FLIGHT SAFETY FOUNDATION
ASIA PACIFIC CENTRE FOR AVIATION SAFETY

Regional Aviation Safety Assessment

Fact Sheets: Highlights

Draft version

November 2023

FORWARD

Draft "Fact Sheets" have been developed that correlate and summarize the initial results of the APAC Regional Safety Assessment relative to high-risk categories of accidents and serious incidents in the APAC region. They are presented in order of total number of accidents and serious incidents reported in the APAC region in the period 2017-2022.

Runway Excursions (RE)
System Component Failure- non power plant (SCF-NP)
Abnormal Runway Contact (ARC)
Turbulence (TURB)
Runway Incursions (RI)
Ground Collision and Ramp (GCOL & RAMP)
Loss of Control inflight (LOC-I)
Controlled Flight into Terrain (CFIT)

The Fact Sheets presented in this document are highlight versions only. They provide a summary of action plans to address previously identified high risk areas, as well as the new or emerging risks.

RUNWAY EXCURSIONS

FACT SHEET 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 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 APAC Regional Aviation Safety Plan (RASP)

2.1 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 APAC Regional Aviation Safety Plan (2023-2025) has factored runway excursions and runway Incursion 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 Unstabilized 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.

2.2 The 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).

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

3.0 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.

3.1 Pre-cursors /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
- Lack of training (before landing on contaminated runway, and CRM)
- Lack of procedures to operate on contaminated runway
- Ineffective SOPs
- Meteorological information regarding CB 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.

3.1.2 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 to be included 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

4.0 **Additional Precursors /Contributory Factors and actions that were not identified by 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 to date.

4.1 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) are not calibrated regularly.

4.2 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.

5.0 **Additional outcomes from the workshop with airline participants**

Ninety percent of the participants had expressed that the greatest impact on the likelihood of runway excursions are due to pilot experience and training followed by airport infrastructure and runway design. Poor safety culture was also an important factor that has a likelihood of contributing to a runway excursion.

Sixty seven percent of participants felt that runway safety training within their organization was somewhat effective.

Thirty three percent of participants were not confident in the adequacy of runway condition assessment and reporting procedures at airports.

SYSTEM COMPONENT FAILURE NON POWERPLANT

FACT SHEET 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% 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 when 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% of all SCF-NP events occurred during the en-route phase of flight and 19% 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% of all reported incidents were the result of pressure system failures followed by 28% hydraulic and landing gear system failures and 8% electrical system failures. Four events were the result of structural or corrosion related failures. 10% 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

2.0 APAC Regional Aviation Safety Plan (RASP)

2.1 The 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.

3.0 National Aviation Safety Plans

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

4.0 Additional Precursors /Contributory Factors and actions that were not identified by RASP or NASPs pertaining to SCF-NP 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 to date.

4.1 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:** Approved by State of Registry but not adhering to a manufacturer's recommended maintenance program and/or Chapter 5 airworthiness limitations. The maintenance program intervals are not adjusted to reflect the environment, role and utilization rate of the aircraft. Also, inadequate or fragmentary maintenance or servicing.
- **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.
- Human factors.

4.2 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.

ABNORMAL RUNWAY CONTACT

FACT SHEET APAC REGION 2017-2022 HIGHLIGHTS

1.0 Analysis

1.1 Abnormal Runway Contact (ARC) is the third highest accident occurrence category (non-fatal) in the APAC region and ranked 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[1]. 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 need for 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 un-stabilized 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% 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.

[1] IATA Recommendations for accident prevention annual safety report 2022

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

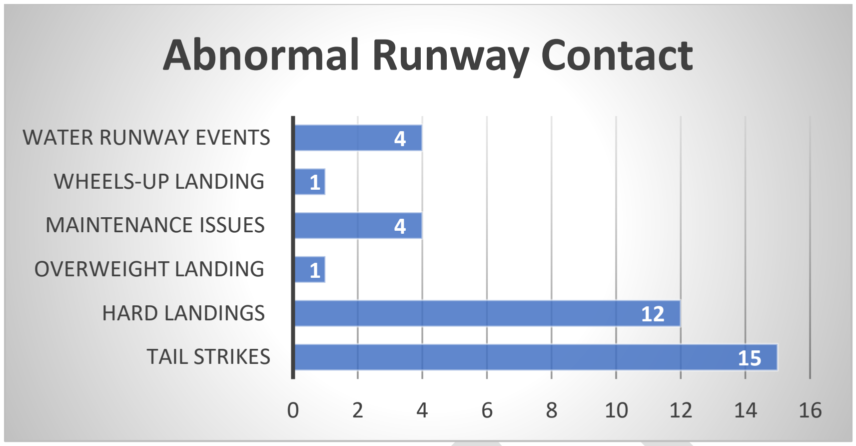

Table 1: Abnormal Runway Incidents

1.7 When comparing 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.

2.0 APAC Regional Aviation Safety Plan (RASP)

2.1 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 2022-2025 RASP. 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 unstabilized 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.

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

3.0 National Aviation Safety Plans (NASP)

3.1 To date, 15 APAC States published 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 Unstabilized Approach (As recommended by the 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

4.0 Additional Precursors /Contributory Factors and actions that were not identified by RASP or NASPs pertaining Abnormal Runway Contact 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 to date. and have been identified Industry partners (IATA, ACI, CANSO) or through AP-CAS workshops with associated stakeholders to date.

4.1 Precursors/contributing factors that may contribute to ARC:

- Unstabilized Approach (refer to the Fact sheet on Runway excursions for additional precursors and contributing factors as well as 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.
- <u>Latent conditions</u>
  - 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
- <u>Airport Infrastructure:</u>
  - 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.

4.2 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 being 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 unstabilized 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.

TURBULENCE

FACT SHEET APAC REGION 2017-2022 HIGHLIGHTS

1.0 Analysis

1.1 Turbulence (TURB) 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% 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 compared 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.

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 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.

1.8 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.

1.9 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.

1.10 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.

1.11 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.

1.12 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).

1.13 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 APAC Regional Aviation Safety Plan (RASP)

2.1 TURB has been identified as an accident occurrence category in the APAC RASP 2023-2025 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).

3.0 National Aviation Safety Plans

3.1 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.

4.0 Additional Precursors /Contributory Factors and actions that were not identified by RASP or NASPs pertaining to Turbulence 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 to date.

4.1 Academic research shows that the rate of severe turbulence in clear skies will increase by 149% 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.

4.2 Contributing factors for severe turbulence events as well as actions that can be taken (defenses) include the following:

4.2.1 Turbulence caused by Thunderstorm (weather/convective activity)

- 45% 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.

4.2.1.1 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. Training as well in aircraft upset awareness, procedures and training for recovery.

- 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 with the help of local flow management position (FMP) possible tactical measures.

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

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

4.2.2.1 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.

4.2.3 Turbulence caused by Wake vortex.

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

4.2.3.1 Actions and Defenses

- ATC provides standard separation.
- Wake Turbulence Re-Categorization (RECAT)- Newer separation standards, have been introduced in Japan and Rep of Korea.
- Wake turbulence separation minima are applied to flights is provided based in PANS-ATM (Doc 4444), time and distance based. Amendment 9 to the PANS-ATM (Doc 4444) applicable on 05 November 2020 amendment concerning wake turbulence: introduction of 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 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.

RUNWAY INCURSIONS

FACT SHEET APAC REGION 2017-2022 HIGHLIGHTS

1.0 Analysis

1.1 Runway Incursions (RI) rank ninth in highest 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), and 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 compared 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.

2.0 APAC Regional Aviation Safety Plan (RASP)

2.1 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 APAC 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

2.2 The 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).

2.3 As of April 2023 approximately 26% of all international airports in the APAC region have established Runway Safety Teams (RST). 44% of States have established RSTs (various levels of implementation) at their international airports.[ii]

3.0 **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.

3.1 <u>Precursors / contributing factors</u>

- 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 language proficiency 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

3.2 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:
    a) Adherence to SOPs for towing/taxiing
- Air operators to develop training program to include:
    a) Understanding the importance of signages, marking and lighting
    b) Familiarization with operating aerodrome layout and taxi procedures specific to the aerodromes
    c) Increased alertness levels amongst crew while taxiing.
    d) Following correct taxiways and speed limits
    e) Clear and unambiguous RT between aircraft and ATC
    f) Meticulous adherence to ground markings and awareness of works in progress at an airfield.
    g) 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.

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

4.0 Additional Precursors /Contributory Factors and actions that were not identified by RASP or NASPs pertaining to Runway Incursion 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 to date.

4.1 <u>Precursors / contributing factors:</u>

- 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.

4.2 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 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.

GROUND COLLISION AND RAMP

FACT SHEET APAC REGION 2017-2022 HIGHLIGHTS

1.0 Analysis

1.1 Ground Collision and Ramp (GCOL 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 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% of all GCOL and RAMP accidents in the APAC region involved ground equipment handling. Another 20% 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 APAC Regional Aviation Safety Plan (RASP)

2.1 GCOL and RAMP together have been identified as an accident occurrence category in the APAC RASP 2023-2025 as 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 <u>Precursors /Contributing Factors</u>

- 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.
- The need for Air Operators, Air Navigation Service Providers, and Aerodromes to manage ground operations related safety risks and reporting.
- Manage and monitor ground operations related occurrences.

3.1.2 <u>Actions</u>

- 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, 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 operators develop a 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.
    - Provide stop bars at airports with high intensity operations.

4.0 Additional Precursors /Contributory Factors and actions that were not identified by RASP or NASPs pertaining to GCOL and RAMP 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 to date.

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:

- Introducing 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 to enhance situational awareness and prevent runway incursions.
  - 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.
- The need to consider establishing or strengthening SMS interface with ground service providers.
- Conducting regular training and competency assessments for ground handling personnel to ensure adherence to standardized procedures and safety protocols.
- Enhancing communication and coordination between air traffic control and ground handling teams to reduce the risk of miscommunication and potential accidents.
- Installing stop bars and other visual aids to indicate critical areas on the apron and taxiways, reducing the risk of aircraft collisions with ground equipment.
- Encouraging the use of technology to aid in aircraft parking and docking to ensure safe and precise positioning.
- 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.

Loss of Control In-flight

FACT SHEET APAC REGION 2017-2022 HIGHLIGHTS

1.0 Analysis

1.1 Loss of Control In-flight (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 to 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 as well as 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 as well as 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. The APAC region averages 1.25 LOC-I accidents per year for the same time period.

2.0 APAC Regional Aviation Safety Plan (RASP)

2.1 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 APAC 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 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

3.0 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:

3.1 <u>Precursors /contributing factors.</u>

3.1.1 Airplane systems-induced

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

3.1.2 Environmentally induced,

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

3.1.3 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.

3.2 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.
- The need to implement 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.

4.0 Additional Precursors /Contributory Factors and actions that were not identified by RASP or NASPs pertaining to LOC-I 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 to date.

4.1 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
- Fatigue and high levels of stress can impair a pilot's cognitive and physical abilities, potentially leading to control-related errors.

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

- **<u>Actions by Operators:</u>**
    - Operators' SMS to include a positive safety culture: Establishing a safety culture within the organisation that prioritizes open communication and proactive identification of safety risks.
    - <u>Strengthen Training Programmes</u>: Enhance training programs for flight crews, particularly in upset prevention and recovery, stall awareness and prevention, manual aircraft handling, and simulator training.
    - <u>Review and update SOPs</u>: 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.
    - <u>Implement Ground Handling Measures</u>: 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.

5.0 Additional outcomes from the workshop with airline participants

Fifty percent of participants indicated that they were very confident to recognize and recover from an imminent stall or upset condition and 40 percent were somewhat confident.

Sixty percent of participants expressed the importance for pilots to maintain proficiency in manual flight control skills in today's highly automated aircraft.

All participants agreed that continuous pilot education and training is the most critical aspect of reducing the risk of loss of Control in Flight incidents.

Controlled Flight Into Terrain

FACT SHEET APAC REGION 2017-2022 HIGHLIGHTS

1.0 Analysis

1.1 Controlled Flight into Terrain (CFIT) accidents are a high-risk category (HRC) 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 accidents resulting in 33 fatalities among passengers and crew. The worst CFIT accident during this reporting period occurred on May 29, 2022, when turboprop airplane struck a mountainside while on a domestic flight. All 22 passengers and crew were killed.

1.3 All but one of the CFIT accidents were turboprop 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 APAC Regional Aviation Safety Plan (RASP)

2.1 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 APAC Regional Aviation Safety Plan (2023-2025) 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 Programmes for 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

3.0 National Aviation Safety Plans

Fifteen APAC States published National Aviation Safety Plans. Of the fifteen States, fourteen States 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.

3.1 Pre-cursors /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 or marked
- 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 on individual load while preparing load and trim sheet.
- Absence of TAWS warning
- Deviation from VFR route
- Intentional low operations leading to CFIT occurrence.

3.1.2 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).
- Guidance on the Establishment of a Flight Data Analysis Programme (FDAP).
- Issuance of advisory circulars on Crew Resource Management Training Programme (CRM), Controlled Flight into Terrain (CFIT) and Approach and Landing Accident Reduction (ALAR) Training Programme.
- Issuance of 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.

4.0 **Additional Precursors /Contributory Factors and actions that were not identified by RASP or NASPs pertaining to CFIT 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 to date.

4.1 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

4.2 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 operative.
- 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 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 reliance 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 of 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) to include 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.

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