings of potential collision risks,
- Airport Surface Movement radar, know as ASDE-X, are designed to receive and process automatic dependent surveillance – broadcast signals from aircraft.

Some prospective systems in flight deck

- Airport moving map with aircraft location on Head Down Display,
- New generation of Head Up Display to provide assistance for ground operation as a tactical tool to taxi the aircraft in low visibility conditions depending on availability of certain new technologies: Surface Guidance System (SGS), Enhanced Vision System (EVS) based on forward looking infrared sensors and Synthetic Vision System (SVS) to provide the display of conformal images assembled from a database,
- Runway Awareness and Advisory System (RAAS) to provide supplemental aural information to the flight crew of aircraft position relative to runways during surface operations and on final approach.

V Summary of Key Points

The following key points should be emphasized:

- Planning, communication and coordination for ground operations as for any other phases of flight,
- Enhanced alertness for factors involved in runway incursions,
- Prevention strategies through implementation of standard taxi operating procedures and proven best practices, and by adherence to ICAO recommendations.

VI Associated Flight Operations Briefing Notes

The following Flight Operations Briefing Notes should be reviewed along with the above information:

- **Effective Pilot / Controller communication**
- **Managing Interruptions and Distractions in the Cockpit**
- **Conducting Effective Briefings**

VII Regulatory References

- ICAO – PANS/ATM (Doc 4444) – Standard phraseologies –Chapter 12.
- ICAO – Annex 11 – Read-back of clearances and safety-related information – Chapter 3.7.
- ICAO – Annex 10 and PANS/ATM – Radio transmission guidelines and techniques.
- ICAO – Annex 14 – Aerodrome design and operations – Markings, signs and lights - Chapter 5.
- ICAO Poster P709 – Taxiing guidance signs.
- FAA – Aeronautical Information Manual (AIM) – Chapter 2 - Aeronautical Lighting and Other Airport Visual Aids.
- FAA – Advisory Circular - AC120-74A - Flight Crew procedures during taxi operations.

VIII Additional Reading Material / Websites References

- European action plan for the prevention of runway incursions
<http://www.eurocontrol.int/safety/runwayincursions.html>
- Eurocontrol Runway Safety Awareness Interactive CD
<http://www.eurocontrol.int/eatm/agas/runwayincursions/material.html>
- US FAA runway safety <http://www.faa.gov/runwaysafety/>
- FAA Flight Standard Service Runway and Surface Safety CD
- US FAA AIM <http://www.faa.gov/atpubs/AIM/index.htm>
- NTSB http://www.nts.gov/events/2000/incursion/incur_video.htm

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Airbus Customer Services
Flight Operations Support and Line Assistance

1 Rond Point Maurice Bellonte - 31707 BLAGNAC CEDEX FRANCE

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