European Action Plan for the Prevention of Runway Excursions

Edition 1.0

CONTENTS

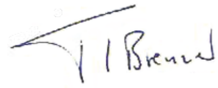
1. STATEMENT OF COMMITMENT

A runway excursion is the event in which an aircraft veers off or overruns the runway surface during either takeoff or landing. ICAO (Global Runway Safety Symposium 2011) has noted that the rate of runway excursions has not decreased in more than 20 years. Accidents continue to take place on and around runways.

The content of this Action Plan is the result of the combined and sustained efforts of organisations representing all areas of runway operations. Their intention is to enhance runway safety by advocating the implementation of the recommendations it contains. The contributing organisations include, but are not limited to, Aerodrome Operators, Air Navigation Service Providers, Aeronautical Information Service Providers, Aircraft Operators, Aircraft Manufacturers, Professional Associations, the European Aviation Safety Agency and National Aviation Safety Authorities.

The commitment of these organisations and of all operational staff is to prevent runway excursions using all practicable means available ranging from the design of aircraft, airspace, procedures and technologies to relevant training for operational staff associated with runway excursion prevention. In this way runway safety actions make a difference to day to day operations.

As such, this Action Plan is directed at all providers and users of European aerodromes and all European aircraft operators for all their operations worldwide.

MEMBER	ORGANISATION	SIGNATURE
Frank Brenner, **Director General**	**EUROCONTROL**	
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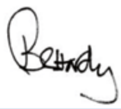
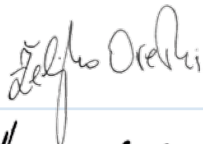
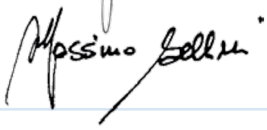
Tim Hardy **Airside Director**	**BAA Airports Limited**	
Zelijko Oreski **Executive Vice President**	**Intl Federation of Air Traffic** **Controller's Associations (IFATCA)**	
Massimo Bellizzi **Director General**	**ENAV S.p.A.**	
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2. INTRODUCTION AND BACKGROUND

There are at least two runway excursions each week worldwide. ICAO has noted that the rate of runway excursions has not decreased in more than 20 years.

ECCAIRS taxonomy and ICAO define a runway excursion as "an event in which an aircraft veers off or overruns the runway surface during either takeoff or landing". .

The EUROCONTROL "Study of Runway Excursions from a European Perspective" shows that the causal and contributory factors leading to a runway excursion are the same in Europe as in other regions of the world. The study findings made extensive use of lessons from more than a thousand accident and incident reports. Those lessons have been used to craft the recommendations contained in this European Action Plan for the Prevention of Runway Excursions.

The European Working Group for Runway Safety has considered all practicable means available ranging from the design of aircraft, airspace, procedures and technologies to relevant training for operational staff associated with runway excursion prevention.

The recommendations and guidance materials contained in this Action Plan are intended for implementation by the relevant stakeholder organisations with the aim of reducing the rate of runway excursions and the runway excursion risk incumbent upon them.

There are important elements to take note of when preventing runway excursions, for example:

- The risk of a runway excursion is increased by wet and contaminated runways in combination with gusts or strong cross or tailwinds;
- Practices such as landing long and or late or ineffective deployment of braking devices is highly relevant to runway excursion risk;
- The majority of runway excursions occur on a dry runway;
- In the cases of both landing and takeoff excursions, the primary opportunity to prevent a runway excursion is in the decision making of the flight crew to go-around or, once at or approaching V1, continue a takeoff.

Although it is acknowledged that the causal factors leading to undershoot and loss of control incidents and accidents may be similar to those leading to runway excursions, this document does not address these other risks.

Central to the recommendations contained in this Action Plan is the uniform and consistent application of ICAO provisions. The recommendations and their supporting guidance materials primarily address States in the area of the European Civil Aviation Conference (ECAC), whilst remaining globally applicable. National Aviation Safety Authorities should decide upon the strategy for implementation by the applicable organisations within States. The recommendations are mainly generic and the responsible organisations should decide specific details, after taking local conditions into account e.g. aerodromes where joint civilian and military operations take place.

Whilst technology is undoubtedly part of the solution, training of unfamiliar situations that may lead to runway excursions is key to their prevention. Rigorous and realistic training scenarios will better prepare operational staff to cope with decisions to go-around or reject a takeoff and lead to the execution of the correct and safe manoeuvres. Training must address the need to continue high standards of airmanship, enabling flight crew to manually fly aircraft in all circumstances, and air traffic controllers to sequence traffic in all circumstances.

Communication practices that offer the chance to prevent runway excursions include the correct use of the Aeronautical Information Publications (AIP), NOTAM and ATIS. Failing to fully brief a flight crew about the departure or arrival airport conditions can lead to misunderstandings.

The content of this Action Plan should be interpreted for the aircraft type being flown and the aerodromes relevant to the flight being undertaken.

There is a genuine need to improve the quality of appropriate occurrence data to facilitate lesson learning and sharing, e.g. regarding phenomena such as unstable and destabilised approaches.

Local Runway Safety Teams should be established. The team should consist of, as a minimum, representatives from the main groups associated with takeoff and landing operations, namely the Aerodrome Operator (which could include navigation aids engineers, infrastructure maintenance etc.) Meteorological Offices and Aeronautical Information Service Providers, representatives from the Air Navigation Service Provider, local Air Traffic Controller associations and pilots from Aircraft Operators, local pilot associations that operate at the aerodrome and other relevant organisations that operate on the manoeuvring area..

There is an obvious need to reach a wide audience with the information contained in this Action Plan. Each organisation conducting or supporting runway operations is invited to review and prioritise the proposed recommendations contained in this document for implementation in their own organisation. It is recommended that appropriate use of safety assessments of any of the proposed changes should be made in coordination with the relevant working partners, prior to implementing those changes.

This document is structured in two main parts: Recommendations in Section 3 and Guidance Materials in a series of Annexes. The guidance found in this Action Plan should not be seen to be limiting, and good practice should be shared as appropriate. The Guidance Materials will be continually updated and made available through the safety knowledge management process of SKYbrary (www.skybrary.aero). The boundaries set by national regulators and internationally accepted provisions should be respected.

FOR FURTHER INFORMATION
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TAP
PORTUGAL

3. RECOMMENDATIONS

3.1 GENERAL PRINCIPLES AND LOCAL RUNWAY SAFETY TEAMS

REF	RECOMMENDATION	ACTION	IMPLEMENTATION DATE	GUIDANCE
3.1.1	At individual aerodromes, as designated by the Regulator, a Runway Safety Team should be established and maintained to lead action on local runway safety issues.	Aerodrome Operators, Air Navigation Service Provider, Aircraft operators Regulator.	Immediate	APPENDIX A
3.1.2	A local runway safety awareness campaign should be initiated at each aerodrome for Air Traffic Controllers, Pilots and Manoeuvring Area Vehicle Drivers and other personnel who operate on or near the runway. The awareness campaign should be periodically refreshed to maintain interest and operational awareness.	Local Runway Safety Team	31 May 2013	APPENDIX A
3.1.3	Confirm that all infrastructure, practices and procedures relating to runway operations are in compliance with ICAO provisions.	Aerodrome Operator (lead), Air Navigation Service Provider.	31 May 2013	APPENDIX A
3.1.4	Where practicable, ensure that specific joint training and familiarisation in the prevention of runway excursions, is provided to Pilots, Air Traffic Controllers and Aerodrome Operator staff. This may include visits to the manoeuvring area to increase awareness of markings, signage, and position of anemometers etc. where this is considered necessary.	Local Runway Safety Team, Air Navigation Service Provider, Regulator, Aerodrome Operator.	31 May 2013	APPENDIX A
3.1.5	Runway safety should be part of initial and recurrent training for operational staff e.g. Air Traffic Controllers, Pilots, Meteorology officers, NOTAM officers and all other personnel involved in manoeuvring area operations.	Aircraft Operator, Air Navigation Service Provider, Aerodrome Operator, Regulator, Flight Training School.	02 January 2014	APPENDIX A
3.1.6	All users of the aviation system should participate in safety information sharing networks and exchange relevant information on actual and potential safety deficiencies to ensure that runway safety risks are correctly identified and appropriately mitigated at each aerodrome.	Aircraft Operator, Air Navigation Service Provider, Aerodrome Operator, Local Runway Safety Team, EUROCONTROL.	31 May 2013	APPENDIX A
3.1.7	Changes to manoeuvring area infrastructure, practices and procedures, including planned works must take account of runway safety and may require consultation with the local runway safety team. An adequate risk assessment should be the basis for procedural and/or infrastructural changes on the manoeuvring area.	Air Navigation Service Provider, Aerodrome Operator, Aircraft Operator.	Immediate	APPENDIX A

3.2 AERODROME OPERATOR

REF	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.2.1	Ensure that runways are constructed and refurbished to ICAO specifications, so that effective friction levels and drainage are achieved.	Aerodrome Operator	Immediate	APPENDIX B
3.2.2	An appropriate program should be in place to maintain the runway surface friction characteristics by removal of contaminants.	Aerodrome Operator	Immediate	APPENDIX B
3.2.3	If provided, ensure that appropriate navigation aids (e.g. ILS, AGL, PAPIs), and surface markings are maintained in accordance with ICAO Standards and Recommended Practices, to promote the accurate landing/touchdown point.	Aerodrome Operator	02 January 2014	APPENDIX B
3.2.4	Ensure that the runway holding points are clearly marked, signed and if required, lit. Consider the use of signage at the runway holding points used for intersection takeoffs to indicate the Takeoff Run Available (TORA).	Aerodrome Operator	02 January 2014	APPENDIX B
3.2.5	Ensure robust procedures are in place for calculating temporary reduced declared distances e.g. due to work in progress on the runway. When reduced declared distances are in operation, ensure that the temporary markings, lighting and signs accurately portray the reduced distances and that they are well communicated, and transferred to States aeronautical information services for publication.	Aerodrome Operator	Immediate	APPENDIX B
3.2.6	If runway contamination occurs or is changing assess the runway conditions.	Aerodrome Operator	Immediate	APPENDIX B
3.2.7	Ensure robust procedures are in place for communicating safety significant information regarding changing surface conditions as frequently as practi-cable to the appropriate air traffic services.	Aerodrome Operator	Immediate	APPENDIX B
3.2.8	In accordance with ICAO provisions, wind sensors and wind direction indi-cators (wind socks) should be sited to give the best practicable indication of conditions along the runway and touchdown zones.	Air Navigation Service Provider. MET Office, Aerodrome Operator.	02 January 2014	APPENDIX B
3.2.9	Consider equipping for digital transmission of ATIS, as appropriate.	Air Navigation Service Provider. MET Office, Aerodrome Operator.	02 January 2014	APPENDIX B

NOTE:

To mitigate the effect of a runway excursion it is agreed that runway end safety areas (which may include arresting systems) and runway strips are useful, although they are not excursion prevention measures.
Runway strips and RESAs are the subject of ICAO Standards and Recommended Practices.

3.3 AIR NAVIGATION SERVICE PROVIDER

REF	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.3.1	Ensure the importance of a stabilised approach and compliance with final approach procedures is included in training and briefing for air traffic control staff.	Air Navigation Service Provider	02 January 2014	APPENDIX C
3.3.2	When assigning a runway or changing a runway assignment for arriving or departing traffic, consider the time the flight crew will require to prepare/ re-brief.	Air Navigation Service Provider	Immediate	APPENDIX C
3.3.3	Review available data (occurrence reports, go-around / missed approach data etc.) with the aim of identifying contributing factors and relevant mitigations for example enhanced airspace design and procedures, and air traffic controller training and procedures.	Air Navigation Service Provider	02 January 2014	APPENDIX C
3.3.4	Review processes covering the provision of safety significant 'essential' information such as weather, wind and runway surface conditions (e.g. when 'wet' or contaminated): 4a. To ensure a consistent, timely and accurate broadcast of aerodrome information. 4b. To ensure the integrity of the safety significant information supply chain from the provider (e.g. Met Office/Aerodrome Operator) to ATC/ AISP and on to the flight crew. 4c. Consider equipping for digital transmission of ATIS, as appropriate 4d. Ensure that training on the use of ATIS/D-ATIS is provided to relevant operational staff (ANSP/AISP).	Air Navigation Service Provider, Aeronautical Information Service Provider, Aerodrome Operator, Aircraft Operator	02 January 2014	APPENDIX C
3.3.5	Ensure that pilots in command/ flight crews are informed of the Takeoff Run Available (TORA) or the Landing Distance Available (LDA) if these differ from the published data using appropriate means.	Air Navigation Service Provider, Aerodrome Operator Aircraft Operator, Aeronautical Information Service Provider.	Immediate	APPENDIX C
3.3.6	Participate in safety information sharing networks to facilitate the free exchange of relevant information on actual and potential safety deficiencies.	Air Navigation Service Provider, Aerodrome Operator	Immediate	APPENDIX C

3.4 AIRCRAFT OPERATOR

REF	FLIGHT PHASE	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.4.1	GENERAL	Aircraft operators are encouraged to participate in safety information sharing networks to facilitate the free exchange of relevant information on actual and potential safety deficiencies.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.2	GENERAL	The aircraft operator should include and monitor aircraft parameters related to potential runway excursions in their Flight Data Monitoring (FDM) program.	Aircraft Operator	02 January 2014	APPENDIX E
3.4.3	GENERAL	The aircraft operator should include runway excursion prevention in their training program. This training should be done using realistic scenarios.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.4	GENERAL	The aircraft operator should consider equipping their aircraft fleet with technical solutions to prevent runway excursions.	Aircraft Operator	02 January 2018	APPENDIX E
3.4.5	GENERAL	The aircraft operator should consider equipping their aircraft fleet with data-link systems (e.g. ACARS) to allow flight crews to obtain the latest weather (D-ATIS) without one pilot leaving the active frequency.	Aircraft Operator	03 June 2015	APPENDIX E
3.4.6	GENERAL	The aircraft operator should report to the ANSP if approach procedures or ATC practices at an airport prevent flight crew from complying with the published approach procedures and their stabilised approach criteria.	Aircraft Operator	Immediate	APPENDIX E
3.4.7	GENERAL	The aircraft operator should ensure the importance of a stabilised approach and compliance with final approach procedures is included in briefing for flight crews. The commander should not accept requests from ATC to perform non-standard manoeuvres when they are conflicting with the safety of the flight.	Aircraft Operator	Immediate	APPENDIX E
3.4.8	GENERAL	The Commander should not accept a late runway change unless for safety reasons. A briefing and if needed flight management computer (FMC) preparation must be completed (e.g. before leaving the gate or starting the final approach).	Aircraft Operator	Immediate	APPENDIX E
3.4.9	GENERAL	If the Commander should request a more favourable runway for Takeoff or Landing for safety reasons, the safety reason is to be declared to Air Traffic Control.	Aircraft Operator	Immediate	APPENDIX E
3.4.10	WEATHER	The Commander, shortly before takeoff and landing, shall verify that the actual weather conditions are similar or conservative compared to the weather data used for the takeoff performance calculations and the in-flight landing distance assessment.	Aircraft Operator	Immediate	APPENDIX E
3.4.11	CROSS WIND OPERATIONS	The aircraft operator should publish the Aircraft's Crosswind Limitations with specific guidance on the runway condition and the gust component.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.12	CROSS WIND OPERATIONS	The aircraft operator should publish specific guidance on takeoff and landing techniques with cross wind; and/or wet or contaminated runway conditions and the correct use of the nose wheel steering. Appropriate training must be provided.	Aircraft Operator	31 May 2013	APPENDIX E

3.4 AIRCRAFT OPERATOR

REF	FLIGHT PHASE	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.4.13	TAKEOFF	The aircraft operator should ensure their standard operating procedure (SOP) requires the flight crew to perform independent determination of takeoff data and crosscheck the results. The aircraft operator should ensure their Standard Operating Procedures include flight crew cross-checking the 'load and trim sheet' and 'performance' data input into the Flight Management Computer (FMC).	Aircraft Operator	31 May 2013	APPENDIX E
3.4.14	TAKEOFF	The aircraft operator should publish the rejected takeoff decision making process. Appropriate training should be provided.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.15	CRUISE	The aircraft operator should publish and provide training on the company policy regarding in-flight assessment of landing performance. Flight crew must be advised whether company landing distance data relates to unfactored or operational distances. In the case of unfactored distances the company should provide the safety margin to be used in normal and abnormal conditions.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.16	APPROACH	The aircraft operator must publish the company policy, procedure and guidance regarding the go-around decision. It should be clearly stated that a go-around should be initiated at any time the safe outcome of the landing is not assured. Appropriate training must be provided.	Aircraft Operator	Immediate	APPENDIX E
3.4.17	APPROACH	When accepting the landing runway the Commander should consider the following factors: weather conditions (in particular cross and tailwind), runway condition (dry, wet or contaminated), inoperable equipment and aircraft performance. Except in conditions that may favour a non precision approach, when more than one approach procedure exists, a precision approach should be the preferred option.	Aircraft Operator	Immediate	APPENDIX E
3.4.18	APPROACH	The aircraft operator must publish Company Criteria for stabilised approaches in their Operation Manual. Flight crew must go-around if their aircraft does not meet the stabilised approach criteria at the stabilisation height or, if any of the stabilised approach criteria are not met between the stabilisation height and the landing. Company guidance and training must be provided to flight crew for both cases.	Aircraft Operator	Immediate	APPENDIX E
3.4.19	APPROACH	The aircraft operator should publish a standard operating procedure describing the pilot non flying duties of closely monitoring the flight parameters during the approach and landing. Any deviation from company stabilised approach criteria should be announced to the pilot flying using standard call outs.	Aircraft Operator	Immediate	APPENDIX E

REF	FLIGHT PHASE	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.4.20	APPROACH	The aircraft operator should publish guidelines on the use of autoland when low visibility procedures (LVP) are not in force. Flight crew that practice automatic landings without LVP in force should take into account the status of the protected area for the Localiser signal. Flight crew should fully brief such practice manoeuvres, in particular, readiness to disconnect the autoland / automatic rollout function and land manually, or go-around.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.21	LANDING	The aircraft operator should publish the standard operating procedure regarding a touchdown within the appropriate touchdown zone and ensure appropriate training is provided.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.22	LANDING	The aircraft operator should publish the appropriate landing technique for landing on wet or contaminated runway and ensure appropriate training is provided. Flight crew should be made aware of the risks of landing on wet/contaminated runway in combination with crosswind conditions.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.23	LANDING	The aircraft operator should publish and provide training on the company policy regarding in-flight assessment of landing performance. Flight crew must be advised whether company landing distance data relates to unfactored or operational distances. In the case of unfactored distances the company should provide the safety margin to be used in normal and abnormal conditions.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.24	LANDING	Flight crew should use full reverse on wet/contaminated runways irrespective of any noise related restriction on their use unless this causes controllability issues. It is important that the application of all stopping devices including reverse thrust is made immediately after touchdown without any delay.	Aircraft Operator	Immediate	APPENDIX E
3.4.25	LANDING	The aircraft operator should publish the standard operating procedure on the pilot non flying duties of closely monitoring the activation of the stopping devices on landing and call out any omission to the pilot flying. Appropriate training must be provided.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.26	LANDING	The aircraft operator should include specific recovery techniques from hard and bounced landings in their training program.	Aircraft Operator	31 May 2013	APPENDIX E
3.4.27	LANDING	In cases where an aircraft operator accepts landing long as a practice, the practice should be safety risk assessed, with a published policy and standard operating procedure suppor-ted by appropriate flight crew training.	Aircraft Operator	31 May 2013	APPENDIX E

3.5 AIRCRAFT MANUFACTURERS

NEW REF	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.5.1	Aircraft manufacturers should present takeoff and landing performance information in similar (common and shared) terminology and to agreed standards.	Aircraft Manufacturer	January 2015	APPENDIX F
3.5.2	Training material promulgated by aircraft manufacturers should emphasize the necessity of making best use of runway length available when conditions are uncertain or when runways are wet or contaminated by applying full braking devices, including reverse thrust, until a safe stop is assured.	Aircraft Manufacturer	May 2013	APPENDIX F
3.5.3	On-board real time performance monitoring and alerting systems that will assist the flight crew with the land/go-around decision and warn when more deceleration force is needed should be made widely available.	Aircraft Manufacturer	January 2014	APPENDIX F
3.5.4	The aviation industry should develop systems and flight crew manuals to help flight crews calculate landing distances reliably.	Aircraft Manufacturer	January 2015	APPENDIX F
3.5.5	Electronic Flight Bag manufacturers and providers (class 1/2/3) should enable the flight crew to perform independent determination of takeoff data and to implement where possible an automatic crosscheck to ensure correct insertion of the takeoff data in the avionics. Standard Operating procedures should be developed to support this crosscheck.	Electronic Flight Bag providers, Aircraft Manufacturer	January 2015	APPENDIX F
3.5.6	Manufacturers should have clear flight crew procedures required to attain the published takeoff and landing performance.	Aircraft Manufacturer	May 2013	APPENDIX F
3.5.7	Maximum crosswind data published by aircraft manufacturers should be based upon one consistent and declared method of calculation.	Aircraft Manufacturer	January 2014	APPENDIX F
3.5.8	Manufacturers should monitor and analyse all (worldwide) runway excursions involving the aeroplanes they support and share the lessons learned.	Aircraft Manufacturer	January 2014	APPENDIX F

3.6 REGULATORY AND OVERSIGHT

REF	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.6.1	Confirm that all infrastructure, practices and procedures relating to runway operations are in compliance with ICAO provisions.	Regulator, National Supervisory Authority, Safety Oversight.	Immediate	APPENDIX G
3.6.2	Regulators should focus on runway safety in their oversight activities e.g. preventing runway excursion risks.	Regulator, National Supervisory Authority, Safety Oversight.	31 May 2013	APPENDIX G
3.6.3	Ensure that the risk of runway excursions is included in the State Safety Programme.	Regulator, National Supervisory Authority, Safety Oversight.	31 May 2013	APPENDIX G
3.6.4	Ensure aircraft operators, aerodrome operators and air navigation service providers have implemented safety management systems in accordance with the applicable standards and considered the risk of a runway excursion as part of their Safety Management System.	Regulator, National Supervisory Authority, Safety Oversight.	31 May 2013	APPENDIX G
3.6.5	Noise mitigation rules should not increase, and, should seek to reduce where possible, the risk of a runway excursion. Noise mitigation rules that could potentially adversely affect the risk of a runway excursion should undergo a risk assessment.	Regulator, National Supervisory Authority, Safety Oversight.	31 May 2013	APPENDIX G
3.6.6	Ensure that training for pilots, air traffic controllers and aerodrome personnel includes runway excursion prevention measures.	Regulator, National Supervisory Authority, Safety Oversight.	Immediate	APPENDIX G
3.6.7	Ensure aircraft operators as part of their Safety Management System identify and promote appropriate precursors for runway excursions that could be used from their flight monitoring data or safety data set as safety performance indicators that could be used to monitor the risk of a runway excursion. Encourage them to share safety related information based on agreed parameters.	Regulator, National Supervisory Authority, Safety Oversight.	Immediate	APPENDIX G
3.6.8	Ensure the European Action Plan for the Prevention of Runway Excursions is disseminated widely to increase understanding of runway excursion causal and contributory factors and to help organisations implement effective runway excursion prevention measures.	Regulator, National Supervisory Authority, Safety Oversight.	Immediate	APPENDIX G
3.6.9	States should promote the establishment of safety information sharing networks among all users of the aviation system and should facilitate the free exchange of information on actual and potential safety deficiencies.	Regulator, National Supervisory Authority, Safety Oversight.	Immediate	APPENDIX G

3.7 EASA

NEW REF	RECOMMENDATION	OWNER	IMPLEMENTATION DATE	GUIDANCE
3.7.1	Establish and implement one consistent method of contaminated runway surface condition assessment and reporting by the aerodrome operator for use by aircraft operators. Ensure the relation of this report to aircraft performance as published by aircraft manufacturers.	EASA	31 December 2017	APPENDIX H
3.7.2	Establish and implement one consistent method of calculation of crosswind limits for use by aircraft manufacturers and aircraft operators.	EASA	01 June 2015	APPENDIX H
3.7.3	It is recommended that aircraft operators always conduct an in-flight assessment of the landing performance prior to landing. Note: Apply an appropriate margin to these results.	EASA	31 December 2017	APPENDIX H
3.7.4	Establish harmonised criteria for the approval of Electronic Flight Bags. The criteria to be used by aircraft manufacturers and electronic flight bag providers.	EASA	01 October 2013	APPENDIX H
3.7.5	Ensure Standard Operating Procedures take account of pertinent items to prevent runway excursions e.g. full use of braking devices, including reverse thrust, prohibit the use of aerodyn.	EASA	31 December 2017	APPENDIX H
3.7.6	Ensure that training curricula for flight crew and other operational staff working on the approach sector or, on or near the runway, fully considers the risk of runway excursions.	EASA	31 December 2013	APPENDIX H
3.7.7	Noise mitigation rules should not increase, and, should seek to reduce where possible, the risk of a runway excursion. Noise mitigation rules that could potentially adversely affect the risk of a runway excursion should undergo a risk assessment.	EASA	Immediate	APPENDIX H
3.7.8	Identify and raise awareness of contributory and causal factors for runway excursions that could be used as safety performance indicators to monitor the risk of a runway excursion.	EASA	17 June 2013	APPENDIX H
3.7.9	Ensure that States promote the establishment of safety information sharing networks among all users of the aviation system and facilitate the free exchange of information on actual and potential safety deficiencies.	EASA	17 June 2013	APPENDIX H
3.7.10	Sponsor research on the impact of fluid contaminants of varying depth on aircraft stopping performance, also accounting for the impact of lower aquaplane speeds of modern aircraft tyres. EASA should research the impact of lower aquaplane speeds of modern aircraft tyres on aircraft performance.	EASA	01 June 2015	APPENDIX H
3.7.11	Develop rulemaking for the approval of on-board real-time crew alerting systems that make energy based assessments of predicted stopping distance versus landing distance available, and mandate the installation of such systems.	EASA	01 October 2013	APPENDIX H

4. APPENDICES - GUIDANCE MATERIALS

Appendix A Guidelines for Local Runway Safety Teams

Appendix B Aerodrome Operator

Appendix C Air Navigation Service Providers

Appendix D Aeronautical Information Service Providers

Appendix E Aircraft Operators

Appendix F Aircraft Manufacturers

Appendix G Oversight activities for Regulators

Appendix H EASA

A14
V03
L05
IBERIA
AIRBUS A320
IBERIA

APPENDIX A GUIDELINES FOR LOCAL RUNWAY SAFETY TEAMS

Introduction

Recommendation 3.1.1 At individual aerodromes, as designated by the Regulator, a Runway Safety Team should be established to lead action on local runway safety issues.

A Local Runway Safety Team should form a key element in the aerodrome runway safety programme and should ensure that a strong focus is maintained on runway safety across all parties creating, de facto, an aerodrome level safety management function. At some aerodromes cross-disciplinary teams may already exist that could carry out the functions of the Runway Safety Team, using a discrete runway safety agenda. If such teams are employed it is essential that their work is not duplicated; instead the work should be integrated as part of the aerodrome's runway safety action plan.

Role

The establishment of a Local Runway Safety Team is intended to facilitate effective local implementation of the recommendations contained in the European Action Plan for the Prevention of Runway Excursions and to stimulate proactive management of runway safety.

Specific objectives of a Local Runway Safety Team may be to:

- Identify potential runway safety issues by reviewing aerodrome practices regularly, and when relevant information is available, from incident investigation findings.
- Develop appropriate runway excursion risk prevention measures and creation of awareness of potential solutions;
- Advise management on runway safety issues and recommend mitigation measures;
- Create a plan containing action items for mitigating runway safety deficiencies. Action items should be aerodrome specific and linked to a runway safety concern, issue or problem at that aerodrome.

Local Runway Safety Team Composition

The team should consist of, as a minimum, representatives from the main groups associated with takeoff and landing operations, namely the Aerodrome Operator (which could include navigation aids engineers, infrastructure maintenance etc.) Meteorological Offices and Aeronautical Information Service Providers, representatives from the Air Navigation Service Provider, local Air Traffic Controller associations and pilots from Aircraft Operators, local pilot associations that operate at the aerodrome and other relevant organisations that operate on the manoeuvring area.

Terms of Reference

The terms of reference for a Local Runway Safety Team may be based around the framework of composition, role and tasks contained in this Appendix A. Several recommendations address specific tasks of Local Runway Safety Teams and are used in this guidance to highlight the importance of those activities.

Preparing a Runway Safety Programme for your aerodrome

A Local Runway Safety Team may contribute to the creation of a runway safety programme for their aerodrome. The programme should demonstrate consideration of runway and taxiway layout, traffic intensity and mix, and both visual and non-visual aids such as markings, lights, signs, radar, taxiway designations, ATS procedures, AIP information etc.

When preparing a runway safety programme for your aerodrome each action item should designate a responsible person or organisation for completing the relevant tasks. There may be more than one person or organisation affected by an action item; however, one person or organisation should take the lead and be responsible for the completion of all the tasks associated with the action item. A realistic time frame to accomplish the work should also be associated with each action item.

The Local Runway Safety Team can also consider the local operating procedures employed by different companies at the aerodrome. One objective for a runway safety programme will be to create or enhance procedures that are integrated where necessary so as to minimise the risk of runway excursions. Extra care should be taken when examining existing or proposed runway capacity enhancing procedures or noise abatement schemes involving preferential runway systems.

Lessons learned from Local Runway Safety Team experience include writing a runway safety programme with the understanding that it may be unrealistic to expect flight crews to be familiar with local procedures. In addition, local difficulties may be encountered at aerodromes where ICAO provisions have not been respected.

The runway programme may contain the following items:

Compliant with ICAO Provisions

Recommendation 3.1.3 Confirm that all infrastructure, practices and procedures relating to runway operations are in compliance with ICAO provisions.

ICAO Standards and Recommended Practices (SARPS) are available to give the same consistent and predictable operations at any aerodrome in the world. However, some aerodromes do not comply with ICAO provisions and this increases the risk that pilots may not be familiar with local, unique procedures and practices.

Raise awareness of runway safety matters

Recommendation 3.1.2 A local runway safety awareness campaign should be initiated at each aerodrome for Air Traffic Controllers, Pilots and other personnel who operate on or near the runway. The awareness campaign should be periodically refreshed to maintain interest and operational awareness.

The Local Runway Safety Team should assist in keeping a spotlight on the subject of runway excursion prevention and to develop and run **local awareness campaigns**.

This can be achieved by ensuring that practices to prevent runway excursions are locally understood and applied, e.g. awareness of the behaviour of local weather including wind and gusts.

The Local Runway Safety Team can set up a user friendly email address to ease communication e.g. lrst@xyzairport.aa

The timing of awareness campaigns is important, making a runway safety briefing at the start of a busy season, or just before a period of weather that may increase the risk of a runway excursion can be helpful to all operational staff.

Local Runway Safety Teams can play a role in preparing the briefing pack for new users of an aerodrome, or for a new season.

Education and awareness of Local Runway Safety Team' achievements, can be communicated via training syllabi, newsletters, posters, stickers and the use of forums, on-line and in workshops.

Raise awareness of runway safety matters

Recommendation 3.1.4 Where practicable, ensure that specific joint training and familiarisation in the prevention of runway excursions, is provided to Pilots, Air Traffic Controllers and Aerodrome Operator staff. This may include visits to the manoeuvring area to increase awareness of markings, signage, and position of anemometers etc. where this is considered necessary.

Recommendation 3.1.5 Runway safety should be part of initial and recurrent training for operational staff e.g. Air Traffic Controllers, Pilots, Meteorology officers, NOTAM officers and all other personnel involved in manoeuvring area operations.

Training on runway safety matters may traditionally have been a supplement to core content training or European training syllabi for licensing and certification and included in the continuation training for air traffic controllers. Today there is an opportunity to include runway safety as part of the initial and recurrent training for all operational staff working on and around the manoeuvring area.

Technology

Technology is available to help to prevent runway excursions and may be considered to supplement good working practices by enhancing situational awareness and providing appropriate decision support information and alerts.

Information Sharing

Recommendation 3.1.6 All users of the aviation system should participate in safety information sharing networks and exchange relevant information on actual and potential safety deficiencies to ensure that runway safety risks are correctly identified and appropriately mitigated at each aerodrome.

ICAO says that all available safety recommendations of global interest to the civil aviation community, resulting from runway related accidents and incidents and their successful risk mitigations should be reported to ICAO using the normal reporting mechanism for the relevant organisations. ICAO Annex 13 emphasizes the need for lesson sharing:

"Exchange of safety information. 8.9 Recommendation.- States should promote the establishment of safety information sharing networks among all users of the aviation system and should facilitate the free exchange of information on actual and potential safety deficiencies."

Runway Excursion definition

To enable the sharing of runway safety lessons a common understanding of runway excursion causal and contributory factors has been made using the following commonly agreed definition:

A runway excursion is the event in which an aircraft veers off or overruns the runway surface during either takeoff or landing (taken from ECCAIRS taxonomy and ICAO).

Understanding runway excursion risk allows individual aerodromes to manage it from their own unique perspective and as a collective contributor to the Air Traffic Management network.

Dissemination of Safety recommendations

A Local Runway Safety Team should ensure wide dissemination of the safety recommendations derived from accident and incident investigation findings as well as other relevant lessons learned, for example from operational experience, and best risk mitigation practices.

Communication Practices

Recommendation 3.2.5 Ensure robust procedures are in place for calculating temporary reduced declared distances e.g. due to work in progress on the runway. When reduced declared distances are in operation, ensure that the temporary markings, lighting and signs accurately portray the reduced distances and that they are well communicated, and transferred to States aeronautical information services for publication.

Recommendation 3.3.4 Review processes covering the provision of safety significant 'essential' information such as weather, wind and runway surface conditions (e.g. when 'wet' or contaminated):

- **4a. To ensure a consistent, timely and accurate broadcast of aerodrome information.**
- **4b. To ensure the integrity of the safety significant information supply chain from the provider (e.g. Met Office/Aerodrome Operator) to ATC/AISP and on to the flight crew.**
- **4c. Consider equipping for digital transmission of ATIS, as appropriate.**
- **4d. Ensure that training on the use of ATIS/ D-ATIS is provided to relevant operational staff (ANSP/AISP).**

Recommendation 3.3.5 Ensure that pilots in command/ flight crews are informed of the Takeoff Run Available (TORA) or the Landing Distance Available (LDA) if these differ from the published data using appropriate means.

Misunderstanding following a communication breakdown due to the use of non standard ICAO phraseology is found in many accident and incident reports. Communication at an aerodrome includes the written information found in the AIP, NOTAMS, SNOWTAMS and their electronic equivalents and ATIS / D-ATIS. Navigation aids, signs, marking and lighting are also an important provider of information to flight crew.

Tasks could also include, assisting in verifying that coordination between the support offices of the aircraft operator, aerodrome operator and air navigation service provider are satisfactory, or if any improvements could be suggested, an example would be to demonstrate the consistent accuracy of maps and charts in use by all organisations. More is said about this subject in Appendix D.

The inherent difficulties of communicating using R/T mean that local airspace design and associated procedures, aerodrome design, visual and navigation aids and infrastructure play an important part in reinforcing the intended instructions passed by the air traffic controller. More is said about this subject in Appendix C.

Change Management

Recommendation 3.1.7 Changes to manoeuvring area infrastructure, practices and procedures, including planned works must take account of runway safety and may require consultation with the local runway safety team. An adequate risk assessment should be the basis for procedural and/or infrastructural changes on the manoeuvring area.

Review proposed changes. Changes proposed to the navigational aids supporting landing on a specific runway and other relevant infrastructure in the light of runway excursion sensitivity must be reviewed and the aerodrome operators or building contractors advised to ensure e.g. that reduced runway lengths are correctly calculated.

Measure the effectiveness of operational solutions periodically. This can be accomplished by comparing the results of the initial analysis with current performance parameters e.g. the number of approaches flown compliant with the stabilised approach criteria.

It may be of interest to look at the regional and global picture for runway excursion numbers as it is rare that one aerodrome will have several to discuss in a short time frame. It is proposed that some members of a Local Runway Safety Team participate in safety case work, regarding changes to existing, procedures or infrastructure involving runways.

A summary list of possible tasks for a Local Runway Safety Team

- Monitor the number, type and the severity of runway excursions or their precursors;
- Identify any local problem areas and suggest improvements e.g. by sharing the outcome of investigation reports to establish local problem areas on the approach and / or at the aerodrome and workable mitigations with and for operational staff;
- Ensure that suitable data is available to provide evidence for making decisions;
- Analyse and understand the findings from incident and accident investigations in the local context;
- Take account of lessons learned from incidents and accidents related to runway safety issues from other aerodromes, as well as one's own aerodrome/organisation;
- Assess all landing and visual aids to check that they are correctly located, working to the appropriate standard and clearly visible where appropriate, to flight crews, in different weather and light conditions;
- Work as a cohesive team to better understand the operating difficulties of personnel who work in other areas and recommend areas for improvement;
- Ensure that the recommendations contained in the European Action Plan for the Prevention of Runway Excursions are implemented;
- Conduct a runway safety awareness campaign that focuses on local issues, and produce and distribute local awareness and guidance materials as considered necessary; and
- Review the airfield to ensure it is in accordance with ICAO Standards and Recommended Practices regularly e.g. navigation aids (e.g. ILS, AGL, PAPIs) and surface markings are provided to promote the appropriate use of the touchdown zone, especially where runway length is limited. All markings and signs should be adequate for and understandable by all parties, with no possible ambiguity of their meaning;
- Review the design of local airspace, associated procedures and approach and landing aids, are checked to be fit for purpose for all aircraft types;
- Ensure that processes and procedures are in place to communicate weather and runway condition reports in a meaningful and relevant timeframe for the flight crew.

Recommendation 3.2.1 Ensure that runways are constructed and refurbished to ICAO specifications, so that effective friction levels and drainage are achieved.

Physical Characteristics

An aerodrome operator can reduce the risk of runway excursions by undertaking some basic steps, to provide a runway suitable for landing and takeoff.

The basic surface elements consist of the slopes – both longitudinal and transverse, which are provided to give as flat a surface as possible for aircraft and drainage properties to remove water. A porous surface or a surface treated with grooves may further reduce the presence of liquid contaminants between the tyre and the runway surface.

Recommendations concerning surface slopes, runway width, lighting, markings, signage etc. are provided in ICAO Annex 14 and in the Aerodrome Design Manual.

Recommendation 3.2.2 An appropriate program should be in place to maintain the runway surface friction characteristics by removal of contaminants.

Maintenance

In addition areas of the runway surface will wear down over time, depending on use, and this needs to be monitored by the airport operator. A smooth or rubber contaminated surface provides less friction than a textured one. Surface assessments or friction readings should be undertaken at adequate intervals to ensure that the runway surface remains suitable for continued operation. This may ultimately lead to runway resurfacing but improvements can be achieved also by improving the texture or removing for example rubber deposits that can build up over time. Should the condition deteriorate too far it may be necessary to advise aircraft operators that parts of the runway may have inadequate friction in certain conditions e.g. slippery when wet.

When constructing or resurfacing a runway the new surface should have an adequate texture to minimise the time window of exposure to slippery conditions after heavy rain showers.

Recommendation 3.2.3 If provided, ensure that appropriate navigation aids (e.g. ILS, AGL, PAPIs), and surface markings are maintained in accordance with ICAO Standards and Recommended Practices, to promote the accurate landing/touchdown point.

Visual Aids

The availability of location information such as signs, lights and markings (for example centreline markings, aiming point markings, edge markings) both along the runway and at the holding points should provide the flight crew with a good situational awareness as to their precise location.

Holding positions should be marked, signed and if required lit as specified in ICAO Annex 14. For example mandatory signs provided at runway-taxiway intersections can assist in reducing the likelihood of runway excursions as their presence will assist flight crew in ensuring the takeoff roll commences at the correct location.

Navigation Aids

Navigation aids e.g. ILS, AGL, PAPIs should also be provided and maintained in accordance with ICAO Standards and Recommended Practices, to promote the accurate landing/touchdown point. When transitioning to visual flight above or at the decision height, the pilot is gradually shifting his or her attention to the visual approach indicator or to the runway and the touchdown point; still using their instruments as a backup.

Recommendation 3.2.4 Ensure that the runway holding points are clearly marked, signed and if required, lit. Consider the use of signage at the runway holding points used for intersection takeoffs to indicate the Takeoff Run Available (TORA).

Recommendation 3.2.5 Ensure robust procedures are in place for calculating temporary reduced declared distances e.g. due to work in progress on the runway. When reduced declared distances are in operation, ensure that the temporary markings, lighting and signs accurately portray the reduced distances and that they are well communicated, and transferred to States aeronautical information services for publication.

Temporary Declared Distances

Should the runway declared distances be temporarily reduced for any reason, for example during maintenance or construction work, the position and nature of the signs, markings and lighting should be carefully planned to ensure the correct temporary information is displayed during any changes. These reduced distances need to be carefully determined as they are used in aircraft performance calculations by the aircraft operators. Temporary or reduced runway lengths must also be carefully communicated to flight crew by NOTAM or AIP entry and to ATS for inclusion in ATIS, flight briefing material or live radio communication. Electronic signs displaying text specific to temporary changes may be a useful addition in certain circumstances. It is clearly very important that such temporary changes are communicated very clearly with adequate advance notice and brought to the attention of all flight crew affected.

An adequate risk assessment should be the basis for procedural and/or infrastructural changes on the manoeuvring area.

Recommendation 3.2.6 If runway contamination occurs or is changing assess the runway conditions.

Changing Runway Conditions

If the runway surface becomes contaminated – for example with large volumes of water or winter contaminants, it is important that the aerodrome operator has a process for promptly assessing or measuring the amount of contamination, or the operational surface friction. This task should be undertaken at any time there is a change in the nature of the contamination – e.g. depth or type of contaminant. The results should be considered by the aerodrome operator as to what action is appropriate e.g. issuing a SNOWTAM, or adequate clearing the runway of snow.

Recommendation 3.2.7 Ensure robust procedures are in place for communicating safety significant information regarding changing surface conditions as frequently as practicable to the appropriate air traffic services.

Recommendation 3.2.8 In accordance with ICAO provisions, wind sensors and wind direction indicators (wind socks) should be sited to give the best practicable indication of conditions along the runway and touchdown zones.

Communication

If the runway is in use, the meteorological observations such as wind speed, direction and variation and the results of runway condition assessments should be passed to flight crew. This can be done in a number of ways, mostly by RTF message from air traffic services, but can also be promulgated by SNOWTAM and ATIS.

This information must be kept up to date – the process should be repeated whenever there is a change in the nature of the contamination, to ensure up to date information is provided. If the conditions are rapidly changing it may be appropriate to consider suspending operations on that runway until the surface conditions can be assessed as stable.

Recommendation 3.2.9 Consider equipping for digital transmission of ATIS, as appropriate.

The aerodrome operator should consider equipping the aerodrome with data-link systems that allow flight crews to obtain the latest weather without one pilot leaving the active frequency e.g. D-ATIS using ACARS.

NOTE:
The FAA has worked with industry and produced the TALPA ARC "Paved Runway Condition Assessment Matrix" for aircraft operators and airport operators to use. This is supported by the FAA although not yet formally adopted.

It is essential the right information is provided to the flight crew

APPENDIX C AIR NAVIGATION SERVICE PROVIDERS

Air Traffic Controllers routinely contribute to the prevention of runway excursions by helping flight crews fly stabilised approaches by adhering to procedures and, for instance, avoiding short-cuts that prevent flight crews from losing the necessary height and speed during the approach. Moreover, through the provision of safety significant, "essential" information such as changes to surface wind, reduced runway lengths and runway surface conditions, Air Traffic Control (ATC) ensures that flight crews have the latest aerodrome information available to enable safe takeoffs and landings.

However, breakdowns in these ATC functions can have unintended outcomes. For instance, sub-optimal control techniques such as late descent and inappropriate speed control can contribute to aircraft flying unstabilised approaches with, statistically at least, an increased risk of runway excursion. In addition, interruptions, omissions or errors involving the flow of "essential" information may deprive flight crews of operational safety decision-making data at critical stages of flight.

The following guidance material is intended to explain further the Recommendations it refers to and complement relevant ICAO provisions. In some instances, 'case study examples' are provided to amplify and provide additional reference to the issue being considered.

> **Recommendation 3.3.1 Ensure the importance of a stabilised approach and compliance with final approach procedures is included in training and briefing for air traffic control staff.**
>
> **Recommendation 3.3.2 When assigning a runway or changing a runway assignment for arriving or departing traffic, consider the time a pilot will require to prepare/re-brief.**

Air Navigation Service Providers are invited to review this guidance material and, where necessary, amend their training programmes, briefing practices and Standard Operating Procedures with regard to their involvement in stabilised approaches and flight crew briefing.

A prime role of ATC is to position aircraft so that a safe approach and landing is possible. The key points to highlight to air traffic controllers are:

- **Flight Crew Environment** Having a basic awareness and appreciation of flight crews' operating (cockpit) environment and constraints. For instance, non-precision approaches (NPAs) involve increased workload therefore, when positioning aircraft for NPAs a longer final approach may be necessary and speed instructions should be avoided.
- **Flight Crew Briefing** Understanding the importance of the flight crew approach brief. This has a single common objective - to preview what will or might well happen during an imminent approach and landing. There is no such thing as a typical briefing but the time to complete the majority of them might be within the range 2 - 6 minutes and it can be expected to be conducted 10 minutes before reaching the top-of descent point (ToD). Any approach re-briefing which might have to be conducted later would be at risk of being interrupted by either ATC communications and/or aircraft management priorities.
- **Inappropriate Speed Control Instruction** Avoiding inappropriate speed control instructions that are incompatible with aircraft performance, distance to go and the required vertical profile below FL100 after taking account of any significant head or tailwind components evident at altitude.
- **Distance to Go Information** Recognising that when providing vectors it is necessary to initially advise/periodically provide flight crews with estimated track miles to go.
- **Delayed Descent Instructions** Understanding that delaying descent and keeping aircraft unduly high may result in flight crews requesting additional track miles or contribute to high energy unstabilised approaches.

> **Example covering speed control, distance to go and delayed descent:**
>
> http://www.skybrary.aero/index.php/B733,_Burbank_CA_USA,_2000_(RE_HF)

- **Late Runway or Approach Type Changes** Appreciating that a change of instrument approach without adequate prior notification at any time after an aircraft has left the higher of cruise altitude or (typically) FL100 in descent to destination is undesirable. A 'late' change from a precision to a non-precision approach can be significant and may not always be feasible unless additional track miles are provided.

- **Runway Selection** Ensuring that the runway selected for operations is based on safety considerations, e.g. best length and or wind conditions, and not primarily on capacity, ease of controlling or environmental/ noise abatement reasons. However, it is recognised that at some locations for a variety of reasons these latter factors do influence the selection of the runway. In these circumstances it is incumbent on ATC to monitor the situation carefully and advise flight crews, for instance, about tailwinds. There is a balance to be struck, but when in doubt the safety considerations must assume primacy and runways should be changed to ensure the safety of operations.
- **Compliance with final approach procedures, including but not restricted to:**
  - According to ICAO Doc 4444, PANS ATM § 4.6.3.6 "Only minor speed adjustments not exceeding plus/ minus 40 km/h (20 kt) IAS should be used for aircraft on intermediate and final approach."
  - According to ICAO Doc 4444, PANS ATM § 4.6.3.7 "Speed control should not be applied to aircraft after passing a point 7 km (4 NM) from the threshold on final approach."

    NOTE:

    The flight crew has a requirement to fly a stabilized approach (airspeed and configuration) typically by 5 km (3 NM) from the threshold (Doc 8168, PANS-OPS, Volume I, Part III, Section 4, Chapter 3, 3.3 refers)
  - According to ICAO Doc 4444, PANS ATM § 8.9.3.6 "Aircraft vectored for final approach should be given a heading or a series of headings calculated to close with the final approach track. The final approach vector should enable the aircraft to be established in level flight on the final approach track prior to intercepting the specified or nominal glide path if an MLS, ILS or radar approach is to be made, and should provide an intercept angle with the final approach track of 45 degrees or less."
  - According to ICAO Doc 4444, PANS ATM in 6.7.3.2 Requirements and procedures for independent parallel approaches § 6.7.3.2.3 "When vectoring to intercept the ILS localizer course or MLS final approach track, the final vector shall enable the aircraft to intercept the ILS localizer course or MLS final approach track at an angle not greater than 30 degrees and to provide at least 2 km (1.0 NM) straight and level flight prior to ILS localizer course or MLS final approach track intercept. The vector shall also enable the aircraft to be established on the ILS localizer course or MLS final approach track in level flight for at least 3.7 km (2.0 NM) prior to intercepting the ILS glide path or specified MLS elevation angle."

Example Case Study:

http://www.bea.aero/docspa/2004/su-f040321a/pdf/su-f040321a.pdf

- **ILS Protected Zone during CAT II/III Training Approaches when Low Visibility procedures are not in force** Some aircraft operators conduct ILS CAT II/III approaches during CAT I (i.e. during non-LVP) for training purposes. The presence of vehicles or aircraft in ILS protected zone can cause undesirable autopilot behaviour at low altitude. In addition, these operations may compromise the regular flow of traffic/sequencing. Permission to conduct a training flight e.g. CAT II/III training approach in good weather must be requested by the aircraft operator as advised in the AIP. ATC may reject such a request or interrupt the current procedure according to the traffic situation at the time.

Example Case Study:

http://www.bfu- web.de/cln_030/nn_226462/EN/Publications/Investigation_20Report/2011/FactualReport__11__EX010__B777__Munic,templateId=raw,property=publicationFile.pdf/FactualReport_11_EX010_B777_Munic.pdf

- **Use of 'non-essential' information** Having a basic understanding that some well-intentioned actions, clearances and instructions to flight crews to improve the flow of air traffic may not always have the planned consequences. For instance, using phrases such as "landing long available" might induce pilots to touch-down further down the runway than they had originally intended/calculated. Furthermore, depending on flight crew experience and constraints, the surface conditions and the time/position in the landing sequence where the manoeuvre is executed, the use of "expedite vacate" may trigger pilots to travel too fast for the conditions and/or aerodrome layout. Of course, in many situations the use of these phrases may be perfectly legitimate (and safe). Nevertheless, to lessen the risk of runway excursion, controllers should use them with care. The timing of the messages is a key consideration and they should be used only in circumstances that are appropriate to the prevailing runway surface conditions and/or aerodrome layout.

- **Periodic Briefing of Controllers** To complement the inclusion of stabilised approach awareness training for controllers, many ANSPs utilise their routine briefing facilities (e.g. Operational Information folders) to highlight runway excursion prevention issues (including stabilised approaches) to controllers on a periodic basis. In addition, immediate post runway excursion incident/accident awareness can be provided for written/oral briefing by Supervisors/Watch Managers as part of watch handover/takeover procedures. In slower time, information gathered in the spirit of ANSP Recommendations 3 and 6 can also be analysed and the outcomes (e.g. lessons learnt, operational changes etc) notified to control staff through the routine briefing processes.
- **ANSP Radar Display Marker** In some ATC facilities in France, controllers are provided with a 'Screen Interception Marker'. The marker arrow is displayed on the radar approach screen for the interception of the final approach track. The marker is located in accordance with ICAO PANS ATM (so as to provide 30 seconds straight and level flight at 180kts). Operational procedures specify that it should be considered as the final point for the controller to provide a straight and level flight.

Example of the 'Screen Interception Marker' arrow (in the red circle)

More detailed guidance/advice to support better controller understanding of all the points listed previously can be found in the Reference material listed below.

Missed approach /go-around

Some runway excursions can be prevented by flight crews executing a go-around when needed. Safe and timely go-arounds are dependant on two main factors: flight crew decision-making and execution. However, ATC actions can also influence both of these processes, for instance, when initiating the execution of a go-around, controllers should use the standard PANS ATM (12.3.4.18) phraseology, "GO-AROUND" (flight crew response "GOING AROUND") rather than alternatives such as "break off the approach" or "execute missed approach" which may lead to misunderstanding.

NOTE:
See also Aircraft Operator Recommendation and Guidance Material - 3.4.16 & 3.4.19

Reference Materials:

- General Local Runway Safety Team (LRST) advice and guidance.
- ICAO PANS ATM, Doc 4444.
- SKYbrary (www.skybrary.aero).
- Runway Excursion Portal.
- Stabilised Approach Awareness Toolkit for ATC.
- Flight Deck Procedures - A Guide for Controllers - courtesy of the NATS, easyJet and bmi "Normal Operations" video.
- CANSO, "Unstable approaches - ATC Considerations", January 2011.
- Operators Guide to Human Factors in Aviation (OGHFA) (FSF).
- DGAC, France: 3 documents (available on SKYbrary Bookshelf).
- "Unstabilised Approaches"; "Synthesis on Unstabilised Approaches"; and "Stabilised Approaches Good Practice Guide".
- Flight Safety Foundation (FSF) ALAR Toolkit, Briefing Notes 4.1, 4.2, 7.1 and 8.1.
- FSF, Runway Excursion Risk Awareness Tool, May 2009.
- IATA, Runway Excursion Risk Reduction Toolkit.
- EUROCONTROL HindSight 12 magazine.
- IFALPA Position Paper: IFALPA Runway Safety Policy - Ref 09POS01.
- ICAO European Interim Guidance Material on Management of ILS Localizer Critical and Sensitive Areas.

Recommendation 3.3.3 Review available data (occurrence reports etc.) with the aim of identifying contributing factors and relevant actions regarding airspace design and procedures, air traffic controller training and procedures, etc

- Sector interfaces and the ability to control the speed and descent profiles should be taken into consideration while trying to remove the excursion risk from airspace design. ANSPs should consider using reported data from aircraft operators about unstabilised approaches in order to consider systemic changes to sector management (e.g. handover and flow rates), airspace design and associated procedures and runway management to reduce the risk of recurrence.
- This pre-supposes that aircraft operators are willing to provide the information to ATC in the first instance. Cooperation through Local Runway Safety Teams (LRSTs) may assist in this regard and ANSPs can address the issue within the wider context of their Safety Management Systems (SMS).
- Some ANSPs record and then analyse go-arounds/ missed approaches; any ATC contribution to unstabilised approaches may be identified during this process. Radar and R/T recordings are another useful source of information to help controllers learn lessons from reported events.

Reference Materials:

See Local Runway Safety Team advice and guidance.

Recommendation 3.3.4 Review processes covering the provision of safety significant 'essential' aerodrome information such as weather, wind and runway surface conditions (e.g. when 'wet' or contaminated):

4a. To ensure a consistent, timely and accurate broadcast of aerodrome information.

4b. To ensure the integrity of the safety significant information supply chain from the provider (e.g. Met Office/Aerodrome Operator) to ATC/AISP and on to the flight crew.

4c. Consider equipping for digital transmission of ATIS, as appropriate.

4d. Ensure that training on the use of ATIS/ D-ATIS is provided to relevant operational staff (ANSP/AISP).

Essential information is provided through 3 main types of media: Aeronautical Information Services (AIPs, NOTAMs etc); ATIS/D-ATIS; and radio telephony. In certain circumstances, aerodrome signage can also supplement the written and/or oral data.

More detailed guidance material covering Recommendation 4b and 4d can be found in the Aeronautical Information Service Providers section. Furthermore, the Aircraft Operator and Aerodrome Operator sections also have complementary Recommendations and Guidance Material for Aircraft Operators and Aerodrome Operators related to the provision of safety significant "essential" information.

Essential Information

ICAO Doc 4444, PANS ATM, states the following:

7.5.2 Essential information on aerodrome conditions shall include information relating to the following:

a) Construction or maintenance work on, or immediately adjacent to the movement area…

h) any other information.

7.5.3 Essential information on aerodrome conditions shall be given to every aircraft, except when it is known that the aircraft already has received all of or part of the information from other sources. The information shall be given in sufficient time for the aircraft to make proper use of it, and the hazards shall be identified as distinctly as possible. Note - "Other sources" include NOTAM, ATIS broadcast, and display of suitable signals.

It is incumbent on all personnel involved in the flow of "essential" information to not only ensure the quality of the data but also the integrity of the processes and procedures that ensures its onward transmission to ATC.

Formal arrangements between data providers and ANSP/ AISP (e.g. in the form of a contract or Service Level Agreement (SLA)) should be introduced to support and enable the relevant data exchange.

In turn, ATC working together with partners, should ensure the timely provision and delivery of the information to flight crews to assist in their operational decision-making.

ANSP/Aerodrome Operator Example - Runway Reporting System

Some air navigation service providers and aerodrome operators have worked together to introduce 'runway reporting systems' (hardware, software applications and associated communications) to forward runway conditions information in real-time and in fixed format automatically to air traffic control and onward to flight crews.

The main components of the systems are a continuous friction measurement device, and advanced pieces of software: one in a lap-top situated in the runway inspection vehicle, and the other on a server, which processes (possibly via 3G connection) transmitted information for various purposes.

Runway reporting systems forward information about the contaminants (e.g. snow and ice) on the runway surface, and about the level of friction. They can also produce SNOWTAM message and include in them, as a new feature, information regarding the operationally most significant contaminant on the runway. The information assists pilot decision-making to optimise safe takeoffs and landings.

The advantage of these systems is that information reporting can be quicker and more consistent.

An example of an operational runway reporting system is the one operated by Finavia and details can be found at https://ais.fi/ais/aica/A/A2011/EF_CIRC_2011_A_006_EN.pdf

ATIS/D-ATIS

NOTE:
Depending on the organisational/operational structure, ANSPs or AISPs may be responsible for the provision of ATIS/D-ATIS. This guidance material is therefore repeated in the Aeronautical Information Service Provider section.

The reception of ATIS via data-link, allows both pilots to maintain their listening of ATC communications during critical high workload phases of flight, thus increasing the situational awareness and reducing the likelihood of distraction induced mistakes, lapses or confusion. Furthermore, depending on the traffic density and the complexity of the approach, it may assist flight crews with the go-around /Landing decision making process by providing the latest changes to the runway condition and local weather, which is subject to the equipment being set up to allow this data to be send to the pilot automatically.

ICAO Annex 11, Air Traffic Services, Chapter 4 (Flight Information Services) states variously that ATIS/ D-ATIS broadcasts shall include,

- significant runway surface conditions (e.g. when the runway is 'wet' or the presence of other contaminants such as snow, slush, ice, rubber, oil) and, if appropriate, braking action;
- surface wind direction and speed, including significant variations;
- any available information on significant meteorological phenomena in the approach and climb-out areas including wind shear, and information on recent weather of operational significance;
- "*other essential operational information*". Runway surface conditions and reduced runway lengths for landing and takeoff fall into this category of data.

In accordance with Sections 4.1 and 4.3 of Appendix 3 to Annex 3, the surface wind direction and speed is to be averaged over 2 minutes. The wind information is to refer to conditions along the runway for departing aircraft and to conditions at the touchdown zone for arriving aircraft. Specifically, Annex 11 Chapter 4 also says that ATIS broadcasts shall include:

"surface wind direction and speed, including significant variations and, if surface wind sensors related specifically to the sections of runway(s) in use are available and the information is required by operators, the indication of the runway and the section of the runway to which the information refers."

In addition, ICAO PANS ATM section 6.6.4 says:

"At the commencement of final approach, the following information shall be transmitted to aircraft:

a) significant changes in the mean surface wind direction and speed;

NOTE
Significant changes are specified in Annex 3, Chapter 4. However, if the controller possesses wind information in the form of components, the significant changes are:

- *Mean headwind component: 19 km/h (10 kt).*
- *Mean tailwind component: 4 km/h (2 kt).*
- *Mean crosswind component: 9 km/h (5 kt)."*

Furthermore, ICAO Annex 3, § 4.1.5.2 states that presence of wind gusts more than 5kts above the average will be indicated if noise abatement procedures are in force. A wind below 1kt will be considered as 'calm'. This information is essential to pilots in their process decision making.

To ensure that ATIS/D-ATIS provide operational and safety benefits, it is essential that the relevant operational AIS/ATC staff is competent in the use of ATIS/D-ATIS equipment and understand and apply the broad principles for the operation of these systems as described in Annex 11, Chapter 4.

Example Case Study:

http://www.skybrary.aero/index.php/B773,_Auckland_Airport_New_Zealand,_2007_(RE_HF)

Radio Telephony

Time critical aerodrome information (such as weather, surface conditions, wind, etc) which may affect runway operations shall be provided to pilots in 'real time' using radio telephony communication, in accordance with ICAO Annex 11 (Chapters 2 and 4).

Reference Materials:

- ICAO Annex 11, Air Traffic Services.
- ICAO Annex 3, Meteorological Services for International Air Navigation.
- ICAO Doc 4444, PANS ATM.
- ICAO Doc 9432, Manual of Radiotelephony.
- Flight Safety Foundation (FSF) ALAR Toolkit. Briefing notes 8.1, 8.5, 8.6 and 8.7.

Recommendation 3.3.5 Ensure that pilots in command/flight crews are informed of the Takeoff Run Available (TORA) or the Landing Distance Available (LDA) if these differ from the published data.

Declared Distances

ICAO Annex 14, Aerodromes, §2.8 recommends that distances shall be calculated to the nearest metre or foot for a runway intended for use by international commercial air transport. These 'declared distances' include: takeoff run available (TORA); takeoff distance available (TODA); accelerate-stop distance available (ASDA); and landing distance available LDA).

NOTE:
Guidance on calculation of declared distances is given in Attachment A, Section of Annex 14.

TORA and LDA for a particular runway may vary from those published due to a variety of reasons, e.g. construction work or snow clearing operations which may reduce the takeoff and landing distances available. **This "essential information" must be made available to flight crews via an appropriate mechanism and format**, in accordance with ICAO Annex 15, Aeronautical Information Services.

Intersection Departures

- Flight crews may opt for, or ATC may suggest, a departure from a runway intersection that effectively reduces the runway length available for flight operations. Intersection departures should be appropriate to the aircraft type and take into account work in progress and other relevant factors limiting operations.
- The ultimate decision rests with the aircraft commander. However, ATC actions assist in the decision-making process. To ensure that the intersection TORA distances are known, ATC should inform pilots of the takeoff run available (in metres) from the runway intersection position if this differs from signage.

ICAO Doc 7030, EUR SUPPs § 6.5.2.4, states:

> *"Runway declared distances for an intersection takeoff position shall be published in the relevant AIP, clearly distinguishable from full runway declared distances"*

- Best practice exists concerning the associated phraseology to be used by ATC which is line with the guidance in the ICAO EUR SUPPs, namely:
  - "TORA" (to be pronounced as "TOR-AH") replaces the words "TAKEOFF" in the R/T message.
  - Thus, an example ATC R/T message to advise of the takeoff run available from an intersection will be:

> *"Call sign, Tora runway 09, from intersection alpha, 2800 metres".*

Example Case Study:

http://www.skybrary.aero/index.php/B772,_St_Kitts_West_Indies,_2009_(HF_RE)

To supplement the oral message, ICAO Annex 14, Aerodromes, recommends that an intersection takeoff sign should be provided when there is an operational need to indicate the remaining TORA for an intersection takeoff. In addition, Annex 14 § 5.4.3.29 says that, "*the inscription on an intersection takeoff sign shall consist of a numerical message indicating the remaining takeoff run available in metres plus an arrow, appropriately located and oriented, indicating the direction of takeoff…*".

ANSPs should cooperate with aerodrome operators to clarify the signage requirements on individual aerodromes.

Construction/Work in Progress

The runway length available for takeoff or landing may change during construction or other work in progress. The revised runway lengths available (TORA/LDA) if these differ from States published data, should be made available to flight crews via changes to the AIP and/or NOTAM. ATIS/D-ATIS should also be used to re-enforce the message.

For short-notice reductions when the necessary aeronautical information amendments have not been promulgated, it is important to clearly state that the TORA / LDA is different from published and it will be necessary for ATC to broadcast the essential information via R/T and/or ATIS/D-ATIS. In addition, ATC may also consider it appropriate to provide this information in 'real-time' even when the changes **have been** notified in aeronautical publications and/or ATIS/D-ATIS.

ICAO Doc 4444, PANS ATM Phraseologies § 12.3.1.10 states:

> d) CAUTION CONSTRUCTION WORK (location);
> e) CAUTION (specify reasons) RIGHT (or LEFT), (or BOTH SIDES OF RUNWAY [Number]);
> f) CAUTION WORK IN PROGRESS (or OBSTRUCTION) (position and any necessary advice).

Example Case Study:

http://www.skybrary.aero/index.php/B738,_Manchester_UK,_2003_(GND_RE_HF)

http://www.skybrary.aero/index.php/DH8D,_Chania_Greece,_2010_(RE_HF)

Landing Distances

As far as reduced landing distances (displaced threshold) are concerned, then Annex 14 §3.5 states:

"Where a runway has a displaced threshold, then the LDA will be reduced by the distance the threshold is displaced… A displaced threshold affects only the LDA for the approaches made to that threshold; all declared distances for operations in the reciprocal direction are unaffected."

Takeoff Cancellation

In certain scenarios (e.g. a runway incursion seen by the controller) it may be necessary for the controller to cancel a takeoff clearance or stop an aircraft that has begun its takeoff roll.

The correct PANS ATM phraseology (para 12.3.4.11) to cancel a takeoff clearance is:

e) HOLD POSITION, CANCEL TAKEOFF, I SAY AGAIN CANCEL TAKEOFF (reasons)

Whilst to stop a takeoff after an aircraft has commenced takeoff roll it is:

g) STOP IMMEDIATELY [(repeat aircraft call sign)] STOP IMMEDIATELY

Readback

h) STOPPING

The final authority rests with the flight crew. There are situations for example at high speeds where the flight crew will decide to continue the take-off regardless of any ATC instructions.

Reference Materials:

- ICAO Annex 14, Aerodromes.
- ICAO Annex 15, Aeronautical Information Services
- ICAO Doc 7030, Regional Supplementary Procedures (Europe).
- ICAO Doc 4444, PANS ATM.
- ICAO Doc 9432, Manual of Radiotelephony.
- Flight Safety Foundation (FSF) ALAR Toolkit. Briefing note 8.3

Recommendation 3.3.6 Participate in safety information sharing networks to facilitate the free exchange of information on actual and potential safety deficiencies.

Exchanging safety information provides significant safety benefits. It allows ANSPs to learn not only from their own experiences but also from the experiences of others.

Having direct contact with other stakeholders allows ANSPs to get first-hand information. It also provides an opportunity to ask specific questions and communicate on specific issues related to runway excursions without losing precious time.

ANSPs can participate in safety information sharing in several ways as part of ongoing SMS activities:

- Set up safety information exchange with other ANSPs.
- Set up safety information exchange agreements with aircraft operators or other stakeholder groups.
- Register and use Internet safety information exchange facilities such as SKYbrary (www.skybrary.aero).
- Join one of the existing safety information exchange networks such as EVAIR (EUROCONTROL Voluntary ATM Incident Reporting); IATA STEADES; Flight Safety Foundation.
- By being an active member of Local Runway Safety Teams.

APPENDIX D AERONAUTICAL INFORMATION SERVICE PROVIDERS

Aeronautical Information Service Providers (AISPs) have a critical role to play in the provision of safety significant "essential" information. AISPs must therefore work together with Aerodrome Operators, ANSPs and the Meteorological Office (as necessary) to ensure the integrity of the "essential" information supply chain. The aim is to ensure that the right (quality) information is available in the right place for it to be passed (by various and appropriate means) to flight crews at the right (optimal) time to aid operational decision making.

AISPs are invited to review this guidance material and, where necessary, amend their processes and procedures with regard to their involvement in the provision of safety significant, "essential" information.

Recommendation 3.3.4 Review processes covering the provision of safety significant 'essential' information such as weather, wind and runway surface conditions (e.g. when 'wet' or contaminated):

4a. To ensure a consistent, timely and accurate broadcast of aerodrome information.
4b. To ensure the integrity of the safety significant information supply chain from the provider (e.g. Met Office/Aerodrome Operator) to ATC/AISP and on to the flight crew.
4c. Consider equipping for digital transmission of ATIS, as appropriate.
4d. Ensure that training on the use of ATIS/D-ATIS is provided to relevant operational staff (ANSP/AISP).

The Aerodrome Operator, Aircraft Operator and ANSP sections all have complementary Recommendations and Guidance Material related to the provision of safety significant "essential" information.

Working Arrangements between Data Providers and Receivers

Formal arrangements allow a solid baseline against a data provider and a data receiver may reasonably expect the exchange of aeronautical data/information to take place.

Formal arrangements should be established between AISP and aerodrome authorities responsible for the aerodrome services to report to the responsible AIS unit with a minimum of delay. This would include information on aerodrome conditions of serviceability and operational status of associated facilities. Visual and non-visual navigation aids and the state of the manoeuvring area (Annex 14, Chapter 20).

To ensure promptness and accuracy in the provision of aeronautical information, liaison should be arranged between AISP and data providers being responsible for the origination of current information/data.

Formal arrangements between data providers and ANSP/AISP (e.g. in the form of a contract or Service Level Agreement (SLA)) should be introduced to support and enable the relevant data exchange.

EUROCONTROL has developed guidance about how to facilitate the establishment of SLAs between aeronautical data originators/providers and AISP, with the purpose to set agreed required quality levels of the data, the timeframe of delivery and their format. Guidance is provided by the CHAIN (Controlled and Harmonised Aeronautical Information Network). More information can be found at http://www.eurocontrol.int/articles/service-level-agreements-phase-3-p-18

Aeronautical Information Services

It is critical for the safety of operations that aeronautical data relating to runway operations is promulgated according to recognised standards. Changes to national AIPs and NOTAMs must be published in accordance with internationally agreed timeframes to ensure that key operational information is made available to aircraft operators with sufficient time for it to be processed and to inform operational decision-making.

Examples of the information to be provided are mentioned variously throughout ICAO Annex 15, Aeronautical Information services.

5.1.1.1 A NOTAM shall be originated and issued concerning the following information: a) establishment, closure or significant changes in operation of aerodrome(s)/heliport(s) or runways;

8.1.2.1 presence and depth of snow, ice or water on runways and taxiways, including their effect on surface friction.

Appendix 1 referring to the content of National AIPs says that that the AIP-GEN 3.5.3 Meteorological Observations and Reports section should contain:

4) specific type of observation system and number of observation sites used to observe and report surface wind, visibility, runway visual range, cloud base, temperature and, where applicable, wind shear (e.g. anemometer at intersection of runways, transmissometer next to touchdown zone, etc.)

Whilst section AIP-AD 1.1 should include details of

5) friction measuring device used and the runway friction level below which the State will declare the runway to be slippery when wet; and
6) other information of a similar nature.

Quality Assurance of AIS Data

ANSPs and AISPs should implement quality assurance procedures regarding the provision of aerodrome information. Adequate QA should also be implemented by any other organisation that originates numerical data (e.g. runway condition/friction data) supporting aeronautical data elements.

EUROCONTROL has developed guidelines supporting the implementation of Quality Management Systems (QMS) in accordance with ISO 9001. More info at:

http://www.eurocontrol.int/aim/public/standard page/qmqa.html

Further guidance is provided at ICAO Annex 14, Aerodromes, § 2.13 Coordination between aeronautical information services and aerodrome authorities.

To ensure that aeronautical information services units obtain information to enable them to provide up-to-date pre-flight information and to meet the need for in-flight information, arrangements shall be made between aeronautical information services and aerodrome authorities responsible for aerodrome services to report to the responsible aeronautical information services unit, with a minimum of delay:

a) information on the status of certification of aerodromes and aerodrome conditions (ref. 1.4, 2.9, 2.10, 2.11 and 2.12);
b) the operational status of associated facilities, services and navigation aids within their area of responsibility;
c) any other information considered to be of operational significance.

2.13.2 Before introducing changes to the air navigation system, due account shall be taken by the services responsible for such changes of the time needed by aeronautical information services for the preparation, production and issue of relevant material for promulgation. To ensure timely provision of the information to aeronautical information services, close coordination between those services concerned is therefore required.

The Implementing Rule on Aeronautical Data and Information Quality (ADQ IR) was adopted by the European Commission and is now referred to as Commission Regulation 73/2010. The Regulation lays down the requirements on the quality of aeronautical data and information for the Single European Sky, in terms of accuracy, resolution, integrity and timelines. The actual scope goes beyond the ANSPs/AISPs to include non-ANSP entities. In terms of scope, the aeronautical data/information process chain extends from the original data source (e.g. surveyors, procedure designers etc) through AIS (publication) to the end use, either by human users or aeronautical applications. Concerning aerodrome operators, Regulation 73/2010 applies for those aerodromes for which IFR or Special-VFR procedures have been published in national AIPs because these procedures demand high quality data.

ATIS/D-ATIS

NOTE:

Depending on the organisational/operational structure, AISPs or ANSPs may be responsible for the provision of ATIS/D-ATIS. This guidance material is therefore repeated in the Air Navigation Service Provider section.

The reception of ATIS via data-link, allows both pilots to maintain their listening of ATC communications during critical high workload phases of flight, thus increasing the situational awareness and reducing the likelihood of distraction induced mistakes, lapses or confusion. Furthermore, depending on the traffic density and the complexity of the approach, it may assist flight crews with the go-around /Landing decision making process by providing the latest changes to the runway condition and local weather, which is subject to the equipment being set up to allow this data to be sent to the pilot automatically.

ICAO Annex 11, Air Traffic Services, Chapter 4 (Flight Information Services) states variously that ATIS/ D-ATIS broadcasts shall include,

- significant runway surface conditions and, if appropriate, braking action;
- surface wind direction and speed, including significant variations;
- any available information on significant meteorological phenomena in the approach and climb-out areas including wind shear, and information on recent weather of operational significance;
- "other essential operational information". Runway surface conditions and reduced runway lengths for landing and takeoff fall into this category of data.

In accordance with Sections 4.1 and 4.3 of Appendix 3 to Annex 3, the surface wind direction and speed is to be averaged over 2 minutes. The wind information is to refer to conditions along the runway for departing aircraft and to conditions at the touchdown zone for arriving aircraft. Specifically, Annex 11 Chapter 4 also says that ATIS broadcasts shall include:

"surface wind direction and speed, including significant variations and, if surface wind sensors related specifically to the sections of runway(s) in use are available and the information is required by operators, the indication of the runway and the section of the runway to which the information refers."

NOTE:

ICAO Annex 3, § 4.1.5.2 states that presence of wind gusts more than 5kts above the average will be indicated if noise abatement procedures are in force. A wind below 1kt will be considered as calm. This information is essential to pilots in their process decision making.

To ensure that ATIS/D-ATIS provide operational and safety benefits it is essential that the relevant operational AIS/ATC staff is competent in the use of ATIS/D-ATIS equipment and understand and apply the broad principles for the operation of these systems as described in Annex 11, Chapter 4.

Reference Documents

- ICAO Annex 15, Aeronautical Information Services
- ICAO Annex 14, Aerodromes
- European Commission Regulation, EU 73/2010.
- ICAO Annex 11, Air Traffic Services
- ICAO Annex 3, Meteorological Services for International Air Navigation
- ICAO Doc 8126, Aeronautical Information Services Manual


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GENERAL

Each aircraft operator is invited to review and prioritise the proposed action plan for implementation. The following guidance material is provided to assist in that implementation.

Safety Information Sharing

Recommendation 3.4.1 Aircraft operators are encouraged to participate in safety information sharing networks to facilitate the free exchange of relevant information on actual and potential safety deficiencies.

Exchanging safety information is providing companies with huge safety benefits. It allows them to learn not only from their own experience but also from the experience of others.

Having direct contact with other stakeholders allows companies to get first hand information. Direct contact also provides the opportunity to ask specific questions and communicate on specific issues without losing precious time.

There are several ways of participating in safety information exchange.

A company may elect to:

- Set up safety information exchange agreements with other companies
- Set up safety information exchange agreements with ANSPs or other stake holders
- Register with internet safety information exchange like Skybrary, UK CAA, etc
- Join one of the existing safety information sharing networks like EVAIR, IATA-STEADES, Flight Safety Foundation
- Become a member of associations like ERA, AEA, IATA who will provide the company with very useful and valuable information

Flight Data Monitoring

Recommendation 3.4.2 The aircraft operator should include and monitor aircraft parameters related to potential runway excursions in their Flight Data Monitoring (FDM) program.

European regulation requires aircraft operators to establish and maintain an accident and flight safety program which includes a flight data monitoring programme (FDM) for aeroplanes in excess of 27.000kg.

The flight path parameters monitored by this system should include parameters closely related to the risk of runway excursion such as:

Landing:

- Deep landing – a certain distance behind the glide slope touchdown point
- Short landing – touching down before the glide slope touchdown point
- Long flare – a landing flare which takes more than a certain number of seconds from e.g. 15 ft above the runway to touchdown
- Monitor spoiler deployment during landing
- Late flaps settings – can be associated with rushed approaches
- Late landing gear selection – can be associated with rushed approaches
- Tail and crosswind
- Stabilised approach criteria of the company, event if not met at the specified gates
- Threshold crossing height
- Excess speed over the threshold
- Use of reverse thrust
- Use of brakes
- High speed exits from runways
- Performance analysis e.g. to trigger alerts to the Aerodrome Operator for abnormally low friction measures.

Takeoff:

- Use of reverse on rejected takeoff
- Use of brakes on rejected takeoff
- Nose wheel steering used at high speeds
- Runway distance remaining after rejected takeoff
- Crosswind and tailwind

FDM should be used as a predictive tool to identify safety hazards in flight operations. In the scope of a Safety Management System (SMS) the data from the FDM should be used to set safety performance targets. It is also a very valuable tool to debrief flight crews. Data can be extracted from the FDM database and can be used in a de-identified manner in flight crew safety courses as case studies. This practice has a great learning effect and helps to raise awareness on different issues among the pilot community.

Flight Crew Training and Runway Excursion

Recommendation 3.4.3 The aircraft operator should include runway excursion prevention in their training program. This training should be done using realistic scenarios.

Flight crew training should contain training on the risks and prevention of runway excursions. Ideally this training should be provided in classroom/Computer Based Training and in the simulator. Data for the training should be identified through the safety data collection process of the aircraft operator's SMS.

The following list gives some examples of data sources:

- Runway excursion toolkits from the industry e.g. ICAO / IATA/Flight Safety Foundation
- Own reporting programme
- FDM data
- Company procedures
- Safety Information Exchange Programme with other aircraft operators
- In house incident and accident reports
- External incident and accident reports
- Safety conferences and meetings
- International safety programmes
- etc.

The safety promotion part of the SMS should also be used to distribute data and raise the crew's awareness on the prevention of runway excursions. Lessons learned from past incidents or accidents can easily be distributed using the following safety promotion tools:

- Memos
- Internal Safety Journal
- Feedback on incident reporting
- Safety Intranet Site
- Email briefings
- Presentations in courses
- etc

Airline specific issues as well as de-identified data from the FDM program should be included in the recurrent training programme, and used to build simulator scenarios (evidence based training).

The traditional way of flight crew training and testing consist in a 6 monthly OPC alternating with a combined LPC/OPC. This method is very prescriptive and doesn't allow for aircraft operator specific training and testing. This is why various aircraft operators have adopted the new Alternative Training and Qualification Programme (ATQP). For the OPC this programme allows the testing to be done in a realistic flight environment (LOFT style) based on failures or events that were experienced by the aircraft operator instead of the formal prescribed items in the OPC. Events and scenario's related to runway excursion can be easily included. This system allows the aircraft operator to train and test their flight crew according the specific nature of their operations.

Technical Solutions to Prevent Runway Excursions

Recommendation 3.4.4 The aircraft operator should consider equipping their aircraft fleet with technical solutions to prevent runway excursions.

The landing phase being very complex does not leave much mental capacity to make complex instantaneous calculations; so basic rules of thumb must be used.

Automated systems provide instantaneous information such as predicted stopping points to the pilots therefore improving their decision making.

Use of the Head up Guidance Systems for all approaches may help the pilots in their decision making. Most Head up Guidance Systems provide for a 3° slope indication, indicate the flight path and have a guidance line for the touchdown point. Using HGS for all approaches may assist the pilots to fly stabilised approaches. This is especially true for visual approaches when no vertical guidance (e.g. ILS, PAPI, VASI etc) is available. Most HGS systems also have the feature to show the runway remaining after touchdown.

Data-Link systems

> **Recommendation 3.4.5 The aircraft operator should consider equipping their aircraft fleet with data-link systems (e.g. ACARS) to allow flight crews to obtain the latest weather (D-ATIS) without one pilot leaving the active frequency.**

The use of data-link systems allows the flight crew to obtain current weather information without one pilot losing situational awareness. It also allows an improved follow-up in a rapid changing weather environment.

The use of data-link systems should be clearly documented in the company procedures. The procedures should also contain limitations on phases of flight during which data-link systems should not be used anymore (e.g. during the final approach phase).

Collaboration with ANSP

> **Recommendation 3.4.6 The aircraft operator should report to the ANSP if approach procedures or ATC practices at an airport prevent flight crew from complying with the published approach procedure and their stabilised approach criteria.**

It is important to understand that stabilised approach criteria must be followed and that, if the ATC clearance does not allow these criteria to be followed, the pilots have the right to refuse the clearance.

Refusing a clearance should be done as soon as possible (e.g. as soon as the pilots recognise that the stabilised approach criteria will not be met) to allow the ATC controller to review his/her traffic sequencing.

Some examples of clearances which may lead to unstabilised approaches are:

- Inappropriate speed control
- Delayed descent instructions
- Late runway changes
- 'Short cuts' vectoring
- etc

NOTE:
In some instances the ATC controller may not be able to adhere to standard procedures due to unforeseen circumstances (e.g. weather). Airline procedures should contain contingency procedures for these situations in order to allow their pilots to safely land the aircraft. However, it needs to be clear that these contingency procedures should not become the standard.

Pilots should proactively report any ATC clearance which is not in line with their SOPs. In the scope of the SMS this will allow the Safety Manager to identify negative trends and take appropriate actions.

Appropriate actions are:

- Reporting problems to the respective ANSP
- Checking if company SOPs are correct
- Identifying airports/approach procedures with potential risk
- Proactive meetings with respective ANSPs to tackle specific issues
- Feedback to crews to raise awareness, lessons learned
- Include specific issues in company safety training
- Exchange of data with other stakeholders (e.g. EVAIR, IATA-STAEDES or other aircraft operators in the scope of the Safety Information Exchange Programme)

Aircraft Operators should seek active cooperation with Local Runway Safety Teams of the airports in their route network.

Non Standard Manoeuvres

Recommendation 3.4.7 The aircraft operator should ensure the importance of a stabilised approach and compliance with final approach procedures is included in briefing for flight crews. The commander should not accept requests from ATC to perform non-standard manoeuvres when they are conflicting with the safety of the flight.

Flight crews are often confronted with ATC clearances or instructions they are not comfortable with.

Examples of this are:

- Controllers giving a tight base-turn
- Controllers asking to keep the speed up
- Controllers asking to expedite vacating the runway
- Controllers giving late runway changes
- etc.

These clearances are often well intended but do not always take into consideration the high workload on the flight deck during the last minutes of the flight. They might even lead pilots to accept a clearance which will make the safe operation of the aircraft a challenge.

Pilots may be reluctant to refuse ATC clearances.

There are many different reasons for this:

- Pilots do not know that they are 'allowed' to refuse an instruction
- Pilots might not realise which situation they are being pushed into
- Pilots do not want to offend the controller by refusing the instruction
- Cultural issues might give the ATC instruction the status of an 'order'
- Felt or real commercial pressure to accept 'short cuts'
- The deviation has become the standard
- etc.

One thing should be clear to all flight crew they shall refuse any ATC instruction which is conflicting with the safety of flight.

In the scope of aircraft operators' SMS it is important that crews understand the importance of reporting these issues. Safety managers will need data in order to be able to address these issues. Having enough data will allow the safety managers to address these issues to the respective ANSP.

A good practice for aircraft operators is to regularly meet with the ANSP at different airports and discuss issues which turned up. Very often these issues are based on misunderstandings (e.g. I thought pilots liked the short cuts we provided to them) or simply on the lack of knowledge about the limitations and procedures of each other (e.g. request to reduce speed and increase descent rates, or late descend clearance given to the pilots, whereas pilots do not understand that the clearance is offered due to airspace restrictions/constraints).

Meetings with the ANSP are a very proactive way of increasing the understanding of each other. The knowledge gained during these meetings should be disseminated to all crews in order to raise their awareness on discussed issues. This will enable the crews to know about 'safety issues' at different locations and thus be prepared for the 'unexpected'

A good industry practice is to have an exchange programme between ANSPs and aircraft operators in place. Meaning that controllers will be allowed to do familiarisation flights in the flight deck or in a flight simulator and that flight crews will visit the ANSP facilities. This will help to raise the understanding of each other's work constraints.

Runway Change

Recommendation 3.4.8 The Commander should not accept a late runway change unless for safety reasons. A briefing and if needed flight management computer (FMC) preparation must be completed (e.g. before leaving the gate or starting the final approach).

Late runway changes are an issue both for takeoff and for landing.

Late runway change for takeoff

A late runway change before takeoff, if not anticipated by the crew, will lead to a serious increase in workload for the crew. Crews should not accept a runway change unless a briefing, performance calculation and FMC preparation can be safely completed in due time.

NOTE:
One crew member will need to be head down to make all the changes required in the setup of the radio and navigation equipment. This should not be done while taxiing. During taxi both pilots should direct their full attention to the movement of the aircraft on the airport.

Issues which might arise from this are:

- Crews following the wrong taxi route
- Crews overlooking other traffic
- Runway incursions
- Discrepancies in the stored SID in the FMC leading to crew confusion or SID violations
- Errors in performance calculations which might lead to runway excursions
- etc.

Consideration should not only be given to reprogramming the new departure route and the corresponding setting of the radios but also to performance calculations. This is especially true if the late runway change includes or is a departure from an intersection.

Late runway change for landing

A late runway change for landing, if not anticipated by the crew, will lead to an increase in workload for the flight crew. Flight crews should not accept a runway change unless a briefing, including the go-around for the new runway, performance calculation and FMC preparation can be safely completed in due time. Ideally the runway change should not be accepted below FL100.

Crews should not start an approach until all of the above is completed.

Issues which might arise if all of the above is not completed before starting the approach are:

- Rushed and unstabilised approaches
- Wrong radio and navigation settings for approach
- Flying the wrong approach
- Not intercepting the cleared approach in time. This is especially critical on airports with parallel runway operations
- Flying the wrong go-around route
- Errors in performance calculations which might lead to runway excursions
- Discrepancies in the stored FMC data leading to crew confusion
- etc.

Where an aircraft is equipped with Flight Management Systems (FMS) capable of storing two flight plans, this feature should be used when the crew is preparing the arrival and there is a possibility for one of two different runways to be assigned for landing. The flight plan 'on stby' can be easily activated without a significant increase in workload.

ANSP often try to use the optimal runway configuration as long as possible for capacity reasons. While the surface wind might still be within the limits the winds at altitude are often well beyond these limitation making it harder for flight crew to stabilise their aircraft. In this case flight crew should not be reluctant to ask for a more appropriate runway; clearly stating that this is for safety reasons; even if this means delaying the approach.

WEATHER

Current Weather versus Forecasted weather

Recommendation 3.4.10 The Commander, shortly before takeoff and landing, shall verify that the actual weather conditions are similar or conservative compared to the weather data used for the takeoff performance calculations and the in-flight landing distance assessment.

Flight crews should check that the wind and runway conditions given with the takeoff or landing clearance is consistent with the one used for the performance calculations.

NOTE:
In headwind situations, to facilitate the cross-check, performance calculations, can be done with zero headwind so that the presence of any headwind will be conservative.

At the actual time of arrival weather conditions can be different from the ones used at time of dispatch or even from the time at which the approach briefing was performed. Flight crews should pay special attention to significant changes in wind direction and or runway surface conditions.

Flight crew shall check the latest weather information before their in-flight landing distance assessment is done. If sufficient time remains and cockpit duties allow it, crews shall always try to get the latest available weather information just prior to starting the approach. If during the approach the crews feel that the weather conditions have changed they may seek clarification on the actual conditions with the ATC controller.

CROSSWIND OPERATIONS

Operations in crosswind conditions not only require specific handling techniques, but also require good knowledge and strict adherence of the applicable crosswind limitations.

Understanding Crosswind Limitations

Recommendation 3.4.11 The aircraft operator should publish the Aircraft's Crosswind Limitations with specific guidance on the runway condition and the gust component.

The aircraft manufacturers publish maximum recommended crosswind values. Aircraft Operators should give clear guidance to their flight crews on how these values should be used. Some operators consider these maximum recommended values as actual aircraft limitations.

Specific guidance should be published on how flight crews should use the value of the wind gust.

The maximum recommended crosswind values also depend on the runway surface condition. Clear guidance should be given on the influence of this runway surface condition or reported braking action on the recommended values.

Example Airbus A320 family

CODE	RUNWAY CONDITION	DECELERATION AND DIRECTIONAL CONTROL OBSERVATION	REPORTED BRAKING ACTION	MAX CROSSWIND (GUST INCLUDED)[1]
6	Dry	-	**Dry**	38kt
5	Damp Wet	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal	**Good**	33kt
	3 mm (1/8") or less of ■ Slush ■ Dry Snow ■ Wet Snow Frost			29kt
4	Compacted Snow (OAT at or below -15°C)	Braking deceleration and controllability is between Good and Medium.	**Good to Medium**	29kt
3	Slippery when wet Compacted Snow (OAT at or above -15°C) More than 3 mm (1/8") depth of: ■ Dry Snow – max 130 mm (5") ■ Wet Snow – max 30 mm (1 1/8")	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be noticeably reduced.	**Medium**	25kt
2	Between 3 mm (1/8") depth of : ■ Water – max 12.7 mm (1/2") ■ Slush – max 12.7 mm (1/2")	Braking deceleration and controllability is between Medium and Poor. Potential for Hydroplaning exists.	**Medium to Poor**	20kt
1	Ice (cold & dry)	Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	**Poor**	15kt
0	Wet ice Water on top of Compact Snow Dry Snow or Wet Snow over Ice.	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain.	**Nil**	-

[1] In case of AUTOLAND, max crosswind limited to 20kt

Flight Technique in Crosswind Operations

Recommendation 3.4.12 The aircraft operator should publish specific guidance on takeoff and landing techniques with cross wind; and/or wet or contaminated runway conditions and the correct use of the nose wheel steering. Appropriate training must be provided.

Takeoff Technique:

Due to differences in flight technique between fly-by-wire and conventional aircraft only general guidance is presented. Aircraft manufactures publish specific guidance in the Flight crew Training Manual.

Initial runway alignment and smooth symmetrical thrust application result in good crosswind control capability during takeoff. Rolling takeoff procedure is strongly advised when crosswinds exceed 20 knots or tailwinds exceed 10 knots to avoid engine surge. Especially on wet or slippery runway conditions special attention should be paid to ensure the engines are spooling-up symmetrically. Light forward pressure on the yoke or side stick increases nose wheel steering effectiveness. Any deviation from the centerline during thrust application should be countered with immediate smooth and positive control inputs.

Approach Technique:

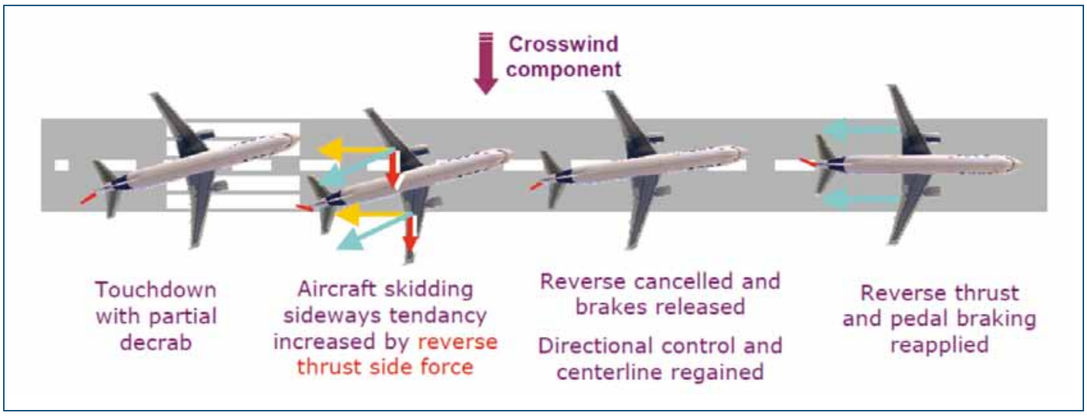
Aircraft Manufacturers consider several factors such as aircraft geometry, aileron and rudder authority when recommending a crosswind approach technique. This can be the wings-level or crabbed approach, the steady side-slip approach or a combination of both in strong crosswind conditions.

In line with standard operating procedures, disconnect the autopilot at an appropriate altitude to have time to establish manual control of the aircraft well before the de-crab phase and flare.

Landing Technique:

Especially on wet or contaminated runways a firm touchdown is recommended to minimise the risk of aquaplaning and ensure a positive touchdown.
When touching down with residual crab angle on a dry runway the aircraft automatically realigns with the direction of travel down the runway. This is not happening on a wet or contaminated runway.

Residual crab angle on the runway has also some implications when reverse is selected.
In the case that a lateral control problem occurs in high crosswind landings, pilots must reduce reverse thrust to reverse idle and release the brakes to correct back to the centreline. This will minimise the reverse thrust side force component and provide the total tyre cornering forces for realignment with the runway centreline.



Working with the Flight Management Computer (FMC)

Recommendation 3.4.13 The aircraft operator should ensure their standard operating procedure (SOP) requires the flight crew to perform independent determination of takeoff data/crosscheck the results. The aircraft operator should ensure their Standard Operating Procedures include flight crew cross-checking the 'load and trim sheet' and 'performance' data input into the Flight Management Computer (FMC).

Traditionally the dispatcher will provide the Flight crew with the load and trim sheet or loading form containing all the loading information. In some instances the flight crew will have to complete the load and trim sheet 'manually'. In this case the company should provide procedures for the pilots to independently crosscheck the data before it is being used for performance calculations.

The next step will be to use the data either to be entered into the EFB or to do the performance calculations on paper.

Performance calculation using the EFB

The information from the load and trim sheet may be entered in the loading module of the Electronic Fight Bag (EFB) to obtain the weights and trim settings for takeoff. This data is then used in the performance module to generate the takeoff performance data. It is highly recommended that each pilot perform his own calculation and then crosscheck it with the other pilot's result. In case where a class 1 EFB is used for the performance calculation each crew member must be provided with one EFB to ensure proper independence of calculation and crosscheck. The calculation should be done prior to receiving the final load and trim sheet when the actual load can be ascertained with reasonable accuracy to avoid errors due to time pressure and hurry up syndrome.

Performance calculation using paper version

The information from the load and trim sheet is then used to determine the takeoff performance data. This data will be written down on the company documentation and shall be crosschecked by the other crew member. The performance data are then inserted by one pilot into the performance page of the FMC and again carefully checked by the other pilot.

In both cases the flight crew should also check the 'reasonableness' of the takeoff reference speeds and thrust setting; which can be challenging for flight crew operating in a mixed fleet environment.

As a backup, technology providers should develop a system that automatically checks the data entered into the FMC for consistency between the take of parameters (e.g. Take Off Securing (TOS) by Airbus).

This data insertion is usually done just before departure when the flight crew is exposed to various distractions. The Operator's CRM training should provide threat and error management guidance on how to mitigate the threats posed by these distractions. Special guidance should also be provided for cabin crew and handling agents not to disturb flight crew while they are performing data insertions or briefings.

Flight crew training is based on monitoring and responding to the attainment of takeoff reference speeds, but they have little 'human' means in detecting reduced or degraded takeoff acceleration until approaching the end of the runway. Technology providers have an important role to develop systems that provide alerts to the flight crew when the actual acceleration is too low to allow a safe takeoff, example Takeoff monitoring (TOM) by Airbus.

Furthermore the FDM programme should be used to identify issues in relation to performance calculations, slow acceleration etc. In the scope of the SMS promotion any issues discovered should be fed back to the crews to raise their awareness and share the lessons learnt.

The Rejected Takeoff Decision Process

Recommendation 3.4.14 The aircraft operator should publish the rejected takeoff decision making process. Appropriate training should be provided.

Takeoff speeds are key elements in a safe takeoff. They are monitored by the pilot non-flying (PNF or PM) V1 is called by the PNF/PM or by the aircraft system; Vr is called by the PNF/PM. The most important speed range for failure management is just before V1, the maximum speed at which a rejected takeoff can be initiated.

There must be a clear policy about which pilot may call a STOP or GO on takeoff, as well as who will make the STOP actions.

To help the "decision maker" in his task, the takeoff roll is divided into a low and high speed segment. Typically the threshold is between 80knots and 100knots, below this speed the aircraft's energy is low and a rejected takeoff is considered low risk. Above this speed the aircraft's energy is high and a correctly executed rejected takeoff is considered critical.

The essential supporting and monitoring task of the pilot non flying should be emphasised. This includes:

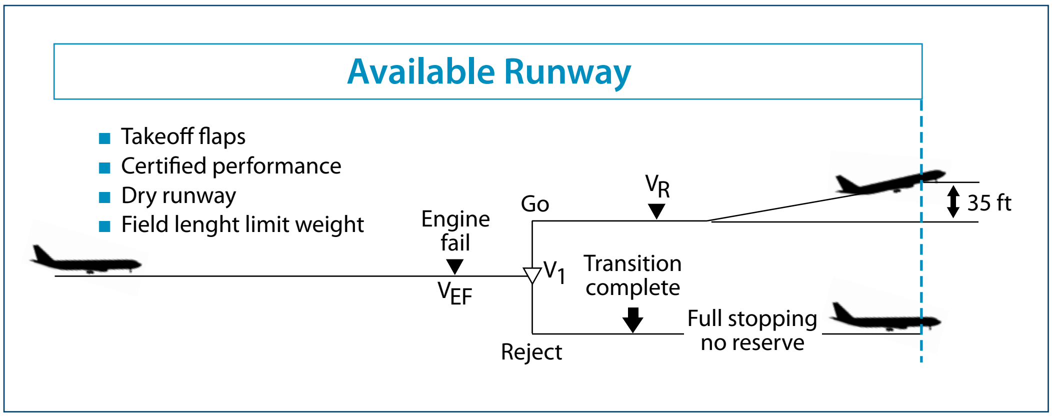
- Monitoring of thrust parameters
- Monitoring the speed trend
- Perform timely standard callouts
- Detect and/ identify any abnormal conditions
- Monitor the use of ALL braking devices

Training:

The rejected takeoff manoeuvre is a mandatory item in the Operators Proficiency Check (OPC), so flight crews are trained and assessed on the manoeuvre on a regular basis. However this assessment is mostly focussed on the correct execution of the manoeuvre and not on the decision making process.

It is strongly recommended that recurrent training and checking, and especially command upgrading courses, also include simulator exercises that require the flight crew to detect and identify abnormal situations that are not the result of a clear and distinct loss of thrust, such as:

- Engine stall
- Tyre burst close to V1



- Nose gear vibrations
- Bird strike at high speed
- Wind shear or uneven aircraft acceleration
- Opening of side window
- Instrument failures
- Flight control issues

Airline Policy:

Aircraft Operators must define the policy, procedures and required task sharing for a rejected takeoff. It should include the decision making process for a STOP or GO event and the task sharing between the Commander and First Officer as well as the PF and PNF/PM.

In-flight assessment of landing performance

Recommendation 3.4.15 The aircraft operator should publish and provide training on the company policy regarding in-flight assessment of landing performance. Flight crew must be advised whether company landing distance data relates to unfactored or operational distances. In the case of unfactored distances the company should provide the safety margin to be used in normal and abnormal conditions.

While most flight crew are familiar with the dispatch requirements on landing performance which are based on un-factored actual landing distances (ALD), multiplied with a regulatory factor, they should be made aware that some manufacturers are basing their new in-flight landing performance on factored Operational Landing Distances (OLD). Aircraft Operators should provide unambiguous landing performance information to their flight crew.

The dispatch calculation usually yields results in weight limitation and not runway length required. Giving results in runway length required for dispatch calculations has two advantages: it requires the crew to be aware of the runway length available at the destination airport and it is possible to compare it with the in flight landing performance that gives results in length also.

Due to the variations of published landing performance data, aircraft operators must clearly inform their flight crew if the calculations are made using factored or unfactored landing distances. This may include declaring the following:

- what level of reverse thrust was assumed,
- the assumption of the wheel braking,
- if the data was factored or not,
- what was the air distance allowance in the data.

The in-flight assessment of landing performance calculation should be made using conservative wind component and runway condition according to the latest weather report and forecast available to the crew to know what weather conditions can be accepted for the landing to be safely performed. It is important to take into account the aircraft status and the latest weather information available. The flight crew should assess the weather with a conservative strategy in particular concerning the runway condition and the wind component.

As an example if the ATIS states runway in use 33 RWY dry, wind 250/10 gusting 25, visibility 9999 Vicinity RaSh, cloud sct 2500 sct 3000 Cb, temperature 32/25, QNH 1009 The crew has two options either they take the actual weather that gives RWY dry, no wind component, or they take the possible scenario of a shower passing on the runway when they will be landing i.e. runway wet (or contaminated) and a wind component of 5 to 10kt tailwind.

The first option is the more favourable case but doesn't prepare the crew for the decision to be taken in case of weather deterioration on short final. The second option will allow the crew to assess whether the landing can be made safely or not (what is the max tailwind and the runway condition he can accept) in this worst case.

So if on final ATC gives: runway wet and 230/ 15 gusting 20 clear to land runway 33, the decision to land or not will be based on sound performance calculation in the second option and on guesswork in the first option.

Specific guidance should be provided for wet or contaminated runway conditions and for failure cases.

Whilst European regulation makes a generic statement regarding the need to assess the landing performance in flight; Aircraft Operators should publish an SOP regarding the in-flight landing performance assessment as part of their approach preparation when:

- Landing on wet or contaminated runway
- Weather deterioration since dispatch
- Change of landing runway
- In-flight failure affecting landing performance
- Etc.

APPROACH

Runway and Approach Type Selection

Recommendation 3.4.17 When accepting the landing runway the Commander should consider the following factors: weather conditions (in particular cross and tailwind), runway condition (dry, wet or contaminated), inoperable equipment and aircraft performance. Except in conditions that may favour a non precision approach, when more than one approach procedure exists, a precision approach should be the preferred option.

Recommendation 3.4.20 The aircraft operator should publish guidelines on the use of autoland when low visibility procedures (LVP) are not in force. Flight crew that practice automatic landings without LVP in force should take into account status of the protected area for the Localiser signal. Flight crew should fully brief such practice manoeuvres, in particular, readiness to disconnect the autoland/automatic rollout function and land manually, or go-around.

Manual flying skills:

Generally aircraft operators encourage the use of the highest level of automation appropriate to the phase of flight or the airspace in which the flight is being conducted in order to reduce crew workload and increase situational awareness. However it's recognised that to maintain the proficiency of manual flying skills flight crew should fly the aircraft manually on a regular basis when appropriate. When a pilot is flying the aircraft manually it increases the flight crew workload and requires more coordination between the pilots. The intention to fly the aircraft manually should be briefed in advance together with any intended use of partial automation (e.g. auto thrust).

Automatic Landing:

Aircraft operators who are authorised to perform low visibility operations (LVO) generally maintain the recency of their flight crew with a recurrent training program in the simulator. However initial type rating conversion generally requires an automatic landing to be performed during line training.

Flight crew should be aware that the ILS signal is only protected from possible interference when low visibility procedures (LVP) are in force at an airport and that these operations may compromise the regular flow of traffic/sequencing. Permission to conduct a training flight e.g. CAT II/III training approach in good weather must be requested by the aircraft operator as advised in the AIP. ATC may reject such a request or interrupt the current procedure according to the traffic situation at the time.

Aircraft operators' standard operating procedure should give the minimum weather conditions and ILS performance allowing an autoland to be performed without LVP in force. Flight crew should be aware ILS interferences can cause undesirable autopilot behaviour at low altitude. Flight crew should therefore be ready to disconnect the autopilot and go-around or land the aircraft manually where the standard operating procedure advises doing this in case of interference or malfunction.

Choice of approach type:

The commander shall consider all relevant factors in choosing the appropriate approach type. When it is appropriate and available a precision approach should be the preferred option. This is based on the fact that the vertical profile of an approach with an 'electronic' glide path is more 'straight forward' to follow and verify than the vertical profile of a non-precision approach.

Stabilised approach

Recommendation 3.4.18 The aircraft operator must publish Company Criteria for stabilised approaches in their Operation Manual. Flight crew should go-around if their aircraft does not meet the stabilised approach criteria at the stabilisation height or, if any of the stabilised approach criteria are not met between the stabilisation height and the landing. Company guidance and training must be provided to flight crew for both cases.

It's well accepted throughout the industry that a pre-requisite for a safe landing is a stabilised approach. This generally means:

- The aircraft is on the correct lateral and vertical flight path
- The aircraft is in the landing configuration
- Thrust and speed are stabilised at the approach value
- The landing checklist is completed.

All of these requirements need to be fulfilled at the stabilisation height in order for the flight crew to continue with the approach.

Although the stabilised approach principle is well accepted and known throughout the pilot community adherence to the principle is not always perfect. Flight crew are still continuing to land from un-stabilised approaches. How can aircraft operators improve the adherence of their flight crew to the stabilised approach principle?

- **Awareness campaign:** to improve the buy-in from flight crews, any new Standard Operating Procedure (SOP) should be introduced with a kind of awareness campaign to explain the philosophy behind this new SOP. Examples of incidents or accidents that could have been prevented with this SOP would certainly strengthen its case.

- **Standard Operating Procedure:** a well-defined SOP regarding the stabilised approach principle must be published in the company Operations Manual. This should include:
  - **Criteria of stabilised approach:** they must be clearly defined and easily assessable by the flight crew. Examples could be:
    - **Correct lateral and vertical flight path:** aircraft within +/- 1 dot vertical path and localiser.
    - **The aircraft is in the landing configuration:** no more changes to a different flap setting due to unexpected wind change in approach
    - **Thrust and speed are stabilised at the approach value:** thrust should be stabilised at its normal approach value or certainly above idle. Speed should be within certain limits of the final approach value (e.g. -5/+10 kt).Note that the use of an Auto Thrust System (ATS) for approach and landing can modify the previous recommendations. The Operator should also specify whether it is possible to use the ATS without autopilot for approach and landing. If it is possible, the Operator should promote the use of ATS in manual flying as it may reduce the pilot workload in monitoring the speed and adjusting the thrust therefore freeing mental capacity for situational awareness. This may also prevent aircraft carrying excess speed over the threshold; (see later)
    - **The landing checklist is completed:** This will allow the pilot flying to fully focus on his flying duties and the non-flying pilot to focus on his monitoring duties (see later)
  - **Definition of stabilisation height:** the following values are accepted throughout the industry: in VMC 500ft above the airfield elevation and 1000ft in IMC conditions. Note that some operators use only one value whatever the weather conditions are. This not only simplifies the operating procedures but also simplifies the verification process. (see later)
  - **Check of stabilised approach criteria at stabilisation height:** The most often reported reason is that the flight crew was not aware of being unstable at the stabilisation height. This could be prevented by a proper check at the stabilisation height, similar to a height check at the outer marker or DME fix. This check would preferably be initiated by an auto callout (e.g. "one thousand") by the aircraft system.
  - **Actions at stabilisation height:** When passing the stabilisation height, the PNF/PM makes the compliance check and calls out the result (for instance "stable" / "not-stable"); the PF has only the choice between two possibilities; continue the approach or discontinue it, using the appropriate call out i.e. "continue" or "go-around". In case the approach is not stabilised, the PF must initiate a go-around manoeuvre.
  - **Actions in case of de-stabilisation below stabilisation height:** while previous SOP protects against high energy or rushed approaches this SOP concerns destabilisation after passing the stabilisation height. Usually this is a transient condition often caused by changing wind velocity or direction. Provided the PF can rejoin the stabilised approach criteria the approach may continue. During the later stages of the flight (below 500ft) the PF's focus shifts from inside the flight deck to outside. He will start looking for the visual references he needs in order to continue the approach beyond the DH. Now the monitoring task of the PNF/PM becomes paramount

and he should call out any deviations from the stabilised approach criteria:

- Excessive Localiser or vertical path deviations;
- Excessive speed deviations
- Vertical speed greater than 1000ft/min
- Excessive pitch
- Excessive bank angle

The PF must acknowledge this call and make positive corrective actions. The question remains at which position must the aircraft ultimately have regained its stabilised criteria before a go-around must be initiated?

One scenario could be as the aircraft passes the threshold, just before the flare manoeuvre is initiated. Considering the complexity of the landing manoeuvre the PF is "task saturated" at this time and may not have the required capacity to make complex judgement calls e.g. to mitigate the risk of tail strike. Furthermore as he has "managed to come this far" he will not be very go-around minded anymore. The PNF who is performing the monitoring duties has the spare capacity and he should his use his judgement to assess the corrections made by the PF will be in time to allow for a safe landing. If he considers this it not the case he should call for a go-around which must be followed by the PF. This philosophy has consequences for the decision-making process and CRM; training is needed to enable the PNF/PM to consistently judge the situation and takes the proper decision on short final.

Flight crew must acquire the visual reference at the minima and maintain it. If at any time during an approach one of the flight crew members is not sure about the safe outcome of the landing a go-around must be initiated or called for. **It must be highlighted that this option remains available until the aeroplane touches the ground and up to the selection of reverse thrust.**

- **Verification of compliance:** this step is very important to indicate that compliance with this SOP is vital and non-negotiable. Verification can be made using means such as an FDM system and air safety report in line with ICAO Safety Management Systems practices. Due to the relationship between unstabilised approaches and landing accidents and incidents, it is in the interest of the flight crew to obtain a debriefing in accordance with the FDM protocol signed between management and pilots.
- **De briefing of results:** company publications should regularly include compliance levels and re-iterate the importance of compliance with the stabilised approach criteria. This should be continued until this principle is well established in the safety culture of the company.
  - **Actions in case of late loss of visual reference:** As evidenced by an event during a night time landing in 2008, visual references may be lost during the final phase of an approach even when sufficient visual contact with the runway was available at decision height. In this event, both pilots became visual with the runway between 300ft and 200ft, and at the decision height of 200ft had more than sufficient visual references to continue the approach. It was only when the aircraft descended through 20ft AGL during the flare that it entered an area of fog. Both pilots lost sight of the runway edge and runway lights became a glow illuminating the fog. At this point the PF made some inadvertent rudder inputs that caused the aircraft to drift sideways until one main gear left the paved surface. The crew initiated a go-around and after just 4 seconds of ground contact the aircraft was airborne again, although they were unaware that the main gear had rolled on unpaved ground. Minor damage was caused to the runway edge lighting and the main gear assembly. The low visibility had not been reported in the ATIS or by the tower. There was no runway centreline lighting, and runway edge lights were not installed as per ICAO Annex 14, too far from the runway edge, frosted and misaligned. This incident highlights the necessity for airport facilities to be in accordance with ICAO Annex 14 provisions, for the accurate and timely reporting of changes in the conditions, including RVR, and for the preparedness of pilots to perform a go-around when encountering significant loss of visual cues even late in the approach and up to deployment of the thrust reversers.
  - **Ref.** http://www.skybrary.aero/bookshelf/books/452.pdf

Go-around Decision Making

A primary opportunity to prevent a runway excursion is in the decision making of the pilot to go-around or continue a takeoff once at or approaching V1, however it is relatively uncommon for a flight crew to call for a go-around, in the order of 30% of go-around manoeuvres are called by Flight crew. Go-around is a normal but rarely performed procedure, statistics show that a flight crew member may perform a go-around during in-line flying only a few times a year. Training in the simulator to perform unprepared as well as prepared go-around manoeuvres should be done regularly using various scenarios.

GO-AROUND Policy and Pilot non flying duties

Recommendation 3.4.16 The aircraft operator must publish the company policy, procedure and guidance regarding the go-around decision. It should be clearly stated that a go-around should be initiated at any time the safe outcome of the landing is not assured. Appropriate training should be provided.

Recommendation 3.4.19 The aircraft operator should publish a standard operating procedure describing the pilot non flying duties of closely monitoring the flight parameters during the approach and landing. Any deviation from company stabilised approach criteria should be announced to the pilot flying using standard call outs.

Flight crew in commercial aviation have been traditionally trained and tested to execute a go-around when they lack the required visual references at the Decision Height (DH). While this offers good testing of the execution of the manoeuvre the involved decision making process is straight forward.

Numerous Incidents and Human Factors studies have revealed that once an individual has selected a particular course of action, it takes very compelling cues to alert them to the advisability of changing their plan (tunnel vision).

This is why the role of the pilot non-flying is so important. Not only his monitoring task is important, but he has more spare mental capacity and has a more "objective" view of the flight. If he's not confident with the safe outcome of the approach and landing he should call for a go-around. This would be a logical call if the pilot non-flying is the commander, but it could be a much more difficult call if it would be a first officer. The philosophy that either pilot can call for a go-around is vital and should be an important item in the company's CRM training. Especially low-experienced first officers should be trained to be assertive when faced with commanders refusing to take their suggestions on board or displaying tunnel vision.

To help flight crew in their decision management various check heights and calls have been introduced:

- The Outer Marker/ fixed distance check
- The stabilisation height
- 100 Above / approaching minimum
- Minimum

Compliance with all the flight parameter tolerance at one 'gate' means the flight can continue until the next 'gate' where again an assessment shall be made. It should be emphasised that the flight crew should not become complacent when a 'gate' is passed successfully. In fact they should be continuously prepared for a go-around until the 'point of no return' the selection of the reverse thrust. Aircraft Operators with aircraft without reverse thrust should define their own specific policy.

Training on go-arounds should be provided in the simulator and in the classroom. Very often crews are 'not aware' that they are flying an un-stabilised approach. Using real case studies helps to raise the understanding of the potential risk for a runway excursion after an un-stabilised approach.

Crews should not be allowed to fly un-stabilised approaches during their simulator training. During simulator training instructors should put the same emphasis on following the go-around procedures than in the real world.

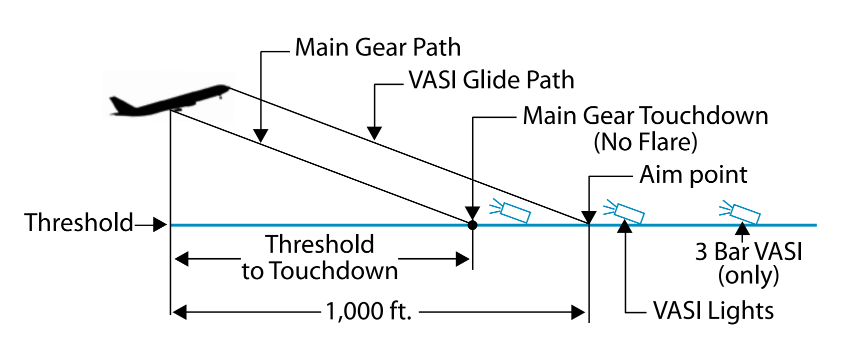
Flight crews are traditionally trained to perform a go-around at minima and this procedure is well mastered by most pilots. However, most of the go-arounds do not happen at minima. It is thus important to include different go-around scenarios into the training.

An open reporting culture in the scope of an SMS will help to identify precursors to 'wrong' decision making. De-identified incidents should be used as examples during recurrent training. This helps to show that incidents/accidents do not only happen to the others. An open policy on go-arounds shall be implemented, making go-around a normal procedure and not an abnormal issue.

Where do we land?

Recommendation 3.4.21 The aircraft operator should publish the standard operating procedure regarding a touchdown within the appropriate touchdown zone and ensure appropriate training is provided.

While still in IMC conditions flight crew are expected to follow the localiser and glide slope indications. When transitioning to VMC conditions the PF is gradually shifting his or her attention to the visual approach indicator or to the runway and the touchdown point; still using their instruments as a backup.



The PAPI or VASI provides visual descent guidance information during the approach. They are visual projections of the approach path normally aligned to intersect the runway at a point 1,000 or 1,800 feet beyond the threshold. Flying the PAPI or VASI glide slope to touchdown is the same as selecting a visual aim point on the runway adjacent to the VASI installation.

737-600 - 737-900ER

737 MODEL	FLAPS 30		MAIN GEAR OVER THRESHOLD		THRESHOLD TO MAIN GEAR TOUCHDOWN POINT-NO FLARE (FEET)
	VISUAL GLIDE PATH (DEGREE)	AIRPLANE BODY ATTITUDE (DEGREES)	PILOT EYE HEIGHT (FEET)	MAIN GEARHEIGHT (FEET)	
-600	3.0	3.7	50	36	657
-700	3.0	3.7	50	34	647
-800	3.0	2.4/3.6	49/50	34/33	651/633
-900	3.0	1.6	49	35	659
-900ER	3.0	2.6	49	34	641

The position of the runway and the touchdown point on the windshield are very important and should become a 'reference value' for the pilot. Any deviation from the approach profile should be recognised by the pilot and corrections made.

Visual aim points versus gear touchdown point differences increase as glide path angle decreases as in a flat approach. For a particular visual approach, the difference between gear path and eye level path must be accounted for by the pilot.

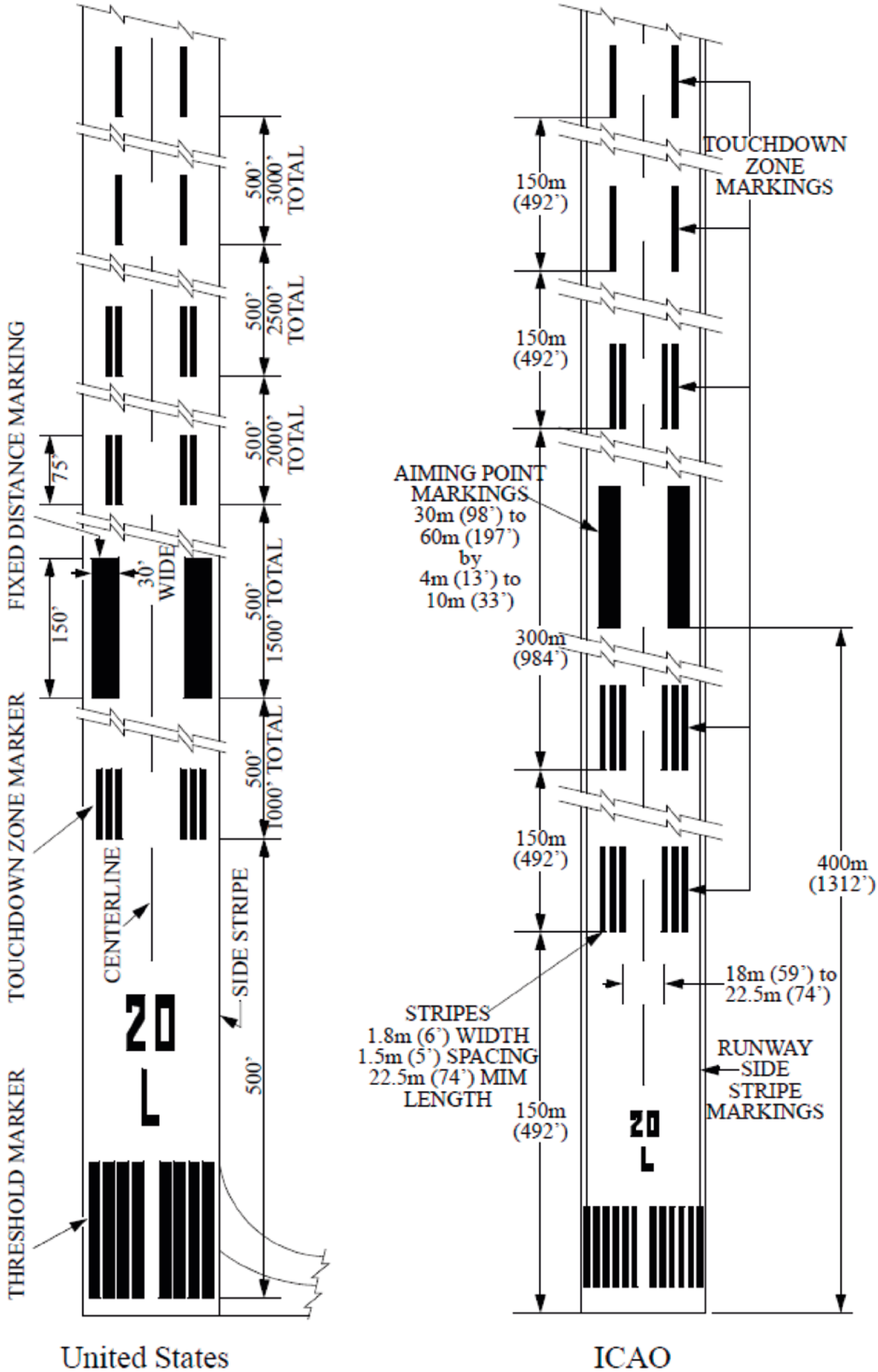
Systematically making long landings or steep approaches would mean different positions of the landing runway on the windshield and dilute the value of this visual reference as a backup for profile deviations.

Being stabilised on the profile and having the runway in sight, pilots can already make a projection of where their flight path will intersect with the runway; this projected visual touchdown point should be the Aiming Point Marking normally resulting in the Main Landing Gear touching down on the second touchdown marker which is at 300 metres. This technique ensures that the landing complies with the assumptions made by the performance calculations: stabilised 3° profile, appropriate threshold crossing height (TCH), and approach speed.

Crews should be made aware of the different existing touchdown zone markings during their initial and recurrent training. Initial and recurrent training should include special or unusual operational requirements at specific airports in the company's network (e.g. downdrafts/updrafts due terrain, shifting winds, and visual illusion induced by narrow/wide runway or night operations).

Aircraft Operators must publish a Standard Operating Procedure on the area where the touch down must be achieved or a balked landing must be initiated. This could be the touch down zone (first 1000m) or 1/3rd of the runway, whichever is less.

Training on the use of the Head Up Guidance System, if installed, should be made during ground courses to assure landing within the appropriate touchdown zone, with practical training being conducted during simulator sessions.



FIXED DISTANCE MARKING
TOUCHDOWN ZONE MARKER
THRESHOLD MARKER
75'
150'
30' WIDE
CENTERLINE
SIDE STRIPE
20 L
500' 3000' TOTAL
500' 2500' TOTAL
500' 2000' TOTAL
500' 1500' TOTAL
500' 1000' TOTAL
500'
United States
TOUCHDOWN ZONE MARKINGS
150m (492')
150m (492')
AIMING POINT MARKINGS 30m (98') to 60m (197') by 4m (13') to 10m (33')
300m (984')
150m (492')
18m (59') to 22.5m (74')
STRIPES 1.8m (6') WIDTH 1.5m (5') SPACING 22.5m (74') MIM LENGTH
RUNWAY SIDE STRIPE MARKINGS
150m (492')
400m (1312')
20 L
ICAO

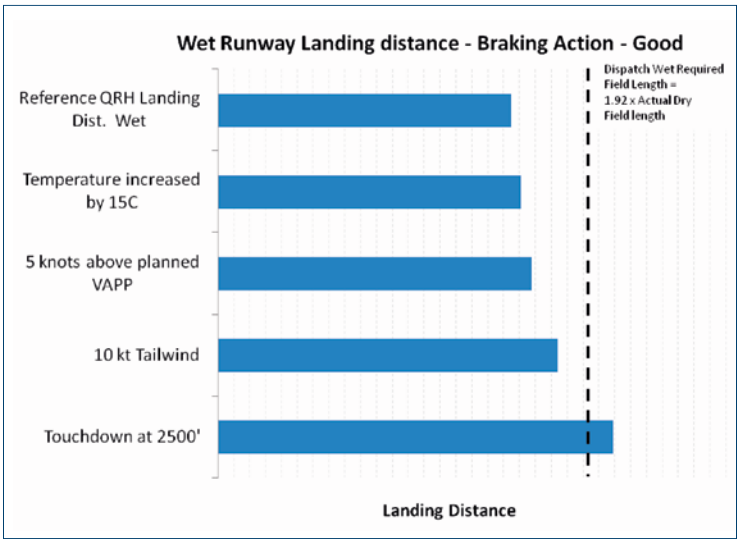
Landing Performance

The parameters affecting the landing distance are published in the Flight Operations Manual. Flight crew should have a good understanding of the sensitivity of the landing distance to these parameters in order to make sound go-around decisions. The following data shows the effect of relatively minor deviations from a baseline calculation of landing distance for a wet runway. The reference condition is a reasonably attainable performance level following normal operational practices on a nominal wet runway surface. The reference QRH data on the bar chart below is based on:

- 1500 foot touchdown
- VAPP=VREF+5, 5 knot speed bleed off to touchdown
- Sea Level, Standard Day (15 C)
- No wind, no slope
- Recommended all engine reverse thrust
- Braking Action – Good, consistent with FAA wheel braking definition of a wet non-grooved runway.

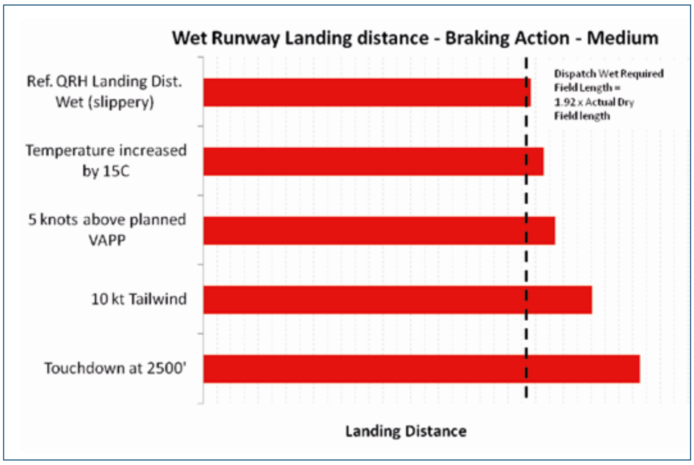
The vertical line represents the dispatch requirement that is 1.92 times the dry runway capability of the aeroplane.

Each bar as you go down the chart demonstrates the cumulative effect of the operational variation listed. In overrun incidents, you usually see a number of factors that contribute to using up the margin available, especially if the runway has worse wet runway friction capability.



It can be seen from this graphic that in general the dispatch landing distance is conservative enough to absorb some deviation from the expected conditions. However, when enough deviations from the reference conditions come together the dispatch landing distance or actual runway available may not be adequate.

Wheel braking may be reduced on the wet runway because of questionable runway condition due to rubber build up, polishing, or puddling due to heavy rain or poor drainage. The following chart shows the same information as above, but assuming a Braking Action Medium runway which is consistent with data that has been seen in some overrun accidents and incidents where the runway's maintenance condition is in question.



You can see from the chart above if the runway is a questionable wet runway you can very quickly use up the entire margin in the dispatch wet runway calculation.

The landing phase being very complex does not leave much mental capacity to make complex instantaneous calculations; so basic rules of thumb must be used. Fully automated system will provide instantaneous information to the pilots therefore improving their decision making. However it is very important for the flight crew to get the aeroplane on the ground at the right point and at the right speed to ensure there is the greatest amount of distance remaining to absorb things the pilot does not have control over such as unreported tailwind or late wind shifts from cross to tail or worse than expected runway friction capability, etc.

Use of all stopping devices

Recommendation 3.4.23 The aircraft operator should publish the Company Policy regarding the appropriate use of all stopping devices after landing and ensure appropriate training is provided.

Recommendation 3.4.24 Flight crew should use full reverse on wet/contaminated runways irrespective of any noise related restriction on their use unless this causes controllability issues. It is important that the application of all stopping devices including reverse thrust is made immediately after touchdown without any delay.

Ground Spoilers/Speed brakes:

Ground Spoilers primarily reduce the lift and increase the drag. Reducing the lift increases the weight on the wheels thus improves the brake performance. The effect of the ground spoilers is even greater on wet or contaminated runway where brake performance is already less, and risk of aquaplaning is increased.

Ground spoilers are usually automatically extended, and their automatic extension should be monitored by the pilot non-flying. If they do not extend, a call out should be made and where possible, they should be extended manually without delay.

Reverse thrust:

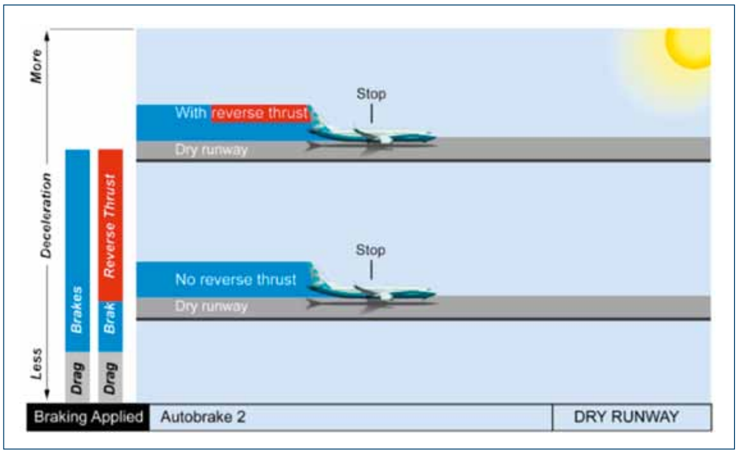
The deceleration effect of thrust reversers is more effective at high speed, so the selection should be done as soon as possible, generally at main landing gear touchdown. The reverse thrust should be maintained until the stop is assured.

It is also important to understand that if the reverser is stowed early, the reapplication of reverse thrust from forward idle can take up to 10-15 seconds to reach effective reverse thrust level (depending on the aircraft type); however, the reapplication from reverse idle will take only 3-5 seconds to reach an effective reverse thrust level.

Like the ground spoiler extension selection of the reverse thrust should be monitored by the pilot non-flying.

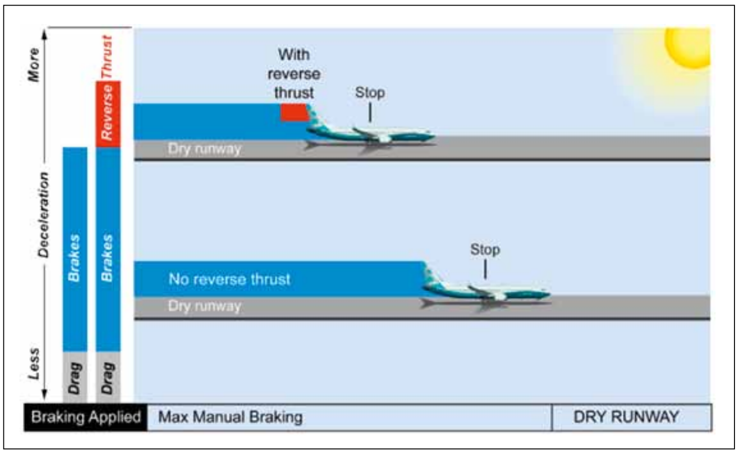
Brakes/Auto brake:

Selecting an auto brake level means selecting a deceleration rate rather than a braking effort. Selecting reverse thrust with an auto brake level will not increase the deceleration effort on a dry runway, assuming ground spoilers/speed brakes are extended; it will simply reduce the energy applied to the brakes. On slippery runways, the target deceleration associated with the selected autobrake level may not be achievable with braking alone, in which case reverse thrust use is essential for stopping the aircraft even with autobrake.



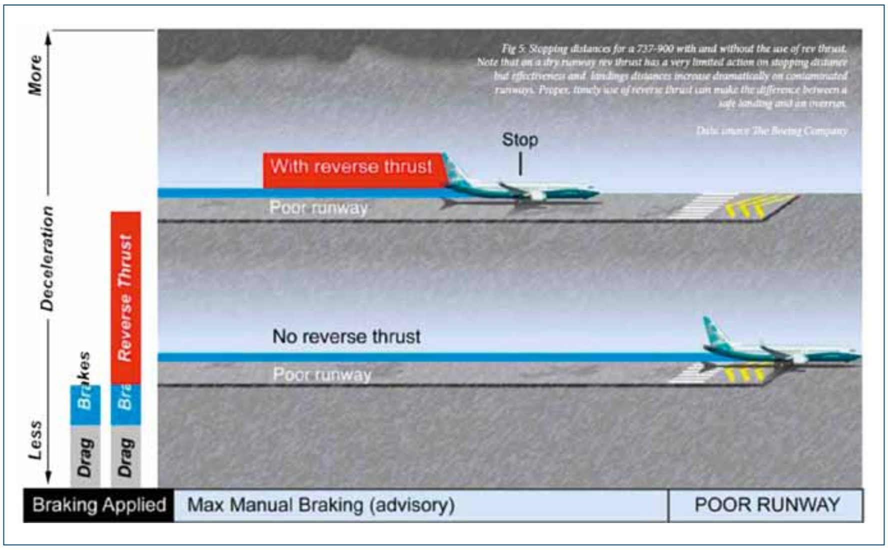
Impact on brake engery using rev thrust with autobrakes
Data source: The Boeing Company

Selecting reverse thrust on a dry runway provides minimal additional deceleration with maximum manual braking and no additional deceleration with auto brakes.



Ratio of stopping forces
Data source: The Boeing Company

However, when landing on a runway with poor braking action, the effect of reverse thrust can make a dramatic difference. The next figure shows when using max manual braking, thrust reversers are additive. The figure shows that the deceleration due to drag has remained the same for all runway conditions, but the deceleration from reverse thrust has increased significantly while brake efficiency has decreased due to slippery runway conditions.



It is important to use full reverse on a wet/contaminated runway irrespective of any noise or environmental restrictions.

Bounced Landing Recovery

Recommendation 3.4.26 The aircraft operator should include specific recovery techniques from hard and bounced landings in their training program.

Bouncing at landing usually is the result of one or a combination of the following factors:

- Excessive sink rate
- Late flare initiation
- Power-on touchdown
- Wind shear or thermal activity
- Etc.

Aircraft Operators should make sure their SOP include the required techniques for bounce recovery. This recovery technique should also be included in the initial and recurrent training, especially for training captains.

In case of a light bounce a typical recovery technique would require the pilot to maintain the pitch attitude (any increase could cause a tail strike) and allow the aircraft to land again. Special attention should be paid to the increased landing distance. If the remaining runway length is not sufficient a rejected landing can still be initiated until the selection of the reverse thrust.

In case of a high bounce, a landing should not be attempted as the remaining runway length might not be sufficient to stop the aircraft. A rejected landing initiated from this position would typically require the pilot to apply Takeoff go-around (TOGA) thrust and maintain the pitch attitude and configuration until the risk for a tail strike or second touchdown has disappeared. Then the normal go-around technique can be used.

Once a rejected landing is initiated, the flight crew must be committed to proceed and not retard the thrust levers in an ultimate decision to complete the landing. On one occasion the commander took control and initiated a go-around after his first officer inadvertently made a bounced landing. After the go-around initiation the aircraft touched the runway again triggering the takeoff configuration warning. This activation was not expected by the commander and made him change his mind to stop the aircraft. This resulted in the aircraft coming to a stop very close to the end of, in this case, a very long runway.

Runway excursions, impact with obstructions and major aircraft damage are often the consequence of reversing an already initiated rejected landing.

Landing Long

Recommendation 3.4.27 In cases where an aircraft operator accepts landing long as a practice, the practice should be safety risk assessed, with a published policy and standard operating procedure supported by appropriate flight crew training.

It was mentioned earlier that long landings or steep approaches would mean different positions of the landing runway on the windshield and dilute the value of this visual reference as a backup for profile deviations. If an aircraft operator accepts this practice, it should be safety risk assessed. A standard operating procedure should be published and adequate training provided.

References:

Airbus: Flight Crew Training Manual (FCTM)
Airbus Flight Crew Operations Manual (FCOM)

Airbus: Getting to grips with aircraft performance
Airbus: Flight Operations Briefing Notes: Flying Stabilised Approaches
Airbus: Flight Operations Briefing Notes: Bounce Recovery – Rejected Landing

Australian Transport Safety Bureau: Tail strike and runway overrun Melbourne Airport, Victoria 2009

Transportation Safety Board of Canada: Runway Overrun and Fire Toronto 2005.

Joint industry/FAA Takeoff Safety Training Aid

BOEING: Flight Crew Training Manual (FCTM)
IFALPA / BOEING: Briefing leaflet: Certified versus advisory landing data on Boeing aircraft.

JAR/EASA Flight Crew Licensing

Flight Safety Foundation: ALAR tool kit

EUROCONTROL: A study of runway Excursion from a European Perspective

IATA: Runway Excursion Case Studies; Threat and Error Management Framework


2
CAUTION
HOT SURFACE

APPENDIX F AIRCRAFT MANUFACTURERS

Manufacturers of aircraft must meet specific minimum criteria when it comes to certifying aircraft for use by the aircraft operators. It is recognised by the manufacturers that the information for certification does not cover all aspects of the aeroplane operations and as such they provide additional documents and information such as Flight Crew Operating Manuals, Flight Crew Training Manuals, Flight Crew Information Bulletins, Flight Operation Technical Bulletins, and material during symposiums, conferences, performance engineer training classes, flight crew training.

Many of these publications contain procedures and information that address issues that have been identified as causal factors in runway excursions. However not all manufacturers provide the same amount or type of information. Below are recommendations for what manufacturers should provide to help address issues associated with runway excursions. It is recognised that much of the information in the list below has been supplied by many but not necessarily all the manufacturers of the aeroplanes.

Takeoff and Landing Performance Presentation

Recommendation 3.5.1 Aircraft manufacturers should present takeoff and landing performance information in similar (common and shared) terminology and to agreed standards.

Significant progress and agreement as to terminology and standards was accomplished during the work of the United States FAA Takeoff and Landing Performance Assessment (TALPA) Aviation Rulemaking Committee (ARC) activity that occurred in 2008 and 2009. In this activity six of the major manufacturers worked with the FAA, aircraft operators, business jet operators, airport operators, and other industry interest groups to recommend a standard terminology for reporting and evaluating runways conditions when the runway is not dry and criteria for manufacturers to use when computing the aeroplanes performance information.

The current status of the recommendations from this activity is that the TALPA ARC recommendations have been issued by the FAA using advisory material. Some aircraft manufacturers have implemented the recommendations and so they are in use by some aircraft operators. Airbus has changed the way it provides data in their operating documents for the bulk of the fleet to use terminology and standards consistent with the TALPA ARC recommendations. Boeing has used the recommendations in creating the certification and operational data for their new aeroplane programs (787 and 747-8) and provides aircraft operators on an as requested basis the information necessary to adjust their landing performance information to meet the recommendations.

It is recommended that other certification agencies consider the work done during the FAA TALPA ARC if/when they change reporting terminology and methods or change standards for computing the performance information.

Runway Conditions and Aeroplane Performance

Recommendation 3.5.2 Training material promulgated by aircraft manufacturers should emphasize the necessity of making best use of runway length available when conditions are uncertain or when runways are wet or contaminated by applying full braking devices, including reverse thrust, until a safe stop is assured.

This type of information is often included in the manufacturer's FCOM or FCTM with supplemental information possibly in bulletins or magazine articles.

An example of a manufacturer's guidance on operating on wet or contaminated runways is provided later in this appendix.

Real Time Performance Monitoring and Warning Systems

Recommendation 3.5.3 On-board real time performance monitoring and warning systems that will assist the flight crew with the land/go-around decision and warn when more deceleration force is needed should be made widely available.

Part of the tools for excursion prevention is improved technology to help the pilot with the following decisions: to proceed to destination or divert, to land or go-around, or to apply all deceleration devices to their maximum utilisation. Different systems are currently available or in development by some manufacturers and 3rd party vendors to use existing technology to provide the flight crew information to assist with these decisions.

Landing Distance Calculations

Recommendation 3.5.4 The aviation industry should develop systems and flight crew manuals to help flight crews calculate landing distances reliably.

The aviation industry has changed greatly in the past decade as to how the calculation of performance in general and landing distances in particular is done. In the late 90s ACARS systems and laptops started showing up in the cockpit. The information the flight crew obtains from these systems is computed based on crew input information such as airport/runway, weather conditions, wind, runway conditions, approach type etc.

These systems replace the need for crew to do multiple hand calculations, flipping through paper charts and adding/subtracting/interpolating in cumbersome tables and charts. Often because of the number of computations required flight crew relied on quick checks of the numbers or didn't do the appropriate performance checks at all.

With the aforementioned ACARS systems and on-board performance programs it is much easier for the flight crew to get an appropriate answer with less exposure to error. It is also easier for the crew to look at multiple scenarios so they can have a plan in the event they obtain additional information late in the approach that the runway has deteriorated.

Manufacturers of these devices and methods are continually searching for better ways to do this and in this very competitive business there is no doubt that continuous improvement will continue.

The availability of such interactive systems however does not discharge aircraft manufacturers and operators from presenting the performance information in an intuitive format that is foolproof to use. This becomes even more important when the performance tables are only used very occasionally as a backup means to an electronic system.

Data Checks

Recommendation 3.5.5 Electronic Flight Bag manufacturers and providers (class 1/2/3) should enable the flight crew to perform independent determination of takeoff data and to implement where possible an automatic crosscheck to ensure correct insertion of the takeoff data in the avionics. Standard Operating procedures should be developed to support this crosscheck.

Manufacturers of EFBs are encouraged to investigate to what degree they can create simple crosschecks between various data sources to ensure the correct information is being used in the calculation of the takeoff data. A typical error that has caused safety problems in the past has been the use of incorrect weights in computing takeoff speeds.

Any means of minimising the sources of such error has to consider human factors aspects of the concerned interfaces and how they integrate into the specific cockpit environment in which they are meant to be used. An example for a human factor driven solution is to require ZFW only as the input to the FMC instead of giving the option of inputting either ZFW or TOW. Another example is removing the weight used in the previous calculation, which requires the flight crew to input the weight for the current flight each time.

Another approach to reducing mistakes are gross-error checks, which must rely on totally independent data sources to validate consistency. An example of a gross-error check is the comparison of the maneuvering speeds calculated independently and from different sources by an EFB and the FMC.

Example guidance material may be found in the FAA AC 120-76A, "Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices" and EASA AMC 20-25, "Approval of Electronic Flight Bags".

Flight Crew Procedures

Recommendation 3.5.6 Manufacturers should have clear flight crew procedures required to attain the published takeoff and landing performance.

The manufacturer's performance presented to flight crew should clearly include the basis for the calculations. This would include items like the following:

- what level of reverse thrust was assumed,
- what is the assumption of the wheel braking,
- is the data factored or not,
- what is the air distance allowance in the data.

FCOM procedures and flight crew training manual recommendations should also be consistent with the assumptions in the data. If the data assumes prompt initiation of reverse thrust, then the procedures should require this, etc.

Maximum Crosswind

Recommendation 3.5.7 Maximum crosswind data published by aircraft manufacturers should be based upon one consistent and declared method of calculation.

The maximum acceptable crosswind depends on the aircraft capabilities and the runway conditions, but also in the personal limits of the flight crew depending on their experience. A consistently determined maximum crosswind recommendation by aircraft manufacturers would be a good basis for a pilot to determine his personal limit from.

At this time however, manufacturers supply recommended crosswind maximums based on the assumptions they consider appropriate. The assumptions include things like:

- modeling for different runway conditions,
- consideration of engine failure or not,
- assumed centre of gravity position,
- flight technique (crab, sideslip), etc.

This is because current methods for determining recommended or limitations on crosswind are not part of the certification basis for the aeroplanes, and only a demonstrated value on a dry runway is required in the AFM.

It is doubtful that manufacturers will come to a consensus on this item without regulatory guidance as in many cases there are fundamental differences in philosophy between manufacturers. A starting point for harmonisation would be for manufacturers to agree on using the description of the runway and braking action such as was accomplished for performance computations for the TALPA ARC.

The development of regulatory guidance in this field should include manufacturer consultation to ensure technical and economical feasibility.

Lessons Learned

Recommendation 3.5.8 Manufacturers should monitor and analyse all (worldwide) runway excursions involving the aeroplanes they support and share the lessons learned.

The reporting and investigation of aircraft accidents and incidents is regulated by ICAO Annex 13. The results of such investigations are sometimes shared publicly. However, due to their much higher rate of occurrence much more can be learned from precursor events if they are identified as such and acted upon.

Some manufacturers review yearly or bi-yearly the significant accidents and incidents as well as the causal factors and issues highlighted by these events. This can be done at meetings and conferences attended by operators, and in manufacturer publications like bulletins, changes in procedures or other information.

Information on the TALPA ARC

The TALPA ARC was tasked with an exhaustive review of safety issues of operations on contaminated runways and recommending modified FAA regulations, which would be retroactively applicable to all existing aircraft.

The proposals for regulatory changes concerning transport category aircraft put forward to the FAA by the ARC were oriented along three main axes:

- Standards for runway condition reporting (FAR139)
- Definition of operational landing performance computation (FAR25/26)
- Operational Rules (FAR121)

The committee also covered FAR23/91/91K/135 operations, which are not further addressed here.

The following aspects were outside of the scope of the FAA TALPA ARC mandate:

- Assessment of landing with in-flight failures,
- Overweight landing without failures,
- Automatic landing distances,
- Dispatch landing distances.

The exclusion of dispatch was made to minimise the economical impact of the proposed changes. Furthermore, the introduction of a more operationally representative assessment of landing distances to be used for dispatch is not considered to constitute a significant improvement in safety levels, while accurate in-flight landing distance assessments are accepted as being the major means to reduce exposure to runway excursions at landing. Even so, for the long term, the need to review dispatch landing distances for consistency with the time of arrival requirements was acknowledged by TALPA ARC in its submission to the FAA.

The concepts detailed in the following are those proposed for aircraft that will be certified under the FAA TALPA ARC rules. The TALPA ARC rules also mandate that landing distances in line with the spirit of the proposal are published for all existing aircraft still supported by the manufacturer, albeit with less stringent requirements and with an increased grace period. For non-supported aircraft a set of fixed and conservative factors to be applied to the AFM dispatch data are provided by the regulator.

The TALPA ARC submitted its proposals to the FAA in May 2009, who will translate them into a Notice of Proposed Rulemaking (NPRM). In parallel, a field trial was launched with selected airports and operators to further validate the Runway Condition Assessment Matrix. It is not expected that the NPRM will be published before 2013 to 2015, to be followed by a mandatory comment period of at least 6 months. The proposals included a grace period for compliance of existing aircraft of two years. However, several manufacturers and countries have taken on board significant elements of the TALPA ARC work for their publications and reporting respectively.

Operational Rules
Challenges

Today, most operational regulations make a very generic statement regarding the need to assess landing performance in flight ("the commander must satisfy himself/herself that, according to the information available to him/her, the weather at the aerodrome and the condition of the runway intended to be used should not prevent a safe approach [and] landing"), which does not detail the criteria and factors to be taken into account for the determination of a safe landing distance.

The lack of clear direction has led to aircraft operator operations departments filling the regulatory deficit with a variety of policies of their own initiative (or sometimes under requirement from their national Operational Authorities). Such variety of aircraft operator policies was observed by the FAA in the aftermath of the Chicago-Midway accident, and subsequently led to the publication of SAFO and AC. These documents made recommendations applicable to US operators to perform in flight landing performance assessment, including the manner in which the Operational Landing Distance should be derived, and instigated the additional 15% margin, except in emergency situations.

Proposals

- **Dispatch landing distance assessment**
  The FAA TALPA ARC has recognised that the current dispatch landing distance, in particular on a wet smooth runway, might, in some cases, like hot & high elevation airports or descending runway slope, deliver unsatisfactory margins. This is why an in-flight landing performance assessment will be required to be made systematically as part of the approach preparation.

- **In-flight landing distance assessment**
  The proposed FAR 121 operational rules will mandate a systematic in-flight landing distance assessment based on a Factored Operational Landing Distance (FOLD) equal to 115% of the OLD published for the prevailing conditions (100% if emergency or in-flight failure):

This 15% FOLD increment serves to provide a margin to cover variations in parameters entering in the OLD calculation, like for example:
- The variability of runway friction due to evaluation and reporting of surface contamination, changing runway condition due to weather and in the case of wet runway surface issues such as texture loss and precipitation rate
- The variability in the flare execution or deceleration means application by the pilot
- The variability in touchdown speed due to turbulence or the impact of cross-wind

- **Use of Autobrake**
  The proposal of operational rules includes an exemption regarding the application of the 15% margin when using autobrake:
  - If the FOLD for manual landing is less than the Landing Distance Available (LDA)
  - And if the OLD for automatic braking is less than the LDA
  - Then the FOLD for automatic braking may be longer than the LDA

The rationale for this exemption is that the pilot can always override autobrake when required.

- **Exemption from In-Flight Assessment**
  It will be permitted to omit the in-flight assessment for landing on the runway planned at dispatch only if:
  - Dispatch was performed for DRY (or worse), and if at time of approach preparation a DRY runway and no worse conditions than the standard ones considered for dispatch are reported (e.g. no tailwind when zero wind considered for dispatch, no higher VAPP than usual)
  - Dispatch performed for WET, and if at time of approach preparation a WET runway and no worse conditions than the ones considered for dispatch are reported and the runway is maintained to the standards defining grooved or PFC runways in AC 150-5320.

Runway Condition Reporting Challenges

There is not currently a single worldwide standard for runway condition reporting.

Most frequently, the type of contaminant (and its depth when available) is reported, although the means for measurement, the threshold for reporting in terms of runway coverage, as well as the format, terminology and resolution of the reported information vary with local ATC practices.

Where runway friction measurements by dedicated vehicles are available, such friction values are sometimes reported to flight crew, although manufacturers do not provide any correlation of runway friction measured with a vehicle or a trailer with aircraft performance capabilities on the same surface. Some aircraft operators and local regulators have developed their own guidance.

In North America, after landing, pilots usually report to ATC their assessment of braking action on a scale from GOOD to POOR to ATC, and thus to following aircraft. This may occur spontaneously when braking action is found to be lower than expected for the reported runway condition, or on request by the tower.

Proposals

The centrepiece of the regulatory proposals is what became known in the work group as the "runway condition matrix". Its structure adheres to the existing ICAO runway codes and shows seven runway condition levels associated to codes from 0 (for nil braking action) to 6 (for dry), where each runway condition code (except 0) is matched with a corresponding aircraft performance level.

Different criteria of runway condition reporting can be used as entry points for the determination of the applicable aircraft performance level. These reporting criteria are:

- Contaminant type and depth,
- Pilot braking action report (PIREP), and
- Runway friction measurement (Mu (μ)).

The latter two types of report should be used only for downgrading of a runway from a friction category basically identified via contaminant type and depth. Pilots will be informed of contamination on the runway as soon as in excess of 10% of the runway surface is contaminated, while runway condition codes will be reported for each third of the runway when more than 25% of the entire runway surface is contaminated. If a friction measurement or reports from preceding aircraft's pilots (PiReps) indicate that the friction levels have dropped below those expected for the type of contaminant on the runway, the airport should report a lower condition code in line with the observed friction or braking action.

The information to be transmitted to the flight crew includes:

- The runway condition code for each third of the runway
- The type and depth of the contaminant and percentage of coverage in 25% increments (to avoid currently used terms such as "thin" and "patchy")
- The PIREPs when available.

AIRPORT RUNWAY CONDITION ASSESSMENT				
ASSESSMENT CRITERIA			**DOWNGRADE ASSESSMENT CRITERIA**	
CODE	RUNWAY CONDITION DESCRIPTION	MU (µ)	DECELERATION AND DIRECTIONAL CONTROL OBSERVATION	**PIREP**
6	■ Dry		-	-
5	■ Wet (includes water 1/8″ or ■ Frost **1/8″ or less depth of:** ■ Slush ■ Dry Snow ■ Wet Snow	**40 or Higher**	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal	**Good**
4	**15°C and Colder outside air temperature:** ■ Compacted Snow		Brake deceleration and controllability is between Good and Medium.	**Good to Medium**
3	■ Wet ("Slippery when wet runway") ■ Dry Snow or Wet Snow (Any Depth) over Compacted Snow **Greater than 3 mm (1/8″) depth of :** ■ Dry Snow ■ Wet Snow **Warmer than -15°C outside air temperature:** ■ Compacted Snow	**39 to 30**	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be noticeably reduced.	**Medium**
2	**Greater than 1/8″ depth of :** ■ Water ■ Slush	**29 to 21**	Brake deceleration and controllability is between Medium and Poor. Potential for hydroplaning exists.	**Medium to Poor**
1	■ Ice		Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	**Poor**
0	■ Wet ice ■ Water on top of Compact Snow[2] ■ Dry Snow or Wet Snow over Ice[2]	**20 or lower**	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain.	**Nil**

The TALPA ARC recommended that friction values should no longer be transmitted to pilots, but restricted to use by the airport authorities in consolidating the runway condition assessment, mainly to downgrade a runway condition assessment from descriptive characteristics. The Runway Condition Assessment Table as presented hereafter, and in particular the area shown in grey, is therefore meant for airport use only.

It is notable that this matrix provides a recommendation for the performance-wise classification of runways that are reported as Slippery When Wet (Code 3) due to rubber contamination or otherwise degraded runway friction. The concept of reporting runways as Slippery When Wet when the measured friction drops below the maintenance threshold was previously recommended for enforcement by the national authorities in ICAO Annex 14, but no associated aircraft performance was so far available to allow the flight crew to take this information into account in their landing performance assessment.

Actual in-service experience has been already acquired with the "matrix" in Alaska and some airports in other northern US states, and has been extensively tested in real conditions during winters 2008-2009 and 2009-2010. The runway condition classification made in the matrix will also be the basis of the digital NOTAM system currently being developed in the US.

The lack in standardisation of today's runway condition reporting has been identified as a contributing factor to overrun accidents at landing. There are encouraging indications from other international workgroups that these proposals developed in the frame of the TALPA ARC will find their way into various international rules and regulations.

Operational Landing Distance

The TALPA proposal defines aircraft performance only for in-flight landing distance determination to reflect actual aircraft maximum performance as it can be expected to be achieved by a line pilot, realistic but without margin. This distance is called Operational Landing Distance (OLD), made up of the components described here below.

Air Distance

The length of the airborne distance is the distance covered in 7 seconds at the ground speed corresponding to the approach speed (including temperature effect and 150% of the tailwind or 50% of the headwind). The touchdown speed is 96% of the approach speed, which more accurately represents modern jet aircraft than the definition in EASA AMC 25.1591.

Activation of Deceleration Means

Deceleration means are taken into consideration in line with their intended use as prescribed in the Standard Operating Procedures (SOP): ground spoiler deployment and maximum pedal braking at or near main gear touchdown, maximum reversers if their use is intended, at or near main gear touchdown. There is no allowance for delayed pilot actions.

Ground Roll

In line with the runway condition matrix above, the proposal identifies and defines aircraft performance levels matching the 6 runway friction codes, which are equally valid whatever the origin of the runway condition classification: contaminant type, measured runway friction or pilot reports on braking action.

Each of the 6 levels is associated to a runway code between 6 – Dry and 1 - Poor, and is approximately consistent with the friction coefficients described for the appropriate runway contaminant in the latest issue of EASA AMC 25.1591:

- 6 – Dry
- 5 – Good — Wet
- 4 – Good to Medium — Compact Snow
- 3 – Medium — Loose Snow
- 2 – Medium to Poor — Standing Water, Slush
- 1 – Poor — Ice

No performance level is provided for Nil, since operations in these conditions are prohibited.

Provisions of performance credit for WET Grooved or Porous Friction Course (PFC) runways have been made. However no specific runway code was assigned to such runways:

- A grooved or PFC runway is considered as an enhanced safety, that would be dissipated if performance credit was given systematically,
- Maintenance and minimum friction thresholds set in Annex 14 for a runway to be declared slippery when wet with associated aircraft performance level are under review by ICAO, which put them outside the time frame of TALPA ARC.

<table>
<tr><th rowspan="2">RUNWAY CONDITION CODE</th><th rowspan="2">BRAKING ACTION</th><th rowspan="2">CONTAMINANT DESCRIPTION</th><th colspan="2">OLD COMPUTATION[1]</th><th rowspan="2">REV CREDIT</th></tr>
<tr><th>AIR DISTANCE</th><th>GROUND ROLL AND FRICTION</th></tr>
<tr><td>6</td><td>-</td><td>DRY</td><td rowspan="6">7 sec, with 4% speed decay</td><td>Flight Tests demonstrated value reduced by 10%</td><td rowspan="6">Allowed</td></tr>
<tr><td>5</td><td>Good</td><td>Wet</td><td>Unchanged FAA/EASA model with wet anti-skid efficiency</td></tr>
<tr><td>4</td><td>Good to medium</td><td>Compact Snow</td><td rowspan="4">Consistent in essence with EASA CS25.1591</td></tr>
<tr><td>3</td><td>medium</td><td>Loose Snow</td></tr>
<tr><td>2</td><td>Medium to poor</td><td>Standing Water, Slush</td></tr>
<tr><td>1</td><td>Poor</td><td>ICE</td></tr>
</table>

1 Defined wheel braking coefficients are assuming a friction limited situation. Final performance is adjusted appropriately to account for autobrake deceleration controls.

An example of a manufacturer's guidance for operating on wet or contaminated runways.

NOTE:
The following information is an example of manufacturer's guidance for operating on wet or contaminated runways. This information is an example only and may change. It will not be kept up to date.

Slippery Runway Landing Performance

When landing on slippery runways contaminated with ice, snow, slush or standing water, the reported braking action must be considered. Advisory information for reported braking actions of good, medium and poor is contained in the PI chapter of the QRH. The performance level associated with good is representative of a wet runway. The performance level associated with poor is representative of a wet ice covered runway. Also provided in the QRH are stopping distances for the various autobrake settings and for non-normal configurations. Pilots should use extreme caution to ensure adequate runway length is available when poor braking action is reported.

Pilots should keep in mind slippery/contaminated runway advisory information is based on an assumption of uniform conditions over the entire runway. This means a uniform depth for slush/standing water for a contaminated runway or a fixed braking coefficient for a slippery runway. The data cannot cover all possible slippery/contaminated runway combinations and does not consider factors such as rubber deposits or heavily painted surfaces near the end of most runways.

One of the commonly used runway descriptors is coefficient of friction. Ground friction measuring vehicles typically measure this coefficient of friction. Much work has been done in the aviation industry to correlate the friction reading from these ground friction measuring vehicles to aeroplane performance. Use of ground friction vehicles raises the following concerns:

- the measured coefficient of friction depends on the type of ground friction measuring vehicle used. There is not a method, accepted worldwide, for correlating the friction measurements from the different friction measuring vehicles to each other, or to the aeroplane's braking capability.
- most testing to date, which compares ground friction vehicle performance to aeroplane performance, has been done at relatively low speeds (100 knots or less). The critical part of the aeroplane's deceleration characteristics is typically at higher speeds (120 to 150 knots).
- ground friction vehicles often provide unreliable readings when measurements are taken with standing water, slush or snow on the runway. Ground friction vehicles might not hydroplane (aquaplane) when taking a measurement while the aeroplane may hydroplane (aquaplane). In this case, the ground friction vehicles would provide an optimistic reading of the runway's friction capability. The other possibility is the ground friction vehicles might hydroplane (aquaplane) when the aeroplane would not, this would provide an overly pessimistic reading of the runway's friction capability. Accordingly, friction readings from the ground friction vehicles may not be representative of the aeroplane's capability in aquaplaning conditions.
- ground friction vehicles measure the friction of the runway at a specific time and location. The actual runway coefficient of friction may change with changing atmospheric conditions such as temperature variations, precipitation etc. Also, the runway condition changes as more operations are performed.

The friction readings from ground friction measuring vehicles do supply an additional piece of information for the pilot to evaluate when considering runway conditions for landing. Crews should evaluate these readings in conjunction with the PIREPS (pilot reports) and the physical description of the runway (snow, slush, ice etc.) when planning the landing. Special care should be taken in evaluating all the information available when braking action is reported as POOR or if slush/standing water is present on the runway.

Wheel Brakes

Braking force is proportional to the force of the tyres on the runway and the coefficient of friction between the tyres and the runway. The contact area normally changes little during the braking cycle. The perpendicular force comes from aeroplane weight and any downward aerodynamic force such as speedbrakes.

The coefficient of friction depends on the tyre condition and runway surface, (e.g. concrete, asphalt, dry, wet or icy).

Automatic Brakes

Use of the autobrake system is recommended whenever the runway is limited, when using higher than normal approach speeds, landing on slippery runways, or landing in a crosswind.

For normal operation of the autobrake system select a deceleration setting. Settings include:

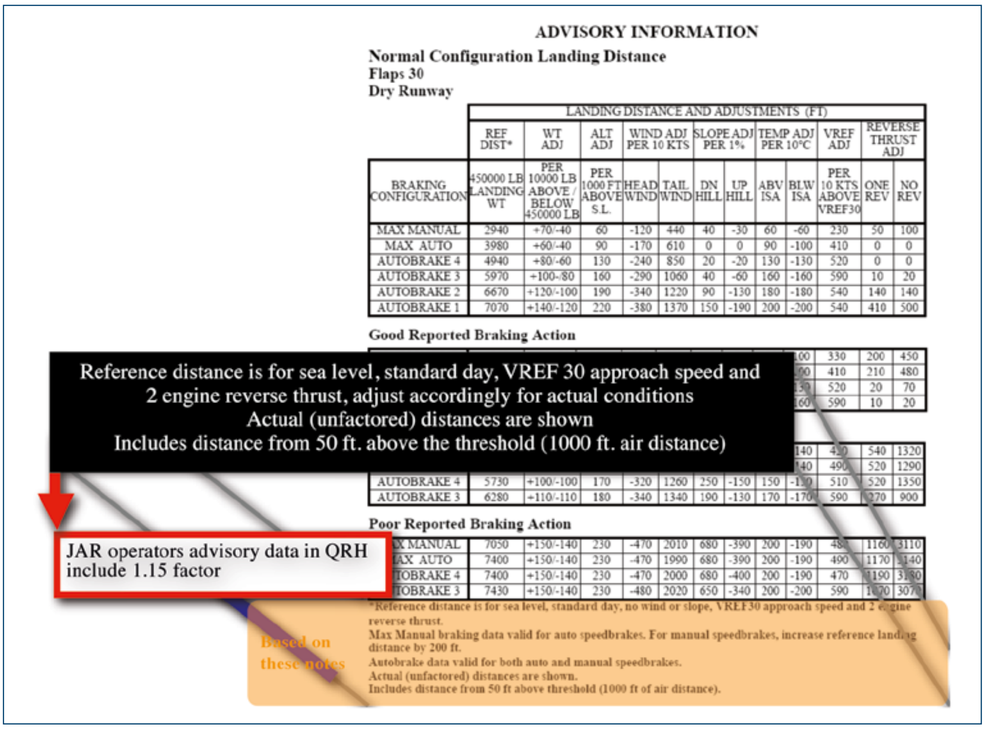
- MAX AUTO: Used when minimum stopping distance is required. Deceleration rate is less than that produced by full manual braking
- 3 or 4: Should be used for wet or slippery runways or when landing rollout distance is limited
- 1 or 2: These settings provide a moderate deceleration suitable for all routine operations.

Experience with various runway conditions and the related aeroplane handling characteristics provide initial guidance for the level of deceleration to be selected.

Criteria to be fulfilled by an effective runway excursion prevention system

The system should work in real time and continuously assess the position of the aircraft relative to the runway to which it performs the approach, as well as its actual energy level. The system should work in manual and automatic landing and manual and automatic braking. It should make a conservative but realistic assessment of the stopping distance required under the prevailing conditions for that energy level. It should compare the necessary distance with that available. It should alert the flight crew during the approach when a safe stop on the runway is not ensured. It should alert the flight crew during the ground roll when more deceleration is required. No runway overruns should occur with aircraft equipped with the system under conditions for which it is certified without an alert being triggered. The system should not generate alerts unnecessarily.

A system fulfilling these conditions permits the definition of clear procedures associated with the alerts (go-around, maximum braking and selection of max reverse thrust) that can, when applied, prevent runway excursions.


ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 30
Dry Runway

BRAKING CONFIGURATION	REF DIST* 450000 LB LANDING WT	WT ADJ PER 10000 LB ABOVE / BELOW 450000 LB	ALT ADJ PER 1000 FT ABOVE S.L.	WIND ADJ PER 10 KTS HEAD WIND	WIND ADJ PER 10 KTS TAIL WIND	SLOPE ADJ PER 1% DN HILL	SLOPE ADJ PER 1% UP HILL	TEMP ADJ PER 10°C ABV ISA	TEMP ADJ PER 10°C BLW ISA	VREF ADJ PER 10 KTS ABOVE VREF30	REVERSE THRUST ADJ ONE REV	REVERSE THRUST ADJ NO REV
MAX MANUAL	2940	+70/-40	60	-120	440	40	-30	60	-60	230	50	100
MAX AUTO	3980	+60/-40	90	-170	610	0	0	90	-100	410	0	0
AUTOBRAKE 4	4940	+80/-60	130	-240	850	20	-20	130	-130	520	0	0
AUTOBRAKE 3	5970	+100-/80	160	-290	1060	40	-60	160	-160	590	10	20
AUTOBRAKE 2	6670	+120/-100	190	-340	1220	90	-130	180	-180	540	140	140
AUTOBRAKE 1	7070	+140/-120	220	-380	1370	150	-190	200	-200	540	410	500

Example of procedures required to obtain published performance

APPENDIX G OVERSIGHT ACTIVITIES FOR REGULATORS

Effective oversight of runway, aerodrome and flight operations forms an important part of the safety management system (SMS) of the aerodrome operator, air navigation service provider, aircraft operator, and other stakeholders and of the State Safety Program activities.

ICAO obligations place responsibilities on States to ensure safety, regularity and efficiency of aircraft operations, air navigation services and operations at aerodromes under their jurisdiction. Therefore, it is essential that the State retains its overseeing responsibility and ensures that the aircraft operator, air navigation service provider and aerodrome operator, whether or not the aerodrome operator is state owned or private, complies with the relevant ICAO SARPs and/or applicable national regulations.

The Regulator in co-operation with the Competent Authorities for oversight and/or Military Authorities should conduct safety regulatory audits and inspection on aircraft operations, aerodromes operations and air navigation services in order to monitor the safe provision of these operations to assess the level of safety achieved and to verify that the applicable safety regulatory requirements and their implementing arrangements are met.

The regulatory oversight of aircraft operator, air navigation service provider aerodrome operators by their Regulator may include, but is not limited to:

- Ensuring that an aircraft operator, air navigation service provider and aerodrome operator has an effective runway excursion prevention programme that meets ICAO or national requirements;
- Joint/ coordinated audits and inspections to examine the interfaces between the aerodrome agencies involved in runway excursion prevention; e.g. communication of safety significant information regarding changing surface conditions in real time to the appropriate air traffic services ;
- Reviewing the training program for Pilots, Air Traffic Controllers and Aerodrome personnel on runway excursion prevention measures;
- Reviewing incident prevention programs, including occurrence reporting relating to runway excursions, and for aircraft operators, includes monitoring aircraft parameters related to potential runway excursions from their flight monitoring data program;
- Reviewing runway maintenance program, including removal of contaminants, refurbishing program, assessment of runway contamination and friction levels, etc.

In addition to the regulatory oversight described above, it may benefit a regulator to keep a high level, national focus on the risk of runway excursions. This can be achieved by establishing a national runway excursion prevention (sub) group as part of a national Runway Safety Steering Group. Membership of the group could include representatives from industry such as aerodromes, aircraft operator flight operations, air traffic services, industry safety groups, runway safety committee members and appropriate representatives from the regulatory authority.

Terms of reference for such a group might be to:

- Address specific, hazards identified nationally, coordinating this through sub-groups or external agencies as required;
- Promote good practice, information sharing and raise awareness through publicity and educate industry;
- Actively enhance work continuing in industry;
- Act as a coordination point for industry;
- Identify and investigate which technologies are available that may reduce runway excursion risks;
- Review current aerodrome, ATC and aircraft operational policies and if necessary make recommendations on future policy to reduce the risk of runway excursions;
- Make recommendations for guidance and advisory material for industry on aerodrome, aircraft and ATC operational issues to reduce the risk of runway excursions;
- Oversee and promote the reporting of runway excursion incidents;
- Thorough analysis of data to identify and examine specific areas of concern.

Regulators should actively support and promote the European Action Plan for the Prevention of Runway Excursions as part of the State Safety Program activities. Although the action plan is guidance material and contains recommendations only, regulators should ensure that it is given a continuous priority in its oversight activities wherever possible by:

- Promoting awareness of the European Action Plan for the Prevention or Runway Excursions guidance material;
- Conducting a gap analysis to ensure that all recommendations are implemented where possible;
- Ensuring that runway safety and the prevention of runway excursions are addressed in regular audit inspections;
- Ensuring that the recommendations arising from audits are implemented wherever possible.

Recommendation 3.7.1 Establish and implement one consistent method of contaminated runway surface condition assessment and reporting by the aerodrome operator for use by aircraft operators. Ensure the relation of this report to aircraft performance as published by aircraft manufacturers.

The AMC to ADR.OPS.A proposed in NPA 2011-11 lists reportable conditions in terms of natural deposits on runways. It also requires reporting of contamination depth by thirds of the runway as required. It encourages the use of friction devices for hard contaminants and precludes the reporting of friction coefficients for slush, wet snow or wet ice.

While so far the guidance is adequate, it also includes a table for determination of braking action proposed to be removed by an ICAO State Letter Annex 14 May 2011. This table is no longer considered to be state of the art, and does not allow runway condition reporting that relates to aircraft performance. This leaves the task of making a performance-relevant assessment to the flight crew, which is not always in full possession of complete, timely and accurate information that permits to draw the correct conclusions on how the performance assessments for takeoff and landing should be made.

The FAA TALPA ARC (described in the manufacturer guidance material) proposes a way of transferring some of that responsibility to the airport personnel with clear directives on how to merge all available information into a report that usefully describes the prevailing runway state on which a performance calculation can be directly based. Some manufacturers already present their data in a format compatible with this reporting method and format.

Recommendation 3.7.2 Establish and implement one consistent method of calculation of crosswind limits for use by aircraft manufacturers and aircraft operators.

CS 25.237 prescribes that "*A 90º cross component of wind velocity, demonstrated to be safe for takeoff and landing, must be established for dry runways and must be at least 37 km/h (20 kt) or 0·2 V_{SR0}, whichever is greater, except that it need not exceed 46 km/h (25 kt).*" Manufacturers publish for this maximum dry runway crosswind component a demonstrated value in the AFM, but it is not considered a limitation since it simply reflects the maximum crosswind encountered during the flight test campaign.

For wet runways, the AMC 25.109 on Accelerate-Stop Distance prescribes that "*exceptional skill is not required to maintain directional control on a wet runway with a 19 km/h (ten knot) crosswind from the most adverse direction. For demonstration purposes, a wet runway may be simulated by using a castering nosewheel on a dry runway. Symmetric braking should be used during the demonstration, and both all-engines-operating and critical-engine-inoperative reverse thrust should be considered. The brakes and thrust reversers may not be modulated to maintain directional control. The reverse thrust procedures may specify a speed at which the reverse thrust is reduced to idle in order to maintain directional controllability.*" Typically, manufacturer guidance on maximum crosswind on wet runway exceeds the regulatory 10kts.

For contaminated runways, AMC 25.1591 simply states "*The provision of performance information for contaminated runways should not be taken as implying that ground handling characteristics on these surfaces will be as good as can be achieved on dry or wet runways, in particular following engine failure, in crosswinds or when using reverse thrust.*" Most manufacturers provide guidance on the maximum crosswind component on contaminated runways in the operational documentation.

The lack of regulation on the way of establishing the published maximum crosswind components for wet and contaminated runways has led to the development of varying methods used by manufacturers, usually based on calculation and simulation since demonstration in flight test is not reasonable or practicable.

Regulation should be developed in cooperation with manufacturers to define the assumptions based on which the maximum crosswind guidance should be established, including but not limited on such aspects as:

- centre of gravity,
- castering nose wheel,
- symmetrical braking,
- margin on rudder authority,
- asymmetric power (engine failure, reverse),
- Maximum allowable deviation from centreline,
- Accountability for gust,
- Aircraft speed.

Recommendation 3.7.3 It is recommended that aircraft operators always conduct an in-flight assessment of the landing performance prior to landing. Note: Apply margin to these results.

EU-OPS 1.400 reads as follows:

"Approach and landing conditions
Before commencing an approach to land, the commander must satisfy himself/herself that, according to the information available to him/her, the weather at the aerodrome and the condition of the runway intended to be used should not prevent a safe approach, landing or missed approach, having regard to the performance information contained in the Operations Manual."

Reference is made to the Operations Manual; Performance is in part B, described in Appendix 1 to EU-OPS 1.1045. For landing, paragraph 4.1. (h) states that the aircraft operator has to include for compliance with subparts F (general) and G (class A) "*landing field length (dry, wet, contaminated) including the effects of an in-flight failure of a system or device, if it affects the landing distance*".

Note that the requirement 1.400 is in subpart D (Operational Procedures) and is thus technically excluded from this requirement. Further this does not prescribe the performance basis on which the data has to be established, or the factors that need to be applied to the data. EU-OPS 1.475:

"*(b) An operator shall ensure that the approved performance Data contained in the Aeroplane Flight Manual is used to determine compliance with the requirements of the appropriate Subpart, supplemented as necessary with other data acceptable to the Authority as prescribed in the relevant Subpart. When applying the factors prescribed in the appropriate Subpart, account may be taken of any operational factors already incorporated in the Aeroplane Flight Manual performance data to avoid double application of factors.*"

Data described in the CS25.125 does not include any safety margins or operational factors. These are specified in EU-OPS 1.515, which refers to 1.475(a) that clearly makes it a pure dispatch or re-dispatch requirement, in line with the requirements of ICAO Annex 6. Paragraph 1.515(d) has been interpreted such that it requires dispatch factors to be used in flight, but in fact it is a reflection of Annex 6, Part 1, Attachment I, Point 7.1.1.3 dealing with a dispatch where the landing mass exceeds the maximum landing weight on the most favourable runway in still air. The in-flight check is thus specific to this type of operation. It means that only in that case does the commander have to check performance in-flight for the actual runway, aircraft weight and outside condition based on EU-OPS 1.510 (go-around), and 1.515 a (factors) and b (parameters to consider). It is a way of mitigating the perceived increased risks of an operation undertaken with reduced margins, and the only case where the RLD is mandated as an in-flight reference. EU-OPS 1.400, which is otherwise applicable, does not specify what performance reference or factors to apply.

However, the core of the problem is technical. The landing distances currently to be considered according to dispatch requirements for landing are inconsistent and non-rational:

- Margin on dry is 67%
- Margin on wet is variable, since the 15% increase on the dry runway certified landing distance does not reflect the physics of friction on a wet runway. If we construct a wet runway landing distance in line with CS25.125 using the wet runway friction of CS25.109 defined for the ASD at takeoff and manufacturer recommended procedures, the real margin at SL is around 30-40% decreasing with increasing altitude, downhill slope etc. Comparable margins to dry only exist on wet when reverse thrust is used, which also poses the problem of aircraft not equipped with efficient reverse thrust.
- The nominal margin on contaminated is just 15% on the certified distance, but the airborne distance in accordance with CS25.1591 is more realistic than for dry, even if the speed bleed-off in the flare was considered too large by the TALPA ARC. On the other hand, the nature of runway contamination introduces an increased uncertainty regarding the actual friction vs. the assumed one.

A rationale for the existing dispatch factors can no longer be traced, but they cover two types of issues:

- Physical parameters neglected in the determination of the certified landing distances (like runway slope within +/-2° and outside air temperature deviation from ISA),
- Operational uncertainties and variability (like actual wind, increased approach speed, flare technique, minor failures, runway friction issues...)

It can be argued that the latter contributors to the safety margin required can be reduced the closer the performance assessment is made to the time of landing and actual conditions are known more accurately. Furthermore, manufacturers are publishing operational data in their operational documentation that allows to varying degrees removing some "unknowns" from the dispatch data with a computation with a consistent and realistic airborne distance, for the planned approach speed, published average runway slope and forecast temperature. Based on such data and a reasonable estimation of the effect of a statistically distributed occurrence of the remaining variabilities, a required in-flight margin of 15% can be rationalised. This, together with an improved runway condition reporting, is the basis for the FAA TALPA ARC proposals.

Unfortunately, the use of such improved data for the in-flight landing performance assessment generates contradictions with dispatch requirements and resulting operational issues.

The purpose of this recommendation is for EASA to mandate the harmonised publication of landing performance data for in-flight use with an adapted safety margin, and to adjust the dispatch requirements accordingly to avoid the potential operational issues linked to the consideration of runway contamination at dispatch.

Recommendation 3.7.10 Sponsor research on the impact of fluid contaminants of varying depth on aircraft stopping performance, also accounting for the impact of lower aquaplane speeds of modern aircraft tyres. EASA should research the impact of lower aquaplane speeds of modern aircraft tyres on aircraft performance.

Background

The speed at which modern aircraft tyres such as radial and H-type tyres start to aquaplane is much lower than for a classical cross-ply tyre. The lower aquaplane speed of modern tyres has been demonstrated by theoretical models and full-scale experiments.

To estimate the aquaplane speed of an aircraft tyre often use is made of the empirical relation $V_p=9\sqrt{p}$, with p the tire pressure in psi and V_p in kts. This equation is simply known as Horn's equation for dynamic aquaplaning which was the result of NASA research in the sixties. This equation was derived using aircraft cross-ply tyres that were commonly used in the sixties and later years. What the simple equation derived by Horne failed to show is the influence of other factors. Important is the influence of the tire footprint on the aquaplaning speed. The longer and the more narrow this footprint becomes, the higher the aquaplane speed will be as it then takes more time to remove water between the tire footprint and the surface. Modern aircraft tyres have different footprints than the classical cross-ply tyres of the same dimensions, at the same pressure and under the same loading. This explains the differences in aquaplane speeds.

The lower aquaplane speeds of modern aircraft tyres can have an impact on aircraft performance and should addressed during certification.

Sources:

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LANDING LTS
LEFT
NOSE
RIGHT
HGS SUNVISOR

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All references given in this document were correct at the time of publication, they may however be updated over time.

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