FLIGHT SAFETY FOUNDATION

Regional Aviation Safety Assessment

Final Report Highlights

MAY 2024

FLIGHT SAFETY FOUNDATION
ASIA PACIFIC CENTRE FOR AVIATION SAFETY

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Purpose

The purpose of this report is to provide aviation stakeholders with highlights from the detailed analysis, insights, conclusions, and recommendations from the Flight Safety Foundation Asia Pacific Centre for Aviation Safety's (AP-CAS) regional safety assessment of the Asia Pacific (APAC) region[1]. The goal of the safety assessment was to provide stakeholders with an overview of regional aviation safety needs, highlighting risk areas and priorities that represent specific opportunities for targeted safety solutions.

Acknowledgements

This project would not have been possible without the assistance of multiple organisations and dedicated people. Specifically, we would like to acknowledge the assistance of our partners, the Association of Asia Pacific Airlines, International Air Transport Association, Airports Council International, Civil Air Navigation Services Organisation, and the International Civil Aviation Organisation (ICAO) Secretariat and ICAO member States, that contributed at every step of the project and helped develop the final fact sheets attached to this paper.

[1] APAC region: Afghanistan, American Samoa, Australia, Bangladesh, Bhutan, Brunei, Cambodia, China, Christmas Island, Cocos (Keeling) Islands, Cook Islands, East Timor, Fiji, French Polynesia, Guam, Hong Kong, India, Indonesia, Japan, Kiribati, Laos, Macau, Malaysia, Maldives, Marshall Islands, Micronesia, Mongolia, Myanmar, Nauru, Nepal, New Caledonia, New Zealand, Norfolk Island, North Korea, Northern Mariana Islands, Pakistan, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, South Korea, Sri Lanka, Taiwan, Thailand, Tonga, Tuvalu, U.S. Minor Outlying Islands, Vanuatu, Vietnam, Wallis and Futuna

Executive Summary

In January 2023, Flight Safety Foundation, through its Asia Pacific Centre for Aviation Safety (AP-CAS), initiated a comprehensive project to assess and analyse aviation safety issues in the Asia Pacific (APAC) region. The analysis, conclusions, and recommendations in this document will inform and enable aviation stakeholders, the Foundation, and AP-CAS to prioritise their regional engagement, including, but not limited to, outreach, technical assistance, and training activities.

A tailored dashboard using the FSF Aviation Safety Network data facilitated in-depth analysis, correlating accidents and serious incidents reported by States with the International Civil Aviation Organisation (ICAO) Universal Safety Oversight Audit Programme effective implementation results and air navigation deficiencies. This approach allowed for the identification and confirmation of new or emerging risk areas in the region, as well as an understanding of the information collected with greater context to better understand past activities and their impact on safety.

Fact sheets were prepared, addressing the top eight risk occurrence categories in the APAC region from 2017–2022. These covered runway excursions, system component failure (non-powerplant), abnormal runway contact, turbulence, runway incursions, ground collision and ramp, loss of control–in flight, and controlled flight into terrain. These fact sheets incorporated precursors, contributing factors, and action plans, and were shared with stakeholders to seek their input on causal factors and mitigation strategies.

Workshops with the Association of Asia Pacific Airlines, Airports Council International, Civil Air Navigation Services Organisation, International Air Transport Association, and ICAO in the Asia Pacific region provided essential inputs. Distinct challenges and mitigation approaches surfaced during interactive discussions.

This report reflects the highlighted version of our analysis of the top eight risk occurrence categories in the APAC region, together with the outcomes from the workshops, including conclusions and recommendations. Twenty-one recommendations were made to either ICAO and its member States and/or service providers (air operators, aircraft maintenance organisations, original equipment manufacturers, aerodrome operators, and air navigation service providers).

Background/Introduction

Asia Pacific (APAC) is expected to face significant growth in the aviation sector over the next two decades in response to growing intra-regional and inter-regional demand for travel. To achieve continuous improvement in safety, which helps to sustain the growing demand, the capabilities of the region and specific safety risks and challenges should be understood, along with the likely solutions for meeting safety challenges in the future.

In 2021–2022, Flight Safety Foundation performed a global safety assessment that included a regional assessment of safety risks in the APAC region. The assessment was produced in collaboration with the Association of Asia Pacific Airlines (AAPA) and examined past safety records, safety action plans under development, and the impact of the recent COVID-19 pandemic across several global regions, including APAC. The assessment helped to identify the extent to which existing safety management systems and state safety programs worked to prepare for safety challenges during significant operational changes and hazards affecting the traveling public, employees, and regulatory authorities. The progress and final outcomes of that project were presented at the 41st International Civil Aviation Organisation (ICAO) General Assembly and were unanimously supported.

The outcomes of the assessment revealed the need for a further and more detailed review to help the region better understand regional safety. In January 2023, Flight Safety Foundation, through its newly formed Asia Pacific Centre for Aviation Safety (AP-CAS), embarked on a more comprehensive assessment and analysis of aviation safety issues to address key sectors of aviation in the Asia Pacific, including air navigation services (ANS). The goal of this project was to assess regional aviation safety needs, highlighting risk areas and priorities that represent specific opportunities for targeted safety solutions.

Scope of Work

This comprehensive assessment and analysis of aviation safety issues addressed key areas of aviation in Asia Pacific, including personnel licensing and training (PEL), airworthiness of aircraft (AIR), aircraft operations (OPS), aircraft accident and serious incidents investigations (AIG), aerodromes and ground aides (AGA), and air navigation services (ANS).

The project utilized all available reference materials, including ICAO global and APAC regional safety plans, annual safety reports, the Beijing Declaration, the ICAO Pacific Small Island Developing States Aviation Needs Analysis, as well as regional, sub-regional, and national plans, where available. Additionally, AP-CAS reviewed the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) meeting reports that listed items/deficiencies that require coordination with the Regional Aviation Safety Group (RASG). AP-CAS leveraged ongoing forums and events, including its participation at ICAO APAC meetings, to elicit relevant information from the APAC region, as well as gathering information from relevant stakeholders.

A customised and interactive dashboard of FSF Aviation Safety Network (ASN) data was created that displays all ASN data relative to the region. Further details on this dashboard are found in para 1.1.1 below.

Additional dashboards were created to reflect safety information displayed in a manner that facilitated performing a systems approach in assessing the entire aviation ecosystem, including air navigation services and aerodromes, regarding elements impacting aviation safety. Relevant screenshots of the dashboards are reflected in the fact sheets to support the analysis and contribute to the final recommendations.

The work performed through this project was shared with our partners (AAPA, Airports Council International (ACI), Civil Air Navigation Services Organisation (CANSO), International Air Transport Association (IATA), and ICAO), to seek their input and to help validate the results. The detailed analysis was summarised and compiled into fact sheets for the top risk occurrence categories in the APAC region, correlating to the highest-risk accidents and serious incidents in the region for the period 2017–2022. The highlighted versions are found in Appendices B to I.

Following the input provided by the partner organisations, the fact sheets were updated and, subsequently, workshops were held with each of our partners in this project. The partners comprised airlines, maintenance organisations, aerodrome operators, air navigation service providers (ANSPs), and the ICAO APAC secretariat and ICAO member States within the Asia Pacific. During each workshop, an in-depth review of the fact sheets most pertinent to the participants was completed. Participants were engaged in interactive discussions and were requested to respond to a series of live poll questions. Details of each workshop are included in this report. The engagement with States was used to gather qualitative safety information and to gain a wider perspective of the safety capabilities and potential issues in the region.

Progress reports, as well as outcomes and conclusions, were then shared through the ICAO process to contribute to updates to regional safety plans and updates or drafting of national safety plans.

The information contained in this report also provides valuable insights for the industry, including air operators, airports, and ANSPs.

1.0 Fact Sheets

Fact sheets were developed that correlate and summarise the results relative to high-risk accidents and serious incidents in the region during the period 2017–2022. The fact sheets synthesize all the precursors documented in the Asia Pacific Regional Aviation Safety Plan (AP-RASP) and across all the National Aviation Safety Plans (NASPs) submitted to ICAO to date for each high-risk area. The results of the regional safety assessment identified and/or confirmed new or emerging risk areas in the region. The precursors/contributing factors and action plans to address the new or emerging risks, in some cases, were different than those already identified and have, therefore, also been included in the fact sheets to supplement the existing plans. Finally, the fact sheets were used as tools to engage with stakeholders in the region to seek input on additional causal factors contributing to the risks and additional actions to address risks that have not been identified within ICAO's Global Aviation Safety Plan (GASP), AP-RASP, or NASPs that have been prepared in the region.

1.1 Fact Sheet Content

Each fact sheet (highlighted version) contains the following information:

Analysis — A deep dive into all the accidents and serious incidents for the risk reviewed, including the common causal factors.

ICAO Global Aviation Safety Plan — Text was added to explain whether the risk was reflected in the global plan as a global high-risk category (HRC). When this was the case, ICAO also provided some safety enhancement initiatives (SEIs) for regional and national consideration, and this is noted in the fact sheet.

Asia Pacific Regional Aviation Safety Plan — Each fact sheet states whether the identified risk was considered in the AP-RASP 2023–2025 version as a regional risk. If the AP-RASP included any precursors/contributing factors or SEIs, they are listed as well.

National Aviation Safety Plan (NASP) — This section of the fact sheet includes any additional contributing factors or actions identified in the NASPs prepared by APAC States that differed from those that may have already been identified by the GASP or AP-RASP. At the time of this study, only 15 States in the region had published their NASPs. For this analysis, we reviewed all 15 NASPs to determine whether they considered the risk as reflected in the fact sheet.

Precursors/contributing factors and additional actions that have not been identified by AP-RASP or NASPs — This section reflects inputs received from AP-CAS partners IATA, AAPA, ACI, and CANSO on additional contributing factors and actions, including latent conditions, to mitigate the risks that were not addressed by the GASP, AP-RASP, or NASPs. This included contributing factors and actions for operators, original equipment manufacturers (OEMs), aerodromes, ANSPs, etc.

This section can also help the RASG-APAC in identifying other SEIs that may be considered for HRCs listed in the AP-RASP.

References: The reference section lists related material on the particular risk.

1.2 Fact Sheets Addressing Top Eight Risk Occurrence Categories

Fact sheets were prepared addressing the top eight risk occurrence categories listed in order of absolute number of accidents and serious incidents reported in the APAC region in the period 2017–2022.

- Runway excursion (RE);
- System/component failure–non-powerplant (SCF-NP);
- Abnormal runway contact (ARC);
- Turbulence (TURB);

- Runway incursion (RI);
- Ground collision and ramp (GCOL & RAMP);
- Loss of control–in flight (LOC-I); and,
- Controlled flight into terrain (CFIT).

Aviation stakeholders including AAPA, ACI, CANSO, and IATA, as well as ICAO in the Asia Pacific region, were surveyed to provide essential inputs into the fact sheets. Stakeholder engagement in this project was essential to ensure that the conclusions and recommendations were relevant and appropriate to the needs of the region. In addition, Flight Safety Foundation worked closely with the ICAO APAC Regional Office to ensure coordination and engagement with States to which the office is accredited.

The fact sheets were then validated and supplemented by engaging with States and industry through workshops. A total of five workshops were held between September 2023 and January 2024. Two workshops were held with the Asia Pacific airline community. The workshops were well attended by a broad cross section of airlines in the APAC region. A workshop was also conducted with States in conjunction with ICAO prior to the RASG-APAC/13 meeting in December 2023. Finally, additional workshops were held with the APAC airport community in conjunction with ACI, as well as with the ANSP community in conjunction with CANSO, in January 2024.

During each workshop, risk occurrence categories of greatest interest were reviewed in detail with airlines, aerodrome operators, ANSPs, and air traffic controllers. Participants engaged in interactive discussions and were requested to respond to a series of poll questions. For each risk category, distinct challenges and approaches to mitigation strategies surfaced.

The purpose of the workshops was to present the fact sheets that were developed as a part of this project and to:

- Review the analysis reflected in each fact sheet and perform an in-depth review of the contributing factors and actions that can be taken to mitigate the risks;
- Engage with workshop participants to identify additional challenges and risks not already identified through the GASP, AP-RASP, and NASPs;
- Gather qualitative information; and,
- Share best practices amongst participants.

Dates of the workshops and the number of participants are summarized below:

Workshop	Date	# of Registered Participants
Airlines (module one)	27 September 2023	70
Airlines (module two)	25 October 2023	70
ICAO State participants	28 November 2023	61
CANSO ANSP members	16 January 2024	246
ACI Airport members	23 January 2024	21

A summary for each of the top eight risk occurrence categories in the APAC region, together with the outcomes from the workshops, including conclusions and recommendations, when applicable, are reflected below.

2.0 Workshop with APAC States

As mentioned above, AP-CAS conducted a workshop with APAC States in collaboration with the ICAO APAC Regional Office. A brief overview of the methodology that was used for the project, including a demonstration of the ASN Dashboard, was presented to participants, followed by an in-depth review of all eight fact sheets addressing risk occurrence categories. Throughout the workshop, participants provided their inputs through live polls.

Participants were made aware of how the fact sheets can be used as reference material in helping them to update or develop their NASP.

The demonstration of the ASN Dashboard revealed that a high percentage of accidents and/or serious incidents was not investigated to the level of producing a final report with recommendations and determining the causal factors of the accident/serious incident. Half the participants highlighted the need for enhanced investigative resources and expertise to improve transparency and effectiveness.

Delving into the fact sheet on runway incursions, participants shared regulatory measures implemented to reduce the risk of runway incursions at airports under their jurisdiction. Seventy percent of the 61 participants said that enhancements were made to air traffic control procedures and that improvements were made to runway signage and lighting. Additionally, 64 percent indicated that their regulatory authority ensured that mandatory pilot training on runway safety for air operators was implemented. Recognizing the significance of collaboration between air traffic controllers and airports in mitigating runway incursion risks, 77 percent agreed that collaboration was essential, while 23 percent acknowledged its significant importance but noted challenges within their respective States.

In terms of general collaboration between regulators and industry, 58 percent reported moderate collaboration with room for improvement, while 36 percent cited strong collaboration with successful joint initiatives.

Sections 3 through 10 outline the eight highest risk occurrence areas, the outcome of the workshops that addressed the high-risk areas, and the findings of the AP-CAS analysis, including its conclusions and recommendations.

3.0 Runway Excursions

Runway excursions (RE) account for the third highest fatal accident occurrence category in the region and the second highest category when considering all accidents (fatal/nonfatal); they make up the highest serious incident category in the region.

Since 2017, 78 percent of the 14 excursion accidents in the APAC region recorded in the ASN database have occurred during landing, with 68 percent resulting in veer-offs and overruns.

Close to 60 percent occurred during poor weather conditions. Unstable approaches and failure to go around were the most common factors. Other contributing factors included flight crew handling errors (speed and directional control), contaminated runways, late or inaccurate runway or weather reports, mechanical failures, lack of adherence to standard operating procedures (SOPs), poor crew resource management (CRM), and no air traffic control tower meteorological officer (MET) presence during severe weather conditions.

Globally and regionally, REs have been identified as HRC events, and therefore, SEIs have been identified at these levels and are tracked and reported within the region.

Actions to be taken to mitigate the risk of RE are considered a collective effort requiring actions from air operators, aerodromes, regulators, and ANSPs. The fact sheet found in Appendix B provides a detailed list

of contributing factors and actions that have been identified globally, regionally, nationally, and by industry, including correlations with air navigation deficiencies.

The majority of the States that prepared NASPs have included RE as a national operational risk, along with their plan to mitigate the risk. The actions to mitigate this risk that were identified at a national level, and are in addition to those identified at the global and regional levels, were reviewed during the workshop, including other actions identified by the industry.

Additional actions included:

- Air operators to include RE risk in their safety management system (SMS).
- Air operators to include runway safety precursors in their flight data analysis program (FDAP). The flight parameters monitored should include parameters such as deep landing, short landing, long flare, monitoring spoiler deployment, late flap settings, etc. Air operators should define stabilised approach, landing, and go-around policies in their operations manual.
- Air operators to include comprehensive training on stabilised approaches, go-around procedures, and runway awareness and alerting systems.

3.1 Workshops with Airlines

During the workshops with the airlines, AP-CAS conducted an in-depth review of RE-related accidents and incidents. Following a discussion of the RE events and mitigation strategies, a series of poll questions were asked to gauge participants' perspectives. The results are outlined below:

1. **Factors Impacting REs:**
   - Participants were asked to identify the factors with the greatest impact on the likelihood of an RE. Pilot experience and training were overwhelmingly perceived as the most likely factors contributing to REs (90 percent of the participants). Airport infrastructure and runway design followed at 70 percent, and safety culture was considered significant by 60 percent.
2. **Effectiveness of Runway Safety Training Programs:**
   - When participants were asked to assess the effectiveness of the current runway safety training programs within their organisations, only 11 percent of participants deemed them highly effective. A majority, 67 percent, considered them somewhat effective, while 22 percent believed improvements were needed.
3. **Confidence in Runway Condition Assessment and Reporting Procedures:**
   - Participants were asked about their confidence in the adequacy of runway condition assessment and reporting procedures at airports. While 56 percent expressed some confidence, 33 percent were not confident in the existing procedures.
4. **Priority Areas for RE Prevention:**
   - Regarding the aspect of RE prevention requiring the most attention within the aviation industry, 89 percent identified pilot training and decision-making as the most critical. Runway surface condition monitoring followed at 56 percent, and airport infrastructure upgrades were deemed important at 22 percent.

These poll results demonstrated the paramount importance of pilot training, decision-making, and runway conditions in the prevention of REs. The findings also indicate room for improvement in runway safety training programs and confidence in existing assessment and reporting procedures.

3.2 Workshop with ACI Members

Following a dedicated workshop on RE events with the aerodrome operators, a poll was conducted among participants representing aerodrome operators in the Asia Pacific region. The key findings are as follows:

1. **Common Contributing Factors to REs:**
   - Participants were asked about the most common contributing factor to REs at their aerodromes. The majority (71 percent) identified human factors, while 14 percent cited weather conditions, and another 14 percent, runway condition and friction.
2. **Emergency Response Plan for REs:**
   - Participants were queried about how well their aerodromes' emergency response plan addressed REs, including potential aircraft departures. Seventy-one percent of the participants felt this was very well addressed, and the rest of the participants believed it was adequately addressed.
3. **Challenging Aspects of RE Prevention:**
   - Views on the most challenging aspect of RE prevention and mitigation varied. Forty-three percent of the participants highlighted effective communication with flight crews and air traffic control, 29 percent pointed to runway condition monitoring and maintenance, and another 29 percent identified regulatory compliance and reporting as challenging.
4. **Need for Increased Awareness, Education, and Training:**
   - Participants unanimously expressed a significant need for increased awareness, education, and training among aerodrome personnel regarding RE risks.
5. **Frequency and Confidence in Runway Condition Assessments:**
   - Participants were asked about the frequency of runway condition assessments and their confidence in their accuracy. Twenty-five percent indicated that assessments were performed regularly, and they were very confident in their accuracy. However, the majority (63 percent) were only somewhat confident in the accuracy of the assessments.

The poll results unveiled critical insights. A majority of participants (71 percent) identified human factors as the most common contributing factor leading to REs, while 14 percent cited weather conditions and another 14 percent, runway conditions and friction. Regarding emergency response plans, 71 percent felt they were very well addressed. Opinions about the most challenging aspects of runway excursion prevention varied, with 43 percent highlighting effective communication, 29 percent pointing to runway condition monitoring, and another 29 percent identifying regulatory compliance as challenging. Participants unanimously expressed a need for increased awareness, education, and training. Additionally, only 25 percent indicated that assessments were performed regularly, and that they were very confident in their accuracy. The majority (63 percent) were somewhat confident. These findings highlight nuanced perspectives and specific areas for improvement, offering valuable insights for refining RE prevention strategies among aerodrome operators in the region.

3.3 Conclusion

REs have been identified as the top risk occurrence category in order of absolute number of accidents and serious incidents reported in the APAC region in the period 2017–2022.

The AP-RASP has identified numerous actions as SEIs to mitigate the risk of RE. Mitigating the risk demands a collective effort from air operators, aerodromes, regulators, and ANSPs. NASPs identify REs as a significant operational risk, and the industry has proposed actions to address the problem.

The workshops that were held with air operators and aerodrome operators confirmed the crucial role of pilot experience and training, with human factors identified as a predominant contributing factor. The assessment of existing training programs and confidence in runway condition reporting procedures were particularly highlighted as areas that needed more focus.

Additional actions that can be taken were identified by the industry and are reflected in Appendix B to this report and address actions that can be taken by air operators, approved maintenance organisations (AMOs), regulators, and other service providers.

3.4 Recommendations

Recommendation 3.1: The RASG-APAC, through the Asia Pacific Regional Aviation Safety Team (APRAST), should review the additional actions listed in the fact sheet related to RE to determine if any additional actions can be included as SEIs or to complement existing activities already identified.

Recommendation 3.2: Service providers (air operators, aerodrome operators and ANSPs) should review the additional actions listed in the fact sheet related to RE to determine if any additional actions can be included within their operations.

4.0 System/Component Failure Non-Powerplant (SCF-NP)

System/component failure or malfunction–non-powerplant (SCF-NP) was ranked as the second highest accident/serious incident (nonfatal) occurrence category in the APAC region after runway excursions. SCF-NP accounts for 13 percent of all accidents and serious incidents in the region.

The AP-RASP 2023–2025 recognized that SCF-NP contributed to accidents and serious incidents in the APAC region that resulted in substantial damage to aircraft. However, since no fatal accidents had occurred, SCF-NP was not identified as a regional high-risk category, and no reference is made in the AP-RASP to SCF-NP. Appendix C to this report provides a detailed analysis of SCF-NP with correlations made to the airworthiness of aircraft.

Over the six-year period, cabin pressure system failures were the leading system component failures, accounting for 51 percent of all reported incidents, followed by 28 percent for hydraulic and landing gear system failures and 8 percent for electrical system failures. Four events were the result of structural or corrosion-related failures. Approximately 10 percent of all SCF-NP occurrences were attributed to poor maintenance practices or could have been prevented by adhering to manufacturer's recommended scheduled maintenance. Further analysis is required to determine if the remaining occurrences could be attributed to poor maintenance practices.

Since the preparation of this report, no APAC State cited SCF-NP as a national operational risk.

It is notable that the combination SCF-NP and system/component failure–powerplant (SCF-PP) occurrences comprise the greatest number of fatal/nonfatal accidents/serious incidents in the region during the analysis period (2017 to 2022).

The fact sheet also reflects that the contributing factors and actions stemming from input from the industry were primarily maintenance-related and would, therefore, be of interest to air operators, maintenance organisations, OEMs, suppliers, and regulators.

4.1 Workshops

During each workshop, AP-CAS provided an overview of this risk category but did not go into detail on the subject, given the diversity of the participants.

4.2 Conclusion

Through our analysis and review of results from the ASN Dashboard, it was evident that SCF-NP, together with SCF-PP, ranked high for accident/serious incident (nonfatal) occurrences in the APAC region. While the AP-RASP 2023–2025 recognized that SCF-NP contributed to accidents and serious incidents, it was not identified as a regional HRC, and no reference was made in the AP-RASP to SCF-PP. Given the high

rate of occurrence, AP-CAS concludes that a proactive approach is needed to address this high-risk area. Additional study would be required to obtain a better understanding of SCF-NP and SCF-PP.

4.3 Recommendations

Recommendation 4.3: While SCF-NP and SCF-PP occurrences have been largely nonfatal, the RASG-APAC should consider further study based upon this information. Consideration should be given to placing more importance on SCF-NP and SCF-PP in the AP-RASP so that APAC States can address these risk occurrence categories in their respective NASPs.

Recommendation 4.4: Maintenance organizations and OEMs should consider the actions that may be taken by the industry as reflected in the fact sheet related to the need to adhere to manufacturer's recommended scheduled maintenance, proactive monitoring, continuous training, and collaboration with OEMs. OEMs, for their part, should develop clear and updated instructions for continuing airworthiness.

By addressing these recommendations collaboratively, air operators, maintenance organizations, and manufacturers can work towards minimising the occurrence of SCF-NP.

5.0 Abnormal Runway Contact (ARC)

Abnormal runway contact (ARC) is the third highest accident occurrence category (nonfatal) in the APAC region and ranked fifth when factoring in serious incidents. In the six-year 2017–2022 period, there were 37 ARC-related accidents/serious incidents reported in the APAC region. Fifty-five percent of the ARC events involved jet airplanes, and the remainder involved turboprop airplanes. There were no fatalities attributed to the ARC events. However, there were nine recorded injuries, all stemming from hard landings.

The APAC region averages five ARC accidents/serious incidents per year (on a five-year rolling average). ARC was identified in the AP-RASP as an HRC and was included as part of the regional risk in the "runway safety" category. While SEIs have been developed to address runway safety, specific SEIs addressing hard landings and tail strikes were considered by only three States that have prepared NASPs.

5.1 Workshops

During each workshop, AP-CAS provided an overview of this risk category but did not go into detail on the subject given the diversity of the participants.

5.2 Conclusion

Additional study is required to obtain a better understanding of this complex issue that involves multiple parties, including multiple States and industry stakeholders.

5.3 Recommendations

Recommendation 5.5: Consideration should be given by the APAC States as well as air operators, ANSPs, and aerodromes to address the additional precursors/contributing factors and actions in Appendix D, section 6.0 that were not identified by the AP-RASP or NASPs pertaining to ARC.

Recommendation 5.6: Consideration should be given by the RASG-APAC to address RI, RE, and ARC as separate regional HRCs rather than grouping them under Runway Safety. This may ensure that each risk is specifically addressed, including with the development of appropriate SEIs, and adequately addressed by State NASPs.

6.0 Turbulence

Turbulence (TURB) was the highest nonfatal accident occurrence category in the APAC region and sixth highest occurrence category when considering all accidents and serious incidents together. During the period from 2017–2022, there were 34 TURB accidents in the APAC region, or an average of 5.8 per year. During 2019 alone, turbulence accounted for almost 50 percent of the 21 accidents in the APAC region. In 2022, for the second year in a row, turbulence-related accidents were the most frequent accident type in the region. All occurred during scheduled passenger operations and 80 percent involved commercial jetliners.

Among the accidents reviewed, crewmembers were injured more severely than passengers, often while conducting cabin checks following a seat belt warning, or during the descent and approach phases of flight, per their company SOPs.

When reviewing the AP-RASP 2023–2025, it was noteworthy that the region felt it important to reflect TURB as one of the top operational risks in the region. The AP-RASP reflects that the TURB occurrence category accounts for the most accidents in the region causing serious injuries to air crew and passengers. However, TURB was not identified as a regional HRC, and as such, no safety enhancement initiative was identified at the regional level. Since the preparation of this report, no APAC State reflected TURB as a national operational risk.

6.1 Workshop with CANSO Members

Following a workshop addressing the fact sheet related to TURB events with participants representing ANSPs and air traffic controllers, a series of poll questions were asked to obtain the participants' perspectives. The key results are as follows:

1. **Communication Effectiveness:**
   - 26 percent of respondents considered communication between pilots and air traffic controllers regarding turbulence in their respective airspace to be very effective.
   - 45 percent believed it was somewhat effective.
2. **Satisfaction with Technology:**
   - Twenty-seven percent of participants were satisfied with the current technology and tools for detecting and monitoring turbulence and only 1 percent felt very satisfied.
   - Nineteen percent of respondents were dissatisfied.
3. **Preparedness in Managing Air Traffic:**
   - Forty-four percent felt well prepared for managing air traffic during turbulence.
   - Nine percent felt ill-prepared, indicating a need for additional training or resources.
4. **Turbulence Forecasts:**
   - Five percent found turbulence forecasts provided by meteorological services to be very reliable.
   - Thirteen percent considered them unreliable.
   - Established Mechanisms for Reporting Incidents:
   - Seventy-three percent believed there were established mechanisms for controllers to report turbulence-related incidents and share lessons learned.
   - Twenty-seven percent did not feel such mechanisms were in place.
5. **Enhancing Safety Measures:**
   - Eighty percent suggested the need for enhanced monitoring systems to improve safety during turbulent conditions.
   - Fifty-eight percent emphasised the importance of improved communication protocols.

The poll results highlight some areas for improvement in the communication, coordination, and preparedness aspects of managing air traffic during turbulence events. Participants expressed the need for further advancements in technology, training, and communication tools to enhance overall safety and efficiency.

During the workshop, participants expressed concern for the difficulty in determining when a turbulence event would need to be classified as an accident, since reported injuries can vary extensively and can even be considered minor. This may result in some air operators reporting more frequently than others.

6.2 Conclusions

The Asia-Pacific region has witnessed a concerning upward trend in reported aviation accidents attributed to turbulence, despite the majority being nonfatal incidents. Appendix E to this report provides a detailed analysis of TURB with correlations made to Air Navigation Deficiencies. Paragraph 3.1.1 provides the outcomes of the workshop with experts from ANSPs when reviewing the fact sheet related to TURB. The escalating issue of TURB underscores the imperative for proactive measures by both air operators and ANSPs to mitigate the associated risks. Addressing this challenge requires a comprehensive approach, including enhanced training for flight crews to navigate turbulence safely, improved communication between pilots and air traffic controllers, and investments in advanced weather forecasting technologies. Collaborative efforts between aviation stakeholders to share data and insights on turbulence incidents can contribute to the development of targeted strategies aimed at minimising the impact of turbulence-related accidents and ensuring the continued safety of air travel in the region.

6.3 Recommendations

Recommendation 6.7: The RASG-APAC may wish to consider carrying out a further study based upon this information. Consideration should be given to placing more emphasis on TURB in the AP-RASP so that APAC States can address this risk occurrence category in their respective NASPs as a potential operational risk.

Recommendation 6.8: The ICAO Accident Investigation Panel (AIGP) should review and amend ICAO Annex 13's serious injury definition due to its descriptive nature, which encourages States to classify occurrences related to severe turbulence as accidents rather than serious incidents.

7.0 Runway Incursions (RI)

In the APAC region, runway incursions (RIs) emerged as a high-risk category, demanding a concerted and coordinated effort among aerodrome operators, airlines, ANSPs, and regulators.

RIs ranked ninth in highest accident (nonfatal) occurrences in the region and seventh highest for serious incidents. During the six-year period 2017 to 2022, there were two accidents resulting from an RI in which both aircraft incurred serious damage. There were 15 serious incidents reported; five occurred while the aircraft were taxiing, five occurred when aircraft were rolling for takeoff, and another five occurred when aircraft were on final approach or had just landed. Three of the serious incidents were on turboprop aircraft, and all but one occurred on scheduled passenger flights.

In the review of runway incursions for the region, 14 of the 15 serious incidents and both accidents were attributable to the performance of the pilot, air traffic controller, or both.

7.1 Workshop With CANSO Members

During the workshop addressing runway incursions and mitigation strategies with participants representing ANSPs and air traffic controllers, a series of poll questions were asked to gauge participants' perspectives. Here are the key results:

1. **Communication and Coordination Effectiveness:**
   - 64 percent of participants found the communication and coordination between air traffic control and stakeholders (e.g., pilots, ground services) moderately effective in preventing RIs.
   - 30 percent deemed it very effective.
2. **Technology Contribution to Mitigation:**
   - 71 percent believed that advanced radar systems and runway status lights made a major contribution to mitigating the risk of RIs, while the rest perceived it as a moderate contribution.
3. **Satisfaction With Training Programs:**
   - Regarding current training and proficiency assessments for air traffic controllers in RI prevention, only 26 percent were very satisfied with the training received, 66 percent were somewhat satisfied, and 5 percent were not satisfied.
4. **Collaboration Effectiveness:**
   - Participants expressed varying opinions on collaboration between ANSPs and airports in the APAC region, with 17 percent finding it very effective, 70 percent moderately effective, and 6 percent ineffective.
5. **Reporting and Analysis of Incidents:**
   - In terms of reporting and analysis of RI incidents in the region, 21 percent found relevant information very well communicated, 69 percent moderately well communicated, and 8 percent poorly communicated.
6. **Safety Culture Assessment:**
   - Concerning safety culture among air traffic controllers and aviation professionals in the APAC region, 28 percent perceived a strong safety culture, 60 percent a moderate safety culture, and 8 percent a limited safety culture.
7. **Preparedness for Emerging Risks:**
   - When asked about preparedness for emerging risks related to runway incursions, such as increased air traffic and changing technology, 15 percent felt very well prepared, 76 percent moderately prepared, and 8 percent not well prepared.
8. **Continuous Improvement Measures:**
   - Participants suggested the need for measures for continuous improvement, with 70 percent emphasising the need to regularly update procedures based on incident analysis, 67 percent highlighting the need for enhanced training programs for air traffic controllers, and 51 percent advocating collaboration with international aviation authorities.

Overall, participants acknowledged the moderate effectiveness of communication and coordination and widely endorsed the significant contribution that technology provides to reducing the risks of RIs. Satisfaction with current training programs varied. Collaboration between ANSPs and airports, communication of incident findings, and perceptions of safety culture showcased diverse perspectives. The majority felt moderately prepared for emerging risks. Recommendations for improvement centered on procedural updates, enhanced training, and international collaboration. Overall, the poll results provided valuable insights into the strengths and areas for improvement in runway incursion prevention strategies and practices across the Asia Pacific region.

7.2 Workshop with ACI Members

During the workshop on RIs with participants representing aerodrome operators, a series of poll questions were asked to obtain the participants' perspectives. The key results are outlined below:

1. **Primary Causes of RIs:**
   - Participants were asked about the primary cause of RIs at their aerodromes. Miscommunication between air traffic control and flight crews was cited by 45 percent of the participants, miscommunication between ground personnel and air traffic control was cited by 36 percent, and pilot and driver errors, cited by 18 percent.
2. **Effective Measures to Reduce RIs:**
   - When participants were questioned about effective measures to reduce RIs, 67 percent believed enhancing communication and awareness programs would be the most effective; 22 percent favored improved signage, lighting, and markings; and 11 percent considered advanced technology and warning systems as the most effective measure.
3. **Effectiveness of Training and Education:**
   - Regarding the effectiveness of training and education provided to personnel at their aerodromes in preventing runway incursions, 45 percent felt it was very effective, while 55 percent believed the training was moderately effective.
4. **Impact of New Technologies on RIs:**
   - Participants expressed positive views on the impact of new technologies, with 82 percent stating that the introduction of new technologies, such as RI warning systems, had a positive impact on reducing RIs at their aerodrome, and 18 percent saying that it had a moderate positive impact.
5. **Communication and Coordination with Stakeholders:**
   - When asked about the effectiveness of communication and coordination with other aviation stakeholders to address RI risks, 64 percent indicated it was very effective, while 27 percent found it moderately effective.
6. **Role of Human Factors:**
   - Participants acknowledged the significant role of human factors (e.g., fatigue, stress, complacency) in runway incursions. Seventy-eight percent said human factors has a significant role, and the remaining participants said it has a moderate role.
7. **Aerodrome Preparedness for RI Incidents:**
   - Participants' opinions on aerodrome preparedness for RI incidents varied, with 56 percent feeling their aerodrome was very well prepared, while the rest said that it was somewhat prepared.

The poll results highlighted miscommunication as a primary factor in RIs, noting that it has contributed to misunderstandings between air traffic control and flight crews or ground personnel. Additionally, participants recognized the influential role of human factors, underscoring their significant impact on RI incidents. In terms of mitigation strategies, enhancing communication and awareness programs was considered the most effective measure by the majority of the participants, followed by improved signage, lighting, markings, and advanced technology. The introduction of new technologies, especially RI warning systems were widely supported as an effective means to reduce runway incursions. The poll results underscore the numerous factors involved in RI prevention, highlighting the importance of tailored strategies amongst aerodrome operators, airlines, and air traffic controllers and the need for continuous improvement efforts in the aviation industry.

When workshop participants reviewed the contributing factors as well as actions that were identified globally, regionally, and by States in their NASPs, some additional contributing factors and actions were

discussed and identified as being relevant for consideration. The RI fact sheet (Appendix F) provides further details on specific topics, including:

- Call sign confusion: A causal factor in safety-related events such as hearback/readback errors.
- Language and communication barriers: Miscommunications or misunderstandings due to language differences between pilots, air traffic controllers, and ground personnel, which can lead to incorrect instructions and actions, potentially resulting in runway incursions.
- Human factors and fatigue: Fatigue, distraction, stress, and complacency among pilots, air traffic controllers, and ground vehicle drivers could lead to errors in communication, decision-making, and situational awareness.
- Inadequate safety culture: A lack of emphasis on safety culture among aviation organizations, airlines, and airport operators may lead to a decrease in vigilance and safety-conscious behavior, increasing the potential for RIs.

Workshop participants were briefed on the Global Action Plan for the Prevention of Runway Incursions (GAPPRI). Flight Safety Foundation, together with ACI, EUROCONTROL, CANSO, IATA and others, under the coordination of ICAO, have recently developed and rolled out the GAPPRI. More than 160 professionals from more than 80 organisations worked on this initiative from OEMs, airports, regulators, airlines, and ANSPs. GAPPRI offers synchronized, consensus-based recommendations encompassing best practices that go beyond regulatory compliance. 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 RIs, fostering a safer, more resilient global aviation ecosystem.

7.3 Conclusion

Mitigating the risk of RIs necessitates the implementation of comprehensive safety protocols, including enhanced training programs for air traffic controllers and flight crews, improved communication systems, and the adoption of advanced technologies such as runway monitoring systems. Collaborative initiatives between aerodrome operators and ANSPs are crucial for optimising runway design and layout to minimise potential conflict points. A holistic and coordinated approach is paramount to ensure the effective reduction of runway incursions and to maintain the highest standards of aviation safety in the region.

Workshop participants representing ANSPs and aerodromes discussed the additional contributing factors for RIs that were not reflected in the GASP and the AP-RASP, in particular with respect to call sign confusion. Call sign confusion is a causal factor in safety-related events such as hearback/readback errors. In Asia Pacific, a project referred to as Alphanumeric Call Sign was initiated to help mitigate the known safety issues associated with call sign confusion and conflict. However, it was noted that the project did not progress during the COVID-19 pandemic.

RIs are not reported as serious incidents unless the State has determined that the incident could have resulted in an accident (as defined by ICAO). Practically, the classification of a serious incident is left to the discretion of States, which may result in some serious incidents not being investigated and valuable safety lessons going undocumented and unlearned. Based on the proportion of investigation reports made available to the ICAO Accident and Serious Incident Investigation Group (AIG), involving accidents, compared to those involving serious incidents, it has been suggested that there is an under-investigation of serious incidents across all ICAO States. Attachment C to ICAO Annex 13 contains a list of typical examples of incidents that are likely to be serious incidents, which includes classification of runway incursions depending on severity. An event risk classification-based approach was also introduced into the 12th Edition of Annex 13 in July 2020.

7.4 Recommendations

Recommendation 7.9: Aviation stakeholders should address the additional precursors and contributing factors to enhance runway safety and mitigate the risk of RIs identified by this assessment. Implementing proper training, improving communication protocols, and utilising advanced technologies can help reduce the occurrence of such incidents in the future.

Recommendation 7.10: With the significant growth expected in air traffic in the region, the Alphanumeric Call Sign project should be continued and perhaps consideration should be given to include it in the AP-RASP as an SEI or otherwise increase its importance.

Recommendation 7.11: APAC States, as well as industry, should review the outcomes and recommendations stemming from GAPPRI. AP-CAS should work with its aviation partners in the region and arrange a series of workshops to highlight the methodology/process used, including the recommendations and best practices stemming from the project that may help empower aviation stakeholders in the APAC region to proactively mitigate the threat of RIs, fostering a safer, more resilient global aviation ecosystem.

Recommendation 7.12: APAC States should review RI incidents to ensure they are classified appropriately using Attachment C to Annex 13, as well as the event risk classification approach reflected in Annex 13.

8.0 Ground Collision (GCOL) and Ramp

Ground collision and ramp (GCOL and RAMP) accidents (fatal and nonfatal) ranked as the fifth highest occurrence category in the APAC region and eighth highest for serious incidents. During the period from 2017–2022. Fifteen ground collisions and ground handling events were recorded in the ASN Database for the APAC region.

Weather/visibility were causal factors in two of the accidents. Twenty percent of all GCOL and RAMP accidents in the APAC region involved ground equipment handling. Another 20 percent of accidents involved aircraft hitting aerodrome infrastructure, such as light poles and fences.

8.1 Workshop With ACI Members

Following a comprehensive workshop on GCOL and RAMP with participants representing aerodrome operators, a series of poll questions were asked to gauge participants' perspectives. The key results are outlined below:

1. **Common Contributing Factors to GCOL:**
   - Participants were divided in their opinions on the most common contributing factor to ground collisions (GCOL) on the airport ramp. Half identified miscommunication between ground personnel and flight crews, while the other half cited driver or operator error.
2. **Perception of Safety Protocols:**
   - Regarding the adequacy of safety protocols addressing GCOL risks at their respective airports, only 25 percent of the participants felt they had very clear procedures and regular training. A majority (63 percent) considered the procedures adequate but identified room for improvement.
3. **Effectiveness of SMS on Ramp Safety:**
   - Participants shared varied views on how well their aerodrome SMS addressed and managed ramp safety risks, including GCOL incidents. While 38 percent said the risks were very well addressed with a comprehensive approach, 63 percent believed their SMS adequately addressed GCOL but identified room for improvement.

4. **Frequency of Maturity Assessments for Ramp Safety:**
   - When asked about the frequency of maturity assessments or checklists specific to ramp safety and SMS effectiveness, including GCOL risk, 57 percent indicated they used regular annual assessments, while 29 percent mentioned occasional assessments without a set schedule.

5. **Integration of Ramp Safety Awareness Into Operational Culture:**
   - Participants provided insights into the integration of ramp safety awareness and GCOL prevention into daily operational culture. Only 13 percent indicated full integration, while the majority expressed that it was partially integrated, acknowledging room for improvement.

The poll results provided insights into key aspects of the management of GCOL risks at airports. Participants were evenly split on the most common contributing factors to GCOL incidents, with half attributing them to miscommunication between ground personnel and flight crews, and the other half citing driver or operator error. Concerns were raised about the clarity and regularity of safety protocols addressing GCOL risk, as only 25 percent felt procedures were very clear, while 63 percent deemed them adequate but identified room for improvement. Views on the effectiveness of SMS in managing GCOL risks varied, with 38 percent indicating that coverage was comprehensive and 63 percent perceiving adequacy with room for enhancement. Assessment frequency regarding ramp safety and SMS effectiveness also was mixed, with 57 percent conducting regular annual assessments, while 29 percent conducted occasional assessments without a set schedule. Additionally, only 13 percent of participants felt that ramp safety awareness and GCOL prevention were fully integrated into daily operational culture, indicating a need for improvement in this respect.

Only a few States in the region have included GCOL and RAMP in their NASPs as operational risks. The GCOL and Ramp Fact Sheet (Appendix G) provides further details, but some topics include:

The need to perform regulatory oversight on the risk management of ground operations organisations or ground handling service providers (GHSPs);

The need to develop national regulations and guidance materials for safe ground operations; and,

The need to ensure that air operator certificate (AOC) holders, ANSPs, and aerodrome operators include ground operations in their SMS.

Some additional contributing factors and actions were discussed and identified as being relevant for consideration. For example:

Promoting a culture of safety and reporting, encouraging personnel to report near-miss incidents or safety hazards to identify potential risks and prevent future accidents;

- Reducing distractions by regulating the use of mobile phones and other devices on the ramp and airside; and,
- Considering establishing or strengthening SMS interface with ground operations organizations and GHSPs. This is challenging because ground service providers, which may include companies involved in ground handling, baggage handling, catering, and aircraft servicing, operate as distinct entities that interact with multiple airlines and airports.

8.2 Conclusion

The effective management of GCOL and RAMP risks is paramount for reducing the number of serious events. The insights gathered highlight a range of challenges, including the large number of contributing factors and actions that should be considered by States and service providers for reducing this risk. The limited inclusion of GCOL and RAMP in NASPs signals a need for broader recognition of operational risks. Recommendations such as strengthened regulatory oversight, national guidelines, and enhanced integration of ground operations into SMS underscore the importance of proactive measures. Cultivating

a safety-oriented culture, regulating distractions, and improving communication interfaces with ground service providers emerge as essential steps towards a more robust and comprehensive approach to mitigating GCOL risks across airports.

Integrating SMS with ground handling service providers can be challenging. However, it is essential for maintaining a high level of safety in aviation ground operations. Collaboration, communication, and a commitment to safety culture are key factors in successfully overcoming these challenges.

8.3 Recommendations

Recommendation 8.13: States should review the GCOL and RAMP Fact Sheets and determine the level of national risk in their State and reflect the risks in their NASP, if appropriate. While Annex 19 standards are not applicable to all service providers, it is important that all hazards in the aviation system be identified, and corresponding risks managed. States may require service providers to implement SMS beyond Annex 19 applicability or to implement some safety management principles.

Recommendation 8.14: All service providers implementing SMS should address the interfaces with organisations that could introduce hazards into their activities and processes.

Note: The 4th edition of ICAO Doc 9859, Safety Management Manual (SMM) addresses the importance of a total systems approach. Guidance was included on the scope of safety management provisions, applying discretionary SMS applicability and safety management interfaces.

9.0 Loss of Control–In Flight (LOC-I)

In the APAC region, LOC-I was the second highest fatal accident occurrence category and the sixth highest occurrence category in terms of all fatal/nonfatal accidents in the region. Over the past six years, there were five accidents categorized as LOC-I, of which four were fatal, resulting in 350 fatalities among passengers and crew. Two of the LOC-I events occurred in the en route phase of flight, three on approach, and one in the landing phase. Two of the LOC-I events occurred on turboprop aircraft, with one event resulting in two fatalities.

Most of the LOC-I accidents can be categorized as either airplane-induced, environmentally induced, pilot/human-induced or any combination of these three. The fact sheet breaks down the contributing factors and actions using these categories However, some of the common contributing factors were the following:

- Incorrect pilot actions;
- Failure to recognise and manage unusual or unexpected aircraft states, or inadequate response to abnormal flight conditions;
- Weather conditions;
- Aerodynamic stalls, including entering or mishandling an aerodynamic stall;
- Mechanical failures; and,
- CRM — human factors as well as communication issues may have been factors.

A common recommendation (safety action) stemming from these accidents that was reflected in accident reports was the need for more training in the following areas:

- CRM and upset prevention and recovery training;
- Stall awareness and prevention;
- Spatial disorientation; and,
- Advanced cockpit techniques such as training on using automated systems.

Since some of the common outcomes or results of these accidents can be linked to the maintenance/airworthiness of the aircraft or flight operations, the fact sheet compares the dashboard results against the states' safety oversight results in the areas of airworthiness and flight operations.

Considering the importance of this HRC, globally and regionally, all States in the region that have published an NASP have included LOC-I as a national operational risk. Collectively, they have highlighted precursors and contributing factors that would need to be addressed nationally. The list of those actions is found in Appendix H, and the actions were discussed during the workshop. Some highlights that were shared with workshop participants included:

- The need for air operators to evaluate existing SOPs to ensure effective flight management during adverse weather and recovery of unusual aircraft attitudes;
- The need for more FDAP guidance to encourage operators to consider LOC-I precursors as part of FDAP;
- The need for regulators to implement measures to reduce potential laser interference with aircraft, which can distract or temporarily blind pilots; and
- The need to establish an industrywide ground handling task force to reduce the risk of weight and balance and deicing events that could lead to LOC-I.

Additional actions were also shared for aerodromes as well as ANSPs. The details are found in Appendix H.

9.1 Workshop With Airlines

Following a workshop on LOC-I events and mitigating strategies with airline representatives, a survey was conducted among airline participants. The results are as follows:

1. **Confidence in Recognizing and Recovering from Imminent Stall or Upset:**
   - When assessing participants' confidence in their ability to recognise and recover from an imminent stall or upset condition, 50 percent felt very confident, while 40 percent said they were somewhat confident.
2. **Importance of Proficiency in Manual Flight Control Skills:**
   - Participants were asked about the importance of pilots maintaining proficiency in manual flight control skills in highly automated aircraft. A majority, 60 percent, considered it extremely important, with the remaining 40 percent acknowledging its importance but not as the top priority.
3. **Critical Aspects for Reducing LOC-I Risk in the Aviation Industry:**
   - When participants were questioned about the most critical aspect of reducing the risk of LOC-I incidents within the aviation industry, a unanimous 100 percent emphasised the importance of continuous pilot education and training. Additionally, 40 percent highlighted improved aircraft design and technology as equally critical, along with industry collaboration and information-sharing.

The survey results provide insights into the perspectives of airline participants in the APAC region on LOC-I prevention. The poll results underscore the significance of pilot confidence and proficiency, the importance of manual flight control skills, and a unanimous consensus on the critical role of continuous pilot education and training in reducing the risk of LOC-I incidents. The results also highlight the equal importance attributed to improved aircraft design, technology, and collaborative industry efforts.

9.2 Conclusion

Globally, regionally, and nationally, LOC-I, has been identified as an HRC. The AP-RASP contains numerous SEIs to mitigate LOC-I events.

The outcomes from the project analysis and input from workshop participants, emphasised the crucial role of ongoing education and training, technological advancements, and collaborative efforts needed to mitigate the risk of LOC-I incidents and enhance aviation safety.

Additional actions that can be taken were identified by the industry and are reflected in Appendix H and address actions that can be taken by air operators, AMOs, regulators, and other service providers.

9.3 Recommendation

Recommendation 9.15: The RASG-APAC, through the APRAST, should review the additional actions listed in the fact sheet related to LOC-I to determine if any additional actions can be included as SEIs or complement existing activities already identified.

10.0 Controlled Flight Into Terrain (CFIT)

In the APAC region, CFIT stands out as the highest fatal accident occurrence category and the fourth highest in terms of both fatal and nonfatal accidents. Over the six-year period from 2017 to 2022, the ASN Database recorded eight CFIT accidents, with four occurring enroute, three on approach, and one during the landing phase of flight. Despite technological advancements contributing to a decline in overall CFIT accidents, when they do occur, they tend to be fatal, emphasising the persistently high risk associated with this category. Adverse weather conditions were a common factor in most occurrences along with operational shortcomings like unstable approaches, improper go-arounds, lost situational awareness, and deviations from established procedures.

Analysis of the accidents revealed that more than half occurred in mountainous terrain, often linked to a loss of situational awareness. The APAC region experiences an average of 1.75 CFIT accidents per year.

Implementation of WGS-84, which provides a standardized global reference frame for geospatial positioning and serves as the geodetic reference for technologies such as the terrain awareness and warning system (TAWS) that contributes to mitigating CFIT, is highly relevant in the Asia-Pacific region. The adoption of WGS-84 may involve overcoming integration challenges, particularly in updating existing systems and databases to align with this global geodetic standard.

The ICAO Aeronautical Information Services Aeronautical Information Management Implementation Task Force (AAITF) has recognized that WGS-84 coordinate data change over time and need to be revalidated periodically.

10.1 Workshop With CANSO Members

During the workshop with ANSPs and air traffic controllers concerning the risks of CFIT and mitigation strategies, a series of poll questions were asked to obtain the participants' perspectives. The key results are as follows:

1. **Effectiveness of Existing Technologies:**
   - When assessing the contribution of existing technologies like TAWS to mitigating CFIT risks, 38 percent found it highly effective, and 51 percent considered it moderately effective.
2. **Integration of Safety Technologies Into Air Traffic Control Systems:**
   - Participants' opinions varied on the integration of safety technologies such as enhanced ground-proximity warning systems (EGPWS) and TAWS, into air traffic control systems to prevent CFIT incidents. While 37 percent felt it was well integrated, 41 percent perceived it as only partially integrated, and 7 percent considered it poorly integrated.
3. **Collaboration Between ANSPs and Airlines:**
   - Views on the effectiveness of collaboration between ANSPs and airlines in the region to address and prevent CFIT incidents varied. Only 20 percent found the collaboration very effective, while 59 percent considered it moderately effective.

4. **Reporting and Analysis of CFIT Accidents:**
   - Concerning the reporting and analysis of CFIT accidents, only 13 percent felt the accidents were very well reported and analysed, with 60 percent perceiving them as moderately well reported, and 7 percent as poorly reported.

5. **Training for Air Traffic Controllers:**
   - Participants' opinions on the level of training that air traffic controllers receive specifically on terrain and obstacle awareness to prevent CFIT revealed gaps. Only 26 percent indicated that they had received comprehensive training, 49 percent said they received limited training, and 14 percent had not received such training.

6. **Continuous Improvement Measures:**
   - When asked about measures to continuously improve strategies and practices to prevent CFIT in the region, 38 percent emphasised the need to regularly update procedures based on incident analysis and 55 percent highlighted the need for enhancing training programs for air traffic controllers.

These poll results underscore the varying perspectives on CFIT prevention strategies in the APAC region, highlighting the effectiveness of existing technologies, the difficulties and complexities associated with seamlessly incorporating various technologies, collaboration efforts, and the importance of ongoing training and procedural updates based on incident analysis for air traffic controllers.

10.2 Conclusion

CFIT accidents frequently underscore operational shortcomings, including continued flight on unstable approaches; delayed or improper go-arounds; lapses in situational awareness; and failure to follow SOPs such as conducting visual flight rules flights in instrument meteorological conditions, descent below established minima, and deviations from established routes.

While air operators bear the primary responsibility for mitigating these risks through comprehensive training and enhanced cockpit technologies, ANSPs play an important role. ANSPs can contribute significantly by providing real-time weather information, optimising air traffic management to minimise conflicting traffic during adverse conditions and fostering collaboration with operators to develop and disseminate best practices. A coordinated effort between air operators and ANSPs is crucial to implementing effective risk mitigation strategies and enhancing overall aviation safety in the region.

10.3 Recommendation

Recommendation 10.16: All APAC States should implement WGS-84. As a result of full implementation of WGS-84, the aviation industry can have a consistent and reliable geospatial reference for navigation systems. Furthermore, for all States that have implemented WGS-84, measures should be put in place to ensure periodic revalidation of all surveyed and calculated coordinate data that are published in Aeronautical Information Publications (AIP) or used in instrument flight procedure design.

11.0 The 'Unknown/Undetermined' Category

According to the ASN Dashboard data, the number of accidents and serious incidents tagged under the "unknown" (undetermined) category ranks as the seventh highest occurrence category in the region, which is considered a high ranking when this information is used to account for risks in the region. According to FSF data, during the period of 2017 to 2019, approximately 35 percent of all accidents and serious incidents were not investigated to the level of releasing a preliminary and/or final report or identifying the causal factors of the accident or serious incident. In 2020, the percentage increased to 40 percent; in 2021, to 57 percent; and in 2022, to 90 percent.

The "unknown" category accounts for accidents/serious incidents with no reports or with preliminary results that do not provide sufficient information to reflect the accident category or contributing factors and causal effects. It is noteworthy that the ICAO AIGP performed a worldwide review of this matter, including with results for the APAC region. However, this review was performed on data from 2006 to 2016. The results of the AP-CAS study reflected the results from 2017–2022, and the situation has not improved.

When reviewing the organizational challenges (in the Roadmap reflected in the AP-RASP 2023–2025), the need for improvement in safety oversight and compliance was identified for AIG. The APAC-AIG has made recommendations which, if implemented, would help to improve each State's capacity to effectively investigate accidents and serious incidents and should also enhance the level of reporting by States/administrations to assist in the identification of regional safety issues and trends.

When the regulators participating in the workshop were asked what improvements could be made to enhance the transparency and effectiveness of the process for reporting and investigating accidents and serious incidents, 50 percent of participants indicated the need to enhance investigative resources and experience. Fifteen percent considered that their national laws to support the publishing of final reports on the public website would need to be revised.

11.1 Recommendations

Recommendation 11.17: The ICAO AIGP, or the Asia Pacific Accident Investigation Group should perform further research on the reasons why more final reports are not made publicly available by States. The research should be done using a more recent reporting period such as 2017 to 2022.

Recommendation 11.18: APAC States should endeavor to increase the required resources, staffing, and training of personnel in the area of AIG to increase their level of implementation.

Recommendation 11.19: The appropriate working group of APRAST should review this report, as well as the information available on the ASN Dashboard and determine if any additional actions should be included in the regional goal related to the improvements to safety oversight and compliance related to AIG.

12.0 Additional Recommendations

12.1 Use of the Fact Sheets

The fact sheets located in Appendices B to I correlate and summarise the results relative to high-risk accidents and serious incidents in the region during the period 2017–2022. The fact sheets synthesise all the precursors documented in the AP-RASP and across all the NASPs submitted to ICAO to date for each high-risk area. Stakeholder engagement was performed to seek input on additional causal factors contributing to the risks and additional actions to address the risks that have not been identified within the GASP, AP-RASP, or the NASPs that have been prepared in the region.

Recommendation 12.20: States, the ICAO-APAC Regional Office, and the industry should review the fact sheets, in particular the sections pertaining to:

- **The analysis of ASN results correlated with the AP-CAS Dashboard,** which may help ICAO and States in performing targeted assistance to States.
- **Precursors/contributing factors and additional actions that have not been identified by AP-RASP or NASPs:**
  - This section can help the RASG-APAC and APRAST in identifying other SEIs that may be considered for HRCs listed in the AP-RASP.

- In addition, this section can assist States in further developing their NASPs, in particular, by identifying additional actions that can be taken to address operational risks. This section will also help industry in addressing operational risks.

- **Accident and serious incident reports**–The comprehensive version of this report includes fact sheet that list all accidents and serious incidents in the region, including hyperlinks to the details of the accidents or serious incidents. This could be useful if the APRAST or any subgroup would wish to peform further analysis.

Recommendation 12.21: States should consider the fact sheet (Appendices B to I) in the development or updating their NASP, as well as aiding the industry in addressing operational risks.

12.2 National Aviation Safety Plans

When preparing the fact sheets found in this report (Appendices B to I), a review was performed of each NASP that was published by APAC States to determine the national operational risks. In performing this review, a few observations can be made:

- At the time of the preparation of this report, only 15 of 39 APAC States had published NASPs.
- While ICAO has provided guidance and a template to help prepare NASPs, not all NASPs contain the required information.
- The majority of the NASPs that have been prepared by APAC States only include high risks with SEIs identified in the GASP and/or AP-RASP and do not include national operational risks.

Based on the results reflected in the fact sheets, risks such as turbulence and system/component failure–non-powerplant figure prominently in the APAC region and are reflected in the AP-RASP as a risk occurrence that contributes to accidents and serious incidents. However, since no SEIs were included, all NASPs excluded these risks.

Recommendation 13.2.1: ICAO RASG-APAC and States should consider the observations made in this report on NASPs and determine what further actions can be taken to ensure NASPs are prepared and include the required information.

Recommendation 13.2.2: Consideration should be given to reflect in the AP-RASP TURB and SCF-NP occurrence categories as additional categories of occurrences that may not have a high fatality risk, but figure prominently in the most frequent types of accidents and serious incidents in the APAC region.

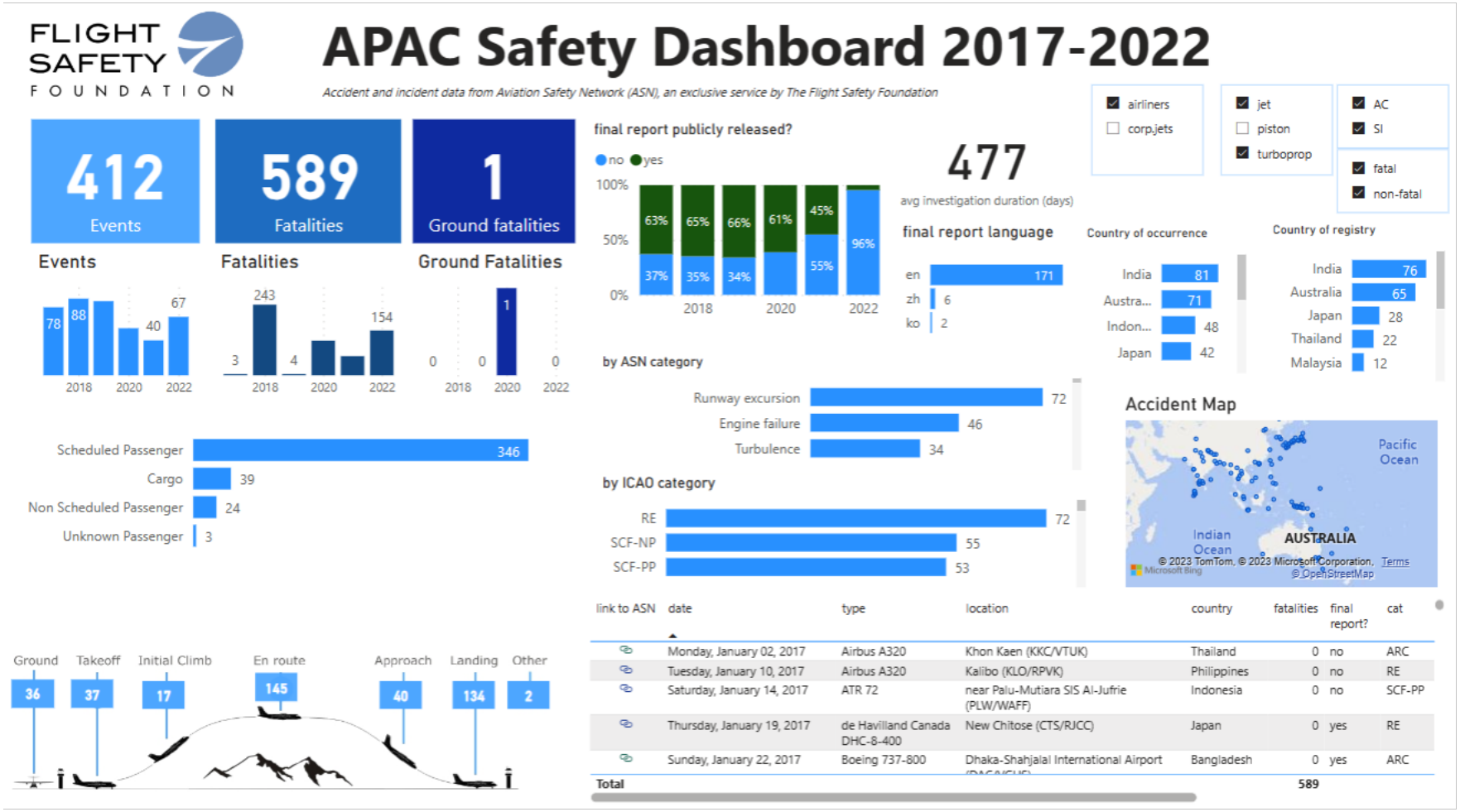
13.0 Conclusion

As we conclude this comprehensive assessment of aviation safety in the APAC region, it is evident that while significant strides have been made in enhancing aviation safety, challenges remain that require our collective attention and action. The AP-CAS is committed to not only identifying these challenges but also to spearheading efforts towards mitigating them through strategic collaboration and focused implementation of our recommendations.

Moving forward, the Centre is poised to engage with all stakeholders across the aviation sector in the region, including airlines, regulatory bodies, ANSPs, and airport operators. Our goal is to foster a collaborative environment where the expertise and resources of each stakeholder are leveraged to achieve the highest standards of aviation safety. We recognize the importance of unity in diversity; by bringing together the various actors in the aviation landscape, we can harness our collective strengths to address the identified safety concerns more effectively.

The AP-CAS will serve as a focal point for coordinating these efforts, facilitating open communication channels, and providing a platform for the exchange of best practices and safety-enhancing technologies. Our role will extend beyond mere coordination; we aim to inspire action and monitor progress, ensuring that the recommendations put forth are translated into tangible improvements in aviation safety across the region.

In the spirit of continuous improvement and shared responsibility, we invite all stakeholders to join us in this critical mission. Together, we can build a safer aviation environment for the Asia Pacific region, setting a benchmark for excellence in aviation safety worldwide. The journey ahead is one of collaboration, innovation, and unwavering commitment to safety, and the AP-CAS is dedicated to leading this charge, ensuring that every effort is made to safeguard the skies for future generations.



link to ASN	date	type	location	country	fatalities	final report?	cat
	Monday, January 02, 2017	Airbus A320	Khon Kaen (KKC/VTUK)	Thailand	0	no	ARC
	Tuesday, January 10, 2017	Airbus A320	Kalibo (KLO/RPVK)	Philippines	0	no	RE
	Saturday, January 14, 2017	ATR 72	near Palu-Mutiara SIS Al-Jufrie (PLW/WAFF)	Indonesia	0	no	SCF-PP
	Thursday, January 19, 2017	de Havilland Canada DHC-8-400	New Chitose (CTS/RJCC)	Japan	0	yes	RE
	Sunday, January 22, 2017	Boeing 737-800	Dhaka-Shahjalal International Airport	Bangladesh	0	yes	ARC
Total					589		

Appendix B—FACT SHEET—RUNWAY EXCURSIONS

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 Runway excursions account for the third highest fatal accident occurrence category in the region, second highest category when considering all accidents (fatal/non-fatal) and is the highest serious incident category in the region.

1.2 Jet Aircraft

1.2.1 Runway excursions account for 23% of all accidents in the region. The ASN database shows there were 3 runway excursion accidents involving airliners (jets) in the APAC region in 2022, which is consistent with the average number of runway excursions from 2017–2020. There were 4 runway excursion accidents in 2020, during which much of the commercial aviation industry was shut down due to the pandemic, but only one in 2021, as the industry began to recover.

1.2.2 Runway excursions are one of the top accident causal factors and are usually not fatal. However, these are rare events relative to the number of operations in the region. In the six-year span between 2017–2022, only one fatal accident occurred, when a Boeing 737–800 suffered a runway excursion on landing at Kozhikode-Calicut Airport, India and broke in two, resulting in 21 fatalities.

1.2.3 Since 2017, 78 percent of the 14 excursion accidents recorded in the ASN database have occurred during landing, with 68% resulting in veer offs and overruns. Close to 60% occurred during poor weather conditions. Unstable approaches and failure to go-around were the most common factors. Other contributing factors included flight crew handling errors (speed and directional control), contaminated runways, late or inaccurate runway or weather reports, mechanical failures, lack of adherence to Standard Operating Procedures (SOPs), poor Crew Resource Management (CRM), and no Air Traffic Control Tower Meteorological Officer (MET) presence during severe weather conditions.

1.2.4 In the analysis period (2017–2022), runway excursion accidents occurred disproportionately more often in Asia, Africa and South America and were less prominent in Europe and Middle East. Asia, Africa and South America account for 36 percent of all accidents, but 56 percent of all runway excursion accidents (globally).

1.2.5 Because of the complexity of risk factors involved in runway excursions — such as stability of the approach, stability of the landing, condition of the runway, capabilities of the aircraft and instructions from air traffic control, among others — prevention requires coordination among numerous stakeholders, including operators, airports, air navigation service providers, manufacturers and regulators. In 2021, the Flight Safety Foundation and EUROCONTROL, working with more than 100 aviation professionals from 40 organizations, published the **Global Action Plan for the Prevention of Runway Excursions** (GAPPRE), which provides recommendations and guidance materials to a variety of stakeholders. The Foundation's 2017 **Go-Around Decision-Making and Execution (GADM&E) Project** report also contains valuable data and recommendations.

1.3 Turboprop Aircraft

1.3.1 In the six-year span between 2017–2022, runway excursions were by far the most common accident type for turboprop operations, accounting for 27% of all turboprop accidents. During this period only one fatal accident occurred in 2018 when 51 passengers on a De Havilland Dash 8–400 suffered a runway excursion, veering off the runway on landing.

1.3.2 Since 2017, 87 percent of the 15 turbo-prop excursion accidents recorded in the ASN database have occurred during landing, with 60% resulting in veer-offs and the other 40% as overruns. 21% occurred during poor weather, including wind shear and turbulence conditions. Unstable approaches and failure to go around were a common factor 30% of the time. Mechanical failures were a contributing factor for 28% of the accidents. Lack of adherence to SOPs, poor CRM, mental health and insufficient training contributed to 43% of the total accidents. Three countries as States of occurrence within the APAC region accounted for 71% of all turboprop runway excursion accidents.

1.4 When comparing the Global accident results for jet and turbo-prop aircraft combined, in 2022, there were 32 RE accidents, of which two were fatal resulting in two fatalities (one passenger and one ground personnel). The 32 RE accidents in 2022 matches the five-year rolling average. The APAC region averages 5.4 RE accidents per year for the same time period, making it the second highest region with RE accidents.

2.0 ICAO Global Aviation Safety Plan (GASP)

2.1 The GASP has identified Runway Excursions as one of the five High Risk Categories (HRCs) of occurrences based on global fatalities, fatality rates and the number of accidents and reported serious incidents.

2.2 The Global aviation safety roadmap serves as an action plan to assist the APAC aviation community in developing the RASP and NASPs by outlining safety enhancement initiatives (SEIs) associated with the global HRCs. Each SEI includes a set of actions that stakeholders may use to develop and implement specific action plans. Regions and States, in collaboration with industry, should use the roadmap to support or complement as applicable for the development of specific SEI as set out in the RASP and NASPs.

- A Safety Enhancement Initiative for runway excursions (SEI-RE) was identified for States to mitigate contributing factors to Runway Excursion accidents and serious incidents.

2.2.1 The following actions have been identified at the global level for States to consider mitigating RE accidents and serious incidents:

a) Ensure the establishment and implementation of a State runway safety programme and runway safety teams

b) Promote the establishment of policy and training on rejected landings, go-arounds, crosswind and tailwind landings (up to the maximum manufacturer-demonstrated winds)

c) Promote equipage of runway overrun awareness and alerting systems on aircraft

d) Ensure effective and timely reporting of meteorological and aerodrome conditions (e.g. runway surface condition in accordance to the ICAO global reporting format in Annex 14–Aerodromes, Volume I–Aerodrome Design and Operations braking action and revised declared distances)

e) Certify aerodrome in accordance with ICAO Annex 14, Volume I, as well as PANS-Aerodromes (Doc 9981)

f) Promote the installation of arresting systems if runway end safety area (RESA) requirements cannot be met

g) Ensure that procedures to systematically reduce the rate of unstabilized approaches to runways are developed and used

2.2.2 The following actions have been identified at the global level for industry to consider mitigating RE accidents and serious incidents:

a) Active participation in runway safety programmes and runway safety teams.

b) Policy and training on rejected landings, go-arounds, crosswind, and tailwind landings (up to the maximum manufacturer-demonstrated winds).

c) Equip the aircraft with runway overrun awareness and alerting systems.

d) Effective and timely reporting of meteorological and aerodrome conditions (e.g. runway surface condition in accordance with the ICAO global reporting format in Annex 14–Aerodromes, Volume I–Aerodrome Design and Operations braking action and revised declared distances).

e) Comply with runway-related provisions in ICAO Annex 14, Volume I as well as PANS-Aerodromes (Doc 9981).

f) Consider an arresting system if RESA requirements cannot be met.

g) Procedures to systematically reduce the rate of unstabilized approaches to runways.

3.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

3.1 The top Regional HRCs for the APAC region were identified from the RASG-APAC Annual Safety Report (ASR) 2022, which reflects safety data up to the end of 2021: These are similar to those identified in the GASP. The Asia Pacific Regional Aviation Safety Plan (2023–2025) has factored Runway excursions, Runway Incursion and Abnormal Runway Contact(ARC) into a regional risk as Runway Safety. Runway Safety is a primary contributor to fatality risk in the region. Regional actions that have been identified to address these risks are:

- **Action Item (A.I.5)** the development and the use of a Runway Safety Maturity Checklist.
- **Action Item (A.I.6)** the development of guidance material on Unstabilised Approach.
- **Action Item (A.I.7)** the development of guidance material and a training program for runway pavement, maintenance and operations from aerodrome operator's perspective.

3.2 The AP-RASP also commits the RASG-APAC to continue its efforts to promote the effective implementation of AGA, with a focus on runway safety programmes that support the establishment of Runway Safety Teams (RSTs) and implementation of inter-organizational SMS and Collaborative Safety Teams (CSTs).

3.3 As of April 2023 approximately 26 percent of all international airports in the APAC region have established Runway Safety Teams (RST). 44 percent of States reflected in Table 1 above have established RSTs (various levels of implementation) at their international airports.[2]

4.0 National Aviation Safety Plans

Fifteen APAC States have published National Aviation Safety Plans. Of the fifteen States, thirteen States have identified runway excursions as national operational risks. Collectively, the thirteen States have highlighted the following precursors/contributing factors and actions that would need to be addressed.

4.1 Precursors/contributing factors.

- Poor decision making during adverse environmental conditions (winds/visibility).
- Runway condition.
- Inaccurate reporting of runway surface condition.
- Reliability of critical components (landing gear, wheels and brakes).
- High-speed rejected take off.
- Take off with abnormal configuration.
- Loss of Situational awareness.

[2] Based on latest results from the ICAO survey on RST implementation

- lack of training (before landing on contaminated runway, and CRM).
- lack of procedures to operate on contaminated runway.
- Ineffective SOPs.
- Meteorological information regarding Cumulonimbus activity and windshear to pilot.
- Failure to adhere to the appropriate SOPs.
- Long/floated/bounced/firm/off-center/crabbed landing.
- Non-stabilized approach.
- Poor awareness of effective landing distance.
- Inadequate regulatory oversight.

4.1.2 Actions:

- Develop National Safety Plans.
- Establish and implement national runway safety programme.
- Promote the establishment of local runway safety teams.
- Audit the effectiveness of the local runway safety teams including the effectiveness of SMS in reducing Runway Safety Precursor events.
- Include Runway Safety precursors in operators Flight Data Analysis Programs (FDAP).
- Operators to include RE/RI risk in their SMS.
- Conduct risk modelling, risk assessment and safety analysis of runway safety based on occurrences reports in the ATM/ANS domain, including low visibility runway operations.
- To establish an effective and timely reporting system for meteorological and aerodrome conditions.
- Certification of aerodromes in accordance with ICAO Annex 14, Volume I as well as Doc 9981, PANS-Aerodrome.
- Air operators to include a training module to include:
  - CRM class: Increased emphasis on coordination between two pilots with respect to traffic clearances given by ATC.
  - Flight Safety Class: Causes of runway excursions and increased emphasis on situational awareness with respect to traffic on approach/departures/taxiing on runways.
  - Simulator training: On performance-limited airfields, stabilized approaches, cross-wind landings to a level required for operations.
- FOQA monitoring of landings made beyond the touchdown zone of the runway (Extended/long flare).
- In case of non-precision approach, the operators are encouraged to carry out Continuous Descent Final Approach Technique (CDFA).
- Specialized ALAR Tool Kit training on visual illusion faced while transitioning to visual segment of approach.

5.0 Additional Precursors/Contributory Factors and actions that have not been identified by AP-RASP or NASPs pertaining to runway excursion events

The following precursors/contributor factors and action were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

5.1 Precursors/contributing factors that may contribute to runway excursions.

- A go around was necessary but not conducted.
- Long touchdown.

- Gear malfunction.
- Ineffective braking (due to hydroplaning, runway contamination, improper technique etc.)
- Incorrect performance calculation.
- Inappropriate aircraft configuration.
- Slow/late rotation.
- Cross wind.
- Abnormal Runway Contact (ARC).
- Latent conditions.
  - Inadequate or absent SOPs, operational instructions and/or policies. Inadequate company regulations and/or controls to assess compliance with regulations and SOPs.
  - Inadequate training of flight crews.
  - Inadequate regulatory oversight by the State.
  - Ineffective safety management.
- Runway surface conditions not well maintained and cleaned.
- Non removal of rubber deposits.
- Inadequate runway surface drainage.
- ILS and visual aids (PAPI and VASI) not calibrated regularly.

5.2 Additional actions that can be taken to eliminate or mitigate runway excursions.

- IATA has developed a Runway Excursion Detailed Implementation Plan (DIP) to be implemented globally and at regional level. The DIP includes many of the recommendations included in this document, some additional recommendations of the DIP are:
  - Active contribution and participation in safety information sharing programs, and regional and local safety groups.
  - Operators should emphasize the proper use of stopping devices, especially when runway conditions are unfavorable.
  - Empower and train flight crew to advise Air Traffic Control when unable to comply with an instruction or a clearance that would decrease safety margins.
- States should ensure that an operators aerodrome manual contains a requirement for reporting runway surface conditions in the Global Reporting Format by enabling a harmonized assessment and reporting of runway surface conditions and an improved flight crew assessment of take-off and landing performance.
- States to implement an action plan for assessing and reporting runway surface conditions.
- Aerodrome operators to use the Global Reporting Format (GRF) implementation checklist.
- Air operators to include comprehensive training on stabilized approaches, go around procedures and runway awareness and alerting systems.
- ANSPs focus on providing accurate and timely meteorological and aerodrome condition reports.
- Aerodrome operators should prioritize proper aerodrome maintenance, friction characteristics, and removal of contaminants.
- States should enforce adherence to ICAO Standards, promote SMS implementation, and establish runway safety programs and teams.
- Regulations should be put in place for the protection of safety information.
- Regulations should encourage a positive safety culture.
- Air operators should clearly define stabilized approach, landing and go-around policies in their operations manual, in accordance with requirements and manufacturers' guidance.

References:

Annex 14–Aerodromes, Volume I–Aerodrome Design and Operations

Doc 8168, Procedures for Procedures for Air Navigation Services–Aircraft Operations (PANS-OPS)

Doc 9981, Procedures for Air Navigation Services – Aerodromes (PANS-Aerodromes)

Doc 9859, Safety Management Manual

ICAO Global Runway Safety Action Plan

ICAO Runway Safety Team Handbook

ICAO Runway Safety IKit

RASGs

EASA Safety Promotion

European Action Plan for the Prevention of Runway Excursions (EAPPRE)

Commercial Aviation Safety Team–Safety enhancements for RE

RSOOs

iSTARS

ACI Global Reporting Format-Implementation Checklist for aerodrome operators

CAST/ICAO Common Taxonomy Team

IATA Safety Report

IATA Runway Safety

Skybrary

Flight Safety Foundation ALAR Toolkit

Global Action Plan for the Prevention of Runway Excursions (GAPPRE)

Circular 355: Assessment, Measurement and Reporting of Runway Surface Conditions

Doc 10064: Aeroplane Performance Manual

EUR/NAT Guidance on the Issuance of SNOWTAM

ICAO/ACI Online Course for Airport Operators

ICAO/IATA Online Course for Aircraft Operators & Flight Crew

ICAO GRF web site **https://www.icao.int/safety/Pages/GRF.aspx**

ICAO Global GRF Symposium **https://www.icao.int/Meetings/grf2019/Pages/default.aspx**

Performance assessment of pilot response to EGPWS

Examining Unstable Approaches-Risk mitigating efforts

NBAA Reducing Runway Excursions in Business Aviation 2023

Appendix C—FACT SHEET—SYSTEM COMPONENT FAILURE NON POWERPLANT

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 System/Component Failure or Malfunction (Non-Powerplant) (SCF-NP) is ranked second highest accident/serious incident (non-fatal) occurrence category in the APAC region after runway excursions, and accounts for 13 percent of all accidents and serious incidents in the region.

1.2 The ASN database shows there were 10 SCF-NP events in the APAC region in 2022, which is consistent with the average number of SCF-NP events year-over-year from 2017–2022. Even during the period of the pandemic, SCF-NP events averaged nine each year during which much of the commercial aviation industry was shut down.

1.3 During the reporting period, all SCF-NP events were non-fatal. 67 percent of all SCF-NP events in the region occurred on jet aircraft, the rest were on turboprop aircraft. 60 percent of all SCF-NP events occurred during the en-route phase of flight and 19 percent occurred during the landing phase.

1.4 Over the six-year period, cabin pressure system failures have been the leading system component failures, non powerplant with 51 percent of all reported incidents were the result of pressure system failures, followed by 28 percent hydraulic and landing gear system failures and 8 percent electrical system failures. Four events were the result of structural or corrosion related failures. 10 percent of all SCF-NP can be attributed to poor maintenance practices or could have been prevented by adhering to manufacturers' recommended scheduled maintenance.

1.5 Serious incidents in the APAC region resulting from hydraulic and landing gear system failures were mainly caused by:

- Wear and tear on the wheels, tires, axles, and other parts
- Leaking hydraulic fluid
- Damaged or malfunctioning hydraulics
- Malfunctions in the locking mechanisms
- Jamming of the wheels

1.6 When comparing the global accident and serious incident results in 2022, there were 28 SCF-NP events, which is below the 29.4 per year on a five year rolling average seen during 2017–2022. The APAC region averages 10.8 SCF-NP accidents/serious incidents per year for the same time period, making it the highest region with SCF-NP events. The comparison of the 5-year average for each ICAO region for SCF-NP events is the following:

2.0 ICAO Global Aviation Safety Plan (GASP)

2.1 The GASP has not highlighted SCF-NP as a global risk and therefore it is not reflected in the latest version of the GASP.

2.2 The Global aviation safety roadmap serves as an action plan to assist the APAC aviation community in developing the RASP and NASPs by outlining safety enhancement initiatives (SEIs) associated with the global HRCs. Since SCF-NP is not reflected as an HRC, no guidance is given to the regions or States in the form of actions that can be considered for the RASP and NASPs.

3.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

3.1 The AP-RASP recognizes that SCF-NP has contributed to accidents and serious incidents in the APAC region that resulted in substantial damage to aircraft, but no fatal accidents. As a result, SCF-NP was not identified as a regional HRC.

4.0 National Aviation Safety Plans

Fifteen APAC States have published National Aviation Safety Plans. No State has reflected SCF-NP as a national operational risk.

5.0 Additional Precursors/Contributory Factors and actions that were not identified by AP-RASP or NASPs pertaining to SCF-NP Events

The following precursors/contributing factors and actions were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

5.1 **Precursors and contributing factors:** While poor aircraft maintenance practices can certainly contribute to SCF-NP, it is not the only reason. Aircraft maintenance is a critical aspect of aviation safety and reliability, and inadequate maintenance practices can lead to a higher risk of failures. However, it is essential to recognize that various factors can contribute to SCF-NP.

- **Material Defects:** Components may have inherent defects or quality issues that can lead to failures over time.
- **Environmental Conditions:** Exposure to harsh environmental factors, such as extreme temperatures, humidity, or corrosive substances, can accelerate component degradation and failure.
- **Deterioration due to ageing components:** Components naturally degrade over time due to wear and tear, leading to reduced performance and eventual failure. The age of an aircraft fleet is also a factor.
- **Design or repair Issues:** Inadequate component design or compatibility issues between components or improper repairs can cause failures in the system. This can occur from unapproved modification or repairs made to an aircraft.
- **Manufacturing Deficiencies:** Poor manufacturing processes or inadequate quality control can lead to component weaknesses and failures.
- **Overload and Stress:** Components can fail if subjected to excessive loads, stress, or vibration beyond their designed limits.
- **Improper Handling:** Mishandling during installation, maintenance, or repairs can damage components and lead to failures.
- **Human Error:** Errors made by maintenance personnel or operators during maintenance or operation can result in component failures.
- **Lack of Training:** Insufficient training of maintenance personnel may lead to improper maintenance practices, increasing the risk of failures.
- **Insufficient Inspections:** If components are not inspected thoroughly and regularly, potential issues may go undetected, leading to unexpected failures.
- **Maintenance programs:** Being approved by the State of Registry but not adhering to manufacturers recommended maintenance schedules and/or Chapter 5 airworthiness limitations, may impact the airworthiness of the aircraft. Additionally, the maintenance program intervals may not be adjusted to reflect the environment, role and utilization rate of the aircraft.

- **Improper implementation of reliability programs and condition monitoring.**
- **Damage:** Accidental Damage (AD) and/or Environmental Damage (ED).
- **Maintenance errors** which create malfunctions that only become apparent long after the maintenance was performed.
- Inability to properly oversee operations due to poor training, operation procedure, and/or maintenance.
- **Major component degradation** as a result of fatigue, fretting, wear, corrosion, or creep, depending on the component or system operation.

5.2 **Actions:**

- Proactive measures that focus on prevention, early detection, and corrective actions.
- Regular Maintenance and Inspections: Implement scheduled maintenance per the approved maintenance program taking into consideration changes to the maintenance programme to reflect operator experience, environment of operation, utilization rate. Conduct thorough inspections of components, equipment, and systems to detect early signs of wear, damage, or deterioration.
- Condition Monitoring or Condition Based maintenance (CBM): Utilize condition monitoring techniques, such as vibration analysis, thermography, and oil analysis, to continuously monitor the health of critical components. This helps in identifying abnormal behavior and taking preventive actions.
- Predictive Maintenance (PdM): Employ predictive maintenance technologies, including data analytics, to predict component failures based on historical data patterns. This approach allows maintenance activities to be performed precisely when needed, reducing downtime and costs.
- Defect control: properly completing an aircraft maintenance log and following correct procedures for logging defects, deferring defects, the use of a minimum equipment list (MEL) as well as the use of electronic logbooks.
- Training and Human Factors: Train operators and maintenance personnel on proper procedures, handling, and troubleshooting techniques. Human errors can contribute significantly to component failures, so an informed workforce is crucial.
- Environmental Protections: Shield components from extreme environmental conditions through the use of enclosures, protective coatings, or climate control measures. This helps extend the life of sensitive components.
- Root Cause Analysis: Perform thorough root cause analysis whenever a failure occurs to understand the underlying reasons and implement corrective actions to prevent similar incidents in the future.
- Software and Firmware Updates: Keep software and firmware up to date to address bugs, security vulnerabilities, and potential system instabilities that could lead to component failures.
- Supplier Quality Assurance: Partner with reliable and reputable suppliers who adhere to strict quality standards, ensuring the delivery of high-quality components.

Appendix D—FACT SHEET—ABNORMAL RUNWAY CONTACT

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 ARC is the third highest accident occurrence category (non-fatal) in the APAC region and ranks fifth when factoring serious incidents.

1.2 In the six-year 2017–2022 period, there were 37 ARC-related accidents/serious incidents reported in the APAC region. The most ARC events occurred in 2017 with eleven, followed by 2018 with 8 events and 2019 and 2020 each having 7 reported accidents/incidents. In 2021, only three events were reported. However, this was the period during which the commercial aviation industry was starting to recover from the pandemic.

1.3 Fifty-five percent of the ARC events occurred to jet aircraft, and the rest to turbo-prop aircraft. There were no fatalities attributed to the ARC events. However, there were 9 recorded injuries, all stemming from hard landings.

1.4 Most ARC accidents/incidents were tail strikes or hard landings or a combination of the two. Tail strike accidents occur when the attitude of the aircraft is such that the tail contacts the runway during takeoff, landing, or go-around, resulting in substantial damage. In the APAC Region between 2017–2022, there were 15 accidents/incidents that were classified as tail strike events. Twelve tail strike events occurred while the aircraft were landing and mostly during daytime. One probable cause that stands out in each of these events was an unstabilized approach. In addition to the unstable approach, contributing factors that led to these tail strike events included:

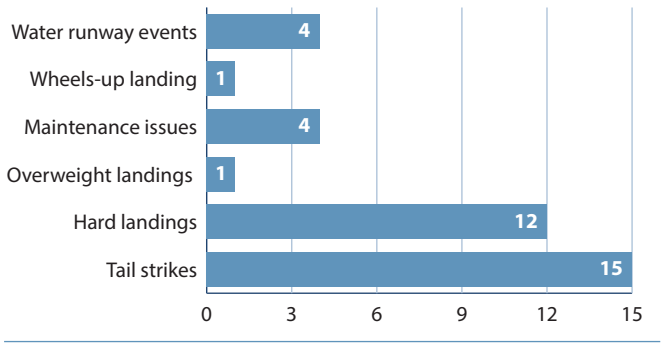
- The lack of Pilot Monitoring to effectively cross-check the actions of the Pilot Flying.
- Pilot Monitoring which did not always call for a Go-Around once the aircraft was in an unstabilized approach and/or did not adhere to Go-Around SOPs. It is worth noting that two of the tail strikes occurred to pilots in the process of getting their check rides/training.

1.5 Three tail strike accidents/serious incidents occurred while the aircraft was taking off, and two were coupled with a tailwind. The third tail strike event was caused by high pitch rotation in order to avoid a vehicle and person on the runway.

1.6 Hard landings accounted for 32 percent of all ARC accidents/incidents in the APAC region. The most common cause of the hard landing was an unstable approach. Most of these events occurred due to a strong tailwind, a "rushed" approach, adverse weather conditions, strong gusts, sudden down drafts, wind shear, or strong cross winds.

The high-level breakdown of all the recorded ARC events is depicted in Figure 1 below.

Figure 1: Abnormal Runway Incidents



1.7 When comparing to the global accident and serious incident results in 2022, there were 17 ARC events, which is below the 21.8 per year five-year rolling average seen during 2017–2022. The APAC region averages five ARC accidents/serious incidents per year for the same time period, making it the second-highest region with ARC events. The comparison of the 5-year average for each ICAO region for ARC events is the following:

2.0 ICAO Global Aviation Safety Plan (GASP)

2.1 The GASP has not highlighted ARC as a global risk and therefore it is not reflected in the latest version of the GASP.

2.2 The Global aviation safety roadmap serves as an action plan to assist the APAC aviation community in developing the RASP and NASPs by outlining safety enhancement initiatives (SEIs) associated with the global HRCs. Since ARC is not reflected as an HRC, no guidance is given to the regions or States in the form of actions that can be considered for the RASP and NASPs.

3.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

3.1 ARC (hard landings and tail strikes) were included as one of the top operational risks for the APAC region and listed as a regional high-risk category (HRC) in the AP-RASP 2023–2025. ARC was included as part of the regional risk as Runway Safety. The regional actions that have been identified that would be considered as safety enhancement initiatives (SEI) to address some of the ARC are:

- **Action Item (A.I.6)** the development of guidance material on unstabilised Approach.
- **Action Item (A.I.7)** the development of guidance material and a training program for runway pavement, maintenance and operations from aerodrome operators' perspective.

The AP-RASP has recommended that these SEI's be included in APAC States' National Aviation Safety Plan.

4.0 National Aviation Safety Plans (NASP)

4.1 To date, 15 APAC States have published a National Aviation Safety Plan (NASP). Of the 15 NASPs, only three States have specifically identified ARC as a national operational risk. Collectively, the three States have highlighted the following actions that would be required to eliminate or mitigate this operational safety risk in addition to what has been published in States' NASPs on runway excursions:

- Develop guidance material on Unstabilised Approach (As recommended by the AP-RASP)
- Promote the establishment of policy and training on rejected landings, go-arounds, crosswind and tailwind landings (up to the maximum manufacturer-demonstrated wind).
- Ensure effective and timely reporting of meteorological and aerodrome conditions (e.g. runway surface condition in accordance with the ICAO global reporting format in Annex 14, Volume I, braking action and revised declared distances)
- Develop guidance material and training program for runway pavement, maintenance, and operations from aerodrome operator's perspective.
- Make use of the Runway Safety Maturity Checklist

5.0 Additional Precursors/Contributing Factors and actions that were not identified by AP-RASP or NASPs pertaining Abnormal Runway Contact Events

The following precursors/contributing factors and actions were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

5.1 Precursors/contributing factors that may contribute to ARC:

- Unstabilised Approach (refer to the Fact sheet on Runway excursions for additional precursors and contributing factors and actions).
- Adverse weather conditions (crosswinds, turbulence or windshear).
- A go-around was necessary but not conducted.
- Inappropriate aircraft configuration (trim setting/CG position, and flap setting).
- Mishandling of crosswinds.
- Mistrimmed stabilizer, rotation at improper speed, excessive rotation rate.
- Holding off in the flare.
- Over-rotation during go-around.
- Improper use of the flight director.
- Under-inflated oleo-pneumatic shock absorber.
- **Latent conditions**
  - Inadequate or absent SOPs, operational instructions and/or policies. Inadequate company regulations and/or controls to assess compliance with regulations and SOPs.
  - Inadequate training of flight crews.
  - Inadequate regulatory oversight by the State.
  - Ineffective safety management.
- Slow or late rotation.
- **Airport Infrastructure:**
  - Runway surface not well maintained and cleaned.
  - Illuminated touchdown zones could be a contributing factor of hard landings and tail strikes due to the black hole effect at night.
  - The absence of center runway lights could be a contributing factor on off-center landings.

5.2 Additional actions that can be taken to eliminate or mitigate abnormal runway contact:

- To establish an effective and timely reporting system for meteorological and aerodrome conditions.
- Empower and train flight crew to advise Air Traffic Control when unable to comply with an instruction or a clearance that would decrease safety margins.
- Increase pilot experience on type and make pilot fully aware of the tail strike attitude.
- Make tail clearance measuring tools available in the simulator for all takeoffs and landings during simulator training and evaluations and provide feedback to crews.
- Use manufacturer's recommended rotation rate.
- Do not continue an unstabilised approach.
- Actively control sink rate in gusty cross wind situations.
- In the event of a late go-around, minimize the pitch change until the aircraft is accelerating.
- On a serious bounced landing, a positive go-around in accordance with SOPs.

- Crew Training on tail strike prevention and training that reinforces proper takeoff and landing procedures.
- Departure and arrival flight crew briefings on pitch limits and clearance limits, particularly important for airlines operating different type variants with different pitch clearance limits.

References

Landing Flare

Rejected landing

Boeing-tail strike prevention

Airbus–Preventing Tail strike at Takeoff

Airbus-Preventing Tail Strikes at Landing

No Landing is Routine–Brake for Safety, Not for Comfort!–Embraer and Boeing production video

Appendix E—FACT SHEET—TURBULENCE

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 Turbulence was the highest non-fatal accident occurrence category in the APAC region and sixth highest when considering all accidents and serious incidents together.

1.2 During the period from 2017–2022, there were 34 turbulence-related accidents in the APAC region or an average of 5.8 per year. The worst years for turbulence-related airliner accidents was 2019, when there were nine, followed by 2022, when there were eight.

1.3 The most common type of injury reported due to turbulence events were ankle fractures (or below ankle) to 80 known persons in these events. Two events resulted in spinal fractures. One of the reported turbulence-related accidents resulted in a fatality when a passenger died 5 months after the accident due to complications.

1.4 In 2019, turbulence accounted for almost 50 percent of the 21 accidents in the APAC region. In 2022, for the second year in a row, turbulence-related accidents were the most frequent accident type in the region. There were eight turbulence-related airliner accidents in 2022, up from three in 2021 when there were fewer overall operations.

1.5 When comparing to the Global accident and serious incident results in 2022, there were 25 TURB events which is above the 20.8 per year average seen during 2017–2022. The APAC region averages 5.8 TURB accidents/serious incidents per year for the same time period, making it the second-highest region with TURB events. The comparison of the 5-year average rolling average for each ICAO region for TURB events is the following:

1.6 Turbulence events were more evident in North America and Asia and less evident in Europe and Africa. North America accounts for 42 percent of all accidents but accounts for 56 percent of all turbulence events. Asia accounts for 16 percent of all accidents but 27 percent of all turbulence events.

1.7 The United States had the most turbulence-related accidents with 55, and there were 16 within the Japan FIR (the four Area Control Centers). Together, these two countries accounted for 69 percent of all reported turbulence accidents during the review period.

1.8 Figures one and two below show the APAC turbulence events by country of occurrence and country of registry for the reporting period.

1.9 Turbulence has long been a leading cause of injuries to airplane occupants in non-fatal accidents, and instances of turbulence are expected to increase as a result of climate change, the International Air Transport Association (IATA) said in 2018, when launching its Turbulence Aware program.

1.10 In its 2021 report, the United States National Transportation Safety Board identified a number of turbulence-related safety issues to be addressed, such as improving the submission and dissemination of turbulence observations, developing a shared awareness of turbulence risks, and mitigating the circumstances of common turbulence-related injuries with robust procedures, such as requiring cabin crew to take their seats and fasten their seat belts early during descent. Wearing a seat belt reduces the risk of serious injury for all aircraft occupants. The US NTSB report also recommends enhancements to automatic dependent surveillance–broadcast (ADS-B) technical standard orders and that aircraft flown in Part 121 air carrier operations be retrofitted with weather-capable ADS-B equipment.

1.11 The major suppliers of weather radar have made significant strides in improving the turbulence-detection capability of weather radars, including increasing the range of detection and depicting

turbulence levels (e.g., moderate and severe) on the navigation display. In addition, suppliers continue to add weather hazard inference capability to radars, which will help mitigate turbulence-related accidents.

1.12 All the instances of turbulence-related accidents in APAC region were recorded on scheduled passenger operations. This helps explain the data trend showing that flight attendants are the most likely people on board airliners to be moderately or severely injured, but passengers are more likely to be seriously injured in larger groups.

1.13 Of the eight turbulence-related airliner accidents in 2022 that were captured in the ASN database, all occurred during scheduled passenger operations and eighty percent involved commercial jetliners. The airframes involved were a mix of narrowbody and widebody aircraft. Two turbulence-related accidents involved commercial passenger turboprops. Of note, 90 percent of all those passengers injured were not restrained at the time of the event, including a significant proportion who were unrestrained despite the seat belt light being illuminated.

1.14 The Foundation's analysis also showed that among the accidents reviewed, crew members were injured more severely than were passengers, often while conducting cabin checks following a seat belt warning, or during the descent and approach phases of flight, per their company standard operating procedures (SOPs).

1.15 Many turbulence encounters, even severe ones, may not rise to the level of an accident if no serious injuries or significant aircraft damage are reported. Turbulence accidents are much more common in airliner operations than corporate jet operations because of the greater number of passengers and crew that usually are on board airliners.

2.0 ICAO Global Aviation Safety Plan (GASP)

2.1 The GASP has not highlighted TURB as a global risk and therefore it is not reflected in the latest version of the GASP.

2.2 The Global aviation safety roadmap serves as an action plan to assist the APAC aviation community in developing the RASP and NASPs by outlining safety enhancement initiatives (SEIs) associated with the global HRCs. Since TURB is not reflected as an HRC, no guidance is given to the regions or States in the form of actions that can be considered for the RASP and NASPs.

3.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

3.1 TURB has been identified as an accident occurrence category in the AP-RASP 2023–2025 and as one of the top operational risks in the APAC region. The RASP reflects that the TURB occurrence category accounts for the most accidents in the region causing serious injuries to air crew and passengers. However, it has not been identified as a regional High-Risk Category (HRC).

4.0 National Aviation Safety Plans

4.1 To date, fifteen APAC States have published National Aviation Safety Plans (NASP). Of the fifteen NASPs, no State has identified TURB as a national operational risk.

5.0 Additional Precursors/Contributory Factors and actions that were not identified by AP-RASP or NASPs pertaining to Turbulence Events

The following precursors/contributing factors and actions were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

5.1 Academic research shows that the rate of severe turbulence in clear skies will increase by 149 percent in the upcoming years due to climate change. In addition to its increased frequency, turbulence will become more severe and more damaging in its scale.

5.2 Contributing factors for severe turbulence events, and actions that can be taken (defenses) include the following:

5.2.1 **Turbulence caused by Thunderstorm (weather/convective activity)**

- 45 percent of the investigated turbulence accidents in the APAC region were triggered by weather/convective activity and occurred between FL120 and FL270 Fifty percent of these events occurred while the aircraft was in its descent phase of flight.

5.2.1.1 **Actions/ Defenses**

- Flight Planning. Thoroughness in identifying possible areas of turbulence during flight planning provides an important mitigating measure against the risk of encountering turbulence that may cause injuries. Rerouting based on available accurate turbulence reports and ensuring sufficient separation between thunderstorm cell and aircraft are existing practices among crew members.
- Training of crew members. Knowledge of the crew on a particular aircraft and/or weather radar capability, awareness of the flight environment and adherence to company SOP regarding weather avoidance is another important risk-mitigating measure. These competencies can be attained by creating training environments that explore subjects such as evaluating risk, good and bad decision making and the importance of crew coordination (within cockpit, between cockpit and cabin) before, during and after a turbulence encounter.
- Awareness training for aircraft dispatchers and/or flight operations officers. Training should be provided to increase the awareness that turbulence avoidance is a collective effort that starts at the planning phase. Leveraging on the existing weather products and services available from the ICAO World Area Forecast System (WAFS) could avoid planning flight routes with known forecasted turbulence.
- Utilizing turbulence reporting and forecasting systems. There have been significant improvements in turbulence reporting and forecasting. Major advances in data processing and delivery have allowed graphical depictions of weather to be delivered in near real-time to the flight decks of suitably equipped aircraft. Advanced reporting, forecasting, and delivery of graphics have been promoted by regulator/industry partnerships and by the leadership of various organizations. Use should be made of all applicable means to collate, compile, and make available information. Additional measures of reviewing historical turbulence encounters and injuries, sharing current information on turbulence encounters and injuries, and thorough pre-flight weather briefings including known or forecast turbulence could contribute to the collective procedural effort to further reduce this risk during daily operations.
- When air traffic is avoiding Cumulonimbus (Cb) cells, particularly in congested airspace, the workload of the controller increases significantly due to the reduction in available airspace, new conflict points, rapidly changing situation, degradation of RVSM capability etc. The following defenses should be considered:
  - Provision of sufficient number of controllers during periods with forecasted severe convective weather.
  - Use of weather radars/ weather displays to enhance information provided to controllers.
  - Use SIGMETS and associated weather forecasts to improve prediction of sector loading.
  - Train controllers to deal with weather during live training; use simulator training to build in more resilience in controller skills.
  - Operational Supervisor (SUP) additional actions to help mitigate the impact of severe weather avoidance by air traffic on the controller's workload by establishing possible tactical measures with the help of local flow management position (FMP).

5.2.2 Turbulence caused by Jet stream- clear air Turbulence (CAT)

- 40 percent of the investigated turbulence accidents in the APAC region were triggered by CAT and occurred between FL 105 and FL410, 50 percent occurred while in cruise flight.

5.2.2.1 Actions and Defenses

- Awareness. SIGMET charts give forecasts of the location and level of clear air turbulence. Information on local terrain induced CAT may be contained in appropriate Aeronautical Information Publications (AIPs).
- Restraint Systems. Passengers and crew should fit seat belts and harnesses when seated to protect them in the event of unforeseen turbulence.

5.2.3 Turbulence caused by Wake vortex.

- 3 percent of the investigated turbulence accidents in the APAC region were triggered by wake vortex.

5.2.3.1 Actions and Defenses

- ATC provides standard separation.
- Wake Turbulence Re-Categorization (RECAT)- Newer separation standards, have been introduced in Japan and Rep of Korea.
- Time and Distance Based separation minima is provided based in PANS-ATM (Doc 4444).
- Amendment 9 to the PANS-ATM (Doc 4444) applicable on 05 November 2020, introduces wake turbulence groups, as an alternative means that States can choose to adopt reduction of separation minima for some traffic pairs of aircraft, enabling runway throughput increase. RECAT provides:
  - more precise categorization of aircraft and safely increases airport capacity through the reduction of separation minima.
  - reduction in fuel use and CO2emission including a decrease in flight time.
  - enhanced safety specifically for the smallest aircraft types, and
  - alternative means that States can choose to adopt.
- ICAO-recommended separation minima for aircraft on approach and departure to be applied by both ATC and pilots with appropriate training, including, for pilots, periodic recovery practice during simulator training. Also, procedural documentation for both pilots and ATCOs to include the ICAO separation recommendations for arrival and departure (as well as any more restrictive national or local arrangements) should be available. [Note: not all CAAs fully adopt ICAO Recommendations on this matter].
- When en-route, the only available direct defense against occupant injuries is for the flight crew to maintain situational awareness by monitoring inflight reports of turbulence in the area by listening on RTF and by use of the TCAS Display and then to use the seat belt sign and direct communication with Cabin Crew to temporarily secure all occupants if in-trail climbing or one-level-above traffic is observed up to 10 nm ahead and confirmed with ATC as being a significantly larger aircraft type.
- When an en-route and an Air Traffic Controller identifies a traffic proximity situation with risk of a potentially hazardous wake encounter, he/she may provide traffic information to the trailing aircraft, including a caution for potential wake turbulence and when possible, may propose a change of lateral or vertical flight path, as appropriate.

Supporting material

International Civil Aviation Organization (ICAO) **PANS-ATM Doc 4444.**

ICAO **Doc 8643** Aircraft Type Designators lists the wake turbulence category for each fixed wing aircraft type and **Doc 9426** Air Traffic Services Planning Manual gives detailed characteristics of wake vortices and their effect on aircraft.

Commission Regulations (EU) **No 965/2012** dated 05 October 2012 and (EU) **No 923/2012** dated 26 September 2012.

ICAO Airplane Upset Prevention and Recovery Training Aid–Revision 3 dated February 2017.

Report "An Improved Understanding of En-route wake vortex encounters", by EUROCONTROL and Delft University of Technology.

SMART Wx Regulation Task Force WP1: Collaborative best practices for handling of adverse weather at European Aerodromes, EUROCONTROL, March 2021

Green Paper on the gains for the European ATM Network of aligned weather impact management, EUROCONTROL, September 2013

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UK AIC: P 056/2010, "The Effect of Thunderstorms and Associated Turbulence on Aircraft Operations", 12 Aug 2010

Air Traffic Management Decision Support During Convective Weather, Mark E. Weber, James E. Evans, William R. Moser, and Oliver J. Newe

Modelling Convective Weather Avoidance in Enroute Airspace, R. DeLaura et al. (MIT Lincoln Laboratory), 2008

CAP 493–Manual of Air Traffic Services Part 1: UK CAA. Section 1, Chapter 6: "Weather Avoidance".

IATA Turbulence Aware- A global platform for sharing automated EDR turbulence reports in real time

https://www.icao.int/RASGPA/Pages/TurbulenceToolkit.aspx

https://www.casa.gov.au/crew-safety-during-turbulence

Preventing Injuries cause by Turbulence (AC 120–88A) FAA, January 2006 **https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/99831**

Preventing turbulence related injuries in Air Carrier Operations, NTSB, August 2021

Trbulence Education and Training Aid, Boeing **https://www.smartcockpit.com/docs/Turbulence_Education_and_Training_Aid.pdf**

Managing Severe Turbulence, Airbus, November 2019 **https://safetyfirst.airbus.com/managing-severe-turbulence/**

Safety Enhancement Initiative, SE078: Turbulence Procedures for Reducing Cabin Injuries, US CAST

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Objective Turbulence Data Enhancing Safety and Efficiency, IATA, 2022

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IATA Turbulence Aware, IATA, April 2020

Visiting Swiss International Air Lines, IATA, May 2019

En route wake turbulence, Skybrary

Appendix F—FACT SHEET—RUNWAY INCURSIONS

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 Runway Incursions rank ninth highest in accident (non-fatal) occurrences in the region and seventh highest for serious incidents.

1.2 RI produce an increased risk of collision for aircraft occupying the runway. When collisions occur outside the runway (e.g.: on a taxiway or on the apron), the aircraft and/or vehicles involved are usually travelling relatively slowly. However, when a collision occurs on the runway, at least one of the aircraft involved will often be travelling at considerable speed (high energy collisions) which increases the fatality risk. Although statistically very few runway incursions result in collisions, there is a high fatality risk associated with these events.

1.3 During the six-year period 2017 to 2022 there were two accidents resulting from a RI whereby both aircraft incurred serious damage. There were 15 serious incidents reported; five occurred while the aircraft were taxiing, five occurred when aircraft were rolling for takeoff and another five occurred when aircraft were on final approach or had just landed. Three of the serious incidents were on turbo prop aircraft and all but one occurred on scheduled passenger flights.

1.4 In the review of runway incursions for the Asia Pacific Region, 14 of the 15 serious incidents and both accidents were attributable to the human performance factor of the pilot, air traffic controller, or both. One serious incident involved a vehicle incursion in which the error could be attributed to the driver entering the runway without authorization/ driver failed to hold short of a runway.

1.5 In all of these events, no fatalities were recorded.

1.6 Except for one event, a collision was averted as the result of a final action by the pilot (in the cases of incorrect clearance by the controller), or the controllers (in the cases of pilot incorrect actions), resulting in accident prevention due to go-around, aircraft stopping before impact, etc. Primary causal factors involved the following:

1. Communications: incorrect phraseology or communication procedures by pilot and/or controller, including hear-back, read-back, and misunderstandings.
2. Loss of position and traffic awareness by pilot and controllers.
3. Issues concerning ATC training.
4. Lack of Flight Deck Crew Resource Management (CRM).

1.7 When comparing to the global accident and serious incident results in 2022, there were eight RI accidents/serious incidents, which is below the 9.2 per year five-year rolling average seen during 2017–2022. The APAC region averages 2.6 RI accidents/serious incidents per year for the same time period, making it the highest region together with EURNAT with RI events. The comparison of the 5-year average for each ICAO region for RI events is the following:

2.0 ICAO Global Aviation Safety Plan (GASP)

2.1 The GASP has identified Runway Incursions as one of the five High Risk Categories (HRCs) of occurrences based on global fatalities, fatality rates and the number of accidents and reported serious incidents.

2.2 The Global aviation safety roadmap serves as an action plan to assist the APAC aviation community in developing the RASP and NASPs by outlining safety enhancement initiatives (SEIs) associated

with the global HRCs. Each SEI includes a set of actions that stakeholders may use to develop and implement specific action plans. Regions and States, in collaboration with industry, should use the roadmap to support or complement as applicable for the development of specific SEI as set out in the RASP and NASPs.

- A Safety Enhancement Initiative for Runway Incursions (SEI-RI) was identified for States to mitigate contributing factors to RI accidents and serious incidents.

2.2.1 The following actions have been identified at the global level for **States** to consider to mitigate RI accidents and serious incidents:

- Ensure the establishment and implementation of a State runway safety programme and runway safety teams.
- Promote the establishment of policy, procedures and training that supports situational awareness for controllers, pilots, and airside vehicle drivers.
- Ensure effective use of suitable technologies to assist the improvement of situational awareness, such as improved resolution airport moving maps (AMM), electronic flight bags (EFBs), enhanced vision systems (EVS) and head-up displays (HUD), advanced-surface movement guidance and control systems (ASMGCS), stop bars and runway incursion warning systems (ARIWS).
- Certify aerodrome in accordance with ICAO Annex 14–Aerodromes, Volume I–Aerodrome Design and Operations, as well as PANS-Aerodromes (Doc 9981).
- Ensure the use of standard phraseologies in accordance with applicable State regulations and ICAO provisions (e.g.: Doc 9432, Manual of Radiotelephony).
- Ensure the identification and publication in the aeronautical information publication (AIP) of hot spots at aerodromes.
- Ensure that suitable strategies to remove hazards or mitigate risks associated with identified hot spots are developed and executed.

2.2.2 The following actions have been identified at the global level for **industry** to consider to mitigate RI accidents and serious incidents:

- Active participation in a runway safety programme and runway safety teams.
- Policy, procedures and training that support situational awareness for controllers, pilots and airside vehicle drivers.
- Effective use of suitable technologies to assist the improvement of situation awareness, such as improved resolution AMM, EFB, EVS and HUD, A-SMGCS, stop bars and ARIWS.
- Comply with runway-related provisions in ICAO Annex 14–Aerodromes, Volume I–Aerodrome Design and Operations, as well as PANS-Aerodromes (Doc 9981).
- Use of standard phraseologies in accordance with applicable State regulations and ICAO provisions (e.g. Doc 9432, Manual of Radiotelephony).
- Identification and publication in the AIP of hot spots at aerodromes.
- Suitable strategies to remove or mitigate hazards associated with identified hot spots.

3.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

3.1 The top Regional HRCs for the APAC region were identified from the RASG-APAC Annual Safety Report (ASR) 2022, which reflects safety data up to the end of 2021: These are similar to those identified in the GASP. The Asia Pacific Regional Aviation Safety Plan (2023–2025) has factored Runway incursions and Runway excursion into a regional risk as Runway Safety. Runway Safety is

a primary contributor to fatality risk in the region. Regional actions that have been identified to address these risks are:

- **Action Item (A.I.5)** Runway Safety Maturity Checklist.
- **Action Item (A.I.8)** Model Advisory Circular — Runway Incursion (RI) Prevention and Pilot Training.

3.2 The AP-RASP also commits the RASG-APAC to continue its efforts to promote the effective implementation of AGA, with a focus on runway safety programmes that support the establishment of Runway Safety Teams (RSTs) and implementation of inter-organizational SMS and Collaborative Safety Teams (CSTs).

3.3 As of April 2023 approximately 26 percent of all international airports in the APAC region have established Runway Safety Teams (RST). 44 percent of States reflected in Table 1 above have established RSTs (various levels of implementation) at their international airports.[3]

4.0 National Aviation Safety Plans

Fifteen APAC States have published National Aviation Safety Plans. Of the fifteen States, twelve States have identified runway incursions as a national operational risk. Collectively, the twelve States have highlighted the following contributing factors and actions that would need to be addressed.

4.1 Precursors/contributing factors

- Aircraft and vehicle movement operations in low visibility conditions.
- Complex or inadequate aerodrome design.
- Phraseology use (e.g.: non-standard vs. standard, call-sign confusion).
- English language competence despite the introduction by ICAO of a system of validating competence in aviation English.
- Inadequate maneuvering area driver training and assessment programme.
- Nonadherence to ATC clearance or instruction.
- Inadequate coordination between controllers.
- ATC-induced:
  - Multiple simultaneous line-ups.
  - Conditional clearances.
  - Simultaneous use of runway.
  - Late issuance of or late changes to departure clearances.
- Weather.
- Deviation from ATC clearances by Flight Crew or Ground Crew.
- Non-Adherence to standard phraseology in ATC communications.
- Non-Adherence to ATC communication procedures (eg readback/hearback).
- Complex or inadequate aerodrome design.
- Lack of Driver Training and Apron Safety.
- Loss of situational awareness of stop bars.
- Poor taxiway lighting, markings, signage.
- Inactivity of Local Runway Safety Team for each aerodrome.

[3] Based on latest results from the ICAO survey on RST implementation

4.2 **Actions:**

- Develop National Safety Plans.
- Develop and implement the requirements, procedures and training materials that can support situational awareness of controllers, pilots and airside vehicle drivers.
- Certify aerodromes in accordance with ICAO Annex 14, volume I as well as Doc 9981, PANS-Aerodrome.
- Ensure the use of ATC standard phraseologies in accordance with applicable State regulations and ICAO Docs (e.g., Doc 9432, Manual of Radiotelephony).
- Include the hot spots of aerodromes in the aeronautical information publication (AIP).
- Develop and implement suitable methodologies to remove hazards or mitigate risks associated with identified hot spots.
- Develop and apply the runway safety checklist.
- Develop and distribute advisory circular for runway incursion (RI) prevention and pilot training.
- Reduce runway incursion incidents involving loss of situational awareness by pilots, non-familiarization with aerodrome layout.
- Airlines and airport operators to ensure training of vehicle drivers to follow speed control and know the sensitive areas.
- Airport operators to introduce and ensure the effective utilization of ATC ground surveillance at all high-density airports.
- Airport operators to introduce training to ATCOs on prevention of runway incursions.
- Improved signage in accordance with ICAO SARPs. Airport operators to introduce breath analyzer tests for all drivers and equipment operators on airport premises.
- Operators to review existing taxing and towing procedures and update them to include adherence to SOPs for towing/taxiing.
- Air operators to develop training program to include:
  - Understanding the importance of signages, marking and lighting.
  - Familiarization with operating aerodrome layout and taxi procedures specific to the aerodromes.
  - Increased alertness levels amongst crew while taxiing.
  - Following correct taxiways and speed limits.
  - Clear and unambiguous RT between aircraft and ATC.
  - Meticulous adherence to ground markings and awareness of works in progress at an airfield.
  - Intermediate holding position marking and lights at all high-density airports.
- Airport operators to develop and introduce procedures to significantly reduce vehicular movements on the maneuvering area during LVP/bad weather.
- Airport operators to provide stop bars at airports with high intensity operations.
- Develop policy, procedures and training that support situational awareness for controllers, pilots, airside-vehicle drivers and other airport users.
- Ensure effective use of suitable technologies to assist the improvement of situation awareness, such as improved resolution airport moving maps (AMM), electronic flight bags (EFBs), enhanced vision systems (EVS) and head-up displays (HUD), advanced-surface movement guidance and control systems (A-SMGCS), stop bars and runway incursion warning systems (ARIWS).

- Ensure the use of standard phraseologies in accordance with applicable State regulations and ICAO provisions (e.g. Doc 9432, Manual of Radiotelephony).
- Ensure airport operators establish runway safety teams (RST).
- Ensure all stakeholders use a runway safety maturity checklist.

4.3 It should be noted that three NASPS differentiated Runway Incursions between Vehicle, aircraft personnel and animals.

5.0 Additional Precursors/Contributing Factors and actions that have not been identified by AP-RASP or NASPs pertaining to Runway Incursions:

The following precursors/contributing factors and actions were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

5.1 **Precursors/contributing factors:**

- ATC Induced
  - Line-up from high-speed exits, with very limited visibility of the final approach area.
  - Allowing line-ups with the stop bars on red.
  - Authorizing the use of two different radio frequencies to cross runways or taxi along runways.
- Call sign confusion as a causal factor in safety related events such as hearback/readback errors
- Human Factors and Fatigue: Human factors play a significant role in runway incursions. Fatigue, distraction, stress, and complacency among pilots, air traffic controllers, and ground vehicle drivers could lead to errors in communication, decision-making, and situational awareness.
- Inadequate Training and Familiarization: Insufficient training for pilots, air traffic controllers, and ground vehicle drivers regarding specific aerodrome layouts, procedures, and operations can contribute to runway incursions. Proper training and familiarization with each aerodrome's unique characteristics are essential to minimize the risk.
- Language and Communication Barriers: Miscommunications or misunderstandings due to language differences between pilots, air traffic controllers, and ground personnel can lead to incorrect instructions and actions, potentially resulting in runway incursions.
- Poor Visibility and Weather Conditions: Low visibility, adverse weather conditions, and poor lighting on the runway and taxiways can reduce situational awareness, increasing the risk of runway incursions.
- Lack of Automation and Technology: Inadequate use or availability of advanced technologies, such as runway incursion warning systems, ground surveillance radar, and improved resolution airport moving maps, may hinder the ability to prevent runway incursions effectively.
- Inadequate Safety Culture: A lack of emphasis on safety culture among aviation organizations, airlines, and airport operators may lead to a decrease in vigilance and safety-conscious behavior, increasing the potential for runway incursions.
- Lack of Reporting and Data Sharing: Incomplete or insufficient reporting and data sharing about near-miss incidents or potential runway incursions may prevent the identification of recurring issues and the implementation of effective safety measures.

5.2 **Actions:**

- Develop policy, procedures and training that support situational awareness for controllers, pilots, airside-vehicle drivers and other airport users.
- The development of regulations or policies on the use of mobile phones and other devices that could lead to distractions during airport operations.

- Continue with the Asia Pacific Alphanumeric Call-sign project to help mitigate the known safety issues associated with call-sign confusion/conflict, given the continued significant growth of air traffic in the region and potentially consider this to be included in the AP-RASP.
- Regularly review and update aerodrome layouts, markings, and signage to enhance visibility and reduce the likelihood of confusion for pilots and drivers.
- Collaborate between air operators, ANSPs, aerodrome service providers, and states to share safety data and best practices to collectively improve runway safety.

References

Annex 14–Aerodromes, Volume I–Aerodrome Design and Operations

Doc 8168, Procedures for Air Navigation Services–Aircraft Operations (PANS-OPS)

Doc 9981, Procedures for Air Navigation Services–Aerodromes (PANS-Aerodromes)

Doc 9432, Manual of Radiotelephony

Doc 9859, Safety Management Manual

Doc 9870, Manual on the Prevention of Runway Incursions

ICAO Global Runway Safety Action Plan

ICAO Runway Safety Team Handbook

ICAO Runway Safety IKit

EASA Safety Promotion

Global Action Plan for the Prevention of Runway Incursions (GAPPRI)–Flight Safety Foundation

Commercial Aviation Safety Team–Safety enhancements for RI

RSOOs

iSTARS

ICAO Safety Report

CAST/ICAO Common Taxonomy Team

IATA Safety Report

IATA Runway Safety

Flight Safety Foundation

Skybrary

EUROCONTROL

European Action Plan for the Prevention of Runway Incursion

CANSO Runway Safety Maturity Checklist

Runway Safety Handbook

Aerodrome Certification Guide

Airfield Maintenance Handbook

Managing Operations During Construction Handbook

Map of APEX reviews

Appendix G—FACT SHEET—GROUND COLLISION AND RAMP

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 Ground Collision and Ramp accidents (fatal and non-fatal) ranked fifth highest occurrence category in the APAC region and eighth highest for serious incidents.

1.2 During the period from 2017–2022, fifteen ground collisions and ground handling events were recorded in the Aviation Safety Network Database for the Asia Pacific Region. Apart from the years 2017 and 2018, which had five ground collisions and ground handling events each year, 2020 and 2021 each recorded two accidents/serious incidents per year.

1.3 No fatalities were reported as a result of the ground collision and ground handling events during the period studied. However, there were two ground incidents whereby a cabin attendant and one ground crew were injured but no damage to the aircraft was sustained. In addition to the fifteen GCOL and RAMP events, there were two instances of aircraft sustaining fire damage in the cargo hold while the aircraft were parked at the gate, in which both aircraft were destroyed.

1.4 Weather/visibility were causal factors in two of the accidents. Eight events involved moving aircraft that collided with parked aircraft, three accidents involved ground equipment and three accidents involved aircraft hitting aerodrome infrastructure.

1.5 Two of the fifteen accidents/serious incidents were turboprop aircraft, six were narrow-body jets and seven of the accidents were wide-body jets.

1.6 20 percent of all GCOL and RAMP accidents in the APAC region involved ground equipment handling. Another 20 percent of accidents involved aircraft hitting aerodrome infrastructure, such as light poles and fences.

1.7 In the analysis period (2017–2022), ground damage accidents have occurred more often in North America and Europe and less often in Asia, Africa and South America. North America accounts for 42 percent of all accidents, but accounts for 54 percent of all ground damage events, while Europe accounts for 17 percent of all accidents but 30 percent of all ground damage accidents.

1.8 The "IATA Ground Damage Report: The Case for Enhanced Ground Support Equipment," released in December 2022, estimates that the annual cost of ground damage could double to nearly $10 billion by 2035 unless preventive action is taken. The study found that most aircraft ground damage that occurs after the aircraft is stationary is caused by motorized ground support equipment striking the fuselage. The study also found that while the widebody aircraft ground damage rate is 10 times higher than the narrowbody rate, regional jets, turboprop aircraft and narrowbodies are 30 percent more prone to severe ground damage. Belt-loaders, cargo-loaders, passenger stairs and passenger boarding bridges cause 40 percent of total incidents, according to the IATA ground damage database.

2.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

2.1 GCOL and RAMP together have been identified as an accident occurrence category in the AP-RASP 2023–2025 and one of the top operational risks in the APAC region. However, it has not been identified as a regional High Risk Category (HRC).

3.0 National Aviation Safety Plans

3.1 To date, fifteen APAC States have published National Aviation Safety Plans (NASP). Of the fifteen NASPs, four States have identified GCOL and RAMP as a national operational risk. Collectively, the four States have highlighted the following precursor/contributing factors and actions that would be required to eliminate or mitigate this operational safety risk:

3.1.1 Precursors/Contributing Factors

- Non-adherence to aircraft loading procedures (passengers, baggage, cargo and fuel).
- Non-adherence to aircraft ground handling procedures (ground signaling, towing, de-icing, refueling).
- Inadequate protection of passengers and ground staff on ramp.
- Lack of training of ground equipment operations staff.
- Non-adherence to positioning, security and parking procedures for ground equipment on the ramp.
- Inadequate FOD detection system.
- Inaccurate calculation or reporting of mass and balance.
- Deviations from ATC clearances.
- Non-Adherence to aircraft ground handling procedures (incl. marshalling, towing, de-icing, refueling, etc.)
- Inadequate protection of passengers and ground staff on aircraft ramp.
- Poor condition of aircraft steps.
- Non-Adherence to positioning, securing and decongestion procedures for ground service equipment on the ramp.
- Improper management of ground operations related safety risks and reporting by Air Operators, Air Navigation Service Providers, and Aerodromes.
- Improper management and monitoring of ground operations related occurrences.

3.1.2 Actions

- To perform regulatory oversight on the risk management of ground operations organizations.
- To develop national regulations and guidance materials for safe ground operations.
- To ensure AOC holders, ANSPs and aerodrome operators include ground operations in their SMS, Runway safety Programme and the establishment of Runway Safety Teams.
- To develop guidance material for Apron Management Service at an aerodrome.
- To develop Guidance on the installation of Stop Bars.
- To ensure airlines and airport operators provide training to vehicle drivers to follow speed control and know the sensitive areas.
- To ensure airport operators introduce and ensure the effective utilization of ATC ground surveillance at all high-density airports.
- To improve signage in accordance with ICAO SARPs.
- To ensure airport operators introduce breath analyzer tests for all drivers & equipment operators on airport premises.
- To ensure operators review existing taxing and towing procedures and update them to include:
  - Adherence to SOPs on ramp.
  - Adherence to SOPs for towing/taxiing.
  - Utilization of wing walkers during pushback/taxi in/out.

- To ensure each air operator develop a training program to include:
  - Understanding the importance of signage, markings and lighting.
  - Familiarization with operating aerodrome layout and taxi procedures specific to the aerodrome.
  - Increased alertness levels amongst crew while taxiing.
  - Following correct taxiways and speed limits.
  - Clear and unambiguous RT between aircraft and ATC.
  - Meticulous adherence to ground markings and awareness of works in progress at an airfield.
  - Intermediate holding position marking and lights at all high-density airports.
- Airport operators:
  - To develop and introduce procedures to significantly reduce vehicular movements on the maneuvering area during LVP/bad weather.
  - Provide stop bars at airports with high intensity operations.

4.0 Additional Precursors/Contributing Factors and actions that were not identified by AP-RASP or NASPs pertaining to GCOL and RAMP Events

The following precursors/contributing factors and actions were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

4.1 Precursors/contributing factors that may contribute to GCOL events.

- Failure to ensure safe parking and docking of aircraft.
- Failure to proactively mitigate the risk of impact damage to parked aircraft.
- Failure to provide adequate signage, markings and lighting that enable aircraft flight crews to comply with taxi clearances.
- Failure to train — at a level of quality consistent with aviation professionals — the various types of unlicensed contractors and subcontractors who conduct and supervise aircraft ground-handling tasks on the maneuvering area and/or in the vicinity of an aircraft parking stand or gate.
- Distractions caused by mobile phones and other devices on the ramp and airside.
- Fatigue (due to long working hours).
- Short turnaround times.

4.2 Actions that can be taken to eliminate or mitigate GCOL and RAMP risks:

- Introduce Air traffic control (ATC) safety barriers for alerting ATC to a runway incursion or a ground safety event in sufficient time for ATC to act in order to prevent a ground collision, including:
  - Direct visual detection of conflict on the maneuvering area.
  - Indirect detection using remote camera displays.
  - Detection following a pilot/vehicle driver report.
  - Detection using basic surface-movement radar.
  - Detection using an advanced surface movement guidance and control system (A-SMGCS Level 1) or based on an alert from A-SMGCS Level 2; and,
  - Detection after an alert from an Integrated Tower Working Position (ITWP) or from aerodrome infrastructure that detects aircraft entry onto the runway (e.g., magnetic loops or lasers).

- Reduce distractions by regulating the use of mobile phones and other devices on the ramp and airside.
- Ensure NOTAMS are kept up to date and with clear text.
- Train ground personnel in Threat and Error Management (TEM) as well as competencies such as leadership, teamwork and decision-making and problem-solving.
- Adopt recommendations made by the ACI Apron Markings and Signs Handbook.
- Consider establishing or strengthening SMS interface with ground service providers.
- Implement advanced ground surveillance systems, such as A-SMGCS Level 2, to enhance situational awareness and prevent runway incursions.
- Conduct regular training and competency assessments for ground handling personnel to ensure adherence to standardized procedures and safety protocols.
- Enhance communication and coordination between air traffic control and ground handling teams to reduce the risk of miscommunication and potential accidents.
- Install stop bars and other visual aids to indicate critical areas on the apron and taxiways, reducing the risk of aircraft collisions with ground equipment.
- Encourage the use of technology to aid in aircraft parking and docking to ensure safe and precise positioning.
- Promote a culture of safety and reporting, encouraging personnel to report near-miss incidents or safety hazards to identify potential risks and prevent future accidents.

References:

ICAO Doc 10121 Manual on Ground Handling

IATA Ground Damage Report/Ground Damage Reduction Program

IATA Ground Operations Manual

**ACI Runway Safety Handbook–Second Edition 2022–
ACI World Store**

Aircraft Ground Handling and Human Factors

AC 150/5210–20A: Ground Vehicle Operations to include Taxiing or Towing an Aircraft on Airports

Appendix H–FACT SHEET–LOSS OF CONTROL–IN FLIGHT

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 LOC-I accidents are a high-risk category because of the likelihood of fatalities. In the APAC region, LOC-I was the second highest fatal accident occurrence category and ranked sixth highest when looking at all fatal/non-fatal accidents in the region.

1.2 Over the past 6 years in the APAC region, there were five accidents categorized as LOC-I, of which 4 were fatal, resulting in 350 fatalities among passengers and crew. Two of the LOC-I events occurred in the en-route phase of flight, three on approach and one in the landing phase. Two of the LOC-I events occurred on turboprop aircraft, with one resulting in two fatalities.

1.3 The accidents during this period generally resulted from:

- Pilot error: Incorrect pilot actions or reactions, failure to recognize and manage unusual or unexpected aircraft states, or inadequate response to abnormal flight conditions.
- Weather conditions: Rapidly deteriorating weather conditions was one of the contributing factors leading to loss of control in at least two accidents in the APAC region.
- Aerodynamic Stalls: Entering and mishandling an aerodynamic stall, in some cases excessive pitch and slow airspeeds.
- Mechanical failures: Aircraft system failures, control surface malfunctions and engine issues resulting from design flaws or inadequate maintenance and continuing airworthiness as well as defect control contributed to at least two of the LOC-I accidents in the region.
- Crew Resource Management (CRM), Human factors and communication issues: Poor coordination and communication among the flight crew, fatigue, stress, distraction, miscommunications between flight crew and air traffic control were all listed as contributing factors to some of the LOC-I events in the APAC region.
- Inadequate training: The need for additional training was identified in most of the LOC-I accidents. Pilot errors, as reflected above, could have been avoided in some cases with additional training on type, CRM, upset recovery training, stall awareness and prevention, additional simulator training, spatial disorientation training as well as advanced cockpit techniques training on using automated systems etc.

1.4 When comparing to the Global accident results, in 2022, there were nine LOC-I accidents, of which three were fatal accidents resulting in 20 fatalities among passengers and crew. The nine LOC-I accidents in 2022 are slightly below the 10.8 per year average seen during the 2017–2021 period.

2.0 ICAO Global Aviation Safety Plan (GASP)

2.1 The GASP has identified Loss of Control–In Flight (LOC-I) as one of the five High Risk Categories (HRCs) of occurrences based on global fatalities, fatality rates, and the number of accidents and reported serious incidents.

2.2 The GASP further reflects LOC-I accidents are caused by many contributing factors that can be categorized as being either airplane systems-induced, environmentally induced, pilot/human-induced or any combination of these three. Of the three, pilot-induced accidents represent the most frequently identified cause of LOC-I accidents. The number of fatalities resulting from LOC-I

events involving commercial air transport airplanes has led to an examination of current training practices, such as the introduction of upset prevention and recovery training requirements for flight crew members.

2.2 The Global aviation safety roadmap serves as an action plan to assist the APAC aviation community in developing the RASP and NASPs by outlining safety enhancement initiatives (SEIs) associated with the global HRCs. Each SEI includes a set of actions that stakeholders may use to develop and implement specific action plans. Regions and States, in collaboration with industry, should use the roadmap to support or complement as applicable the development of specific SEI as set out in the RASP and NASPs.

- A Safety Enhancement Initiative for LOC-I was identified for States to mitigate contributing factors to LOC-I accidents and incidents.

2.2.1 The following actions have been identified at the global level for States to consider mitigating the risk of LOC-I:

- Require and promote upset prevention and recovery training in all full flight simulator type conversion and recurrent training programmes.
- Require and promote more time devoted to training for the pilot monitoring role.

2.2.2 The following actions have been identified at the global level for industry to consider mitigating LOC-I accidents and serious incidents:

- Aircraft upset prevention recovery training in all full flight simulator type conversion and recurrent training programmes.
- More time devoted to training multi-crew pilots for the monitoring role.
- Promote bank angle alerting systems into all multi-engine aircraft.
- Training on manual aircraft handling of approach to stall and stall recovery (including at high altitude).
- Recurrent training on flight mechanics.
- Improving simulator fidelity.

3.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

3.1 The top Regional HRCs for the APAC region were identified from the RASG-APAC Annual Safety Report (ASR) 2022, which reflects safety data up to the end of 2021: These are similar to those identified in the GASP. The Asia Pacific Regional Aviation Safety Plan (2023–2025) has identified LOC-I as a contributor to fatality risk in the region. It is worth noting that the RASP attributes one fatal accident in Asia-Pacific in 2021 to LOC-I, while our analysis using ASN data found five accidents attributable to LOC-I within the period 2017–2022, four of which were fatal. Nevertheless, regional actions which have been identified to address this risk are:

- **Action Item (A.I.1)** Model Advisory Circular — Air Operators Standard Operating Procedures for Flight Deck Crewmembers.
- **Action Item (A.I.2)** Guidance material on flight crew proficiency.
- **Action Item (A.I.3)** Advisory Circular — Mode Awareness and Energy State Management Aspects of Flight Deck Automation.
- **Action Item (A.I.6)** Guidance material on Upset Prevention and Recovery Training (UPRT)–ICAO Doc 10011–ICAO Doc 9868–Airplane UPRT Aid.

4.0 National Aviation Safety Plans

Fifteen APAC States have published National Aviation Safety Plans. All fifteen States have identified LOC-I as national operational risks. Collectively, the fifteen States have highlighted the following precursors/contributing factors and actions that would need to be addressed:

4.1 Precursors/contributing factors.

4.1.1 *Airplane systems-induced*

- Malfunctioning and/or misunderstanding of automation.
- Aircraft system malfunction–Power plant, flight command.
- Smoke or fire events.
- Aircraft mechanical failure.

4.1.2 *Environmentally induced*

- Air traffic-related such as wake turbulence.
- Environment, including adverse weather conditions.
- Laser interference.
- Wildlife hazards.

4.1.3 *Pilot/human-induced*

- Pilot performance as a result of Human Factors.
- Inadequate flight crew training.
- Operating procedure design.
- ATS procedure design–SIDs & STARs.
- Malfunctioning and/or misunderstanding of automation.
- Lack of adherence to operator SOPs.
- Inadequate training requirements relating to engine malfunction and proper loading of aircraft.
- Distraction.
- Complacency.
- Inadequate standard operating procedures (SOPs) for effective flight management.
- Insufficient height above terrain for recovery.
- Lack of awareness of or competence in procedures for recovery from unusual aircraft attitudes.
- Inappropriate flight control inputs in response to a sudden awareness of an abnormal bank angle
- Insufficient oversight by the regulator especially in the field of periodic check of load sheet.

4.1.2 Actions:

- Develop regulations and guidance material on upset prevention and recovery training in all full flight simulator type conversion and recurrent training programmes and ensure implementation.
- Require more time devoted to training for the pilot monitoring role.
- Establish an industry-wide Ground Handling Task Force to reduce the risk of weight and balance and de-icing events that could lead to a LOC-I event.
- Publish Guidance Material on Flight Crew Proficiency related to Loss of Control prevention and upset recovery.
- Publish guidance on mode awareness and energy state management aspects of flight deck automation.

- Air operators to Implement Upset Prevention and Recovery Training (UPRT) in all full flight simulator type conversion and recurrent training programmes.
- Ensure that ATC surveillance system is improved for the provision of timely and accurate warnings about terrain proximity and other potential hazards. The provision of Minimum Safety Altitude Warning (MSAW) system.
- Ensure that the pilot training extensively incorporates human factors such as distraction, complacency, situational awareness etc..
- Air Operators should evaluate existing SOPs to ensure effective flight management during adverse weather and recovery of unusual aircraft attitudes.
- Air Operators establish SOPs to deal with windshear during take-off and landing.
- Implementation of wildlife hazard management at airports.
- Flight Data Analysis Program (FDAP) guidance to encourage operators to consider LOC-I precursors as part of FDAP.
- Regulators to Implement measures to reduce potential laser interference with aircraft, which can distract or temporarily blind pilots.

5.0 Additional Precursors/Contributing Factors and actions that have not been identified by AP-RASP or NASPs pertaining to Loss of Control–In Flight (LOC-I)

The following precursors/contributing factors and actions were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

5.1 Precursors/contributing factors that may contribute to LOC-I.

Aeroplane systems-induced

- Structural or powerplant damage.

Environmentally induced

- Low-level wind shear or higher-level clear air turbulence (CAT).

Pilot/human-induced

- Intended flight with total load or load distribution outside of safe limits
- Unintentional mismanagement of aircraft pressurization system: Incorrectly managing the aircraft's pressurization can lead to discomfort, reduced oxygen levels, and potential confusion among the flight crew.
- Poor cockpit resource management (CRM).
- Pilot fatigue and stress: Fatigue and high levels of stress can impair a pilot's cognitive and physical abilities, potentially leading to control-related errors.
- Insufficient regulatory oversight.
- Fuel exhaustion.
- The effects of special disorientation.

5.2 Additional actions that can be taken to eliminate or mitigate LOC-I:

- **Actions by Operators:**
  - Operators' SMS to include a positive safety culture: Establishing a safety culture within the organization that prioritizes open communication and proactive identification of safety risks.

- Strengthen Training Programmes: Enhance training programs for flight crews, particularly in upset prevention and recovery, stall awareness and prevention, manual aircraft handling, and simulator training.
- Review and update SOPs: Evaluate and update Standard Operating Procedures (SOPs) to address various aspects, including clarification and acceptance of air traffic control (ATC) clearances, handling of adverse weather conditions, and recovery from unusual aircraft attitudes.
- Implement Ground Handling Measures: Collaborate with ground handling organizations to establish procedures that reduce risks associated with weight and balance issues, as well as de-icing events that could potentially lead to a LOC-I event.

- **Actions by Approved Maintenance Organizations (AMOs)**
  - Implement Comprehensive Maintenance Programs: Develop and implement robust maintenance programs that focus on aircraft systems and powerplant health. Address issues related to potential system malfunctions, automation misunderstandings, and mechanical failures that could contribute to LOC-I events.

- **Regulatory and Industry measures**
  - ICAO to continue to develop and update standards and guidance material in accordance with GASP and RASP safety enhancement initiatives.
  - Regulators to implement annex 19 and in particular measures to identify and mitigate risks associated with LOC-I and promote a proactive safety culture.
  - Mandate upset recovery and stall recognition training. Require comprehensive training for pilots to recognize and recover from upset conditions and stalls.
  - Enhance regulatory oversight to ensure compliance with training requirements and safety practices.
  - Regulatory Oversight and Implementation: Implement regulations that mandate upset prevention and recovery training in all full flight simulator type conversion and recurrent training programs. Promote training for the pilot monitoring role to ensure effective crew coordination.
  - Enhance Surveillance Systems: Improve Air Traffic Control (ATC) surveillance systems to include features such as Minimum Safety Altitude Warning (MSAW) systems that provide timely alerts to flight crews about potential altitude hazards.
  - Address Human Factors and Crew Qualifications: Ensure that air operators conduct extensive training that incorporates human factors principles. Require that flight crew members, cabin crew members, and flight dispatch/flight operations officers have the required training and qualifications before performing flight duties.
  - Safety Culture Promotion: Encourage operators to foster a positive safety culture within their organizations. Promote the use of Safety Management Systems (SMS) that prioritize safety and encourage open reporting of potential issues.
  - Monitor Compliance and Evaluate SOPs: Conduct regular oversight to ensure air operators' compliance with training requirements, safety practices, and SOPs. As part of CBTA and EBT, evaluate and assess the effectiveness of established procedures, especially during adverse weather conditions and unusual flight attitudes.

References:

Annex 1–Personnel Licensing

ICAO Doc 10011 Manual on Aeroplane Upset Prevention and Recovery Training

ICAO PANS-TRG (Doc 9868)–Chapter 7, Upset Prevention and Recovery Training,

ICAO Safety Report

ICAO LOC-I

Commercial Aviation Safety Team–Safety enhancements for LOC-I

IATA LOC-I

IATA Safety Report

Skybrary

Environmental Factors Affecting Loss of Control In-Flight: Best Practice for Threat Recognition & Management

IATA-Unstable Approaches

Implementation of Upset Prevention and Recovery Training (UPRT)

FAA AC 120-111 Upset Prevention and Recovery Training

IATA Guidance and Best Practices for the Implementation of UPRT

Appendix I—FACT SHEET—CONTROLLED FLIGHT INTO TERRAIN

APAC REGION 2017–2022 HIGHLIGHTS

1.0 Analysis

1.1 Controlled Flight into Terrain (CFIT) accidents are a high-risk category because of the likelihood of fatalities. In the APAC region, CFIT was the highest fatal accident occurrence category and fourth highest fatal/non-fatal accident occurrence category.

1.2 The ASN database includes eight CFIT accidents in the APAC region over a six-year period 2017–2022, four of which occurred in the en-route phase of flight, three on approach and one in the landing phase. Six of the accidents were fatal, resulting in 33 fatalities among passengers and crew. The worst CFIT accident during this reporting period occurred on May 29, 2022, when a de Havilland Canada DHC-6 Twin Otter 300 operated by Tara Air struck a mountainside while on a domestic flight in Nepal. All 22 passengers and crew were killed.

1.3 All but one of the CFIT accidents were turbo prop aircraft. Most of the CFIT accidents that occurred during the 2017–2022 period involved adverse weather conditions, such as low visibility and ceilings, due to fog or thunderstorms. In addition, the majority of accidents involved operational shortcomings of some kind, continued flight on unstable approach, late or improper go-arounds, lost Situational Awareness (SA), failure to follow SOPs including visual flight rules flights in instrument meteorological conditions, descent below established minima and deviations from established routes. Operations in mountainous terrain were listed for more than half of the events as was loss of situational awareness.

1.4 Fifty percent of all CFIT accidents occurred during cargo operations.

1.5 When comparing to the Global accident results, in 2022 there were five CFIT accidents, of which three were fatal accidents resulting in a total of 26 fatalities among passengers and crew. The five CFIT accidents in 2022 are slightly below the 6.40 per year average seen during 2017–2022. The APAC region averages 1.75 CFIT accidents per year for the same time period, making it the second highest region with CFIT accidents.

2.0 ICAO Global Aviation Safety Plan (GASP)

2.1 The GASP has identified Controlled Flight Into Terrain (CFIT) as one of the five High Risk Categories (HRCs) of occurrences based on global fatalities, fatality rates and the number of accidents and reported serious incidents.

2.2 The GASP further reflects CFIT accidents involve many contributing factors, including: procedure design and documentation, pilot disorientation, and adverse weather. Requirements for aircraft to be equipped with ground proximity warning systems have significantly reduced the number of CFIT accidents. Despite the absence of CFIT accidents involving transport category aircraft over the past few years, CFIT accidents often have catastrophic results when they occur, with very few, if any, survivors. Therefore, there is a high fatality risk associated with these events.

2.3 The Global aviation safety roadmap serves as an action plan to assist the APAC aviation community in developing the RASP and NASPs by outlining safety enhancement initiatives (SEIs) associated with the global HRCs. Each SEI includes a set of actions that stakeholders may use to develop and implement specific action plans. Regions and States, in collaboration with industry, should use the roadmap to support or complement, as applicable, the development of specific SEI as set out in the RASP and NASPs.

- A Safety Enhancement Initiative for controlled flight into terrain (CFIT) was identified for States to mitigate contributing factors to the risk of CFIT.

2.3.1 The following actions have been identified at the global level for States to consider for mitigating the risk of CFIT:

- Ensure aircraft are equipped with terrain awareness and warning system (TAWS) in accordance with Annex 6.
- Promote the wider use of TAWS beyond the requirements of Annex 6.
- Issue a Safety Advisory to increase adherence to TAWS warning procedures.
- Promote greater awareness of approach risks.
- Consider the implementation of continuous descent final approaches (CDFA).
- Consider the implementation of minimum safe altitude warning (MSAW) systems.
- Ensure the timeliness of updates and accuracy of Electronic Terrain and Obstacle
- Data (eTOD).
- Promote the use of GPS-derived position data to feed TAWS.

2.3.2 The following actions have been identified at the global level for industry to consider mitigating CFIT accidents and serious incidents:

- Equip aircraft with TAWS.
- Increase adherence to TAWS warning procedures.
- Develop greater awareness of approach risks.
- Promote CDFA.
- Utilize MSAW systems.
- Utilize up-to-date eTOD.
- Utilize GPS-derived position data to feed TAWS.

3.0 Asia Pacific Regional Aviation Safety Plan (AP-RASP)

3.1 The top Regional HRCs for the APAC region were identified from the RASG-APAC Annual Safety Report (ASR) 2022, which reflects safety data up to the end of 2021: These are similar to those identified in the GASP. The Asia Pacific Regional Aviation Safety Plan (2023–2025) has identified CFIT as a contributor to fatality risk in the region. Regional actions that have been identified to address this risk are:

- **Action Item (A.I.1)** Model Advisory Circular — Air Operators Standard Operating Procedures for Flight Deck Crewmembers.
- **Action Item (A.I.9)** Model Regulation on Ground Proximity Warning System (GPWS).
- **Action Item (A.I.10)** Advisory Circular — Guidance for Operators to Ensure Effectiveness of GPWS Equipment.
- **Action Item (A.I.11)** Advisory Circular — Guidance for Operators on Training Programme on the use of GPWS.
- **Action Item (A.I.12)** Model Advisory Circular — Instrument Approach Procedures Using Continuous Descent Final Approach Techniques.
- **Action Item (A.I.13)** Guidance on the Establishment of a Flight Data Analysis Programme (FDAP).
- **Action Item (A.I.14)** Advisory Circular — Crew Resource Management Training Programme (CRM).
- **Action Item (A.I.15)** Advisory Circular — Controlled Flight into Terrain (CFIT) and Approach and Landing Accident Reduction (ALAR) Training Programme.

- **Action Item (A.I.16)** Guidance for Air Operators in Establishing a Flight Safety Documents System.
- **Action Item (A.I.17)** Model Advisory Circular — Issuance of Terrain or Obstacle Alert Warning.
- **Action Item (A.I.1)** Model Advisory Circular — Air Operators Standard Operating Procedures for Flight Deck Crewmembers.

4.0 National Aviation Safety Plans

Fifteen APAC States have published National Aviation Safety Plans. Of the fifteen States, fourteen States have identified CFIT as national operational risks. Collectively, the fourteen States have highlighted the following precursors/contributing factors and actions that would need to be addressed.

4.1 Precursors/contributing factors:

- ATS procedure design and documentation.
- Pilot fatigue and disorientation.
- Instrument Landing System (ILS) malfunction or requiring calibration.
- Precision Approach Path Indicator (PAPI) alignment with glideslope
- Crew resource management (CRM).
- Adverse weather.
- Obstacles not appropriately documented or marked on charts.
- Loss of situational awareness.
- Mountainous terrain.
- Aircraft not equipped with TAWS/EGPWS.
- Aircraft system malfunction (Navigation equipment and EGPWS).
- Critical terrain and rapidly deteriorating weather condition.
- Nonadherence to Standard Operating Procedures (SOPs).
- Improper pilot response to stall warning.
- Inadequate pre-flight planning and lack of consideration of individual load while
- preparing load and trim sheet.
- Absence of TAWS warning.
- Deviation from VFR route.
- Intentional low operations leading to CFIT occurrence.

4.1.2 Actions:

Establish a task force with industry to identify actions to reduce the likelihood of CFIT events and to identify CFIT risk hotspots.

Publish guidance for operators to ensure effectiveness of Ground Proximity Warning System (GPWS).

Publish guidance for operators on training programme on the use of GPWS.

- Publish guidance on Controlled Flight into Terrain (CFIT) and Approach and Landing Accident Reduction (ALAR) training programme.
- Publish instrument approach procedures using continuous descent final approach (CDFA) techniques.
- Ensure aircraft are equipped with terrain awareness and warning system (TAWS) in accordance with Annex 6.

- Promote the wider use of TAWS beyond the requirements of Annex 6.
- Issue a Safety Advisory to increase adherence to TAWS warning procedures.
- Promote the use of GPS-derived position data to feed TAWS.
- Model Regulation on Ground Proximity Warning System (GPWS).
- Promote greater awareness of approach risks.
- Implement minimum safe altitude warning (MSAW) systems.
- Ensure the timeliness of updates and accuracy of Electronic Terrain and Obstacle Data (eTOD).
- Provide guidance on the Establishment of a Flight Data Analysis Programme (FDAP).
- Issue advisory circulars on Crew Resource Management Training Programme (CRM), Controlled Flight into Terrain (CFIT) and Approach and Landing Accident Reduction (ALAR) Training Programme.
- Issue guidance for air operators in establishing a Flight Safety Documents System.
- Emphasize, monitor, and enforce that pilots carry out instrument approaches, follow all stabilized approach criteria and SOPs for approach and landing.
- Regulators should perform analysis of CFIT occurrence rates and trends and identify sector-based safety issues.
- Air operators should manage CFIT related safety risks and report pre-cursor events that could result in a CFIT occurrence.
- ANSPs should develop approach procedures to minimize the risk of CFIT.

5.0 Additional Precursors/Contributing Factors and actions that were not identified by AP-RASP or NASPs pertaining to CFIT Events

The following precursors/contributing factors and action were identified in collaboration with AP-CAS partners (AAPA, ACI, CANSO and IATA) or were identified during workshops that have been conducted.

5.1 Precursors/contributing factors that may contribute to CFIT.

- Non-precision approaches: The need for enhanced training and awareness regarding altitude management during these approaches.
- Inappropriate action by the flight crew was cited as a contributing factor. This refers to the flight crew continuing descent below the minimum descent altitude (MDA) or decision height without adequate visual reference.
- Lack of positional awareness: Improved situational awareness tools and training are needed to mitigate this risk.
- Deficiencies in CRM (cross-check, communication, coordination, leadership etc.)
- Adverse Weather Conditions: Poor visibility, wind, windshear, gusts, and thunderstorms can significantly affect aircraft performance during critical phases of flight. Enhancing pilot training to manage adverse weather conditions is vital.
- Ground Navigation Aid Malfunctions: Robust maintenance procedures and immediate action in case of malfunctions are essential.
- Aircraft handling errors: Continuous flight crew training and competency assessments are necessary to prevent such errors.
- Dispatch and Flight Planning: Dispatch should take into account additional risk mitigation with adverse weather predictions and noted malfunctions in navigational aids. Inflight contingencies that arise from risks of greater chances of missed approaches versus fuel remaining should be minimized with empowerment of dispatch to override company policies on minimum fuel uplift.

- Latent conditions such as:
  - Deficient regulatory oversight.
  - Absent or deficient air operator safety management systems (SMS).
  - Omitted training, language skill deficiencies, operational needs leading to training reductions, deficiencies in assessment qualifications and experience of flight training or training resources.
  - Lack of a positive safety culture.

5.2 Additional actions that can be taken to eliminate or mitigate CFIT:

- Enhanced Ground Proximity Warning System (EGPWS)/Terrain Awareness Warning Class B Systems: Equipping aircraft with real-time terrain information can significantly improve pilot awareness and provide timely warnings in CFIT risk scenarios. There is also a need to ensure the equipment is operational.
- Inflight decision-making: Crew members should develop effective strategies to manage threats to safety during flight and execute well-informed contingency plans to avoid CFIT. LOFTS should be designed with identified critical approaches in adverse weather and instances of failure of navigational aids.
- Flight Path Monitoring: Active monitoring and cross-checking of flight path, aircraft performance, systems, and other crew members should be practiced to maintain accurate situational awareness.
- Positive Safety Culture: Operators should establish a positive safety culture within their Safety Management Systems (SMS) to encourage reporting and proactive risk mitigation. Operators should be required to provide evidence of safety data sharing with other operators, highlighting key risk factors that are identified through hazard and incident reporting.
- FOQA Data Monitoring: Flight crew responses to EGPWS events should be monitored and corrective training provided where necessary. Such events should be shared with all operational personnel, including dispatch.
- EGPWS/TAWS Software Updates: Operators and manufacturers should ensure timely updates of software and terrain databases to reflect accurate terrain information.
- Technical Operations: Maintenance departments should maintain up-to-date EGPWS software and terrain databases, utilize GPS/GNSS for position source to EGPWS, and adhere to recommended maintenance practices.
- WGS-84 implementation should be made mandatory to enable the ability to rely on ground-based non-precision approaches to be migrated to PBN approaches.
- **Actions by Operators:**
  - Operators' SMS to include a positive safety culture.
  - Encourage operators to use FOQA data to monitor proper responses by flight crew to EGPWS events.
  - Increase awareness and visibility on the implications of deviating from established procedures.
  - Training Departments should perform gap analysis against the latest EGPWS training guidance available from IATA, EASA, FAA, ICAO, OEMs, and others.
  - Enhancing flight crew training by implementing Competency-based Training and Assessment (CBTA) which would include an Evidence Based Training program.
  - Consult with the performance assessment of EGPWS Guidance Material (GM) and its recommendations.
- **Flight Operations department:**

- Use of Terrain display in order to enhance full situational awareness and ensure timely and appropriate pilot response.
- Encourage pilots and operators to report instantly to the relevant ATC Units and authorities all incidents related to GPS interference.
- Encourage Flight crew to immediately respond to EGPWS warning.
- Consult with and promote the performance assessment of EGPWS GM and its recommendations.
- Technical operations (AMOs/Engineering and Maintenance)
- EGPWS/TAWS Maintenance: Ensure the proper maintenance and updating of EGPWS software and terrain databases to provide accurate and up-to-date information to flight crews. Consult with the performance assessment of EGPWS GM and its recommendations.

- **Manufacturers:**
  - Ensure the timely update of the EGPWS Software & Terrain Database.
  - Consult with and promote within your organization the performance assessment of EGPWS GM and its recommendations.
  - Consider revising the MMEL tolerances to operate for a long period of time or an excessive number of sectors with a GPWS/EGPWS inoperative.
- **ANSPs:**
  - Collaboration with Operators: Collaborate with air operators to share information about terrain-related incidents, identify risk hotspots, and jointly develop strategies to mitigate CFIT risks.
- **States:**
  - Regulatory Oversight: Strengthen regulatory oversight by regularly assessing air operator safety management systems, ensuring adherence to SOPs, and evaluating the effectiveness of training programs related to CFIT prevention. WGS-84 compliance should not be optional.

References:

Consult with and promote the **performance assessment of EGPWS Guidance Material (GM) and its recommendations**

A study on **"Terrain Awareness Warning System Capability and Human Factors in CFIT Accidents"** (pdf)

IATA has developed a **CFIT Detailed Implementation Plan** (DIP) Introduction