Chapter 9
Escape Maneuvers

ABSTRACT

Important escape maneuvers are covered here. From a mission success standpoint, the information presented is arguably the most important. The terrain escape maneuver, wind shear escape maneuver, engine failure during second segment climb, upset recovery maneuver, and stall warning and recovery during takeoff operations are discussed in detail. Terrain escape maneuvers include operations from terrain critical airports when the engine fails. This information is useful to not only system designers but training designers as well. We also introduce the dynamic “rudder bar.” The rudder bar improves maneuver precision but reduces workload. We contend that the escape maneuver package presented here become part of the crew station for all future aircraft and retrofitted to all aircraft currently operating that possess data bus technologies.

INTRODUCTION

This section will discuss two important escape maneuvers that have been a part of the maneuver package for all flight crews for some time. The purpose is to provide additional information to design teams that desire to develop flight deck performance aids that target these maneuvers. These two maneuvers are the terrain escape maneuver generated by a Ground Proximity Warning System (GPWS) alert, and the wind shear escape maneuver caused by an encounter with a wind shear event.
**Escape Maneuvers**

**ESCAPE MANEUVERS: TERRAIN**

Controlled flight into terrain (CFIT) has been a major cause of aircraft accidents for many years. There are many specific causes of CFIT, but most involve a breakdown of situation awareness by the crew. Many things may cause degraded crew performance, but in a large number of cases, high workload has gone unchecked, operational risk has either been misidentified or ignored, improper procedures have employed, or improper use of the autoflight systems were evident.

Terrain can be detected by the terrain detection system GPWS. In some modern airplanes this is enhanced by terrain data (EGPWS). Sloping terrain of an unknown gradient is often a serious problem for flight crews because once employed, even an escape maneuver may not be effective if the slope exceeds the aircraft’s climb rate.

**ESCAPE MANEUVERS: WIND SHEAR**

Encountering a wind shear event is a serious challenge for all flight crews. During this type of event, atmospheric disturbances will impact the dynamics of the aircraft by reducing energy or causing inadvertent rolling or pitching moments. Energy change can be either minor or dramatic. Airspeed may fluctuate and flight trajectories may be significantly altered. Each fluctuation of airspeed may signify a complete cycle of the disturbance. These repetitive short-term encounters can be caused by atmospheric eddies, in turn caused by convective or frontal weather conditions. In some dramatic encounters the aircraft can experience large, rapid changes in airspeed and G-force levels.

An example of a minor encounter may be the crossing of a cold front where the aircraft may experience an increase or decrease in indicated airspeed. This often is because of wind directional shift. Usually the aircraft will return to its original condition after a short time.

More dramatic conditions, known as microburst events, are of the greatest concern. These events are extremely dangerous because they may represent conditions in which the aircraft does not have enough energy for recovery. Consequently, avoidance is of primary concern. The escape maneuver should be used as a last resort in these instances.

**Energy Management**

Maximizing the energy state of the aircraft in any escape maneuver is essential. This is optimized by selecting maximum thrust for these maneuvers. For all escape maneuvers, selecting maximum thrust is almost always required. Establishing the
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