Global Action Plan for the Prevention of Runway Incursions

Volume I — Recommendations

ORGANISATIONS THAT SUPPORTED THE INITIATIVE:

ACI Airports Council International — Air Dream College — Aer Lingus — AESA — AIRBUS — ATNS Air Traffic & Navigation Services

AIRNAV IRELAND — ANA Aeroportos de Portugal / VINCI Airports — Air Navigation Solutions — ALTA — ANAC National Civil Aviation Agency - Brazil

avianca — AVINOR — BCAST Grupo Brasileiro de Segurança Operacional da Aviação Comercial — bhansa — Brussels Airport the heart of Europe

CANSO — Changi Airport Group — DFS Deutsche Flugsicherung — Copa Airlines A Star Alliance Member — Copenhagen Airports CPH

DELTA — Devlet Hava Meydanları İşletmesi (DHMI) — dgac DSNA — DHL — easyJet — EBAA European Business Aviation Association

ECA Piloting Safety European Cockpit Association — EMBRAER — Emirates — ENAIRE — enav

EUROCONTROL — Federal Aviation Administration — GdF Gewerkschaft der Flugsicherung — GENÈVE AÉROPORT — GOL — GROUPE ADP

Heathrow — Honeywell — (crest) — IATA — IBAC International Business Aviation Council

ICAO · OACI · ИКАО — isavia ANS Air Navigation Services — LATAM — Luxair — NATS

NAV CANADA — NAV PORTUGAL — NETJETS — nlr — Prague Airport

RASG-PA International Civil Aviation Organization (ICAO) + States + International Organisations + Industry — RYANAIR — SAAB — Schiphol Group — SENASA

skeyes nice to guide you — SKYSAFE GLOBAL — Southwest — SUNRISE airways — skyway

TagAirlines — Think ATM & Airports Consultancy — Civil Aviation Authority — (logo) — UNITED

This document has been produced under the framework of the ICAO Global Aviation Safety Plan and Global Aviation Runway Safety Action Plan. It provides complimentary best practices.

COORDINATING ORGANISATIONS		SIGNATURE
Michele Merkle, Director, Air Navigation Bureau	ICAO	
Hassan Shahidi, President and CEO	FLIGHT SAFETY FOUNDATION	
Raúl Medina, Director General	EUROCONTROL	

VALIDATING ORGANISATION		SIGNATURE
Luis Felipe de Oliveira, Director General	ACI World	
Simon Hocquard, Director General	CANSO	
Nick Careen, Senior Vice President	IATA	
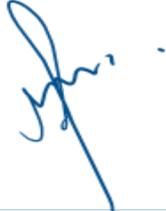
Executive Summary

Runway incursions[1] are among the most persistent threats to aviation safety. The International Civil Aviation Organization (ICAO) places runway incursions among the five highest-risk categories of events that must be addressed to mitigate the risk of aviation fatalities. The potential consequences of a runway incursion are severe, especially if that incursion ends in a collision.

Despite repeated attempts over the decades to end incursions, they still occur, as evidenced by a spate of incidents at U.S. airports in 2023. These close calls heightened concerns about the potential for disaster. While the United States experienced nearly two dozen of these serious incidents in 2023, the risk of runway incursions is a global issue. As air traffic operations increase, the risk of runway incursions also is likely to increase unless new safety defenses are implemented. While general aviation aircraft are involved in as many as 70 percent of all incursions in some parts of the world, data show upward trends not only in the overall rate of high-risk runway incursions but also in airliner involvement in those incidents.

Overall, runway incursion risks include a complex combination of factors that can only be addressed through a collaborative approach involving aircraft operators, air navigation service providers (ANSPs), airports and regulators. All of these stakeholders have been involved in developing the Global Action Plan for the Prevention of Runway Incursions (GAPPRI), with more than 200 aviation experts from 80 organisations around the world working together to develop the initiative.

The findings and recommendations in Volume I of the GAPPRI report are based on an analysis of multiple global and regional datasets, combined with insights from operational expertise. This inclusive strategy extended beyond the study of only hazardous events; the recommendations incorporate lessons from all operations, with both desirable and undesirable outcomes. The following are the high-level findings and conclusions:

Variability in human performance: Runway incursions predominantly arise from scenarios involving human performance. Individuals at the forefront of the aviation system, including pilots, air traffic controllers and vehicle drivers on aerodrome manoeuvring areas, consistently adapt to varying pressures and workloads, balancing multiple goals within an increasingly complex operational environment. While this adaptability contributes to the safe functioning of the system, it can sometimes interact unfavourably with operational conditions, leading to issues such as distraction, miscommunication, misidentification, or misapplication of operational processes, which have resulted in serious incidents.

Lack of systemwide collision avoidance barriers: Significantly disparate efficacy levels were observed between collision avoidance barriers for runway incursion incidents and en route separation incidents. Unlike the airborne collision avoidance system (ACAS/TCAS), which serves as the final technological barrier in the skies, there exists no universally implemented last line of defence against runway collisions. While ground-based technologies such as ASMGCS[2] and ASDE-X[3] at large airports have been effective as a last-resort barrier in preventing runway collisions, these systems are often cost-prohibitive and not scalable to deploy at thousands of airports. Effective layers of systemic barriers upstream and downstream in the chain of events potentially leading to runway collision are required to ensure safe growth in the future.

Degraded runway status awareness: More than one-third of high-risk runway incursions could have been averted through better situational awareness technologies that assist air traffic controllers in detecting potential runway conflicts. Taxiway and runway stop-bars or similar functional barriers can significantly strengthen runway status awareness for pilots. Among the foremost risk scenarios for runway incursions are instances in which air traffic controllers clear pilots to land or depart on an occupied runway, pilots fail to hold short of a runway as instructed, or vehicles enter a runway without clearance. A systematic approach to addressing runway incursion scenarios and potential runway collision scenarios through risk and resilience management is likely to reduce or eliminate serious runway incursions.

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1. Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take off of aircraft.
2. Advanced surface movement guidance and control (ASMGC) is a system providing routing, guidance and surveillance of aircraft and vehicles.
3. Aircraft Surface Detection Equipment, Model X (ASDE-X) is a surveillance system using radar, multilateration and satellite technology that allows air traffic controllers to track surface movement of aircraft and vehicles.

- **Miscommunication and coordination**: A prevalent theme across incidents is the apparent breakdown in communication and coordination between air traffic control and pilots. Instances include simultaneous clearances given to aircraft on the same runway, aircraft crossing paths due to misunderstood instructions, and inefficiencies in communication among manoeuvring area vehicle drivers because of language barriers or differing communication channels — conditions that can impede shared situational awareness.

- **Challenges in surface navigation**: Safe navigation for runway management poses a significant challenge, as evidenced by multiple incidents. Incorrect positioning of aircraft or manoeuvring area vehicles on runways due to inaccurate position awareness or navigation routing points to potential procedural lapses, inadequacies in navigation capabilities and guidance, or insufficiencies in aerodrome signage, markings and lighting.

To address these findings, GAPPRI provides a comprehensive, collaborative plan to enhance safety through synchronised, consensus-based recommendations encompassing best practices that exceed regulatory requirements. It empowers aviation stakeholders around the world to proactively mitigate the threat of runway incursions.

GAPPRI includes 127 recommendations across stakeholder groups, including airport operators, ANSPs, aircraft operators, manufacturers, national governments and regulators, and organisations involved in research and development.

The GAPPRI findings emphasise the need to fortify various operational barriers for operators, ANSPs and aerodromes. In addition, they highlight the pivotal role of regulators, policymakers and manufacturers in facilitating risk management and strengthening operational barriers. The key areas of broad recommendations include:

- **Empowering and equipping aviation personnel:** This entails fostering a culture that prioritises safe runway operations over commercial pressures, emphasising the importance of taking sufficient time for critical safety tasks, promoting mental readiness, raising awareness about fatigue, nurturing positive team dynamics, and encouraging informed decision-making. Of the 127 recommendations, several call for enhanced and recurrent training, specifically focusing on scenarios involving runway incursions. A specialized human performance training program tailored to runway safety is likely to be instrumental in understanding and managing external pressures and workload.

- **Integration of advanced technologies**: The deployment of cutting-edge technological systems capable of providing real-time awareness of aircraft and vehicle positions, navigation route assistance, detection of deviations, and timely alerts for potential runway incursions and collisions is strongly recommended. These systems should be equipped to offer multiple layers of systemic barriers and in-depth defenses. Immediate alerts for air traffic controllers, pilots and maneuvering area vehicle drivers in the event of a potential collision or unauthorized runway entry are vital components.

- **Enhanced procedures for runway operations**: Recommendations call for regular reviews and updates of procedures and policies for aerodrome operators, ASNPs and aircraft operators to ensure the protection of runway operations. These recommendations underscore the importance of maintaining vigilance during all ground operations, implementing threat-and-error-based briefings for the crew and emphasising the significance of effective monitoring. Moreover, there is a pressing need for flight crews and air traffic controllers to optimise teamwork and enhance their awareness of traffic and runway statuses during runway operations.

- **Enhanced communication protocols**: Implementation of standardised phraseology and enhanced communication procedures for runway operations is crucial to minimise misunderstandings between air traffic controllers, flight crews and maneuvering area vehicle drivers. Fostering a culture that prioritises immediate clarification of any communication uncertainties is recommended. Additional recommendations include the adoption of a sterile control room and cockpit concept; managing the specific threats of conditional clearances, complex or early clearances, runway entry or take-off clearance omission; and planning for a common frequency and language for all movements in the maneuvering area.

- **Enhanced aerodrome visual aids**: Enhancements to runway and taxiway signs, markings and lights, particularly in adverse weather conditions, are essential for increased visibility and safe navigation. The installation of additional signage at critical intersections and the use of stop-bars or other lighting

systems (e.g., autonomous runway incursion warning systems) are also recommended.

Risk mitigation through infrastructure design: While aerodrome infrastructure is predominantly a permanent fixture, any additions or modifications should be made in a manner that minimises or eliminates the risk of runway collisions.

Enhanced safety management and support for runway safety teams: Beyond regulatory compliance, the recommendations propose evaluation of the efficiency of safety management systems and aerodrome safety teams in reducing the risk of runway collision. Enhanced safety learning and sharing of information among all involved parties are crucial for raising awareness and comprehensive operational insights. Cooperative change management between aerodrome operators and ANSPs should occur in relation to ongoing aerodrome work and infrastructure development to reduce the likelihood of runway incursions.

GAPPRI is intended to serve as a roadmap for addressing risk and instilling resilience, enabling government and industry not only to cope with increases in traffic but also to be proactive in anticipating and addressing problems. Its recommendations include immediate and near-term actions to mitigate the serious incidents studied, but also future solutions involving introduction of new technologies that are in the development pipeline that could be deployed in the medium time horizon. GAPRRI also identifies research and development investments with potential high-risk mitigation benefits that would be mature for deployment in the longer-term time horizon.

GAPPRI's next steps include collaboration amongst stakeholders to review the plan's recommendations and assess their relevance, to identify the best practices for implementing the recommendations they have identified as relevant, to conduct an appropriate impact assessment when deciding how to implement the recommendations, to implement specific actions and monitor their effectiveness, and to share lessons learned with the industry.

GAPPRI acknowledges diversity in risk profiles and encourages the sharing of successful strategies with a goal of empowering aviation stakeholders worldwide to proactively mitigate the threat of runway incursions and build a safer, more resilient aviation ecosystem.

1 Acknowledgements

2 Statement of Commitment

Runway incursions are one of the most serious types of aviation incidents. The International Civil Aviation Organisation (ICAO) identifies runway incursions as one of the five high-risk categories of occurrences to be addressed to mitigate the risk of fatalities in aviation. Runway incursion is the main precursor to be managed to prevent collision on the runway. The potential consequences of a runway collision are very serious if it involves fast, high energy jet planes moving on a relatively confined runway strip. Unlike having the airborne collision avoidance system (ACAS) as the last technological barrier in the skies, there is no similar universally implemented system to serve as last line of defence against runway collision.

Runway collision risk depends on the number of traffic interactions on and around runways. Runway traffic interactions more than double when traffic doubles. Runway collision risk will increase considerably if no additional safety defences are implemented, considering that traffic will double in 20 years. Runway incursion risk is made up of a complex combination of factors in different aviation segments. Addressing the risk can only be done in synchronisation and collaboration.

The jointly owned risk requires joint solutions. This is why the industry came together, in a dedicated working group, to discuss and agree on what are the most important actions to address the runway incursion risk. More than 200 professionals from more than 80 organisations worked in sub-working groups led by the International Air Transport Association (IATA), Airports Council International (ACI), the U.S. Federal Aviation Administration (FAA), CANSO, EUROCONTROL, the U.K. Civil Aviation Authority (CAA) and Flight Safety Foundation. The initiative was developed within, and complements the frameworks of, the ICAO Global Aviation Safety Plan and Global Runway Safety Action Plan.

The resulting Global Action Plan for the Prevention of Runway Incursions (GAPPRI) is a comprehensive, collaborative effort to enhance aviation safety. It offers synchronised, consensus-based recommendations encompassing best practices that go beyond regulatory compliance. This plan acknowledges diversity in risk profiles and resilience among stakeholders, encouraging the sharing of successful strategies. It provides a robust roadmap for various time horizons, ensuring adaptability to evolving aviation needs. By addressing risk and resilience holistically, this action plan empowers aviation stakeholders worldwide to proactively mitigate the threat of runway incursions, fostering a safer, more resilient global aviation ecosystem.

The organisations that contributed to this action plan are committed to enhancing the safety of runway operations by advocating the implementation of the recommendations that it contains.

The imperative to address this issue is clear. The goal is not merely to cope with the increased traffic but also to stay ahead of it, so that we can minimise the risks associated with higher runway traffic interactions and increased operational complexity. Ultimately, our commitment to safety in the face of growing air traffic is non-negotiable, and it demands our unwavering dedication and proactive action.

We are committed to a culture of continuous improvement. We encourage a culture of reporting runway safety concerns and incidents but also seek to develop resilient behaviours and best practices to prevent runway collisions.

We recognise the importance of effective communication and collaboration among all stakeholders in aviation, including air traffic control, pilots, ground personnel and regulatory authorities. We will work together to improve coordination and communication.

We will invest in training and education programs for our personnel to ensure they are well-prepared to prevent runway collisions. This includes awareness of procedures, technology and human factors.

We will explore and implement advanced technologies and systems that aid in runway collision prevention.

We commit to supporting runway collision prevention research efforts and sharing relevant data and insights to advance our collective understanding of the challenges and solutions.

We will establish clear lines of accountability within and across our organisations to ensure that runway collision prevention measures are consistently enforced and improved.

We will actively engage with the public to raise awareness about the importance of runway collision prevention and its role in aviation safety.

3 Introduction and Background

This document is Volume I of the Global Action Plan for the Prevention of Runway Incursions (GAPPRI) and contains the agreed recommendations to the following civil aviation organisations: aerodrome operators, air navigation service providers, aircraft operators, manufacturers, and regulators. It also addressees research and development (R&D) recommendations to States, international organisations and the industry.

Volume II of GAPPRI will provide explanatory and guidance material, and related best practices for the recommendations listed later in this document.

The development of the GAPPRI recommendations is based on the following principles:

- Provide recommendations that **address actions beyond regulatory compliance**. The recommendations in this action plan are not exhaustive in managing runway incursion risk and resilience. It is fundamental that organisations shall comply with international, regional and national rules and regulations.

- Provide recommendations **to organisations and not to individuals. Specifically address runway collision risk and resilience, supporting the system at the front end to manage workload, external pressures, goal conflicts and constraints,** rather than addressing the safety management system in general.

- Recommendations should be **based on consensus.** A recommendation is included in the action plan only if there was a consensus for it during the drafting and the subsequent validation process.

- The approach followed by the working group is **knowledge-based and data-driven and uses Learning From All Operations**, an approach expanding from a focus on hazardous events to an analysis of routine operational data, to learn from all operations and events — not just from those that are unwanted.

- **Promote technology embedded in systemic solutions**. Promote technological solutions that are clearly integrated with the respective training, procedures, standardisation, certification and oversight.

- **Provide recommendations for three different time horizons**. The first time horizon is now — organisations addressed by the recommendations should start assessing their relevance and plan for implementation as soon as this action plan reaches them. The second time horizon is up to 10 years in the future and is mainly for recommendations that require development and global implementation of new technologies. Finally, the third time horizon of 15 years is for R&D recommendations that address issues with clear potential high-risk mitigation benefits but lack maturity for implementation within the 10 years horizon.

- **Provide functional recommendations.** Responsible organisations should decide specific details and implementation solutions after taking into account local conditions and specific context. When reviewing the recommendations, organisations should note that they are not prioritized in any specific order.

- The **verb "should"** is used to signify that, while a recommendation does not have the force of a mandatory provision, its content, if relevant, has to be appropriately transposed at the local level to ensure its implementation.

The organisations this action plan is addressed to should:

- Organise a review of the respective recommendations and assess their relevance against local conditions and specific context.

- Consult the best practices for implementing the selected recommendations and seek support, if needed, from the GAPPRI coordinating partners.

- Conduct an appropriate impact assessment (including safety risk assessment) when deciding on the specific action to implement the recommendations.

- Implement the specific action/change and monitor its effectiveness.

- Share the lessons learnt with the industry.

Global Action Plan for the Prevention of Runway Incursions

Recommendations

- **Aerodrome Operators**

- **Air Navigation Service Providers**

- **Aircraft Operators**

- **Manufacturers**

- **States and Regulators**

- **R&D recommendations for States, international organisations and the industry**

RECOMMENDATIONS TO AERODROME OPERATORS

REF	Recommendation
SAFETY MANAGEMENT AND SUPPORT TO RUNWAY SAFETY TEAMS	
ADR1	Annually assess own contribution to the effectiveness of the aerodrome local runway safety teams (LRSTs), including the existence and implementation of runway safety action plans.
ADR2	Ensure harmonised awareness of runway incursion risk management procedures, practices and issues among front-line operators (pilots, air traffic controllers and manoeuvring area vehicle drivers).
ADR3	Annually evaluate the consistency of runway safety procedures for operations on the manoeuvring area of the aerodrome (pilots and manoeuvring area vehicle drivers) at LRST meetings.
ADR4	Ensure that information is provided to and requested from all participating parties in an incident, so that a complete picture of causal and contributory factors can be built, lessons learned and actions taken.
ADR5	Share at local, national and international levels the lessons learned and essential safety information from occurrence investigation reports and runway safety analyses.
ADR6	Coordinate changes to manoeuvring area procedures with stakeholders operating on the manoeuvring area of the aerodrome. Periodically assess the effectiveness of the arrangements and update as necessary.
ADR7	Ensure that new aerodrome infrastructure and changes to existing infrastructure are designed to reduce the likelihood of runway incursions.
ADR8	Assess all arrangements associated with aerodrome construction works in progress (WiP) and: a. The potential for runway incursion during runway closure or WiP should be risk-assessed in coordination with the air navigation service provider (ANSP) and resident aircraft operators and mitigated. b. Ensure that appropriate coordination between the aerodrome operator and ANSP is in place prior to notifying the regulator. c. Ensure that up-to-date information about temporary work areas and the consequential operational impact is adequately presented and disseminated. d. Ensure that existing signs on related area are covered, lights are switched off, and markings are removed when appropriate. e. Ensure that temporary signs and markings are clearly visible, adequate and unambiguous in all applicable conditions.
ADR9	In coordination with ANSPs and as part of the management of change procedures before works, assess the sight lines from the tower visual control room (VCR) and existing visibility restrictions which have a potential impact on the controllers' ability to see the runway. Avoid such visibility restrictions or develop and implement appropriate short-term mitigations and identify longer term improvement measures, whenever possible.
ADR10	Implement peer reviews to assess runway safety, the state of airside infrastructure and operational processes.
ADR11	Establish leading and lagging runway safety performance indicators.
TRAINING AND COMPETENCE	
ADR12	Annually assess, and update as necessary, how the runway incursion risks and mitigations are included within initial and refresher/recurrent training of operational staff.
ADR13	Define driver training program requirements. Periodically assess formal manoeuvring area driver permits, training and refresher programmes (including practical training and proficiency checks) against driver training requirements.

REF	Recommendation
ADR14	Consider implementing a three-level scheme for aerodrome driving permits: apron only, manoeuvring area (excluding runways) and runways. Periodically, in a phased manner, audit airside driving permits (e.g., check 'recency' of use), in particular those allowing access to the runways, which should be as few as possible. Adjust, if needed, the validity period of the permit.
RUNWAY INSPECTION	
ADR15	In collaboration with the ANSP, periodically review the procedures for runway inspections and other runway works. This should include: a. Carrying out routine runway inspections in the opposite direction of runway movements with vehicle lights on regardless of time of day. b. Ensuring that uni-directional lighting is inspected efficiently on the basis of risk and operational needs assessment. c. Implementing procedures to increase overall situational awareness when vehicles occupy a runway (to be decided locally, e.g., technology, 'vehicle operation normal' calls or other means). d. Implement standard routes and timings for routine runway inspections. e. Temporarily suspending operations to allow a full runway inspection to be performed without interruption on the basis of risk and operational needs assessment. f. Vehicles entering a runway should be equipped with a dashboard camera recording the outside view from the vehicle, to collect information about actual and potential risks of runway incursion. The information would be used exclusively for safety improvement.
AERODROME INFRASTRUCTURE SUPPORTING SAFE NAVIGATION	
ADR16	Periodically assess and ensure that signs, markings and lights on the movement area are clearly visible, adequate and unambiguous in all appropriate conditions, e.g., in all light conditions and when wet.
ADR17	Avoid designing closely spaced multiple parallel runway holding positions on the same taxiway. Where this cannot be done, the holding positions should be clearly segregated.
ADR18	In relation to aerodrome protected areas: a. In coordination with ANSPs, identify the protected area for each runway and produce a chart/map of aerodrome protected areas. b. Ensure that drivers of vehicles operating on the manoeuvring area are familiar with the protected area map.
ADR19	Implement enhanced taxiway centreline markings and mandatory instruction markings at all certified airports.
ENHANCED PROCEDURES FOR SAFE RUNWAY OPERATIONS	
ADR20	a. In cooperation with ANSPs, implement H24 stop bars or other lighting systems (e.g., autonomous runway incursion warning systems (ARIWS)) at all active runway holding positions, providing an equivalent level of safety commensurate with the level and complexity of operations and the potential risk of runway incursion. b. Assess the need for elevated stop bars to improve stop bar visibility. c. Consider use of LED technology and reduced spacing (e.g., spacing of 1,5 m) to improve stop bar clarity. d. In cooperation with ANSPs, implement procedures, in line with the applicable regulations, to be followed in case of stop bar unserviceability.
ADR21	Review procedures which require pilots to monitor or call secondary VHF frequencies (e.g., for ramp entry, gate location) while manoeuvring on airport taxiways to avoid high workload for the pilot handling the aircraft and air traffic control (ATC) communication (wherever relevant to aerodrome operator or apron management service provider).

REF	Recommendation
ADR22	Ensure all manoeuvring area vehicle drivers are briefed at the start of a shift, including providing awareness of safety-significant airport information. The safety-significant information should also be checked before the start of the mission.
ADR23	Ensure that vehicle driver procedures and guidance contain a requirement for explicit ATC clearances to enter or cross any runway, regardless of runway status (active/inactive).
SAFE RUNWAY OPERATIONS COMMUNICATIONS	
ADR24	To minimise call sign confusion at aerodromes, aerodrome operators should ensure the use of pre-defined and process-specific unique call signs for manoeuvring area vehicles.
ADR25	Develop and implement a phased plan for use of one frequency and English language for all communication associated with the operation of a runway. The phased plan should aim at improving the shared situational awareness of all front-line operators and should provide realistic and practicable measures that ensure an adequate level of safety for each of its phases.
ADR26	Periodically evaluate radio telephony practices, assessing elements such as use of ICAO-compliant phraseology.
ADR27	In cooperation with ANSPs, implement communication procedures for airside vehicles' drivers on what phraseology needs to be applied by both parties, including standard phrases for: a. Radio checks and readability scale. b. Radio communication failures (transmitting blind). c. When a driver becomes lost or uncertain of the vehicle's position in the manoeuvring area. d. Position reporting. e. Runway access and runway crossing requests.
AERONAUTICAL INFORMATION	
ADR28	In collaboration with ANSPs, ensure that significant and up-to-date aerodrome information which may affect operations on the runway is provided to manoeuvring area drivers and pilots (e.g., by NOTAMS, automatic terminal information service (ATIS), radiotelephony (R/T), maps, new digital technology or other means).
ADR29	Information on temporary changes to operating conditions at the aerodrome should be communicated in a way to increase situational awareness of the most critical changes. When needed, an Aeronautical Information Publication (AIP) supplement with graphics and charts should be published.
ENHANCED TECHNOLOGY FOR SAFE RUNWAY OPERATIONS	
ADR30	Commensurate with the level and complexity of operations and the potential risk of a runway incursion, consider providing airside vehicle drivers with a real-time functionality for awareness and alerting to the potential for a runway collision between an aircraft and an airside vehicle and with real-time alerts when crossing into the protected area, such that drivers will be alerted in the event of a runway incursion.
ADR31	Enable the tracking of vehicle movements in the manoeuvring area when possible. Facilitate situational awareness by adopting technologies that enable ATC and other parties to locate and identify traffic in the manoeuvring area.
ADR32	Assess technical feasibility and business sustainability of new procedures and technologies for runway inspection.
ADR33	Implement policies and means to support vehicle drivers with identification of hold limits in respect to the protected area of a crossing runway (e.g., marking, geofencing, airport moving map).

RECOMMENDATIONS TO AIR NAVIGATION SERVICE PROVIDERS

REF	Recommendation
SAFETY MANAGEMENT AND SUPPORT FOR RUNWAY SAFETY TEAMS	
ANSP1	Support the regulator to periodically assess the effectiveness of aerodrome local runway safety teams (LRSTs), including the existence and implementation of runway safety action plans. Annually assess own contribution to the effectiveness of the aerodrome LRSTs. Promote the creation and support the work of a national runway safety team.
ANSP2	Ensure harmonised awareness of runway incursion risk management procedures, practices and issues among the front-line operators (pilots, air traffic controllers and manoeuvring area vehicle drivers). Support aerodrome operators to develop aerodrome-specific educational materials to familiarise pilots and vehicle drivers with hot spots and other aerodrome-specific safety information in the aerodrome environment.
ANSP3	Annually assess, and update as necessary, how runway incursion risk management is included within initial and refresher/recurrent training of operational staff.
ANSP4	Ensure that information is provided to, and requested from, all participating parties in an incident, so that a complete picture of causal and contributory factors can be built, lessons learned and actions taken.
ANSP5	Share at local, national and international level the lessons learned and salient safety information from occurrence investigation reports and runway safety analyses.
ANSP6	Ensure that arrangements are in place to coordinate changes to manoeuvring area procedures, including work in progress, with stakeholders operating on the manoeuvring area of the aerodrome. Periodically assess the effectiveness of the arrangements and update as necessary.
ANSP7	Periodically (initially and upon change) review runway capacity–enhancing procedures when used either individually or in combination (intersection departures, multiple line-ups, conditional clearances etc.) to identify any potential hazards and, if necessary, develop appropriate mitigation strategies.
ANSP8	Annually assess the consistency of runway safety procedures for operation on the manoeuvring area of the aerodrome internally and at LRST meetings. The assessment should include coordination and communication procedures and practices between ATC work positions and between ATC and the other parties operating on the manoeuvring area.
ANSP9	In coordination with the aerodrome operators, periodically review the procedures for runway inspections and other runway works. This should include: a. Carrying out routine runway inspections in the opposite direction of runway movements with illuminated vehicle lights regardless of time of day. b. Informing flight crew of the runway inspection in progress in case of aircraft on final approach or approaching the runway holding position. c. Implementing procedures to increase overall situational awareness when vehicles occupy a runway (to be decided locally, e.g., technology, 'vehicle operation normal' calls or other means). d. Implement standard routes and timings for routine runway inspections. e. Wherever practicable, approval for a planned runway inspection should be given when there is sufficient time for the inspection to be carried out without any interruption. f. New procedures and technologies (e.g., unmanned aircraft systems) for runway inspection should be assessed for future implementation.
SAFE RUNWAY OPERATIONS COMMUNICATIONS	
ANSP10	Develop and implement a phased plan for use of one frequency and English language for all communication associated with the operation of a runway. The phased plan should aim at improving the shared situational awareness of all front-line operators and should include realistic and practicable measures that provide an adequate level of safety for each of its phases.

REF	Recommendation
ANSP11	Periodically evaluate radio telephony practices, assessing elements such as frequency loading and use of ICAO-compliant phraseology. Promote wherever practical ATC teamwork in crosschecking communication messages and read backs.
ANSP12	Ensure that ATC communication messages are not overly long or complex in order to assist pilots and vehicle drivers to maintain good situational awareness whilst taxiing or during critical stages of operations.
ANSP13	Ensure that, whenever practicable, en route clearances are passed prior to taxi, and, in order to avoid flight crew distractions during taxi, consider passing any revision to the en route clearance whilst the aircraft is stopped.
ANSP14	Ensure that air traffic controllers always use the phrase: "HOLD POSITION" when passing a revised clearance to an aircraft that is at a holding position or on the runway.
ANSP15	In cooperation with aerodrome operators, implement procedures for airside vehicle drivers, including standard phrases for: a. Radio checks and readability scale. b. Radio communication failures (transmitting blind). c. The use of predefined and process-specific discrete call signs for manoeuvring area vehicles. d. When a driver becomes lost or uncertain of a vehicle's position in the manoeuvring area. e. Position reporting. f. Runway access and runway crossing requests
ANSP16	In relation to conditional clearances: a. The procedures should eliminate or mitigate the risk of the operational use of conditional clearances. b. If conditional clearances are used, ensure a policy and procedures are developed and implemented in accordance with ICAO provisions. c. Ensure that air traffic control officers (ATCOs) are aware of potential threats and errors when using conditional clearances.
AERONAUTICAL INFORMATION
ANSP17	In relation to aeronautical information: a. In coordination with aerodrome operators, implement procedures to ensure that significant and up-to-date aerodrome information which may affect operations on the runway is provided to manoeuvring area drivers and pilots (e.g., by notices to airmen (NOTAMS), ATIS, R/T, maps, new digital technology or other means). b. Information on temporary changes to operating conditions at the aerodrome should be optimised to increase the situational awareness of the most critical changes. When needed, an AIP supplement with graphics and charts should be published.
SUPPORTING PILOT WORKLOAD AND PRESSURES MANAGEMENT
ANSP18	In relation to standard taxi routes: a. Assess the risk potential of taxiing traffic confusion on or near the runway and mitigate it by implementing, whenever practicable, the use of standard taxi routes. b. If standard taxi routes are implemented, they should be published with clear designators. c. To reduce complexity during taxi operations, the number of published standard taxi routes should be restricted to only the routes with potential risk of taxiing traffic confusion.
ANSP19	When planning a runway assignment change for departing or arriving traffic, consider the time the flight crew will need to prepare/rebrief. As far as practicable, changing the runway assignment for an aircraft taxiing for departure should be avoided.

REF	Recommendation
ANSP20	To prevent pilots from taking the wrong intersection, a line-up and/or take-off or crossing clearance should be issued only when the aircraft is at or approaching the runway holding position and there are no intersections on the taxiway ahead of the aircraft.
ANSP21	Line-up clearance should not be issued if: a. The pilot has reported the aircraft is not ready to depart. b. The aircraft is expected to wait on the runway for more than 90 seconds for the take-off clearance. If the aircraft holds on the runway for longer than 90 seconds, an updated instruction should be provided to the pilot.
ANSP22	If the take-off clearance is not issued together with the line-up clearance, the phrase "line-up and wait" should be used.
ANSP23	Ensure that when an aircraft is instructed to line up and wait due to a reason other than usual runway traffic spacing, the aerodrome controller provides the reasons for waiting (e.g., provides information about traffic to cross the runway).
ANSP24	Issuance of a premature or late landing clearance should be avoided. Criteria should be decided locally (e.g., not before the final approach fix/final approach point (FAF/FAP), not below 1,000 ft above ground level).
ANSP25	Assess the policy, procedures and practices related to the use of "immediate departure" to avoid, as far as practicable, its use or mitigate the associated runway incursion risks.
ANSP26	Assess the policy, procedures and practices related to the use of line-up clearance while runway inspection is in progress to avoid, as far as practicable, its use or mitigate the associated runway incursion risks.
ENHANCED PROCEDURES FOR SAFE RUNWAY OPERATIONS	
ANSP27	Assess the current procedures and practices regarding runway occupancy status and ensure the use of memory aids, considering also the availability of new/emerging technologies.
ANSP28	a. In cooperation with aerodrome operators, implement H24 stop bars or other lighting systems (e.g., ARIWS) at all active runway holding positions to provide a level of safety commensurate with the level and complexity of operations and the potential risk of runway incursion. b. Ensure that stop bars at runway holding positions are controlled by the controller in charge of the runway operations on that runway (aerodrome controller). c. In cooperation with aerodrome operators, implement procedures, in line with the applicable regulations to be followed in case of stop bar unserviceability.
ANSP29	Assess the sight lines from the tower visual control room (VCR) and existing visibility restrictions which have a potential impact on the controllers' ability to see the runway and: a. Implement appropriate short-term mitigations, and b. Identify longer-term improvement measures.
ANSP30	Review controllers' tasks, the operational environment and operating procedures to ensure optimal "heads-up" time for aerodrome controllers.
ANSP31	Ensure that operating procedures include monitoring of aircraft vacating runways, in particular where the exit taxiway may lead directly to another runway (crossing).
ENHANCED TECHNOLOGY FOR SAFE RUNWAY OPERATIONS	
ANSP32	Consider the implementation of runway safety nets and emerging technologies that can improve the situational awareness of front-line operators.
ANSP33	Improve situational awareness by adopting the use of technologies that enable location identification of traffic on the manoeuvring area (e.g., via GPS with transponder, Mode S squitter).

RECOMMENDATIONS TO AIRCRAFT OPERATORS

REF	Recommendation
SAFETY MANAGEMENT AND TRAINING	
AO1	Aircraft operators should, through their safety management systems, ensure that information is collected on all runway and taxiway incursion incidents and perform analysis and risk assessments to identify risks and contributing factors. Operators should develop and implement action plans to mitigate identified risks and monitor the implementation/effectiveness of those action plans.
AO2	Aircraft operators should actively participate in aerodrome local runway safety team (LRST) activities.
AO3	Aircraft operators should actively participate in safety information–sharing programs that would allow them to benchmark their safety performance (including runway incursions) with the industry and get a better awareness of existing and emerging safety risks.
AO4	Aircraft operators should provide training for pilots regarding aerodrome signage, markings and lighting. Operators should ensure pilot competence in this area is achieved both during initial and recurrent training.
AO5	Aircraft operators and training providers should include realistic, evidence- and competency-based scenarios in their training programmes, requiring threat and error management for runway incursion prevention and mitigation.
AO6	Aircraft operators should, through their initial and recurrent training programmes, ensure pilots use standard RT phraseology, in the English language, and are aware of the runway incursion risks of non-standard RT procedures. Flight crews should be trained to recognise and increase own vigilance when local ATC procedures are non-standard, when ATCOs speak too quickly or when frequencies are congested.
GROUND OPERATIONS	
AO7	Aircraft operators should implement policy and procedures that enable flight crews to plan ground operations effectively, by providing up-to-date airport charts, relevant NOTAMs, active runway configuration, latest weather/airfield conditions, and airport briefing sheets, in order to provide optimum situational awareness and reduce runway incursion–related risks.
AO8	Aircraft operators should consider implementing threat and error management–based briefings which focus on threats for the taxi phase and runway incursions.
AO9	Aircraft operators should implement policies or standard operating procedures (SOPs) for flight crews not to conduct a take-off or an approach following any runway change until the appropriate set-up, planning, performance calculations and re-briefings are completed. When a take-off runway change is received whilst taxiing, set-up, planning, performance calculations and re-briefings should be performed by the flight crew without rushing and when the aircraft is stationary.
AO10	Aircraft operators should implement policy and procedures that aerodrome charts must be displayed on the flight deck during taxi. This includes when operating at home and familiar aerodromes. Operators should consider implementation of flight deck moving map technology, where feasible, and provide crews with training and procedures for use of moving maps, including any built-in runway incursion prevention systems.
AO11	Aircraft operators' procedures should include maintaining a sterile flight deck during all aerodrome surface movements, as well as during flight below 10,000 ft above ground level (AGL).

REF	Recommendation
AO12	Aircraft operators should implement policy and ensure procedures are in place for flight crews who doubt their exact position on the surface of an aerodrome. These procedures should include guidance on stopping the aircraft immediately and contacting ATC.
AO13	Aircraft operators should implement policy and procedures which require pilots to handle and process ATC clearances during ground manoeuvring with the same caution and attention as in-flight clearances. Operators should consider SOPs on recording and verbalising the clearance so that all crewmembers have a shared understanding of the routing, including when pilot-off-air.
WORKLOAD MANAGEMENT AND MONITORING	
AO14	Aircraft operators should publish SOPs and guidance and provide training highlighting the importance of active monitoring and effective intervention by the pilot monitoring (PM) during taxi-in and taxi-out, especially when another runway is crossed.
AO15	Aircraft operators' procedures should include policy and procedures to minimise "heads-down" activities and enable effective monitoring of the movement area whilst taxiing. For multi-pilot flight decks, "heads-down" activities for more than one pilot should be restricted to times when the aircraft is stationary with the parking brake set.
AO16	Aircraft operators should train and allow both pilots to be the pilot flying (PF) on the ground, commensurate with aircraft configuration and systems. Where not feasible, the right-seat pilot should be trained in intervention strategies and handover procedures which effectively mitigate runway incursion risks.
AO17	Aircraft operators should implement policy and procedures which encourage pilots of departing aircraft to manage workload so that the aircraft arrives at runway holding points with all crewmembers maintaining good lookout/listen-out and having strong situational awareness regarding current aircraft position, runway clearance status and other traffic (on same, parallel and intersecting runways).
AO18	Aircraft operators should implement policy and procedures which address and manage the runway incursion risks of engine-out-taxi (EOT). Policy should address risks such as "heads-down" activities, distraction and exposure to surface movement errors.
RUNWAY OPERATIONS	
AO19	Aircraft operators should discover and consider implementation of technology which increases pilot awareness of airborne traffic when approaching the runway holding positions and supports crew decision-making regarding safe runway entry, e.g., airborne traffic situation awareness (ATSAW). New runway incursion technology developments, which provide real time on-board conflict detection and collision prevention on the runway, should also be considered for implementation by operators.
AO20	Aircraft operators should implement policy and procedures that mitigate the runway incursion risks associated with using rapid exit taxiways or angled taxiways for line-up or crossing; these taxiways can limit the ability of the flight crew to see the runway threshold or the final approach area.
AO21	Aircraft operators should implement policies for flight crews in relation to extended time on the active runway before take-off and the associated runway incursion risks. The policy should include guidance on, but not limited to, entering a runway when not ready for departure, engine run-ups, departure path assessment and back-tracks.
AO22	Aircraft operators should have a strict policy that pilots shall not cross illuminated red stop bars. Policy and procedures should mandate that crews do not cross stop bars when lining up or crossing a runway (or taxiway), even with an ATC clearance but instead must challenge the clearance. Operator and aerodrome procedures should include contingency procedures to cover cases where the stop bars or controls are unserviceable.

REF	Recommendation
AO23	Aircraft operators should provide flight crews with guidance and training on ARIWS (e.g,. runway status lights (RWSL), where relevant to the operation. Guidance should include technical information, guidance on inclusion in flight crew briefings, and clear policy for dealing with activation (e.g., "Red means Stop").
AO24	Aircraft operators should ensure that flight deck procedures contain a requirement for explicit clearances to enter, cross or land on any runway, regardless of runway status (active/inactive). Operator policy should require each flight crewmember to independently hear the three parts of any runway clearance (call sign, clearance and runway), and procedures should include clear, effective means to ensure crew understanding and mitigate cognitive bias. Any doubts must be resolved immediately.
AO25	Aircraft operators' procedures should include a means (memory aid) for the pilot flying (PF) and PM to visually indicate, crosscheck and verify receipt of any ATC clearance to enter, cross, line up, take off and land.
AO26	Aircraft operators' procedures should require pilots to make optimum use of all exterior lights to increase the aircraft's detectability when approaching a runway, especially at night. All forward-facing lights should be switched on, at the latest, after receiving, confirming and verifying clearance to take off or land.
AO27	Aircraft operators should implement policy and procedures to manage the threat of early runway clearances (take off, line up, cross, land). Policy should include tools to help flight crew recognition of the threat, and if there is any uncertainty, crews shall request confirmation of clearance before entering the runway.
AO28	Aircraft operators should implement policy and procedures to manage the threat of conditional runway clearances (take off, line up, cross, land). Policy should include tools to help flight crew recognition of the threat, and if there is any uncertainty, crews shall request confirmation of clearance before entering the runway.
AO29	Aircraft operators should implement policy, technical solutions or SOPs which confirm that the aircraft is using the correct intersection and lining up on the planned runway (e.g., by verbally confirming the correct intersection and runway).
APPROACH AND LANDING	
AO30	Aircraft operators should implement policy and procedures which require flight crews conducting visual approaches to verify final approach path and runway with reference to GPS, area navigation (RNAV) position information or conventional navigation aids in order to avoid wrong-surface landings. When available, same runway instrument landing system (ILS) frequencies should be tuned, identified and displayed. Visual approaches to parallel runway systems require special risk mitigation, particularly if runways are close-spaced, have parallel taxiways or visual cues are reduced (at night, in low visibility, etc).
AO31	Aircraft operators should implement policy and procedures that flight crew, as part of the approach briefing, include planned runway exit and strategies to mitigate runway incursion threats during taxi to parking (including runway crossing or should the planned exit be missed). Operator training and policy should highlight to crews the human error potential during this phase, when crews may be distracted by events on approach/landing and after-landing tasks, and their attention may drift to the next flight or the end of duty.

RECOMMENDATIONS TO MANUFACTURERS

REF	Recommendation
MFR1	Aircraft manufacturers should consider developing a real-time, on-board functionality to provide flight crew with awareness of aircraft runway operations.
MFR2	Aircraft manufacturers should consider developing a real-time, on-board functionality to provide flight crew with alerting in case of a risk of a runway collision with another aircraft.
MFR3	Vehicle navigation system manufacturers, in collaboration with aerodrome operators, should consider developing and providing a real-time functionality to provide airside vehicle drivers with awareness and alerting in case of a risk of a runway collision between an aircraft and an airside vehicle and with real-time alerts when crossing into the protected area, such that drivers will be alerted in the event of a runway incursion.
MFR4	Aircraft manufacturers should consider developing on-board functionality that helps flight crew in the manoeuvring area to confirm their location in relation to the runway and taxiways.
MFR5	Aircraft manufacturers should consider developing real-time, on-board functionality to provide flight crew with awareness and alerting to prevent taking off or landing on a wrong runway or on a taxiway.
MFR6	Aircraft manufacturers should consider providing flight crew awareness when aircraft systems contributing to position surveillance (e.g., Mode-S, ADS-B, etc.) or runway collision–prevention functions — when available — are deactivated or failed in a phase when these functions are normally active by convention or design.

RECOMMENDATIONS TO STATES AND REGULATORS

REF	Recommendation
REG1	As part of the State's safety management activities, ensure that the establishment and operation of aerodrome local runway safety teams (LRSTs) is included in the regulator's aerodrome, flight operations and air traffic management (ATM) oversight programme.
REG2	Ensure that the GAPPRI is used in runway incursion prevention training and familiarisation for all key stakeholders — pilots, air traffic controllers and manoeuvring area vehicle drivers.
REG3	As part of the regulators oversight programme: a. Ensure that the subject of runway safety is included within initial and recurrent training with specific reference to manoeuvring area signs, markings and lights for pilots and drivers. b. Ensure that the content of training materials for pilots, air traffic controllers and drivers working in the manoeuvring area includes runway incursion prevention measures and awareness.
REG4	a. During aerodrome, ATM and flight operations oversight activities, specific assessment should be made of the role of the LRST in relation to any changes to the manoeuvring area procedures, with particular reference to a change management plan (e.g., for dealing with structural and layout changes and works in progress on the manoeuvring area). b. Conduct periodic reviews of the effectiveness of methods whereby temporary closures or repairs to runways and taxiways, and associated safety-critical infrastructure (e.g., lighting and signage) are promulgated to aircraft operators. The reviews should aim to improve the publications with regard to the ease of use and interpretation of NOTAMS or other communication means for flight crews and vehicle operators.
REG5	Promote that all vehicles on the manoeuvring area are in radio contact with the appropriate ATC service (i.e., ground and/or the tower), either directly or through an escort.
REG6	Ensure that all aerodrome vehicles are assigned unique numbers or airside identification call signs for each airside vehicle to reduce the risk of vehicle-related call sign confusion.
REG7	As part of regulatory oversight, assess the operational use of aerodrome ground lighting (e.g., stop bars) to ensure a robust policy to protect the runway from the incorrect presence of traffic. Wherever practicable, the use of H24 stop bars at all runway holding positions should be considered, as this has been shown to be an effective runway incursion prevention barrier. The use of ARIWS at all runway holding positions should also be evaluated.
REG8	National agencies charged with the oversight of aviation safety should consider how they discharge their responsibilities for runway safety risk management, which may include: a. The establishment and coordination of a national/state runway safety group that will address the prevention of runway incursions and runway collision risk. b. Define the prevention of runway incursions as a safety priority, with associated risk mitigation actions, in national aviation safety plans. c. Support the statewide promotion and coordinated implementation of GAPPRI to include incorporation of relevant elements into national aviation safety plans.
REG9	Where more than one aerodrome operator exists at a joint-use aerodrome, a leading aerodrome operator should be identified to secure a harmonised, consistent and coordinated application of the recommendations for the prevention of runway incursions.
REG10	Differences in the application of civil and military traffic procedures that can affect operational safety should be published in accordance with ICAO Annex 15, Aeronautical Information Services.

REF	Recommendation
REG11	Coordinate civil and military inspection/audit activities and subsequent safety recommendations with civil and military authorities to ensure runway incursion mitigations are jointly agreed and implemented.
REG12	GAPPRI recommendations on infrastructure (e.g., stop bars) should be implemented at civil/military joint-use aerodromes where civil aircraft operations are permitted.
REG13	International, regional and national regulatory authorities should define, clarify and standardize the size, extent and layout of the 'protected area of the runway'. Regulators should ensure that the protected area is agreed to by the aerodrome operator and the ANSP and that it recognises the relationship between the runway strips, runway cleared and graded areas, runway holding positions, obstacle free zone and any low visibility operations requirements.
REG14	International and regional regulatory authorities should review standards and guidance material for visual aids at runway holding positions to allow for more accurate aircraft positioning for all types of aircraft with varying flight crew field of vision. This includes, but is not restricted to, visibility of stop bars, aircraft low point-of-view assessment, the orientation of the lights and the view in situations where an aircraft is stopping at distance to keep sight of stop bars.
REG15	The regulator should ensure that during flying operations inspector (FOI) checks, ground and taxi manoeuvres are seen as key flight elements in flight crew briefings.
REG16	States should ensure that, as part of their safety management and oversight responsibilities, the variable level of runway incursion risk is assessed at those aerodromes that cater solely to large commercial air transport (CAT), mixed CAT with business and general aviation, and only general aviation and that actions are taken as appropriate in case of risk profile differences.

RECOMMENDATIONS FOR R&D TO STATES, INTERNATIONAL ORGANISATIONS AND THE INDUSTRY

REF	Recommendation
R&D1	Research improvements for ground-based runway collision alerting systems that improve detection-reaction times.
R&D2	Research use of high-fidelity cameras and artificial intelligence (AI) to detect ground movements on and around runways.
R&D3	Research data-driven runway collision safety by using automated analysis of air-ground communication recordings.
R&D4	Research the human performance aspects of detection and reaction to runway signs, markings and lighting, including stop bars.
R&D5	Research new ways of delivering direct auditory warnings, alarms, alerts for runway collision risk in the cockpit.
R&D6	Research and develop an on-board functionality that provides a flight crew with visual aids concerning taxi clearance and signs corresponding to runway and airport status (e.g., out-of-service zones).
R&D7	Research visual aids on the airport surface regarding ATC clearance or impediments.
R&D8	Research ways to lower the activation threshold speed of ground-based runway collision alerting systems.

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