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INTERNATIONAL CIVIL AVIATION ORGANIZATION

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Controlled Flight Into Terrain (CFIT) Workshop
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ICAO Regulatory Provisions on Controlled Flight Into Terrain (CFIT) and Safety Enhancement Initiatives (SEIs) to mitigate its related risks

CFIT Workshop Outline

- ICAO regulatory provisions on CFIT.
- AFI Occurrence Data, 2013-2024.
- Regional Operational Safety Risks
- Focus on CFIT - Safety Enhancement Initiatives (SEIs) for Mitigating risks associated with CFIT (GPWS; SOPs; CDFA; FDAP; CRM; ALAR; MSAW; PBN).
- References.
- Conclusion.
- Take-Away.

ICAO regulatory provisions on CFIT

- What is Controlled flight into terrain (CFIT) ?

- A situation where a properly functioning aircraft under the control of a fully qualified and certificated crew is flown into terrain (mountain, ground, water mass, trees, etc.) with no apparent awareness on the part of the crew.
- Accident Data indicates that controlled flight into terrain (CFIT) accounts for just over 20% of all fatal accidents, a disproportionately high percentage given the low proportion of all accidents attributed to this category.

ICAO regulatory provisions on CFIT (Cont'd.)

- While ICAO and other Organizations (FSF, CAST, JSAT, JSSI, etc.) have undertaken a number of initiatives over the past 20 years which have met with considerable success, the data would suggest that additional efforts should be considered.

- ICAO Assembly Resolution A31-9 urges States to implement the ICAO programme for the prevention of CFIT. ICAO introduced a number of amendments to SARPs and related guidance material to reduce the risk of CFIT accidents.

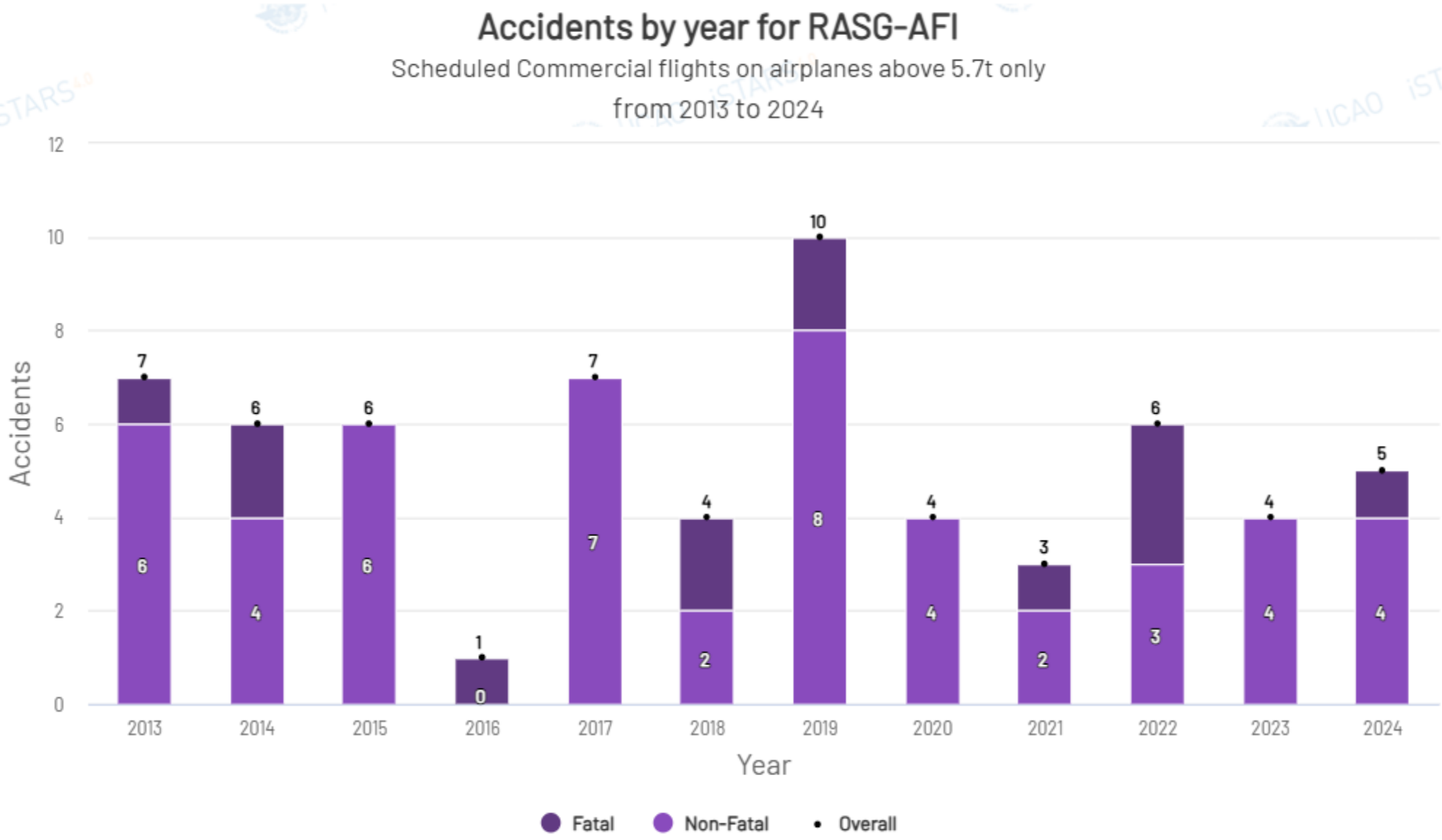
ICAO regulatory provisions on CFIT (Cont'd.)

- Over the years, ICAO and aviation partners have taken initiatives to reduce the risk of CFIT accidents such as the production of an Approach and Landing Accident Reduction (ALAR) Toolkit; and the conduct of several workshops to encourage States, air operators, and air traffic management to implement many of the safety interventions that are contained in the Toolkit.
- Each time you approach a runway, the risks associated with approach and landing accidents are present. It is this phase of flight operations where the greatest number of accidents occur. The risks include the non-stabilised approach, landing short, landing off the side of the end of the runway and controlled flight into terrain.

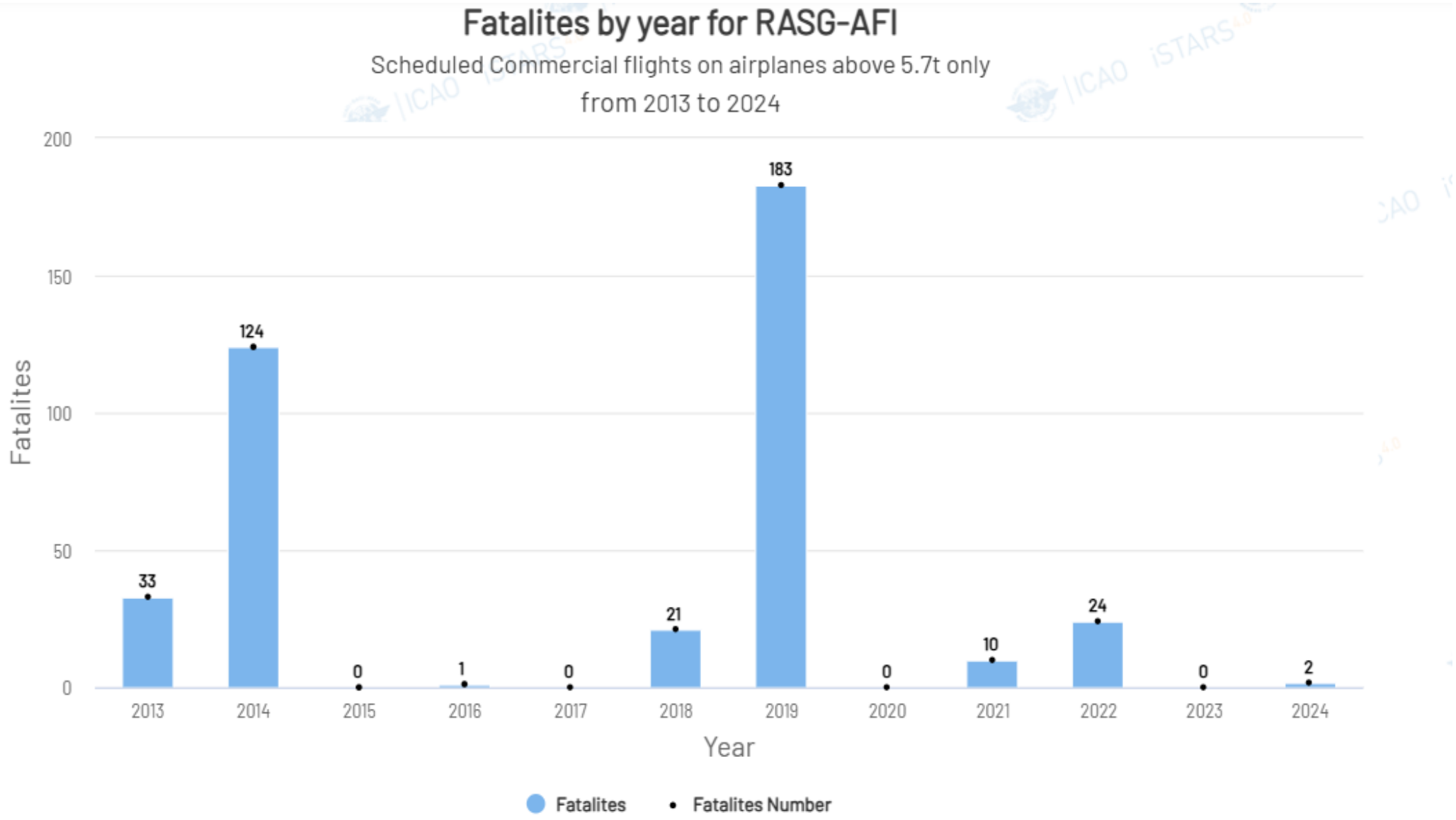
ICAO regulatory provisions on CFIT (Cont'd.)

- During the 1990s extensive industry attention was focused on CFIT because it was the single biggest risk to aircraft, crew and passengers.

AFI Occurrence Data, 2013-2024 – Accidents by Year



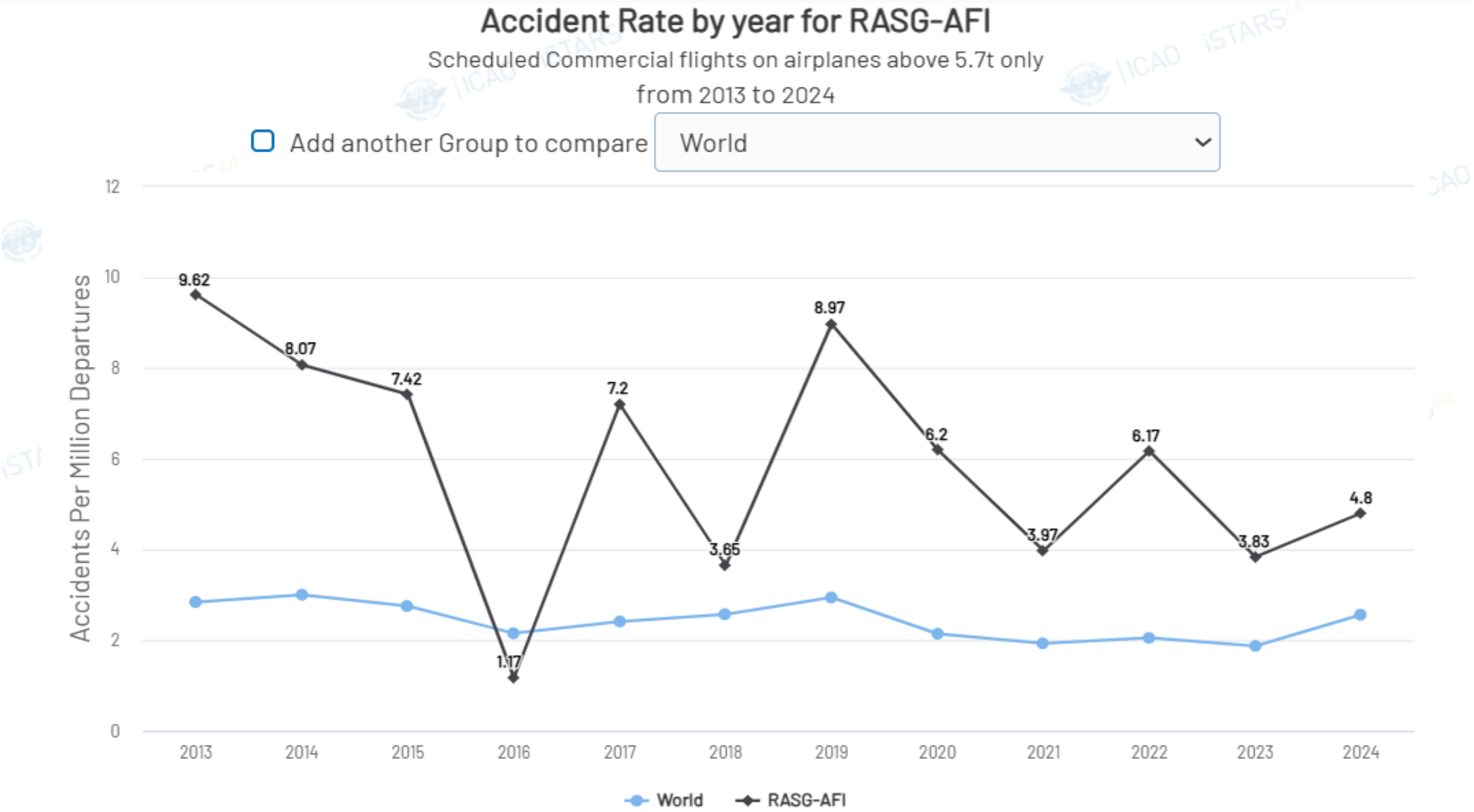
AFI Occurrence Data, 2013-2024 – Fatalities by Year



AFI Occurrence Data, 2013-2024 – Accident Rate by Year

World Accident Rate in 2024: **2.56** per Million departure

RASG-AFI Accident Rate in 2024: **4.8** per Million departure



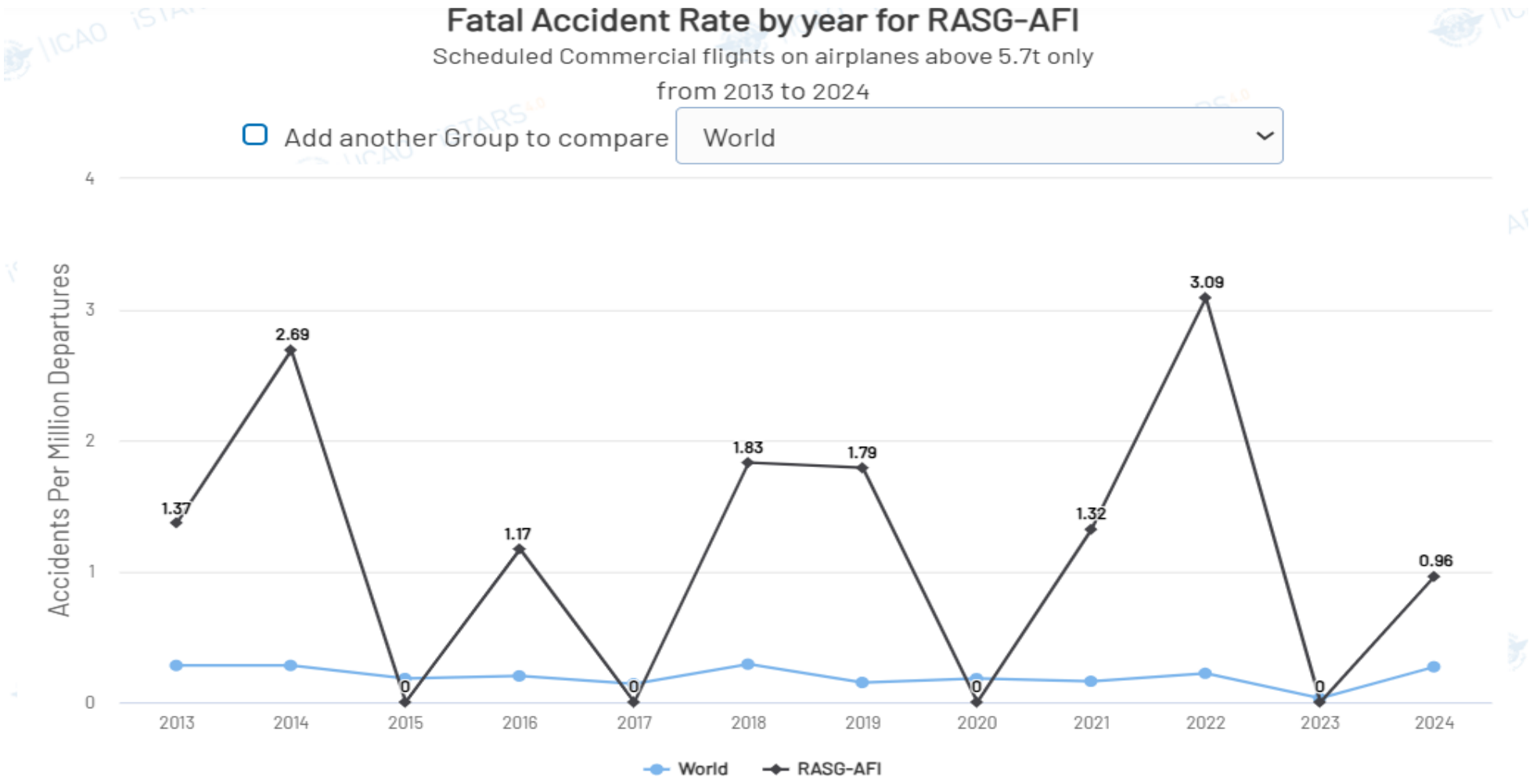
AFI Occurrence Data, 2013-2024 – AFI Fatal Accident Rate

- The vision of both the Global Aviation Safety Plan (GASP) and the Regional Aviation Safety Plan (AFI-RASP) is to achieve and maintain the aspirational safety goal of zero fatalities in commercial operations by 2030 and beyond, which is consistent with the *United Nations' 2030 Agenda for Sustainable Development.* The plan's mission is to continually enhance the global aviation safety performance (and in consequence the regional aviation safety performance) and resilience by providing a collaborative framework for States and industry.

AFI Occurrence Data, 2013-2024 – AFI Fatal Accident Rate by Year

World Fatal Accident Rate in 2024: **0.27** per Million departure

RASG-AFI fatal Accident Rate in 2024: **0.96** per Million departure



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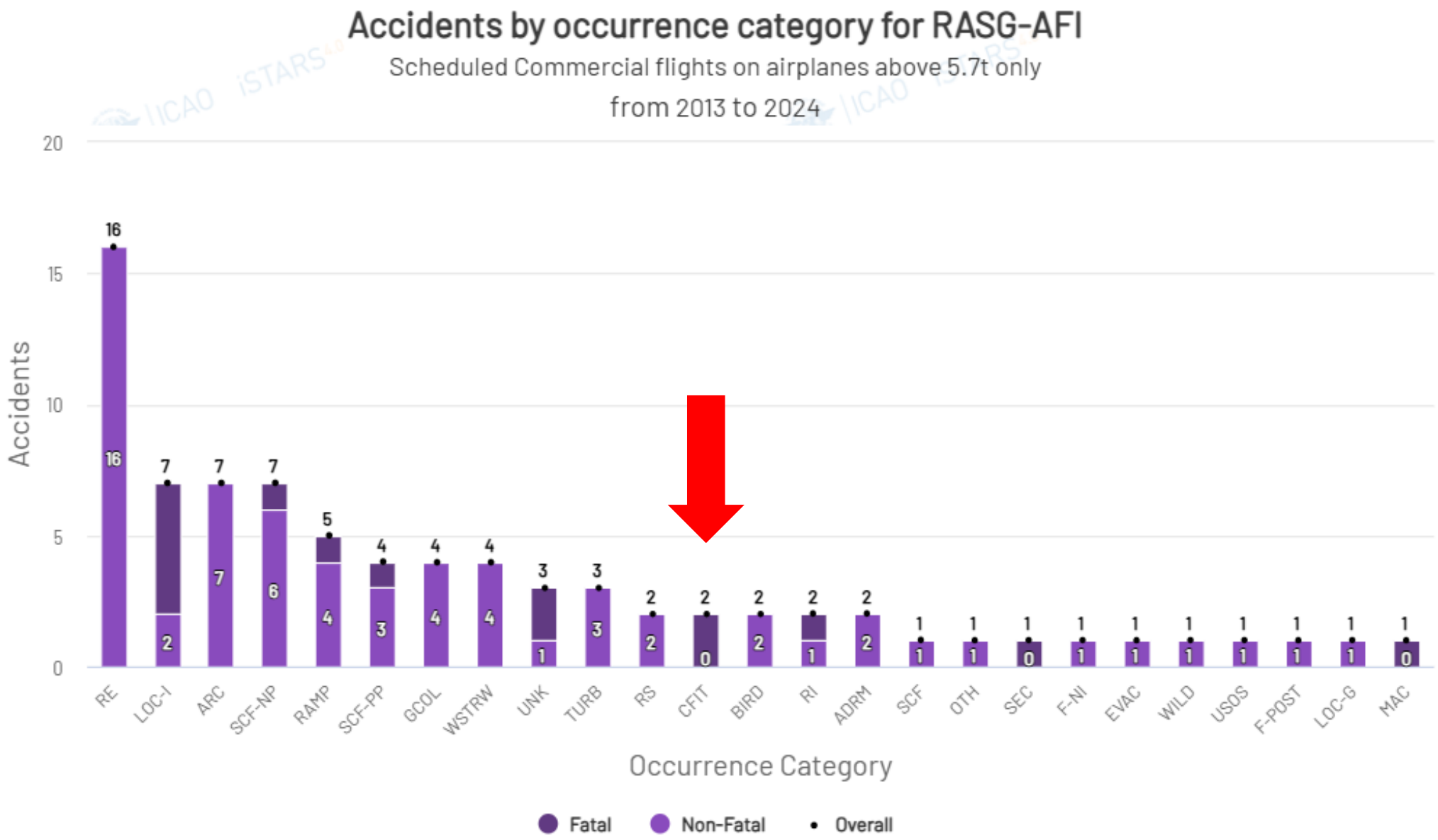
AFI Accidents by Occurrence Category



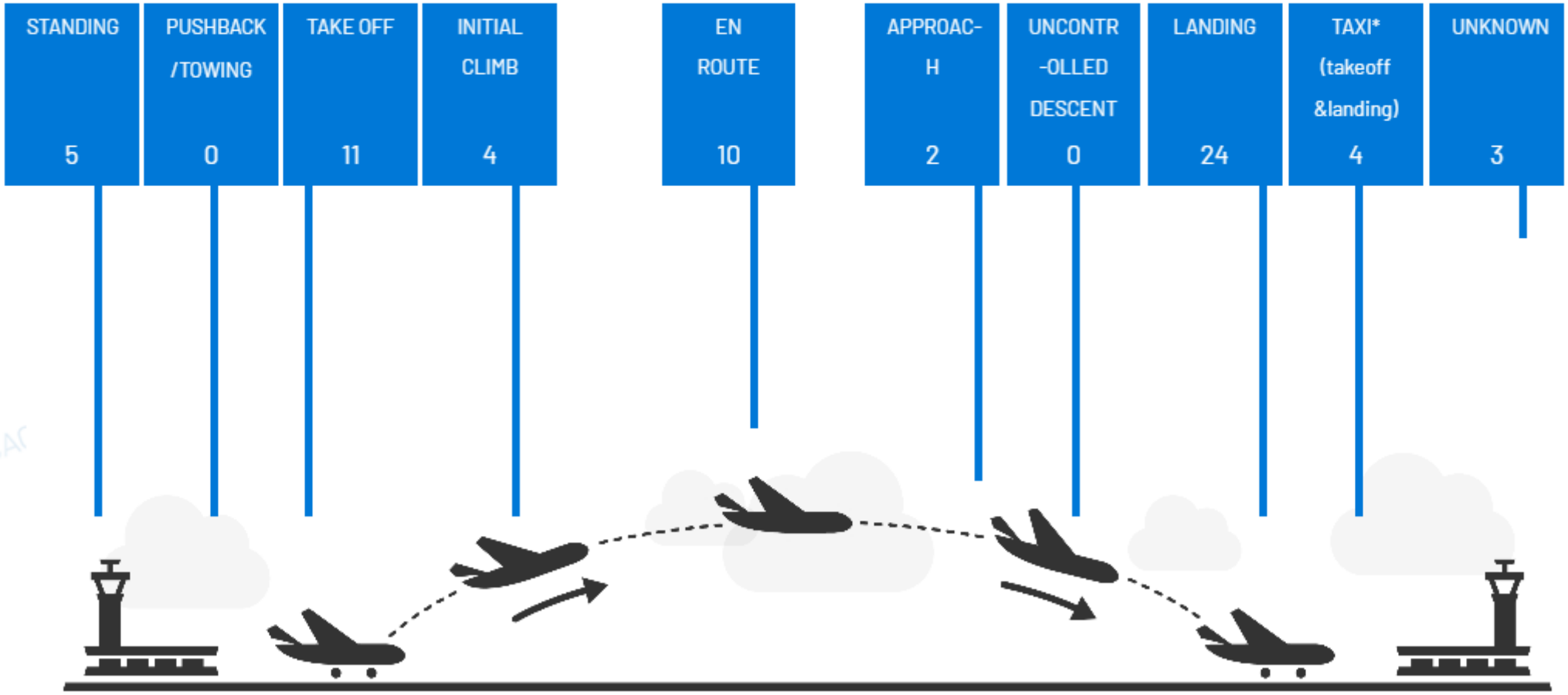
AFI Accidents by Flight Phase

Accidents by flight phase chart for RASG-AFI

Scheduled Commercial flights on airplanes above 5.7t only

from 2013 to 2024

**TAXI Numbers on the graph included both takeoff and landing*



Regional Operational Safety Risks

- The Regional Aviation Safety Plan for Africa-Indian Ocean (AFI-RASP) which was approved by the Ninth Meeting of the RASG-AFI in November 2023, has identified the following nine occurrences, in no particular order of priority, as the RASG-AFI high-risk categories of occurrences (R-HRCs) under the context of the number of fatalities and risk of fatalities associated with such events:
  - **Controlled Flight into Terrain (CFIT);**
  - Loss of Control In-Flight (LOC-I);
  - Mid-Air Collision (MAC);
  - Runway Excursion (RE);
  - Runway Incursion (RI);

(These five HRCs are also G-HRCs)

Regional Operational Safety Risks

- System/Component Failure/Malfunction – Non-Powerplant (SCF-NP);
- Bird Strikes and Wildlife Hazard;
- Dust Haze; and
- Large Height Deviation (LHD).

(These four HRCs are specific to the RASG-AFI Region)

AFI Aviation System Planning and implementation Group (AASPG) – a merger of APIRG AND RASG-AFI

- With the establishment of the AFI Aviation Systems Planning and implementation Group (AASPG), which is the merger of the AFI Planning and Implementation Regional Group (APIRG) and the Regional Aviation Safety Group for Africa-Indian Ocean (RASG-AFI), and the ultimate dissolution or reformulation of the contributory bodies of the Groups, there is a need to create relevant contributory bodies to carry out tasks that may be identified by the AASPG. In this regard, Sub-Groups have been created: the Airspace and Airports Operations (AAO/SG), Infrastructure and Information Management (IIM/SG), and the Safety Management and Oversight (SMO/SG). The former two Sub-Groups were in existence under the APIRG, while the latter has been newly created to replace the Safety Support Teams of the RASG-AFI.

SMO/SG

- To discharge their mandates, the Sub-Groups will employ project approach – by identifying project areas, establish project teams (comprising highly competent personalities) with clearly defined terms of reference and objectives, nominate Project Team Coordinators and Assistant Project Team Coordinators, implement and monitor progress - regular reports on the implementation status of these projects will be furnished to the Programme Review and Coordination Committee (PRCC) and the AASPG.
- The meeting on Establishment of the AASPG Safety Management and Oversight Sub-Group, which was convened in Nairobi, Kenya, from 24 to 25 April 2025, has identified the *"Development and Implementation of Regional and National Aviation Safety Plans (AFI-RASP and NASPs)"* as a project area to be embarked upon by the SMO/SG.

AFI Regional Aviation Safety Plan (AFI-RASP)

- With the new cycle of the GASP (2026-2028 Edition) coming into effect after its approval by the recently concluded 42nd ICAO Assembly, the Project Team to be established will be responsible for revising the AFI-RASP 2023-2025 Edition, in a bid to align it with the GASP 2026-2028 Edition; and in consequence, support States in the Region to develop/revise their NASPs accordingly.

- It is envisaged that this exercise will be part of the routine activities of the Project Team, as the GASP, AFI-RASP and NASPs are living documents that will be subject to regular review and amendments, in order to make them relevant to prevailing circumstances.

AFI-RASP

- With the GASP 2026-2028 Edition coming into effect; and considering the fact that the GASP is a living document that is subject to periodic revisions (three-year cycle), the SMO/SG deems it appropriate to have the revision of the AFI-RASP 2023-2025 Edition and the development/revision of NASPs as a project area. In this regard, a Project Team should be established, with a mandate to develop the relevant project document and support its implementation. The Project Team should also provide support to States for the development/revision of their NASPs in alignment with the AFI-RASP; as well as their implementation efforts.

Focus on CFIT Occurrences

- Although two (2) non-fatal CFIT-related accidents have been reported during the period 2013-2024 for the AFI Region, CFIT continues to be a High-Risk Category of occurrence both globally (GASP, G-HRC) and regionally (AFI-RASP, R-HRC) thus, no room for complacency

CFIT Avoidance: What can we do?

- It might be difficult to believe, but, the Controlled Flight Into Terrain has been, for many years around the 90s, the leading cause of aircraft crashes. How is it possible that a fully certified pilot flies a serviceable plane into the ground? The main reason is the loss of situational awareness. Most of the CFIT accidents has been caused by pilots that didn't know where they were, so it is imperative that you know where you are at all times especially when you are below the top of the mountains and you cannot see outside. In the1970s the Terrain Avoidance Warning System was introduced, followed by the Enhance Ground Proximity Warning System.

CFIT Avoidance: What can we do?

- These systems combined with the improved Pilots and Air Traffic Control procedure reduced drastically the CFIT accidents. The EGPWS terrain warning gives you 20 to 30 seconds of protection before the impact, so you need to react quickly. If you hear the EGPWS warning "**Terrain terrain pull up!**" there is no discussion, apply full thrust pitch up and get out of the terrain, climb to the Minimum Sector Altitude and then figure out where you are. **The CFIT threat can be easily managed if you keep your situational awareness high.**

Safety Enhancement Initiatives (SEIs) for Mitigating risks associated with CFIT

- **Safety Enhancement Initiative CFIT 1 (SEI-1): Ground Proximity Warning Systems (GPWS) With Forward Looking Terrain Avoidance Function.**

This safety enhancement substantially reduces or eliminates CFIT accidents by improving pilot situational awareness through the installation and use of Ground Proximity Warning Systems (GPWS) with a forward-looking feature (also known as TAWS or EGPWS).

SEI-1: GPWS

- Amendments 21 and 27 to Annex 6 Part I to the Chicago Convention; and Amendment 22 to Annex 6 Part II strengthened the requirements for carriage of GPWS and introduced the requirements for aircraft to be equipped with GPWS with forward looking terrain avoidance function.
- As of 1 January 2007, all turbine-engined aeroplanes of a maximum certificated take-off mass in excess of 5,700 kg or authorized to carry more than nine passengers shall be equipped with a ground proximity warning system which has a forward looking terrain avoidance function.

SEI-1: GPWS (Cont'd.)

- However, the accuracy of the TAWs equipment is greatly reduced in aircraft that are not equipped with Global Positioning System (GPS), especially in areas with limited Navaid coverage. In order to mitigate this situation, Advisory Circular was issued on modification of TAWS equipment to include GPS input or the development of Standard Operating procedures (SOPs) to deal with map shifts. In addition, information was provided to ensure that databases are maintained current.
- States were urged to highlight the need to ensure that the serviceability of TAWS equipment, including status of software and data base, was examined when conducting inspections of air operators.

SEI-1: GPWS (Cont'd.)

- **87%** of the accidents showed the flight crew did not execute a goaround when that could be more appropriate. Crew were not aggressive in responding to Ground Proximity Warning System (GPWS) warnings in low altitude go-around situation (**Whoop! Whoop! Pull-up!**).

- Standard Operating Procedures (SOPs) should contain appropriate information regarding these situations and those procedures should be followed

Recommendation on SEI -1:

- *Modification of TAWS equipment to include GPS input or the development of SOPs to deal with map shifts. In addition, information should be provided to ensure that databases are maintained current. An Advisory Bulletin should be issued by States to highlight the need to ensure that the serviceability of TAWS equipment, including status of software and data base, is examined when conducting inspections of air operators.*

Safety Enhancement Initiative CFIT 2 (SEI -2): Standard Operating Procedures (SOPs).

- All air operators should have Standard Operating Procedures (SOPs) and training which should address all projected normal situations which crew and company personnel will encounter. SOPs address: use of checklists, what each person's responsibilities are, use of available equipment, and expected procedures to be used during preflight, taxi, take-off, climb, cruise, descent, approach, missed approach, landing, taxi and parking.

SEI-2: SOPs (Cont'd.)

- Annex 6 requires that an Operations Manual must contain SOPs for each phase of flight. Further, ICAO Procedures for Air Navigation Services — Aircraft Operations (PANS – OPS) Volume 1 (Doc 8168) contains additional guidance material on the requirements for SOPs to include checklists and crew briefings as an integral part of SOPs.

Safety Enhancement Initiative CFIT 3 (SEI-3): Precision-Like Approach Standard Operating Procedures

- Analysis of accident data indicates that the accident rate is five times greater during non-precision approaches than when aircraft are conducting precision approaches. In the interest of safety, air operators should discontinue the use of step-down or “dive-and-drive” non-precision approach procedures as soon as, and wherever possible. Air operators that are yet to do so should, at the earliest possible date, develop procedures and train pilots to fly continuous descent final approaches (CDFA) when flying non-precision approach procedures. All types of aircraft can fly procedures utilizing a constant rate descent, even those with just basic navigation capabilities.

SEI-3: CDFA (Cont'd.)

- **ICAO PANS-OPS (Doc 8168), Volume I, Part I, Section 4, Chapter 1**, promotes the use of Constant Decent Final Approach (CDFA) through utilization of a number of techniques.

- ***Recommendation:***

Guidance should be issued for Operators conducting Continuous Decent Final Approach for Non-Precision Approaches, which is a technique that requires a continuous descent, flown either with VNAV guidance calculated by onboard equipment or based on manual calculation of the required rate of descent, without level-offs.

Safety Enhancement Initiative CFIT 4 (SEI-4): Flight Data Analysis

- A Flight Data Analysis Programme (FDAP) is a predictive and nonpunitive use of information derived from aircraft flight data recorders to improve aviation safety. The use of FDA as an important safety tool has grown as emerging technology expands the capabilities of gathering and analyzing such data. Daily collection and analysis of data provides valuable information to correct undesirable trends, improve safety and ultimately reduce the number of accidents.

SEI-4: FDAP (Cont'd.)

- **From 1 January 2005 Annex 6, Part 1** requires operators of aeroplanes of a maximum certificated take-off mass in excess of 27,000 kg to establish and maintain a flight data analysis programme (FDAP) as part of its accident prevention and flight safety programme. A flight data analysis programme shall be nonpunitive and contain adequate safeguards to protect the source(s) of the data.

SEI-4: FDAP (Cont'd.)

✈ ***Recommendations:***

- *States should establish regulations to be utilized to implement the ICAO requirement on FDAP.*
- *Guidance material should be developed to be utilized to ensure that air operators have implemented an effective Flight Data Analysis programme.*
- *Guidance should be provided to CAA and air operator staff for the implementation of an effective Flight Data Analysis programme.*

Safety Enhancement Initiative CFIT 5 (SEI-5): Crew Resource

- Annex 6 requires air operators to provide training to flight crew on Human Factors principles. **The ICAO Human Factors Training Manual (Doc 9683), Part 2 Chapter 2**, contains information on Crew Resource Management (CRM) Training.

- ***Recommendation:***

Guidelines should be provided for developing, implementing, reinforcing, and assessing Crew Resource Management (CRM) training programmes for flight crew members and other personnel essential to flight safety. These programmes are designed to become an integral part of training and operations.

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Safety Enhancement Initiative CFIT 6 (SEI-6): CFIT/ALAR Training.

- CFIT accidents could be substantially reduced if all air operators and training centers developed CFIT prevention training and procedures to be added to their approved training curricula, stressing position awareness and escape maneuvers in the event of a terrain warning indication

SEI-6: ALA (Cont'd.)

- Approach and Landing Accidents could also be reduced if flight crew were properly trained on topics related to stabilized approaches. This training should include: crew resource management, go around criteria, approaches with system malfunctions, non-normal conditions, and emphasis on basic airmanship, approach briefings, approach and missed approach procedures.
- Situational awareness is important, as crew can recognize many of the risk factors before an event threatening safety – crew action can be taken to avoid potential approach and landing accidents (ALA). ALA causal factors include:

SEI-6: ALA (Cont'd.)

- Not being stabilized on approach;
- Not following established procedures;
- Lack of vertical position awareness; and most critically,
- Failure to go around.

SEI-6: ALA (Cont'd.)

✈The following parameters constitute a stabilized approach and should be met at 1000ft above touchdown in IMC condition:

- Aircraft is on the correct flight path;
- Speed not more than VREF + 20KIAS, and not less than VREF;
- Sink rate not more than 1000 feet per minute;
- Aircraft in proper approach and landing configuration;
- Power setting is no lower than minimum specified for aircraft type;
- All briefings and checklists have been performed.

SEI-6: ALA (Cont'd.)

- All these parameters must be met by 500ft including visual approach. The SOPs should include these parameters for a stabilized approach.
- Weather and runway conditions are two areas which can compound the risk during landing. For example, increased risk of short runway, wet and icy runway, wind and obscuration of runway. Make preparations and decisions early!
- Vertical situational awareness is your responsibility as a pilot. GPWS "**PULL-UP! PULL-UP!**" Warning you must be prepared to execute an immediate pull-up.

SEI-6: ALA (Cont'd.)

✈***Recommendation on SEI-6, ALA:***

States should develop appropriate legislation, regulations and/or standards to require air operators to ensure flight crew receive initial and recurrent Approach and Landing Accidents (ALA) and CFIT prevention training.

Safety Enhancement Initiative CFIT 7 (SEI-7): Minimum Safe Altitude Warning (MSAW).

- Recognizing that installation of radars and associated MSAW capability provides the necessary levels of terrain avoidance protection to aircraft operations, States are to consider this aspect when determining the justification for installation of new radar equipment. Justification would be strengthened for installation of radar where the CFIT risk is high.

Safety Enhancement Initiative CFIT 8 (SEI-8): Performance-Based Navigation (PBN) Procedures.

✈PBN is an international harmonization of navigation requirements and specifications based on the **accuracy/integrity** of the aircraft position. It is based on two main sets of specifications:

- **RNAV = aRea NAVigation**: Capability to fly any desired flight path – especially on long-range flights – defined by waypoints such as geographic fixes (LAT/LONG) and not necessarily by ground navaids.

SEI-8: PBN (Cont'd.)

- **RNP = Required Navigation Performance**, which is GNSS based.

✈PBN approach procedures is a **key factor for safety enhancement:**

- Automation of approaches;
- Lateral navigation;
- Vertical navigation.

SEI-8: PBN (Cont'd.)

- ICAO controlled flight into terrain (CFIT) studies have shown that runway-aligned approaches (LNAV only) are **25 times safer** than circling approaches, and that once some form of vertical guidance is added to approaches the **safety margin is increased again by a factor of 8.**
- The benefits of PBN include:
  - Enhance Safety;
  - Improve Accessibility;
  - Reduce Fuel Burn Increase Payload;
  - Increase Capacity;
  - Avoid Sensitive Areas.

SEI-8: PBN (Cont'd.)

Recommendation on SEI-8:

- *All AFI States should implement PBN procedures for all instrument runways by end of 2025.*
- *PBN Implementation – Runways: As at December 2024, **92.63%** of instrument runways were with PBN approaches (2.26% increase from 90.37% in 2023).*
- *PBN Implementation - State Levels: As at December 2024, **80.85%** of States had PBN approaches on all instrument runways (2.13% increase from 78.72% in 2023).*

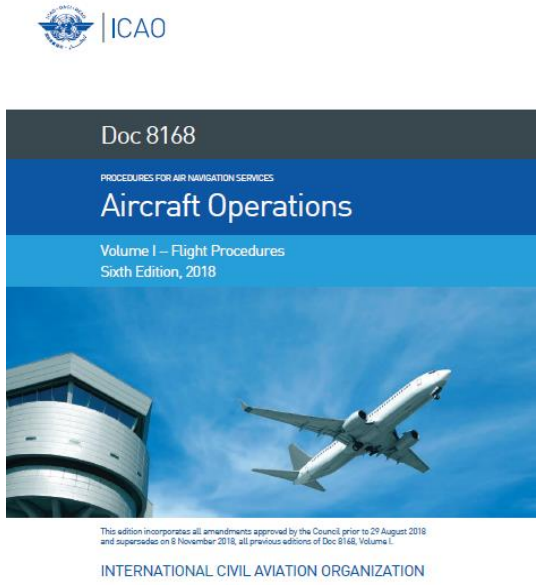
ICAO References

- STD A6, Part I, 3.3 & Att. H:
- Flight Safety Documents System;

  STD A6, Part I, 3.3, 4.2.2 & App. 2, 2.1.30:

  Policy for the use of the
- ground proximity warning system (GPWS);
- STD A6, Part I, 3.3, 4.2.2 &

  App. 2, 2.1.34: Safety Management System (SMS);
- STD A6, Part I, 3.2.3: FDAP;
- PANS-OPS Doc 8168, VOL I: SOPs.



CONCLUSIONS:

- Approach and Landing Safety
- Pull up when warned;
- Use SOPs;
- Use the approach briefing plan;
- It’s okay to go-around.

Take Away!

✈**Safety Enhancement Initiative (SEI):** Mitigate contributing factors to CFIT accidents and incidents.

1. Implement the following CFIT global safety enhancements:

   a) Ensure aircraft are equipped with TAWS in accordance with Annex 6 to the Chicago Convention;

   b) Promote the wider use of TAWS beyond the requirements of Annex 6;

   c) Issue Safety Advisory to increase adherence to TAWS warning procedures;

Take Away!(Cont'd.)

d) Promote greater awareness of approach risks;

e) Consider the implementation of Continuous Descent Final Approaches (CDFA);

f) Consider the implementation of Minimum Safe Altitude Warning (MSAW) systems;

g) Ensure the timeliness of updates and accuracy of Electronic Terrain and Obstacle Data (eTOD);

h) Promote the use of GPS-derived position data to feed TAWS;

i) Implement PBN procedures for all instrument runways by 2025.

Take Away!(Cont'd.)

2. Validate the effectiveness of the global safety enhancements through the analysis of MORs and VORs and accident/incident investigations (apply safety management methodologies).

3. Identify additional contributing factors for example:

a) Flight in adverse environmental conditions
b) Approach Design and documentation
c) Phraseology used (standard vs non-standard)
d) Pilot fatigue and disorientation.

Take Away!(Cont'd.)

4. Develop and Implement further safety enhancements to mitigate the risk of the identified contributing factors, if any, for CFIT.

5. Conduct continuous evaluation of the performance of the safety enhancements.

6. Video: https://youtu.be/JBxg6hgbAr8.

7. GPWS and EGPWS video:

https://studio.youtube.com/video/peJf

Thank you!
Merci beaucoup!

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