IATA Controlled Flight Into Terrain Accident Analysis Report

2008-2017 Data

2018 Edition

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Section 1—Introduction

The International Air Transport Association (IATA) is dedicated to implementing a data driven approach to the evaluation of aviation safety risks and the development of potential solutions. IATA is conducting an accident analysis report on Controlled Flight Into Terrain (CFIT) to assess and evaluate the contributing factors from recent CFIT accidents and presents information designed to aid industry in the implementation of mitigation strategies.

CFIT refers to accidents in which there is in-flight collision with terrain, water, or obstacle without indication of loss of control. The critical distinction in these types of accidents is the fact that the aircraft is flyable and under the control of the flight crew.

There are numerous factors contributing to such events; typically, aircraft malfunction was not found to be a leading factor in the accident under review; rather the accident's contributing factors are often attributed to human performance deficiencies, such as poor crew resource management (CRM), non-compliance with established procedures (SOPs), poor flight planning by the pilot, inadequate flight path management, lack of vertical and/or horizontal position awareness in relation to terrain, unstabilized approaches, failure to initiate a go-around when a go-around was necessary, and operating in adverse weather. The absence of a precision approach as well as inadequate situational awareness (SA) have also been noted as factors in CFIT accidents.

This report is organized in a way to provide a dynamic and interactive environment data from 47 CFIT accidents that occurred over the last 10 years, spanning from 2008 through 2017. This report is written to support a user-friendly methodology to analyze and visualize CFIT accident data and to identify patterns, trends, comparisons between data selections.

Although few in number, CFIT accidents are almost always catastrophic; over the reported period, 89 percent of the CFIT accidents involve fatalities to passengers or flight crew. CFIT is the second largest fatal accident category. Given this fatality risk, CFIT has been assessed by the IATA Safety and Flight Operation department, and the industry representatives as one of the highest priorities for safety intervention and risk mitigation.

Section 2—Controlled Flight into Terrain (CFIT) Definition

The definition of Controlled Flight into Terrain (CFIT) as stated in the IATA Safety Report is an in-flight collision with terrain, water, or obstacle without indication of loss of control.

Section 3—Data Source

The data set from which the report was generated includes worldwide reported accidents resulting in a hull loss or substantial damage to aircraft that has a certificated Maximum Take-Off Weight (MTOW) of at least 5,700KG (12,540 lbs.). These accidents from January 2008 to December 2017 inclusive were extracted from the IATA Global Aviation Data Management (GADM) Accident Database.

Section 4—Exclusions

This report specifically excludes accidents involving the following types of operations:

- Private (general) aviation
- Business or military aviation
- Flights as part of illegal activities
- Humanitarian relief flights
- Crop spraying or other agricultural flights
- Security-related events (e.g. hijackings)
- Experimental or other test flights[1]
- Training flights

Section 5—Scope

The purpose of this report is to share information on Controlled Flight Into Terrain (CFIT) accidents and to find out how and why they happened. It is intended to identify contributory factors that may have led to such events and from which preventive measures can be formulated.

Section 6— Manipulating Interactive Report

Interactive Reporting enables the reader to customize reports. If you see an Excel icon such as this one shown in this section that means the chart is interactive.

To run an interactive chart, follow these steps:

- Double click on the Graph Icon on the top right-hand corner of the chart.
- Click Enable Macros if asked.
- Select the desired conditions in-list in the filter pane box next to the chart.
- Select the range of years on top of the chart.

This report is also written in a way to allow you to focus more precisely on certain data; this report displays a combination of filters applied in the in-list filter pane. Click and highlight your selection, and the data will automatically correspond to your choice. Please note that each chart is presented in the best way for its data, you might find different selector options for each different chart, select the options you like in any way you would like them displayed.

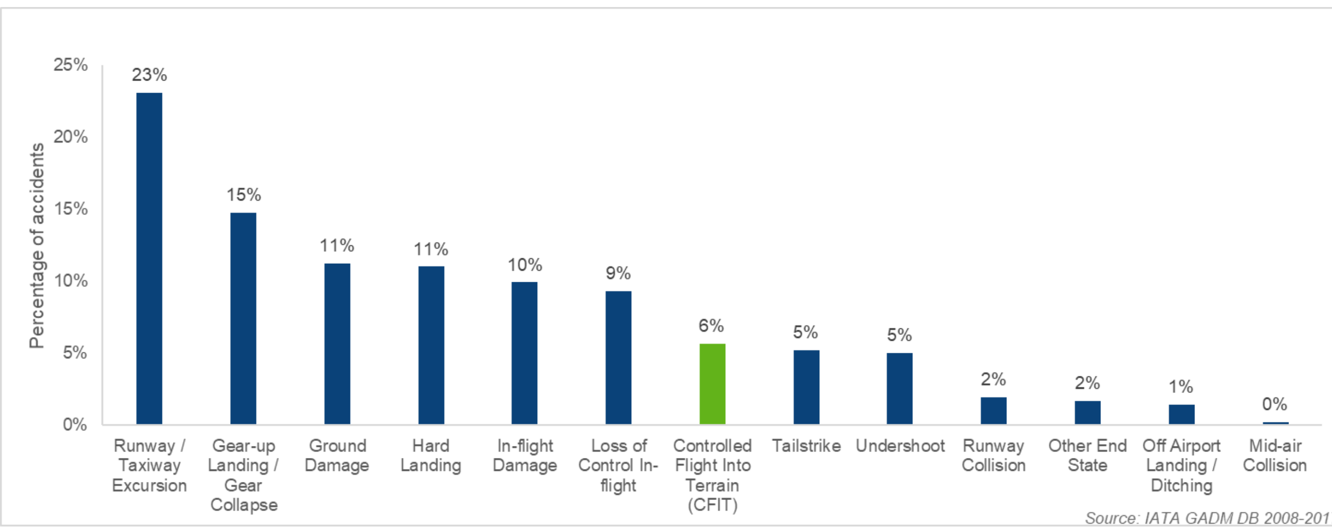
[1] Such as post maintenance functional check flights

Section 7—A Comparison of CFIT Accidents Relative to Other Accident Categories

837 commercial aviation accidents[2] were recorded in the IATA GADM Accident Database, six percent (6%) or 47 of which were classified, by the Accident Classification Technical Group (ACTG), as CFIT. Figure 1 illustrates the global breakdown of accidents across all accident categories. It should be noted that in 830 of the accidents enough information was available for the ACTG to determine the accident category (End State[3]), while the remaining seven (7) accidents lacked sufficient information.

CFIT ACCIDENTS ACCOUNT FOR ALMOST SIX PERCENT OF THE TOTAL ACCIDENTS

FIGURE 1: PERCENTAGE OF COMMERCIAL ACCIDENT CATEGORIES IN RELATION TO THE TOTAL ACCIDENTS



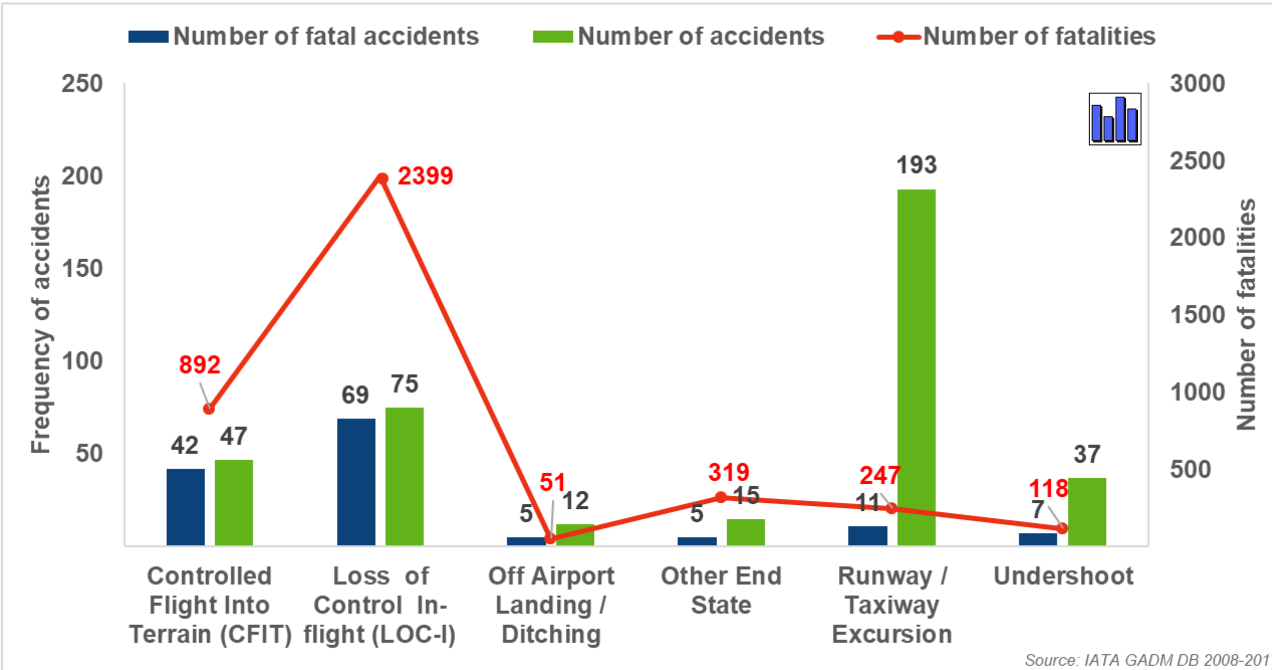
Out of the 837 accidents, 149 of which were fatal, resulting in 4,070 total fatalities. CFIT was the second most frequent category of fatal accident representing 42 fatal accidents or almost 28 percent of total fatal accidents. These CFIT accidents resulted in 892 fatalities among passengers and crew. It is obvious that CFIT is one of the accidents with lowest survivability ratio. The collection of data on the top six fatal accident categories reported in the last 10 years are shown in Figure 2.

[2] Analysis includes a de Havilland Canada DHC-4T Caribou cargo accident happened in 2016.

[3] An End State is the first unrecoverable stage of an accident, also known as the Accident Category.

CFIT WAS THE SECOND HIGHEST FATAL ACCIDENT CATEGORY, AFTER LOC-I

FIGURE 2: COLLECTION OF DATA ON TOP SIX FATAL ACCIDENT CATEGORIES



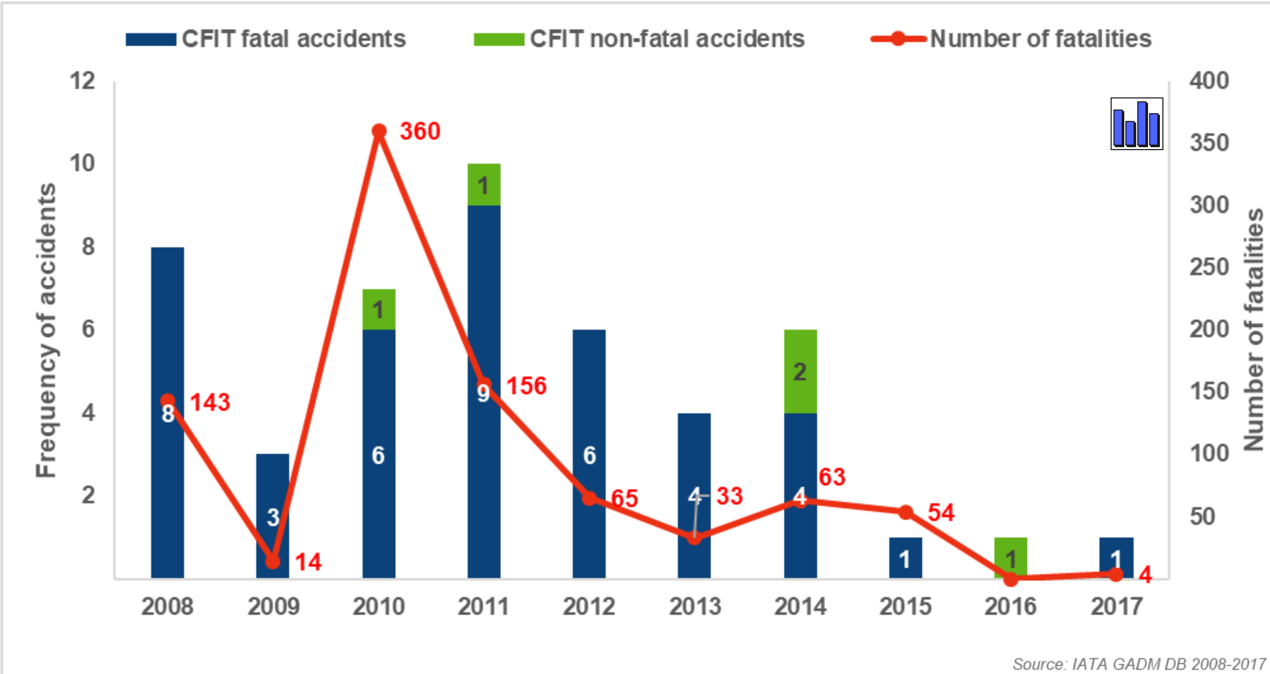
Despite the fact that CFIT accidents represented only about six percent (6%) of all commercial aircraft accidents under review, this risk area was the second-highest fatal accident category after Loss of Control Inflight (LOC-I). This issue still deserves industry attention.

Section 8—CFIT Accident Data

Over the 10 years, a total of 47 CFIT accidents were reported to IATA GADM database, with an average of about five (5) accidents per year. The numbers of yearly CFIT accidents and aviation deaths worldwide have been dropping. The last 5 years (2013-2017) saw a decrease in CFIT accidents compared with the previous years. For example, there were a total of ten (10) CFIT accidents in 2011 (the highest in the reporting period), and nine (9) of which were fatal; zero fatal accidents reported in 2016; and a single fatal accident reported in 2015 and 2017. Figure 3 illustrates the annual distributions of CFIT fatal and non-fatal accidents and the number of fatalities this accident category caused.

THE FREQUENCY OF CFIT ACCIDENTS HAVE BEEN DECLINING

FIGURE 3: ANNUAL DISTRIBUTIONS OF CFIT FATAL AND NON-FATAL ACCIDENTS, AS WELL AS THE NUMBER OF FATALITIES

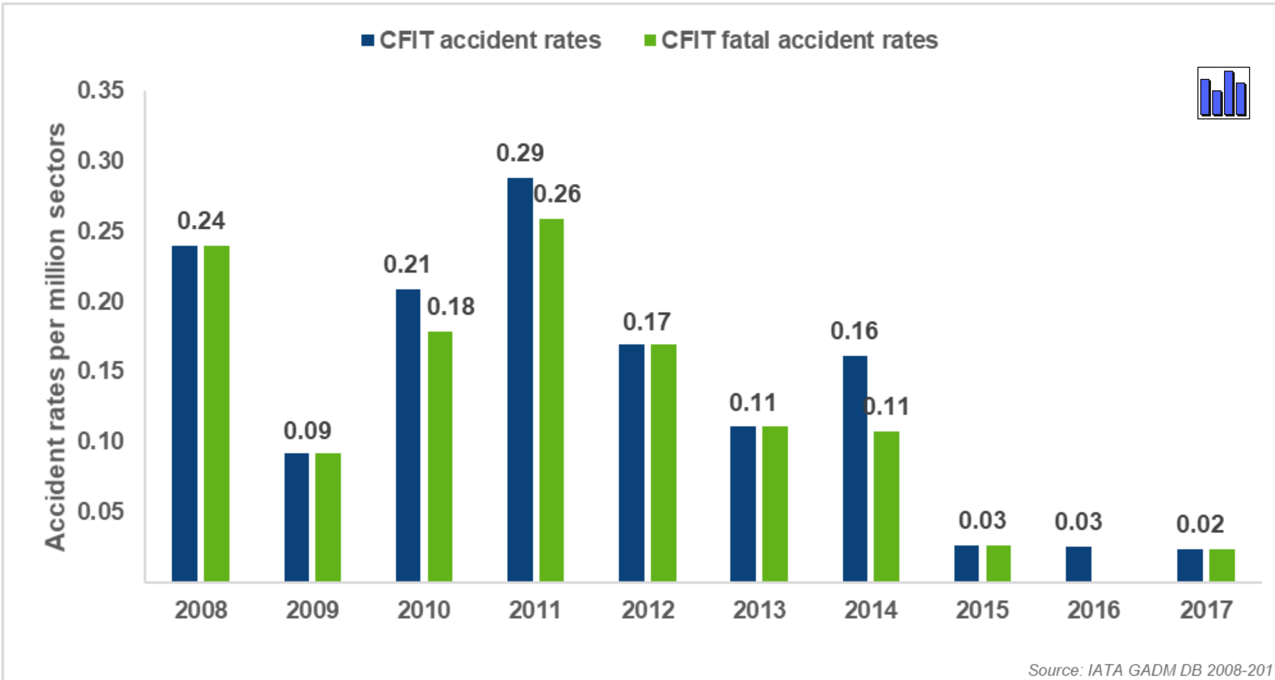


Absolute numbers of accidents are seldom a good indication of safety performance and are of limited comparative value unless they are normalized by the number of sectors[4] flown per year to create an accident rate. Figure 4 presents the CFIT accident rates by year. The data shows that there has been a decline in the CFIT fatal and non-fatal accident rates each year for the last five. In 2017 the downward trend in CFIT accident rates continued with 0.02 accidents per million sectors. This rate is below the five year average of 0.05 per million sectors for fatal accidents and 0.07 for all CFIT accidents. 2016 was the safest year in terms of CFIT fatal accidents, there were zero fatal accidents.

4 IATA defines "sector" as the aircraft between takeoff at one location and landing at another location (other than a diversion).

THE CFIT FATAL AND NON FATAL ACCIDENT RATES HAVE BEEN DECLINING

FIGURE 4: DISTRIBUTION OF CFIT ACCIDENT RATES (FATAL VS NON-FATAL) PER YEAR



Note: Where the accident rate is equal, this indicates that all CFIT accidents that year were fatal.

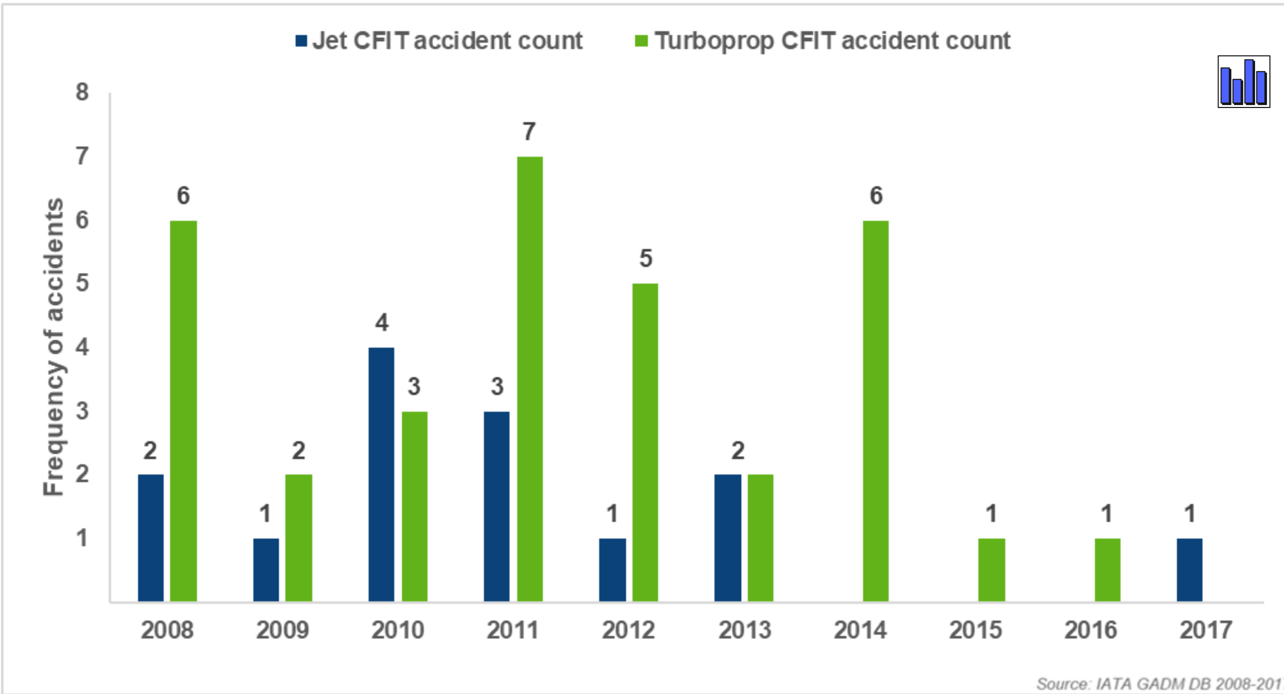
It is generally accepted that the reduction in CFIT accidents can be traced back to the introduction of Ground Proximity Warning System (GPWS), and Terrain Awareness Warning System (TAWS). Other improvements, may have also contributed directly or indirectly to the reduction of the likelihood of CFIT accidents, including aircraft design, replacing non-precision with precision approach procedures, pilot training, improved flight standards, Continuous Descent Final Approach (CDFA) technique, approach lightning, visual approach guidance and procedures, ground-based Minimum Safe Altitude Warning (MSAW) system, visual and instrument approach guidance and procedures.

8.1Controlled Flight into Terrain (CFIT) by Aircraft Propulsion Type

This section provides a breakdown of the CFIT accidents by type of aircraft propulsion and accident rates per million sectors flown. Jet aircraft were involved in 14 accidents or 30 percent of the total CFIT accidents; whereas turboprop aircraft were involved in 33 accidents or 70 percent of the total CFIT accidents. Figure 5 illustrates the distribution of annual CFIT accidents per aircraft propulsion type. The accident data shows that jet operations did not suffer any CFIT accidents in 2014, 2015, and 2016 had one (1) CFIT accident in 2017. Turboprop had zero CFIT accidents in 2017.

JET AIRCRAFT WERE INVOLVED IN 30 PERCENT OF CFIT ACCIDENTS AND TURBOPROP AIRCRAFT WERE INVOLVED IN 70 PERCENT OF THE TOTAL CFIT ACCIDENTS

FIGURE 5: DISTRIBUTION OF JET AND TURBOPROP AIRCRAFT CFIT ACCIDENT – COUNT



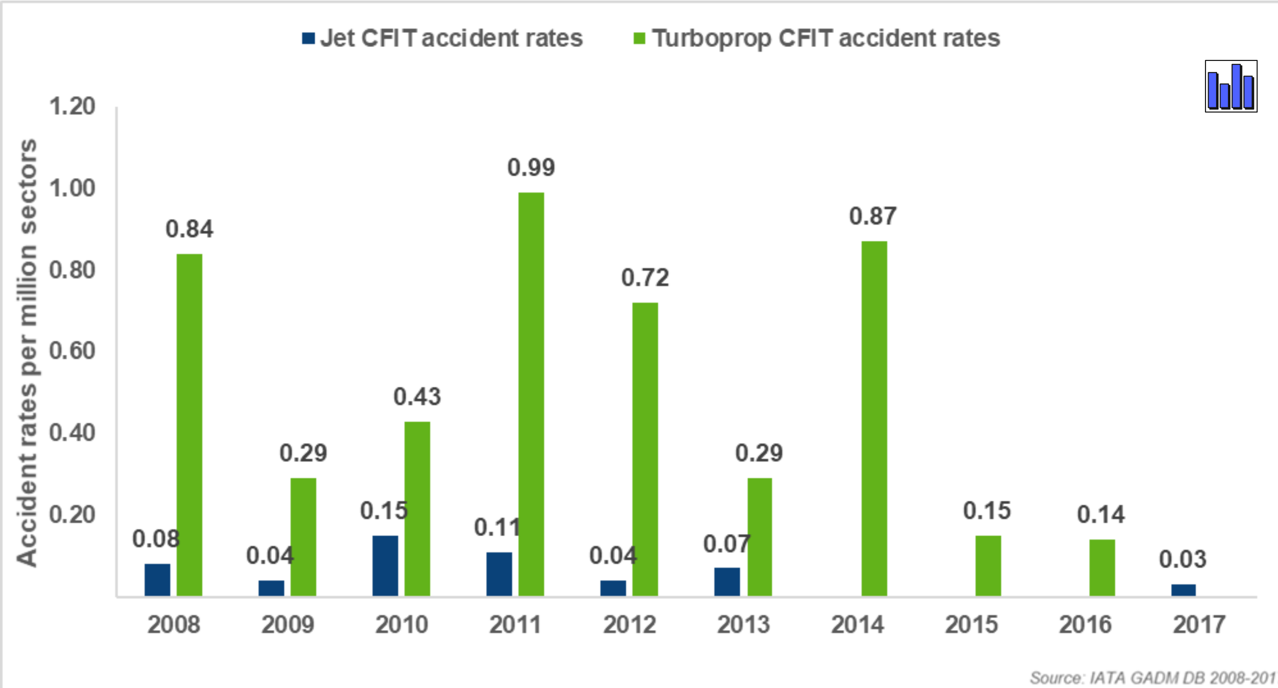
Note: One value shown on top of the two-bar graph of figure 5 indicates that the number of CFIT accidents involving jet and turboprop aircraft are exactly the same.

When converting jet/turboprop accident frequencies to accident rates per million sectors, it was found that turboprop aircraft had a significantly higher average rate of CFIT accidents than jet aircraft (0.47 accidents per million flights as opposed to 0.05). Figure 6 illustrates the distribution of accident rates per year broken-down by aircraft propulsion type. It is to be noted that jet and turboprops had two accidents each in 2013.

The turboprop CFIT accident rate was much higher than jet CFIT accident rate per million sectors, which is consistent with the all accidents rate. Turboprop aircraft operated 16.5 percent of the world's commercial flights in 2017, but accounted for 44 percent of all accidents and 5 out of the 6 fatal accidents. However, a positive improvement in turboprop safety can be seen when the 2017 all accident rate of 2.90 per million flights, is compared to the five year (2012 – 2016) rate of 4.89 per million flights.

THE TURBOPROP CFIT ACCIDENT RATE IS HIGHER THAN THE JET CFIT ACCIDENT RATE

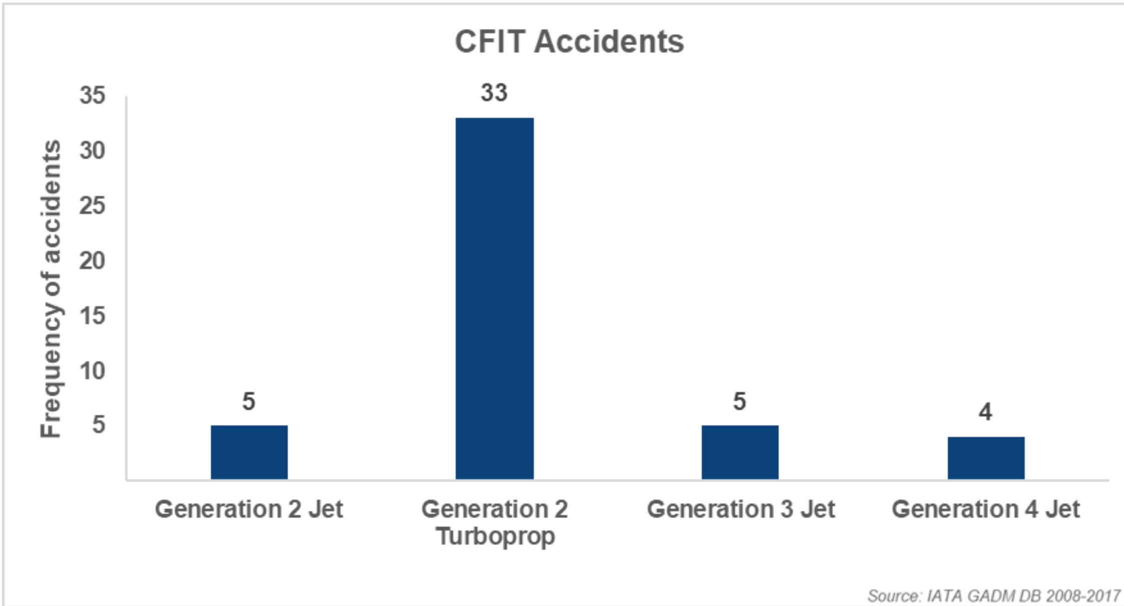
FIGURE 6: DISTRIBUTION OF JET AND TURBOPROP CFIT ACCIDENT RATES



Comparison of accidents by generation of aircraft shows a correlation between the number of CFIT accidents and aircraft generation. Older generation aircraft were involved in more CFIT accidents. Further analysis and normalization of this data is required before any firm conclusion can be drawn from this. The largest number of CFIT accidents occurred in the 2nd generation turboprops. The 4th generation jets shows that a reduction in the CFIT accidents has been achieved compared to the 3rd generation jets. Figure 7 illustrates the distribution of CFIT accidents per aircraft generation.

THE LARGEST NUMBER OF CFIT ACCIDENTS OCCURRED IN 2ND GENERATION TURBOPROPS

FIGURE 7: CFIT ACCIDENTS BY AIRCRAFT GENERATION

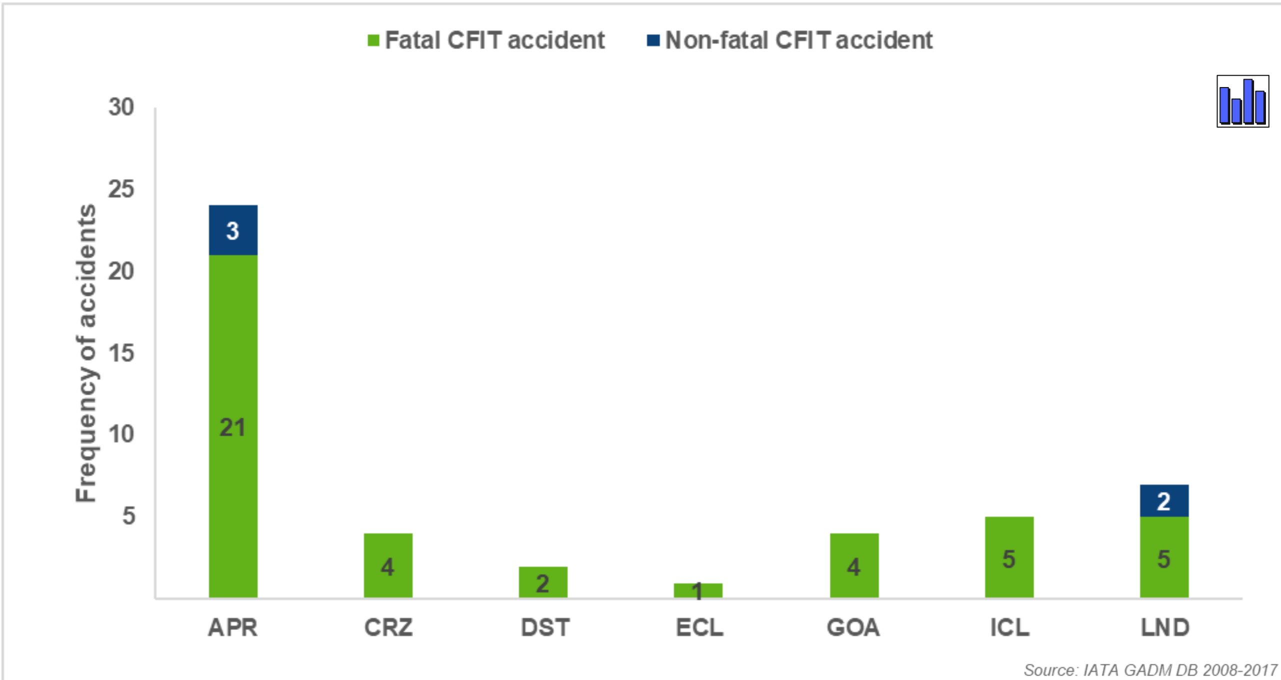


8.2 Controlled Flight into Terrain (CFIT) Accidents by Flight Phase

This accident category can occur during any airborne phase of flight, but CFIT is more common during the approach flight phase. When examining the CFIT accidents for both fatal and non-fatal it can be seen in figure 8 that the highest frequency of accidents occurred during the approach (APR) phase of flight with 24 accidents in total, or 51 percent of all CFIT accidents. There were five (5) non-fatal accidents over the past ten years, two (2) of which occurred on landing and three (3) occurred on approach. Figure 8 presents the CFIT accidents per phase of flight.

THE HIGHEST FREQUENCY OF CFIT ACCIDENTS OCCURRED DURING THE APPROACH

FIGURE 8: DISTRIBUTION OF CFIT ACCIDENTS BY PHASE OF FLIGHT



The approach and landing phase of flight account for 66 percent of all CFIT accidents, and 62 percent of fatal CFIT accidents. Table 1 depicts the annual distribution of CFIT fatal and non-fatal accidents per phase of flight.

Phase	Severity		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ICL	Fatal			1		1			3			
ECL	Fatal		1									
CRZ	Fatal				1	1	1			1		
DST	Fatal		1			1						
APR	Fatal		3	2	3	5	4	4				
APR	Non-Fatal								2		1	
GOA	Fatal		1				1		1			1
LND	Fatal		2		2	1						
LND	Non-Fatal				1	1						

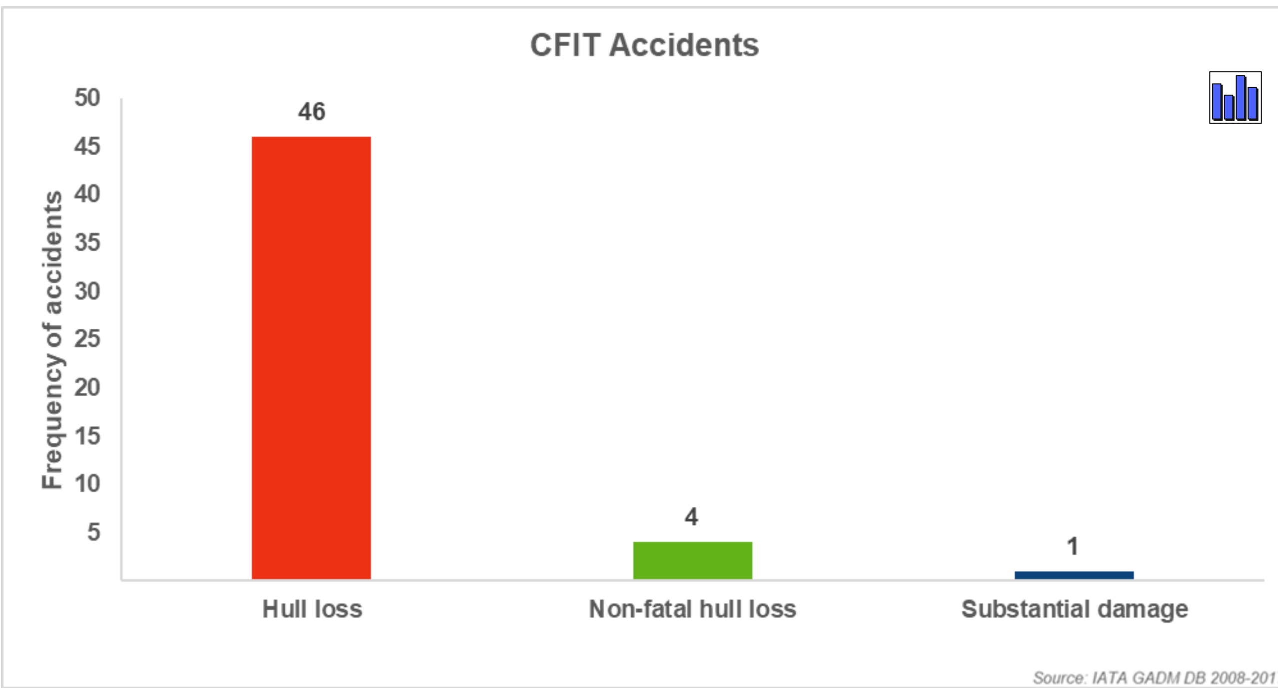
Table 1: Annual distribution of all CFIT (fatal and non-fatal) accidents per flight phase

8.3Controlled Flight into Terrain (CFIT) Severity

CFIT accidents tend to be severe in terms of number of fatalities and extent of damage to the airframe. Forty six out of the 47 CFIT accidents resulted in a hull loss, 42 of which were responsible for 892 fatalities. Only one CFIT accident sustained substantial damage with no fatalities. Figure 9 illustrates the annual distribution of total CFIT hull loss, substantial damage and non-fatal hull loss accidents.

THE MAJORITY OF CFIT ACCIDENTS RESULTED IN HULL LOSS ACCIDENTS

FIGURE 9 ANNUAL DISTRIBUTION OF TOTAL CFIT HULL LOSS, SUBSTANTIAL DAMAGE AND NON-FATAL HULL LOSS ACCIDENTS

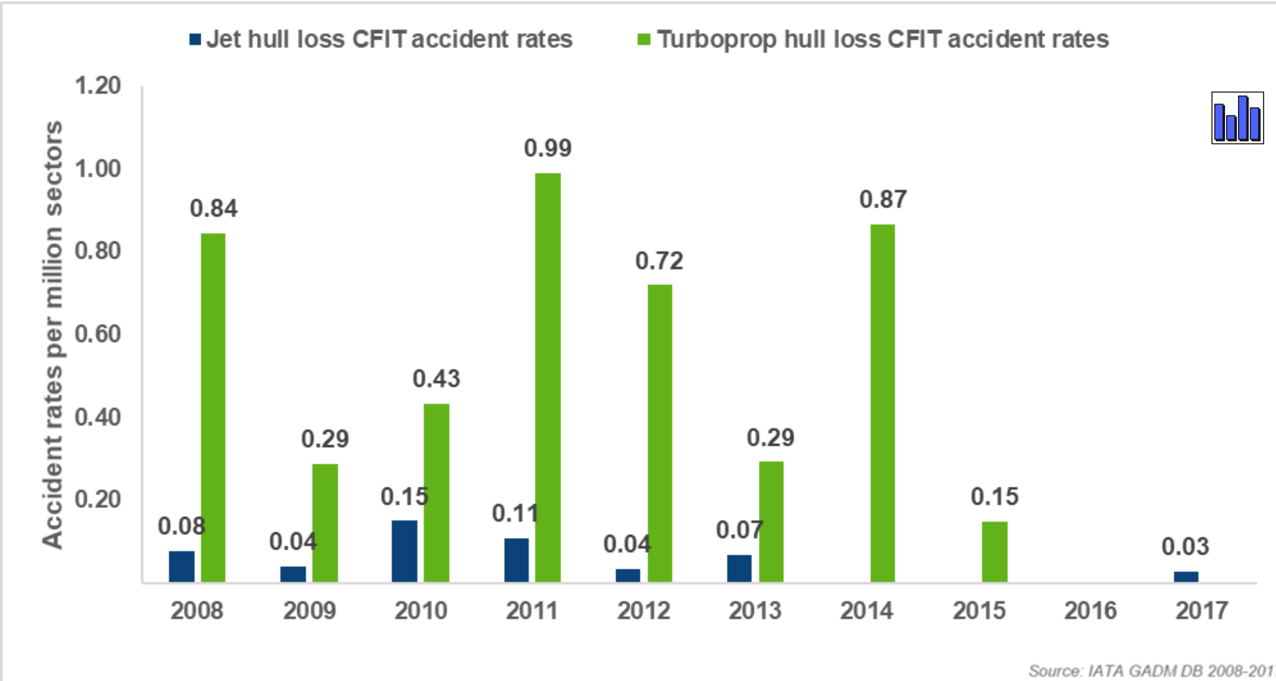


Measured in hull loss CFIT accidents, turboprop aircraft accidents accounted for the majority of those accidents, almost 70 percent of all CFIT hull loss accidents; whereas, 30 percent involved jet accidents. The average CFIT hull loss accident rates per million sectors recorded in the last ten years for turboprop was 0.46 opposed to 0.05 for jet fleet. Figure 10 presents the distribution of CFIT hull loss accident rates per million sectors by aircraft propulsion.

Note: There were zero jet CFIT hull loss accidents recorded in 2014, 2015 and 2016. In fact 2016 was the safest year for both jet and turboprop CFIT hull loss accidents - there were zero jet and turboprop CFIT hull loss accidents. Also, there were zero turboprop CFIT hull loss accidents recorded in 2017.

TURBOPROP CFIT ACCIDENTS ACCOUNTED FOR THE MAJORITY (70%) OF HULL LOSSES

FIGURE 10: DISTRIBUTION OF CFIT HULL LOSS ACCIDENT RATES PER MILLION SECTORS BY AIRCRAFT PROPULSION



Moreover, CFIT accidents involving turboprops accounted for the majority of fatal accidents and fatalities in this respective category. Table 1 presents the number of CFIT fatal accidents, normalized in rates per million sectors, and the number of fatalities per aircraft propulsion type. There were no fatal CFIT jet and turboprop accidents in 2016, but in 2017 there was one involving a jet cargo operation.

Note: The one fatal jet aircraft accident in 2017 resulted in four flight crew fatalities and 35 on-ground fatalities. More information on this accident can be found in section 8.5.

Year	Number of jet accidents	Number of Jet fatal accidents	Jet fatal accident rates	Number of fatalities on jets	Number of turboprop accidents	Number of turboprop fatal accidents	Turboprop fatal accident rates	Number of fatalities on Turboprops
2008	2	2	0.08	68	6	6	0.84	75
2009	1	1	0.04	6	2	2	0.29	8
2010	4	3	0.11	297	3	3	0.43	63
2011	3	3	0.11	68	7	6	0.85	88
2012	1	1	0.04	1	5	5	0.72	64
2013	2	2	0.07	23	2	2	0.29	10
2014	0	0	0.00	0	6	4	0.58	63
2015	0	0	0.00	0	1	1	0.15	54
2016	0	0	0.00	0	1	0	0.00	0
2017	1	1	0.03	4	0	0	0.00	0

Table 2: Collection of CFIT accident data and number of fatalities by aircraft propulsion

IATA member airlines outperformed the industry average with a jet hull loss CFIT accident rate of 0.01 over the preceding ten years (2008 through 2017), vs. non-IATA jet hull loss CFIT accident rate of 0.09 per million sectors. IATA member airlines also surpassed the overall industry average of CFIT jet hull loss accidents of 0.11 per million sectors. There is a strong correlation between IATA Operational Safety Audit (IOSA) accreditation and safe performance. See next section.

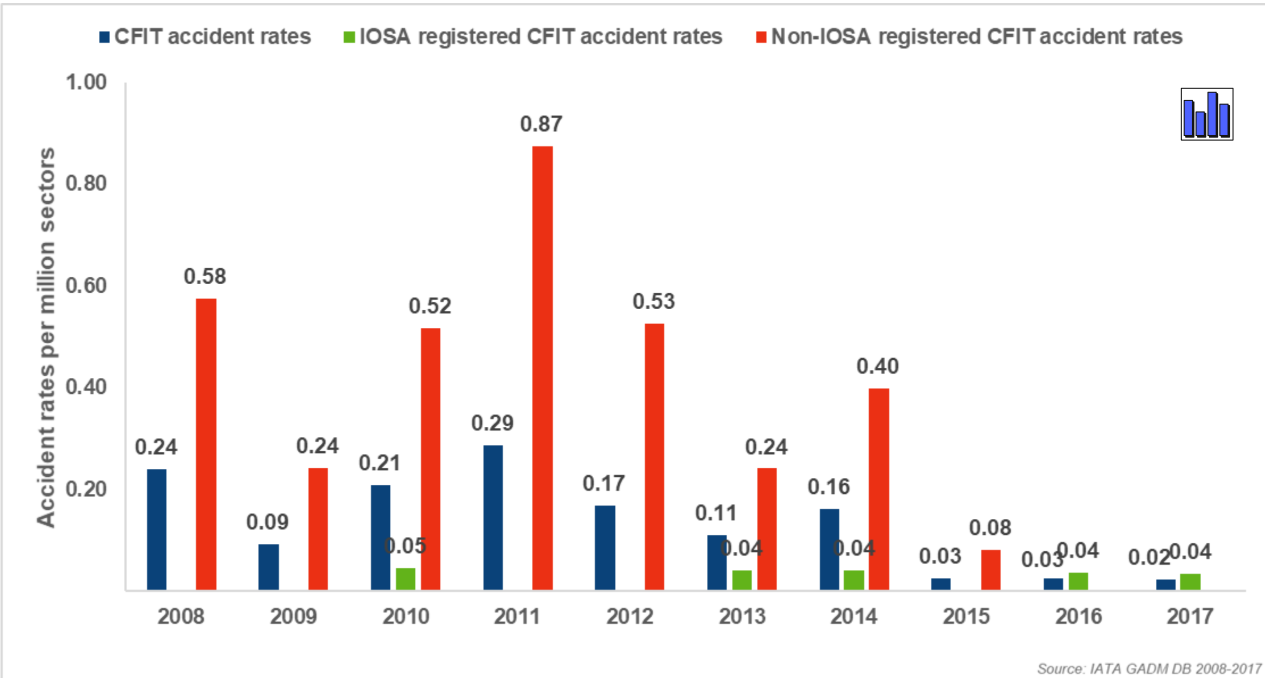
8.4 IOSA Registered Carriers versus Non-IOSA Registered CFIT Accidents

The accident rate for IATA carriers is at the lowest level since IOSA became a condition of IATA membership. The IOSA program is an internationally recognized and accepted evaluation system designed to assess the operational management and control systems of an airline. All IATA members are IOSA registered and must remain registered to maintain IATA membership. There are 146 non-IATA members who are IOSA accredited.

The positive results of IOSA were also illustrated when all accidents were broken-down to show the rate for IOSA registered airlines compared to the rate for operators not on the IOSA registry. The overall CFIT accident rate for IOSA-registered airlines was 17.5 times lower than that for non-IOSA-registered airlines for the period between 2008 and 2017 (0.02 vs. 0.35). Figure 11 illustrates CFIT accident rate for IOSA registered carriers versus non-IOSA.

IOSA-REGISTERED AIRLINES HAVE A LOWER CFIT ACCIDENT RATE THAN NON-IOSA-REGISTERED AIRLINES

FIGURE 11: CFIT ACCIDENT RATES FOR IOSA VERSUS NON-IOSA REGISTERED CARRIERS



This analysis shows that operators continue to deliver better safety performance when the operator's operational infrastructure, including that of its safety management capabilities, is robust. Furthermore, operational standards such as IOSA are certainly a key to safer operations.

The following section provides insight into the different type of operational service on CFIT accidents. Accidents are broken-down by scheduled/unscheduled airlines, cargo/passenger flights, and domestic/international service.

8.5 Type of Service

Different operational service types and/or the familiarity of the operating environment can influence the potential for a CFIT accident. This section presents the type of operational service, in terms of cargo or passenger operations and scheduled or unscheduled operations. 24 accidents or 51 percent of CFIT accidents involved passenger flights, and 18 accidents or 38 percent were represented by cargo operations. Five (5) accidents or 11 percent involved a ferry flight. Table 3 presents the breakdown of CFIT accidents by the type of service and operation.

Note: Since we do not have the sector information to normalize the data in this section, it is very difficult to draw any firm conclusion.

Service	Total CFIT accidents	Domestic flights	International flights
Passenger	24	21	3
Cargo	18	13	5
Ferry	5	0	0

Table 3: CFIT accidents by type of service and operation

Analyzing the type of service and operation involved in CFIT accidents per region of operators as seen in table 4, it is notable that Asia pacific (ASPAC) had the highest number of CFIT passenger accidents in domestic flights, whereas Africa (AFI) had the highest number of CFIT Cargo accidents. More Regional CFIT accident analysis can be found in section 8.6.

	CFIT passenger accidents		**CFIT cargo accidents**	
Region	Domestic Flights	International Flights	Domestic Flights	International Flights
AFI	0	1	5	1
ASPAC	7	0	2	0
CIS	4	1	0	3
EUR	0	0	0	1
LATAM	5	0	1	0
MENA	2	1	0	0
NAM	1	0	5	0
NASIA	2	0	0	0

Table 4: Type of service and operation involved in CFIT accidents per region of operators

Out of the 24 CFIT passenger flights, 22 of which were fatal accidents resulting in 808 fatalities in the last ten years. Of those 22 fatal accidents, eight (8) of which were on jet aircraft; and there were no CFIT commercial jet passenger accidents at all recorded in the last four years (2014, 2015, 2016 and 2017) and no CFIT cargo turboprop accidents in the last three years (2015, 2016 and 2017). Table 5 presents the annual distribution of the fatal CFIT passenger and cargo accidents per aircraft propulsion.

Note: The one fatal jet aircraft accident in 2017 involved a cargo jet flight. The crash of the cargo jet also resulted in the death of 35 persons on the ground, as well as the crew of the jet.

	CFIT passenger accidents				CFIT cargo accidents			
Year	All jet accidents	Number of jet fatal accidents	All turboprop accidents	Number of turboprop fatal accidents	All jet accidents	Number of Jet fatal accidents	All turboprop accidents	Number of turboprop fatal accidents
2008	1	1	2	2	0	0	3	3
2009	0	0	0	0	1	1	1	1
2010	3	3	2	2	0	0	1	1
2011	2	2	6	5	1	1	1	1
2012	1	1	3	3	0	0	2	2
2013	1	1	0	0	1	1	2	2
2014	0	0	1	1	0	0	4	3
2015	0	0	1	1	0	0	0	0
2016	0	0	1	0	0	0	0	0
2017	0	0	0	0	1	1	0	0

Table 5: CFIT Fatal accidents by type of service and aircraft propulsion

Moreover, when CFIT accidents were broken-down by scheduled and non-scheduled operations, it was apparent that scheduled passenger operations had a higher number of accidents (almost by a factor of 3.8) compared to non-scheduled passenger operations, while it was reversed with the cargo operations. All non-scheduled passenger flights were fatal. Whereas in the cargo service, it was apparent that all scheduled flights were fatal. Table 6 summarizes the number of accidents by scheduled vs. non-scheduled operations.

	All	Fatal	Fatalities	Survivability
Passenger				
Scheduled	19	17	714	25%
Non-Scheduled	5	5	94	4%
Cargo				
Scheduled	3	3	7	0%
Non-Scheduled	15	14	66	12%

Table 6: CFIT Accidents By Scheduled Vs. Non-Scheduled

Note: Given the 10-year fleet size, cargo shares about 12 percent of the total passengers and cargo fleet size. Cargo operations account for 38% of total CFIT accidents. The percentage of accidents is disproportional.

The following section presents an analysis of the regional differences in CFIT accidents. Regions are defined by IATA and the breakdown of regions and countries is listed in Appendix A.

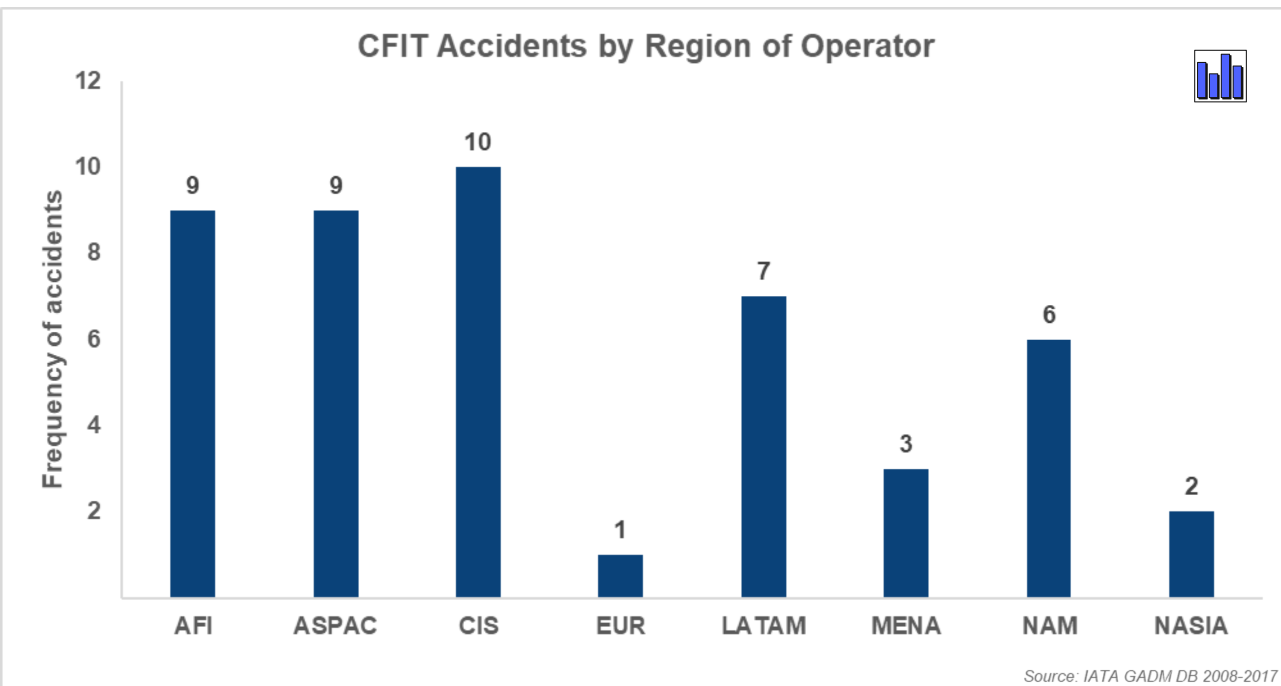
8.6Controlled Flight Into Terrain (CFIT) Regional Analysis

Aviation safety varies across different regions of the world. Figure 12 presents the overall distribution of CFIT occurrences by IATA global regions of operator for the reporting period 2008 through 2017. Operators from Commonwealth of Independent State (CIS) had the highest number of CFIT accidents with ten (10) accidents, or 21 percent, of the total CFIT accidents. The four regions which marked equal or below the regional average of six (6) CFIT accidents per year were Europe (EUR), North Asia (NASIA), Middle East and North Africa (MENA) and North America (NAM). The other regions were above the total regional average.

All regions showed improvement in the last three years when compared to earlier years. The exception is EUR, Latin American and Caribbean (LATAM) and Asia Pacific (ASPAC), where they encountered one accident each. Further, EUR managed to maintain zero CFIT accidents until 2017.

OPERATORS FROM COMMONWEALTH OF INDEPENDENT STATE (CIS) HAD THE HIGHEST NUMBER OF CFIT ACCIDENTS, CLOSELY FOLLOWED BY AFRICA (AFI) AND ASIA PACIFIC (ASPAC)

FIGURE 12: CFIT ACCIDENTS BY REGION OF OPERATOR

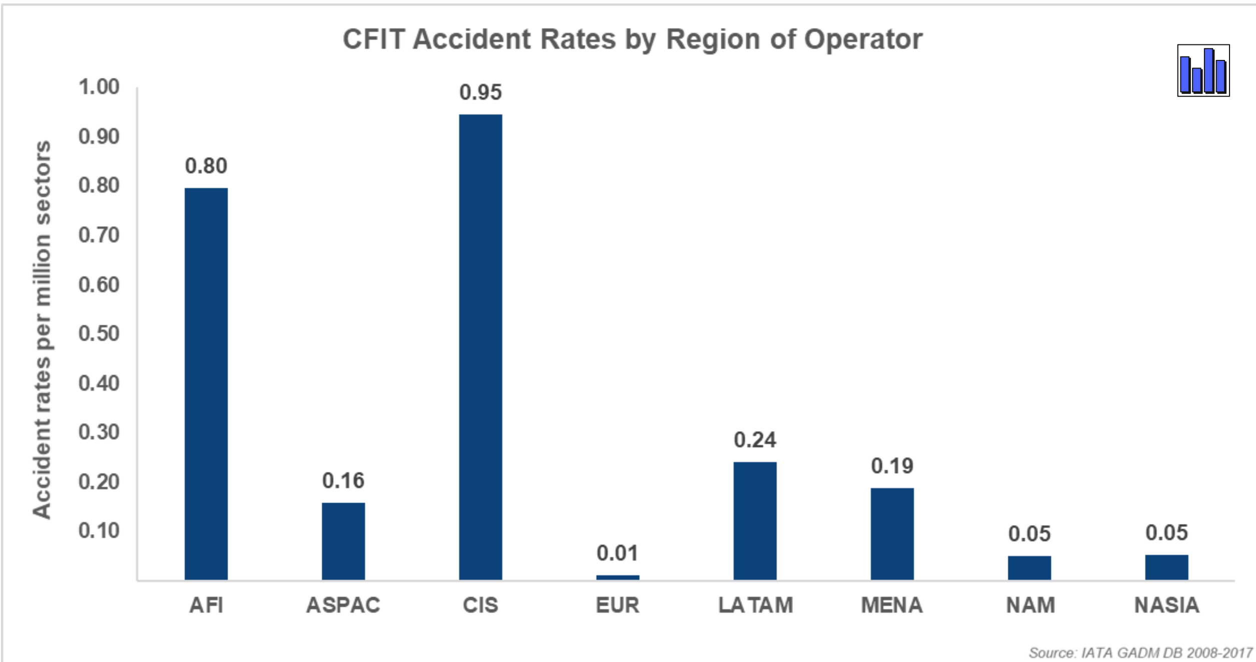


The same data is normalized to reflect the accident rate per million sectors. It was indicated that the highest CFIT accident rate was found for CIS operators with a rate of 0.95 accidents per million sectors flown. Although, the requirement to mandate GPWS exists in Russia since 01 July 2012, CIS suffered the highest accident rate and that is not because TAWS/EGPWS is not installed, but the accidents were attributed to other factors such as flight crew did not react properly to its signals. More information on TAWS/GPWS can be found in Section 10.

To normalize by the number of sectors flown per region of operator to create an accident rate, figure 13 presents the CFIT accident rates per million sectors based on region of operator (region of registration of operator). It is worth noting that the following regions outperformed the regional CFIT accident rate of 0.31, North America (NAM) and NASIA with 0.05 each, MENA with 0.19, LATAM with 0.24, EUR with 0.01, and ASPAC with 0.16.

OPERATORS FROM COMMONWEALTH OF INDEPENDENT STATE (CIS) HAD THE HIGHEST CFIT ACCIDENT RATE

Figure 13: CFIT Accident Rates by IATA Region of Operator



A comparison of all CFIT accident rates versus fatal accident rates in respect to each of the IATA global regions of operator shows that all CFIT accidents involving operators from ASPAC, EUR, MENA, NAM and NASIA were fatal. Figure 14 illustrates the distribution of fatal accident rates per region of operator.

THE MAJORITY OF CFIT ACCIDENTS WERE FATAL

FIGURE 14: CFIT ALL ACCIDENTS VERSUS FATAL RATES BY REGION OF OPERATOR

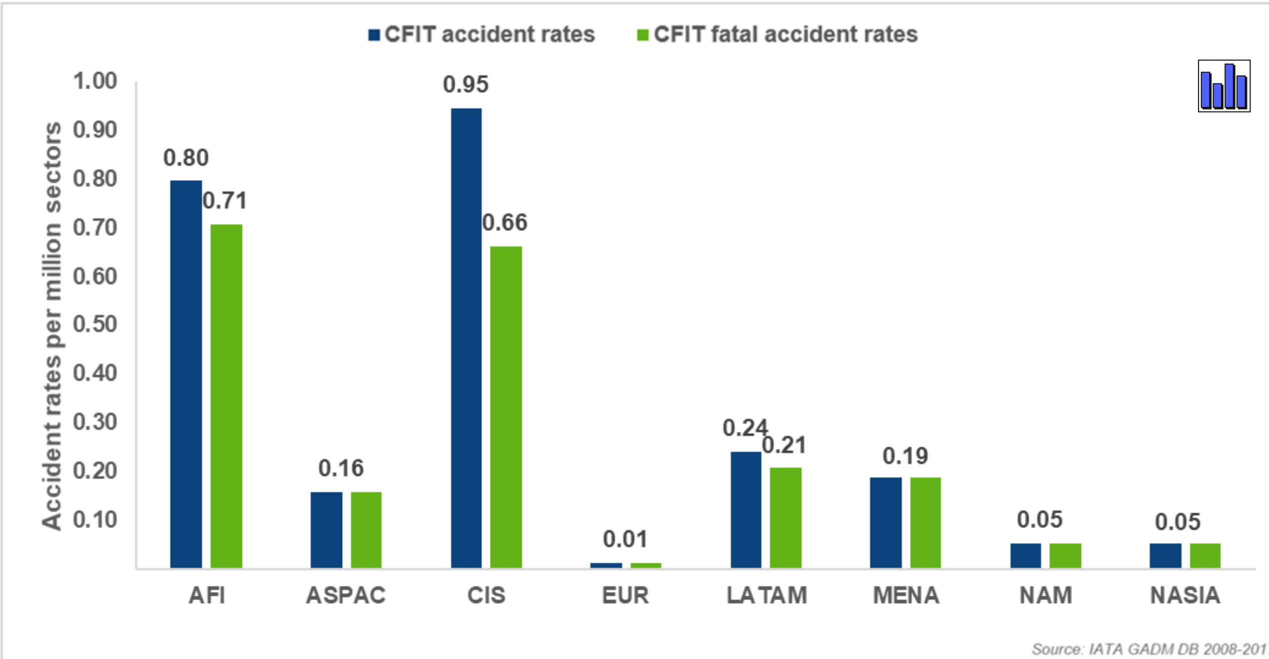
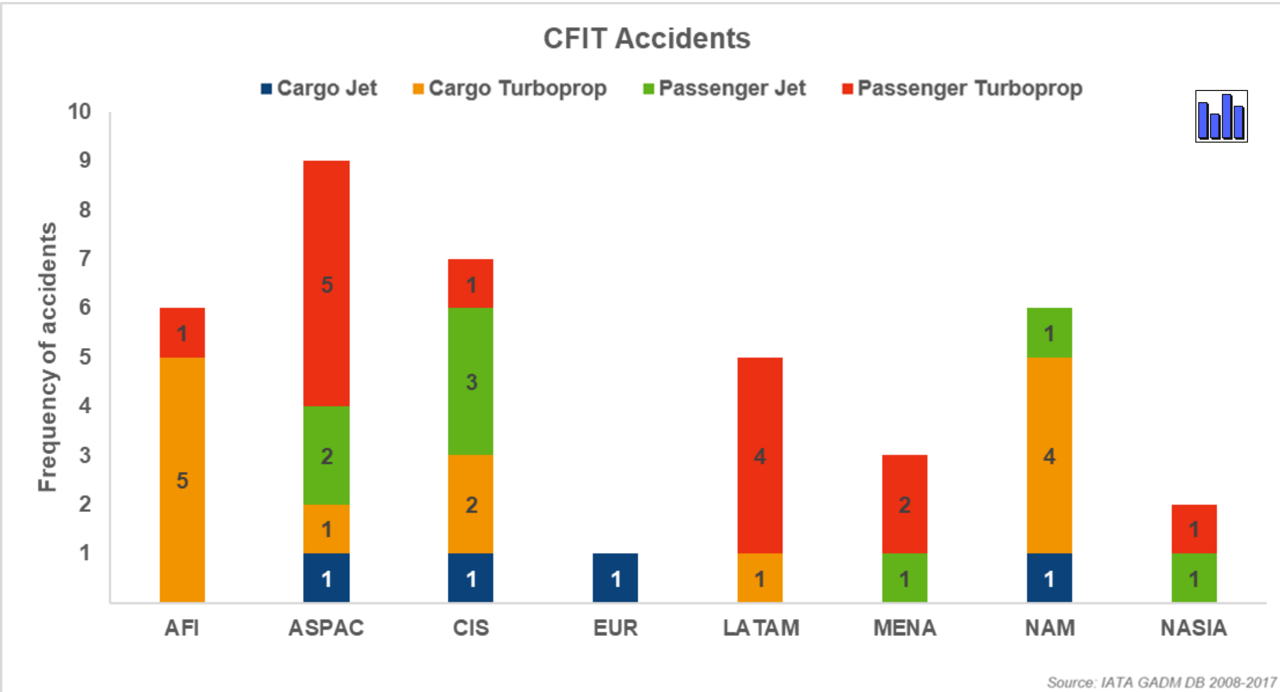


Figure 15 shows the distribution of fatal CFIT accidents by service type and aircraft propulsion per region of operator. The data shows that EUR and AFI operators have had no jet CFIT accidents involving passenger fatalities. However, there were a total of eight (8) fatal jet CFIT accidents resulted in 443 passenger and crew fatalities. These accidents involve ASPAC, CIS, MENA, NAM and NASIA operators. The remaining 365 fatalities involved turboprop aircraft of AFI, ASPAC, CIS, LATAM, MENA, and NASIA.

ASPAC BASED OPERATORS HAD THE HIGHEST NUMBER OF FATAL CFIT ACCIDENTS

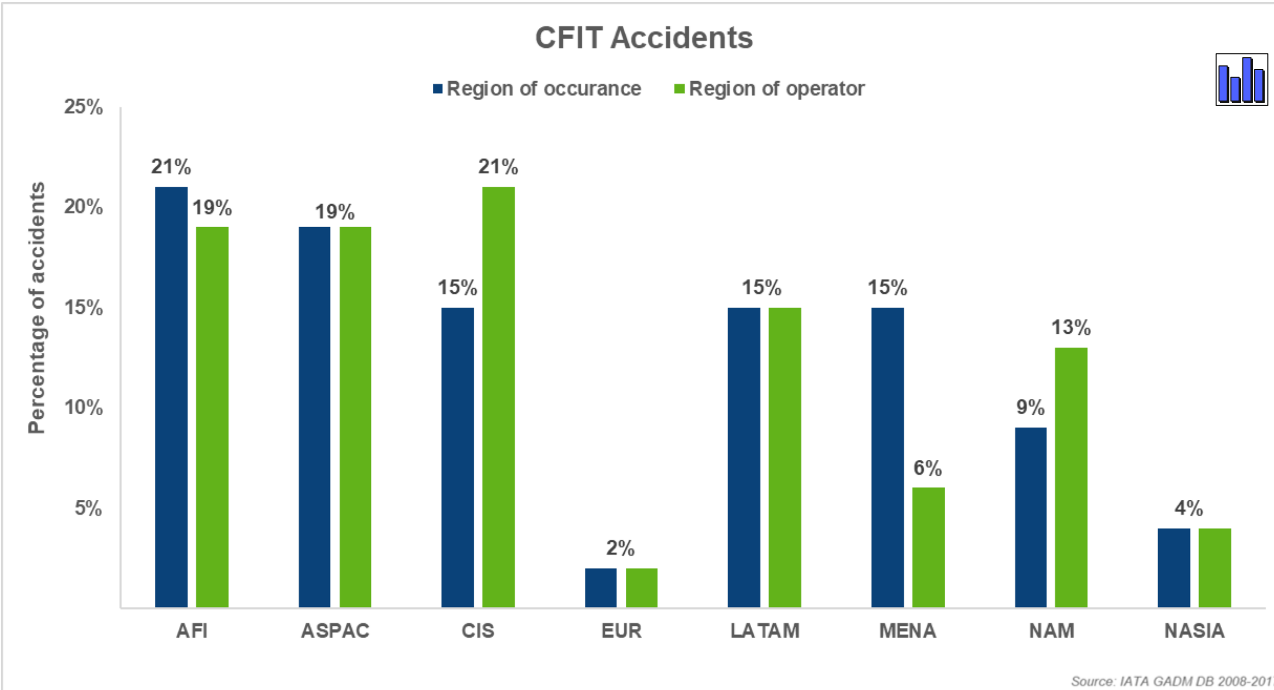
FIGURE 15: THE DISTRIBUTION OF CFIT FATAL ACCIDENTS BY TYPE of SERVICE and AIRCRAFT PROPULSION PER REGION OF OPERATOR



It is also important to analyze CFIT accidents on the location of occurrence in comparison to the region of operators, it is to be noted that 21 percent of CFIT accidents occurred in Africa, while 19 percent of the accidents involved African based operators. Fifteen percent of the accidents occurred in the territory of CIS region, while 21 percent involved CIS operators. Figure 16 details the distribution of CFIT accidents by region of operator versus region of occurrence.

CIS, AFI AND ASPAC BASED OPERATORS HAD THE HIGHEST PERCENTAGE OF CFIT ACCIDENTS

Figure 16 - Distribution of CFIT accidents by region of operator versus region of occurrence



It is recognized that CFIT accidents are generally the consequence of a chain of events, and not the result of just one contributing factor. There are different contributing factors and influential parameters such as the non-availability of precision approach aids, airport infrastructure, type of aircraft involved, air traffic control, poor CRM behavior, noncompliance to SOPs, adverse meteorological conditions, as well as the socio-cultural environment that may differ from one region to another. It is, therefore, important to understand the common contributing factors which are presented in the next section.

8.7 Controlled Flight into Terrain (CFIT) Contributing Factors

CFIT accidents results from numerous contributing factors that may occur individually but quite often occur in combination. The question is asked 'what risk mitigation strategies would likely have prevented the accident?', e.g. more stringent regulatory oversight, the provision of a Safety Management System (SMS), enhanced CRM, strict adherence to SOPs, or training.

The identification of all contributing factors for CFIT accidents, was found to be most useful for the purpose of establishing mitigation strategies. Therefore, further accident analysis may be required for the development of any mitigation strategy.

IATA, through the ACTG, assigns contributing factors to accidents to better understand the correlations. The contributing factors follow a Threat and Error Management structure and are divided into the following four areas:

- Latent Conditions: Conditions present in the system before the accident and triggered by various possible factors.
- Environmental and Airline Threats: An event or error that occurs outside the influence of the flight crew, but which requires crew attention and management if safety margins are to be maintained.

  Mismanaged threat: A threat that is linked to or induces a flight crew error.

- Flight Crew Errors: An observed flight crew deviation from organizational expectations or crew intentions.

  Mismanaged error: An error that is linked to or induces additional error or an undesired aircraft state.

- Undesired Aircraft States: A flight-crew-induced aircraft state that clearly reduces safety margins; a safety-compromising situation that results from ineffective error management. An undesired aircraft state is recoverable.

  Mismanaged UAS: A UAS that is linked to or induces additional flight crew errors.

The most frequent contributing factors to CFIT accidents are listed in figure 17.

Note: Eight (8) accidents (or 17% of CFIT accidents) were not classified due to insufficient data; these accidents were subtracted from the total accident count in the calculation of contributing factor frequency.

Latent Conditions	Percentage	Flight Crew Errors	Percentage
Regulatory Oversight	**72%**	SOP Adherence / SOP Cross-verification	**56%**
Technology & Equipment	**54%**	Intentional	**41%**
Safety Management	**46%**	Manual Handling/Flight Controls	**21%**
Flight Operations	**31%**	Callouts	**18%**
Flight Ops: SOPs & Checking	**21%**	Unintentional	**15%**
Environmental Threats	**Percentage**	**Undesired Aircraft States**	**Percentage**
Meteorology	**51%**	Controlled Flight Towards Terrain	**56%**
Nav Aids	**51%**	Vertical / Lateral / Speed Deviation	**49%**
Ground-based nav aid malfunction or not available	**49%**	Unnecessary Weather Penetration	**18%**
Poor Visibility / IMC	**46%**	Unstable Approach	**10%**
Lack of Visual Reference	**33%**	Continued Landing after Unstable Approach	**5%**
Airline Threats	**Percentage**	**Countermeasures**	**Percentage**
Operational Pressure	**10%**	Monitor / Cross-check	**56%**
Aircraft Malfunction	**11%**	Overall Crew Performance	**49%**
Avionics / Flight Instruments	**5%**	In flight decision making/contingency management	**23%**
Autopilot / FMS	**3%**	Communication Environment	**21%**
		Leadership	**21%**

Figure 17: Most frequent CFIT contributing factors

CFIT accidents were predisposed by a number of contributing factors. These include, deficiencies in regularity oversight, which was a factor in 72 percent of CFIT accidents; malfunction or lack of ground-based nav-aids which was a contributing factor in 49 percent of the accidents. The implementation of precision approaches or performance based navigation (PBN) approaches is seen as a method to reduce the risk of CFIT accidents. Authorities are therefore encouraged to comply with ICAO recommendations and guidelines regarding PBN implementation; particularly Approaches with Vertical Guidance (APV).

Operating in adverse weather conditions was also cited a contributing factor in 51 percent of CFIT accidents; poor visibility / IMC and lack of visual reference including darkness and black hole effect in 46 percent.

Runways with limited lightings can dramatically increase the risk of CFIT. In order to help mitigate the risk of CFIT, pilots should always receive accurate weather forecast, with emphasis on wind conditions, for the time and route to be flown. Likewise, illuminations such as a visual glideslope indicator (VGSI) or a visual approach slope indicator system (VASIS) is another method to keep the aircraft safe.

Incorrect or unclear chart pages or operating manuals was likewise cited as a contributing factor in two percent (2%) of CFIT accidents. Incorrect, outdated or unclear approach charts can increase the risk of a CFIT accident. Unclear approach templates may cause pilots to deviate from them or misinterpret them hence taking them close to unsafe areas especially if the airport is near mountainous regions. This is exacerbated especially if pilots are unfamiliar and are operating into the airport in a night time environment. Operators and pilots must ensure that they carry the most up-to-date flight instrument charts so that they fly the correct instrument charts and do not fly into terrain mistakenly. They also must ensure to conduct a proper preflight planning session and familiarize themselves with the terrain that may surround them during their flight, as terrain familiarization is a critical to safe visual operations in particular at night.

An unstable approach was also a factor contributing to such accidents. Unstable approaches increase the possibility of diverting a flight crew's attention away from the approach procedure to regain better control of the airplane. Stabilized approach policies broadly concur in stating that a safe approach requires the flight path angle, configuration, and airspeed to be stabilized. Once one or more of these parameters are violated, the approach becomes unstable and the margin for a safe landing is decreased to a level requiring flight crew action; a go-around should be initiated.

Since the CDFA techniques contribute to a stabilized approach, the industry should also as soon as, and wherever, possible to develop procedures and train pilots to fly a stabilized CDFA. This would include procedures such as the constant rate descent that can be flown by all types of aircraft and use of the modern vertical navigation capability (VNAV) by some existing and most new aircraft types.

Operators must require their pilots to fly a stabilized approach and to always make timely decision to go-around from an unstable approach. IATA encourages pilots, air traffic controllers, manufacturers, operators, regulators, air navigation service providers and others to consult with the 3rd edition of the IATA/IFALPA/IFATCA/CANSO Unstable Approaches: Risk Mitigation Policies, Procedures and Best Practices.

It is evident that most of the CFIT accidents result from a pilot's breakdown in situational awareness (SA) instead of aircraft malfunction or a fire. In other words, these accidents are, for the most part, entirely preventable by the pilot. SA refers to the accurate perception by flight crew of the factors and conditions currently affecting the safe operation of the aircraft, and their vertical and/or horizontal position awareness in relation to the ground, water, or obstacles. The data shows that 49 percent of CFIT accidents had vertical, lateral or speed deviations as a contributing factor to CFIT accidents. One method to provide pilots with a greater level of safety through enhanced situational awareness and, more reliable warnings of possible terrain conflicts such as EGPWS that is equipped with accurate navigation systems like global positioning system (GPS) for both navigation and terrain surveillance.

Flight crew non-compliance with established procedures was as well a contributing factor in 23 percent of CFIT accidents. Poor CRM was also a frequent contributing factor. Effective crew coordination and crew performance, and in general CRM principles and behaviors can reduce pilots' workload and decrease the probability of human errors.

Pilot Performance remains a major factor in CFIT accidents; despite the efforts to mitigate risk, handling and/or inappropriate actions by flight crew continue to be emphasized. Enhancing pilot performance and complacency, both in normal and abnormal circumstances, will empower pilots to intervene, with greater confidence and competence, to prevent any environmental threats and hazards that could lead to high-risk outcomes.

Operators must ensure that their training programs robustly address potential deficiencies, environmental, technical/non-technical factors such as human factors, air carrier's SOPs fatigue, CRM techniques for the most effective prevention and threat mitigation strategies, and any occurrence reporting which affect their performance. Training, whether it is academic or simulator training, should allow pilots to experience realistic situations that require timely decisions and correct responses. Simulator training should also be given to provide pilots the opportunity to practice CFIT prevention strategies, including the escape maneuvering. Training should be given to pilots during initial, transition and recurrent training.

Another important element of continued improvement in CFIT accidents is the collection and sharing of flight data in order to identify hazards ahead of time and mitigate those risks that can lead to an accident. The use of Flight Data Management (FDM) is essential as it identifies potential hazards in flight operations and provides accurate quantitative data. It is also the best known indicator of undesired aircraft states like operation outside aircraft limitation. More information on FDM can be found in the next section (section 9).

Additionally, numerous Safety Enhancements (SEs) have been developed by the Commercial Aviation Safety Team (CAST). These SEs address domains such as SOPs, training, proactive safety programs, human factors, improvement in minimum safe altitude warning systems (MSAWs), terrain avoidance warning system (TAWS) and others. Implementation of the SEs is estimated to reduce the risk of CFIT accidents. Appendix B to this report provides further insight on the SEs for the prevention of CFIT.

Section 9—Flight Data Monitoring (FDM)

The best potential source of operational data is the operators' own Flight Data Monitoring (FDM), Flight Data Analysis (FDA), or Flight Operations Quality Assurance (FOQA) programs. The aim is to improve safety through an analysis of information downloaded from an aircraft's on-board computer at the end of every flight. This information can be used to identify trends and discover issues that might develop into a serious safety problem.

The routine download and analysis of recorded flight data has been used by operators for many years as a tool to identify potential hazards in flight operations, evaluate the operational environment, validate operating criteria, set and measure safety performance targets, monitor SOP compliance and measure training effectiveness.

In non-routine circumstances, when an incident occurs the data can be used to debrief the pilots involved and inform management. In a de-identified format the incident data can also be used to reinforce training programs, raising awareness amongst the pilot group as a whole.

Data collection and analysis can provide information of threats, hazards and identify potential weaknesses of an operator. As indicated in the jointly agreed IATA/ICAO/IFALPA Evidence-based Training (EBT) Implementation guide that the collection and analysis of operational data (such as the characteristics of the operators, reporting systems, flight data analysis, flight deck observation; data sharing groups outcomes) helps to develop relevant and effective training programs, by managing the most relevant threats and errors, based on evidence collected in operations and training.

IATA encourages operators to produce set of standardized FDM safety measures and precursors related to potential CFIT accidents; such as GPWS/TAWS alert/warning (genuine, nuisance or false), MSAW warning, low-energy state during approach, Lateral deviation during approach, and others. IATA also encourages reporting and investigating all incidences including the false warnings.

With the established standardized FDM, operators can be able to monitor precursors and common factors leading to CFIT events. Furthermore, FDM will not only enable operators to be alerted to CFIT events and trends, but also to enable them to review procedures and training programs to reduce such events. FDM tools should be used as a primary source whenever possible.

In addition to an FDM program, preventative and recovery risk control measures should be encouraged and implemented by regulators, pilots, operators and manufacturers to help mitigate or avoid the serious consequences of CFIT.

Section 10—Ground Proximity Warning System (GPWS) / Terrain Awareness and Warning System (TAWS)

A separate study was conducted to verify that a pilot demonstrates the ability to response adequately to an EGPWS warning and properly interpret information emitted by an EGPWS warning and alert. JACDEC, Aviation Safety Network, official investigation reports, Aviation Herald, and IATA GADM accident database were all used as a reference.

The study was based on 51 accidents and incidents from 2008 through 2017 where GPWS/TAWS was found in their respective narratives. It may have been a contributing factor to the accident/incident, but not necessarily in all cases. The study reveals that

- About 39 percent of the incidents and accidents under review showed that pilots had the ability to properly respond to an EGPWS alert and warning.
- About 47 percent (24 accidents/incidents) showed that pilots did not adequately respond (whether in timely manner or have taken the correct action maneuver) to EGPWS warnings.
  - The lack of adherence to procedures and the lack of documented and clear procedures in SOPs were apparent in some cases;
  - In one case, the pilot attempted to respond to an EGPWS warning but had difficulty controlling the aircraft which may have been caused by significant change of wind and visibility;
  - In one case, the EGPWS warnings should have been treated as genuine rather than the crew ignoring the alert;
  - The 24 accident and incident reports involved operators from
    - AFI (2)
    - ASPAC (10)
    - CIS (4)
    - EUR (3)
    - LATAM (1)
    - MENA (2)
    - NAM (1)
    - NASIA (1)
- About 6 percent (3 events) show that the system did not emit a warning sound.
  - In one case, the EGPWS did not emit a warning due to the EGPWS being disabled, the report had identified some pilots including the accident pilot with behavior of pulling EGPWS circuit breaker to eliminate nuisance of EGPWS warnings.
  - The three (3) accident and incident reports involved operators from
    - ASPAC (2)
    - EUR (1)

- About 8 percent or (4 events) were not equipped with GPWS/TAWS system or the latest generation of EGPWS
  - The four accident and incident reports involved operators from
    - NASIA (1)
    - CIS (1)
    - ASPAC (1)
    - AFI (1)

IATA is planning to conduct a further in-depth study to see if pilots response adequately to an EGPWS alert or warning.

The following section presents two case studies.

Section 11—Case Studies

This section provides two case studies of CFIT accidents with the intent to learn from the errors that may have led to the accident. Each accident, in general, summarizes the description of the event and then highlights the probable causes and the safety recommendations.

Case study number 1:

Event Description:

- Accident occurred in 2013 on approach, aircraft was operating on an old-generation.
- Crashed short of runway during a localizer non-precision approach.
- The cargo flight was operating a scheduled domestic service.
- The aircraft was destroyed by impact force and the only two (2) flight crew members died.
- Forecasted weather at destination indicated that the low ceilings upon arrival required an alternate airport. Information about variable ceilings at the airport was not provided to the flight crew.
- The captain briefed the localizer runway non-precision profile approach, and the first officer entered the approach into the airplane's flight management computer (FMC).
- The flight plan was not properly sequenced.
- The autopilot was not engaged in the profile mode, the captain changed the autopilot mode to the vertical speed mode and did not brief the first officer of the autopilot mode change. Further, by selecting the vertical speed mode, the approach became a "dive and drive" approach.
- Accident data showed that the EGPWS provided a "sink rate" alert at 0447:24.5 when the aircraft was descending through about 250 ft agl at a vertical speed of about 1,500 fpm. The captain then reduced the airplane's descent rate. About 8 seconds later, the CVR recorded the first sounds of the airplane impacting trees, and, 1 second later, the EGPWS provided a "too low terrain" alert.

Probable Causes:

- Lack of proper configuration and verification of the flight management computer for the profile approach.
- Lack of cockpit communication and callouts.

- Flight crew fatigue.
- Automated "MINIMUM" alert not activated.
- Inadequate response to the EGPWS alert.
- EGPWS software was not updated.
- Stabilized criteria was not respected.
- Failed to monitor the aircraft's altitude during the approach.
- The relevant weather was not provided to the flight crew.

Safety actions:

- The use of a newer-version of EGPWS software linked with GPS on the aircraft will provide an advanced alert and significantly improve safety margins.
- It may be apparent that a series of terrain awareness and warning system (TAWS) alerts before impact with terrain or obstacles is not always guaranteed due to technological limitations, which reduces the safety effectiveness of the TAWS during the approach to landing. Encourage operators to review their procedures for responding to alerts on final approach to ensure that these procedures are sufficient to enable pilots to avoid impact with terrain or obstacles in such situations
- Revise the minimum operational performance standards to improve the effectiveness of terrain awareness and warning systems when an airplane is configured for landing and near the airport, including when the airplane is descending at a high rate and there is rising terrain near the airport.
- Require all operators of airplanes equipped with the automated "minimums" alert to activate it. For those airplanes not equipped with an automated "minimums" alert, require all operators of airplanes equipped with terrain awareness and warning systems (TAWS) to activate the TAWS 500-ft voice callout or similar alert.
- Require that the current meteorological conditions should be reported to flight crew.
- CRM behavior should be enhanced.
- Operators should always ensure that their EGPWS software is update to date.

Case study number 2:

Event Description:

- Accident occurred in 2011 on approach, aircraft was operating on older-generation aircraft.
- Eight (8) out of the 11 passengers and all four (4) crew members died in this accident.
- The passenger flight was operating a domestic non-scheduled service.
- The approach was an unstable one.
- The weather at the accident location was variable with fluctuations in visibility and cloud ceiling.
- During descent from cruise altitude, the flight crew recognized that they were above the nominal descent profile. They increased the rate of descent with the view of regaining profile.
- The aircraft was configured for landing when the first GPWS aural alert, "sink rate", was issued at 4.1 seconds before the collision. At 2.6 seconds before impact, the aural alert "minimums, minimums" was issued.
- The flight crew initiated a go-around after the "sink rate" GPWS alert, but they had insufficient altitude and time to execute the maneuver and avoid the collision with terrain.

- The flight crew had initiated a go-around 2 seconds before impact. At this time, the flaps were set to position 40, the landing gear was down and locked, the speed was 157 knots.

Probable Causes:

- The descent was initiated late, and the aircraft was about 600 feet above glideslope as the flight turned onto final approach.
- The flight crew did not effectively resolve the problems they encountered during descent and final approach.
- Stabilization criteria was not respected.
- Although the company had a policy that required an immediate go-around in the event of an unstable approach below 1,000 feet above field elevation, no go-around was initiated.
- Lack of cockpit communication, with nonstandard phraseology, and the flight crew's crew resource management (CRM) was ineffective.
- Flight crew lost situational awareness.
- Flight crew's workload increased.

Safety actions:

- A company's stabilized approach policy, including a go-around policy should be respected.
- Operationalized stabilized approach and compliance to SOPs including flight crew phraseology should be enhanced.
- CRM should be enhanced.
- Use of FDM to identify and monitor SOPs non-compliance, unstable approaches, exceedance of flap limited speeds, excessive bank angles, GPWS/TAWS warnings, etc.
- The use of newer-generation TAWS with GPS technology will enhance flight crew's situational awareness and provide increased time for crew reaction.

Section 12—Mitigation Strategies

As seen above and throughout the document, effective CFIT accident risk mitigation strategies broadly fall into three (3) categories: Human; Procedural, and; Technological.

The available human mitigations involve improving and maintaining pilots' knowledge, their awareness and their competence, and each of these can be achieved by a comprehensive training program embracing classroom, simulator and flight training. Pilots' knowledge of aircraft systems, aircraft performance and normal/abnormal procedures is vital to ensure that they do not find themselves in unexpected situations from which they cannot immediately recover. Pilots must also be keenly aware of the risks of CFIT, the circumstances in which those risks are greatest and the best strategies for maintaining an accurate picture of their horizontal and vertical situation. Finally, pilots' competence in recognizing and responding to potential CFIT must be realistically trained and tested in recurrent simulator training sessions, using examples from operational experience.

Additionally, many airlines use past CFIT accidents in their training courses to help pilots to understand their own limitations and recognize when an undesirable situation is developing. With realistic training, flight crew will be well prepared to:

- know the hazards of flying close to terrain,
- recognize the symptoms of spatial disorientation,
- recognize the factors that may lead to CFIT accidents,
- know the mitigation strategies that will ensure a safe flight,
- improve situational awareness in order to avoid CFIT; and,
- learn an escape maneuver and techniques designed to enhance the possibility of survival.

Moreover, improved monitoring and cross-checking were found to be methods that could have prevented many of the accidents, while a better display of leadership could have positively affected a number of accidents. Good CRM behavior and Pilot Monitoring can help to mitigate CFIT accidents. Training should emphasize crew interaction to vocalize the divergence conditions. A progressive intervention strategy is initiated by communicating a flight path deviation (alert), then suggesting a course of action (advocacy and assertion), and then directly intervening, if necessary, by taking the controls to prevent an incident or accident. IATA has developed a guidance material for Improving Flight Crew Monitoring. This GM can be found on the following IATA website: http://www.iata.org/whatwedo/ops-infra/training-licensing/Documents/Guidance-Material-for-Improving-Flight-Crew-Monitoring.pdf.

Procedural CFIT mitigations include effective and straightforward actions to initiate and fly the CFIT escape maneuver but they go deeper than that into the safety management and training systems of the operator. The Safety management systems (SMS) must incorporate management procedures to constantly review and assess the CFIT risk exposure to the operation in order to ensure that the risk is as low as reasonably practicable (ALARP) and tolerable. Operational procedures can also provide CFIT risk mitigations by avoiding non-precision approaches especially in high risk destinations or adopting risk reducing strategies such as CDFA or PBN approaches.

Technologies have also been developed to mitigate the risk of a CFIT accident. There are a variety of technologies available but the most considerable one is TAWS/EGPWS; this technology can be used with a terrain map database via GPS to provide the pilots with a more reliable source of data. This system provides a visual and an aural warning for terrain warnings. The warnings sound approximately 60 seconds before terrain impact giving ample time for the pilot to make corrections. Unfortunately, many pilots falsely believe that there is sufficient time to react once an EGPWS alert is sounded. In order to be effective, it is essential that the aircraft system hardware and firmware are correctly maintained and that the software database is properly updated. Vertical situation displays in the cockpit are becoming more common and these provide pilots with an easy to assimilate picture of the terrain profile ahead of the aircraft, together with its projected vertical flight path. It is recommended therefore that operators to ensure that the latest modifications are incorporated in their TAWS/EGPWS computer and with GPS providing aircraft position data directly to the computer. These provide earlier warning times and minimize unwanted alerts and warnings. Airlines are encouraged to familiarize their flight crew with the proximity of terrain once the EGPWS has triggered an alarm.

Furthermore, appropriate TAWS/EGPWS response procedures by the operators should be established for the flight crew in accordance to the aircraft type performance capability. These procedures should include and encourage pilots that “warnings” should be followed without hesitation as soon as a triggered.

Authorities are also recommended to investigate mandating procedures that ensure EGPWS databases are kept accurate and up-to-date. This has to be emphasized in light of two cases where the EGPWS database was never updated. These updates are critical as they include terrain and runway ends.

Note: Even if the aircraft is equipped with avoidance and warning systems, it does not mean that a CFIT accident will necessary be avoided. Pilots must believe and adhere to the warning signals displayed by these warning units to avoid these types of accidents.

Section 13—Recommendations

A number of recommendations extracted from the 2017 IATA Safety Report are listed below to aid in CFIT risk reduction.

Recommendations to operators:

- Use SMS principles to assess and mitigate risks in operations to airfields with non-precision or circling approach procedures.
- Implement Continuous Angle Non-Precision Approaches (CANPA) for a more stable descent profile than traditional “dive and drive” methods used for non-precision approaches.
- Consider replacing circling approaches in favor of using Area Navigation (RNAV) or Required Navigation Performance (RNP) approaches.
- Train flight crews to respond immediately to a hard Enhanced Ground Proximity Warning System (EGPWS) warning, and respect and respond to EGPWS soft warnings.
- Train flight crews to understand the limitations of EGPWS in scenarios such as non-precision approaches. Mandate procedures that ensure EGPWS databases are kept accurate and up-to-date. In other words, as soon as the database update is available. The current grace period is potentially a latent failure in the system. In addition, the latest modifications are incorporated in their particular Terrain Awareness Warning System (TAWS) or EGPWS computer and with Global Positioning System (GPS) providing aircraft position data directly to the computer.
- Airlines are encouraged to use simulators to show their crews exactly how close terrain is when the EGPWS warning occurs to reinforce the need for an immediate response to the warning to avoid the terrain. Time for reorientation is only available when the warning has ceased.
- Where possible, aircraft should be equipped with approved GPS so that accurate positioning and altitude data is available.
- Risk assess retrofitted navigation systems so that navigation source switching does not become a hazard.
- Ensure that flight crews are trained to understand the source of information driving terrain and navigation displays to ensure that accurate information is followed.
- Train flight crews to respect weather minima and not to penetrate weather unnecessarily.
- Train flight crews to go around from an unstable approach.
- Train and ensure effective implementation of SOPs, flight crew monitoring, cross-checking and pilot-to-pilot communication in all approaches when weather and visibility are factors.
- Use a Flight Operations Quality Assurance (FOQA) program to monitor compliance and reinforce a policy of go-around from an unstable approach.
- Consult the IATA Guidance Material for Improving Flight Crew Monitoring.

Recommendations to regulators/states:

- Implement precision approaches or PBN approaches to reduce the risk of CFIT accidents.
- Adopt CANPA for non-precision approaches.
- Mandate the use of TAWS in air transport aircraft.
- Provide to manufacturers the respective terrain data when a new airport opens.
- Comply with ICAO recommendations and guidelines regarding PBN implementation.

Section 14—Conclusion

CFIT has been and continues to be the dominant reason for turboprop accidents involving airplane hull losses and fatalities. It is imperative that the CFIT accident rate be lowered because the number of commercial airplane departures is increasing greatly. This CFIT accident analysis report examined data from 47 accidents in the period 2008-2017, which resulted in 892 fatalities, thereby making CFIT the second largest fatal accident category after LOC-I. CFIT accidents have a low survivability ratio for aircraft occupants.

The widespread adoption of TAWS/EGPWS technology has led to a significant global reduction in the rate of CFIT accidents. EGPWS is not a solution for eliminating CFIT accidents but it can help change a flight path which is likely lead to an accident. EGPWS can help provide flight crew with an alert, wake up advisory, and/or a warning.

Aircraft malfunction is not the main cause of CFIT accidents. Causes rather are most often attributed to flight crew or human error, involving the absence of adequate pilot knowledge, situational awareness or competency in aircraft handling, noncompliance with SOPs, poor CRM, inadequate flight path management, etc... Operators must ensure that their training and checking programs robustly address these potential deficiencies and the regulatory framework should include processes to effectively evaluate operators' training systems. Also the adherence of SOPs, the timely response to a warning, reporting and investigating all incidences including the false warnings; and implementation of a safety management system by the operator.

Aircraft operators can also obtain the greatest safety benefit from TAWS/EGPWS by following certain practices directly related to the equipment in use.

They should for example:

- Update software to the latest available standard;
- Update databases to the latest available standard;
- Ensure that the GNSS position is provided to GPWS; and
- Implement any applicable service bulletins issued by manufacturers.

The lack of precision approaches has been noted as a major contributing factor to CFIT accidents. The implementation of precision approaches or PBN approaches is seen as a method to reduce the risk of CFIT accidents. Where this is impractical, the use of CDFA can help with the transition from approach to landing by providing a more stable descent profile than traditional "dive and drive" methods used for non-precision approaches.

State Safety Programs (SSP) and airline SMS offer the overarching structures to identify and manage CFIT risk but they must be constantly tested and improved to remain effective. High risk activities such as poorly designed non-precision approaches at difficult destinations should be eradicated from the operation or actively managed by intelligent risk reducing operational procedures.

By definition controlled flight into terrain can be avoided and it is hoped that the content of this report will help achieve that goal.

Appendix A – IATA Regions

Region	Country
AFI	Angola
	Benin
	Botswana
	Burkina Faso
	Burundi
	Cameroon
	Cape Verde
	Central African Republic
	Chad
	Comoros
	Congo, Democratic Republic of
	Congo
	Côte d'Ivoire
	Djibouti
	Equatorial Guinea
	Eritrea
	Ethiopia
	Gabon
	Gambia
	Ghana
	Guinea
	Guinea-Bissau
	Kenya
	Lesotho
	Liberia
	Madagascar
	Malawi
	Mali
	Mauritania
	Mauritius
	Mozambique
	Namibia
	Niger
	Nigeria
	Rwanda
	São Tomé and Principe
	Senegal
	Seychelles
	Sierra Leone
	Somalia
	South Africa
	South Sudan

Region	Country
	Swaziland
	Tanzania, United Republic of
	Togo
	Uganda
	Zambia
	Zimbabwe
ASPAC	Australia[1]
	Bangladesh
	Bhutan
	Brunei Darussalam
	Cambodia
	Fiji Islands
	India
	Indonesia
	Japan
	Kiribati
	Korea, Republic of
	Lao People's Democratic Republic
	Malaysia
	Maldives
	Marshall Islands
	Micronesia, Federated States of
	Myanmar
	Nauru
	Nepal
	New Zealand[2]
	Pakistan
	Palau
	Papua New Guinea
	Philippines
	Samoa
	Singapore
	Solomon Islands
	Sri Lanka
	Thailand
	Timor-Leste
	Tonga
	Tuvalu
	Vanuatu
	Vietnam

Region	Country
CIS	Armenia
	Azerbaijan
	Belarus
	Georgia
	Kazakhstan
	Kyrgyzstan
	Moldova, Republic of
	Russian Federation
	Tajikistan
	Turkmenistan
	Ukraine
	Uzbekistan
EUR	Albania
	Andorra
	Austria
	Belgium
	Bosnia and Herzegovina
	Bulgaria
	Croatia
	Cyprus
	Czech Republic
	Denmark[3]
	Estonia
	Finland
	France[4]
	Germany
	Greece
	Holy See (Vatican City State)
	Hungary
	Iceland
	Ireland
	Italy
	Israel
	Kosovo
	Latvia
	Liechtenstein
	Lithuania
	Luxembourg
	Macedonia, the former Yugoslav Republic of
	Malta
	Monaco

Region	Country
	Montenegro
	Netherlands[5]
	Norway
	Poland
	Portugal
	Romania
	San Marino
	Serbia
	Slovakia
	Slovenia
	Spain
	Sweden
	Switzerland
	Turkey
	United Kingdom[6]
LATAM/ CAR	Antigua and Barbuda
	Argentina
	Bahamas
	Barbados
	Belize
	Bolivia
	Brazil
	Chile
	Colombia
	Costa Rica
	Cuba
	Dominica
	Dominican Republic
	Ecuador
	El Salvador
	Grenada
	Guatemala
	Guyana
	Haiti
	Honduras
	Jamaica
	Mexico
	Nicaragua
	Panama
	Paraguay
	Peru
	Saint Kitts and Nevis
	Saint Lucia

Region	Country
	Saint Vincent and the Grenadines
	Suriname
	Trinidad and Tobago
	Uruguay
	Venezuela
MENA	Afghanistan
	Algeria
	Bahrain
	Egypt
	Iran, Islamic Republic of
	Iraq
	Jordan
	Kuwait
	Lebanon
	Libya
	Morocco
	Oman
	Palestinian Territories
	Qatar
	Saudi Arabia
	Sudan
	Syrian Arab Republic
	Tunisia
	United Arab Emirates
	Yemen
NAM	Canada
	United States of America[7]
NASIA	China[8]
	Mongolia
	Korea, Democratic People's Republic of

[1]Australia includes:

Christmas Island
Cocos (Keeling) Islands
Norfolk Island
Ashmore and Cartier Islands
Coral Sea Islands
Heard Island and McDonald Islands

[2]New Zealand includes:

Cook Islands
Niue
Tokelau

[3]Denmark includes:

Faroe Islands
Greenland

[4]France includes:

French Guiana
French Polynesia
French Southern Territories
Guadalupe
Martinique
Mayotte
New Caledonia
Saint-Barthélemy
Saint Martin (French part)
Saint Pierre and Miquelon
Reunion
Wallis and Futuna

[5]Netherlands include:

Aruba
Curacao
Sint Maarten

[6]United Kingdom includes:

Akrotiri and Dhekelia
Anguilla
Bermuda
British Indian Ocean Territory
British Virgin Islands
Cayman Islands
Falkland Islands (Malvinas)
Gibraltar
Montserrat
Pitcairn
Saint Helena, Ascension and Tristan da Cunha
South Georgia and the South Sandwich Islands
Turks and Caicos Islands
British Antarctic Territory
Guernsey
Isle of Man
Jersey

[7]United States of America include:

American Samoa
Guam
Northern Mariana Islands
Puerto Rico
Virgin Islands, U.S.
United States Minor Outlying Islands

[8]China includes:

Chinese Taipei
Hong Kong
Macao

Appendix B – Safety Enhancements

IATA continues to proactively use any available resources to reduce CFIT accidents. IATA as a member of CAST has promoted and encouraged, where and when applicable, implementation of a number of the CFIT prevention SEs. These SEs for mitigations include

- SE-1: Implementing TAWS
- SE-2: SOPs for Flight Crews
- SE-9: MSAW for Air Traffic Controllers
- SE-10: FOQA and ASAP Programs
- SE-11: CRM Training for Pilots
- SE-12: CFIT Training for Pilots
- SE-120: TAWS Improved Functionality

The recommendations listed are part of the CAST SEs, which were developed and designed to reduce CFIT accidents. Each of these SEs was associated with detailed implementation plans (DIPs) for the industry and government to deploy these safety solutions. Below is a list of interventions called for action to mitigate CFIT:

- New CFIT-prevention flight deck equipment that in some cases may provide redundant terrain information.
- New air traffic control surveillance, flow, and separation procedures that increase traffic volume and decrease separation.
- Changing responsibilities for flight crew and ATC for merging, spacing, and separation assurance for near-term ATC concepts; especially in high-density traffic or metroplex situations.
- Heavy dependence on global positioning system/global navigation satellite system (GPS/GNSS), a multiplicity of electronic databases, and increasingly integrated aircraft systems.
- Advances in consumer electronics that increase the potential for back-door use of this non-certified equipment.
- Human-factors concerns regarding the increasing amounts of information, warnings, cautions and alerts in both flight deck and air traffic control (ATC) systems.

Details of all safety enhancements including risk description, risk mitigation plan, and DIPs are available and can be found at no cost on the following link:

http://www.skybrary.aero/index.php/Portal:CAST_SE_Plan.