

**BOEING**

# **Flight Operations *REVIEW***

A MESSAGE TO FLIGHT CREWS FROM THE BOEING COMMERCIAL AIRPLANE GROUP

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## PROPER LANDING TECHNIQUES

Recent increases in reported landing incidents indicate a need to review proper landing techniques. The reported incidents involved short landings, hard landings or tailstrikes during the landing flare. It appears that many of these incidents could have been prevented. This article discusses the key elements that lead to a good landing.

All proper landings have one thing in common - A STABILIZED APPROACH. The airplane must be stabilized on speed, and on the planned approach profile well before crossing the threshold. Speed variations of plus or minus five knots from the target speed are generally acceptable without need for rapid or large thrust changes. Speeds lower than Vref result in higher than normal pitch attitudes. At normal landing weights, being ten knots slower results in being about three degrees pitch attitude higher. This is an important consideration because as pitch attitude increases, aft body clearance at touchdown decreases. Also, for the same pilot eye height, main gear height over the threshold decreases with increasing pitch attitude. This may result in touching down short of the runway. We will not go into any more detail on stabilized approaches but will concentrate on important aspects of the flare technique.

A properly executed flare is essential to a good landing. It is important to flare at the right altitude, and hold the correct pitch attitude through touchdown. A high flare, or early thrust reduction, results in bleeding off speed, requiring an increase in pitch attitude to prevent a subsequent high descent rate. If flare begins too early, the airplane may float resulting in increased landing distance. The nose high pitch attitude also increases the possibility of a tailstrike. If flare occurs late, a hard landing may result. The optimum flare usually only requires increasing pitch attitude by about two or three degrees. Use of stabilizer trim during flare should be avoided due to the potential of causing an increase in pitch attitude which would require forward control column pressure to avoid tailstrike. Even

if pitch attitude does not increase prior to touchdown, re-trimming may change the airplane's pitch response to normal control column inputs while lowering the nose resulting in unanticipated or rapid changes in attitude.

Let us now consider thrust effects during the flare maneuver. On some airplanes, a rapid thrust reduction may result in a more pronounced downward pitching tendency requiring a rapid control column input to prevent a high descent rate, which might also result in increasing pitch attitude at touchdown. It's much easier to be precise if thrust is reduced slowly, controlling the rate of thrust reduction so that the thrust levers reach idle just at, or near, the time of main gear touchdown. In addition, if pitch attitude is still increasing at touchdown, or worse yet being trimmed nose-up, the pitch attitude may continue to increase after touchdown. Don't anticipate a nose down pitch change after touchdown. An early nose up control column input to compensate for the anticipated pitch change may cause a pitch attitude increase.

There is one more aspect of the flare maneuver that should be mentioned - the view out the cockpit windows. Cockpit windows in the newer generation jetliners, such as the 757 and 767, have more downward visibility compared to older airplanes. The increased downward vision provides an advantage in sighting the runway on low visibility approaches, but may result in less awareness of pitch attitude because more of the runway remains in view at high pitch attitudes. Because of this increased visibility, the need for pitch corrections as a result of disappearing runway may not be readily apparent. So, don't depend entirely upon such visual cues for awareness of pitch attitude.

In summary, a bad landing is usually the result of making more than one mistake. Being high and fast, or being slower than  $V_{ref}$ , over the threshold can lead to rapid pitch and thrust adjustments during the flare. Remember, the key elements in the flare are timing and control. Large, rapid changes which require large rapid corrections aren't usually appropriate close to the ground. So, if a stabilized approach is not evident as touchdown approaches, a go-around should be considered. Going around is not necessarily indicative of poor performance, but rather good judgement.

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