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# Unstable Approaches: Risk Mitigation Policies, Procedures and Best Practices



1<sup>st</sup> | Edition

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## ACRONYMS

AAL	Above Airport Level
ACTF	Accident Calcification Task Force
AGL	Above Ground Level
ALAR	Approach and Landing Accident Reduction
AMDB	Airport Mapping Database
ANSP	Air Navigation Service Provider
APV	Approach Procedures with Vertical
ATC	Air Traffic Control
ATSU	Air Traffic Services Unit
CFIT	Controlled Flight into Terrain
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DH	Decision Height
EAFDM	European Authorities coordination group on Flight Data Monitoring
EFB	Electronic Flight Bag
EGPWS	Enhanced Ground Proximity Warning Systems
ELISE	Exact Landing Interference Simulation Environment
FAF	Final Approach Fix
FDA	Flight Data Analysis
FDM	Flight Data Monitoring
FDR	Flight Data Recorder
FMS	Flight Management System
FOBN	Flight Operations Briefing Notes
FOQA	Flight Operations Quality Assurance
FSF	Flight Safety Foundation
GADM	Global Aviation Data Management
GPWS	Ground Proximity Warning System
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IMC	Instrument Metrological Conditions
IOSA	IATA Operational Safety Audit
LOC-I	Loss of Control Inflight
MDA	Minimum Descent Altitude
OEM	Original Equipment Manufacturer
OM	Outer Marker
PBN	Performance Based Navigation
PF	Pilot Flying
PM	Pilot Monitoring
PNF	Pilot not flying
PANS OPS	Procedures for Air Navigation Services — Aircraft Operations
ROPS	Runway Overrun Prevention System
SAAFER	Situational Awareness & Alerting For Excursion Reduction
SMS	Safety Management System
SOP	Standard Operating Procedure
TAWS	Terrain Awareness and Warning System
TOD	Top-of-Descent
VMC	Visual Metrological Conditions



## ABSTRACT

Safety is a priority for the entire aviation industry and for many years 'continuous improvement' has been the guiding principle in aviation safety management. A primary goal is to improve crew responses to unexpected and undesired events, which have the potential to erode the margins between safe operations and accidents.

Inevitably safety management resources are finite and must be targeted in ways that offer the greatest opportunities for prevention. During the data period 2010-2014 considered within the following chapters approximately 64% of all recorded accidents occurred in the approach and landing phases of flight, and unstabilized approaches were identified as a factor in 14% of those approach and landing accidents.

A stabilized approach is one during which several key flight parameters are controlled to within a specified range of values before the aircraft reaches a predefined point in space relative to the landing threshold (stabilization altitude or height), and maintained within that range of values until touchdown. The parameters include attitude, flight path trajectory, airspeed, rate of descent, engine thrust and aircraft configuration. A stabilized approach will ensure that the aircraft commences the landing flare at the optimal speed, and attitude for the landing.

The industry as a whole – manufacturers, regulators, professional associations, air navigation service providers (ANSPs), operators, controllers and pilots – must adopt an unequivocal position that the only acceptable approach is a stabilized one, and pilots in particular must take professional pride in achieving it every time. Recognized industry practice is to recommend that a failure by the flight crew to conduct a stabilized approach should result in a go-around.

The industry has developed a number of technological solutions to help tackle unstabilized approaches and more are on the way. In 2015 IATA conducted a survey of pilots to establish the extent of their knowledge of these systems, and their opinions regarding the part technology has to play in reducing approach and landing accidents. 541 responses were received and these have been analyzed in the document attached to this GM as Appendix I.

# Chapter 1—Guidance Overview

## 1.1 Manual Objective

The purpose of this document is to enhance the overall awareness of the contributing factors and outcomes of unstabilized approaches, together with some proven prevention strategies and to provide a reference based upon the guidance of major aircraft manufacturers and identified industry best practice, against which to review operational policy, procedures and training.

## 1.2 Manual Content

The material in this manual is based on:

- Airbus Flight Operations Briefing Notes (FOBN);
- Flight Safety Foundation (FSF) Approach and Landing Accident Reduction; (ALAR) Briefing Note 2.2: Crew Resource Management;
- FSF ALAR Briefing Note 4.2: Energy Management;
- FSF Go-around Decision Making and Execution Project Study [in progress as at December 2015];
- ICAO Doc. 8168 Procedures for Air Navigation Services — Aircraft Operations (PANS OPS) VOL I (Flight Procedures);
- IATA Operational Safety Audit (IOSA) Manual 8<sup>th</sup> Edition;
- IATA 51<sup>st</sup> Safety Report;
- Go-around Safety Forum, 18 June 2013, Brussels: Findings and Conclusions;
- European Authorities coordination group on Flight Data Monitoring (EAFDM): developing standardized FDM-based indicators.

## 1.3 Data Sources for Manual

The data supporting this manual are derived primarily from IATA Global Aviation Data Management (GADM) Accident database, IATA 2014 Safety Report and the 1,901 responses to the IATA Unstabilized Approaches Survey. The data period includes the five (5) years from 2010 to 2014.

## 1.4 Definitions

### 1.4.1 Unstable Approach

The Accident Classification Task Force (ACTF) allocates the factor 'Unstable Approach' to an accident when it *'has knowledge about vertical, lateral or speed deviations in the portion of the flight close to landing'*, (see IATA Safety Report 2014 for more information).

**Note:**

*This definition includes the portion immediately prior to touchdown and in this respect, the definition might differ from other organizations. However, accident analysis gives evidence that a 'destabilization' just prior to touchdown has contributed to accidents in the past.*



## 1.4.2 Failure to Go-Around after Destabilization During Approach

Flight crew does not execute a go-around after stabilization requirements are not met.

## 1.4.3 Flight Crew

This is used throughout this document interchangeable with **pilot(s)**.

## 1.4.4 Undesired Aircraft State

A flight-crew-induced aircraft state that clearly reduces safety margins; a safety-compromising situation that results from ineffective error management. An undesired aircraft state is still **recoverable**.

## 1.4.5 End State

An End State is a reportable occurrence. It is **unrecoverable**.

### **Note:**

*An unstabilized approach is recoverable and is therefore an Undesired Aircraft State, whereas a runway excursion is not recoverable and is an End State.*

## 1.4.6 Phase of Flight Definition

The phase of flight definitions developed and applied by IATA are presented in the following table:

**Approach:** Begins when the crew initiates changes in aircraft configuration and /or speeds enabling the aircraft to maneuver for the purpose of landing on a particular runway; it ends when the aircraft is in the landing configuration and the crew is dedicated to land on a specific runway. It may also end by the crew initiating an 'Initial Climb' or 'Go-around' phase.

**Go-around:** Begins when the crew aborts the descent to the planned landing runway during the 'Approach' phase; it ends after speed and configuration are established at a defined maneuvering altitude or to continue the climb for the purpose of cruise (same as end of 'Initial Climb' phase).

**Landing:** Begins when the aircraft is in the landing configuration and the crew is dedicated to touch down on a specific runway; it ends when the speed permits the aircraft to be maneuvered by means of taxiing for the purpose of arriving at a parking area. It may also end by the crew initiating a 'Go-around' phase.

**Descent:** begins when the crew departs the cruise altitude for the purpose of an approach at a particular destination; it ends when the crew initiates changes in aircraft configuration and/or speeds to facilitate a landing on a particular runway. It may also end by the crew initiating an "En Route Climb" or "Cruise" phase.

**Initial Climb:** begins at 35 feet above the runway elevation; it ends after the speed and configuration are established at a defined maneuvering altitude or to continue the climb for the purpose of cruise. It may also end by the crew initiating an "Approach" phase.

### **Note:**

*Maneuvering altitude is based upon such an altitude to safely maneuver the aircraft after an engine failure occurs, or predefined as an obstacle clearance altitude. Initial Climb includes such procedures applied to meet the requirements of noise abatement climb, or best angle/rate of climb.*

## 1.5 Collaborative Approach

Consistent stabilized approaches are more likely when effective 'collaboration', 'cooperation' and 'communication' occur between all participants, including the operators, manufacturers, state regulators, training organizations, Air Navigation Service Providers (ANSPs), Air Traffic Controllers (ATCs) and of course the pilots themselves, allowing the aircraft to accurately follow the published lateral and vertical approach paths in steady, stabilized flight from a reasonable altitude above touchdown.



# Chapter 2—Background

## 2.1 The Aim of an Approach

A safe landing and completion of the landing roll within the available runway is the culmination of a complex process of energy management that starts at the top of descent, from which point the sum of kinetic energy (speed) and potential energy (altitude) must be appropriately dissipated to achieve taxi speed before the runway end. This can be a continuous process from start to finish or the continuum may be broken by a holding pattern or protracted level flight, in which case it starts afresh when descent recommences. The pilots have thrust and drag available as primary energy management tools but with the input of the controller they may also use track miles in the equation. The descent and arrival phases can be considered as the wide 'mouth' of a large funnel offering a relatively broad spectrum of speed/altitude/distance relationships within the 'acceptable range. The approach and in particular the final approach, constitutes the narrow 'neck' of the funnel guiding the aircraft precisely to the threshold and the energy options are more limited. The aim of the approach is to deliver the aircraft to the right point in space above the runway from which an accurate flare maneuver will result in touchdown at the right speed and attitude, and within the touchdown zone.

## 2.2 Unstabilized Approaches Synopsis

The safety data from the IATA GADM Accident database show that the approach and landing phases of flight account for the major proportion of all commercial aircraft accidents; 64% of the total accidents recorded from 2010-2014. Unstable approaches were identified as a factor in 14% of those accidents.

Many contributory factors can be identified in each accident but approach-and-landing accidents are frequently preceded by a poorly executed and consequently unstabilized approach, together with a subsequent failure to initiate a go-around.

The aviation community has for some time recognized that establishing and maintaining a stabilized approach is a major contributory factor in the safe conclusion of any flight. The aircraft must have the right configuration, attitude, airspeed, power/thrust setting and be at the right position over the runway to provide the pilots with the best opportunity for a safe landing. Each of these performance criteria must be within a specified range of values throughout the final approach in order for the approach to be considered 'stabilized'. Individual operators must first define the criteria they require for a stabilized approach based upon aircraft types, operational requirements, meteorological conditions and acceptable margins of safety. They must then promulgate a policy of strict compliance with the stabilized approach criteria, develop procedures and training to support that policy and use flight data to monitor adherence to the policy in routine operations.

A multidisciplinary approach, requiring collaboration and communication between all industry stakeholders, as described above, is required to coordinate the network-wide implementation of effective stabilized approach polices and identified best practices.

The International Air Transport Association (IATA), in collaboration with the International Federation of Air Line Pilots' Associations (IFALPA), addresses recommendations and guidance to help avoid unstabilized approaches and thereby assist in the reduction of approach-and-landing accidents.

## 2.3 Data Analysis

Of the total of 415 commercial aircraft accidents recorded in IATA GADM Accident database during the period of 2010 to 2014, 264 or 64% occurred during the approach-and-landing phase and 44 of these involved fatalities.

The following types of events accounted for 57% of the approach and landing accidents: Controlled Flight into Terrain (CFIT), Loss of Control Inflight (LOC-I), Runway Excursion, and Hard Landing. Some of the causal factors cited in those accidents were:

- Regulatory Oversight;
- Safety Management;
- Meteorology;
- Adverse Wind Conditions;
- Aircraft Malfunction;
- Manual Handling / Flight Controls;
- Standard Operating Procedures;
- Unstable Approach;
- Decision not to initiate a go-around;
- Pilot/Controller communications;
- Monitor/Cross-check;
- Call outs.

In the terminology of Threat & Error management (TEM) an unstabilized approach is a serious Undesired Aircraft State (see Definitions above) that can have a catastrophic outcome or 'End State' (also see Definitions above) if not correctly managed by the pilots. Nine percent (9%) of total accidents between 2010 and 2014 were found to have an unstable approach as a factor. Figure 1 below illustrates the percentage of accidents with an unstable approach as a factor over each of the five years of the period:

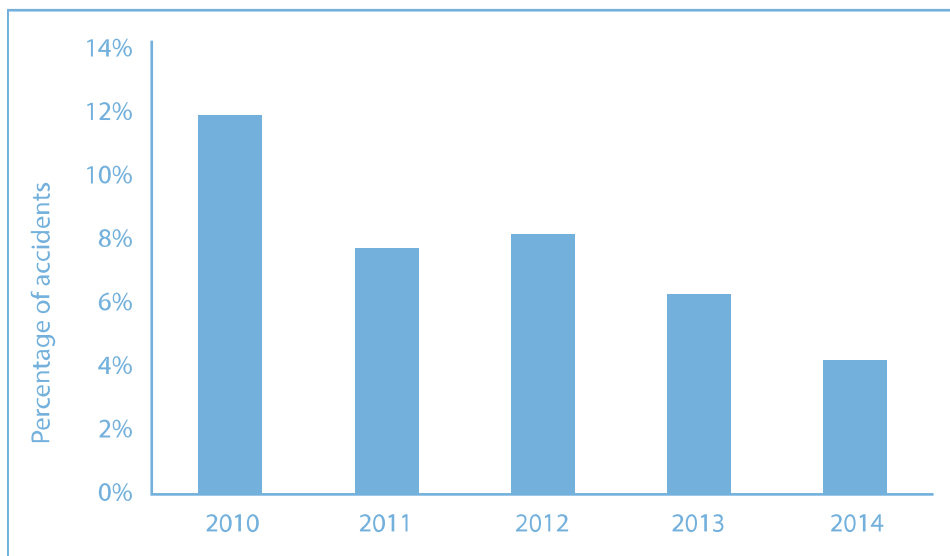
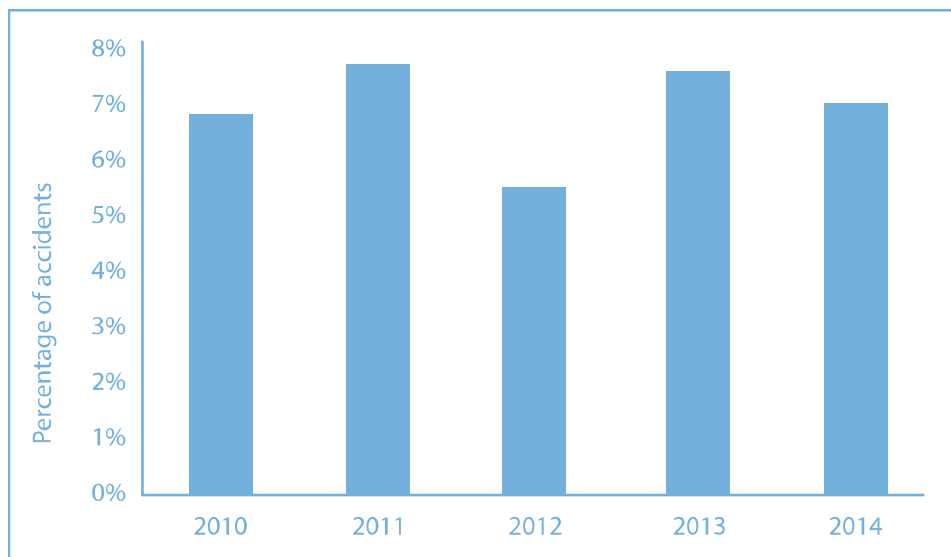


Figure 1: Percentage of accidents with unstable approaches as a factor

Failure to go-around from an unstabilized approach was a contributing factor in eight percent (8%) of the accidents between 2010 and 2014. Failure to go around after a destabilized approach as eight percent (8%) of total accidents is included in figure 2 below.



**Figure 2: Failure to go-around after destabilized approach as a percent of total accidents**

The data also shows that the failure to go-around after the approach became unstable contributed to 15% of all hard landing accidents.

Unstable approaches were identified as a factor in 15% of all runway excursion (landing) accidents, and failure to go around after a destabilized approach was a factor in 19% of runway excursion (landing) accidents.

**Note:**

*In order for an event to be considered as an accident, the aircraft involved must meet IATA Accident Criteria and Definition, which is listed in the IATA Safety Report 2014, 51<sup>st</sup> edition. The percentages quoted above represent that proportion of accidents for which there was sufficient data available for the ACTF to make category classifications.*

Many studies have been conducted with respect to unstable approaches and approach-and-landing accidents using differing source data, definitions and analytical logic. However, the consistencies in the findings from study to study indicate that unstable approaches have been and continue to be a significant factor in a high proportion of commercial aircraft accidents.

# Chapter 3—Stabilized Approaches (Concept and Global Criteria)

## 3.1 Defining the Elements of a Stabilized Approach

If stabilized approaches are to become the industry standard it is essential to define a common set of parameters that constitute a stabilized approach. That will help ensure that all stakeholders will be working towards the same shared outcome. However, there are many variables to be embraced within the global industry including a wide variety of aircraft types, the environmental constraints of certain airports and the operational needs of airlines, airports and ANSPs. Furthermore, the recognition and adoption of the stabilized approach concept has not emerged from a single source, and a number of different methodologies and criteria have developed. Nevertheless, in general and conceptual terms these criteria are essentially the same.

Because the aim is to achieve and maintain constant flight conditions for the approach phase of the flight, it is evident that whatever the target flight characteristics are for the point immediately prior to commencement of the landing flare, these will be the same flight characteristics required to be met at an earlier point in the approach, and maintained thereafter. The desired 'pre-flare' characteristics are defined by the aircraft manufacturer and generally consist of:

- Target approach speed a few knots faster than the desired touchdown speed and on the 'right' side of the total drag curve (corrected for wind if necessary);
- Rate of descent commensurate with the approach angle and approach speed (generally around 600-700 feet per minute for jet aircraft on a 3° approach);
- Landing configuration of gear and flap;
- Stable aircraft attitude in all 3 axes;
- Engine thrust stable above idle.

Recognizing that the aircraft is operating in a dynamic environment a tolerable range is defined for each of these parameters (+ 5 knots/- 0 knots airspeed for example), allowing the pilots to make corrective inputs to maintain flight within the stabilized criteria. These stable flight characteristics make it easier for pilots to recognize any deviations, decrease the cockpit workload by reducing the variables to external forces only, and provide a clear cue for go-around decision making if one or more of the criteria limits are breached.

Whilst the adoption and conduct of stabilized approaches is recognized as best practice in commercial aviation, individual operators are expected to devise their own specific criteria to suit their aircraft, destination network and operational requirements and to promulgate them in the Operations Manual.

From 1,901 responses to a recent study by IATA on stabilized approaches, it was apparent that:

- Many operators define a lower stabilization altitude/height for approaches in VMC than IMC;
- Some operators require all approaches to be stabilized at 1,000 feet irrespective of meteorological conditions (this has the advantage of consistency for decision making and for flight data monitoring);
- The required stabilization altitude can range from 1,500 feet to 500 feet.

A recent study conducted by FSF revealed that variations in required stabilization altitudes between operators, between approach types (precision/non-precision) and between meteorological conditions (IMC/VMC) could be a cause for concern and potential confusion. For example the some industry guidance recommends that approaches in IMC must be stabilized by 1000 feet and in VMC by 500 feet, for precision, non-precision, and unguided approaches alike, while on a circling approach maneuvering is acceptable down to 300 feet. Pilots may question why they would be required to abandon a precision approach and go-around in VMC at 500 feet when it would be perfectly acceptable (and presumably safe) to continue a circling approach for a further 200 feet.

### RECOMMENDATION (1):

- 3.1.1 Aviation safety regulators to require operators to define and apply stabilized approach procedures, including criteria suitable for their operations, and for a mandatory go-around to be flown if they are not met and maintained;
- 3.1.2 All operators to adopt the stabilized approach concept, characterized by maintaining a stable speed, descent rate, attitude, aircraft configuration, displacement relative to the approach path and stable power/thrust settings from an appropriate height above touchdown until the commencement of the landing flare.

## 3.2 Stabilization Altitude/Height

Airbus Flight Operations Briefing Notes (FOB) state that the minimum stabilization height constitutes a particular 'gate' or 'window' along the final approach, for example for an ILS approach the objective is to be stabilized on the final descent path at  $V_{APP}$  (approach speed) in the landing configuration, at 1,000 feet above airfield elevation in IMC, or at 500 feet above airfield elevation in VMC, after continuous deceleration on the glide slope.

### **Note:**

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

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 pilot estimates that only small corrections are necessary to rectify minor deviations from stabilized conditions due, amongst others, to external perturbations.

The FSF study also concluded that operators should consider the implementation of two stabilization altitudes/heights on each approach; the first being a point at which the stabilization criteria 'should' be met and the second at which they 'must' be met, or a go-around 'must' be initiated.

### RECOMMENDATION (2):

- 3.2.1 Operators to ensure that policy, procedures and training optimize pilots' situational awareness throughout the approach, and specifically in relation to the minimum stabilization altitude/height;
- 3.2.2 Operators to regularly review and if necessary redefine their stabilization criteria.

## 3.3 Callouts

In order to achieve and maintain stabilized flight, pilots must be constantly aware of each of the required parameters throughout the approach. A 'callout' is required if either pilot observes a deviation from the specified limits of the stabilization criteria or a deviation from SOP. If the deviation has been observed first by the flying pilot, his callout advises the non-flying pilot that he is aware and attempting to correct; if observed by the non-flying pilot, his callout will bring the flying pilot's attention to the deviation. Each callout requires a corresponding acknowledgement from the other pilot, which can assist in the early detection of pilot incapacitation. The routine use of callouts in this manner improves communication and enhances situational awareness on the approach.

The FSF study recommended that pilot callouts should not be limited to a single occasion at the initial deviation but should continue at reasonable intervals until the deviation ceases. The repeated callouts ensure continuing awareness of the undesirable condition until it has been corrected and mimics the aural warning logic of a Ground Proximity Warning System (GPWS) or Traffic Collision Avoidance System (TCAS) for example, which continues until the hazardous condition is no longer present.

The adoption of calls of "STABILIZED", "UNSTABLE" or "GO-AROUND" at a given point on the approach (stabilization altitude/height for example) may improve decision making and compliance to ensure a timely go-around is carried out. While a "STABILIZED" callout might be required only once on each approach, the "GO-AROUND" command could be made if necessary at any time prior to deployment of thrust reversers. Once again, if such callouts are adopted it is essential that an acknowledgement is made by the other pilot in every case.

Another option to assist pilots in their decision making process would be the installation of a monitoring system to provide alerts if the stabilized approach criteria are not met, similar to wind-shear alerting systems. Among different technologies (see Section 8 of this Guidance Material) two avionics products are available as options – Honeywell's SmartLanding and Airbus's Runway Overrun Prevention System (ROPS).

### **RECOMMENDATION (3):**

- 3.3.1 Operators to require pilot callouts to ensure timely awareness of deviations in flight parameters beyond specified limits.
- 3.3.2 Operators to require that:
  - Pilots acknowledge any callout to ensure crew coordination and assist in the detection of pilot incapacitation;
  - The flying pilot takes immediate action in response to a callout to correct the deviation and return to within the stabilized approach parameters;
  - Following a deviation the pilots assess whether a stabilized approach can be recovered by the required altitude/height;
  - If the stabilized approach criteria cannot be met, pilots initiate a go-around without delay.
- 3.3.3 Operators to require callouts to be continued at reasonable intervals until the deviation is corrected; similar in concept to GPWS or TCAS.

## **3.4 Standard Operating Procedures (SOPs)**

An approach is stabilized only when all of the performance criteria specified by the operator are met. It is therefore essential that the criteria are complementary to the operator's Standard Operating Procedures (SOPs) and that the SOPs are conducive to meeting the stabilized approach criteria. Operators must ensure that SOPs are clear, concise and appropriate, and include the requirement to meet and maintain the stabilized approach criteria, the requirement to go-around if the criteria are not met and guidance for the go-around decision making process. Consistent adherence to SOPs is a demonstrated factor in improving approach and landing safety and can be measured by flight data monitoring.

The performance parameters which are chosen to define a stabilized approach should be selected in accordance with the aircraft manufacturers' guidance and include at least the following:

- A range of speeds specific to each aircraft type, usually by reference to  $V_{APP}$  or  $V_{REF}$ ;
- A range of power/thrust setting(s) specific to each aircraft type;
- A range of attitudes specific to each aircraft type;
- Crossing altitude deviation tolerances;
- Configuration(s) specific to each aircraft type;
- Maximum rate of descent; and
- Completion of checklists and crew briefings.

ICAO Doc. 8168 Procedures for Air Navigation Services — Aircraft Operations (PANS OPS) VOL I (Flight Procedures) requires under Part III Section 4. Operational Flight Information, Chapter 3, the elements of stabilized approaches to be stated in the operator's SOPs. These elements should include, as a minimum:

- that in instrument meteorological conditions (IMC), all flights shall be stabilized by no lower than 300 meters (1,000 feet) height above threshold; and
- that all flights of any nature shall be stabilized by no lower than 150 meters (500 feet) height above threshold.

The IOSA Standards Manual 8<sup>th</sup> Edition contains Standard FLT 3.11.59 which reads:

“FLT 3.11.59 The Operator shall have a stabilized approach policy with associated guidance, criteria and procedures to ensure the conduct of stabilized approaches. Such policy shall specify:

- (i) A minimum height for stabilization not less than 1,000 feet above airport level (AAL) for approaches in IMC or not less than 500 ft. AAL for approaches in IMC as designated by the operator and/or State where a lower stabilization height is operationally required;
- (ii) A minimum height for stabilization not less than 500 feet AAL for approaches in VMC;
- (iii) Aircraft configuration requirements specific to each aircraft type (landing gear, wing flaps, speed brakes);
- (iv) Speed and thrust limitations;
- (v) Vertical speed limitations;
- (vi) Acceptable vertical and lateral displacement from the normal approach path. (GM)”

### **RECOMMENDATION (4):**

- 3.4.1 Operators to develop SOPs that reflect the aircraft manufacturers’ guidance, to include stabilized approach criteria and a non-punitive go-around policy;
- 3.4.2 SOPs must be clear, concise and appropriate, and support mandatory policies for stabilized approaches and go-arounds, together with guidance on the go-around decision making process;
- 3.4.3 Operators to reaffirm the importance of SOPs through policies and training and enforce SOP compliance through effective monitoring and a ‘just’ process for managing non-compliance.

## **3.5 Crew Resource Management (CRM)**

Many approach and landing accidents included contributory factors related to poor group decision-making by flight crews, together with ineffective communication, inadequate leadership and poor management. CRM training was developed as a response to these deficiencies, based on flight data recorder (FDR) and cockpit voice recorder (CVR) data. These data suggested that many accidents were not the result of technical malfunctions, but of the inability of flight crews to respond appropriately to the developing situation (in TEM terminology an undesired aircraft state) prior to the accident. CRM encompasses a wide range of knowledge, skills and in particular attitudes with respect to communication, situational awareness, problem solving, decision making, leadership, and teamwork. CRM can therefore be described as a management system which promotes the optimum use of all available resources, in order to best assure a safe and efficient operation in both routine and abnormal situations.

CRM Components:

- SOPs providing clear, unambiguous roles for the pilot flying (PF) and pilot monitoring (PM) in normal and non-normal operations;
- Briefings to assure ‘transparency’ and a common understanding of the plan;
- Effective communication between all flight crew members (in the cockpit and in the cabin) and between flight crew and ATC;
- Flight crew coordination, cross-checking and backup.

### **RECOMMENDATION (5):**

- 3.5.1 Operators to ensure that training programs include CRM at initial and recurrent phases, which is appropriate to the cultural constituency of the pilot group.

## 3.6 Briefing

The importance of briefing techniques can be underestimated, and effective briefings can influence teamwork, co-ordination, understanding, behavior and communication.

The Airbus FOBN for example states that the descent-and-approach briefing provides an opportunity to identify and discuss factors such as altitude or airspeed restrictions that might require non-standard energy management in the descent. A comprehensive briefing ensures:

- An agreed strategy for the management of the descent, deceleration, configuration and stabilization;
- A common objective and point of reference for the PF and PM.

The descent-and-approach briefing should include the following generic aspects of the approach and landing:

- Approach conditions (i.e., weather and runway conditions, special hazards);
- Lateral and vertical navigation (including intended use of automation);
- Stabilized approach criteria;
- Instrument approach procedure details;
- Go-around and missed approach;
- Diversion;
- Communications;
- Non-normal procedures, as applicable; and,
- Review and discussion of approach-and-landing hazards.

Specific to the approach and go-around, the briefing could include the following:

- Minimum sector altitude (MSA);
- Terrain and man-made obstacles;
- Other approach hazards, such as visual illusions;
- Applicable minimums (visibility or RVR, ceiling as applicable);
- Applicable stabilization altitude/height (approach gate or window);
- Final approach flight path angle and vertical speed;
- Go-around altitude and missed approach procedure.
- Review of any relevant NOTAMs and ATIS remarks that might affect the stability of the approach.

### RECOMMENDATION (6):

- 3.6.1 Operators to require effective and interactive briefings to enhance flight crew coordination and preparedness for planned actions and unexpected occurrences, by creating a common mental model of the approach.

## 3.7 Crew Coordination, Monitoring and Cross-Check

The following elements of flight crew behavior can contribute to stabilized approaches, facilitate go-around decision making, and improve overall situational awareness:

- Call out acknowledgements;
- Passing altitude calls;
- Excessive flight parameter deviation callouts;
- Monitoring and cross-checking;
- Task sharing;
- Standard calls for acquisition of visual references.

### RECOMMENDATION (7):

- 3.7.1 Operators to ensure that SOPs include adequate monitoring and cross-checking to support crew co-ordination during approach and landing;



### 3.8 Flight Data Monitoring

The best potential sources of operational data are the operators' own Flight Data Monitoring (FDM), Flight Data Analysis (FDA), or Flight Operations Quality Assurance (FOQA) programs.

The routine download and analysis of recorded flight data has been used by operators for many years as a tool to identify potential hazards in flight operations, evaluate the operational environment, validate operating criteria, set and measure safety performance targets, monitor SOP compliance and measure training effectiveness.

In non-routine circumstances, when an incident occurs the data can be used to debrief the pilots involved and inform management. In a de-identified format the incident data can also be used to reinforce training programs, raising awareness amongst the pilot group as a whole.

With respect to stabilized approaches, standard FDM software will normally assist in:

- Monitoring of the flight parameters used to define stabilized;
- Establishing the level of compliance with the stabilized approach and go-around policies;
- Understanding the factors contributing to unstabilized approaches;
- Identifying correlations between unstabilized approaches and specific airports/runways (e.g., ATC restrictions), individual pilots, specific fleets, etc.;
- Hazard identification in the approach environment, (an element of the Safety Risk Management component of the Safety Management System (SMS) framework).

EAFDM recommends the development of standardized FDM-based indicators to be used by all operators for the monitoring of operational risk (LOC-I, runway excursion, CFIT, etc...). These standardized indicators are expected to bring several advantages:

- All operators monitoring common operational risks;
- Ensure that for those identified common risks, operators have relevant indicators in place;
- Facilitate voluntary reporting of FDM summaries in a standardized way.

#### **RECOMMENDATION (8):**

- 3.8.1 Operators to establish, implement, and maintain an accident prevention and flight safety program, which includes a comprehensive flight data monitoring (FDM) program;
- 3.8.2 De-identified data from the FDM program to be used in initial and recurrent training programs, including the creation of simulator scenarios (evidence based training);
- 3.8.3 Operators to work with ANSP/Air Traffic Services Unit (ATSU) to implement procedural changes to systematically reduce the rate of unstabilized approaches at runways identified as higher risk by FDM data analysis.

# Chapter 4—Effect of Unstabilized Approaches

## 4.1 What is an Unstabilized Approach?

An unstabilized approach is any approach that does not meet the stabilized approach criteria defined by the operator in its SOPs.

If the stabilized approach criteria are not met or, having been met initially, are subsequently breached, the pilots may correctly initiate a go-around, or they may sometimes continue to landing. In the latter case, this may be because they failed to recognize that the approach was unstabilized or alternatively they may have intentionally failed to comply with the stabilized approach policy for emergency or other reasons. In a recent study by IATA, some flight crew were found to be under considerable pressure from various sources to continue approaches including peer pressure, commercial pressure to reduce delays, perceptions about their companies' go-around policies, fatigue, etc.

The continuation of an unstabilized approach to landing, contrary to SOPs, may result in the aircraft touching down too fast, too hard, outside the touchdown zone (long or short), off the runway center-line, in the incorrect attitude or incorrectly configured for landing. These may in turn lead to a 'bounced' landing, aircraft damage, runway excursion or landing short.

An unstabilized approach may have any number of contributing factors (weather, tailwind, fatigue, workload, poor planning, pilot error, ATC interaction, procedures etc.), which can be encountered at any stage of the descent, arrival and approach, and the whole management process begins in the cruise phase as plans are made and approach briefings delivered.

### RECOMMENDATION (9):

- 4.9.1 Operators to train flight crew to recognize and correct flight parameter deviations before they develop to the extent that a stabilized approach cannot be achieved or maintained. If these corrective actions fail then the only safe solution is a go-around.

## 4.2 Understanding the Stabilized Approach Criteria

A recent study conducted by IATA asked operators a series of questions to understand their stabilized approach criteria and how they had been developed. 42% of the 1,116 respondents stated that the criteria had been developed from previous accidents, from the IOSA standards, international standards, FDM analysis, and multi-cultural flight crew and company management influences. When asked about the level of satisfaction with the existing stabilized approach criteria, 86% of them replied that they were satisfied, while 12% indicated dissatisfaction. The respondents who expressed dissatisfaction complained about the rigidity of the criteria and that the stabilized approach policy was too restrictive and stringent.

## 4.3 Factors Leading to Unstabilized Approaches

Human error and procedural non-compliance have been identified as primary contributing factors to unstabilized approaches. Procedural non-compliance may be inadvertent due to an error or a lack of knowledge, or alternatively the result of an intentional violation but in either case represents an undesirable deviation that increases risk. However, there are many other factors, both threats and errors that can contribute to an approach being unstabilized, including:

- Loss of situational awareness;
- Poor visibility and visual illusions;
- Inadequate recognition of the effect of wind conditions;
- Adverse weather (e.g. strong or gusty winds, windshear, turbulence, tailwind);
- Inadequate monitoring by flight crew;
- Excessive altitude and/or airspeed (inadequate energy management) early in the arrival or approach;
- Flight crew fatigue;

- Commercial pressure to maintain flight schedule;
- Peer pressure;
- Failure of automation to capture the glideslope requiring late intervention;
- Loss of visual references;
- Premature or late descent caused by failure to positively identify the final approach fix (FAF);
- Malfunctioning ground-based navigational aids;
- Radar vectoring that did not end on the intermediate approach segment, either laterally or vertically.
- The breakdown of flight crew and ATC communications;
- ATC requiring crew to fly higher, faster, or shorter routings (challenging clearances);
- ATC pressure to maximize number of movements;
- ATC restrictions or directives;
- Noise abatement operational procedures including late extension of landing gear, reduced flap setting, continuous descent operations;
- Lack of monitoring by the Pilot-Non-Flying / Pilot Monitoring;
- Late change of runway.

In order for stabilized approaches to become routine it is essential that the operator's policy is unequivocal in requiring compliance, that training and SOPs support the policy and that every unstabilized approach that is continued is debriefed. Pilots must regard an unstabilized approach as a failure rather than viewing an abandoned approach and go-around in that way. The operator must also adopt a non-punitive response to go-arounds, in spite of any commercial implications associated with delays and cost.

Many operators may underestimate the dangers posed by unstabilized approaches, and their policies and SOPs may do little to ensure that pilots follow the relevant procedures. Pilots and operators should understand the importance of stabilized approach criteria as critical elements of flight safety.

### **RECOMMENDATION (10):**

- 4.10.1 Operators to enhance the awareness of the pilots and management personnel of the contributing factors to – and risks associated with – unstabilized approaches.
- 4.10.2 Operators to adopt and promote a policy of compliance with stabilized approach criteria and mandatory go-around.

# Chapter 5—Mitigation of Unstabilized Approaches

## 5.1 Mitigation of Unstabilized Approaches

Any approach that fails to meet or maintain the stabilized approach criteria constitutes an undesired aircraft state in the terminology of TEM. In order to avoid this developing further into an unrecoverable 'end state' it is vital that the pilots take action to adequately manage the undesired aircraft state. The flight crew must:

- Recognize that the approach is unstable;
- Communicate with fellow crew members;
- Take immediate action to rectify the situation;
- Monitor the corrective action.

To avoid an unstabilized approach in the first place, it is important for flight crew:

- To be aware of the stabilized approach criteria;
- To be aware of the aircraft horizontal and vertical position in respect to a stabilized approach at all times, even when under radar control;
- To comply with the stabilized approach criteria published in their SOPs;
- To refuse clearances that would result in the aircraft being too high and/or too fast, would require approach path interception from above or would unduly reduce separation from other aircraft;
- To refuse ATC instructions that are incompatible with a stabilized approach;
- To advise ATC when reducing or increasing speed to achieve a stabilized approach;
- To decline late changes of landing runway when approach stabilization would become marginal or impossible;
- To prepare for visual approaches by briefing speed/altitude/configuration gates, equivalent to those of an instrument approach and follow the published 'visual approach' pattern in the manufacturer's or operator's SOP;
- To execute a go-around if the approach cannot be stabilized by the stabilization altitude/height or subsequently becomes unstabilized;
- To be alert to the approach becoming unstabilized on very short final or in the flare;
- To be aware that it may be possible to go-around even after touchdown as long as reverse thrust has not been selected.

ATC can contribute to stabilized approaches by:

- Issuing proper clearances and providing timely and accurate weather information;
- Ensuring that aircraft are managed safely in the final stage of flight before landing;
- Understanding the risks of unstabilized approaches;
- Understanding the influence of ATC on stabilized approaches.

### **RECOMMENDATION (11):**

- 5.11.1 Operators to ensure that pilots are aware of and understand the risks associated with unstabilized approaches;
- 5.11.2 Operators to ensure that pilots are aware of and understand the stabilized approach criteria;
- 5.11.3 Operators to work with pilots to improve compliance with SOPs;
- 5.11.4 ANSPs/ATSUs to improve controllers' awareness of the risks associated with ATC actions during approach through initial and recurrent training;
- 5.11.5 ANSPs/ATSUs to ensure that controllers provide accurate information on changing meteorological and runway surface conditions to aircraft on approach.

# Chapter 6—Go-Around Decision-Making

## 6.1 Go-Around

A go-around can be initiated for a number of reasons, including failure to acquire or loss of the required visual reference for a landing, late change in wind velocity, a runway incursion and of course when it has not been possible to meet or maintain the stabilized approach criteria. Failure to execute a go-around is a leading risk factor in approach and landing accidents and one of the primary contributing factors for landing runway accidents. A study by FSF estimated that industry wide 97% of unstabilized approaches are continued to landing.

As with the stabilized approach policy it is the responsibility of operators to develop and promulgate a clear policy on go-arounds, which states that a go-around is a normal flight maneuver to be initiated whenever a continued approach would not be safe or when the approach does not meet the stabilized approach criteria. The policy must also state that there will be no punitive response from management to a go-around and that conversely any failure to go-around when appropriate will be followed up.

Two independent sources of information on the go-around policy are:

- ICAO Doc. 8168 PANS OPS 1 states the need for operators to publish a 'go-around policy'. This policy should state that if an approach is not stabilized in accordance with the parameters previously defined by the operator in its operations manual or has become destabilized at any subsequent point during an approach, a go-around is required. Operators should reinforce this policy through training.
- The IOSA Standards Manual 8<sup>th</sup> Edition contains the Standard FLT 3.11.60 which reads:

"FLT 3.11.60 The Operator shall have a policy that requires the flight crew to execute a missed approach or go-around if the aircraft is not stabilized in accordance with criteria established by the Operator. (GM)

### **Guidance:**

The intent of this provision is for an operator's stabilized approach policy to address the actions to be taken by the flight crew in the event of deviations from the criteria that define a stabilized approach, and to designate the minimum altitude at which a go-around must be accomplished if the aircraft is not stabilized in accordance with the operator's stabilization criteria."

In addition to the stabilized approach parameters for a go-around mentioned in previous sections, parameters should also include visibility minima required before proceeding past the Approach Ban Point, usually at 1,000 feet or the final approach fix (FAF). The flight parameter deviation criteria and the minimum stabilization altitude/height at or below which the decision to land or go-around should be made, must also be defined in SOPs.

If all go-around policies met these requirements and were effective in driving flight crew decision making, the industry accident rate would be reduced. This is because there is probably no other routine operational decision that so clearly marks the difference between a safe choice and a less safe one.

The Flight Safety Foundation 'Go Around Decision Making and Execution Project' was launched to research and answer the question "why are we so poor at complying with established go-around policies", and determine strategies to address the findings. The project predicts that enhanced compliance would result from identifying the reasons for non-compliance and addressing each of them individually. The project is ongoing at the time of writing and will also examine the psychosocial role of flight operations management in the non-compliance phenomenon, as well as the risks associated with flying the go-around maneuver itself.

In the IATA unstabilized approaches survey one question asked operators if they have a mandatory go-around policy in place, and of the 1,116 respondents the majority of the participants (91%) indicated that they have a policy of mandatory go-arounds from unstabilized approaches, while nine percent (9%) indicated that they did not. The majority of the positive responses (96%) indicated that their policies encourage execution of go-around, while four percent (4%) indicated that they did not. Another question was related to whether their policy 'allows execution of a go-around from an unstabilized approach in a non-punitive environment?' Although many operators have implemented a 'non-punitive' policy in such circumstances, there was a limited number of operators that did not support the concept.

The IATA survey asked for the respondents' perception as to whether their operator reflects the industry rate (97%) of unstabilized approaches continued to landing. 69% indicated that they were below the industry rate but 26% indicated that they matched it and six percent (6%) of the participants indicated that they were higher.

Another reason why a go-around is not carried is a perception that the risk of executing the go-around maneuver is higher than continuing the approach. This may be due to unfamiliarity with the go-around maneuver outside of simulator training or potentially to bad weather in the vicinity of the missed approach path.

Pilots need to regard the go-around as a normal phase of flight, to be initiated whenever the conditions warrant. Nevertheless, the go-around is like any other phase of flight and has potential safety issues associated with it. Increased training and awareness of the dynamic nature of the go-around maneuver are vital to reduce the risk of undesirable outcomes.

Analysis of accident data indicates that common go-around related safety issues were:

- Ineffective go-around initiation;
- Loss of control during the go-around;
- Failure to fly the required track;
- ATC failure to maintain separation from other aircraft;
- Significant low level wind shear;
- Wake turbulence created by the go-around aircraft itself creating a risk for other aircraft.

If the FSF prediction is correct and without improved compliance with stabilized approaches, most unstable approaches will continue to a landing, significantly increasing the risk of approach and landing accidents.

### **RECOMMENDATION (12):**

- 6.12.1 Operators to implement a genuine non-punitive go-around policy, reminding flight crew that go-arounds are normal flight maneuvers;
- 6.12.2 Operators to emphasize to flight crews the importance of making the proper go-around decision and callout "GO AROUND", if the approach exhibits any element of an unstabilized approach.
- 6.12.3 Operators to review go-around policy, procedures and training to maximize their effectiveness, clarity and understanding;
- 6.12.4 The importance of flight crew being prepared for a go-around and being 'go-around minded' to be emphasized;
- 6.12.5 Operators to enhance awareness of go-around policy non-compliance rates, and the significant impact non-compliance has on approach and landing accident risk;
- 6.12.6 Operators to ensure go-around policies are clear, concise and unambiguous, and include management follow up procedures for non-compliance;
- 6.12.7 ANSPs/ATSUs should review and if necessary enhance the provision of go-around risk awareness training for ATCs;

## 6.2 Go-Around Decision

When many accidents could have been prevented with a sound go-around decision, the question remains why flight crew try to salvage a bad approach rather than abandon it and start again.

As part of the FSF go-around study, a psychological survey was developed to understand the etiology of compliant versus non-compliant go-around decision making. This evaluated pilots' experiences using a series of questions exploring the psychological precursors of risk assessment and decision-making. A second survey was designed to assess managers' perceptions and experiences of the issue of unstable approaches and how they are managed.

The lack of a correct go-around decision is the leading risk factor identified in approach and landing accidents. Unless absolutely necessary, the decision to go around should not be delayed; the more altitude and time available to apply power, establish a climb, and select the go-around configuration, the easier and safer the maneuver becomes. Once the decision is made, the pilots must maintain positive control of the flight trajectory and accurately follow the published missed approach, in accordance with manufacturer's recommendations and operator's SOPs. Following the initiation of a go-around no attempt should be made to reverse the decision and to land. Conversely, even when the pilots have decided to land at decision altitude, the option remains for them to go-around at any point up until reversers are deployed.

The IATA unstabilized approaches study sought evidence that operators provided go-around decision-making guidance for flight crew when the stabilized approach criteria were not met. 63% of the responses were negative and 37% positive. 65% of those who responded negatively indicated that guidance for flight crews in go-around decision making would be appropriate.

Factors affecting the go-around decision extend beyond the flight deck and management should consider:

- Implementation and operation of a non-punitive policy for go-arounds;
- Fuel policies which allow pilots to carry additional fuel when they consider it necessary, without undue interference from management;
- Acceptance of the delay and costs associated with go-arounds;
- Provision of simulator time for the practice of go-arounds from altitudes other than decision altitude;
- Requirement for approach briefings to include the conditions in which the approach may be continued and must be discontinued;
- Use in training of real examples of go-arounds to reaffirm the non-punitive policy.

### **RECOMMENDATION (13):**

- 6.13.1 Operators to publish clear and concise SOPs which separate the decision to go-around or continue with regard to stabilized approach criteria from the decision at the approach minimum with regard to visual references.
- 6.13.2 Operators to provide go-around training in simulator sessions that requires decision making with regard to stabilized approach criteria, both above and below the decision altitude.

## 6.3 Factors Governing the Go-Around Decision

- Premature or late descent caused by failure to positively identify the FAF;
- Inadequate awareness of wind conditions;
- Incorrect anticipation of airplane deceleration;
- Over confidence of achieving a timely stabilization;
- Flight crew too reliant on each other to call excessive deviations or to call for a go-around;
- Visual illusions;
- Lack of operator policy (or lack of clarity of such policy), organizational culture and training to support go-around decision making with regard to the stabilized approach criteria;
- Lack of practice/confidence in performing a go-around maneuver, especially from altitudes other than decision altitude.

## 6.4 When to Initiate a Go-Around

- Whenever the safety of a landing appears to be compromised. Typically, this occurs for one of these reasons:
- Instructed by ATC; ATC may instruct a go-around for a variety of reasons, including inadequate spacing, landing runway occupied or traffic on a parallel runway;
- Abnormal aircraft conditions; an aircraft system malfunction or erroneous indication may make a landing unsafe;
- Environmental factors; sudden and/or un-forecast changes in environmental conditions like tailwind, windshear or precipitation;  
*These unexpected events may require a go-around even after the airplane has touched down following a stable approach.*
- Whenever the stabilized approach criteria are not met at the required stabilization altitude and maintained thereafter until landing;
- Whenever the landing cannot be made within the touchdown zone; in the case of a long flare or 'floated' landing.

### RECOMMENDATION (14):

- 6.14.1 Operators to ensure that flight crew are prepared for a go-around throughout the entire approach;
- 6.14.2 Operators to enforce the requirement for a go-around as opposed to continuing an unstabilized approach;
- 6.14.3 Operators to emphasize to flight crews the importance of making the proper go-around decision.

## 6.5 Organizational Factors

Certain aspects of the organizational culture of Operators can have a significant effect upon the frequency of unstabilized approaches and the behavior of flight crews when an approach does not meet the stabilized approach criteria. The following have been demonstrated to reduce the frequency of unstabilized approaches and increase the likelihood of a go-around when appropriate:

- A comprehensive FDM program ensuring that approach performance of the whole pilot group and of the individuals therein, are immediately visible and properly addressed;
- Mandatory requirement to initiate a go-around when stabilized approach criteria are not met;
- Consistent non-punitive response to go-arounds;
- Absence of commercial pressure with regard to completing an approach;
- Consistent management response to non-compliance with stabilized approach criteria, to include safety debriefs, and retraining as appropriate;
- Implementation of safety technologies when technically and financially feasible.

## 6.6 Go-Around Below Minimums

Pilots are all familiar with the 'land/go-around' decision at decision altitude which is based upon the available visual references in relation to the published minima. They may be less familiar with the same decision in the final part of the approach below decision altitude, which may be based upon visual references but may also be driven by other factors such as runway incursion or perhaps less obviously a breach of the stabilized approach criteria. Below decision altitude:

- If a go-around is indicated the decision must not be delayed;
- Go-around can be initiated until the selection of the reverse thrust;
- Once a go-around has been initiated, it must be completed;
- Reversing a go-around decision is hazardous, especially when close to touch down.

In accordance with IATA IOSA Standard Manual 'FLT 3.11.60 The Operator shall have a policy that requires the flight crew to execute a missed approach or go-around if the aircraft is not stabilized in accordance with criteria established by the Operator. (GM)'



## 6.7 Training

Go-arounds carried out during training are most frequently conducted in the same conditions, i.e. in the landing configuration at Minimum Descent Altitude (MDA) or Decision Height (DH) and often with the help of the autopilot. Flight crews are rarely trained to execute a go-around at lower or higher altitudes where controlling the aircraft can be more difficult because of the differing sequence of actions to be performed.

When developing crew training programs, operators are encouraged to create unexpected go-around scenarios at intermediate altitudes with instructions that deviate from the published procedure; this addresses both go-around decision-making and execution. The training should also include go-around execution with all engines operating, including flight path deviations at a low altitude and go-arounds from long flares and bounced landings. Operators should also consider go-arounds at light weight with all engines operative in order to demonstrate the higher dynamics.

Training should address unstabilized approaches at the stabilization altitude but also cover destabilization after being stabilized, especially at low altitude (below MDA/DH).

Programs should reflect and support the operator's go-around policy.

### **RECOMMENDATION (15):**

- 6.15.1 Operators to implement appropriate education and training to enhance flight crew decision making and flying techniques to perform a safe go-around in any situation;
- 6.15.2 Operators should include lessons learned from past occurrences in go-around training;
- 6.15.3 Go-around training should include a range of operational scenarios, including go-arounds from positions other than DA/MDA and the designated stabilized approach altitude. Training should include go-around from higher and lower altitudes and rejected landings. Scenarios should involve realistic simulation of surprise, typical landing weights and full power go-arounds;
- 6.15.4 Manufacturers to ensure that go-around procedures presented in pilot training and manuals are applicable to go-arounds commenced at any stage on final approach up to and including landings rejected after touchdown.

# Chapter 7—Descent and Approach Profile Management

## 7.1 Descent and Approach Profile

Inadequate management of descent-and-approach profile may lead to:

- Loss of vertical situational awareness;
- Inadequate terrain separation; and/or,
- Rushed and unstabilized approaches.

An Airbus FOBN states that 70% of rushed and unstabilized approaches involve inadequate management of the descent-and-approach profiles and/or an incorrect management of energy level; this includes:

- Aircraft higher or lower than the desired vertical flight path; and/or,
- Aircraft faster or slower than the desired airspeed.

To ensure that flight crews meet the stabilized approach criteria at the required point, they must actively monitor and manage the profile from the very start of the descent.

In all cases there exists an optimal lateral and vertical profile for arrival and approach and this is generally reflected in the published procedures, although operators should develop mitigating measures for procedures that are not conducive to a stabilized approach.

Flight crew should start their descent preparation and approach briefings as soon as all pertinent data have been received – ten (10) minutes prior to top of descent is a good target for completion. Strict adherence to SOPs for Flight Management Systems (FMS) setup will assist in descent planning and execution, including confirmation of FMS navigation accuracy, crosscheck of all data entries, review of terrain and other approach hazards.

## 7.2 Aircraft Energy Management

The inadequate management of aircraft total energy (potential energy plus kinetic energy, plus an element of chemical energy from engine power/thrust) during descent, arrival and approach is a factor in unstabilized approaches. Either a deficit of energy (being low and/or slow) or an excess of energy (being high and/or fast) on approach may result in:

- Loss of control in flight (LOC-I);
- Controlled flight into terrain (CFIT);
- Landing short;
- Hard landing;
- Tail strike; and/or;
- Runway excursion

Large aircraft especially are designed to have highly efficient low drag aerodynamic characteristics and possess a great deal of energy in the cruise that must be dissipated appropriately throughout the descent, arrival, approach, landing and landing rollout. Aircraft must meet certain criteria on approach to be able to land safely, and controlling an aircraft during the descent and approach phases essentially becomes a task of energy management. In an unstable approach, the rapidly changing and abnormal condition of the aircraft may lead to a loss of control. Therefore, active energy monitoring and management is critical to reducing the risk of unstabilized approaches and abnormal landings.

Aircraft total energy is a function of airspeed and altitude but is affected by the following:

- Environmental factors;
- Vertical speed or flight path angle;
- Drag (caused by speed brakes, slats/flaps and landing gear); and,
- Thrust.

Flight crew must monitor aircraft energy and control these variables in order to:

- Maintain the appropriate energy condition for the flight phase; or
- Recover the aircraft from a low- or high-energy condition.

ATC can assist flight crew by issuing instructions with appropriate consideration to aircraft energy management, timely interception of the desired final approach path and the provision of useful information like track miles to touchdown.

# Chapter 8—Technology and Operational Enhancement

## 8.1 Operational Enhancement

Air traffic and airspace management procedures are evolving to minimize the risk of an unstabilized approach:

Many newer aircraft support Required Navigational Performance (RNP) operations, which enhance safety by standardizing approach procedures, providing lateral and vertical guidance to help in flying stabilized approaches, and in avoiding obstacles down to lower altitudes above the runway threshold.

Performance Based Navigation (PBN) can deliver safety benefits by providing flight crew with vertical as well as lateral guidance from top of descent to touchdown. PBN provides for fully managed approaches, lower approach minima, a well-defined descent profile and improved terrain separation.

## 8.2 Technology Enhancement

Honeywell's Enhanced Ground Proximity Warning System (EGPWS) helps reduce CFIT risks by constantly monitoring terrain and obstacles in proximity of the aircraft. Pilots can see nearby terrain and obstacles displayed on cockpit screens to enhance situational awareness but they are alerted only when there is a risk of reduced terrain separation.

EGPWS uses aircraft inputs such as position, attitude, air speed, glideslope, and an internal terrain database, to predict a potential conflict between the aircraft's flight path and terrain or an obstacle.

A software extension of the EGPWS, Honeywell's SmartLanding warns pilots aurally and visually when they are flying outside predefined criteria in relation to speed, flight path trajectory and touch down point during approach.

SmartLanding encourages compliance with stabilized approach criteria, such as:

- Aircraft should be stable at 1000 feet;
- Aircraft **MUST** be stable at 500 feet;
- Aircraft is properly configured to land;
- Aircraft is on the correct vertical path;
- Aircraft is at the correct speed.

Enhancements in development at Boeing include improved traffic displays (both airborne and on the ground), monitoring and alerting for unstable approaches and long landings, optimized runway exiting guidance, taxi guidance, and improved crew awareness of take-off and landing performance – particularly for short, wet or contaminated runways.

## 8.3 Monitoring of Realistic Aircraft Landing Performance

**Technology enhancements include:**

- 1) Airport Moving Map Display, is an enhancement of the Airport Mapping Database (AMDB) and a fully functional tool within the Electronic Flight Bag (EFB). Airport moving maps integrate published charts with real time aeronautical data based on aeronautical information publications, revision and distribution processes for aeronautical data products (FMS databases and Route Manuals), adding tailored information according to client requirements.

Some of the goals are to:

- Improve situational awareness,
- Reduces runway incursion/excursion risks,
- Prevent take-off from wrong runway, and
- Reduce pilot workload.

- 2) Boeing's Situational Awareness & Alerting For Excursion Reduction (SAAFER) strategy offers flight deck technology, procedural enhancements and training aids to improve pilot awareness and decision making during approach. It recognizes that whilst new aircraft can be delivered with the latest safety technologies installed, older types still in service may require modification, retrofit or more innovative solutions. The strategy aims to address all types over time. Lower cost 'quick fix' elements of the SAAFER initiative include improved approach and landing procedures, and training and awareness tools to educate pilots.
- 3) Airbus Runway Overrun Prevention System (ROPS) is an on-board cockpit technology that is designed to increase pilots' situational awareness during landing, in order to reduce exposure to runway excursion risk. It continuously monitors total aircraft energy and landing performance capability versus runway end point. It is integrated with the aircraft flight management and navigation systems and provides pilots with a real-time, constantly updated picture on the navigation display of where the aircraft will stop on the runway in wet or dry conditions.

The system combines data on weather, runway condition and topography, aircraft weight and configuration to alert pilots to unsafe situations, assisting them go-around decision-making and/or the timely application of retardation on touchdown.

Some of the goals are to:

- Improve situational awareness,
  - Reduce runway excursion risks,
  - Predict realistic operational landing distance in relation to runway end,
  - When necessary provide alerts,
  - Complement a stabilized approach policy.
- 4) Airbus Advanced ILS Simulation – Exact Landing Interference Simulation Environment (ELISE) is a software application for air navigation service providers and airport operators to effectively eliminate interference to an Instrument Landing System (ILS) signal, due to aircraft, vehicles, buildings and other objects in close proximity to the runway.

In addition to improved safety ELISE enables increased runway capacity and the optimization of airside land usage.

### **RECOMMENDATION (16):**

- 8.16.1 Operators to equip their aircraft with technological solutions to reduce unstabilized approaches and support go-around decision making.
- 8.16.2 Operators to use the latest EGPWS version, keep the terrain database current and provide GPS position data to the EGPWS;
- 8.16.3 Operators to implement vertically guided approaches that facilitate stabilized approaches;
- 8.16.4 Manufacturers should continue development of stable approach and energy management monitoring and alerting systems.

## Chapter 9—Conclusion

It is commonly accepted within the industry that flying a stabilized approach is important to the safe completion of a flight, and this should be the fundamental aim of all parties involved in the conduct and management of approaches. Other factors such as good flying skills, timely and appropriate decision making, adequate flight path management, adherence to SOPs, and effective monitoring by the flight crew contribute to achieving a stabilized approach.

Accident/incident data identifies unstabilized approaches as one of the most significant safety issues remaining to be addressed. Most operators have developed and implemented stabilized approach policies and defined the relevant criteria in their SOPs to help flight crews in go-around decision making but there is evidence of widespread non-compliance.

The decision to initiate a go-around whenever an approach cannot be stabilized, or cannot otherwise be completed safely, is critical to the reduction of approach and landing accident risk.

Training programs must address identified operational risks and not simply follow the regulatory minimum requirement. Specifically flight crew must be trained to fly an accurate go-around from all stages of the approach.

To manage the risk of unstabilized approaches, it is important to enhance operational procedures for both flight crew and ATC, to promote the adherence of SOPs, to inform and improve go-around decision making, encourage implementation of PBN, and to consider installing the proactive on-board technology that is currently available.

# Appendix 1: Technological Solutions to Unstabilized Approaches and Overrun – Survey and Analysis

## Introduction

In recent years an increasing range of technologies and aircraft systems have been developed to help address the persistent occurrence of unstabilized approaches and the consequent approach and landing accident risk. Aircraft technologies fall into three general categories: flight path trajectory management; aircraft energy management, and; aircraft configuration management. They are further sub-divided into those systems which provide alerts in the air and those which provide alerts on the ground after landing. There are fewer ground-based technologies available but in recognition of the contribution air traffic controllers can make to the achievement of a stabilized approach some ATC software enhancements have been developed, while engineered materials are proving successful in controlling runway overruns where they are installed. There may also be opportunities for improvements to the technology used to assess runway friction and surface condition.

As part of a wider project to review and update industry guidance material on reducing unstable approaches and approach and landing accident risk, IATA commissioned, in coordination with and support of the Safety Group and IFALPA Aircraft Design and Operation (ADO) committee, a survey of flight crew and airline management on the subject of unstabilized approach and runway overrun prevention technologies. Thirty questions were posed to determine the views and opinions of operational pilots and airline managers and more than 500 responses were received. In most questions respondents were asked to choose between 2 or 3 discrete answers but they were further invited to add narrative comments if they wished. The responses to each question have been analysed below and are displayed in both numerical and percentage terms, along with some broad analysis of the comments received. Readers should bear in mind that quoted narrative comments may have been amended for spelling or grammar and because for many of the questions comments were received from only a small percentage of the respondents, the content may not be statistically representative.

## Question 1

<b>I am an:</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Airline Captain</b>	48.6%	263
<b>Airline First Officer</b>	28.7%	155
<b>Training/ Safety/Operations Manager</b>	17.2%	93
<b>Other (please specify)</b>	5.5%	30
	<b>answered question</b>	<b>541</b>
	<b>skipped question</b>	<b>0</b>

Approximately half of all respondents were Captains and a little over a quarter First Officers. With 17% of responses coming from Managers the survey sample was predominantly drawn from line pilots.

## Question 2

I am based or primarily conduct operations in this region:		
Answer Options	Response Percent	Response Count
Africa (AFI)	6.8%	37
Asia Pacific (ASPAC)	19.6%	106
Commonwealth of Independence States (CIS)	2.0%	11
Europe (EUR)	32.2%	174
North America (NAM)	4.8%	26
North Asia (NASIA)	1.3%	7
Latin America and the Caribbean (LATAM/CAR)	21.4%	116
Middle East and North Africa (MENA)	11.8%	64
	<b>answered question</b>	<b>541</b>
	<b>skipped question</b>	<b>0</b>

At almost one third of the total, the greatest proportion of responses came from Europe (EUR), while Asia Pacific (ASPAC) and Latin America and the Caribbean (LATAM/CAR) each generated around a fifth of responses. The comparatively low response rates from Commonwealth of Independence States (CIS) and North Asia (NASIA) may reflect language difficulties with the survey, whereas the rather higher 11.8% response from Middle East and North Africa (MENA) may be indicative of the large number of native English speaking pilots working as expatriates in the region.

## Question 3

Are elements or precursors to unstable approaches monitored by Flight Data Management (FDM) in your organization?		
Answer Options	Response Percent	Response Count
Yes	6.8%	37
No	19.6%	106
Please comment		60
	<b>answered question</b>	<b>541</b>
	<b>skipped question</b>	<b>0</b>

The overwhelming majority of respondents answered 'Yes', indicating an almost universal adoption of FDM monitoring for unstable approach performance elements and/or precursors. Comments showed that at least some of those answering 'No' were operating smaller turbo-prop aircraft, apparently not equipped for FDM. Several other responses showed that FDM analysed 100% of approaches.



### Question 4

<b>Are pilots in your organization debriefed following an unstabilized approach?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	84.4%	453
<b>No</b>	15.6%	84
<b>Please comment</b>		88
	<b><i>answered question</i></b>	<b>537</b>
	<b><i>skipped question</i></b>	<b>4</b>

Once again the responses indicated that a significant majority of airlines debrief their pilots in some way following an unstable approach but the additional comments illustrated a marked variation in how and when the debrief was conducted and by whom. Some of the comments indicated that replay animations were used to debrief the more serious unstabilized approach events. A majority of comments stated that aggregated FDM data and analysis, including unstabilized approaches, were regularly shared through information bulletins, pilot safety meetings and other media, and the lessons learned were incorporated into training programs.

### Question 5

<b>There are a number of solutions including technology, training, procedures used for preventing Unstable Approaches. Bearing in mind that this survey is related to technology, state whether, in your opinion, use of technology is the best solution to prevent unstabilized approaches?</b>	
<b>Answer Options</b>	<b>Response Count</b>
	479
	<b><i>answered question</i></b>
	<b><i>skipped question</i></b>
	<b>62</b>

There was no discrete Yes/No option for this question but some comments recorded by the respondents consisted of a simple positive or negative, whereas most gave a qualified response. Overall the opinions numerically favoured technology as the best solution to unstabilized approaches but in most comments the view was that robust procedures, training and awareness were required to support the technologies because they alone could not prevent unstable approaches. This view is supported by the answers given to Question 28 below. The value of FDM in managing unstabilized approaches was specifically mentioned in a significant minority of responses, reflecting the answers to Question 4 above.

## Question 6

What stabilized approach technologies does your organization utilize?	
Answer Options	Response Count
	432
<i>answered question</i>	<b>432</b>
<i>skipped question</i>	<b>109</b>

This question sought narrative answers, which may explain the 20% who ‘skipped’ it. The answers received ranged from ‘none at all’ through FDM, simulator training, vertical flightpath guidance, RNP approaches, approach and landing aids, EGPWS, and RAAS to Smart Landing, HUD and ROPS, which indicates a less than consistent methodology to address unstable approaches throughout the industry. This needs to be considered in light of the fact that some of the newer and more sophisticated technologies are not available for smaller or older aircraft types.

## Question 7

Do you consider your organization to be fully aware of the availability and functionality of stabilized approach technologies?		
Answer Options	Response Percent	Response Count
Yes	78.1%	417
No	21.9%	117
Please comment		56
<i>answered question</i>		<b>534</b>
<i>skipped question</i>		<b>7</b>

Over one fifth of respondents did not consider their airline to be fully aware of the availability and functionality of stabilized approach technologies, which may go some way to explain the inconsistent implementation of technologies identified in Question 6. Comments included: ‘there might be technologies we are not aware of’; ‘yes they are’; ‘we use all currently available technologies’; and ‘no technology employed’.

### Question 8

<b>Are the current stabilized approach technologies available adequate for prevention of unstabilized approach?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	69.7%	364
<b>No</b>	30.3%	158
<b>Please comment</b>		102
<b><i>answered question</i></b>		<b>522</b>
<b><i>skipped question</i></b>		<b>19</b>

Almost a third of respondents felt that current technologies were not adequate for the prevention of unstabilized approaches but the comments indicated that this was more to do with the role of Human Factors in the outcomes rather than inadequacies of the technologies themselves. Many of the 102 comments stated that even the best technology could not overcome deficiencies in human performance but can offer an additional layer of defence. Other comments included: ‘technology alone is not sufficient, it should be combined with Pilot training’; ‘increase go-around mind set’; ‘a mandatory go-around policy for unstable approaches is important for runway excursion prevention’; ‘SOP discipline remains the final defence’.

### Question 9

<b>Are there already enough systems and warnings on the modern flight deck without adding more?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	59.7%	319
<b>No</b>	40.3%	215
<b>Please comment</b>		114
<b><i>answered question</i></b>		<b>534</b>
<b><i>skipped question</i></b>		<b>7</b>

Well over half of respondents answered ‘Yes’ – that there are already enough warnings on the flight deck. Several comments cautioned of the risk of ‘information overload’ or conflicting warnings while others suggested that existing warnings could be improved or refined. Many comments reiterated the view from Question 8 that ultimately the weaknesses in human performance had to be addressed in order to prevent unstable approaches. Other comments included: ‘systems can always be improved’; ‘warnings must be relevant’; ‘warnings do not address the root cause’; and ‘many older aircraft do not have these systems’.

## Question 10

<b>Should ICAO and consequently state regulators develop a required standard for stabilized approach technology functionality, as with TCAS/ACAS and TAWS/EGPWS?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	81.9%	435
<b>No</b>	18.1%	96
<b>Please comment</b>		75
	<b><i>answered question</i></b>	<b>531</b>
	<b><i>skipped question</i></b>	<b>10</b>

Most responses supported the view that the industry should have a regulatory standard for stabilized approach technologies and this opinion accords with the responses to Question 6, which indicated a wide variation in the adoption of technology. However, the comments highlighted the fact that different aircraft types and unusual airport characteristics would demand variations in the technologies and some cautioned that there were already enough regulations in the industry. Comments included: 'probably too late'; 'regulation has gone too far'; 'definitely'; and 'highly recommended'.

## Question 11

<b>Should aircraft manufacturers fit stabilized approach technology systems as standard equipage?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	88.6%	475
<b>No</b>	11.4%	61
<b>Please comment</b>		49
	<b><i>answered question</i></b>	<b>536</b>
	<b><i>skipped question</i></b>	<b>5</b>

The incorporation of stabilized approach technologies as standard when aircraft are manufactured was strongly supported by respondents but some comments qualified this by insisting that it should reflect an industry standard as in Question 10, and must be retro-fitted to existing aircraft to ensure operational consistency. Specific comments included: 'on new equipment only'; 'industry standard should be established'; and 'good way to start'.

### Question 12

In the approach phase are aural, visual or combined aural/visual alerts best?		
Answer Options	Response Percent	Response Count
Aural	8.6%	46
Visual	2.8%	15
Both (Aural & Visual)	88.6%	476
Please comment		42
	<b>answered question</b>	<b>537</b>
	<b>skipped question</b>	<b>4</b>

Respondents overwhelmingly supported the use of combined aural and visual alerts, as opposed to just one or the other. Some of the 42 additional comments indicated that these combined alerts improved situational awareness and reduced the risk of going unnoticed at times of high workload. Comments included: 'I prefer visual'; 'aural is best'; 'it's a double confirmation'; and 'both improves situational awareness'.

### Question 13

Should ground-based system or airborne unstabilized approach technologies include an automated 'go-around' instruction or function?		
Answer Options	Response Percent	Response Count
Yes	46.8%	250
No	53.2%	284
Please comment		128
	<b>answered question</b>	<b>534</b>
	<b>skipped question</b>	<b>7</b>

Respondents were almost equally divided on whether stabilized approach technologies should include an automated 'go-around' instruction or function. A variety of views were expressed in the many comments submitted, the most frequent being that pilots must be able to override any automated system to allow for malfunctions or unforeseen circumstances. Comments included: 'it will help when there is doubt'; 'no this should be left as is'; 'with capability of being overridden'; 'must be customizable'; and 'only an instruction not a function'.

## Question 14

Should the development of stabilized approach technologies focus on airborne or ground-based systems, such as Compliant Approach?		
Answer Options	Response Percent	Response Count
Airborne	32.5%	163
Ground Based	4.4%	22
Both	63.1%	316
Please comment		32
<b>answered question</b>		<b>501</b>
<b>skipped question</b>		<b>40</b>

Almost two thirds of respondents felt that both airborne and ground based stabilized approach technologies should be developed, while one third believed that the effort should focus on airborne systems alone. Only a very small proportion of responses favoured the development of just ground based technologies. There were few (32) narrative comments but they included: ‘don’t know’; ‘no opinion’; and ‘easier to implement on aircraft’.

## Question 15

Are you and/or your organization aware of the term ‘compliant approach’?		
Answer Options	Response Percent	Response Count
Yes	32.3%	169
No	67.7%	355
Please comment		41
<b>answered question</b>		<b>524</b>
<b>skipped question</b>		<b>17</b>

Only a third of respondents replied that they and/or their airline were aware of the concept of a ‘compliant approach’. It may be that this term, developed within the air traffic control community to describe certain characteristics of an approach which may help facilitate stabilization, has yet to be communicated widely to airlines and pilots. This view was supported by several of the comments, including: ‘first time I’ve heard of it’; ‘only after reading this’; and ‘will read up on it’.

**Note:**

*a ‘compliant’ approach includes a closing track to final approach within 45°, a level segment of at least 30 seconds before the glideslope, glideslope intercept from below and speeds which permit aircraft configuration.*

### Question 16

If you answered yes to the previous question (Q15), then, in your opinion, should all ANSPs adopt 'compliant approach' symbology for approach radar?		
Answer Options	Response Percent	Response Count
Yes	82.2%	175
No	17.8%	38
Please comment		39
	<b><i>answered question</i></b>	<b>213</b>
	<b><i>skipped question</i></b>	<b>328</b>

There may have been some confusion resulting from the wording of this question because rather more responded to it (213) than responded 'Yes' to Question 15 (169). However, the substantial majority of these responses supported the adoption of compliant approach symbology by ANSPs. There were only a few (39) narrative comments, many of which were 'N/A (not applicable)' or 'don't know'.

### Question 17

Is the use of Heads Up Display (HUD) beneficial or detrimental to stabilized approach management?		
Answer Options	Response Percent	Response Count
Beneficial	46.2%	247
Detrimental	1.7%	9
Don't Know	52.1%	279
Please comment		54
	<b><i>answered question</i></b>	<b>535</b>
	<b><i>skipped question</i></b>	<b>6</b>

Over half of respondents replied that they didn't know whether the use of HUD was beneficial or detrimental to stabilized approach management and this would reflect the fact that this technology is far from universally available at present. Of the remaining 47.9% who did express an opinion, almost all felt that the use of HUD was beneficial. Comments included: 'very, very beneficial'; 'better scanning'; 'especially in bad weather'; 'never used HUD'; and 'beneficial but will never come'.

## Question 17

Should primary flight displays include angle of attack/alpha indication as a standard flight parameter?		
Answer Options	Response Percent	Response Count
Yes	73.2%	386
No	26.8%	141
Please comment		52
	<b>answered question</b>	<b>527</b>
	<b>skipped question</b>	<b>14</b>

Almost three quarters of respondents felt that primary flight displays should include angle of attack/alpha as a standard flight parameter. Opinions expressed in the comments varied from very positive to quite negative and included: 'essential'; 'too much information'; 'some already do'; 'useful during a go-around'; and 'yes, yes, yes'.

## Question 19

Should primary flight displays include angle of attack/alpha indication as a standard flight parameter?		
Answer Options	Response Percent	Response Count
Yes	79.4%	419
No	20.6%	109
Please comment		44
	<b>answered question</b>	<b>528</b>
	<b>skipped question</b>	<b>13</b>

Supporting the response to Question 18, most respondents believed that technology such as angle of attack displays would alert pilots to undesirable conditions. Comments highlighted the need for appropriate training to ensure that all such technologies are properly understood and correctly used. Specific comments included: 'absolutely if properly trained'; 'with the proper training'; 'not unless they have been trained'; and 'no, pilots must fly basics'.



### Question 20

<b>Are current landing performance calculation technologies (electronic flight bags) adequate to cope with changing environmental and runway conditions?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	74.1%	378
<b>No</b>	25.9%	132
<b>Please comment</b>		82
	<b><i>answered question</i></b>	<b>510</b>
	<b><i>skipped question</i></b>	<b>31</b>

While the majority of respondents were satisfied with current landing performance calculation technologies, over a quarter were not. Many of the comments stated that EFBs had yet to be made available within their airline/fleet and others suggested that it was not always possible to update the calculation input data in response to rapidly changing conditions. Specific comments included: ‘excellent’; ‘I have yet to be convinced’; ‘complicated and not fully understood’; ‘absolutely not, braking action can change very quickly’; ‘not available in our organization’; and ‘don’t know’.

### Question 21

<b>If you answered yes to the previous question (Q20) above, do you then believe that there are technological solutions to runway overrun excursion?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	80.9%	352
<b>No</b>	19.1%	83
<b>Please comment</b>		64
	<b><i>answered question</i></b>	<b>435</b>
	<b><i>skipped question</i></b>	<b>106</b>

Once again there may have been a misunderstanding of the question because rather more answered it (435) than answered ‘Yes’ to Question 20 (378). However, most believed that there were further technological solutions to prevent runway overruns. The comments referred to ROPS, ROW, RAAS, braking action indication and other modern systems while several raised the need for accurate runway surface and condition information to help prevent overruns. Specific comments included: ‘only with effective input’; ‘can’t be a substitute for situational awareness’; ‘runway conditions not always accurate’; ‘largely yes’; and ‘together with policies and procedures’.

## Question 22

If you answered yes to the previous question (Q21), then do you believe that installation of such should be part of your airline certification process?

Answer Options	Response Percent	Response Count
Yes	73.0%	295
No	27.0%	109
Please comment		29
	<b>answered question</b>	<b>404</b>
	<b>skipped question</b>	<b>137</b>

Almost three quarters of respondents who believed that there were technological solutions to runway overruns in Question 21, felt also that the installation of these technologies should form part of airline certification (note that there were actually 42 more answers to this question than answered 'Yes' to Question 21). There were only 29 narrative comments but those who did not support the positive view raised concerns about cost and the fact that the technologies are not yet fully developed.

## Question 23

Is runway overrun excursion risk best managed in the air (go-around) or on the ground (use of retardation)?

Answer Options	Response Percent	Response Count
Air	50.7%	271
Ground	3.2%	17
Both	46.2%	247
Please comment		31
	<b>answered question</b>	<b>535</b>
	<b>skipped question</b>	<b>6</b>

Half of all respondents felt that runway overrun risk is best managed in the air by the initiation of a go-around. However, most of the remaining half believed that the risk was best managed both in the air and on the ground. Some of the 31 comments saw a go-around as a preventative measure whereas retardation was the last line of defence. These included: 'if in doubt go-around'; 'sooner the better'; 'better to avoid'; and 'mostly airborne'.

### Question 24

<b>Is the ground based technology for measuring runway friction adequate?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	31.1%	160
<b>No</b>	68.9%	354
<b>Please comment</b>		88
	<b><i>answered question</i></b>	<b>514</b>
	<b><i>skipped question</i></b>	<b>27</b>

More than two thirds of responses supported the view that current technology for measuring runway friction was inadequate. Comments raised concerns that the technology was not available in all geographical regions, and where it was it did not necessarily reflect the braking action experienced by an aircraft. One comment criticised the complexity of QRH landing distance calculations. Other comments included: ‘Europe and US but elsewhere in the world I’d disagree’; ‘almost never present’; ‘readings are terribly unreliable’; ‘depends on the country’; and ‘far from adequate’.

### Question 25

<b>If an overrun risk is detected by systems once on ground should maximum braking be applied automatically?</b>		
<b>Answer Options</b>	<b>Response Percent</b>	<b>Response Count</b>
<b>Yes</b>	65.8%	350
<b>No</b>	34.2%	182
<b>Please comment</b>		77
	<b><i>answered question</i></b>	<b>532</b>
	<b><i>skipped question</i></b>	<b>9</b>

This question sought opinion on fully automated braking to be applied in the event of a detected overrun risk and two thirds of respondents supported it. Several comments suggested that an alert would be more appropriate, allowing pilots more control over the braking decision. Comments included: ‘would prefer an alert’; ‘there is little risk in maximum braking’; ‘must be cancelled by a go-around’; ‘trust the pilots’ judgement’; and ‘need to do a risk assessment’.

## Question 26

Is there any possible technological solution to reduce runway veer-off excursion risk?		
Answer Options	Response Percent	Response Count
Yes	56.6%	262
No	43.4%	201
Please comment		107
	<b>answered question</b>	<b>463</b>
	<b>skipped question</b>	<b>78</b>

A little over half of respondents felt that there were technological solutions that could prevent runway veer-off excursions. Many of the comments suggested roll-out guidance similar to autoland whilst others suggested automated differential braking but most comments simply stated 'don't know'. Some of the comments suggested that the respondents had not understood the meaning of a 'veer-off' excursion as opposed to an overrun, including: 'EMAS'; 'RESA/lights'; and '60-40 knots auto-callout'. This question might better be directed to aircraft manufacturers.

## Question 27

In your opinion, do you believe that there should be one global standard defined for stabilized approaches?		
Answer Options	Response Percent	Response Count
Yes	83.8%	446
No	16.2%	86
Please comment		52
	<b>answered question</b>	<b>532</b>
	<b>skipped question</b>	<b>9</b>

This question showed a high proportion of support for a single global standard for stabilized approaches. Several comments cautioned that there would always be a need for some flexibility to allow for differing aircraft types, approach characteristics and environmental conditions. Respondents' comments included: 'why not?'; 'the guidelines are very clear'; 'limits should be the same for all operators'; 'must consider different approach profiles'; 'some airports cannot be the same as others'; and 'there would need to be minor variations'.

### Question 28

In your opinion, do you believe the solution to solve the problem of unstabilized approaches is:		
Answer Options	Response Percent	Response Count
Technology	50.7%	271
Training and Awareness	3.2%	17
Both	46.2%	247
Please support your answer by providing additional comments		82
<i>answered question</i>		<b>541</b>
<i>skipped question</i>		<b>0</b>

The substantial majority of responses supported the view that the solution to unstabilized approaches required a combination of technology, training and education. Virtually none felt that technology alone would offer the solution, whereas 13.5% believed that the solution lay solely in training and awareness. Many comments expressed an opinion that without good training and awareness, technology could not succeed, including: ‘training and risk awareness are the main thing’; ‘new toys without proper training have little value’; ‘training and awareness are best, technology is a support’; and ‘technology is useless without proper training’.

### Question 29

In your opinion, do you believe the solution to solve the problem of runway overrun excursion is:		
Answer Options	Response Percent	Response Count
Technology	1.7%	9
Training and Awareness	13.5%	73
Both	84.8%	459
Please support your answer by providing additional comments		56
<i>answered question</i>		<b>541</b>
<i>skipped question</i>		<b>0</b>

Similarly to Question 28 the majority of respondents felt that the solution to runway overruns required a combination of technology, training and awareness and not technology alone. Many comments emphasised the vital importance of training while accepting the value of technology. Several comments were ‘same as above’, referring to the response to Question 28, while others included: ‘both have to work in unison for best results’; ‘understand that technology can fail’; and ‘technology alone is not enough’.

## Question 30

In your opinion, do you believe over-reliance on technology introduces a whole new field of possible failure modes?		
Answer Options	Response Percent	Response Count
Yes	84.8%	459
No	15.2%	82
Please support your answer by providing additional comments		114
<i>answered question</i>		<b>541</b>
<i>skipped question</i>		<b>0</b>

Most respondents expressed the opinion that over-reliance on technology introduces new potential failure modes in flight operations. Comments raised concerns about the role of Human Factors and the need for good training to support the use of technology, including: 'training should come first'; 'technology breeds complacency'; 'technology alone is not the answer'; 'fly the airplane first'; and 'technology should be the last barrier'.

### Survey Summary

In summary the general body of pilot opinion, as divined by this survey, appears to support the view that technologies which facilitate stable approaches and alert pilots to unstable conditions are useful and helpful but without robust and effective policies, procedures and especially training surrounding the conduct of the approach and landing phases, no technology will provide the entire solution. A recurring theme in many of the responses reflected an opinion that if pilots flew approaches in accordance with SOPs and adhered to company policy on go-arounds, most unstable approaches and runway excursions could be avoided.

Many respondents expressed concern that there was already enough technology on the average flight deck, potentially encouraging an unhealthy reliance of automation, and that the numerous alerts could lead to confusion or sensory overload. There was also a level of opinion that the available technologies had not yet reached maturity and there was further development required.

The survey indicated that a majority of airlines take sufficient interest in unstable approaches to use FDM to monitor for them but the response to detections was fragmented and varied. Some airlines always debriefed the pilots involved, whereas others only did so in the most extreme cases and some did not debrief at all. Even more varied was the type of stabilized approach technologies that airlines had installed on their aircraft, ranging from none at all to the very latest and most sophisticated systems, although this must be considered in light of the fact that some technologies simply are not available for certain aircraft types. As many of the systems are not mandatory, installation may also be influenced by cost.

With regard to standardisation there was a strong view that the industry should agree common characteristics of a stable approach (within the constraints of aircraft and approach design), that regulators should set a standard for required stabilized approach technologies (as is the case for TCAS and TAWS) and that manufacturers should install these technologies as standard equipment. The respondents appeared to prefer a greater level of standardisation in all respects.

A majority of respondents favoured the combined use of aircraft and ground based technologies to reduce unstable approaches, although a significant number supported aircraft systems alone and it was apparent that knowledge of certain ATC strategies (compliant approaches) was limited amongst pilots and their airlines. In terms of runway excursions, opinion was evenly divided as to whether the risk was best managed in the air by initiation of a go-around or on the ground with appropriate retardation.

Responses showed a very low level of confidence in the accuracy of runway friction reporting but conversely most believed that modern EFBs calculate landing performance satisfactorily. There was less than 50% support for an automated go-around function or instruction when an unstable approach was detected but the automatic application of maximum braking if an overrun was predicted received rather more backing.

