

Unstable Approaches



Risk Mitigation Policies, Procedures and Best Practices 3rd Edition



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Senior Vice President
Safety and Flight Operations
International Air Transport Association
800 Place Victoria
P.O. Box 113
Montreal, Quebec
CANADA H4Z 1M1

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Acronyms

ACTG	Accident Classification Technical Group
ALAR	Approach and Landing Accident Reduction
AMDB	Airport Mapping Database
ANSP	Air Navigation Service Provider
APV	Approach Procedures with Vertical Guidance
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATIS	Automatic Terminal Information Service
ATSU	Air Traffic Services Unit
CDFA	Continuous Descent Final Approach
CFIT	Controlled Flight into Terrain
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DA	Decision Altitude
DH	Decision Height
EAFDM	European Authorities coordination group on Flight Data Monitoring
EBT	Evidence Based Training
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
FSTD	Flight Simulation Training Device
GADM	Global Aviation Data Management
GPWS	Ground Proximity Warning System



I-ASC	IATA Aviation Safety Culture
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
MSA	Minimum Safety Altitude
MTOW	Maximum Take Off Weight
NCA	Non-Compliant Approach
NOTAM	Notice to Airmen
NPA	Non - Precision Approach
OEM	Original Equipment Manufacturer
PANS ATM	Procedures for Air Navigation Services — Air Traffic Management
PANS OPS	Procedures for Air Navigation Services — Aircraft Operations
PBN	Performance Based Navigation
PF	Pilot Flying
PIREPs	Pilot Reports
PM	Pilot Monitoring
RNP	Required Navigation Performance
ROPS	Runway Overrun Prevention System
RSAT	Runway Situation Awareness Tool
RVR	Runway Visual Range
SMS	Safety Management System
SOP	Standard Operating Procedure
STAR	Standard Terminal Arrival Route
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TEM	Threat and Error Management
TOD	Top-of-Descent
VFR	Visual Flight Rules
VMC	Visual Metrological Conditions
VNAV	Vertical Navigation

Abstract

Every day, there are over 100,000 landings occurring on runways at airports worldwide. Despite improvements in safety of operations, there remains a risk of an approach and landing accident. A stable approach means that the aircraft will arrive at the runway in the correct configuration, at the correct speed and power setting and on the correct lateral and vertical path. An unstable approach is where one or more of these parameters is incorrect, and as a result carries an increased risk of an approach and landing incident and/or accident. In addition, an approach which is stable for the final 1,000 feet of the approach affords the pilots the time to fulfil their flying and monitoring duties, maintain situational awareness and preserve mental capacity for any unexpected factors that may occur, during this critical phase of flight. Continuous improvement to stable approach policy compliance, including discontinuation of an unstable approach, will reduce the risk of an accident. The IATA Accident Classification Technical Group (ACTG), which reviews all accidents recorded in the Global Aviation Data Management (GADM) Accident Database, categorizes accidents and assigns contributing factors. The ACTG found that an unstable approach was a contributing factor in 16% of approach and landing accidents over the last five years (2012-2016), giving rise to the publication of this 3rd edition of Unstable Approaches: Risk Mitigation Policies, Procedures and Best Practices.

A stable 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 (the stabilization altitude or height), and maintained within that range of values until touchdown. The parameters include attitude, flight path trajectory, airspeed, rate of descent, thrust and configuration. A stable approach ensures that the aircraft commences the landing flare at the optimum speed, and attitude for the landing.

The industry- manufacturers, regulators, professional associations, air navigation service providers (ANSPs), operators, air traffic controllers and pilots – share an unequivocal position that the only acceptable approach is a stable one. Professional pilots pride in achieving it on every occasion. Recognized industry practice is to recommend that a failure by the pilot to achieve a stabilized approach must result in a go-around, which is an essential safety maneuver for all flight crew. In this case the pilot executing the go-around is considered to have demonstrated good situational awareness, decision making and professionalism.

An important part of a stable approach training program is that pilots have the ability to recognize an unstable approach, when it occurs, and initiate a go-around. Pilots must be trained to go-around from any point on the approach where the approach may need to be discontinued because it is unstable, or has become unstable. The training must include the difference between a go-around at weather minima, which usually requires immediate initiation and one due to an unstable approach. Pilots must also be trained to understand the risks of an unstable approach, because an unstable approach can be completed successfully, which may reinforce bad practice. Understanding the rationale for a stable approach is a better path to 100% compliance.



The most effective unstable approach countermeasures are the Threat and Error Management (TEM) and Crew Resource Management (CRM) skills. Behaviors, such as leadership, monitoring, cross checking, communication and sharing mental models, if used correctly, can all prevent an Undesired Aircraft State from developing into a more serious End State.

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Section 1—Guidance Overview

1.1 Manual Objective

The purpose of this document is to reiterate the importance of a stable approach and encourage pilots to make the proper go-around decision if the approach exhibits any element of an unstable approach. Also, it enhances the overall awareness of the contributing factors and outcomes of unstable approaches, together with some proven prevention strategies. This manual provides 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 References

The material in this manual is based on:

- Airbus Flight Operations Briefing Notes (FOBN);
- DGAC France. c. 2005. Unstabilised Approaches. Directorate General of Civil Aviation, Department of Safety Management;
- 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 ALAR Briefing Note 7.1;
- 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);
- ICAO Doc. 4444 Procedures for Air Navigation Services – Air Traffic Management (PANS ATM);
- ICAO Doc. 9868 PANS - Training;
- ICAO Doc 9863 - Human Factor Training Manual;
- CANSO Standard of Excellence in Safety Management Systems
- IATA Operational Safety Audit (IOSA) Standards Manual 11th Edition;
- IATA 53rd Safety Report - 2016;
- IATA Guidance Material for Improving Flight Crew Monitoring;
- Go-around Safety Forum, 18 June 2013, Brussels: Findings and Conclusions;
- Lussier, Marc et al. 2016. Eye on Safety: Unstabilized Approach. Nav Canada: Montreal, Canada;

- European Authorities coordination group on Flight Data Monitoring (EAFDM): developing standardized FDM-based indicators;
- SKYbrary: 2014, Stabilized Approach Awareness Toolkit for ATC. CANSO, Eurocontrol, FSF;
- CANSO Unstable Approaches: Air Traffic Control Considerations.

1.3 Data Sources

The data supporting this manual are derived primarily from the IATA Global Aviation Data Management (GADM) Accident Database, and the IATA Safety Report, 53rd edition. The data period is the five (5) years from 2012 to 2016.

1.4 Definitions

1.4.1 Stable Approach

The Flight Safety Foundation (FSF) Approach and Landing Accident Reduction (ALAR) briefing note 7.1, states that all flights must be stabilized by 1,000 feet above airport elevation in Instrument Metrological Conditions (IMC) and 500 feet above airport elevation in Visual Metrological Conditions (VMC). An approach should be considered stable when all of the following stabilized approach elements are met:

- The aircraft is on the correct flight path;
- Only small changes in heading/pitch are necessary to maintain the correct flight path;
- The airspeed is not more than $V_{REF} + 20$ kts indicated speed and not less than V_{REF} ;
- The aircraft is in the correct landing configuration;
- Sink rate is no greater than 1,000 feet/minute; if an approach requires a sink rate greater than 1,000 feet/minute a special briefing should be conducted;
- Power setting is appropriate for the aircraft configuration and is not below the minimum power for the approach as defined by the aircraft operating manual;
- All briefings and checklists have been conducted;
- Specific types of approach are stable if they also fulfil the following:
 - ILS approaches must be flown within one dot of the glide-slope and localizer;
 - a Category II or III approach must be flown within the expanded localizer band;

Unique approach conditions or abnormal situations necessitating a deviation from the elements of a stable approach require a special briefing.

1.4.2 Accident

IATA defines an accident as an event where ALL of the following criteria are satisfied:

- Person(s) have boarded the aircraft with the intention of flight (either flight crew or passengers).
- The intention of the flight is limited to normal commercial aviation activities, specifically scheduled/charter passenger or cargo service. Executive jet operations, training, maintenance/test flights are all excluded.
- The aircraft is turbine powered and has a certificated Maximum Take-Off Weight (MTOW) of at least 5,700KG (12,540 lbs.).
- The aircraft has sustained major structural damage which adversely affects the structural strength, performance or flight characteristics of the aircraft and would normally require major repair or replacement of the affected component, exceeding \$1 million USD or 10% of the aircraft's hull reserve value, whichever is lower, or the aircraft has been declared a hull loss.

Note: The accident data used in this document meets the IATA accident criteria.

1.4.3 End State

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

Note: An unstable approach is recoverable and is therefore an Undesired Aircraft State, whereas a runway excursion is not recoverable and is an End State.

1.4.4 Failure to Go-Around after Destabilization during Approach

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

1.4.5 Fatality

A passenger or crewmember who is killed or later dies of their injuries resulting from an operational accident. Injured persons who die more than 30 days after the accident are excluded.

1.4.6 Flight Crew

The term flight crew used throughout this document is interchangeable with **pilot(s)**.

1.4.7 Phase of Flight Definitions

The definitions of the various phases of flight were developed and applied by IATA. These definitions were extracted from the 53rd IATA Safety report.

Approach: Begins when the crew initiates a change in aircraft configuration and /or speed 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 a go-around.

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").

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 the "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 speed 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.

It is also worth noting the definitions considered by the collaborators, such as, the "Approach phase" from an Air Traffic Control Officer (ATCO) perspective, is considered as the transition from the last en-route waypoint in the en-route phase until landing is performed or a missed approach is executed. It includes descent and speed clearances, adherence to a Standard Terminal Arrival Route (STAR), (if applicable) and vectoring to final approach course.

1.4.8 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**.

It is worth noting also the International Civil Aviation Organization (ICAO) definition of the Undesired Aircraft State is “flight crew-induced aircraft position or speed deviations, misapplication of flight controls, or incorrect systems configuration, associated with a reduction in margins of safety”. Undesired aircraft states that result from ineffective threat and/or error management may lead to compromising situations and reduce margins of safety in flight operations.

1.4.9 Unstable Approach

The ACTG 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 2016 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 shows that a ‘destabilization’ just prior to touchdown has contributed to accidents.

1.4.10 Approach Procedures with Vertical Guidance (APV)

ICAO defines an APV as “An instrument approach procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations”.

1.5 Collaborative Approach

Consistent stable approaches are more likely when effective ‘collaboration’, ‘cooperation’ and ‘communication’ occur between all participants, including the air navigation service providers (ANSPs), ATCOs and of course the pilots, allowing the aircraft to accurately follow the published lateral and vertical approach paths in steady, stable flight from a reasonable altitude above touchdown. Additionally, operators, manufacturers, state regulators, and training organizations also play a vital role in fostering a stable approach culture.

Section 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 runway threshold where the energy management options are more limited. Both ATCOs and pilots are experiencing very short decision time, high workload and few options to manoeuvre in this flight phase. The aim of the approach is to deliver the aircraft to the point in space above the runway from which a consistent flare maneuver will result in touchdown at the right speed and attitude, and within the touchdown zone.

2.2 Unstable Approach 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; 61% of the total accidents recorded from 2012-2016 occurred during the approach and landing phase of flight. Unstable approaches were identified as a factor in 16% 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 unstable approach, together with a subsequent failure to initiate a go-around.

The aviation community has for some time recognized that establishing and maintaining a stable approach is a major contributory factor in the safe conclusion of any flight. Not only, must the flight crew complete all briefings and checklists, but also the aircraft must have the correct configuration, attitude, airspeed, power/thrust setting, descent rate, and be at the right position over the runway to provide the pilots with the best opportunity for a safe landing. Each of these stabilization criteria must be within a specified range of values throughout the final approach in order for the approach to be considered stable. Individual operators must define the criteria they require for a stable approach based upon their aircraft types, operational requirements, meteorological conditions and acceptable margins of safety. They must then promulgate a

policy of strict compliance with the stable 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, through collaboration and communication between all industry stakeholders, as described above, is required for network-wide implementation of effective stable approach polices and identified best practices.

The International Air Transport Association (IATA), in collaboration with the International Federation of Air Line Pilots' Associations (IFALPA), the International Federation of Air Traffic Controllers' Associations (IFATCA), and Civil Air Navigation Services Organisation (CANSO), addresses recommendations and guidance to help avoid unstable approaches and thereby assist in the reduction of approach-and-landing accidents.

2.3 Data Analysis

Of the 375 commercial aircraft accidents recorded in IATA GADM Accident Database during the five year period from 2012 to 2016, failure to go-around was a factor in 10% of accidents. 230 accidents or 61% occurred during the approach-and-landing phase, of which 19 of resulted in 376 fatalities.

The distribution of approach and landing categories is illustrated in figure 1.

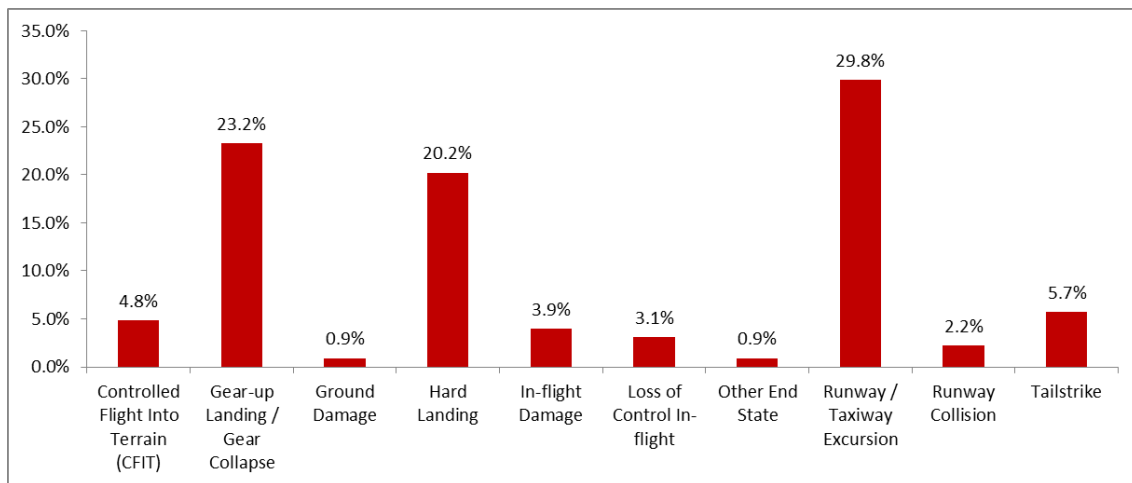


Figure 1. Distribution of Approach and Landing Accident Categories

Note: Two of the approach and landing accidents could not be assigned an End State due to insufficient data.

All stakeholders including operators, flight crew, regulators, ATCOs, and ANSPs should consider the recommendations in this document. Stable approaches significantly increase the chances of a safe landing.

Ensuring a stable approach is the first line of defense available to flight crew against accidents in the critical flight phases of approach and landing. After this first line of defense is crossed, the ability to perform a go around is a crucial factor in preventing an unwanted outcome during or after the approach.

The ACTG, assigns contributing factors to accidents. Some of the factors cited in those accidents are listed in Figure 2.

Note: Thirty-nine (17%) of approach and landing accidents could not be assigned causal factors due to insufficient data. The remainder of the data was classified and the most frequent contributing factors are shown in Figure 2.

Latent Conditions (deficiencies in...)		Flight Crew Errors (related to...)	
Regulatory Oversight	34%	Manual Handling / Flight Controls	42%
Safety Management	28%	SOP Adherence / SOP Cross-verification	23%
Flight Operations	16%	Failure to GOA after Destabilized Approach	15%
Flight Ops: Training Systems	12%	Intentional	16%
Maintenance Ops: SOPs & Checking	8%	Unintentional	5%
Environmental Threats		Undesired Aircraft States	
Meteorology	38%	Long / Floated / Bounced / Firm / Off-Center / Crabbed Land	36%
Wind/Windshear/Gusty Wind	23%	Vertical / Lateral / Speed Deviation	24%
Airport Facilities	18%	Unstable Approach	16%
Poor visibility / IMC	13%	Continued Landing after Unstable Approach	14%
Nav Aids	12%	Unnecessary Weather Penetration	8%
Airline Threats		Countermeasures	
Aircraft Malfunction	24%	Overall Crew Performance	24%
Gear / Tire	20%	Monitor / Cross-check	15%
Maintenance Events	11%	Contingency Management	10%
Operational Pressure	3%	Leadership	5%
Dispatch / Paperwork	2%	Captain should show leadership	4%

Figure 2. Approach and Landing Top Contributing Factors

There was an average of six accidents a year, which were preceded by an unstable approach. Figure 3 illustrates the number of events, with an unstable approach as a factor, in each of the five years under review.

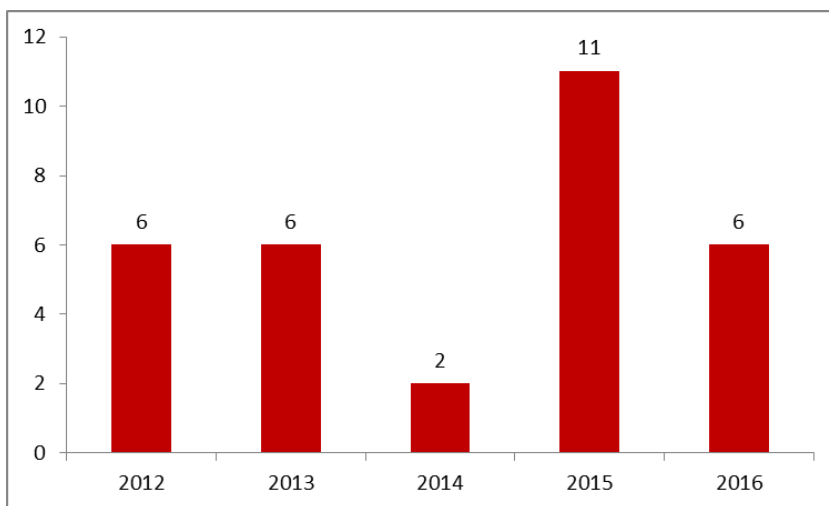


Figure 3. Frequency of approach and landing accidents with unstable approaches as a factor

Absolute numbers of accidents are not necessarily a good indication of safety performance and are of limited comparative value unless they are normalized by the number of sectors flown per year to create an accident rate. Figure 4 shows the occurrence rates of aircraft flying unstable approaches per million sectors, per year.

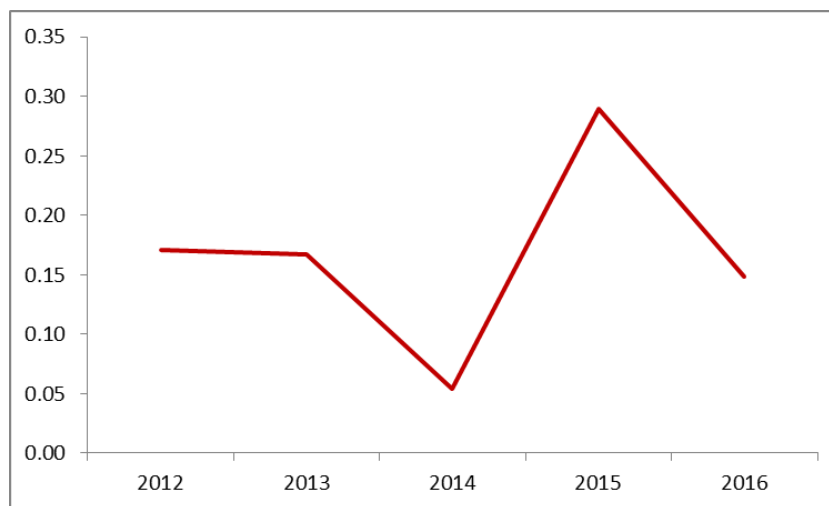


Figure 4. Occurrence Rates of Aircraft Flying Unstable Approaches per Million Sectors

Note: Accidents included meet the IATA definition of an accident. See 'Definitions'. The percentages quoted in this section represent the proportion of accidents for which there was sufficient data available for the ACTG to make a classification.

Many studies have been conducted with respect to unstable approaches and approach-and-landing accidents using different data sources, definitions and analytical logic. However, the findings of these studies consistently conclude that unstable approaches have been and continue to be a significant factor in commercial aircraft accidents. Without improvements in the rate of stable approaches flown and stable approach policy compliance, unstable approaches that continue to a landing will continue to occur, with the attendant risk of an approach-and-landing accident.

In the terminology of Threat & Error management (TEM) an unstable approach is an Undesired Aircraft State (see Definitions) that if not recovered can lead to an unrecoverable outcome or 'End State' (see Definitions). Following standard procedures and best practices, that allow the monitoring of stable approach criteria and parameter deviations, afford the best opportunity to manage and recover from an undesired aircraft state. Undesired aircraft state management is an important component of the TEM model. Undesired aircraft state management largely represents the last opportunity to avoid an unsafe outcome and thus maintain safety margins in flight operations. Eleven percent of the induced undesired aircraft state from 2012 to 2016 were found to have an identified factor of an unstable approach. The analysis revealed that unstable approaches was cited as one of the contributing factors in:

- Hard Landing: 50%
- Runway / Taxiway Excursion: 27%
- Tailstrike: 9%
- Undershoot: 6%
- Loss of Control In-flight (LOC-I): 3%
- In-flight Damage: 3%
- Controlled Flight Into Terrain (CFIT): 3%

Analysis of the 11% of mismanaged undesired aircraft states that involved unstable approaches showed that: 74% of those accidents were attributed to incorrect manual handling/flight controls; 47% to non-compliance with Standard Operating procedures (SOPs) and 53% to a failure to go-around after a destabilized approach. Such undesired aircraft states can be effectively recovered by the pilots, restoring margins of safety; alternatively, incorrect response(s) can induce an additional error, breaching a line of defense and increasing the risk of an incident or accident.

Section 3—Stable Approach (Concept and Global Criteria)

3.1 Defining the Elements of a Stable Approach

For stable approaches to become the industry standard, it is essential to define a common set of parameters that constitute a stable approach. This will ensure that all stakeholders are 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 stable approach concept has not emerged from a single source, with a number of different methodologies and criteria being developed. However, these criteria share many similarities.

Because the aim is to achieve and maintain constant flight path 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 should be the same flight characteristics required to be met at an earlier point during the approach, and maintained thereafter. The desired 'pre-flare' characteristics are defined by the aircraft manufacturer and consist of:

- Target approach speed;
- Rate of descent commensurate with the approach angle and approach speed;
- Landing configuration of gear and slats/flap extended;
- Stable aircraft attitude in all three axes;
- Engine thrust stable usually 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 defined stable flight characteristics make it easier for pilots to recognize any deviations, decrease the cockpit workload by reducing the variables to external factors 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 stable 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.

3.2 Stabilization Altitude/Height

Aircraft OEM Flight Operations Manuals 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 stable 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.

If the aircraft is not stable on the approach path in landing configuration, at the minimum stabilization height, a go-around must be executed. The timely decision to initiate a go-around can be critical to the maneuver's outcome. It is worth noting that the go-around maneuver is not hazardous in itself, it becomes hazardous when executed improperly. To reiterate, not going around has been identified as a contributing factor in accident analysis.

If however, the pilot chooses to continue with an unstable approach, he or she is increasing the risk of landing too long, too fast, out of alignment with the runway centerline, or otherwise being unprepared for landing. The ACTG, using data from GADM Accident Database, determined that 14% (26) of approach-and-landing accidents occurred where pilots mismanaged the risk and continued a landing from an unstable approach. Fifty percent of these resulted in long, floated, bounced, firm, off-center or crabbed landing and 46% resulted in a vertical, lateral or speed deviation. Fifty-eight percent were attributed to non-compliance with SOPs, and 77% to manual handling or flight control. Managing the undesired aircraft state, using established recovery techniques, would have prevented these accidents.

3.3 Special Airports

There are unique situations around the world that make transitioning to a stable approach difficult because of unusual circumstances. For example, mountainous terrain surrounding airports. Approaches developed to accommodate terrain may require airspeeds in excess of those airspeeds which are normally flown in the terminal area. Airports with an exceptionally steep glide slope or, ATC clearances that require an aircraft to remain at altitude to a point where intercepting the normal glide path is difficult to achieve, will also prove challenging for the achievement of stable approach criteria. Normally those special airport approaches imply additional aerodrome qualification which is gained through a flight simulation training device (FSTD) training session and/or familiarization flight under the supervision of a suitably qualified flight crew.

Many pilots learn to manage these unusual circumstances. However, it is a more robust mitigation if the operator identifies such airports, through their Safety Management System (SMS), and provides comprehensive briefing material, pilot experience limitations and where necessary airport specific training. This reduces the burden on the operating pilots who may in any case need to adapt their decision to make a specific approach under any unique situation which occurs on the day. A thorough briefing to include but not limited to mountainous or terrain awareness (aircraft position, altitude, applicable Minimum Safety Altitude (MSA)), as well as descent profile management, terrain features, and energy management should be performed.

Furthermore, a two-way communication or a discussion between operators and ANSPs / ATCOs should also be sought in order to try to eliminate as much as possible constraints leading to unstable approaches in those unique environments. ATCOs and operators should discuss and seek a solution that would benefit both parties and help eliminate the risk of unstable approaches.

It is worth noting that at some airports a delayed go-around may not be possible due to its geographical landscape. In such cases, an early decision and early execution of a go-around may be required, together with good proficiency both in flying and judging aircraft performance. In some circumstances, if practical, and traffic permitting, it may be helpful to overfly at a safe altitude before making the approach. If the aircraft is not positioned for a safe landing, a timely decision to go-around should be initiated. Pressing on or failing to go-around at the right time is a factor of attitude. One mind set is to consider every approach, an approach from which a landing MAY be made, but from which a go-around is a REAL possibility. Accidents have occurred where a very late go-around has been attempted.

3.4 Visual Meteorological Condition (VMC)/Instrument Meteorological Condition (IMC) Operations

Some of the accident figures show that, whilst conducting an approach, inadvertently flying from Visual Meteorological Condition (VMC) into Instrument Meteorological Condition (IMC) conditions has resulted in an accident. Attempting to fly visual flight rules (VFR), then encountering IMC conditions is a threat to aviation safety. Note: The terms VMC and VFR are often used interchangeably, although VMC refers to the actual weather conditions and VFR refers to the flight rules surrounding those conditions.

Variations in required stabilization altitudes between operators, between approach types (precision/non-precision) and between meteorological conditions (IMC/VMC) could be a cause for potential confusion. Some applications of the stable approach principle do not distinguish between VMC and IMC approaches; using the same stabilization altitude. This makes it easier to track compliance using Flight Data Monitoring (FDM), whereas different altitudes require the FDM analyst to know which type of approach was being conducted and in what conditions.

Many airlines implemented a single set of criteria for a stable approach, a number of years ago. Feedback from the pilot group has been overwhelmingly positive. The alignment of a single harmonized approach criteria, and the use of one gate per approach type for example, 1,000 feet for an instrument approach, requires certain discipline and should not be converted to 500 feet if the weather conditions are VMC. Notwithstanding, the operator may specify 500 feet or another value for a visual circuit or a circling approach.

3.5 Callouts

In order to achieve and maintain a stable approach, 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 the SOPs. If the deviation has been observed

first by the pilot flying (PF), his or her callout advises the pilot not flying that he/she is aware and attempting to correct; if observed by the pilot not flying, his or her callout will bring the pilot flying's attention to the deviation. Identification of a potential unstable approach before reaching the specified gate must also be made by either pilot. Each callout requires a corresponding acknowledgement from the other pilot, which can also assist in the early detection of pilot incapacitation. The timely standard and the routine use of callouts in this manner improves communication and enhances situational awareness throughout the approach. It also encourages effective flight management and rapid error correction.

It should be worth noting that as workload increases an individual's capacity is reduced with hearing being one of the senses first affected. This may reduce the effectiveness of the callout during situations of high workload in the cockpit.

It is recommended that callouts should not be limited to a single occasion at the initial deviation, but should continue at reasonable intervals, until the deviation is corrected. The repeated callouts, ensure continuing awareness until the undesirable condition has been corrected much like the aural warning logic of a Ground Proximity Warning System (GPWS) or Traffic Collision Avoidance System (TCAS), which continues until the hazardous condition is no longer present. It is also recommended that either pilot makes a callout in anticipation of a potential unstable approach; if a callout is made pointing out the likelihood of an unstable approach, pilots will have sufficient time to correct the flight trajectory before the stable approach gate. Callouts should also be made to let the other pilot know they are back within the limits of a stable approach. As humans, we tend to be weak at calling out items, except when they are out of compliance. Callouts should also be made on the approach at specific gates to ensure both pilots are aware of their current profile.

The IATA Operational Safety Audit (IOSA) Standards Manual 11th Edition contains Standards FLT 3.11.21 which reads:

"The Operator shall have a policy and procedures that define and specify the requirements for standardized verbal callouts (standard callouts) by the flight crew during each phase of flight."

Furthermore, the adoption of calls of "STABLE", "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 "STABLE" callout might be required at either 1,000 feet, 500 feet above touchdown, or Decision Height (DH), the "GO-AROUND" command can and must be made 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. For example, when passing the stabilization height, either pilot makes the compliance check and calls out the result (for instance "stable" / "not-stable"); the other pilot has only the choice between two possibilities; either continue the approach or discontinue it, using the appropriate call out i.e. "continue" or "go-around". In case the approach is not stable, the pilot must acknowledge the call and initiate a corrective action such as the execution of a go-around maneuver.

The idea that either pilot can call for a go-around is an essential part of CRM, which is the core concept of TEM, and in fact should be an important element in the company's TEM training.

Other options to assist pilots in their decision making process would be the installation of a monitoring system to provide automatic callouts if the stable 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: The Honeywell SmartLanding System and the Airbus Runway Overrun Prevention System (ROPS).

3.6 Standard Operating Procedures (SOPs)

An approach is stable only when all of the stabilization criteria specified by the operator are met. It is therefore essential that the criteria are complementary to the operator's SOPs and that the SOPs are conducive to meeting the stable approach criteria. Operators must ensure that SOPs are clear, concise and appropriate, and include the requirement to meet and maintain the stable 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 stabilization criteria which are chosen to define a stable 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;
- A range of path deviation;
- 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 stable approaches to be stated in the operator's SOPs. These elements should include, as a minimum:

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

The IOSA Standards Manual 11th Edition contains Standard FLT 3.11.59 which reads:

"The Operator shall have a stabilized approach policy with associated guidance, criteria and procedures to ensure the conduct of stabilized approaches.

3.7 Threat and Error Management (TEM)

Threat and Error Management (TEM) is a conceptual framework that is developed to help understand the inter-relationship between human performance and safety in a challenging operational environment. Pilots must always employ countermeasures to keep threats, errors and undesired aircraft states from reducing margins of safety in flight operations. Examples of countermeasures would include checklists, briefings, call-outs and SOPs. Many of the best practices supported by CRM can be considered TEM countermeasures.

Approach and landing accidents frequently include contributory factors related to poor decision-making by flight crews, together with ineffective communication, inadequate leadership and poor management. TEM 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 coordination, communication, situational awareness, planning, managing, problem solving, decision making, leadership, and teamwork.

According to ICAO Doc 9863, "CRM is a widely implemented strategy in the aviation community as a training countermeasure to human error. Traditionally, CRM has been defined as the utilization of all resources available to the crew to manage human error."

Today, the relation between TEM and the ICAO Pilot Competencies (including CRM skills) has to be clarified. The IATA Pilot Training Task Force considers that in the TEM framework and the ICAO Pilot Competencies (including CRM skills) can be seen as flight crew countermeasures. The ICAO Pilot Competencies are the tools against the ever present rain of threats, errors and undesired aircraft states. Their continuous application leads the flight crew to anticipate and manage threats, recognize and correct errors and identify and recover from Undesired Aircraft States.

CRM Components:

- SOPs providing clear, unambiguous roles for the 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.

As seen above, threats can be identified through many alerting onboard technologies and methods; some of these technologies can detect the threat and may warn the pilot to lead him or her to take an assertive action to counter it. However, effective use of the ICAO pilot competencies (including CRM skills) as countermeasures in the TEM model provides better threat anticipation, detection and management. Many accident reports demonstrate that a failure to employ CRM countermeasures or inadequate CRM elements in the cockpit, was the last option for detecting a threat, and therefore, the last opportunity to prevent the accident.

3.8 Briefing

The importance of briefing techniques should not be underestimated. Effective briefings can influence teamwork, co-ordination, understanding, behavior and communication.

The Aircraft OEM Flight Operations Manuals, for example state 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 possible threats and errors during the descent, deceleration, configuration, stabilization and landing;
- 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);
- Stable approach criteria;
- Instrument approach procedure details;
- Go-around and missed approach;
- Diversion;
- Communications;
- Non-normal procedures, as applicable;
- Review and discussion of approach-and-landing hazards; and,
- Expected restrictions, delays and other non-standard aspects of the approach, as advised by ATC.

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

- The threats associated with the day of operation;
- Minimum sector altitude;
- Terrain and man-made obstacles;
- Other approach hazards, such as visual illusions;
- Applicable minima (visibility or runway visual range (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 Notices to Airmen (NOTAMs) and Automatic Terminal Information Service (ATIS) remarks that might affect the stability of the approach; and,
- Other non-standard aspects of the approach, as advised by ATC.

3.9 Crew Coordination, Monitoring and Cross-Check

The following elements of flight crew behavior can contribute to stable 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.

3.10 Flight Data Monitoring (FDM)

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

Data collection and analysis can provide information of threats, hazards and identify potential weaknesses of an operator. As indicated in the jointly agreed IATA/ICAO/IFALPA Evidence Based Training (EBT) Implementation Guide, the collection and analysis of operational data (such as the characteristics of the operators, reporting systems, flight data analysis, flight deck observation; data sharing groups outcomes) helps to develop relevant and effective training programs, by managing the most relevant threats and errors, based on evidence collected in operations and training.

Furthermore, according to researchers, the methodology of data collection and analysis using historical flight track data, navigation procedure data, weather data, and aircraft performance data can also help predict the

likelihood of unstable approaches. Alerting or warning the pilots of a potential unstable approach before the aircraft reaches the stabilization altitude can provide sufficient time for the flight crew to check and correct the aircraft trajectory in order to avoid an unstable approach.

Similarly, ATCOs and ANSPs use of historical and radar data, inter alia, and analysis of specific events can lead to discovering trends, enhancing awareness, improving initial and recurrent training, etc.

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

- Monitoring of the flight parameters used to define a stable approach;
- Establishing the level of compliance with the stable approach and go-around policies;
- Understanding the factors contributing to unstable approaches;
- Identifying correlations between unstable 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 SMS framework).

EAFDM recommends the development of standardized FDM-based indicators to be used by operators for the monitoring of precursors to operational risk, such as LOC-I, Runway Excursion and CFIT. 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.

3.11 Safety Culture

This section emphasizes the requirement for an operator to have a defined safety policy, and to incorporate a Safety Culture in the organization. Accident investigations have identified a poor Safety Culture as a factor that increases the probability and severity of occurrence of accidents. It also influences the likelihood of incidents and near misses.

The understanding of an organization's Safety Culture is a prerequisite for successful and effective SMS implementation, as it can provide insight into the daily challenges and perceived risk areas of front line and management employees, thus helping organizations identify specific areas of improvement and hazards. In recognition of this, the 1st amendment of ICAO Annex 19 includes the promotion and development of a positive Safety Culture. This includes the establishment of an open non-punitive reporting culture, supported by a Just Culture, as noted in IOSA (ISM Ed.11) Standard ORG 3.1.5 which reads:

"The Operator should have a non-punitive safety reporting system that is implemented throughout the organization in all areas where operations are conducted".



A healthy Just Culture plays a vital role in a successful Safety Culture by encouraging employees to report safety incidents and hazardous conditions. This information enables the proactive identification of safety-related problems and allows for the identification of safety trends. A critical part of Just Culture is also the responsibility to be consistently intolerant of willful misconduct or reckless behavior. Adopting a clearly defined Just Culture policy and program will benefit the safety management of each aviation organization.

Consequently, to improve safety performance, including the reduction of Unstable Approaches, it is necessary for all organizations to continuously improve their Safety Culture through a cycle of self-assessment, understanding and action. Employee surveys, such as "I-ASC" (IATA Aviation Safety Culture) survey, are a recognized means to measure and demonstrate improvement of an organizations Safety Culture.

Expanded guidance may be found in the ICAO Safety Management Manual (SMM), Document 9859.

Section 4—Causes of an Unstable Approach

4.1 What is an Unstable Approach?

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

If the stable 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 unstable or alternatively they may have intentionally failed to comply with the stable approach policy due to an emergency or other reason. In the 1st edition, it was reported that some flight crew were found to be under considerable pressure to continue approaches such as peer pressure, commercial pressure to reduce delays, perceptions about their companies' go-around policy or fatigue.

The continuation of an unstable approach to landing, contrary to SOPs, may result in a successful landing. Just like a speeding driver, successfully completing a car journey, this can reinforce negative behavior. This may in itself be a cause of future unstable approaches. However, just like the speeding driver, the pilot continuing an unstable approach has less time and mental capacity to identify and address the unexpected. Accident analysis shows that additional unanticipated factors lead to 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.

Taking a person approach by attempting to appeal to a pilot's sense of fear of an accident is unlikely to be effective. An unstable approach may have any number of contributing factors, such as weather, tailwind, fatigue, technical failure, mishandling or misunderstanding of auto flight and flight director modes, workload, poor planning, pilot error, ATC interaction, procedures or approach design, all of which can be encountered at any stage of the descent, arrival and approach. It is therefore important that pilots understand that each defensive layer against these factors is rarely intact. As James Reason pointed out, the reality is that *'they are more like slices of Swiss cheese, having many holes—though unlike in the cheese, these holes are continually opening, shutting, and shifting their location. The presence of holes in any one "slice" does not normally cause a bad outcome. Usually, this can happen only when the holes in many layers momentarily line up to permit a trajectory of accident opportunity—bringing hazards into damaging contact with the victim'*. The effective management process begins in the cruise phase as plans are made and approach briefings delivered to ensure that a stable approach is realized and the weaknesses of other defenses are not allowed to come into play.

4.2 Factors Leading to an Unstable Approach

Human error and procedural non-compliance have been identified as primary contributing factors to unstable 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 unstable, 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;
- Excessive altitude and/or airspeed too close to the threshold;
- 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);
- Late descent clearance due to traffic;
- Malfunctioning ground-based navigational aids;
- Radar vectoring that did not end on the intermediate approach segment, either laterally or vertically;
Final intercept vectoring above approach slope (especially if combined with a tailwind at altitude);
- 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;
- Procedures and approaches design;
- Noise abatement operational procedures including late extension of landing gear, reduced flap setting, continuous descent operations;
- Lack of monitoring by the Pilots (includes both PF/PM);
- Late change of runway, including a parallel runway "sidestep";
- Instructions to keep the approach as tight as possible during a downwind visual approach;
- Speed restriction inappropriate to the type of aircraft and/or to the weather conditions prevailing at the airport (e.g. low ceiling, visibility, tail wind at altitude, etc.);

- Terrain and obstacles near the airport;
- Vertical speed or flight path angle;
- ATC misunderstanding of operational characteristics of various aircraft types;
- The aftermath of, what ATCOs call, the Non-Compliant Approach (NCA).

In order for stable 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 unstable approach that is continued is reviewed. Operators and their pilots must regard an unstable approach that is continued, 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.

Operators must adopt a no tolerance policy towards non-compliance with stable approach criteria, within the context of a Just Culture. Their SOPs must be robust enough to ensure that pilots can follow the relevant procedures. Pilots and operators should understand the importance of stable approach criteria as critical elements of flight safety.

Section 5—Mitigation of an Unstable Approach

5.1 Mitigation of an Unstable Approach

Any approach that fails to meet or maintain the stable approach criteria constitutes an undesired aircraft state in the terminology of TEM. An undesired aircraft state is recoverable. 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 unstable approach in the first place, it is important for flight crew:

- To be aware of the stable approach criteria;
- To be aware of the aircraft horizontal and vertical position in respect to a stable approach at all times, even when under radar control;
- To comply with the stable approach criteria published in their SOPs;
- To advise ATC when unable to comply with a clearance 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 advise ATC when unable to comply with instructions that are incompatible with a stable approach;
- To advise ATC when reducing or increasing speed to achieve a stable 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 unstable;
- To be alert to the approach becoming unstable 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;
- To pay attention to the wind in traffic pattern operations, especially on the base to final turn;

- To adjust the stable approach guidelines to the type of aircraft based on manufacturer's guidance;
- To configure the aircraft for landing at some predetermined distance from the airport or altitude, after which only small corrections to pitch, heading, and power setting should be made.

Additionally, from an ATCO's perspective, ICAO Procedures for Air Navigation Services – Air Traffic Management document (PANS-ATM – Doc 4444) contains provisions intended to mitigate unstable approaches.

ATC can contribute to stable 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 unstable approaches;
- Understanding the influence of ATC on stable approaches;
- Remaining current on the latest developments with regards to unstable approaches;
- Being cognizant of pilots needs during the final approach phase;
- Recognizing that jet cannot expedite descent and decelerate simultaneously;
- Being prepared to react if a crew decline instructions or advise difficulty in complying with previously accepted instructions; by always having alternate plans and options to solve traffic conflicts and sequences;
- Being prepared for a go-around;
- Being prepared to instruct a go-around if safety considerations require it;
- Issuing landing clearances as soon as possible;
- Avoiding last-minute changes, by keeping interventions and communications on short final to a strict minimum;
- Informing the pilot in advance if you plan to:
 - request high speed on final for separation purposes;
 - vector the aircraft to intercept closer to the FAF;
 - maintain the aircraft at a higher than normal altitude for the intercept;
 - vector the aircraft to intercept the extended center line/localizer at a greater than normal procedural angle.
- Maintaining continuous situational awareness when it comes to weather conditions that could affect approach stabilization by the crew:
 - downwind on final approach;
 - wind shear;
 - low ceiling;

- Being responsive to pilot requests;
- Avoiding routine vectoring of aircraft off a published arrival procedure only to shorten the flight path;
- Giving preference to approaches with vertical guidance (ILS, MLS, GLS, GPS, GNSS, etc.);
- When aircraft are being vectored, issue track miles to the airport and keep the flight crew informed of the plan;
- In case of go-around, avoid changing the published miss approach procedure, except for a safety reason;
- In case of go-around, avoid initiating radio exchange with the pilot during this critical phase, except for a safety reason.

In relation to ATC, pilots can contribute to stable approaches by:

- Not accepting restrictions that they won't be able to make, and controllers should not give restrictions that are not realistic. In such cases controllers and pilots are required to be careful and monitor the situation and request (the pilot) or issue (the controller) an alternative clearance when it is obvious the restriction cannot be met.

Furthermore, ICAO PANS-ATM – Doc 4444 describes what information ATCOs are expected to provide the flight crew during and before the final approach. This information has been identified as a way to mitigate unstable approaches.

It is also recommended to promote the use of stable approach techniques during non-precision approach (NPA) procedures where such a technique would enhance the safety of the flight. The continuous descent final approach (CDFA) techniques contribute to a stable approach. It can simplify the final segment of the non-precision approach by incorporating techniques similar to those used when flying a precision approach procedure or an approach procedure with vertical guidance. The CDFA technique is preferred and used whenever possible as it adds to the safety of the approach operation by reducing pilot workload and lessening the possibility of error in flying the approach. The industry, therefore, should as soon as, and wherever, possible develop procedures and train pilots to fly a stable CDFA. This would include procedures such as the constant rate descent that can be flown by all types of aircraft and use of the modern vertical navigation capability (VNAV) in some existing and most new aircraft types.

Section 6—Go-Around Decision-Making

6.1 Go-Around

If an approach is not stable by a certain height above the ground as specified in the company SOP, the pilot must execute a go-around. It is possible for a pilot to initiate a go-around even after touchdown on the runway, provided that in the judgement of the pilot this can be safely executed, but not after the thrust reversers have been deployed.

In addition to an unstable or destabilized approach, 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, an unexpected event where a pilot may determine that something is not correct for landing such as a flap gauge or gear indication, wind shear, a runway incursion, a request from ATC, or the determination that the landing cannot be made within the touchdown zone, and whenever the safety of a landing appears to be compromised. Failure to execute a go-around is a leading contributing factor in approach and landing accidents.

As with the stable 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 11th Edition contains the Standard FLT 3.11.60 which reads:

"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".

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.

One reason why a go-around is not carried out 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 should 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 during the go-around manoeuver;
- Significant low level wind shear;
- Wake turbulence created by the go-around aircraft itself creating a risk for other aircraft.

Additionally, with regard to unstable approaches, ICAO PANS-ATM – Doc 4444 contains provisions detailing circumstances where ATCOs are expected to direct/suggest an aircraft to do a go around. When the aircraft appears to be dangerously positioned on final approach or when the aircraft reaches a position from which it appears that a successful approach cannot be completed.

6.2 Go-Around Decision

If accidents could have been prevented with a sound go-around decision, the question remains as to why flight crews try to salvage a bad approach rather than abandon it and start again. The proper and timely decision to execute a go around from an unstable approach is an important factor in reducing the risk of unwanted events, such as an accident or incident within the industry.

The go-around is an exercise in good judgment. The pilots' decision can be impacted by traffic, turbulence, hazards, speed, pilots' experience, peer and company pressure and approach problems. However, the earlier the decision the better it is. Pilots should understand the importance of making a go-around decision if they experience an unstable approach or conditions change during the flare or touchdown up to the point of initiating thrust reverse during the landing rollout. Accidents that are subsequent to execution of a go-around are reflective of a late decision. GADM data analysis revealed that in the past five years, from 2012 through 2016, there were 11 accidents occurred during the go-around phase of flight.

The failure to correctly identify the need for a go-around is the leading risk factor identified in approach and landing accidents. The decision to execute a go around where recommended should not be rushed in order

to ensure a well flown and executed maneuver. 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 (DA), the option remains for them to go-around at any point up until reversers are deployed.

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.

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 stable approach criteria;
- Lack of practice/confidence in performing a go-around maneuver, especially from altitudes other than decision altitude;
- In a crowded TMA, ATC deviation from the standard procedure might discourage flight crew from going around. Therefore, it is important that ATC adhere to published go-around procedures, whenever possible.

6.4 When to Initiate a Go-Around

A go-around should be initiated 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 insufficient separation, occupied runway or runway incursion;
- Abnormal aircraft conditions; an aircraft system malfunction or erroneous indication may make a landing unsafe;
- Abnormal approach conditions; speed and altitude, either ATC or pilot related;
- 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 stable 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.

6.5 Organizational Factors

Certain aspects of the organizational culture of Operators can have a significant effect upon the frequency of unstable approaches and the behavior of flight crews when an approach does not meet the stable approach criteria. The following have been demonstrated to reduce the frequency of unstable 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 stable 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 stable approach criteria, to include safety debriefs, and retraining as appropriate;
- Implementation of safety technologies when technically and financially feasible.

6.6 Go-Around below Minima

Pilots are all familiar with the 'land/go-around' decision at DA 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 stable approach criteria. Below decision altitude:

- If a go-around is indicated the decision must not be delayed;
- A go-around can be initiated until the selection of the reverse thrust, provided that in the judgement of the pilot taking all factors into consideration the maneuver can be completed safely;
- Once a go-around has been initiated, it must be completed;

In accordance with IATA IOSA Standards Manual 11th Edition *"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. "*

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 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 flight 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.

Furthermore, training should also address the following:

- Unstable approaches at the stabilization altitude but also cover destabilization after being stabilized, especially at low altitude (below MDA/DH);
- The go-around procedure is rarely flown and is a challenging maneuver. Flight crew must be sufficiently familiar with flying go-arounds through initial and recurrent training;
- 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;

- Somatogravic head-up illusions during the unfamiliar forward acceleration in a go-around can lead to the incorrect perception by the flight crew that the nose of the aircraft is pitching up. This illusion can cause pilots to respond with an inappropriate nose down input on the flight controls during the execution of a go-around. Such responses have led to accidents;
- Training for Somatogravic illusions during the initiation of a go-around is possible. Simulators that combine the possibilities of both the hexapod and the human centrifuge are already available and in use, (e.g., for military training). They can be used to demonstrate the illusions during go-around initiation and train pilots for a correct reaction on the heads-up illusion. As preventive means, crews are recommended to brief the go-around, not delay it unduly, respect minima, monitor the flight parameters and fly the go-around pitch and the Flight Director bars where available.

There are also cases when the flight crew engage the autopilot to reduce the workload, but instead put the aircraft in an undesired situation due to a lack of situational awareness with the automation.

Operators should not limit training scenarios to the initiation of a go-around at the approach minimum or missed approach point. Training scenarios should focus on current operational threats, anticipation and management, as well as traditional situations.

Section 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 unstable approaches.

An Airbus Flight Operations Briefing Notes (FOBN) states that 70% of rushed and unstable 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 pilots meet the stable approach criteria at the required position or altitude, they must actively monitor and manage the profile from the very start of the descent, using all available instruments and chart references, including:

- FMS vertical-deviation indication, as applicable
- Raw data; and
- Charted descent-and-approach profile.

In addition, pilots should also closely monitor wind conditions to anticipate if there is any decrease in head wind or increase in tail wind components and wind changes, and accordingly to adjust the flight path profile appropriately.

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 stable approach.

To help prevent delaying or any rushing in the management of the descent profile and increased workload, flight crew should start their descent preparation and approach briefings as soon as all pertinent data has been received. Ten minutes prior to top of descent (TOD) is a good target for completion. Rushing during descent and approach is a significant factor in approach-and-landing incidents and accidents. 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 are factors in unstable 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:

- LOC-I;
- CFIT;
- Landing short;
- Hard landing;
- Tail strike; and/or;
- Runway excursion

Large aircraft 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 unstable 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 performance for a given phase of flight/approach, timely interception of the desired final approach path and the provision of useful and timely information like track miles to touchdown. Furthermore, ATC can greatly reduce the risk of an unstable approach by limiting changes to the descent profile once the aircraft has started the descent.

Section 8—Technology and Operational Enhancement

8.1 Operational Enhancement

Air traffic and airspace management procedures are evolving to minimize the risk of an unstable 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 stable 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

Alerting and monitoring systems as well as advanced sensor technologies have proven to have a significant and positive impact on safety of flight.

Honeywell's Enhanced Ground Proximity Warning System (EGPWS) helps reduce CFIT risks by constantly monitoring terrain and obstacles in proximity of the aircraft.

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 stable approach criteria, such as:

- Aircraft should be stable at 1,000 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. Airbus also has similar technology available for their product range.

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 Runway Situation Awareness Tool (RSAT) 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 RSAT 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 stable 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.

Section 9—Conclusion

An unstable approach is an undesired aircraft state which is recoverable only with the execution of a missed approach or go around. Fifteen percent of the landing accidents in the five year period reviewed would have been prevented by such action.

Failure to go around from an unstable approach or an approach which becomes unstable is an intentional violation of standard operating procedures. Understanding why procedures are violated is a complex human factors equation. There is often little reward for complying with SOPs and violations, which do not always generate adverse outcomes, can reinforce non-compliant behavior. It is therefore important for pilots to understand what it is that an unstable approach is compromising. The accidents show that the stable approach gate is a safe height to review the aircraft energy state. If the gate is not achieved the flight crew are carrying the energy management problem to an unsafe height. In accident scenarios, when other unexpected conditions are encountered, a decision to go around below the gate is too late to recover the undesired aircraft state. Conversely, in some accidents studied the option to go around was still available to the flight crew from, for example, from the baulked or bounced landing as a result of the unstable approach.

Flight crews must be completely comfortable and confident with execution of a go around from any position on the approach and landing right down to a bounced landing. This requires training and practice, so far as it is possible, in the simulator, because the maneuver is seldom encountered in routine line operations. It also requires a company culture where go arounds are encouraged and not the catalyst for sanctions.

A culture of compliance with all SOPs must also prevail. Compliance with stable approach procedures can easily be monitored with a FDM/FOQA program and protocols must be in place to allow flight crews to be debriefed and retrained as appropriate. Some operators also have a system to monitor for repeated non-compliance by using pseudo codes and a method for approaching this under agreements with pilot representative bodies.

Challenging operating environments, a can do culture and operational pressure must all be balanced and assessed by operators to ensure that this accident precursor is eliminated from their operation. An active SMS and positive safety culture is a benefit in this regard and is encouraged.

The contributory factor to accidents of a failure to go around will continue to be monitored between the ACTG and reported in the IATA safety report. Operators are commended to apply the guidance in this document.

Section 10—Recommendations

Regulators

- Regulators should require operators to define and apply stable approach procedures, including criteria suitable for their operations, and for a mandatory go-around to be flown if they are not met and maintained.

Procedure Designers

- Procedure designers should consider aircraft performance and flight crew workload in the go-around when allocating initial level off altitude and lateral maneuvers.

Operators

- All operators should develop SOPs that reflect the aircraft manufacturers' guidance and adopt the stable approach concept, characterized by completion of briefings and checklists, maintaining a stable speed, descent rate, attitude, aircraft configuration, displacement relative to the approach path with power/thrust settings appropriate for the flight conditions until the commencement of the landing flare. The SOP should be clear, concise and appropriate, and support mandatory go-arounds, together with guidance on the go-around decision making process.
- Operators should ensure that SOPs include adequate monitoring and cross-checking to support crew co-ordination during approach and landing. The go-around policy should be non-punitive. The stable approach policy should be subject to regular review.
- Operators should provide a policy to their flight crew emphasizing that either the pilot flying or the pilot monitoring should make a timely go-around callout if either pilot believes an approach is, or has become unstable, and that the response should be an immediate verbal response followed by a missed approach.
- Operators should require callouts to be continued at reasonable intervals until corrective action is taken. Training scenarios should be designed under CRM and TEM principles during normal and non-normal situations in order to enhance pilot competencies. Approach briefings should be designed to enhance flight crew coordination and preparedness for planned actions and unexpected occurrences, by creating a common mental model of the approach.
- Operators should provide pilot training and guidance on the importance of a stable approach SOPS in the approach and landing system, including early recognition and handling of the symptoms of an unstable approach. Training should also be developed in accordance with IATA Guidance Material for Improving Flight Crew Monitoring. This Guidance Material can be found at <http://www.iata.org/whatwedo/ops-infra/training-licensing/Documents/Guidance-Material-for-Improving-Flight-Crew-Monitoring.pdf> Pilots should be trained to be proficient in go-around management from different stages of the approach to touchdown and bounced landing. Pilots should be presented with scenarios that requires decision making with regard to stable approach criteria, both above and below the decision altitude. Go-around training should incorporate training on somatogravic illusions during the

initiation of a go-around. Training should include go-arounds not only at heavy weight and one engine inoperative, which are the typical scenarios, but also at light weight with both engines operative. Operators should include the procedures developed to fly specific approaches to specific runways at specific airports in their flight crew training.

- Operators should develop a non-punitive go-around policy and should reinforce SOP compliance through effective monitoring and a 'just' process for managing non-compliance;
- Operators should conduct FDM analysis to identify and monitor precursors of unstable approaches;
- De-identified data from the FDM program to be used:
 - in initial and recurrent training programs, including the creation of simulator scenarios;
 - to help the airline determine correlations of interest between unstable approaches and specific airport;
 - to monitor SOP compliance with stable approach criteria;
 - to better understand the factors, which influence the occurrence of unstable approaches;
 - for operational trends such as the rate of unstable approaches and corresponding rate of resultant go-arounds versus landings.
- Operators should work with ANSP/Air Traffic Services Unit (ATSU) to implement procedural changes to systematically reduce the rate of unstable approaches at runways identified as higher risk by FDM data analysis.

Pilots

- All **pilots** should comply with the stable approach SOPs.

ATC

- ATC should advise of any known peculiarities to a given approach/descent profile (e.g. weather conditions, windshear, delays, pilot reports (PIREPs) from previous aircraft, turbulence orographic activity).
- ATC should be reminded that any time an aircraft might execute a balked landing or missed approach.
- ATCOs should keep altitude and route clearances as well as communications to a minimum during a go-around, as it adds workload to an already busy flight crew. Additionally, clearances and instructions should be as simple as possible and it should not require extensive manipulations from the crew (e.g. FMS entries). They should also understand that the aircraft might be entering a fuel critical state such that routing and sequencing for diversion or subsequent landing must be without undue delay.
- ANSPs/ATSUs should improve controllers' awareness of the risks associated with ATC actions during approach through initial, recurrent and simulator training.
- ATC should be cognizant of the various constraints related to the approach phase and the associated risk of an unstable approach. This can be achieved by initial, recurrent or simulator training.

- ANSPs/ATSUs should review and if necessary enhance the provision of go-around risk awareness training for ATCs. This should not be limited to theory, and proper training in a simulated environment should be provided. Awareness campaigns, best practices from the industry should be shared to the best extent possible and guidance material should be made available to ATCOs on unstable approaches and go-around.

Technology

- Operators should include technology in new aircraft acquisitions and take a risk based data driven assessment of unstable approach risk to measure the benefits retrofitting such technologies to existing aircraft.
- Operators should implement vertically guided approaches that facilitate stable approaches.

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