



## FSF ALAR Briefing Note 6.2 — Manual Go-around

The importance of being *go-around-prepared* and being *go-around-minded* must be emphasized, because a go-around is not a frequent occurrence.

This requires that the pilots have a clear mental image of applicable briefings, standard calls, sequences of actions, task-sharing and cross-checking, and that the pilots are prepared to abandon the approach if requirements are not met in terms of:

- Weather minimums; or,
- Criteria for a stabilized approach (Table 1, page 122).

After the go-around is initiated, the flight crew must fly the missed approach procedure as published (i.e., following the published vertical navigation and lateral navigation).

### Recommendations

#### Task-sharing

The following task-sharing principles are important in the very dynamic phase of initiating a go-around.

The pilot flying (PF) is responsible for controlling vertical navigation and lateral navigation, and for energy management, by either:

- Supervising autopilot vertical guidance and lateral guidance, and autothrottle (A/THR) operation; and maintaining awareness of flight-mode annunciator (FMA) status and FMA changes; or,

- Flying manually, with flight director (FD) guidance and an adapted (e.g., horizontal situation indicator [HSI]-type) navigation display (ND) mode.

If manual thrust is selected, the pilot not flying (PNF) should monitor closely the airspeed, airspeed trend and thrust, and call any excessive deviation (e.g., airspeed decreasing below  $V_{REF}$ ).

The PNF is responsible for monitoring tasks and for conducting actions requested by the PF, including:

- Conducting the standard PNF tasks:
  - Performing standard operating procedures (SOPs);
  - Conducting selections on the automatic flight system (AFS) control panel when in manual flight; and,
  - Reading abnormal checklists or emergency checklists (electronic and/or paper checklists) and conducting required actions in case of failure;
- Monitoring the thrust setting;
- Monitoring vertical speed and radio-altimeter altitude; and,
- Monitoring pitch attitude, bank angle, airspeed and airspeed trend, and calling out any excessive deviation.

#### Understanding the Flight Dynamics of the Go-around

Unlike the takeoff rotation, in which the aircraft is pre-trimmed and the thrust is already set, the initiation of a go-around

## Table 1 Recommended Elements Of a Stabilized Approach

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

1. The aircraft is on the correct flight path;
2. Only small changes in heading/pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than  $V_{REF} + 20$  knots indicated airspeed and not less than  $V_{REF}$ ;
4. The aircraft is in the correct landing configuration;
5. Sink rate is no greater than 1,000 feet per minute; if an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft 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 glideslope 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 aircraft reaches 300 feet above airport elevation; and,
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 above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.*

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force (V1.1 November 2000)

requires a very dynamic sequence of actions and changes (thrust, configuration) affecting the pitch balance.

Pitch effects depend largely on the location of engines (i.e., mounted under the wings or on the tail) and other aircraft or systems features.

Pitch effects are amplified:

- At low gross weight, low altitude and low outside air temperature (hence, at a high thrust-to-weight ratio); and/or,

- With all engines operative, as compared to a one-engine-inoperative go-around.

The pitch effects of underwing-mounted engines are discussed in this briefing note.

When initiating a go-around at decision altitude/height (DA[H]), the PF is expected to minimize the altitude loss: The PF must apply simultaneously nose-up pitch pressure on the control column, advance the throttle levers and select the takeoff/go-around (TOGA) mode.

Pitch is affected by the following factors:

- The nose-up elevator input initiates a pitch-attitude change that minimizes altitude loss;
- Within a few seconds, thrust increases (resulting in an additional nose-up pitch effect); and,
- Retracting one step of flaps results usually in a slight nose-up pitch effect.

As a result of these three nose-up pitch effects:

- The pitch-attitude rate increases; and,
- The nose-up pitch force required to maintain the pitch-attitude target decreases until a nose-down pitch force is required to prevent an excessive nose-up pitch attitude.

To maintain the desired pitch-attitude target (and prevent overshooting this target), the PF must:

- Release back (nose-up) pressure on the control column;
- Apply progressively, as thrust increases, forward (nose-down) pressure on the control column; and,
- Re-trim the aircraft (nose-down), as necessary.

Stated simply, the PF should aviate (fly the aircraft) while closely monitoring the primary flight display (PFD).

If the pitch attitude is not controlled *positively*, pitch will continue to increase and will reach values at which airspeed will decrease despite the go-around thrust.

### Flying a Manual Go-around

For a safe go-around, the following “three Ps” constitute a golden rule:

- Pitch:
  - Set and maintain the pitch-attitude target;
- Power:
  - Set and check the go-around thrust; and,
- Performance:

- Check aircraft performance: positive rate of climb, airspeed at or above  $V_{REF}$  (reference landing speed), speed brakes retracted, radio-altimeter indications and barometric-altimeter indications increasing, wings level, gear up, flaps as required.

The operational recommendations and task-sharing for the safe conduct of a manual go-around can be expanded as follows:

For the PF:

- When calling “go-around/flaps,” *without delay*:
  - Select the TOGA mode and follow through the A/THR operation;
  - Rotate (at the same rate as for takeoff, typically three degrees per second);
  - Follow the FD pitch command (but do not exceed the maximum pitch attitude applicable to the aircraft type);
  - Check go-around power (thrust); and,
  - Check go-around performance:
    - Positive rate of climb;
    - Airspeed at or above  $V_{REF}$ ;
    - Speed brakes retracted;
    - Radio-altimeter indication and barometric-altimeter indication increasing;
    - Wings level;
    - Gear up; and,
    - Flaps as required;
  - As thrust increases, be prepared to counteract the nose-up pitch effect (i.e., apply increasing forward pressure — nose-down input — on the control column); and,
  - Trim the aircraft nose-down, as required.

The pitch attitude should not be allowed to exceed an *ultimate value* (e.g., 25 degrees), because such a pitch attitude would result in a significant airspeed reduction.

*Immediate and firm elevator nose-down input (together with a nose-down pitch trim adjustment)*, however, may allow recovering the pitch-attitude target.

For the PNF:

- When hearing the “go-around/flaps” call, *without delay*:
  - Set flaps as appropriate;
  - Announce “positive climb” and retract the landing gear on PF command;
  - Monitor:

- Airspeed and airspeed trend;
- Pitch attitude and bank angle; and,
- Thrust increase (confirm the thrust-limit mode, as applicable, and actual thrust on fan-speed [ $N_1$ ] or engine-pressure-ratio [EPR] indicators);

– Check the FMA:

- Announce in a loud and clear voice the FMA-thrust mode, vertical-mode and lateral-mode selection;
- Check the autopilot (AP) status; call “AP engaged” or “hand-flying”); and,
- Check FD engagement status; and,

– Continue monitoring the flight parameters and call any excessive deviation:

- “Speed,” if dropping below  $V_{REF}$ ;
- “Speed trend,” if negative;
- “Pitch attitude,” if approaching the ultimate value (e.g., at 20 degrees if the ultimate value is 25 degrees);
- “Bank angle,” if in excess of 15 degrees (30 degrees if the missed approach procedure requires a turn); and/or,
- “Thrust,” if a significant thrust reduction is observed.

## Summary

To manually fly a safe go-around, adhere to the three-Ps golden rule:

- Pitch:
  - Set and maintain the pitch-attitude target;
- Power:
  - Set and check go-around thrust; and,
- Performance:
  - Check the aircraft performance: positive rate of climb, airspeed at or above  $V_{REF}$ , speed brakes retracted, radio-altimeter indication and barometric-altimeter indication increasing, wings level, gear up, flaps as required.

While conducting the go-around, adherence to the defined PF-PNF task-sharing and the optimum use of crew resource management (e.g., for monitoring flight parameters and calling any excessive flight-parameter deviation) are of paramount importance.

The manual go-around technique must:

- Minimize the initial altitude loss; and,

- Prevent an excessive nose-up pitch attitude by following FD pitch commands, not exceeding the ultimate pitch attitude applicable to the aircraft type.

Should any warning be triggered or any other abnormal condition occur during the go-around, the PF must concentrate his or her attention on flying the aircraft (controlling the vertical flight path and the lateral flight path).

The following FSF ALAR Briefing Notes provide information to supplement this discussion:

- 1.1 — *Operating Philosophy*;
- 1.3 — *Golden Rules*;
- 1.4 — *Standard Calls*;
- 6.1 — *Being Prepared to Go Around*; and,
- 7.1 — *Stabilized Approach*.♦

## Related Reading from FSF Publications

Flight Safety Foundation (FSF). “Killers in Aviation: FSF Task Force Presents Facts about Approach-and-landing and

Controlled-flight-into-terrain Accidents.” *Flight Safety Digest* Volume 17–18 (November–December 1998, January–February 1999).

FSF Editorial Staff. “Spatial Disorientation Linked to Fatal DC-8 Freighter Crash.” *Accident Prevention* Volume 50 (March 1993).

FSF Editorial Staff. “Unstabilized Approach, Icing Conditions Lead To Commuter Tragedy.” *Accident Prevention* Volume 49 (December 1992).

## Regulatory Resources

International Civil Aviation Organization (ICAO). *International Standards and Recommended Practices, Annex 6 to the Convention of International Civil Aviation, Operation of Aircraft*. Part I, *International Commercial Air Transport – Aeroplanes*. Appendix 2, “Contents of an Operations Manual,” 5.14, 5.16, 5.18, 5.21, 5.22. Seventh edition – July 1998, incorporating Amendments 1–25.

ICAO. *Preparation of an Operations Manual*. Second edition – 1997.

## Notice

The Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force has produced this briefing note to help prevent ALAs, including those involving controlled flight into terrain. The briefing note is based on the task force’s data-driven conclusions and recommendations, as well as data from the U.S. Commercial Aviation Safety Team (CAST) Joint Safety Analysis Team (JSAT) and the European Joint Aviation Authorities Safety Strategy Initiative (JSSI).

The briefing note has been prepared primarily for operators and pilots of turbine-powered airplanes with underwing-mounted engines (but can be adapted for fuselage-mounted turbine engines, turboprop-powered aircraft and piston-powered aircraft) and with the following:

- Glass flight deck (i.e., an electronic flight instrument system with a primary flight display and a navigation display);
- Integrated autopilot, flight director and autothrottle systems;

- Flight management system;
- Automatic ground spoilers;
- Autobrakes;
- Thrust reversers;
- Manufacturers’/operators’ standard operating procedures; and,
- Two-person flight crew.

This briefing note is one of 34 briefing notes that comprise a fundamental part of the FSF *ALAR Tool Kit*, which includes a variety of other safety products that have been developed to help prevent ALAs.

This information is not intended to supersede operators’ or manufacturers’ policies, practices or requirements, and is not intended to supersede government regulations.

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Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S.  
Telephone +1 (703) 739-6700, Fax: +1 (703) 739-6708  
[www.flightsafety.org](http://www.flightsafety.org)

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