FLIGHT SAFETY FOUNDATION

ADVANCING AVIATION SAFETY STANDARDS IN ASIA-PACIFIC:

A COMPREHENSIVE ASSESSMENT AND STRATEGIC RECOMMENDATIONS

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ASIA PACIFIC CENTRE FOR AVIATION SAFETY

1. Introduction

Flight Safety Foundation's Asia Pacific Centre for Aviation Safety (AP-CAS) recently concluded a comprehensive regional safety assessment aimed at enhancing aviation safety across the Asia Pacific. This comprehensive review brought to light several pivotal findings, underscoring the importance of collaborative efforts to mitigate identified risks. The aviation sector in Asia Pacific stands on the brink of significant growth, so understanding and addressing these safety concerns is paramount. The assessment, which included in-depth analysis of the Foundation's Aviation Safety Network (ASN) data, augmented by other data sources collected within the region, highlights several risk areas.

A critical area of focus identified by the assessment was **runway safety**, with abnormal runway contact, runway excursions, and runway incursions emerging as significant challenges. These issues underscore the need for a multifaceted approach to safety, combining enhanced pilot training, infrastructural improvements at airports, and the integration of advanced technological aids to prevent such incidents effectively. By prioritising these areas, the aviation community can take significant strides towards minimising risks associated with runway operations.

The assessment also highlighted concerns regarding **system and component failures**, pointing to the essential role of rigorous maintenance practices. The combination of system/component non-powerplant and powerplant failures were the contributing factors that resulted in the highest occurrence category in the region. While these occurrences did not result in fatalities, given the high number of occurrences, a proactive approach is needed. In response, the AP-CAS underscores the importance of close collaboration among States, airlines, maintenance organisations, and manufacturers. This partnership is crucial to ensure that aircraft systems and components are maintained to the highest standards, thereby reducing the risk of failures that could compromise safety.

Turbulence-related accidents and serious incidents were another area that the analysis spotlighted. Turbulence (TURB) was the highest nonfatal accident occurrence category in the Asia Pacific (APAC) region. During the period from 2017 to 2022, there were 34 turbulence-related accidents in the APAC region or an average of 5.8 per year, making it the second highest region in the world for TURB events. 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.

Loss of control–in flight (LOC-I) occurrences are rare but typically fatal. Over the past six years in the APAC region, 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. When comparing the global accident results, the APAC region averages 1.25 LOC-I accidents per

year (on a five-year rolling average), making it the second highest region with LOC-I events. This review highlighted 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.

Controlled flight into terrain (CFIT) stands out as the highest fatal accident occurrence category by absolute number of accidents in the region and the fourth highest in terms of both fatal and nonfatal accidents. Despite technological advancements contributing to a decline in overall CFIT accidents, as is the case with LOC-I, when CFIT events occur, they often are fatal, emphasising the persistently high risk associated with this category. Adverse weather conditions were a common factor in most incidents, along with operational shortcomings like unstable approaches, improper go-arounds, lost situational awareness, and deviations from established procedures. This review highlighted the need for comprehensive training, effective use of existing technologies, and integration of advanced technologies on flight decks and in air traffic control facilities. A coordinated effort between airlines and air navigation service providers (ANSPs) will be crucial to implementing effective risk mitigation strategies.

The analysis did not overlook the significance of **ground operations safety**, emphasising the need for improved communication, training, and adherence to strict safety protocols by ground handling teams. Addressing potential risks in ground operations, including collision prevention, is crucial for a holistic approach to aviation safety, ensuring that safety measures encompass all aspects of aircraft operations, both in the air and on the ground.

Central to the findings of this assessment is advocacy for a robust safety culture that thrives on collaboration and shared responsibility. Encouraging the adoption of regional and national safety plans can significantly enhance safety measures. By fostering an environment where airlines, airports, regulatory bodies, and other stakeholders work together, sharing data and best practices, the aviation sector can achieve substantial improvements in safety standards.

The Centre's recommendations, which focus on training, technology, regulatory updates, and collaborative efforts, present a clear path forward. As stakeholders across the aviation spectrum unite to implement these strategies, the vision of a safer aviation environment in Asia Pacific moves closer to reality. The journey towards enhanced aviation safety is ongoing, and through collective action and commitment, significant progress is within reach.

The assessment reveals insights into the various domains impacting aviation safety. With a focus on enriching the contextual understanding of the challenges and strategies pivotal for enhancing safety measures, the detailed data shed light on specific safety areas, as outlined below.

2. Runway Safety: Core Findings

In the Asia Pacific, runway excursions, runway incursions, and abnormal runway contact are grouped into a single regional high-risk category.

Runway excursions (RE) accounted for the third-highest fatal accident occurrence category

in the region, the second-highest category when considering all accidents (fatal/nonfatal), and the highest serious incident category. Since 2017, 78 percent of the 14 excursion accidents in the APAC region recorded in the ASN database occurred during landing. 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.

Source: Shutterstock

Runway incursions (RI) emerged in the Asia Pacific 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 from 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 five occurred when aircraft were on final approach or had just landed. Three of the serious incidents involved turboprop airplanes, and all but one occurred on scheduled passenger flights.

Source: Shutterstock

Human factors figured prominently in both runway excursions and incursions. Most participants (71 percent) identified human factors as the most common contributing factor leading to runway excursions. Some 78 percent also acknowledged the significant role of human factors (such as fatigue, stress, or complacency) in runway incursion events.

Abnormal runway contact (ARC) is the third highest accident occurrence category (nonfatal) in the APAC region and ranked fifth 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 remaining events involved turboprop airplanes. There were no fatalities attributed to the ARC events. However, there were nine recorded injuries, all stemming from hard landings.

Strategic Recommendations

- Improve Training: There is a pressing need to reinforce existing training programmes to address runway excursion and incursion prevention for pilots, air traffic controllers and airport personnel. Polls conducted with airlines, ANSPs, and airports highlighted training and decision-making skills as one of the most critical elements in preventing runway excursions.

- Enhance Runway Condition Assessment and Reporting Procedures: There is a need to improve runway condition assessments and reporting. During the assessment, airlines 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. Airport participants were asked about the frequency of runway condition assessments and their confidence in their accuracy. The majority (63 percent) were only somewhat confident in the accuracy of the assessments.

- Enhance Communication and Coordination for Runway Safety: There is an urgent need to improve communication and coordination between regulators, airlines, ANSPs, and airports to reduce the risk of runway excursions and incursions. Local runway safety teams should be established and supported by all stakeholders.

- Prioritize the Alphanumeric Call Sign Project to Mitigate Call Sign Confusion: Call sign confusion was identified as a causal factor in several runway incursion events. With the significant growth expected in air traffic in the region, the alphanumeric call sign project in the Asia Pacific should continue and increase in importance.

- Invest in Technology to Improve Situational Awareness: Effective use of existing technologies such as advanced radar systems and runway status lights can make a significant contribution to reducing the occurrence of runway incursions. There is a need for further investment in new technologies to mitigate the risk of runway incursions, including systems intended to improve situational and runway occupancy awareness.

- Implement Global Action Plans for the Prevention of Runway Incursions and Excursions (GAPPRE and GAPPRI): APAC States, as well as industry, should review the outcomes as well as recommendations stemming from GAPPRE and GAPPRI. AP-CAS should work with its aviation partners in the region and arrange a series of workshops to highlight the recommendations and best practices stemming from the projects that may help empower aviation stakeholders in the APAC region to proactively mitigate the threat of runway excursions and incursions, as well as to foster a safer, more resilient, aviation ecosystem.

- Conduct Additional Study on Abnormal Runway Contact: As mentioned above, runway excursions and incursions, as well as abnormal runway contact occurrences, are considered by the region as a single risk category. Additional and focused study is required to obtain a better understanding of ARC that involves multiple parties,

including multiple States and industry stakeholders. Regional stakeholders should consider if RI, RE and ARC should be addressed as separate regional high-risk categories (HRCs) rather than grouping them under runway safety. This would improve the ability of all stakeholders to specifically address the issues associated with each type occurrence and facilitate the development of appropriate safety enhancement initiatives within the region.

3. Weather-Induced Turbulence: Core Findings

Turbulence, particularly when induced by weather phenomena, has emerged as a critical safety concern within the Asia Pacific airspace. The assessment underscores a discernible uptrend in turbulence-related incidents, marking it as the highest non-fatal accident occurrence category within the region. This uptick in turbulence incidents, notably in the years leading up to 2022, accentuates the urgent need for targeted strategies to mitigate this growing risk.

- **Turbulence Trends:** The Asia Pacific region witnessed an average of 5.8 turbulence-related accidents per year over the 2017–2022 period, positioning it as the second highest region for such events globally. The year 2019 was particularly significant, with turbulence accounting for nearly 50 percent of all accidents recorded in the region.

Source: Shutterstock

- **Crew and Passenger Safety:** Analysis reveals that cabin crewmembers, often during cabin checks following seatbelt warnings or during descent and approach phases, face more severe injuries from turbulence-related incidents. This fact emphasises the critical need for both preventive measures and effective management strategies during flights.

Strategic Recommendations

In response to these findings, the AP-CAS delineates several targeted recommendations aimed at curtailing the risks associated with weather-induced turbulence:

- Invest in Advanced Meteorological Tools for Better Forecasting: There is a pressing need for the aviation community to invest in advanced meteorological tools and systems. These investments will enable more accurate and timely weather forecasting, allowing flight crews to navigate away from or prepare for turbulence-prone areas effectively.

- Enhance Flight Crew Training for Turbulence Management and Communication: Flight crews should receive robust training focused on turbulence management. Such training should equip them with the necessary skills and strategies to handle unexpected turbulence, ensuring the safety and comfort of passengers and reducing the risk of injuries. Additional training is also needed to improve the communication and coordination between flight and cabin crew, as well as air traffic controllers.

- Refine Weather Reporting Systems for Turbulence Forecasts: Collaborating with meteorological agencies to refine the accuracy and reliability of weather reports, especially concerning turbulence forecasts.
- Encourage Real-Time Turbulence Data Sharing: Encouraging the exchange of real-time turbulence data among airlines and pilots to aid in-flight planning and in-flight adjustments to avoid known turbulence areas.

4. Airplane System Component Reliability: Core Findings

System component failure non-powerplant (SCF-NP) has been identified as a significant area of concern, given its implications for flight safety and operational integrity.

The AP-CAS data on SCF-NP incidents brought to light the prevalence and consequences of system component failures within the Asia Pacific aviation sector. These failures, while not always leading to accidents, possess the potential to significantly compromise safety.

- I**ncident Statistics:** The SCF-NP category was ranked as the second highest in terms of accident/serious incident occurrence (non-fatal) in the region. This highlights the pervasive nature of system component failures and underscores the necessity for stringent maintenance and monitoring protocols. When compared to the global accident and serious incident results, the APAC region averages 10.8 SCF-NP accidents/serious incidents per year (five-year rolling average) making it the highest region with SCF-NP events.
- **Leading Causes and Components Affected:** The assessment pointed out that cabin pressure system failures were the leading type of SCF-NP incidents, accounting for 51 percent of all reported cases. This was followed by hydraulic and landing gear system failures (28 percent) and electrical system failures (8 percent), indicating critical areas where maintenance and reliability need to be enhanced.
- **Maintenance and Oversight Concerns:** Approximately 10 percent of SCF-NP occurrences were directly attributed to inadequate maintenance practices or failure to adhere to the manufacturer's recommended maintenance schedules. This finding suggests a significant gap in maintenance execution and oversight, emphasising the need for improved practices and adherence to safety standards.
- **Compliance and Implementation Issues:** A concerning revelation was that 49 percent of APAC States demonstrated low effective implementation (EI) of the critical elements of a State safety oversight system in airworthiness aspects, particularly in the realms of technical personnel qualifications, certification, approvals, surveillance obligations, and resolution of safety concerns. This correlation points to a broader issue of compliance and implementation within the regulatory framework governing aircraft maintenance and safety.

Strategic Recommendations

Given the data and insights gathered, the AP-CAS has put forward several strategic recommendations aimed at bolstering system component reliability across the Asia Pacific aviation industry:

- Adhere to Enhanced Maintenance Schedules and Protocols: There's a pressing need for airlines and maintenance, repair and overhaul (MRO) organizations to rigorously adhere to recommended maintenance schedules and protocols. This includes timely inspections, component replacements, and adherence to manufacturer guidelines to preempt failures.
- Provide Ongoing Technical Training for Maintenance Personnel: Ensuring that maintenance personnel and government safety inspectors receive ongoing technical training is vital. This training should cover the latest technological advancements, best practices in maintenance, and specific training on the systems most prone to failure.
- Enhance Regulatory Oversight for Airworthiness and Maintenance Compliance: Regulatory bodies should enhance their oversight capabilities, ensuring that all operators and MROs meet the highest standards of airworthiness and maintenance. This may involve more frequent audits, the implementation of stricter regulations, and the provision of guidance and resources to operators to help them comply.
- Invest in Diagnostic Technologies: Airlines and maintenance organizations are encouraged to invest in advanced diagnostic technologies that can predict failures before they occur. These predictive maintenance technologies can significantly reduce the incidence of SCF-NP by allowing for timely interventions.

5. LOC-I and CFIT: Core Findings

The assessment focused considerable time and attention on LOC-I and CFIT occurrences, given the high number of associated fatalities. The assessment underscored the pressing need for targeted interventions to mitigate these high-risk occurrences.

LOC-I involves an aircraft departing from controlled flight, a scenario that can stem from a myriad of factors, including system failures, adverse weather conditions, or human error. Despite its relatively lower frequency compared to other accident categories, the outcome of LOC-I incidents is disproportionately severe, often culminating in the catastrophic loss of life.

CFIT occurs when an airworthy aircraft, under the pilot's control, is unintentionally flown into the ground, water, or an obstacle. These incidents are particularly insidious as they often occur without any awareness from the crew that a critical situation is unfolding until it is too late. CFIT accidents highlight critical gaps in situational awareness, navigation, and the effective use of terrain avoidance technologies.

- **LOC-I Accident Insights:** In the APAC region, LOC-I was the second highest fatal accident occurrence category and the sixth highest occurrence category when looking

at all fatal/non-fatal 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 resulting in two fatalities.

- When comparing the global accident results, the APAC region averages 1.25 LOC-I accidents per year (on a five-year rolling average), making it the second highest region with LOC-I events.
- **CFIT Accident Insights:** CFIT stands out as the highest fatal accident occurrence category (absolute number of occurrences over six years) and the fourth highest in terms of both fatal and non-fatal accidents. Over the six-year period from 2017 to 2022, the ASN database recorded eight CFIT accidents, with four occurring en route, three on approach, and one during the landing phase of flight. Despite technological advancements that contributed to a decline in overall CFIT accidents, when these accidents 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 events, 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, making it the second highest region in this category globally. Some 95 percent of APAC States that have low effective implementation of the critical elements of safety oversight audit systems also had air navigation deficiencies that can contribute to CFIT, including deficiencies related to implementation of the World Geodetic System 1984 (WGS-84).

Strategic Recommendations

- **Enhance Pilot Training:** Advanced training programs focusing on managing adverse conditions and emergency situations, particularly for LOC-I and turbulence encounters, including the adoption of upset prevention and recovery training (UPRT) to mitigate LOC-I risks, should be adopted. The assessment also concluded there is a need to reinforce pilot confidence and proficiency through continuous pilot education and training, as well as regular exposure to manual flight operations.
- **Adopt Advanced Technologies:** Utilizing state-of-the-art meteorological tools for accurate weather forecasting and equipping aircraft with modern navigation aids to prevent CFIT incidents is recommended. The study advocates for the widespread adoption of enhanced ground-proximity warning systems (EGPWS) and rigorous flight planning and terrain awareness training for pilots as crucial steps towards reducing CFIT incidents.

6. Ground Collision (GCOL) and Ramp Safety: Core Findings

The assessment revealed that GCOL and ramp accidents, while less frequent compared to other categories like runway excursions or weather-induced turbulence, still present significant safety concerns that demand attention. These incidents not only pose risks to personnel and equipment on the ground but can also lead to serious accidents affecting passengers and crew.

- **Accident and Incident Data:** For the period from 2017 to 2022, the AP-CAS noted 15 notable ground collisions and ground handling events in the APAC region. These incidents have been attributed to a variety of factors, including vehicle-to-aircraft collisions, equipment misuse, and miscommunication among ground staff.
- **Weather/Visibility Factors:** The assessment indicates that weather and visibility played a causal role in approximately 20 percent of the GCOL and ramp accidents. This underscores the importance of ensuring effective communication and operational protocols during adverse weather conditions.
- **Ground Equipment Handling:** 20 percent of all recorded GCOL and ramp accidents involved ground equipment handling mishaps, highlighting the need for enhanced training, better supervision, and the implementation of more rigorous safety protocols for ground-handling operations.
- **Miscommunications and Safety Protocols:** A poll conducted during the assessment provided insights into key aspects in the management of ground collision 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 to 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.
- **Aerodrome Infrastructure Interactions:** Another 20 percent of accidents involved aircraft interacting with aerodrome infrastructure, such as light poles and fences, pointing towards the need for improved aerodrome design, better signage, and enhanced situational awareness among pilots and ground personnel.

Source: Shutterstock

- **Compliance and Certification Issues:** A significant finding from the assessment is that 58 percent of GCOL and ramp accidents occurred at airports that either had not been certified or had occurred in states with compliance issues related to aerodrome operations, design, maintenance, or operational area management. This fact highlights the critical need for airports to adhere to international safety standards and for regulatory bodies to enforce compliance rigorously.

Strategic Recommendations

In response to these findings, the AP-CAS has proposed several recommendations aimed at mitigating the risks associated with GCOL and ramp operations:

- **Include GCOL as a Key Risk Category in National Aviation Safety Plans:** The limited inclusion of GCOL in National Aviation Safety Plans signals a need for a broader recognition of GCOL as a significant risk category. National plans should include actions to strengthen regulatory oversight, develop national guidelines, and enhance integration of ground operations into safety management systems (SMS). The plans should also seek to cultivate a safety-oriented culture, regulating distractions, and improving communication interfaces with ground service providers as essential steps towards a more robust and comprehensive approach to mitigating GCOL risks across airports.
- **Strengthen Training Programs:** There's a clear need for comprehensive training programs for all personnel involved in ground operations. This includes specialised training for handling equipment safety and effectively communicating during all phases of ground operations.
- **Improve Aerodrome Design and Signage:** Enhancing the physical layout of aerodromes and improving signage can significantly reduce the risk of collisions and accidents on the ground. This also involves ensuring that ground lighting and markings are visible and clear, even in poor weather conditions.
- **Implement Advanced SMS:** Airports and airlines are encouraged to develop and implement advanced SMS that specifically address GCOL and ramp safety. These systems should include risk assessment tools, reporting mechanisms, and continuous improvement processes to address safety concerns proactively.
- **Adopting Technological Solutions:** The use of technology, such as advanced surveillance systems, real-time communication tools, and automated safety systems, can greatly enhance situational awareness and reduce the potential for human error in ground operations.

7. Conclusion

It is evident that while significant strides have been made in enhancing aviation safety in the APAC region, challenges remain that require our collective attention and action. The Asia Pacific Centre for Aviation Safety is committed not only to 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.