A go-around maneuver performed according to standard operating procedures by crews can be effective and safe.

Performing Safe Go-Around Maneuvers

A go-around maneuver may be performed in a number of situations, including when requested by air traffic control (ATC) or when an airplane is making an unstabilized approach. Once a go-around decision has been made, flight crews must focus on ensuring that the maneuver is flown correctly by being aware of the difficulties that can occur and following the appropriate procedures to address those difficulties. A go-around maneuver can be both effective and safe when performed according to standard operating procedures by crews who are alerted to possible hazards.

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Performing a go-around is the best decision to make whenever the safety of an approach or a landing appears to be compromised. While the go-around maneuver should be a normal and well-trained procedure, difficulties can occur. This article focuses on some of the problems flight crews can experience when executing a go-around maneuver and how they can address these problems to make the maneuver safer.

THE NATURE OF GO-AROUND MANEUVERS

Although only 3 percent of commercial airplane landing approaches meet the criteria for being considered unstabilized, 97 percent of these unstabilized approaches are continued to a landing, contrary to airline standard operating procedures. (See *AERO* second-quarter 2014.) In many of these cases, a go-around maneuver should have been performed.

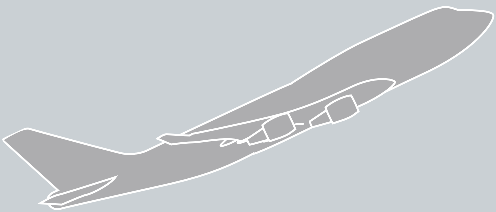
Go-around maneuvers are often performed at low altitude, low speed, and sometimes very close to the ground. A significant number of actions must be performed in a short period of time, and all of them are related to important changes of attitude, thrust, flight path, airplane configuration (i.e., flaps and gear), and pitch trim. Each of these actions must be carefully monitored and cross-checked.

Automation has brought additional checks related to autopilot, flight director, and autothrottle modes, all of which need to be read, checked, and announced by pilots during the go-around. At the same time, ATC can add to the flight crew's workload by requesting information about the cause of the go-around, crew intentions, and sometimes issuing frequency changes. Even without being asked by ATC, a pilot may feel the need to communicate immediately with ATC. The capacities of both the pilot flying (PF) and pilot monitoring (PM) to manage priorities during this phase follow the safety adage of "aviate, navigate, communicate — in that order."

All of these factors explain why the go-around maneuver needs to be approached with care. Airlines should also use data

Handling extreme nose-up incidents

Boeing, in concert with the aviation industry, has developed a nose-high upset recovery procedure that pilots should perform if they encounter this situation.



Pilot Flying

- Recognize and confirm the situation.
- Disconnect autopilot and autothrottle.
- Apply as much as full nose-down elevator.
- Apply appropriate nose-down stabilizer trim.
- Reduce thrust.
- Roll (adjust bank angle) to obtain a nose-down pitch rate.
- Complete the recovery: when approaching the horizon, roll to wings level, check airspeed, and adjust thrust. Establish pitch attitude.

Pilot Monitoring

- Recognize and confirm the situation.
- Call out attitude, airspeed, and altitude throughout the recovery.
- Verify all required actions have been completed and call out any omissions.

monitoring programs to better detect and analyze such events.

TWO PRIMARY ISSUES RELATED TO GO-AROUND MANEUVERS

When there are incidents related to go-around maneuvers, they are usually the result of excessive pitch-up or pitch-down attitude.

Extreme nose-up attitude. These events, which typically result from a particular combination of go-around thrust, speed, and nose-up trim, are characterized by a lack of pitch-down control authority at the beginning of the go-around. They account for a number of scenarios in which a go-around is initiated after a speed excursion well below the approach speed, long enough to have a trim moving into an unusual nose-up setting. The increase of thrust combined with the nose-up trim may result in loss of control. The Airplane Upset Recovery Training Aid (Rev. 2) has been developed by manufacturers to address these situations. (See "Handling extreme nose-up incidents" above.)

One example occurred in the United Kingdom. On final approach, the airplane slowed to near the stall speed. Because the autopilot was still engaged, the stabilizer trim was very nose up to compensate for the reduced speed on approach. When the crew noticed the slow speed and decided to do a go-around, the combination of pitch-up contributions of the engines, stabilizer, and slow speed made the nose pitch up, and the crew was unable to arrest the pitch-up with elevator only until the airplane stalled. Fortunately, the nose fell straight ahead and the airplane recovered; it would have pitched up again except that the crew intervened with nose-down stabilizer input.

Extreme nose-down attitude. Since 2000, several incidents have involved extreme nose-down attitudes during the go-around maneuver on different types of airplanes from different manufacturers. These incidents often result from a breakdown in correct cockpit instrument scanning. Here are some examples:

- After the PF initiated a manual go-around at night over the sea, at 1,000 feet (305 meters), the PF kept a prolonged pitch-down input resulting in a 15-degree nose-down attitude and a dive that was not recovered before the impact with the sea. The amplitude and duration of the initial reaction by the PF to the "pull-up" warning from the ground proximity warning system (GPWS) was insufficient (i.e., a full back stick input was required).
- After the PF initiated a manual go-around in instrument conditions, and approaching 2,500 feet (762 meters), the flight director altitude capture mode was activated earlier than expected by the crew because of a high rate of climb. The PF manually initiated a level-off but kept a prolonged pitch-down input that resulted in a dive that reached an extreme negative attitude (minus 40 degrees). The PF recovered from the dive at about 400 feet (122 meters) above the ground with a vertical acceleration of 3.6 g-force (g).

Handling extreme nose-down incidents

Boeing, in concert with the aviation industry, has developed a nose-down upset recovery procedure that pilots should perform if they encounter this situation.

Pilot Flying

- Recognize and confirm the situation.
- Disconnect autopilot and autothrottle.
- Recover from stall, if required.
- Roll in shortest direction to wings level (unload and roll if bank angle is more than 90 degrees).
- Recover to level flight.
- Apply nose-up elevator.
- Apply nose-up trim, if required.

Pilot Monitoring

- Recognize and confirm the situation.
- Call out attitude, airspeed, and altitude throughout the recovery.
- Verify all required actions have been completed and call out any omissions.

Source: From the flight maneuvers section of the quick reference handbook flight manual and adapted from the Airplane Upset Recovery Training Aid (Rev. 2)

- After the PF initiated a manual go-around at night over the sea, the altitude acquisition mode activated while approaching the selected altitude and the PF pitched down to level off. The indicated airspeed increased toward the maximum for the configuration. Instead of leveling off, the PF kept a prolonged pitch-down input. The attitude quickly decreased and reached a negative 9-degree pitch with a vertical speed of 4,000 feet (1,219 meters) per minute. When the GPWS activated, the PF reacted by pitching the airplane up. The minimum altitude was 600 feet (183 meters) over the sea. The total duration of the event was about 15 seconds. Neither pilot could explain the reason for the upset.

In all of these examples, pilots reacted very late to extreme negative attitudes displayed on both attitude director indicator (ADI) instruments. All of these events happened at night over a dark area or in instrument meteorological conditions. At the time of the upset, in the absence of visual reference, the only attitude information was provided by the ADIs. When flying manually or when monitoring the autopilot, the ADIs are at the center of a control process in which pilots must detect and then quickly and accurately correct deviations from targeted values. (See “Handling extreme nose-down incidents” above.)

A reasonable explanation for this initial lack of pilot reaction is that both pilots become distracted from monitoring the ADIs at the time of a pilot nose-down input. When pilots are distracted, an airplane could change its flight path from a normal go-around climb to a steep dive in fewer than 10 seconds.

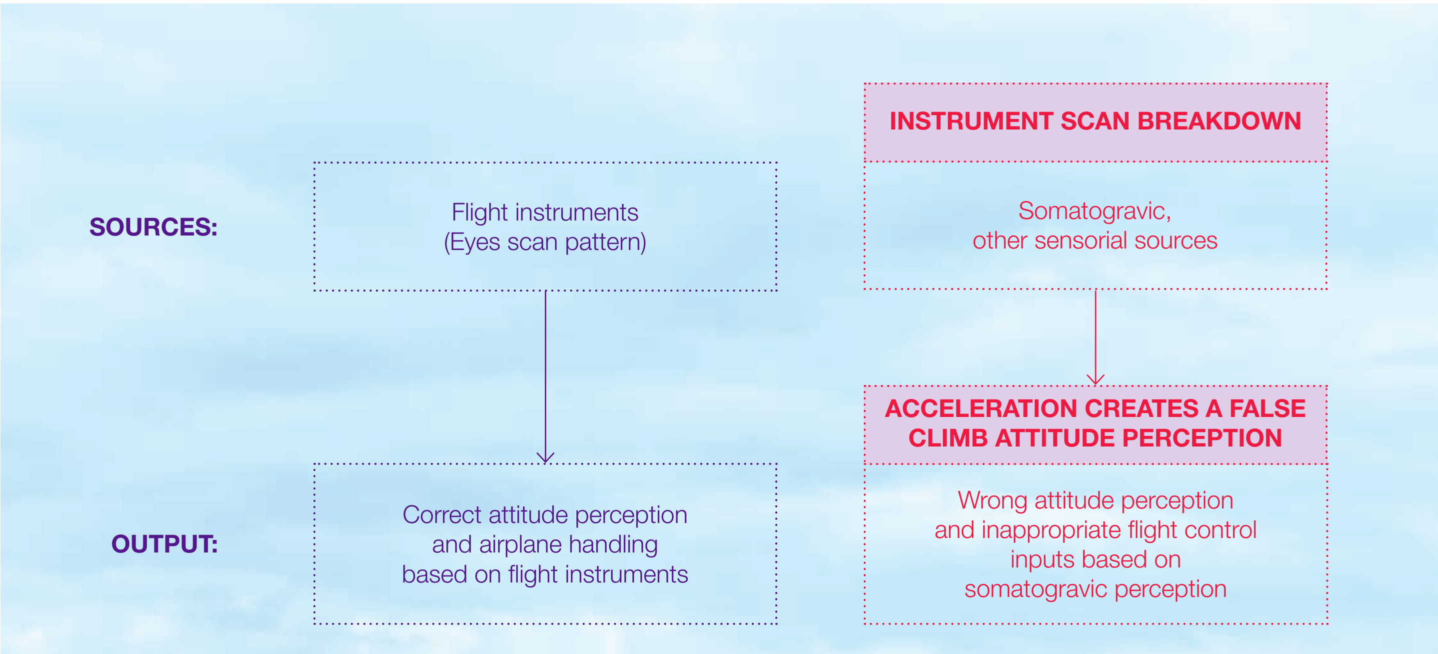
It may appear that such a deep dive would be perceived physically by the flight crew, without need of instruments. However, at constant thrust, any significant nose-down attitude reduction will create acceleration. The physical effect of the resulting acceleration corresponds exactly to the perception of attitude change. Both pilots, unless they look at their instruments, will believe they are climbing while their airplane has entered a deep dive (i.e., the pilots’ mental picture is becoming inaccurate) (see fig. 1). When the pilots return to their instruments, what they read will conflict with their mental picture of the airplane attitude. This causes cognitive confusion and potentially severe spatial disorientations. Poor or disrupted pilot instrument scannings may lead to a somatogravic illusion, which is present during high accelerations or decelerations when a pilot has no clear visual reference. A somatogravic illusion is when the human senses of the pilot cause spatial disorientation about the actual airplane movement.

THE NORMAL AND ESSENTIAL INSTRUMENT SCAN

All pilots trained on instrument flight rules learn the T-shape principle of basic instruments scan (see fig. 2). The attitude indication (i.e., pitch and roll information) is at the center of the instrument flying or monitoring process during dynamic phases. From the center of the ADI, the pilot’s focus moves successively to speed, altitude, vertical speed, and heading indication — all of which are directly dependent on the airplane attitude presented by the ADI.

Figure 1: Spatial disorientation can confuse pilots

A situation known as somatogravic illusion can occur when an airplane accelerates. If the pilots lose track of visual references and are not looking at instruments, they perceive that the airplane is nosing up, when in fact, it is entering a deep dive.



Modern primary-flight-display design makes the instruments scan easier, but a very common misperception is that the classic T-type eye-scan pattern is no longer needed. Because all basic flight instruments are gathered on the same screen, many pilots erroneously believe that these instruments can be embraced and processed at the same time. However, a T-type eye-scan pattern is still necessary for several reasons:

- The use of central vision is still needed to read digital values.
- Pilots need to focus attention in a sequential manner to monitor and control flight parameters.
- Human cognitive performance does not allow pilots to process speed, heading, altitude, vertical speed, and pitch and roll values simultaneously and accurately.
- The T-type eye-scan pattern forces a sequential method that has been proved to provide more accurate and reliable readings.

FACTORS THAT COULD DEGRADE THE ESSENTIAL EYE-SCAN PATTERN

During a significant pitch reduction, the indicated airspeed increases quickly toward the maximum speed red band (see fig. 3). This has a powerful attraction effect and could capture the attention of both pilots to the point that the instrument scan is slowed down or even suspended. Simultaneously, somatogravic effects, due to longitudinal acceleration, remove the perception of descent while maintaining the feeling of a climb or a level flight path. As a consequence, an extreme nose-down attitude could develop without being noticed, causing the pilots to lose situational awareness.

Similarly, flight management annunciation (FMA) information must be read through central vision. An unexpected FMA display during a go-around maneuver could capture attention and distract pilots from the basic instrument scan long enough to lead to the same consequences.

The PM may be distracted from tasks during the go-around by getting involved with ATC communications at a critical moment. This could happen when the PM feels obliged to call or answer ATC at the precise time that the PF is deviating from the correct course.

PERFORMING SAFER GO-AROUNDS

A flight crew can successfully avoid the hazards that may be present in a go-around maneuver in a number of ways:

- Both pilots should keep a robust instrument eye-scan pattern for the duration of the go-around maneuver until the end of the level-off phase.
- Both pilots should be aware of the consequences of failing to closely monitor the pitch indication of the ADI.

Figure 2: The T-shape instrument scan of the attitude director indicator

The T-shape principle of basic instruments scan provides a quick assessment of speed, altitude, vertical speed, heading, and airplane attitude.

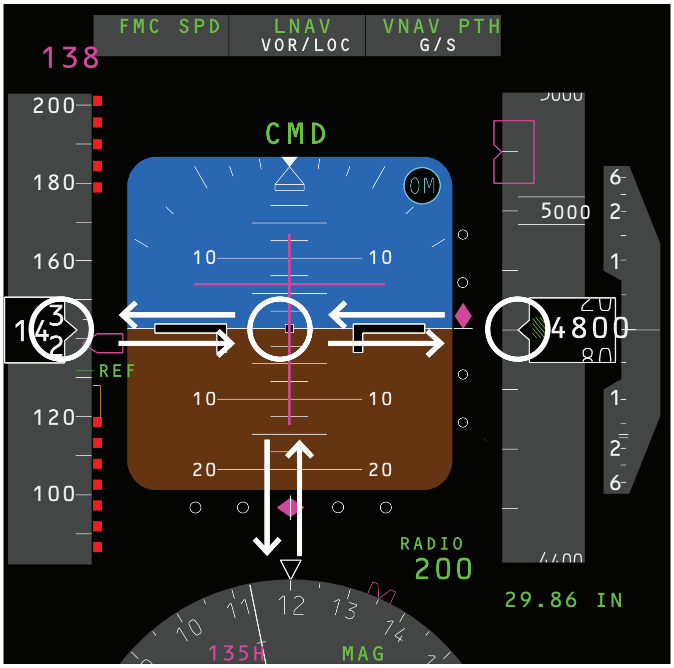
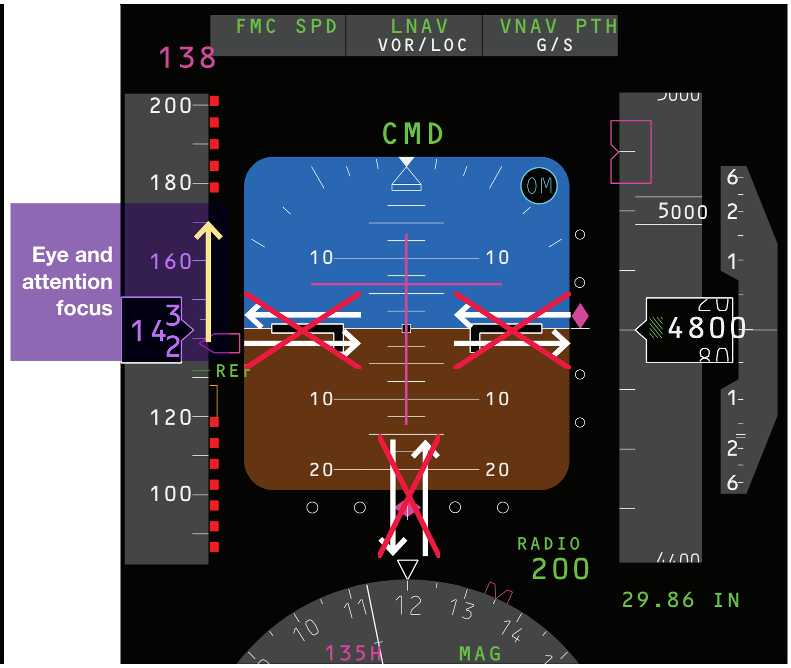


Figure 3: The danger of distraction

As the airspeed increases toward the red band, indicating maximum speed, both pilots may see this to the exclusion of noticing the attitude shown on the instruments.



At night or in instrument meteorological conditions, an extreme nose-down attitude could develop in fewer than 10 seconds without being felt by the pilots.

- Flying the pitch and monitoring the pitch during attitude changes have priority over any other tasks, including communication with ATC. The PM could answer "Stand by, I will call you back" while monitoring and coordinating the maneuver with the PF.
- Pilots should understand automation and mode changes that occur during go-arounds. Many of these features are designed to aid pilot performance.
- Pilots should train for and understand the issues involved in go-arounds conducted at other than minimum approach altitudes. These present different challenges that, combined with the issues already addressed, can be difficult.

HOW AIRLINES CAN CONTRIBUTE TO SAFER GO-AROUNDS

Airlines can enhance the success of go-around maneuvers by closely monitoring them:

- Are flight crews encouraged to choose to go around in the event of an unstabilized approach?
- Are crews performing the go-around maneuver correctly?
- Are serious go-around upsets visible enough?

A robust internal reporting and flight-data monitoring program can help answer these questions. The airline's air safety reports and dedicated surveys can provide an operator's safety or training department with relevant qualitative feedback regarding go-around maneuvers.

In addition, a flight operational quality-assurance program, incorporating flight-data monitoring, can provide important quantitative information and make it possible to track statistics and trends. This data can be shared anonymously with the industry through safety sharing programs.

Airlines can also develop safety performance indicators for go-around maneuvers to capture rate and trends, including attitude exceedances (i.e., pitch or roll), speed exceedances (i.e., too fast or too slow), and automation-mode mismanagement.

SUMMARY

Once a go-around decision has been made, flight crews need to ensure the go-around maneuver is flown correctly through concentrated effort. Difficulties can occur in both nose-high and nose-low situations. It's important that flight crews be aware of the appropriate procedures for those situations. A go-around maneuver performed according to standard operating procedures by crews mindful of possible hazards associated with the maneuver will be effective and safe.