

Flight Operations Briefing Notes Approach Techniques Flying Stabilized Approaches

I Introduction

Rushed and unstabilized approaches are the largest contributory factor in CFIT and other approach-and-landing accidents.

Rushed approaches result in insufficient time for the flight crew to correctly:

- Plan;
- Prepare; and,
- Execute a safe approach.

This Flight Operations Briefing Note provides an overview and discussion of:

- Criteria defining a stabilized approach; and,
- Factors involved in rushed and unstabilized approaches.

Note:

*Flying stabilized approaches complying with the stabilization criteria and approach gates defined hereafter, does not preclude flying a **Delayed Flaps Approach** (also called a **Decelerated Approach**) as dictated by ATC requirements.*

II Statistical Data

(Source: Flight Safety Foundation Flight Safety Digest Volume 17 & 18 – November 1998 / February 1999).

Continuing an unstabilized approach is a causal factor in 40 % of all approach-and-landing accidents.

In 75% of the off-runway touchdown, tail strike or runway excursion/overrun accidents, the major cause was an unstable approach.

Table 1 shows the factors involved in rushed and unstabilized approaches.

Factor	% of Events
High and/or fast approach or Low and/or slow approach	66 %
Flight-handling difficulties : - Demanding ATC clearances - Adverse wind conditions	45 %

Table 1

Factors Involved in Unstabilized Approaches

III Stabilization Heights

The following minimum stabilization heights are recommended to achieve timely stabilized approaches:

Meteorological Conditions	Height above Airfield Elevation
IMC	1000 ft
VMC	500 ft

Table 2

Minimum Stabilization Heights

Note:

A lower minimum stabilization height may be allowed for circling approaches (e.g. 400 ft).

IV Defining the Elements of a Stabilized Approach

An approach is considered stabilized only if all the following elements are achieved before or when reaching the applicable stabilization height:

<p>The aircraft is on the correct lateral and vertical flight path (based on nav aids guidance or visual references)</p>
<p>Only small changes in heading and pitch are required to maintain this flight path</p>
<p>The aircraft is in the desired landing configuration</p>
<p>The thrust is stabilized, usually above idle, to maintain the target approach speed along the desired final approach path</p>
<p>The landing checklist has been accomplished as well as any required specific briefing</p>
<p>No flight parameter exceeds the criteria defined in Table 4</p>

Table 3

The Elements of a Stabilized Approach – All Approaches

Note 1:

For Non-Precision Approaches, some of these elements (desired landing configuration and VAPP) should be achieved when the aircraft reaches the FAF (Airbus recommended technique).

Note 2:

Non-normal conditions requiring deviation from the above elements of a stabilized approach should be briefed formally.

V Excessive Flight Parameter Deviation Callouts Criteria

When reaching the applicable stabilization height and below, a callout should be performed by the PNF if any flight parameter exceeds the limits provided in **Table 4**.

Parameter	Callout Criteria
Airspeed	Lower than $V_{APP} - 5 \text{ kt}$ or Greater than $V_{APP} + 10 \text{ kt}$ (*)
Vertical Speed	Greater than $- 1000 \text{ ft/mn}$
Pitch Attitude	Lower than (**) Nose Down or Greater than (**) Nose Up
Bank Angle	Greater than 7 degrees
LOC deviation	1/4 dot or Excessive (Beam) Deviation Warning
Glide Slope deviation (ILS)	1 dot or Excessive (Beam) Deviation Warning

Table 4

Excessive Flight-Parameter-Deviation Callouts

(*)

The final approach speed V_{APP} is considered to be equal to $V_{REF} + 5 \text{ kt}$ (or $V_{LS} + 5 \text{ kt}$, as applicable).

V_{REF} is the reference target threshold speed in the full flaps landing configuration (i.e., in the absence of airspeed corrections because of wind, windshear or non-normal configuration).

(**)

Refer to the applicable SOPs for applicable pitch attitude limits.

VI Benefits of a Stabilized Approach

Conducting a stabilized approach increases the flight crew' overall situational awareness:

- **Horizontal situational awareness :**
 - By closely monitoring the flight path;
- **Speed awareness :**
 - By monitoring speed deviations;
- **Vertical situational awareness :**
 - By monitoring the vertical flight path and the rate of descent;
- **Energy awareness :**
 - By maintaining the engines thrust to the level required to fly a 3-degree approach path at the final approach speed (or at the minimum ground speed, as applicable).

This also enhances the readiness for go-around.

In addition, a stabilized approach provides the following benefits:

- More time and attention are available for the monitoring of ATC communications, weather conditions, systems operation;
- More time is available for effective monitoring and back-up by the PNF;
- Defined flight-parameter-deviation criteria and minimum stabilization height support the decision to land or go-around;
- Landing performance is consistent with published performance; and,
- Situational awareness is increased.

VII Best Practices

Throughout the entire flight a **next target** should be defined to **stay ahead of the aircraft** at all times.

The defined **next target** should be any required combination of:

- A position;
- An altitude;
- A configuration;
- A speed;
- A vertical profile (vertical speed or flight path angle); and,

- A power setting (e.g. thrust is stabilized, usually above idle, to maintain the target approach speed along the desired final approach path).

If it is anticipated that one or more element(s) of the next target will not be met, the required corrective action(s) should be taken without delay.

During the approach and landing, the successive **next targets** should constitute **gates** that should be met for the approach to be continued (**Figure 1**).

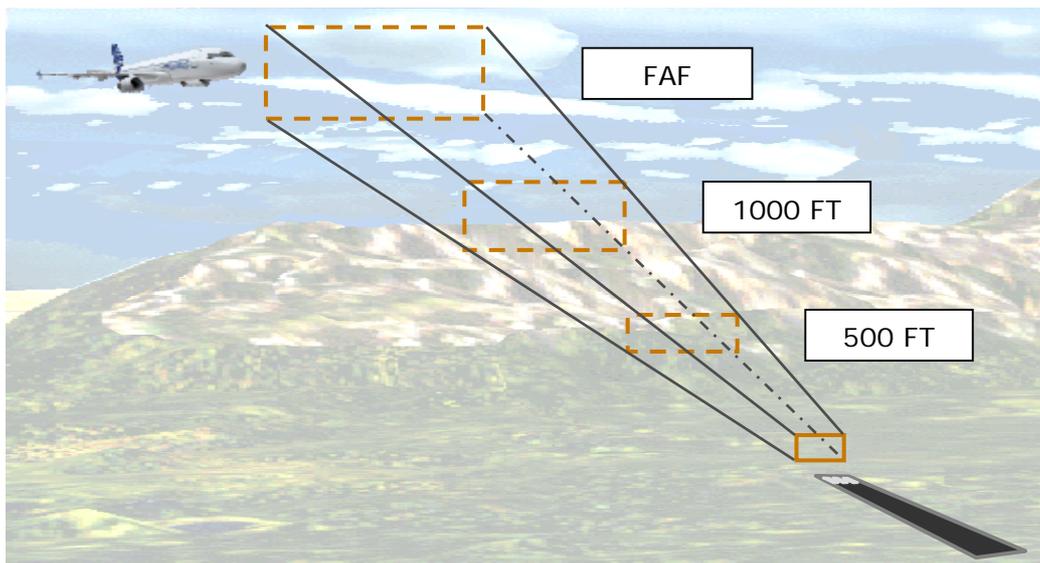


Figure 1

Typical Gates during Final Approach

The Final Approach Fix (FAF), the Outer Marker (OM) or an equivalent fix (as applicable) constitute an assessment gate to confirm the readiness to proceed further; this assessment should include the following:

- Visibility or RVR (and ceiling, as appropriate):
 - Better than or equal to applicable minimums;
- Aircraft readiness:
 - Position, altitude, configuration and energy; and,
- Crew readiness:
 - Briefing completed and agreement on approach conditions.

The minimum **stabilization height** constitutes a particular gate along the final approach (e.g. for an ILS approach, the objective is to be stabilized on the final descent path at V_{APP} in the landing configuration, at 1000 feet above airfield elevation in IMC, or at 500 feet above airfield elevation in VMC, after continuous deceleration on the glide slope).

If the aircraft is not stabilized on the approach path in landing configuration, at the minimum stabilization height, **a go-around must be initiated unless the crew estimates that only small corrections are necessary to rectify minor deviations from stabilized conditions** due, amongst others, to external perturbations.

Following a PNF flight parameter exceedance callout, the suitable PF response will be:

- Acknowledge the PNF callout, for proper crew coordination purposes
- Take immediate corrective action to control the exceeded parameter back into the defined stabilized conditions
- **Assess whether stabilized conditions will be recovered early enough prior to landing, otherwise initiate a go-around.**

VIII Factors Involved in Unstabilized Approaches

The following circumstances, factors and errors are often cited when discussing rushed and unstabilized approaches:

- Fatigue (e.g., due to disrupted sleep cycle, personal stress, ...);
- Pressure of flight schedule (i.e., making up for takeoff delay, last leg of the day, ...);
- Any crew-induced or controller-induced circumstances resulting in insufficient time to plan, prepare and execute a safe approach;
This includes accepting requests from ATC for flying higher and/or faster than desired or flying shorter routings than desired;
- ATC instructions that result in flying too high and/or too fast during the initial or final approach (e.g., request for maintaining high speed down to the [outer] marker or for GS capture from above – slam-dunk approach);
- Excessive altitude and / or excessive airspeed (i.e., inadequate energy management) early in the approach;
- Late runway change (i.e., lack of ATC awareness of the time required to reconfigure the aircraft systems for a new approach);
- Non-standard task-sharing resulting in excessive head-down work (e.g., FMS reprogramming);
- Short outbound leg or short down-wind leg (e.g., in case of unidentified traffic in the area);
- Inadequate use of automation: Late takeover from automation (e.g., in case of AP failing to capture the GS, usually due to crew failure to arm the approach mode);

- Premature or late descent due to absence of positive FAF identification;
- Insufficient awareness of wind conditions:
 - Tailwind component;
 - Low altitude wind shear;
 - Local wind gradient and turbulence (e.g., caused by terrain, forest or buildings); or,
 - Recent weather along the final approach path (e.g., downdraft caused by a descending cold air mass following a rain shower);
- Incorrect anticipation of aircraft deceleration characteristics in level flight or on a 3-degree glideslope;
- Failure to recognize deviations or to remember the excessive-parameter-deviation criteria;
- Belief that the aircraft will be stabilized at the stabilization height or shortly thereafter;
- Excessive confidence by the PNF that the PF will achieve a timely stabilization;
- PF/PNF over reliance on each other to call excessive deviations or to call for a go-around;
- Visual illusions during the visual segment;
- Continued approach without acquisition of adequate visual references or after loss of visual references;
- Failure to accurately follow the PAPI / VASI; and / or,
- Failure to adequately maintain the aiming point (i.e., duck-under).

IX Typical Deviations Observed in Unstabilized Approaches

The following procedure deviations or flight path excursions often are observed, alone or in combination, in rushed and unstabilized approaches (figures provided between brackets reflect extreme deviations observed in actual unstabilized approaches, worldwide):

- Full approach flown at **idle down to touchdown**, because of excessive airspeed and/or altitude early in the approach;
- Steep approach (i.e., above desired flight path with excessive vertical speed up to – 2200 ft/mn, flight path angle up to 15 % gradient / 9-degree slope);
Steep approaches appear to be twice as frequent as shallow approaches;
- Shallow approach (i.e., below desired glide path);
- Low airspeed maneuvering (i.e., inadequate energy management);

- Excessive bank angle when capturing the final approach course (up to 40-degree);
- Activation of a GPWS warning:
 - Mode 1 : SINK RATE;
 - Mode 2A : TERRAIN (not full flaps);
 - Mode 2B : TERRAIN (full flaps).
- Late extension of flaps or flaps load relief system activation (as applicable), resulting in the late effective extension of flaps;
- Flight-parameter excessive deviation when crossing the stabilization height:
 - Excessive airspeed (up to $V_{REF} + 70$ kt);
 - Not aligned (up to 20-degree heading difference);
 - Excessive bank angle (up to 40 -degrees);
 - Excessive vertical speed (up to – 2000 ft/mn);
 - Excessive glide slope deviation (up to 2 dots);
- Excessive bank angle, excessive sink rate or excessive maneuvering while performing a side-step;
- Speedbrakes being still extended when in short final (i.e., below 1000 ft above airfield elevation);
- Excessive flight-parameter deviation(s) down to runway threshold;
- High runway-threshold crossing (up to 220 ft);
- Long flare and extended touchdown.

X Company's Prevention Strategies and Personal Lines-of-defense

Company's prevention strategies and personal lines-of-defense to reduce the number of unstabilized approaches should:

- Identify and minimize the factors involved; and,
- Provide recommendations for the early detection and correction of unstabilized approaches.

The following four-step strategy is proposed:

- Anticipate;
- Detect;
- Correct; and,
- Decide.

X.1 Anticipate

Some factors likely to result in a rushed and unstabilized approach can be anticipated.

Whenever practical, flight crews and controllers should avoid situations that may result in rushed approaches.

The descent-and-approach briefing provides an opportunity to identify and discuss factors such as :

- Non-standard altitude or speed restrictions requiring a careful **energy management**:
 - An agreed strategy should be defined for the management of the descent, deceleration and stabilization (i.e., following the concepts of **next targets** and **approach gate**);
 - This strategy will constitute a common objective and reference for the PF and PNF.

X.2 Detect

Defined excessive-parameter-deviation criteria and a defined stabilization height provide the PF and PNF with a common reference for effective:

- Monitoring (i.e., early detection of deviations); and,
- Back-up (i.e., timely and precise deviation callouts for effective corrections).

To provide the time availability and attention required for an effective monitoring and back-up, the following should be avoided:

- Late briefings;
- Unnecessary radio calls (e.g., company calls);
- Unnecessary actions (e.g., use of ACARS); and,
- Non-pertinent intra-cockpit conversations (i.e., breaking the sterile-cockpit rule).

Reducing the workload and cockpit distractions and/or interruptions also provides the flight crew with more alertness and availability to:

- Cope with fatigue;
- Comply with an unanticipated ATC request (e.g., runway change or visual approach);
- Adapt to changing weather conditions or approach hazards; and,
- Manage a system malfunction (e.g., flaps jamming or gear failing to extend or to downlock).

X.3 Correct

Positive corrective actions should be taken before deviations develop into a challenging or a hazardous situation in which the only safe action is a go-around.

Corrective actions may include:

- The timely use of speed brakes or the early extension of landing gear to correct an excessive altitude or an excessive airspeed;
- Extending the outbound leg or downwind leg.

X.4 Decide

If the aircraft is not stabilized on the approach path in landing configuration, at the minimum stabilization height, a go-around must be initiated unless the crew estimates that only small corrections are necessary to rectify minor deviations from stabilized conditions due, amongst others, to external perturbations.

Following a PNF flight parameter exceedance callout, the suitable PF response will be:

- Acknowledge the PNF callout, for proper crew coordination purposes
- Take immediate corrective action to control the exceeded parameter back into the defined stabilized conditions
- Assess whether stabilized conditions will be recovered early enough prior to landing, otherwise initiate a go-around.

The following behaviors often are involved in the continuation of an unstabilized approach:

- Confidence in a quick recovery (i.e., postponing the go-around decision when parameters are converging toward target values);
- Overconfidence because of a long and dry runway and/or a low gross-weight, although airspeed and/or vertical speed are excessive;
- Inadequate readiness or lack of commitment to conduct a go-around;

A change of mindset should take place from:

- “We will land unless ...”; to,
- “Let’s be prepared for a go-around and we will land if the approach is stabilized and if we have sufficient visual references to make a safe approach and landing”.
- Go-around envisaged but not initiated because the approach was considered being compatible with a safe landing; and,
- Absence of decision due to fatigue or workload (i.e., failure to remember the applicable excessive deviation criteria).

XI Summary of Key Points

Three essential parameters need to be stabilized for a safe approach:

- Aircraft track;
- Flight path angle; and,
- Airspeed.

Depending on the type of approach and aircraft equipment, the most appropriate level of automation and visual cues should be used to achieve and monitor the stabilization of the aircraft.

When breaking-out of the cloud overcast and transitioning to visual references, the pilot's perception of the runway and outside environment should be kept constant by maintaining:

- **Drift correction:**
 - To continue tracking the runway centerline, resisting the tendency to prematurely align the aircraft with the runway centerline;
- **Aiming point** (i.e., the touchdown zone):
 - To remain on the correct flight path until flare height, resisting the tendency to move the aiming point closer and, thus, descend below the desired glide path (i.e., "duck-under"); and,
- **Final approach speed and ground speed:**
 - To maintain the energy level.

XII Associated Flight Operations Briefing Notes

The following Flight Operations Briefing Notes can be reviewed in association with the above information:

- **Descent and Approach Profile Management**
- **Energy Management during Approach**
- **Being Prepared to Go-around**
- **Flying Constant-Angle Non-Precision Approaches**
- **The Final Approach Speed**
- **Factors Affecting Landing Distances**

XIII Regulatory references

- ICAO – Annex 6 – Operations of Aircraft, Part I – International Commercial Air transport – Aeroplanes, Appendix 2, 2.1.25
- ICAO – Procedures for Air navigation services – Aircraft Operations (PANS-OPS, Doc 8168), Volume I – Flight Procedures (particularly, Part IX - Chapter 1 - Stabilized Approach – Parameters, Elements of a Stabilized Approach and Go-around Policy)

XIV Airbus References

- Flight Crew Operating Manuals (FCOM) – Standard Operating Procedures
- A318/A319/A320/A321 & A330/A340 Flight Crew Training Manuals (FCTM) – Approach General – Trajectory Stabilization

XV Additional Reading Materials

- U.S. National Transportation Safety Board (NTSB) – Report NTSB-AAS-76-5 – Special Study: Flight Crew Coordination Procedure in Air Carrier Instrument Landing System Approach Accidents

This FOBN is part of a set of Flight Operations Briefing Notes that provide an overview of the applicable standards, flying techniques and best practices, operational and human factors, suggested company prevention strategies and personal lines-of-defense related to major threats and hazards to flight operations safety.

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Flight Operations Support and Services

1 Rond Point Maurice Bellonte - 31707 BLAGNAC CEDEX FRANCE

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