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CONTROLLED FLIGHT INTO TERRAIN (CFIT) - RISK AVOIDANCE

1 Introduction

1.1 Controlled Flight Into Terrain (CFIT) - the term used to describe accidents in which an aircraft that the crew can control in direction and speed collides with the ground or water - is still the cause of more fatalities than any other accident associated with air travel.

1.2 Because reports of incidents in which CFIT accidents are narrowly avoided continue to be received by the Civil Aviation Authority, guidance is offered for use by pilots and aircraft operators. This guidance is based upon documents published by the International Civil Aviation Organization (ICAO) and by the Flight Safety Foundation's Industry Task Force, and upon occurrence reports.

1.3 **The aim of this Circular is to identify what can and should be done by pilots and by aircraft operators to minimise the risk of CFIT accidents.** The contents are intended to apply to all types of operations - private, corporate, public transport, aerial work, etc. - undertaken by aeroplanes and by helicopters.

1.4 Arguably the best protection against CFIT is that **all** flight crew should keep the risk potential uppermost in their minds at all times when the subject matters. Those who are responsible for writing and reviewing operational procedures should satisfy themselves that the latter reflect all relevant items listed below - **and then consider amending these procedures if their content could be improved or if any topic has not been addressed.**

2 Before the Aircraft Moves

2.1 Consideration should be given to which runway will be used, what departure route will be flown, how the track required will be flown accurately, what ground-based navigation aids will be selected, what vertical constraints will apply (eg obstacles and minimum climb gradient), and what the track will be if, after getting airborne, an immediate return to land should become necessary.

2.2 In multi-crew aircraft, the commander should ensure that all flight crew members know what the flight path will be once the aircraft gets airborne, noting that this might change if there were to be any loss of thrust due to engine failure or if there were any need to avoid significant weather, such as a thunderstorm. The crew should relate these tracks and altitudes to the Sector Safe Altitude (SSA) which takes into account local terrain and significant obstacles. The importance of monitoring where the aircraft tracks should be mentioned: this applies regardless of whether it is being hand flown or is being managed by an autopilot or autostabilisation system.

2.3 All the items that follow should be confirmed once the air traffic clearance or departure instructions have been received. Care should be taken to ensure that charts containing details of the Standard Instrument Departure (SID) - if applicable - are to hand and that if a Flight Management System (FMS) is used that this displays the correct track angles and distances. All ground-based navigation aids that are within range should be identified with their associated needles pointing in the right direction. Display and function control switches should all be set correctly to ensure track-keeping accuracy and, in aircraft that have FMS, to act as a back-up if internal navigational systems should fail. A check of altimeters should ensure that all readings are correct within tolerances with the relevant and current QNH set. **The first 'stop' altitude, if published, should be set into the altitude selector and any displayed information confirmed as correct.**

2.4 The pre-flight briefing should also consider the effects of any likely degradation of performance due to the presence of relatively high ambient temperatures or to the expected use of engine and airframe anti-icing or de-icing systems. Note should be made of any differences in instrument layouts and information displays from what may usually be encountered, so that misreading altimeters and DME readouts is less likely to occur. Any significant Minimum Safe Altitudes (MSA) that may be encountered en-route should be noted.

3 Before Take-Off

3.1 The commander should ensure that all navigation instruments function correctly and that, if it will help the crew to remain aware of where they are in relation to significant terrain, the aircraft radar and any predictive terrain display (if fitted) are selected appropriately. 'Constraints' data, if provided, should be displayed. Any 'last minute' departure changes received from Air Traffic Control should be discussed with other crew members, and any adjustments to navigation aids and function selectors made with care.

3.2 At an appropriate time - which may not be until the aircraft is cleared for take-off - the 'present position' displayed by an FMS or RNAV equipment should be confirmed as correct. This confidence check is especially important when the initial departure is an FMS route where tracks are not aligned with bearings or radials to or from ground-based navigation aids.

4 After Take-Off

4.1 If flight in Visual Meteorological Conditions (VMC) is planned, care should be taken to ensure that the cloud and visibility encountered do not prevent the pilot seeing sufficiently far ahead to identify terrain and obstacles that might prove to be a hazard. If doubt arises that VMC may not continue to exist (lowering cloud or reducing visibility), the pilot should - without delay - consider what options are available, and take whatever course of action seems most appropriate. This should be done before the situation degrades beyond the point when it becomes difficult to see where the aircraft is going. Excessive reliance on information derived from Global Positioning Systems (GPS) for navigation in worsening weather without adequate terrain or obstacle clearance being assured is a major hazard for pilots of light aeroplanes and helicopters flying in the lower airspace, when to 'press on' in deteriorating conditions could be fatal.

4.2 In multi-crew aircraft, the whole flight crew should ensure that, by reference to all navigation aids that are displayed, the aircraft tracks where intended. If Air Traffic Control should require the pilot to depart from the vertical and horizontal profiles that had been briefed, the crew should satisfy themselves that in following the new clearance the aircraft will not be flown lower than any relevant safe altitudes. If at all uncertain as to whether adequate clearance from terrain can be achieved, the crew should inform Air Traffic Control or challenge the instructions. It should not be assumed that aerodrome or en-route radar will assure terrain clearance.

4.3 When flying FMS-based departure routes, the crew should confirm on passing waypoints that the computed position agrees with the distance and/or radial that have been used to define them. FMS or area navigation equipment status should be monitored, and the information or guidance produced should not be used below SSA or MSA if it ceases to remain of 'high accuracy' or equivalent. On being cleared to climb from an altitude to a flight level, the crew should normally at once set the main altimeter(s) to 1013.2 and compare readings, leaving at least one altimeter with its subscale set to QNH to provide altitude readings that can be compared with the SSA until the latter has been passed. Awareness of that point will be improved if the crew announce 'passing SSA' as the aircraft climbs through it. In regions where the Transition Altitude is relatively high, such as 18,000 ft in North America, and where national regulations require it, altimeter subscale settings should not be adjusted to 1013.2 until the aircraft passes through that Altitude.

5 In the Cruise - En-Route

5.1 Routinely, note should be made of any significant terrain features or obstacles that could be cause for concern if the aircraft had suddenly to descend to a lower altitude, as might be the case when avoiding weather (helicopters and light aeroplanes), loss of ability to control the cabin altitude (pressurised aeroplanes), or loss of thrust (any aircraft).

5.2 The crew should all be aware as to what would be done in such circumstances, ie what heading should be selected in order to avoid the high ground or obstruction, or what the engine-out stabilising altitude would be. To be prepared for this eventuality, charts depicting the MSA and relevant performance data should be kept readily to hand. Predictive terrain displays should be used in an appropriate mode, and crews should remain aware how they may, if the FMS contains this data, rapidly obtain information from this source.

6 In the Cruise - Before Descent

6.1 The commander should ensure before the aircraft leaves its cruising altitude or flight level that the descent briefing addresses: the route intended to be flown (the initial descent, the intermediate approach, the final approach, and the 'go around') including any Standard Terminal Arrival Route (STAR); what navigation aids will be used; the vertical profiles; and all significant terrain or obstacle features depicted on the Instrument Approach Charts (IAC), even if the intention is to carry out the intermediate or final approach visually.

6.2 Mention should be made of the relevant Decision Heights/Decision Altitudes, Minimum Descent Heights/Minimum Descent Altitudes, or Circling Altitudes that will apply (together with their associated RVR or visibility minima) which should be set on altimeter 'bugs' or inserted into the FMS. Note should be made of all holding patterns associated with the expected route together with their lowest altitudes or flight levels. NOTAM should be reviewed and ATIS messages heard in their entirety to ensure that any non-availability of facilities (navigation aids, lighting, aerodrome instrument approach categorisation, etc) are noted and their effect on the approach taken into consideration.

6.3 Before commencing the descent, the present position of the aircraft should be verified by using whatever means are most appropriate: visually (if there is absolutely no doubt); by using radio navigation aids (for example by comparing a radial and distance from a VOR and DME with the bearing and distance calculated by FMS from the same reference); or by ground-based radar. FMS or area navigation operational status should be noted, and if 'high accuracy' or equivalent is not shown, any positional information displayed should be cross-checked against other aids. At least one altimeter should have its subscale setting adjusted to display the relevant QNH so that as the aircraft descends the crew can easily monitor the altitudes they are passing against known safe altitudes shown on IACs or pilot navigation logs.

7 The Initial Descent

7.1 The main altimeter subscale settings should be changed to the relevant QNH when the aircraft is cleared to descend to an altitude, all crew members checking immediately that their altimeters read the same (within tolerances) to ensure that no errors have been made. All altitude selector changes should be cross-checked for accuracy, and 'alert' calls made before reaching each new altitude. Crews should, having briefed the relevant safe altitudes, be wary of responding to air traffic clearances to altitudes that are lower than those known to be safe for the route being flown, and be prepared to challenge any instructions about which they feel uneasy. On passing through the SSA this should be announced (to stimulate awareness), and the aircraft's position should be re-confirmed. It should not be assumed that aerodrome or en-route radar will assure terrain clearance.

8 The Intermediate and Final Approach

8.1 Most CFIT accidents occur under or adjacent to the intermediate or final approach path.

8.2 Great care should be taken when flying visual approaches in poor visibility or at night to ensure that when manoeuvring to line up with the runway the aircraft does not encounter prominent terrain features or obstacles that cannot be seen and that are not marked or illuminated in any way. Even when visibility is good, note should be taken of the prevailing wind speed and direction so that the aircraft does not drift closer to adjacent terrain than is intended - relatively strong tail winds being a potential problem at aerodromes surrounded by prominent high ground or other obstructions.

8.3 The commander should ensure that arrival routes, where specified, are flown accurately. 'Constraints' data, where provided by the FMS, should be shown on navigation displays, and use made of weather radar or predictive terrain data to aid situational awareness. If holding patterns are to be flown, speed on entry should not be excessive lest the aircraft strays outside the area that is safe in terms of terrain for the altitude to which the aircraft is cleared. FMS-displayed holding patterns should be checked for correct orientation and turn directions. As situational awareness can suffer during holding pattern joining procedures, care should be taken when choosing what headings to fly, and other flight crew members should confirm that selections made are correct. Radio altimeter readings should be brought into the instrument scan from the moment when they first appear to confirm adequate clearance from and rate of closure with ground or water beneath the aircraft.

8.4 All aids that can assist with confirming that the aircraft follows the intended horizontal and vertical profiles should be used: this includes following VASIS or PAPI guidance and any other lighting cues that are provided. Special care should be taken if step-down approaches are to be flown where misinterpretation of altitudes linked to DME ranges is likely to be a risk. If available, NDB locator beacons should be used to confirm that the aircraft is aligned with the correct ILS azimuth signal and, by cross-checking the height or altitude when passing overhead the beacon, that the aircraft is following the correct ILS glidepath. On many such approaches, DME fixes enable the same confidence check to be accomplished and should be used to confirm that the altitude or height being passed agrees with the altitude or height shown on the IAC.

8.5 Where it is provided, ILS should always be selected, identified and used for final approach guidance. Where a glide path signal is not available, other means should be used to monitor the aircraft's descent to ensure that it does not come lower at any stage than is safe. Often, range from a datum point is provided by a DME, but the crew should check its location to ascertain where this is in relation to the runway threshold. All ground-based navigation aids that are selected should be identified by all flight crew members, noting that DMEs co-located with VORs and ILS installations code separately. Note should be made of the location of aids associated with the final approach (and possible 'go around') and their position relative to the runway. Where approved, FMS-generated distance information may be available to assist, but only when confirmation has first been obtained that the aircraft's position is known accurately by the system: thereafter, the crew should be alert to any 'map shift' that could occur and continue to monitor FMS status.

8.6 'Gates' should be specified for the final approach, beyond which the approach should not be continued unless the aircraft is on the desired glide path, in the landing configuration, with power and speed stabilised, the aim being to reduce the risk of undetected high rates of descent close to the ground. Approaches flown in IMC might require higher 'gates' from those flown in VMC.

8.7 During training, emphasis should be placed on the fact that there is no guarantee that the required visual references will be obtained at the decision altitude on any approach and that on non-precision approaches in conditions at or near the runway visual range, a missed approach could be a real possibility. It should be remembered that the visibility as reported by the meteorological observation on the ground may not be the same as the in-flight visibility. Thus, particularly for a non-precision approach, the actual visibility at the minimum descent altitude (height), can be significantly different than the reported RVR.

9 Go Around

9.1 If required, 'go arounds' from an instrument approach should be flown accurately, especially with regard to tracking, turns being made when specified on the IAC and neither early nor late. Minimum altitudes for manoeuvring should be respected, and speeds contained as specified in order that the aircraft stays within airspace that is safe with regard to adjacent terrain.

9.2 If the intention is then to fly to an alternate aerodrome, due consideration should be paid to ensuring that the aircraft remains clear of terrain in its initial climb out and en-route cruise.

10 Terrain Awareness Warning Systems (TAWS) and Minimum Safe Altitude Warning Systems (MSAWS)

10.1 The relevance of TAWS and MSAWS needs to be clarified. Both systems have been designed to provide alerts and warnings (via the controller in the case of the latter) that the aircraft has infringed certain preset thresholds and that, if not corrected by the pilot, it may fly into terrain. Neither system is a substitute for crews so planning and executing their flight that the need for TAWS or MSAWS never arises. Despite continuous improvements being made to them, and the undoubted safety benefit each can provide, neither system can be relied upon absolutely.

10.2 There is not, and there never will be, any better 'CFIT Avoidance' system than pilots and other flight crew members who by their pre-flight preparations and in-flight actions ensure that all relevant preventive measures to avoid CFIT are applied conscientiously on every occasion.

11 Training

11.1 Training in procedures that include all relevant points described above will help promote a healthy 'CFIT Avoidance' attitude. Good crew co-operation - Crew Resource Management (CRM) to use a familiar term - will add value. First, though, the operator or whoever has responsibility for specifying procedures should ensure that these contain all that is appropriate. Crews should then be trained in their use and in particular, the operator should emphasise that during operations to destinations where the visibility is at or near minima that missed approaches are real possibilities.

11.2 Staff employed to teach procedures should ensure that the latter's purpose is fully understood, staff tasked to examine or to assess proficiency should ensure that crews routinely employ these procedures, and staff who assess competency 'on the line' should ensure that 'CFIT Avoidance' standards do not suffer when unexpected circumstances such as weather avoidance, re-routeing or change of runway arise.

12 Conclusion

12.1 CFIT accidents, and incidents that might have turned into CFIT accidents continue to occur and remain a cause for concern. The risk of CFIT cannot be left to back-up systems such as TAWS and MSAWS to solve, but it can be reduced if all flight crew members are given well thought out procedures to employ, are properly trained in their use, and apply them conscientiously.

12.2 Pilots and operators are encouraged to review their procedures for 'CFIT Avoidance' content - as described above - and to ensure that, once confirmed as suitable, they are applied in all operations.

This Circular is issued for information, guidance and necessary action.