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LEGAL CAUTION
The material contained in this training program is based on the information obtained from current national, international and company regulations and it is to be used for training purposes only. At the time of designing this program contained then current information. In the event of conflict between data provided herein and that in publications issued by the authority, the authority shall take precedence.

INTRODUCTION
Controlled Flight into Terrain (CFIT) mishaps remains one of the largest threats to aviation today. Since the beginning of commercial jet operations, more than 9,000 people have died worldwide because of CFIT mishaps. CFIT mishaps are a sub-category under a larger category called ‘Approach and Landing Accidents’ or ALAR and are covered by a safety program titled ‘Approach and Safety Accident Reduction Program’. ALAR mishaps also include mishaps that include the aircraft running off the end or side of the runway during landing or takeoff.

In this program;
- We will examine the definitions/terms associated with CFIT events, then discuss exactly what contributes to the CFIT threat and then examine a few infamous CFIT mishaps
- Next we will look at what causes CFIT mishaps. Loss of situation awareness, a breakdown of CRM in the cockpit, communication errors and then altimeter errors will be examined.
- Our next step is to look at methods to reduce the number of CFIT mishaps through better altitude awareness techniques, use of CRM training, use of correct communication phraseology and using proper altimeter procedures.
- Finally, we will examine the CFIT Escape Procedure to emphasize the method to recover and the need to apply the procedure immediately.

DEFINITIONS & TERMS
Controlled Flight into Terrain or ‘CFIT’ accident: is one where an airworthy aircraft in complete control of the pilot(s) has been inadvertently flown into terrain (ground), obstacle, or water with no or little awareness by the pilot(s), until too late. These mishaps do not include events in which the pilots have a loss of control of the aircraft.

Controlled Flight Toward Terrain or ‘CFTT’ incident: is one where an airworthy aircraft in complete control of the pilot(s) has been inadvertently flown towards terrain (ground), obstacle, or water with no or little awareness by the pilot(s), but sufficient time existed to effect a safe recovery.

Enhanced Ground Proximity Warning System (EGPWS): an improved version of the GPWS system which uses only the radio altimeter to avoid terrain, this system also uses aircraft flight management system databases to identify both terrain and obstacles ahead of
the aircraft (look ahead function) so the crew has advanced knowledge of and a visual depiction of hazards earlier to avoid CFIT type mishaps.

**Loss of Control:** refers to emergency situations in which the aircraft departs from normal flight parameters from which a pilot may have been able to recover but did not, such as problems with situation awareness, recovery from windshear, mishandling of an approach, and recovery from a stall.

**Grid MORA:** an altitude printed on sectional charts within each individual grid (1 degree North/South-East/West) covering the charted area and provides 1000 feet obstacle clearance in terrain below 5000 feet and 2000 feet clearance in terrain at or above 5000 feet.

**Ground Proximity Warning System (GPWS):** a computer system that monitors an aircraft's height above ground as determined by a radar altimeter to avoid CFIT type mishaps. This system does not provide warnings of approaching obstacles such as towers and has limited effect in sharply rising terrain.

**Minimum Enroute Altitude (MEA):** the lowest altitude on an airway that provides at least 1000 feet obstacle/terrain clearance and adequate radio/navaid coverage along the entire segment of the airway.

**Minimum Obstruction Clearance Altitude (MOCA):** is an altitude that assures terrain/obstacle clearance of at least 1000 feet (in flat terrain) or 2000 feet (in mountainous terrain) and assures acceptable navigational signal coverage within 22 NM (25SM) of a VOR.

**Situational Awareness:** means the pilot is aware of what is happening around the pilot’s aircraft at all times in both the vertical and horizontal plane. This includes the ability to project the near term status and position of the aircraft in relation to other aircraft, terrain, and other potential hazards.

**THE CFIT/ALAR THREAT**
Most CFIT accidents occur on runway centerline, within 8 nm of runway threshold, on non-precision approaches.

Are there some operational areas that are more hazardous than others?

**HULL LOSS MISHAP RATES BY REGION (1986-1996)**
As you can see by the above statistics, flights outside of Europe and the USA/Canada are much more hazardous. These are many different reasons for these events but the most significant are that there are less precision approaches and less radar control areas outside of Europe and North America.

Are there other specific threats that the pilot must be aware of?
• 60% of all CFIT mishaps occur on a Non-Precision or visual approaches,
• 47% of Non-Precision approach mishaps occur during a ‘step-down fix approach’,
• Almost all CFIT mishaps occur at Night or Instrument Meteorological Conditions
• 48% of CFIT events occur in mostly flat terrain not in the mountains
• More than 66% of all CFIT accidents are the result of altitude error or lack of vertical situational awareness.

Based on all the above statistics you can develop a good picture of the phases of flight and operational areas that are prone to CFIT type events. If you are flying in areas without radar coverage, on a non-precision approach with step-down altitudes or a visual approach, at night or in IMC conditions, your chances of a CFIT mishap are greatly increased, especially if you are rushing during the approach or adversely affected by fatigue.

CFIT/ALAR HISTORY
Some of the most infamous accidents due to CFIT.
The crash of Eastern Air Lines Flight 401 near Miami, Florida on December 29, 1972:
The pilot, co-pilot, and flight engineer had become fixated on a faulty landing gear light and had failed to realize that the autopilot had been switched off (no warning system was required at the time). ATC saw the descent but did not effectively communicate the descent to the crew. The distracted flight crew did not recognize the plane’s slow descent and the completely airworthy aircraft struck the ground in the Everglades, killing 101 out of 176 passengers and crew.

The crash of Air New Zealand Flight 901 into Mount Erebus, Antarctica on November 28, 1979:
There is still disagreement over the exact causes of the crash, but it is commonly accepted that the pilots’ loss of situational awareness and whiteout conditions at the time were contributory factors leading to the crash. All 257 people on the plane were killed.

The crash of Pakistan International Airlines Flight 268 on approach to Kathmandu on September 28, 1992:
This is a difficult approach as the airport is located in an oval-shaped valley surrounded by mountains. Flight 268 was approximately 900 feet below the designated approach path and impacted a steep cloud-covered hillside. All 167 people on the plane were killed.

The crash of American Airlines Flight 965 on December 20, 1995:
The Boeing 757-223 impacted tree-covered mountainous terrain near Cali, Colombia. The crew failed to recognize a navigational error they had made. The database contained a waypoint error that was not detected by the pilots. During the GPWS
escape manoeuvre, the crew used TOGA power and forgot to stow the speed brakes. All eight crewmembers and 152 of the 156 passengers were killed.

**CAUSES OF CFIT/ALAR MISHAPS**

There are many different cause factors that lead to a CFIT mishap. Like any mishap many different layers of protection must fail for an accident to occur. The primary cause of CFIT mishaps is the pilots losing situation awareness during some phase of the flight causing the aircraft to fly too close to terrain, obstacles or the water.

**LOSS OF LATERAL / VERTICAL SITUATION AWARENESS**

What is situation awareness? It includes both position awareness (lateral situation awareness) and vertical situation awareness.

One definition of situational awareness is an accurate perception by pilots of the factors and conditions currently affecting the safe operation of the aircraft and the crew.

Another formal definition provided by NASA is as follows:

‘SITUATION AWARENESS IMPLIES AN ALERT ACTIVE ASSESSMENT OF AIRCRAFT POSITION RELATIVE TO TERRAIN, OTHER AIRCRAFT AND THE AIRPORT. IT IS AN ENERGIZED CONSCIOUSNESS THAT NOT ONLY EMBRACES EVERY ASPECT OF THE AIRCRAFT ENVIRONMENT BUT ALSO INCLUDES A COMMITMENT TO DO IMMEDIATELY WHATEVER IS NECESSARY TO ENSURE THE SAFETY OF THE FLIGHT.’

One operational method to define your state of situation awareness is addressed in these three questions. Where are we? Where are we going? What could get in our way? If all the crewmembers have the same answers to these questions, the chances are you have a very effective situation awareness of your circumstances.

Let’s look at each question and apply it to line operations.

Where are we? Does each of the pilots know the position of the aircraft, at all times, in relation to the following: desired course, assigned altitude, and correct airspeed? Is the course the crew is flying, the course that was flight planned or assigned by ATC? Does the crew have a proper three-dimensional cognitive understanding of their position in the planned flight? Do all crewmembers share the same position awareness?

Where are we going? Does the entire crew share the same perception of the planned path ahead? Does everyone agree that your flight plan agrees with your clearance? Does everyone agree on the procedure to get to the next waypoint or if a change is received, does the entire crew agree on the new waypoint? Does everyone agree on assigned altitude and airspeed to reach the new or next waypoint?

What could get in our way? This is a question that is very seldom addressed but is the key factor in many aircraft accidents. What could get in your way while flying to the next waypoint? It could be terrain, severe weather, restricted airspace or another aircraft. It could be that within the cockpit there are two or more different perceptions of the present position and where the aircraft is going. This is an example for ‘What could
Aviation is never static; it is always dynamic. Situation awareness is constantly changing, sometimes in seconds. Because of this constant change, the crew must also constantly make changes to their perception of the situation to correctly react to these changes. The crew must always know the answers to these three questions and be in agreement within the cockpit in order to stay out of harms way. These questions are very important in the high threat areas on the approach or landing phases of flight, we discussed earlier.

BREAKDOWN OF CRM IN THE COCKPIT
Crew Resource Management is a field of study designed to identify human performance errors in flight operations, which lead to aircraft mishaps. The training emphasizes using the synergy of the crew to overcome operational challenges. Some of the principles of CRM are controlling workload management, communication, situation awareness, assertiveness of crewmembers and technical proficiency of the crew. You can see how many CFIT mishaps are attributed to the breakdown of CRM procedures in the cockpit.

An example of a CRM breakdown is the crew rushing the operation. If the crew gets behind on an approach procedure and begins to rush normal procedures such as checklists or other standard operating procedures (SOP), significant items can be missed. The process of rushing can cause the crew to funnel or tunnel their situation awareness on to one or two items and miss an altitude restriction or another clue that situation awareness has been lost. This type situation loss is caused by poor workload management and pacing. The Captain has to set and maintain a workload pace that the entire crew can keep up with to assure proper situation awareness. SOPs and checklist will not protect the crew if the pace is allowed to accelerate to a point individual crewmembers are missing items. Often, pilots prioritise tasks and expect to recover their situational awareness after they have dealt with the task they have assigned higher priority. In most situations that works but if an item like vertical situation is delayed, the rocks could meet you before awareness has been regained.

Another breakdown in CRM that is relatively common, is misperceiving or not paying attention to altitude restrictions when flying a non-precision approach. Books have been written about such accidents. Especially non-precision approaches that have step-down fixes. Many CFIT accidents have occurred because pilots have misinterpreted approach plates and started down at the wrong DME to an altitude that is published but for another DME resulting in a mishap. In some cases crews were using the DME from the wrong navaid to make the descent.
COMMUNICATION ERROR

Communication errors often occur during flight operations both inside and outside the aircraft. These miscommunications have lead to several CFIT type mishaps. Some of the communication errors between the pilots and ATC are caused by:

- Language differences
- Lack of standardized phraseology
- Read back errors

The following is an actual example taken from operations in South America:
An airliner was making an approach to Quito, Ecuador but had to perform a missed approach due to visibility below limits to land. The crew requested to go to their alternate airport of Guayaquil, Ecuador. The ATC controller cleared them ‘Cleared direct Guayaquil’. The First Officer selected ‘present position direct’ to Guayaquil in the FMS while the Captain was on the radio and executed the change. Once the Captain got off the radio, the First Officer explained what he had done. The Captain turned the aircraft immediately back to the original flight plan route because the aircraft was at 17,000 ft and the Grid MORA or highest terrain in their direct routing was 24,000 feet. This was not a radar environment and occurred at night. This is a perfect scenario for a CFIT mishap.

If ATC clears your aircraft ‘Direct to’ a fix or destination, what do they really mean? Were you cleared ‘present position direct to the fix or destination’ or were you cleared ‘via your flight planned route to the fix or destination’? In our example the ATC Controller was clearing the aircraft ‘via flight plan route to Guayaquil’ not present position direct. The Controller did not use proper phraseology. The proper phraseology should have been: ‘Cleared to the Guayaquil airport as filed, maintain FL 280’. The proper clearance of ‘Cleared present position direct Guayaquil’ would have the proper clearance if the Controller wants you do fly direct from your present position to the fix or destination. The outcome in this case could have been a disaster.

What can get in your way if you fly present position direct to the fix? Is your present altitude adequate for terrain clearance if you go direct to the fix? If you’re not sure of the clearance, you can’t be sure of the result of going direct. Does your crew always go where ATC sends them without crosschecking the Controllers?

Another example from South America is as follows:
An airline crew was cleared as follows: ‘N-123AL cleared to fix ABC 17000 ft’ What does this clearance mean? The airliner was established on a jet airway as filed and cruising at Flight Level 350. The aircraft was not in radar contact and operating at night. Would you begin a descent to 17,000 at this time based on this clearance?
A review of the Enroute Chart shows that the MEA is FL 240 on the present segment of the airway. After passing a waypoint 90 NM down track from their present position the MEA is reduced to 17,000. The controller’s instructions were supposed to communicate,
‘continue on flight plan route, at the appropriate waypoint you are cleared to descend to 17,000 ft. Could you make this descent without a local altimeter setting? Not legally!

Another example was an aircraft cleared to fly a heading provided as a ‘radar vector’ until intercepting the Localizer course for an ILS Approach. The crew had dialled in the wrong Localizer frequency and remained on the vector until impacting terrain. These are just a few examples of the hundreds of miscommunications that happen daily in flight operations around the world. In countries were English is not the first language of the pilots and/or controller many other miscommunications can occur.

ALTIMETER ERROR
Altimeter errors have lead to many CFIT type mishaps. There are several types of altimeter errors that can occur based on your operational area, altimeter types and pressure changes you experience.

One problem identified was the measurement used to determine altimeter settings. For example in North America the altimeters are determined and given in 'Inches of Mercury (In)’. In most regions of the world, altimeters are calibrated in ‘Millibars (Mb) or Hectapascals (hPa)’. In Russia, China and Mongolia, the altimeters are given in ‘Millimeters (MM) of Mercury’. Conventional altimeters in the West cannot use the MM setting and must get an Mb/hPa setting.

A pilot from North America flying in Europe for example would be given an altimeter setting in Mb/hPa and would have to place that setting in their altimeters in an appropriate selector location which is different from their standard ‘In’ location. An altimeter setting of 995 Mb given by ATC could be mistakenly entered into the In selector as 29.95 (a very common error). This error could make several hundred feet difference in the reading on the altimeter and make the crew unknowingly at risk of a CFIT mishap.

Another altimeter problem occurs in Russia, Mongolia and parts of China. These areas use ‘meters’ to determine altitudes in flight. The West uses feet and flight levels measured in feet using In or Mb/hPa to measure altitudes. While flying through these regions, Western crews either have to adjust their altimeter to fly in meters or use an altitude adjustment to change meters to feet in order to fly at the proper altitude. These regions also use what is known as the ‘QFE’ altimeter setting below the transition level. The QFE altimeter measures height above the ground rather than height above mean sea level or ‘QNH’. In the West, all flight procedures are computed above mean sea level or QNH. Western aircraft flying in these regions must either use the local QFE altimeter settings or convert them to QNH altimeter setting to assure they are flying a safe altitude. If a crew mistakenly uses a QFE altimeter setting and attempts to fly QNH altitudes, the crew will be low on approach by the measure of mean sea level. For example, if a crew attempts an approach to an airport in Russia that has a Runway Elevation of 1000 ft. (above sea level), the crew would be 1000 ft. low on approach if they use a QFE altimeter setting to fly the approach while using published QNH altitudes.
Another altimeter error could occur due to the difference in transition altitudes and transition levels throughout the world. The transition altitude is the point during a climb at which the crew sets in ‘QNE’ altimeter setting or normal enroute (standard pressure 29.92 In/1013 Mb). In US/Canada, the transition altitude and transition level are the same altitude normally 18,000 ft. or FL 180. Most of the world however changes the transition altitudes by either country or even by airport. The transition altitude could be 5,000 ft. at one location and 9,000 ft. at another location. Transition altitudes established close to the ground could be easily missed if the crew is task saturated during departure procedures. Crews descending must change their altimeters to local altimeter setting by the transition level. Most countries have a 500-1000 ft transition layer to change altimeters settings. Distractions or rushing during the approach could lead to the crew making an approach using the QNE altimeter setting rather than the proper local altimeter. This is another element in CFIT type mishaps.

Another altimeter error can occur if the temperature at the airport you are approaching is significantly below the standard temperature of 15 degrees C. As air temperature decreases the air compresses, therefore your published altitude may have you flying well below a safe altitude clearance. In the Introduction Section of Jeppesen, is a cold temperature adjustment chart, which the crew should use to adjust their published altitudes on the initial, intermediate and final approach segments of the planned approach. For example if you were flying to a location that had an approach altitude of 5000 ft. above the runway and a reported temperature of –55 degrees, the correction factor could be as much as 1500 ft in addition altitude added to the published initial approach altitude.

**REDCUTING CFIT/ALAR MISHAPS**

Many different studies, training courses and books have been produced through the years to combat this problem. There is no one solution to the problem!

There are generally two different solutions sets that develop after a CFIT type mishap. One group, usually the avoidance system/aircraft manufactur es suggest a new avoidance system to avoid the next CFIT mishap. Another group suggests that the crews should be better trained in skills like maintaining situation awareness in areas of high risk for a CFIT type mishap. The truth is neither approach works successfully by itself. For example for years aircraft with both two and three crewmembers cockpits were experiencing CFIT mishaps. Aircraft were then equipped with GPWS equipment and all the systems group followers stated that this was the solution to CFIT mishaps. Unfortunately they were incorrect. The GPWS systems did not identify obstacles or quickly rising terrain. The American Airlines aircraft in Cali, Columbia was equipped with GPWS but the warning did not allow enough time for the crew to escape the mishap at the top of the mountain. CFIT type mishaps continued at a somewhat reduced rate.
The next great suggestion from the avoidance system groups was to add EGPWS. This system was designed to give crews an additional 60-seconds to respond to a CFIT threat. The system added a database ‘look ahead’ function and the ability to warn of obstacles, like towers, and quickly rising terrain like steep mountains ahead. This system also gives a visual display of the terrain in front of the aircraft in flight if the crew turns on the weather radar or terrain display device. CFIT mishaps are still occurring even with EGPWS equipped aircraft. Why?

The same amount of money and effort dedicated to new aircraft systems has not been dedicated to adequately training pilots than has been spent on new avoidance devices. That does not mean that the systems do not add a significant layer of protection to preventing CFIT mishaps, because they do! Depending on the study you review, 60-80% of all aircraft mishaps occur due to some form of human error, however 95% of training budgets are spent on simulator training rather than on human error reduction. Decision-making, situation awareness, communication breakdowns and not properly following SOPs have led to the majority of CFIT mishaps. No system is going to correct that fact.

The solution is a balanced approach to avoid CFIT mishaps. Operators should equip their aircraft with the latest terrain/obstacle avoidance systems but must also dedicate the money and effort into training their crews to use proper procedures to maintain proper position/altitude awareness, avoid communication errors, use proper CRM techniques, set altimeters properly and properly use terrain avoidance systems.

POSITION / ALTITUDE AWARENESS
One very effective way to assure the crew has the correct position and vertical awareness is the use of the operation situation awareness definition we discussed earlier, using the three questions:

- Where are we?
- Where are we going?
- What can get in our way?

Where are we?
Does the entire crew share the same cognitive knowledge of the relationship between the flight planned or assigned position/altitude and the present aircraft position/altitude? The crew must use both the database reference and all available charts to compare ‘present position’ and planned/assigned. The pilot not flying (PNF) should be assigned the duty of keeping the crew current on their location relative to the assigned/planned route or altitude. No turn or descent should be initiated without the PNF confirming, ‘present position/altitude’ on both the Flight Management System (FMS) and available chart information. Many pilots flying modern aircraft do not see the need to use enroute charts since according to them ‘Everything I need to know is in the database’. Does the database contain MEA, MOCA, Grid MORA, MSA altitudes or restricted/prohibited areas? The answer is NO! If pilots use only database information to change position or
altitude, they cannot check their path against known threats. This greatly increases the chance of a CFIT mishap or a violation.

Where are we going?
In the Cali accident we discussed earlier, the crew was cleared direct to ‘ROZO’ which is depicted as ‘R’ on the approach plate. The Captain selected ‘Direct to R’ in the database. There were 14 different ‘Rs’ in database. The Captain selected the top item on the list (the closest R), which ended up being the NDB at Bogotá, Colombia, 137 nm behind the aircraft. The database did not correctly comply with the ARINC 424 procedures and allowed the Bogotá NDB to be included in the database rather than the Cali ‘ROZO’ entry. The Captain selected the wrong waypoint by mistake and executed the change without the crew cross-checking the flight path prior to execution of the database change. The aircraft began a 180-degree descending turn to Bogotá. The mistake was caught 1-minute later and the aircraft course changed manually back to ROZO. The PNF should assure the position or altitude is confirmed by all pilots and checked against enroute charts prior to ‘executing’ the change. If you select the ‘EXEC’ button on the FMS prior to confirming the position or altitude you’re going to, you could be ‘executing’ everyone on the aircraft if you are wrong!

What can get in our way?
In the Cali event the crew changed runways to cut a few minutes off the flying time. The change caused the crew to ‘rush’ to get down earlier than was originally planned. The crew was descending with the spoilers deployed to expedite the descent. After the course reversal discussed above, the crew had flown out of the valley used for the normal arrival and was now behind a very steep mountain with quickly rising terrain. The aircraft was equipped with GPWS but not EGPWS equipment. The crew had lost situation awareness due to the course change. When the GPWS alert sounded the crew applied an incorrect CFIT escape procedure and hit the top of the mountain causing many fatalities. The GPWS did not have the capabilities to inform the crew of the quickly rising terrain. EGPWS would have given them a warning 60-seconds earlier than GPWS equipment and could have given them a visual display of the threat around them. In a rush it may not have stopped them from getting into the situation in the first place. Some crews that have EGPWS equipment do not use the terrain display capability of their aircraft, which could have left them in a similar situation as the mishap crew. The PNF should confirm that terrain, obstacles, restricted/prohibited airspace or severe weather conditions are not a factor on the intended route. The PNF should be responsible for cross-checking all turns or descents against published MEAs, MOCAs, MSAs, Grid MORAs, restricted or prohibited areas and the EGPWS visual displays and/or weather radar displays prior to any turn or descent.

Avoid accepting night visual or contact approaches! Once accepted, the crew becomes responsible for terrain, obstacle and traffic separation. Several CFIT mishaps have been caused an aircraft striking terrain while the runway lights were in sight several
miles away. Use radar services and published approach procedures even in night visual conditions to the maximum extent possible.

Proper CRM is the basis of the items that we just discussed. The crew must maximize the use of all their resources such as FMS, Charts, and displays available to them to avoid a CFIT mishap.

CORRECT COMMUNICATION PROCEDURES
Communication procedures, inside or outside the cockpit, can lead to a CFIT event. It is important that communication within the cockpit adds to situation awareness rather than distract from it. As in communication outside, the aircrews should use phraseology that is standard and appropriate for the situation. The language used should not lead to confusion. If the crew does not have a common first language, they should use a common language like English especially in critical situations. For example, if the Captain and the ATC controller start speaking in Spanish during an emergency situation because it is a common first language for both, and a First Officer who speaks only English is involved, he will not have a common level of situation awareness with the controller and the Captain.

Pilots should avoid using short cuts or ambiguous statements assuming the other pilot or ATC understands the meaning. For example, if one pilot states, ‘level off’. Does that mean level the aircraft now? Are you approaching the assigned altitude? Are they asking the assigned altitude? Most operators have a published procedure or established calls for the crews to use like, ‘1000 ft. above, 100 ft. above, level off’. The PNF should be monitoring all descents and climbs and make the appropriate calls are made to back up the PF in compliance with SOPs.

One technique to use to reduce the chance of a ‘read-back/hear-back error’, or confusion about a newly assigned altitude, is for the PNF to set a newly assigned altitude in the altitude selector window, answer ATC by confirming the altitude leaving for the newly assigned altitude, all the while pointing at the altitude in the selector window until the PF acknowledges and confirms the altitude change by pointing at the selector window. Once confirmed and the altitude has been checked, the altitude change can be activate to initiate the climb or descent to the newly assigned altitude. This technique is referred to as the ‘point and shoot’ format. Any method used should assure that both pilots have heard and understand the correct altitude change prior to the change being made. If the crew ‘expects’ a specific altitude based on published altitudes on the sector or approach chart or based on experience, for example, ‘We always get assigned 3000 ft on this part of the approach’; even an experienced crew can ‘hear’ what they expect rather than what was actually assigned. Both ATC and Crews should strive to use proper radio phraseology to include a full read-back of clearances to avoid a critical error.
ALTIMETER PROCEDURES
As discussed earlier in this program there are several different types of altimeter errors that can lead to a CFIT mishap. How do you avoid an altimeter error in flight?

First, prepare before you depart by reviewing both enroute and approach charts and State Aeronautical Information Publications for each country of the intended route. These documents can show you the type of altimeter measuring system used in the country (In, hPa, MM); feet or meters; the applicable transition altitudes/levels; and if the altimeter settings will be give for QNH or QFE. Once the crew has collected this altimeter information they can develop a plan of action and prepare any charts necessary to adjust to requirements at the destination. For example, some aircraft like the Gulfstream III (G III) can not modify their altimeters to read in meters. If the crew plans a flight to Russia, they need to develop an accurate chart that will convert altitude levels like 11,000 meters given in Russian airspace to Flight Levels measured in QNE feet for example FL 366 that the G III can monitor. Enroute charts do provide an estimate but the crews would have to interpolate while in flight but preparing in advance will eliminate errors.

Another advantage to preparing before departure is to put the crew in the correct mindset for entering altimeter data in the correct selector location such as hPa/Mb rather than using In selectors. Also so the crew can prepare for different transition altitudes and transition levels to avoid errors that could lead to a CFIT event.

In flight, the crew should avoid rushing and avoid going ‘heads down’ in the cockpit to compute altimeter differences. These distractions are directly linked to many different CFIT mishaps. If your crew is operating in a flying environment significantly different than normal, such as, flying in a QFE altimeter setting country, assure that all crewmembers are in agreement on the procedures to be followed, all correction factors have been computed in advance and there is no question which altimeter setting has been received QFE or QNH.

CFIT/ALAR ESCAPE PROCEDURES
Another cause of CFIT mishaps, is a crew delaying and/or incorrectly executing an escape maneuver to avoid terrain. Many CFIT type events have ended with an aircraft hitting near the top of a hill or mountain, with the aircraft in a climb to avoid the mountain.

PROPER PROCEDURES
Caution: Always comply with the specific escape procedure provided with your AFM, company procedures manual or other published procedure. The information here is for training purposes only and does not in any way try to override any of the above procedures.

Once a GPWS or EGPWS escape alert is sounded the crew should do the following:
First, the crew should disconnect all levels of automation, for example autopilot and autothrottles should be immediately disconnected by the PF and confirmed by the PNF.

Next, the PF should simultaneously apply ‘Maximum Thrust’ by manually pushing the throttles full forward and raising the aircraft vertical path manually to the ‘Pitch Limiter’ indication or about 17-20 degrees nose up. Remember, this nose up degree can vary depending on the aircraft type. Please refer to your FCOM for specific aircraft type you are flying. Most aircraft are equipped with ‘Electronic Engine Controls (EECs) or other type fuel control devices to stop engines from ‘over-boosting’ during rapid engine advances. The use of autothrottles in the Takeoff Go-around (TOGA) mode can limit throttle advancement speed and limit the potential amount of thrust available for the escape procedure which could be fatal in a CFIT event! Most AFMs require the crew to ‘honor the stick shaker’ or reduce the angle of attack and ‘Gs’ applied during the escape procedure, however the crew should also strive to maximise the climb rate to avoid quickly rising terrain.

Confirm all drag devices have been stowed! The PF should manually stow spoilers or speed brakes as soon as possible during the escape procedure. The PNF should confirm manually that the drag devices have been stowed. Some aircraft are configured so that the drag devices stow automatically upon a TOGA activation but may or may not stow in a manual escape procedure. The PNF should still confirm that the drag devices have stowed to prevent a reduction in climb capability. In the Cali mishap described earlier the crew used TOGA mode to advance the throttles and failed to stow the spoilers. Would the aircraft have cleared the mountain if either or both of these errors not been made? Probably! The airline changed their CFIT escape procedures after the mishap to better improve the chance of recovery from a CFIT event warning.

Do not terminate the escape procedure until the crew is assured that the terrain hazard has been cleared. Reducing the thrust setting or angle of climb during the escape maneuver could lead to a fatal end to the event.

**TIMELINESS OF THE PROCEDURES**
React immediately to a GPWS/EGPWS warnings without hesitation! Many CFIT escape events have turned in fatal mishaps because the crews delayed to react to the warning. When the GPWS system was first installed, many crews received ‘false’ warnings which lead to crews ignoring some of the warning. In modern time the systems have been shown to be very accurate. One problem with delays in responding to the warnings is caused by the crews having a level of situation awareness which tells them they are not in danger while trying to assess the accuracy of the warning prior to committing to an escape maneuver. These delays can be fatal! If the escape maneuver is delayed too long the aircraft systems may no be able to fly the aircraft out of the situations. A loss or change in situation awareness, as we discussed earlier, is a critical cause of CFIT mishaps.
Crew should also use the EGPWS visual displays on both takeoffs and landings to provide them with a visual presentation of the terrain or obstacles in their flight path. A picture is worth a thousand words when it comes to situation awareness. The visual display provides a layer of protection that assures correct situation awareness. Many pilots do not see the need for EGPWS during takeoff and climb because the aircraft is climbing away from terrain and obstacles. If the crew has to return to the airport after takeoff for an emergency, it is imperative that they have a visual picture of the terrain or obstacles in their path.

**SUMMARY**

Controlled Flight into Terrain (CFIT) mishaps remains one of the largest threats to aviation today. Even with the use of GPWS and EGPWS equipment, in this program:

- We have examined the definitions/terms associated with CFIT events, then discussed exactly what contributes to the CFIT threat and then examined a few infamous CFIT mishaps.
- Next we looked at what causes CFIT mishaps. Loss of situation awareness, communication errors and then altimeter errors were examined.
- Our next step was to look at methods to reduce the number of CFIT mishaps through better altitude awareness techniques, use of CRM training, use of correct communication phraseology and using proper altimeter procedures.
- Finally, we examined the CFIT Escape Procedure to emphasize the method to recover and the need to apply the procedure immediately.

End of the Course