Flight crews should execute a go-around maneuver instead of continuing an unstabilized landing approach.

Why and When to Perform a Go-Around Maneuver

Industry statistics indicate that while only 3 percent of commercial-airplane-landing approaches meet the criteria for being unstabilized, 97 percent of these unstabilized approaches are continued to a landing, contrary to airline standard operating procedures. Most runway excursions can be attributed at least in part to unstabilized approaches, and runway excursions in several forms are the leading cause of accidents and incidents within the industry. Airlines should emphasize to flight crews the importance of making the proper go-around decision if their landing approach exhibits any element of an unstabilized approach.

By Michael Coker, Lead Safety Pilot, Flight Services

According to industry sources, no single decision has the potential impact on the overall aviation industry accident rate than the timely decision to execute a go-around maneuver. The reason is that runway excursions or overruns — which are typically the result of an unstabilized approach with a failure to perform a go-around — account for 33 percent of all commercial aviation accidents and are the primary cause of hull loss.

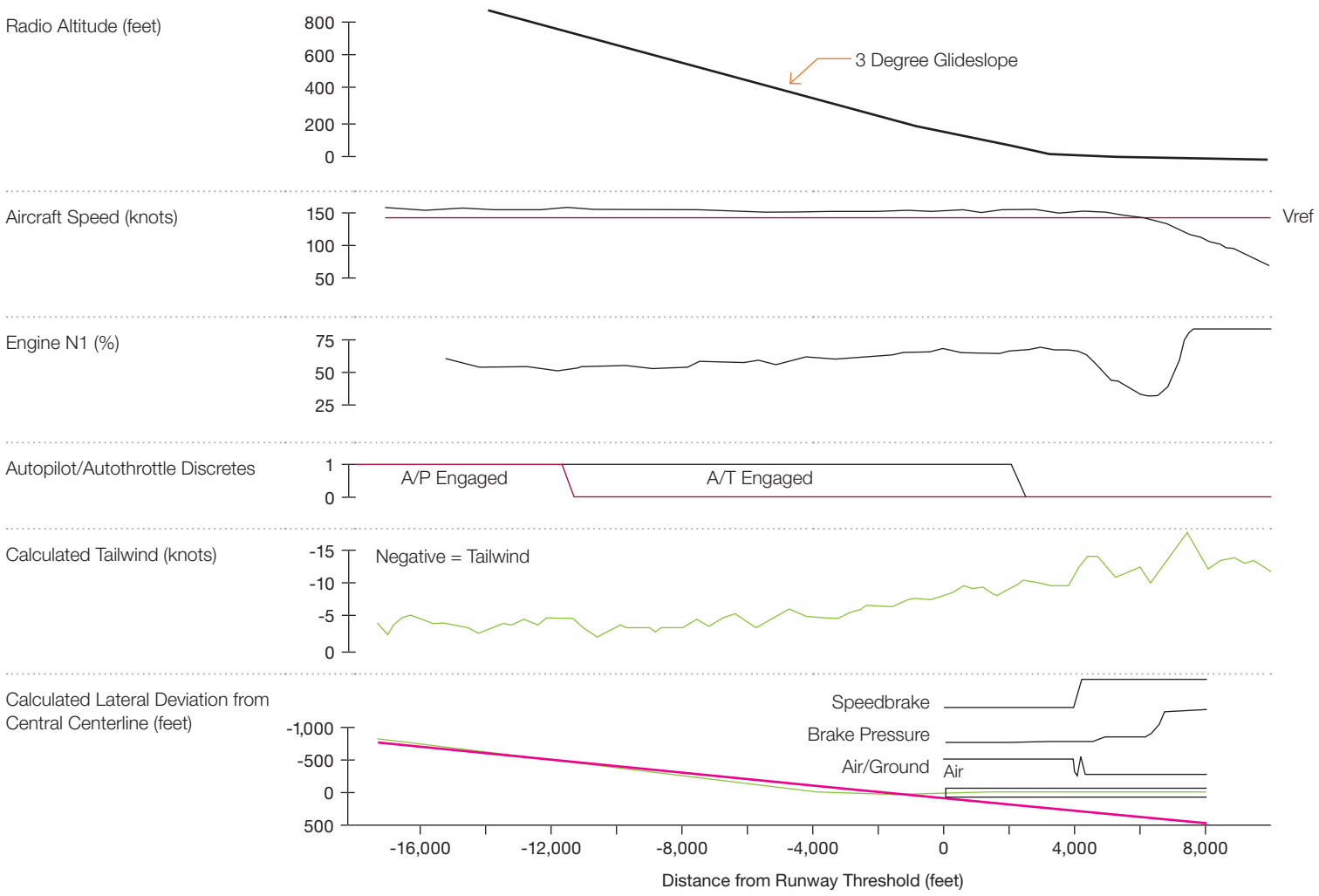
This article explains the relationship between unstabilized approaches and hull loss, why flight crews continue landing despite an unstabilized approach, the factors that govern landing outcomes, when flight crews should choose a go-around maneuver, and industry education efforts related to go-arounds.

THE RELATIONSHIP BETWEEN UNSTABILIZED APPROACHES AND HULL LOSS

Boeing developed an analysis to help visualize runway events. This Boeing Runway Track Analysis combines multiple sets of investigation data, including time-based flight-data-recorder data, distance-based ground-scar data, and the calculated track (see fig. 1).

Figure 1: Boeing Runway Track Analysis

Boeing Runway Track Analysis uses a variety of data to analyze runway events.



This analysis shows the relationship between unstabilized approaches and hull loss, due to runway excursion (see fig. 2). In every instance of hull loss, the outcome may have been very different if the flight crews involved had elected to perform a go-around instead of attempting a landing. According to a Flight Safety Foundation (FSF) study, more than half of all commercial airplane accidents in 2011 could have been prevented by a go-around decision. In fact, according to FSF's analysis 83 percent of approach-and-landing accidents could be prevented by a go-around decision.

The conclusion from this analysis is that flight crews need to know when to abandon an approach to landing and perform a go-around maneuver because the decision to go around is an essential element of conducting a safe flight.

WHY FLIGHT CREWS CONTINUE LANDING WITH AN UNSTABILIZED APPROACH

According to the FSF, a number of factors contribute to a flight crew's decision to continue landing with an unstabilized approach, including:

- Fatigue.
- Pressure of flight schedule (e.g., making up for delays).
- Any crew-induced or air-traffic-control (ATC)-induced circumstances resulting in insufficient time to plan, prepare, and conduct a safe approach.
- ATC instructions that result in flight too high and/or too fast during the initial approach.
- Excessive altitude or excessive airspeed (e.g., inadequate energy management) during the initial approach.
- Late runway change.
- Excessive head-down work.
- Short outbound leg or short downwind leg (e.g., because of traffic in the area).
- Late takeover from automation.

Figure 2: Relationship between unstabilized approach and hull loss

This analysis shows that four out of seven unstabilized approaches in this study resulted in hull loss.

		Touchdown Point (TD)		Touchdown Speed		Deceleration				Result	
						Speedbrake (SB)	Thrust Reversers (TR)		Runway		
	Approach	Point (feet)	Runway Used (% LDA)	Airspeed >Vref (knots)	Tail Wind (knots)	When SB Deployed (sec)	When TR Deployed (sec)	When TR Reduced (feet)	Braking Action	Overrun Speed (knots)	Hull Loss
Long	Unstable	7,000	72%	23	0	TD	TD + 3	Departure	Good	81	Yes
	Unstable	6,200	70%	12	5	TD	Never		Dry	50	No
	Unstable	5,300	60%	16	3	TD	TD + 4	Departure	Good	35	No
	Unstable	5,150	48%	20	0	TD + 5	TD + 7	900	Med	70	No
	Unstable	4,700	52%	30	-1	TD	TD + 2	1,000	—	100	Yes
	Unstable	4,500	60%	-3	1	TD	TD + 2	Departure	Good	47	Yes
	Unstable	4,500	56%	6	3	TD	TD + 3	400	Dry	90	Yes
	Stable	3,950	44%	0	14	TD	TD + 3	Departure	Med	63	Yes
	Stable	3,260	41%	20	-1	TD	TD + 3	2,000	Med	40	No
	Stable	3,200	48%	-7	4	With TR	TD + 2	Departure	Good	30	No
	Stable	3,120	42%	10	10	TD	TD + 2	Departure	Good	50	No
	Stable	3,000	37%	-5	6	TD	TD + 2	Departure	Med	30	No
	Stable	3,000	34%	3	5	TD	TD + 3	Departure	Med	5	No
		13									
Fast	Stable	1,600	20%	12	10	TD	TD + 27	Departure	Good	25	No
	Stable	1,500	20%	20	10	TD	TD + 3	600	Med	5	No
	Stable	1,450	20%	11	15	TD	TD + 3	1,250	Med	20	No
	Stable	1,450	20%	6	9	TD	TD + 3	Departure	Med	0	No
	Stable	1,250	18%	4	11	TD	TD + 2	Departure	Poor	45	No
				5							
Deceleration	Stable	2,700	30%	0	0	Never	Never		Med	45	No
	Stable	400	6%	2	-6	Never	TD + 22	Departure	Med	48	No
	Stable	500	8%	3	4	With TR	TD + 20	Departure	Med	32	No
	Stable	1,250	21%	0	9	TD	TD + 16	Departure	Poor	42	No
	Unstable	1,720	27%	6	5	TD+9	TD + 13	Departure	Good	20	No
	Unstable	1,800	23%	10	2	With TR	TD + 11	Departure	Poor	28	No
	Stable	1,900	26%	6	-2	TD	TD + 8	Departure	Med	20	No
	Stable	1,150	24%	5	-5	TD	TD + 6	100	Med	12	No
	Stable	2,900	28%	0	-6	TD + 3	TD + 5	2,800	Poor	10	No
	Stable	2,600	31%	0	2	TD	TD + 2	2,250	Good	25	No
	Stable	2,200	27%	5	7	TD	TD + 2	2,000	Med	45	No
						11					

- Premature or late descent caused by failure to positively identify the final approach fix.
- Inadequate awareness of wind conditions.
- Incorrect anticipation of airplane deceleration characteristics in level flight or on a three-degree glide path.
- Excessive confidence by the pilot monitoring (PM) that the pilot flying (PF) will achieve a timely stabilization.
- PF and PM too reliant on each other to call excessive deviations or to call for a go-around.
- Visual illusions that cause a crew to misinterpret the airplane's position, such as a narrow runway that may give the impression that the airplane is higher than it actually is.
- Lack of airline policy, cultural norm, and training to direct pilots to perform a go-around instead of continuing an unstabilized approach.
- Lack of practice in performing a go-around maneuver.

FACTORS THAT GOVERN LANDING OUTCOMES

Three primary factors govern the outcome of every landing:

- Touchdown point. Defines runway remaining to dissipate energy. Having a stabilized approach contributes heavily to a proper touchdown point.
- Touchdown speed. Defines energy to be dissipated.

Recommended elements of a stabilized approach

All flights must be stabilized by 1,000 feet (305 meters) above airport elevation in instrument meteorological conditions (IMC) and by 500 feet (152 meters) above airport elevation in visual meteorological conditions (VMC). An approach is stabilized when all of the following criteria are met:

1. The airplane is on the correct flight path.
2. Only small changes in heading/pitch are required to maintain the correct flight path.
3. The airplane speed is not more than Vref + 20 knots indicated airspeed and not less than Vref.
4. The airplane is in the correct landing configuration.
5. Sink rate is no greater than 1,000 feet per minute (FPM) or 305 meters per minute; if an approach requires a sink rate greater than 1,000 FPM, a special briefing should be conducted.
6. Power setting is appropriate for the airplane configuration and is not below the minimum power for approach as defined by the airplane operating manual.
7. All briefings and checklists have been conducted.
8. Specific types of approaches are stabilized if they also fulfill the following: instrument landing system (ILS) approaches must be flown within one dot of the glide scope and localizer; a Category II or Category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the airplane reaches 300 feet (91 meters) above airport elevation.
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

An approach that becomes unstabilized below 1,000 feet (305 meters) above airport elevation in IMC or below 500 feet (152 meters) above airport elevation in VMC requires an immediate go-around.

Source: Flight Safety Foundation Approach-and-Landing Accident Reduction Task Force

- Deceleration after touchdown. Defines the effectiveness of dissipating the energy.

An analysis of overruns indicates that if two out of three conditions exist, an overrun is likely. But if one condition is removed, the overrun risk is reduced.

WHEN TO PERFORM A GO-AROUND MANEUVER

A go-around maneuver should be performed whenever the safety of a landing appears to be compromised (see fig. 3). Typically, this occurs for one of these reasons:

- Requested by ATC. ATC may request a go-around for a variety of reasons, including tight airplane spacing, an airplane on the runway, or an airplane too close on a parallel landing runway.
- Unexpected events. The flight crew may determine that something is not correct for landing — such as a flap gauge or gear indication — and that a checklist is needed to configure the airplane for landing. The presence of wind shear is another unexpected cause of go-arounds. These unexpected events may warrant initiation of a go-around even after the airplane has touched down following a stable approach. Runway conditions, surface winds, friction coefficients, or unknown conflicts may be different than those reported to the crew during approach. A successful go-around may be possible after touchdown up to the point where the crew initiates the use of thrust reverse if conditions warrant. Because these types of go-arounds involve unexpected events, it is difficult to anticipate them.
- Unstabilized approach. An unstabilized approach occurs when an airplane fails to keep one or more of these variables stable: speed, descent rate, vertical/

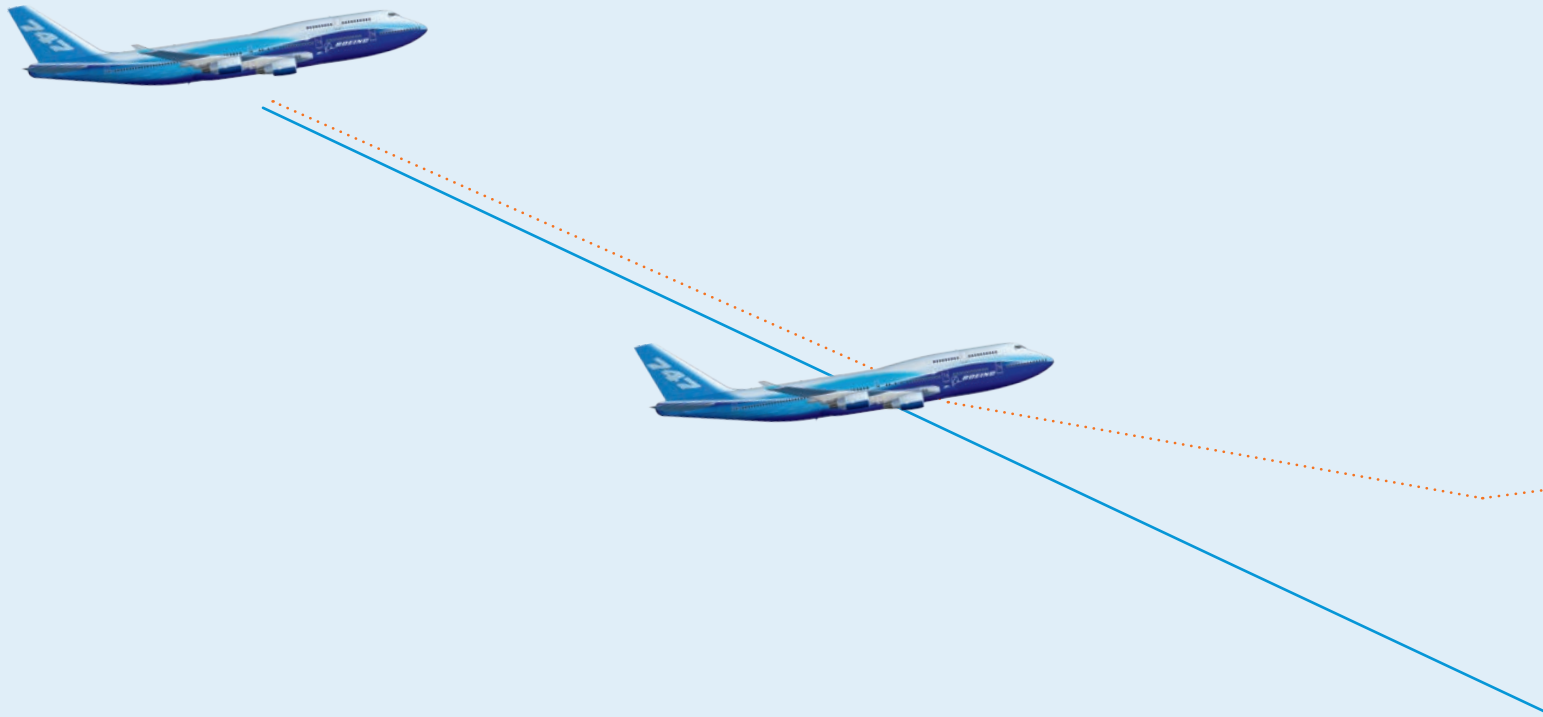


Figure 3: When to perform a go-around

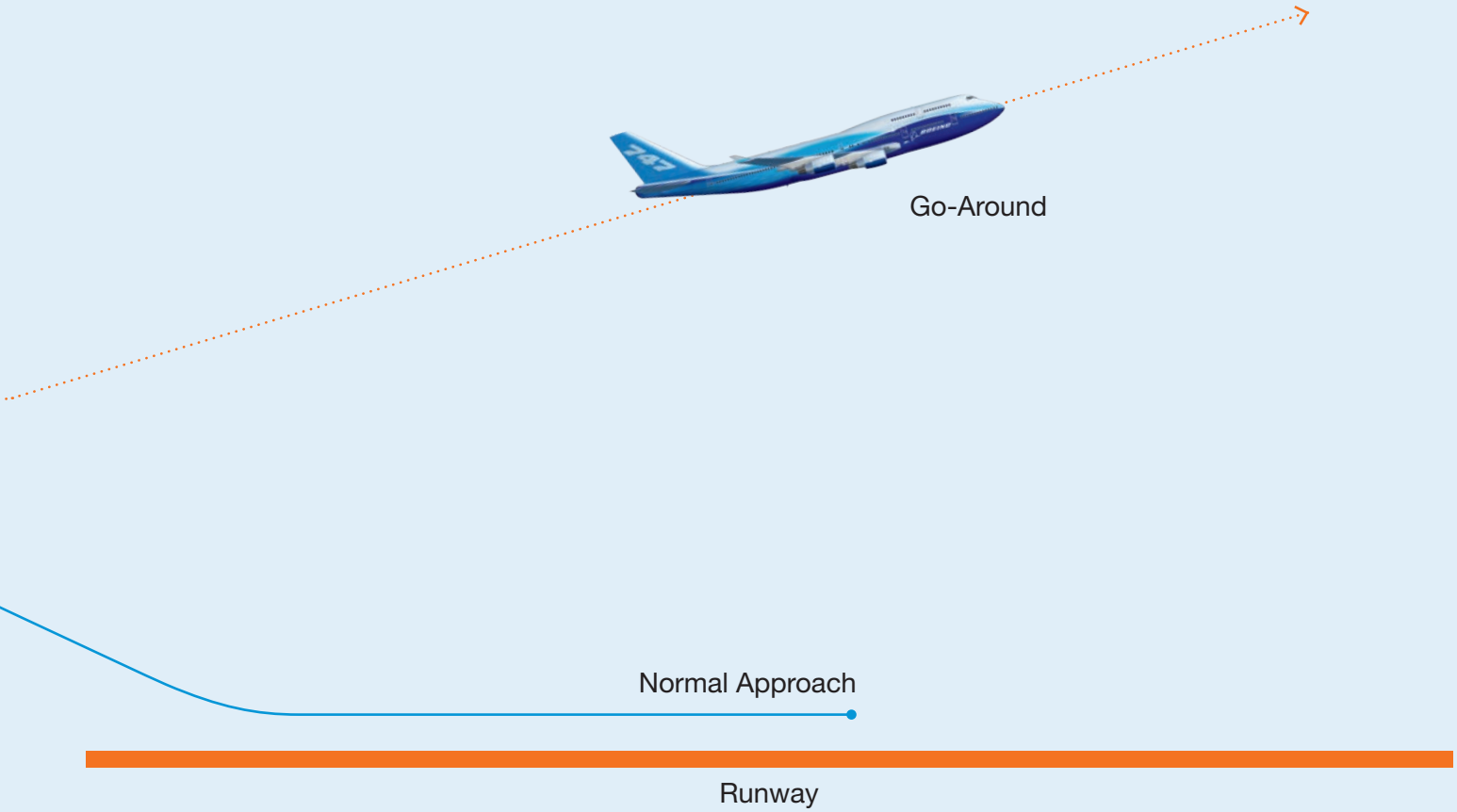
The timely decision to initiate a go-around if the approach is unstable or conditions have changed, such that a safe landing is at risk, allows the crew to safely conduct a follow-on approach. There are several reasons to perform a go-around maneuver, including a request by ATC, an unexpected event (such as wind shear), an unstabilized approach, or the determination that the landing cannot be made within the touchdown zone.

lateral flight path, and configuration for landing. It is important to understand that the stabilized approach recommendations do not apply only to the "gates" of 1,000-foot (305-meter) instrument meteorological conditions (IMC) and 500-foot (152-meter) visual meteorological conditions (VMC). Those altitudes are merely a snapshot analysis of the approach, and the elements need to be maintained throughout the landing. (See "Recommended elements of a stabilized approach" on page 9.)

- Landing cannot be made within the touchdown zone. This is defined as the first 3,000 feet (915 meters) or first third of the runway, whichever is shorter. Crews should calculate a landing distance based on current conditions and compare that distance to the runway available for every landing. Touchdown at the far end of the accepted first 3,000 feet (915 meters) or first third of the runway may not be appropriate if conditions change at the last moment during the flare or touchdown.

INDUSTRY EDUCATION EFFORTS

Numerous airline pilot associations and regulatory authorities have efforts under way to educate flight crews about go-arounds. These include the FSF, International Civil Aviation Organization (ICAO), International Air Transport Association, Commercial Aviation Safety Team (CAST), and European Commercial Aviation Safety Team.



Resources include:

- FSF Approach-and-Landing Accident Reduction Tool Kit Briefing Note, *Being Prepared to Go Around* (http://flightsafety.org/files/alar_bn6-1-goaroundprep.pdf).
- ICAO Working Paper, *Measures for Preventing Runway Excursion Caused by Unstabilized Approach* (http://www.icao.int/Meetings/a38/Documents/WP/wp302_en.pdf).
- CAST Go-Around Safety (http://www.skybrary.aero/index.php/Portal:Go-Around_Safety).

SUMMARY

Runway excursions are the leading cause of accidents and incidents within the industry. Airlines can avoid most runway excursions if flight crews choose to execute a go-around maneuver instead of continuing an unstabilized approach to a landing. Flight crews should understand the importance of making a go-around decision if they experience an unstabilized approach or conditions change during the flare or touchdown up to the point of initiating thrust reverse during the landing rollout.