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AN APPRAISAL OF THE LEGAL, OPERATIONAL AND REGULATORY INTERVENTIONS IN THE CONTROL AND PREVENTION OF CONTROLLED FLIGHT INTO TERRAIN (CFIT) IN CIVIL AVIATION OPERATIONS

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ABSTRACT

Aviation accident reports worldwide have identified a list of causative factors as leading causes thereto. One of such factors is Controlled Flight into Terrain (CFIT). CFIT as one of the causes of aviation accidents is relatively unknown to non-aviators. Irrespective of this obscurity, CFIT remains a major cause of aviation accidents globally as evident in aviation investigation reports. However, the preceding two decades have witnessed rapid technological advancements which have evolved in the aviation industry to aid pilots' (crews) situational awareness in the course of navigation. These advances have contributed greatly, leading to a dramatic reduction in the global statistics of General Aviation (GA) Controlled Flight into Terrain (CFIT) accidents and incidents. Albeit, CFIT has continued to

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occur in the aviation industry, it is gratifying to notice a geometric decline in statistics thereof. This paper, cognisant of the foregoing, discusses the concept of CFIT as a causative factor in accidents in the aviation industry. This is with a view to advancing the study of CFIT as one of the causes of aviation accidents. The paper examines the causes of CFIT, paying particular attention to consequential contributory factors and measures of control especially technological, regulatory and legal interventions. The paper undertakes an assessment of CFIT vis-à-vis crew operational challenges. The paper also proffers measures aimed at averting controlled flight into terrain. The paper finds that there are various reasons why CFIT occur, but mostly as a result of loss of situational awareness by the crew.

1. **INTRODUCTION**

The commonest denominator in the assessment of safety records in the aviation industry is the available statistics on accidents and incidents arising from aviation operations. Aircraft accidents and incidents remain the greatest threat to the safety of civil aviation all over the world. In response to this unwholesome state of affairs, operators, legal and regulatory institutions have continued to evolve a wide spectrum of strategies aimed at reducing to its barest minimum accidents in aviation operations.

An aviation accident is defined by Annex 13 to the Convention of the International Civil Aviation Organisation, as an occurrence associated with the operation of an aircraft, which takes place from the time any person boards the aircraft with the intention of flight until all such persons have disembarked, and in which:-

1. a person is fatally or seriously injured;
2. the aircraft sustains significant damage or structural failure;
3. the aircraft goes missing or becomes completely inaccessible[1].

Annex 13 defines an aviation incident as an occurrence, other[2] than an accident, associated with the operation of air aircraft that affects or would affect the safety of operation.

In the aviation industry, the concept of safety includes any of the various devices designed to prevent accident. Safety involves risk

[1]Aviation accidents and incidents – wikipediahttps://en.m.wikipedia.org sourced on the 4th day of November, 2021

[2] ibid

management. Although an accident is clear evidence that safety is lacking, the lack of it does not, however demonstrate that safety has been achieved. An accident is, therefore, the final most viable event in the process of safety decline[3]. While operational safety should be a recurrent thematic concern in the aviation industry, it is only when a crash occurs that the absence or otherwise of safety in aviation operations assumes global interest. This fact is also evident in Nigeria. The absence of air accidents implies that standards are being upheld while the reverse is the case in cases of air crashes, especially the multiple crashes of the years 2005 and 2006 in Nigeria. The aforementioned crashes, it suffices to add, constituted the end chain in the institutional decay that was the lot of the aviation industry in Nigeria in those years.

Usually, a number of contributory factors or errors culminate in accidents. These error chains are basically either operational or human or both factors. It is not uncommon to hear a verdict of "Act of God[4]" after an aircraft accident has occurred. This is far from the truth considering the assertion that "every aircraft accident is as a result of somebody's negligence." Several renowned authorities worldwide have supported this view to conclude that the root cause of every aircraft accident is negligence or in fact recklessness as in cases of sabotage or terrorist action[5]. However, the thesis that every accident is attributable to human error is not tenable as accidents, in aviation operations, still have causative linkages to the phenomenon of Act of God or *force majeure* as in the Sosoliso plane crash of 2005. The crash was due to pilot error aggravated by microburst-induced windshear (*force majeure*).

Accidents and incidents are phenomena in the aviation industry which are features of aviation operations. These phenomena have been attributed to several factors which include human factors/errors, lightning, ice and snow, engine failure, metal fatigue, delamination, stalling, bird strike, ground damage, volcanic ash, fire and controlled flight into terrain (CFIT). CFIT, is amongst the several other causes of aviation accidents, though relatively unknown. These classes of causative factors are not

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[3] Dele Ore "Flight Safety and Negligence" in *Law and Business Quarterly* vol. 3 No. 1 March, 1998 1 MILBQ; EVL Publications Ltd. p.89

[4] Known in **La**tin terminology as "force majeure" that's, an act which is beyond human control.

[5] Dele Ore, ibid p.89.

closed. These factors could operate individually or with a host of other causative factors to cause an aviation accident.

The IATA Accident Database shows that CFIT is not the most frequent of accident categories. However, these accidents account for a substantial number of fatalities[6].

This paper however, is limited to examining Controlled Flight into Terrain as a causative factor in accidents and incidents in the aviation industry.

2. WHAT IS CONTROLLED FLIGHT INTO TERRAIN IN AVIATION ACCIDENTS AND INCIDENTS?

Controlled Flight into Terrain (CFIT) is not a new problem. It has been around since the beginning of manned flight[7].Throughout the history of aviation, controlled flight into terrain (CFIT) has been a major cause of fatal accidents[8].

Controlled Flight into Terrain (CFIT) occurs when an airworthy aircraft is flown, under the control of a qualified pilot, into terrain (water or obstacles) with inadequate awareness on the part of the pilot of the impending collision[9].

Controlled flight into terrain is a class of accidents in which an undamaged aircraft is flown, under control into terrain[10]. CFIT describes an accident in which an airworthy aircraft, under pilot control, is unintentionally flown into the ground, a mountain, water or an obstacle[11]. In a typical CFIT scenario, the crew is unaware of the impending disaster

[6] Sourced from Controlled Flight into Terrain (CFIT) https://www.lata.org on the 4th day of December, 2021

[7] Sourced from Controlled Flight into Terrain: How the Airlines and the Federal Aviation Administration are addressing the problem by Roger C. Mattesen in https://common.eran.edu on the 4th day of November, 2021

[8] Sourced from CFIT-Controlled Flight into Terrain: A study of terrain Awareness Warning System Capability and Human Factors in CFIT Accidents 2005 – 2014 1st Edition, on the 4th day of November, 2021

[9] Regulations 7.1.1.2 (12)(Definition Section) of Part 7 (Instrument and Equipment) NigCARs, December, 2015

[10] Sourced from http://en.wikipedia.org/wiki/air safety on the 14th April, 2014

[11] Sourced from http://en:wikipedia.org/wiki/CFIT_Safety

until it is too late[12]. CFIT accidents, typically, are as a result of pilot error or of navigational system error[13].

Accidents which occur where the aircraft is out of control at the time of the impact, because of mechanical failure or pilot error, are not considered CFIT (they are known as uncontrolled flight into terrain or UFIT), nor are accidents resulting from the deliberate action of the person at the controls, such as acts of terrorism or suicide by pilot[14]. The pilots are generally unaware of the danger until it is too late. Most CFIT accidents occur in the approach and landing phase of flight and are often associated with non-precision approaches[15].

The term, controlled flight into terrain, was coined by engineers at Boeing in the late 1970s. The pilots are generally unaware of the damage until it is too late[16]. Controlled Flight into Terrain (CFIT) or, in simple terms, when crews unwittingly fly their aeroplane into the ground, remains still the single most contributor to and causative factor of aircraft accidents[17].

CFIT (usually pronounced *see-fit*) in essence, is an aviation accident which ordinarily ought not occur because the Pilot-in-Command (PIC) and his crew are not inexperienced to warrant such an accident or incident in the first instances. Secondly, the accidented aircraft, courtesy of a CFIT occurrence is usually airworthy. However, CFIT accidents are usually a consequence of spatial disorientation by the crew which leads to unintended consequences - aviation accidents.

3. CAUSATIVE FACTORS IN CONTROLLED FLIGHT INTO TERRAIN ACCIDENTS

According to Boeing in 1997, CFIT was a leading cause of airplane accidents involving the loss of life causing over 9,000 deaths since the beginning of the commercial jet age. CFIT was identified as a cause of 25% of United States Air Force (USAF) Class A mishaps between 1993 and 2002. According to data collected by the International Air Transport Association (IATA) between 2008 and 2017, CFITs accounted for six percent of all commercial

[12]Sourced from https://en.m.wikipedia.org on the 3rd November, 2021
[13]https://en.wikipedia.org/wiki/CFIT)Safety
[14] Sourced from Controlled Flight into Terrain https://skybrary.aero on the18/10/2021
[15]Ibid
[16]https://en.wikipedia.org/wiki/CFIT_Safety
[17]Ruwantisa I.R. Abeyratne "Prevention of Controlled Flight into Terrain: Regulatory and Legal Aspects" in *University of Denver Transportation Law Journal* 27. Transp. L.J p.159

aircraft accidents, and was categorised as "the second-highest fatal accidents category after loss of control inflight (LOCI)[18].While there are many reasons why a plane might crash into terrain, including bad weather and navigation equipment problems, or disorientation, pilot error is the most common factor found in CFIT accidents[19]. CFIT is considered to be caused by spatial disorientation, where the pilot(s) do not correctly perceive their position and orientation with respect to the earth's surface[20]. Spatial disorientation is more likely to occur when there is no visible horizon on a dark might or in Instrument Metrological Conditions (IMC). If malfunctioning flight instruments, high workload or a breakdown in Crew Resources Management (CRM) are present, then the risk of spatial disorientation is increased[21].

It seems unbelievable that an aircraft capable of a safe flight can be flown into terrain, water or obstacle while under the control of the pilot. While CFIT accidents are often the product of a chain of events, the investigation of nine CFIT accidents has identified the following causative factors

1. CFIT can occur during most phases of flight, but is more common during the approach and landing phases
2. Non-precision approaches were associated with CFIT accidents
3. Inappropriate action by the flight crew was cited as a contributory factor. This refers to the flight crew continuing descent below the minimum descent altitude (MDA) or decision height without adequate visual reference
4. Lack of positional awareness, resulting in an accident
5. Failure in CRM (cross-check, communication, co-ordination, leadership etc) was cited as a contributory factor
6. Pilots have either failed to respond or delayed their response to ground proximity warnings.
7. Non-adherence to Standard Operating Procedures (SOPs)

[18] Controlled Flight into Terrain sourced from https://skybrary.aero on the 18/10/21
[19] Sourced from causes of CFIT from https://en.wikipedia.org 7 wiki on the 1/10/21
[20]http://en.wikipedia.org/wiki/CFIT.Safety
[21]Sourced from Controlled Flight into Terrain from https://www.lata.org on the 4th November, 2021

8. The use of early Ground Proximity warning systems (GPWS) equipment[22].

A critical appraisal of the nine causative factors linked to Controlled Flight into Terrain identified the approach and landing phases of flight as critical phases in which CFIT occur significantly. In addition, it identified non-precision approaches as another factor in the CFIT problem[23]. Non-precision approach being implied to mean flights under visual flight rules (VFR)[24] rather than the technologically driven instrument flight rules (IFR)[25].

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[22] Sourced from https"//hartzall prop.com on the 4/11/21

[23] Under the provisions of Regulations 7.2.1.2 of Part 7 of the Nigeria Civil Aviation Regulations, in operating an aircraft under either IFR or VFR, no person may operate any powered aircraft unless it is equipped with the following flight instruments:

1. An airspeed indicating system calibrated in knots, miles per hour or kilometres per hour

2. Sensitive pressure altimetre calibrated in feet with a sub-scale setting calibrated in hectopascals/millibars, adjustable for any barometric pressure likely to be set during flight.

3. An accurate timepiece indicating the time in hours, minutes and seconds.

(a) For non AOC operations, either equipage or carriage is acceptable

4. A magnetic compass

5. Any other instrument as prescribed by the Authority

Regulations 7.2.1.2 applies both to precision and non-precision approaches

[24] For operations under the Visual Flight Rules (VFR) Regulations 7.2.1.2 specifies instruments required thereto.

Regulations 7.2.1.3 provides

7.2.1.3 – (a) [AOC] whenever two pilots are required, each pilot's station shall have separate flight instruments as follows:-

1. An airspeed indicator calibrated in knots, miles per hour or kilometers per hour;
2. A sensitive pressure altimetre calibrated in feet with a sub-scale setting calibrated in hectopascals/millibars, adjustable for any barometric pressure likely to be set during flights;
3. A vertical speed indicator;
4. A turn and slip indicator, or a turn co-ordinator incorporating a slip indicator
5. An altitude indicator

(1) A stabilised direction indicator; and

(2) Any other equipment as required by the Authority

[25]For operations under the Instrument Flight Rules, Regulations 7.2.1.4 provides for required instruments for IFR operations.

Regulations 7.2.1.4 (AAC) All aeroplanes when operated in IFR or when the aircraft cannot be maintained in a desired altitude without reference to one or more flight instruments, shall be equipped with:-

(a) A means of measuring and displaying;

c. Magnetic heading (standby compass);

Another causative factor identified is spatial disorientation on the part of the operating crew. Identified in the study also is the problem of operational delay/procrastination on the part of the crew and the failure to adhere to, or comply with Standard Operating Procedures (SOPs)

While it would make sense for most of CFIT accidents to occur during night time flights, the majority (over 75%) of CFIT accidents actually occur in visual conditions. Nevertheless, flying Visual Flight Rules (VFR) into Instrument Meteorological Conditions (IMC) is one of the deadliest precursors to CFIT accidents. In a study of a group of 41 CFIT accidents, 25% of the accidents were preceded by continued VFR into IMC, all of which was fatal[26].

Another veritable cause of CFIT is pilot fatigue. Thus, faced with fatigue, distraction or disorientation even highly experienced pilots can make mistakes. In most General Aviation (GA) operation, there is only one pilot who is responsible for handling the entire in-flight workload. Therefore, it is essential that GA pilots remain vigilant about safety procedures and resist becoming complacent. Always fly well-rested and stay alert Pilots should avoid distractions, especially during critical phases of flight[27].

The Nigeria Civil Aviation Regulations vide the provisions of Regulations 8 (Operations) and more particularly pursuant to the provisions of Regulations 8.11 makes copious provisions with respect to fatigue management[28].

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d. The time in hours, minutes and seconds;
(a) For Non-AOC operations either equippage or carriage is acceptable;
e. Pressure altitude;
f. Indicated airspeed, with a means of preventing malfunctioning due to either condensation or icing
g. Turn and slip
h. Aircraft altitude heading;
i. Stabilized aircraft; and
j. Whether the supply of power to the gyroscopic instruments is adequate;
k. The outside air temperature;
l. Rate-of-climb and descent; and

[26]Sourced from https://www.flight_into_terrain

[27] ibid

[28] Regulations 8.12.1.2 (a) provides that with respect to duty periods:-

1. Persons are considered to be on duty if they are performing any tasks on behalf of the AOC holder, where scheduled, requested or self-initiated.

The fatigue element, as a causative factor in Controlled Flight into Terrain, has attracted the attention of institutional regulators worldwide. The Nigerian Civil Aviation Authority (NCAA) in response thereto made provisions under Part 8 (Operations) of Regulations 8.14.2.9 of the Nigeria Civil Aviation Regulations for a Fatigue Management Programme. Under the Regulations, an operator is under an obligation to establish and implement a fatigue management programme. The programme is meant to ensure that all operator personnel involved in the operation and maintenance of aircraft do not carry out their duties when fatigued. The programme is meant to address flight and duty times and shall be included in the operations manual.

The provisions on fatigue management under the provisions of part 8 of the Nigeria Civil Aviation Regulations (NigCARs) is meant to address situations that could lead to a Controlled Flight into Terrain situations.

Many CFIT accidents occur because of loss of situational awareness particularly in the vertical plane and many crash sites are on the centreline of an approach to an airfield. Lack of familiarity with the approach or misreading of the approach plate are common causal factors particularly where the approach features steps down in altitude from the initial approach fix to the final approach fix[29]. Loss of situational awareness often manifests in a pilot failing to know at all times what the aircraft position is and how that position relates to the altitude of the surface immediately below and ahead and how both relate to the course being flown[30].

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2. If an AOC holder requires a flight crew member to engage in dead head transportation for more than 4 hours, one half of that time shall be treated as duty time, unless they are given 10 hours of rest on the ground before being assigned to flight duty
3. No AOC holder may schedule:
    i. A flight crew member for more than 14 hours of duty, except as prescribed by the Authority
    ii. A cabin crew member for more than 14 consecutive hours of duty, except as prescribed by the Authority paragraph (b) provides with respect to rest periods:-
        i. The minimum rest period is considered to be 8 consecutive hours
        ii. The minimum rest period for flight crewmembers shall be 9 consecutive hours, unless otherwise prescribed by the Authority.

[29] ibid

[30] Sourced from Controlled Flight into Terrain in www.FAAsafety.gov. on the 4th November, 2021

3.1 Other Contributory Factors in Controlled Flight into Terrain Accidents

CFIT has also been attributed to a host of other contributory factors. One of such factors is climatic conditions. Meteorological conditions have been identified as a major causative factor in aviation accidents/incidents. However, the interface between weather and human error has led to cases of CFIT. In an instance, a pilot encountered weather conditions that were worse than forecast and, in an attempt to maintain or regain visual contact with the ground in an area of very low cloud, descended below Minimum Safe Altitude (MSA) and the aircraft struck the ground[31]. The scenario painted herein depicts a situation in which the pilot relied on Visual Flight Rules (VFR).

Other top causes of CFIT are IFR procedural mistakes (e.g flight below minimum enroute altitude, descent below MDA and unrealistic aircraft performance expectations (e.g high density altitude, tailwind on approach)[32].

To avoid these pitfalls, a pilot should make sure that he is in compliance with all aspects of the accepted clearances and the procedures undertaken to be flown. A thorough knowledge of the geographical terrain or landscape of the environment to be navigated is also important. A pilot ought to survey such environment as high altitudes for a proper awareness of the environment.

The most common reason for CFIT is pilot error; frequently due to loss of situational awareness. Spatial disorientation is one aspect of situational awareness. When a pilot is spatially disoriented, he or she is either unsure or mistaken about the aircraft's position in relation to surrounding terrain. Degraded situational awareness, particularly a lack of understanding of the aircraft geographical position and altitude can lead to poor decision making and mistakes[33].

4. CONTROLLED FLIGHT INTO TERRAIN AND CREW OPERATIONAL ISSUES

In a typical CFIT incident, the crew is unaware of the impending disaster until it is too late. This creates the unintentional element in CFIT scenarios.

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[31] Sourced frohttps://en.m.wikipedia.org on the 4/11/2021

[32] Sourced from https://www.FAAsafety.govInstrument Flight Rule (IFR) procedural mistakes occur when the crew despite relying on IFR rather than VFR could misread or misapply the procedural steps that should be observed in IFR flight conditions.

[33] ibid

However, it is pertinent to state that the element of unawareness may be as a result of external stimuli which impacts on the crew's lack of situational awareness. External stimuli being understood to mean the ingestion of substances which have the capacity of impeding situational awareness. Such substances could be psychotropic/psychoactive substances such as heroin, cocaine and other prohibited drugs which tend to affect the cognitive awareness of the crew with respect to their environment.

Cognisant of the foregoing, the Nigeria Civil Aviation Regulations Pursuant to Regulations 8.5.1.5 expressly prohibits the use of psychoactive substances including drugs or alcohol. Thus, no person may act or attempt to act as a crew member of a civil aircraft under the following conditions.

(a) within 8 hours after the consumption of any alcoholic beverage
(b) while under the influence of alcohol; or
(c) while using any psychoactive substance that affects the person's faculties in any way contrary to safety.

Regulations 8.5.1.5 (b) provides that 8 hours subsequent to (ie before) and consequent on (after) acting or attempting to act as a crew member, on the request of a law enforcement officer or the authority, a crew member shall submit to a test to indicate the presence of alcohol or other psychoactive substances in the blood.

In addition to the foregoing, Regulations 8.5.15 (c) provides that whenever there is a reasonable basis to believe that a person may not be in compliance with the request for test of alcoholic substance or psychoactive substances in the blood, such a crew member shall upon the request of the Authority furnish the Authority or authorize any clinic, doctor or other person to release to the authority the result of each blood test taken for presence of alcohol or narcotic substances up to 8 hours before or immediately after acting or attempting to act as crew member.

That test information provided to the Authority under the provisions of Regulations 8.5.15 may be used as evidence in any legal proceedings.

A community reading of the provisions of Regulations 8.5.1.5 reveals the intendment of the draftsmen in ensuring that crew members operate under appropriate situational awareness regime. The influence of alcohol or other psychoactive substances in impeding quick decision making is among the several operational situations sought to be addressed by the provisions

of Regulations 8.5.1.5. However, it needs be stated that breathalyser tests could be inaccurate at times due to non-optional performance of such kits. Their inaccuracy could also be attributed to the dictates of human compromises in the administration of such tests.

The implication of the foregoing is that a lack of situational awareness could be self-induced by crew members through the use of alcohol, drugs or other psychoactive substances for social use or to enhance their performance in the cockpit. Where this is the case, such crew members could also be said to have flown unintentionally into obstacles thus creating a Controlled Flight into Terrain (CFIT) situation.

It is an erroneous assumption by non-aviators or the flying public to think that most CFITs occur at night due to the inexperience of the crew at the cockpit. However, the General Aviation Joint Steering Committee (GAJSC) observed that a clear majority of the CFIT accidents in a typical year occur in daylight and with visual conditions[34].

5. CONTROL MEASURES IN AVERTING CONTROLLED FLIGHT INTO TERRAIN

The aviation industry, aware of the damages posed by Controlled Flight into Terrain, has evolved several measures aimed at controlling accidents/incidents emanating therefrom.

Crew awareness and monitoring of navigational systems can prevent or eliminate CFIT accidents. Crew Resource Management is a modern method now widely used to improve the human factors of air safety. The Aviation Safety Reporting System (ASRS) is another[35]. Other aids can be used to help pilots maintain situational awareness. Most of these aids are technological inventions deployed to warn pilots and crews about impending obstacles and the impending Controlled Flight into Terrain situations.

An effective control measure evolved in a bid to avert controlled flight into terrain is the knowledge-based Safety Flight Management (SFM). The Safety Flight Management is a vital part of warding off a possible CFIT accident. It involves knowing what you are getting into and understanding what capabilities and resources you have that will ensure a flight is

[34] ibid

[35] http://en.wikipedia.org/wiki/Air_Safety

completed safely. This starts at pre-flight. Make use of a Flight Risk Assessment Tool (FRAT) and the PAVE (acronym for Pilot, Aircraft, Environment and External Pressures) to help you build a personalized risk assessment before a flight[36]. In the course of flight, pilots and the crew ought to be well informed about operational dynamics and other allied situations such as deteriorating weather conditions, fuel status and the onset of fatigue. Pilots are enjoined to eschew plan continuation bias (aka Get-there-it is) and also resist being pressured into making poor operational decisions.

There are a host of other technological programmes, applications and devices that can aid pilots in situational awareness and risk assessment e.g. moving maps with terrain overlaps. In fact, pilots have access to more information than ever before and that has already contributed to a 20-year reduction in CFIT accidents. But all that information comes in many different forms, so pilots must be thoroughly familiar with, and proficient in device operation and information interpretation[37].

Throughout the history of aviation, Controlled Flight into Terrain (CFIT) has been a major cause of fatal accidents. In response to this concern, the aviation industry developed the ground proximity warning systems (GPWS) which warned pilots if the aircraft was in proximity to terrain. This system became a mandatory installation for large aircraft in 1974 and it is evident that since then, the number of CFIT accidents has reduced significantly[38].

Although GPWS was very successful, it was limited in that it was only able to detect terrain directly below the aircraft if there is a sharp change in terrain[39]. A ground proximity warning system is an on-board system that will alert a pilot if the aircraft is about to fly into the ground. Also, Air Traffic Controllers (ATCs) constantly monitor flights from the ground and at airports[40].

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[36] Sourced from https://www.faa.gov>media

[37] ibid

[38]https://www.harzellprop.com

[39] ibid

[40]ibid. Under the provisions of Regulation 7.7.15 of the NCARs Part 7 (Instruments and Equipment) there are extant regulations on the mandatory use of Ground Proximity Warning Systems (GPWS)

The utility of the Ground Proximity Warning System (GPWS) in checking incidents of controlled flight terrain is provided for under Regulations 7.7 (Warning Instruments and Systems) of Part 7 (Instruments and Equipment) of the Nigeria Civil Aviation Regulations 2015. Regulations 7.7.1.5 of the provisions is to the effect that: -

(a) No operator may operate a turbine powered aeroplane, or piston engine aeroplane of a maximum certified take off mass in excess of 5,700 kg or authorized to carry more than nine passengers, unless it is equipped with a ground proximity warning system that has a forward-looking terrain avoidance function.

(b) Each ground proximity warning system shall automatically provide by means of aural signals which may be supplemented by visual signals, timely and distinctive warning to the flight crew of the following circumstances.

1. Excessive descent rate;
2. Excessive terrain closure rate;
3. Excessive altitude loss after take-off or go-ground;
4. Unsafe terrain clearance while not in landing configuration;
9. Gear not locked down
10. Flaps not in a landing position; and

(c) Excessive descent below the instrument guide path.

GPWS does not detect the aircraft closure rate until it is too late for evasive action. To overcome this limitation, a more advanced technology known as Enhanced Ground Proximity Warning System (EGPWS) was introduced. This technology combines a worldwide digital terrain database with an accurate navigation system; ideally using the Global Positioning System (GPS). The aircraft's position is compared with a database of the earth's terrain; if there is a discrepancy, pilots receive a timely caution or warning of terrain hazards. This enhanced system provides a warning in advance of steeply rising ground and also extends the warning area almost to the runway threshold, overcoming the limitations of GPWS. The EGPWS is also widely known as Terrain Awareness Warning System (TAWS).

EGPWS/TAWS systems are a critical component during low visibility operations and during approach and landing[41].

The IATA Accident Database shows that while CFIT is not the most frequent of accident categories, the power survivability of CFIT accidents means that it continues to account for a substantial number of fatalities – a total of 1,346 from 67 CFIT accidents during this period 2005 – 2014. This equates to 88% of CFIT accident occurring fatalities[42].

A terrain awareness and warning system (TAWS) aims to prevent controlled flight into terrain (CFIT) accidents. The actual systems in current use are known as Ground Proximity Warning Systems (GPWS) and Enhanced Ground Proximity Warning Systems (EGPWS). Strictly speaking, the term TAWS encompasses all systems which warn of terrain. However, the term TAWS is often used to refer to second generation EGPWS systems as opposed to first generation GPWS systems[43].

Today, advanced ground warning terrain awareness warning systems are available for helping pilots prevent CFIT on take-offs and landings. While these systems and devices are valuable tools to have in the cockpit, they do have limitations. Avoid becoming over dependent on technology and always remember to fly the airplane first[44].

While there are many reasons why a plane might crash into terrain, including bad weather and navigation equipment problems, or disorientation, CFIT is considered to be caused by spatial disorientation, where the pilots do not correctly perceive their position and orientation with respect to the earth's surface[45]. The incidents often involve a collision with terrain such as hills or mountains, and may occur in conditions of clouds or otherwise reduced visibility. CFIT often occurs during aircraft descent to landing near an airport. CFIT may be associated with subtle equipment malfunction.

If the malfunction occurs in a piece of navigational equipment and it is not detected by the crew, it may mislead the crew into improperly guiding the aircraft despite other information received from all properly

[41]https://www.hartzellprop.com
[42] ibid
[43] ibid
[44] ibid
[45]https://en.wikipedia.org/wiki/CFIT.Safety

functioning equipment, or despite clear sky visibility that should have allowed the crew to easily notice ground proximity[46].

Nigeria, in recent times, has had her own fair share of aviation accidents which investigation reports traced to the incidence of controlled flight into terrain. The Beechcraft 1900D aircraft which crashed on March 15, 2008, on its way from Lagos to Bebi Airstrip in Cross River State, was attributed partly to controlled flight into terrain as a result of pilot error[47]. Also, the OAS helicopter, registration number 5N BKA which crashed on July 29, 2011 at Osun State was attributed to pilot error[48].

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[46] ibid

[47]According to Chinedu Eze "NAMA, NCAA, Airlines Sing Discordant Tunes" *Thisday* The Sunday Newspaper, April 5, 2009 pp. 114-115;On March 14, the Accident Investigation Bureau (AIB) made public a preliminary report on the crash of the aircraft owned by Wings Aviation. The three-member crew was killed in the accident. The AIB said that the crew of the aircraft deviated from its initial flight plan, which estimated that the aircraft which left MMA at 6:36am would arrive Ikrop at 8:06am. The report stated that the crew ignored several warnings by Enhanced Ground Proximity Warning System (EGPWS) and subsequently crashed. The Commander, the report stated, did not promptly initiate terrain avoidance action when the EGPWS sounded "Terrain" Terrain "Pull up" The Report Stressed that the Enugu Control tower of NAMA descended the aircraft to 5000 feet outside its area of control, not considering that the aircraft was not flying the filed flight plan route and the Minimum Safe Altitude (MSA) of the area reported by Jeppersen (International air mapping) chart as 11,200 feet. In other words, while the aircraft was in the airspace outside the control of Enugu Control Tower, the controller directed the pilot to descent 11,200 feet. The AIB investigation revealed the causal factors responsible for the crash to include lack of situational awareness which led to a controlled flight into terrain; the inability of the members of the crew to identify their position while navigating to their planned destination. AIB also identified as contributory factors to include flight crew's deviation from initial filed flight plan to Bebi, poor Cockpit Resource Management (CRM) and the crew's inability to respond promptly to several EGPWS warnings.

[48]According to Chinedu Eze "Late kuteyi had flown crashed Chopper over 200 times" "Thisday" Friday, August 12, 2011 p.31 the helicopter was flight worthy and was manufactured in 2005 and was fitted with Mode 406 Emergency Locator Transmitter (ELT) and had obtained airworthiness certificate less than two months before the crash. The pilot was highly experience and had flown in the Philippines military and had his Civil Aviation Certification with over 5000 flying hours to his licence on helicopters before joining OAS helicopters. The pilot held both the NCAA and the Civil Aviation Authorities of the Philippines (CAAP) licenses.

In addition, bad weather was identified as the cause of the OAS helicopter crash. According to Chinedu Eze "NCAA: Bad weather caused OAS Chopper's Crash" *Thisday* August 5. 2011

Traditionally, adequate procedures and crew coordination and communication (CRM) as well as control or surveillance by air traffic services may reduce the likelihood of CFIT.

In order to prevent the occurrence of CFIT accidents, manufacturers and safety regulators developed terrain awareness and warning systems (TAWS). The first generation of these TAWS systems is known as a ground proximity warning system (GPWS), which uses a radar altimeter to assist in calculating terrain closure rates. This system has now been further improved with the addition of GPS terrain database as is known as enhanced ground proximity warning system (EGPWS)[49]. Statistics show that aircraft fitted with a second generation EGPWS have not suffered a CFIT accident, if TAWS or EGPWS are properly handled[50].

7. CONCLUSION

Controlled Flight into Terrain (CFIT), as one of the leading causes of aviation accidents and incidents, has elicited responses from the industry in the form of technological advancements with the introduction of equipment which warn pilots of terrain especially in instances of flight simulated under Visual Flight Rules (VFR). Although CFIT is not the most frequent of accident categories, such accidents account for a substantial number of fatalities. Between 2017 and 2021, CFIT accidents resulted in 108 fatalities. IATA advocates for a data-driven approach to the evaluation of risks and the development of solutions to mitigate CFIT accidents[51]. Although few in number, CFIT accidents are always catastrophic, 91 percent of the accidents involve fatalities to passengers or crew. CFIT which is the second largest fatal accident category after loss of Control Inflight (LOC-I), has contributed to 707 of 2,541 fatalities in the period evaluated. Given this severity, CFIT accidents have been assessed by the IATA Safety Department and the

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p.7 the NCAA through its erstwhile DG, Dr. Harold Demuren said that the weather at Ife Odan hills (site of the crash) must have blurred the vision of the pilot who was on a Visual Flight Rule (VFR) and that situation explains why the helicopter hit the tall hill and crashed in what was described as Controlled Flight into Terrain (FCIT).

[49]http://en.wikipedia.org/wiki/CFIT_Safety

[50] ibid

[51] IATA-Controlled Flight into Terrain (CFIT) sourced from https://www.iata.org on the 8/5/23

industry to be the second highest risk to aviation safety, and deemed to be an area for increased attention[52].

A host of strategies have been evolved at multi-layer levels designed to help prevent CFIT. Such levels include stages such as pre-flight, during flight and post flight. At the pre-flight stage, aviators are expected to utilise available sources of training and simulators and continue flying in order to maintain and improve proficiency and to obtain a comprehensive and accurate weather briefing. During the flight period, crews are expected to know their equipment and their uses and they should not allow regulatory enforcement override their need to make safe decisions during an emergency. At the post-flight stages, crew members are to reflect on their experiences, maintain proficiency or improve their skills on the equipment[53].

While statistics available with respect to CFIT accidents have decreased in the last two decades, it is imperative that research and development (R & D) in the manufacture of advanced GPWS should be encouraged with a view to ensuring that CFIT incidents are reduced to the barest minimum.

[52] IATA Controlled Flight into Terrain Accident Analysis Report 2014-2014 1st Edition sourced from https://www.iata.org on the 8/5/23

[53] Controlled Flight into Terrain (CFIT) causes and mitigations sourced from https;//www.faa.gov>media on the 8/5/2023