SIRM (SAFETY ISSUE REVIEW MEETING)
DAKAR 24-25 APRIL 2024

Runway SAFETY

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Introduction

- At the request of several international aviation organizations
- in late 2006, the Flight Safety Foundation initiated a
- project entitled Runway Safety Initiative (RSI) to address
- the challenge of runway safety.
- International collaboration with aviation organizations
- Aimed at addressing runway safety challenges
- Reviewed runway incursions, confusion, and excursions
- Gathered specific data on runway safety
- Identified runway excursions as primary focus for risk reduction efforts

Exemple of cases

Tenerife airline disaster, runway collision of two Boeing 747 passenger airplanes in the Canary Islands on March 27, 1977. The disaster killed more than **580 people**.

Exemple of cases

The crash of LATAM Perú flight 2213 on the 18th of November 2022

- 9 passengers were seriously injured
- **Two were declared dead on the scene**
- The third after a 7-month hospital battle.

Exemple of cases

The 737 Max 8's left main landing gear separated from the aircraft after striking a large concrete "manhole" .

Captain of United 737 that left pavement in Houston wanted to 'expedite' time on runway.

Definitions

Runway Excursion: When an aircraft on the runway surface departs the end or the side of the runway surface. Runway excursions can occur on takeoff or landing.
They consist of two types of events:

Veer-Off: A runway excursion in which an aircraft departs the side of a runway
Overrun: A runway excursion in which an aircraft departs the end of a runway

Stabilized approach: All flights must be stabilized by 1,000 feet above airport elevation when in instrument meteorological conditions (IMC) or by 500 feet above airport elevation in visual meteorological conditions (VMC).

Stabilized approach conditions:

- Correct flight path maintained
- Minimal heading/pitch adjustments needed
- Speed within VREF + 20 knots
- Correct landing configuration
- Sink rate ≤ 1,000 feet per minute
- Appropriate power setting
- Completed briefings and checklists
- Specific approach criteria met (e.g., ILS within one dot of glideslope)
- Special briefing for unique procedures or abnormal conditions

Unstabilized approach that is Below 1,000 feet AGL in IMC or 500 feet AGL in VMC Immediate go-around required

Background

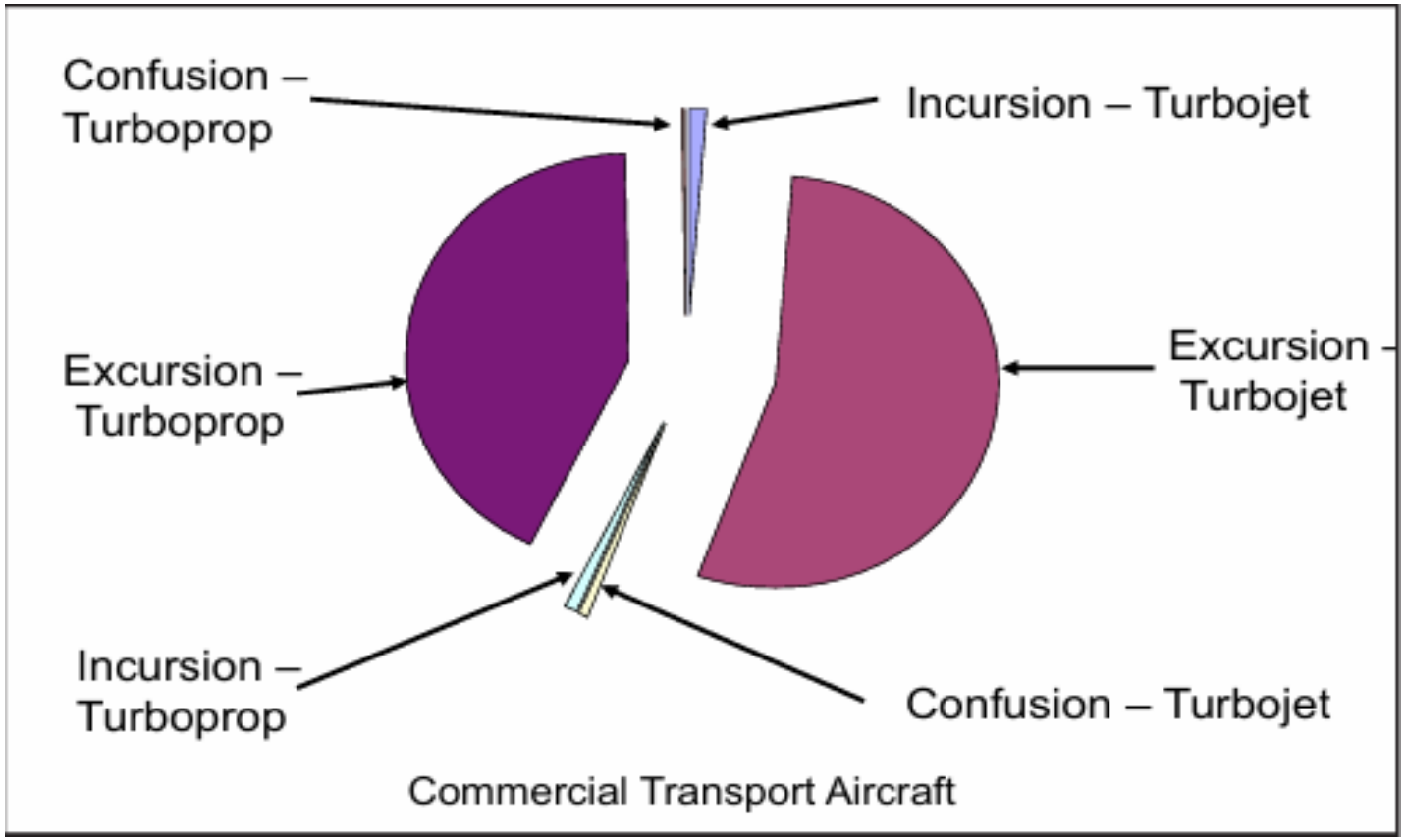
- Data sourced from World Aircraft Accident Summary (WAAS)
- Analysis covers major and substantial-damage accidents
- Includes Western- and Eastern-built commercial jet and turboprop aircraft
- Period: 1995 through 2008
- Focus on overall accident numbers and runway-related accidents

Aircraft Type	Turbojet		Turboprop	
Damage	Major	Substantial	Major	Substantial
	286	372	528	243
Total	658		771	
1,429 Total Accidents				

Western- and Eastern-built Turbojet and Turboprop Aircraft

- 1,429 accidents involving major or substantial damage from 1995 to 2008
- 431 accidents (**30%**) were runway-related
- **97%** of runway-related accidents were **runway excursion**s (417 out of 431)

Background



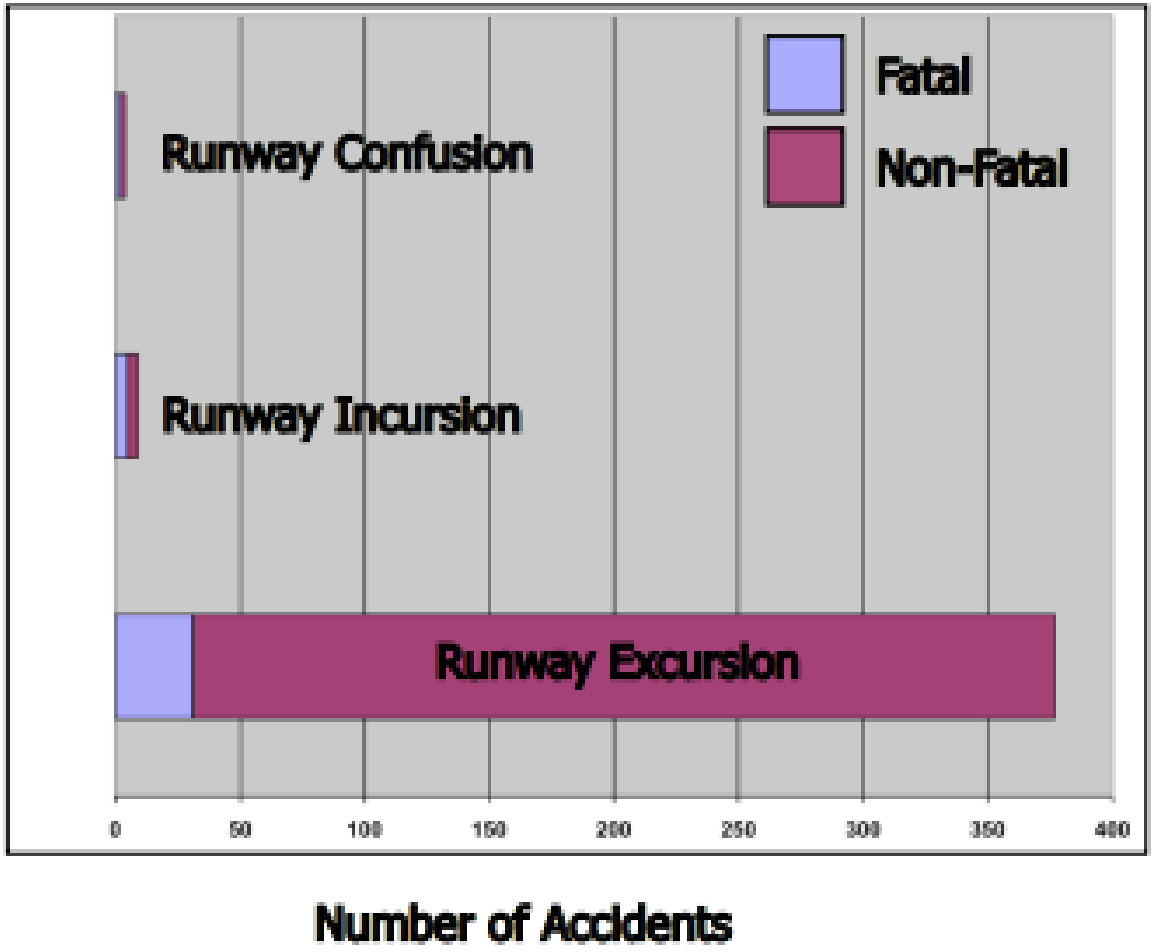
The largest portion of runway-related accidents is, by far, excursion accidents.

Background

Accident Type	Number of Accidents	Average Annual Rate	% of Total Accidents
Incursion	10	0.7	0.6%
Confusion	4	0.3	0.3%
Excursion	417	29.8	29.0%

- Runway excursion accidents **outnumber** runway incursion accidents by **over 40 times**
- Runway excursion accidents **outnumber** runway confusion accidents by **over 100 times**
- Average of nearly **30 runway excursion accidents per year** for commercial aircraft
- Combined average of **one runway incursion and confusion accident per year** over the past 14 years

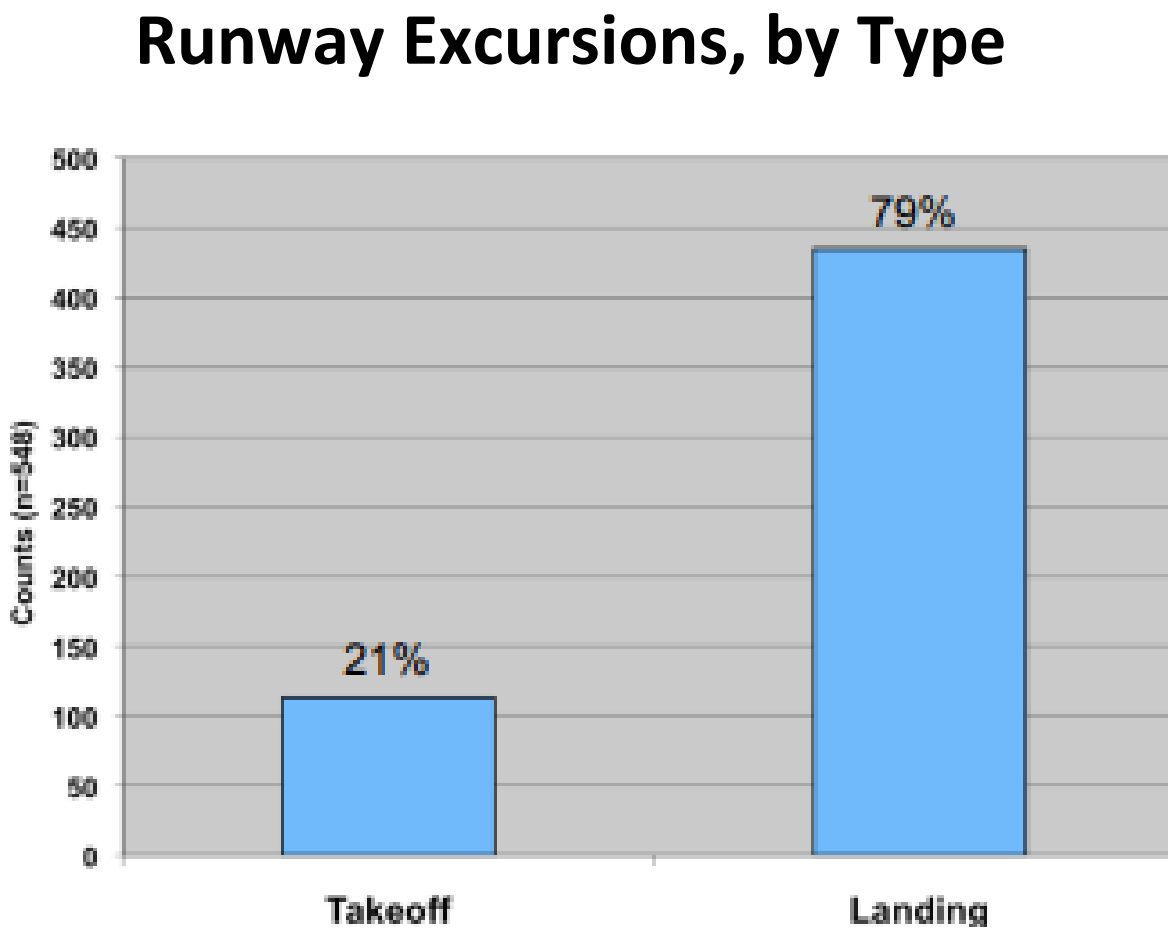
Background



- 41 out of 431 runway accidents resulted in fatalities
- Excursion accidents accounted for 34 of the fatal accidents (83%)
- So greater number of runway excursion accidents leads to substantially more fatal excursion accidents

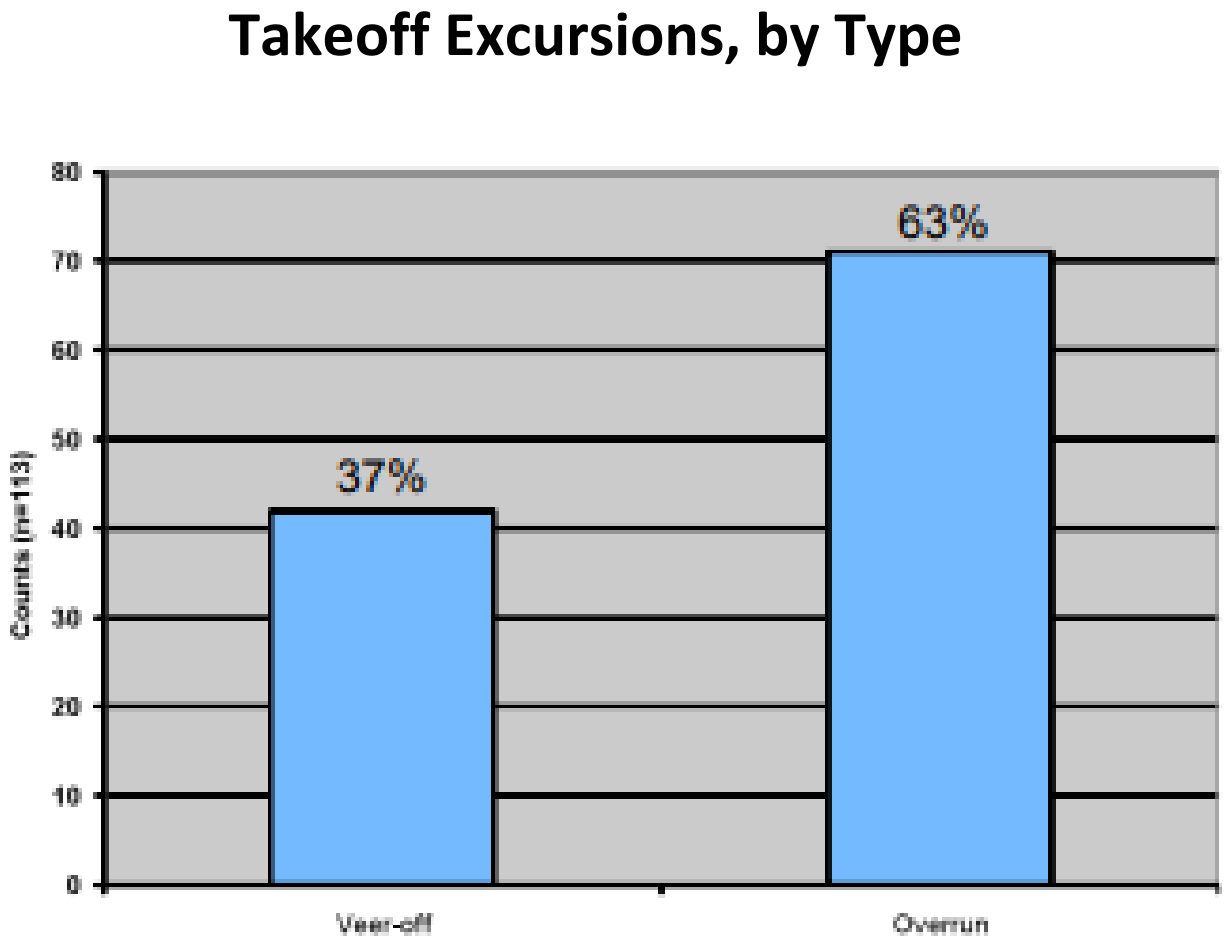
Data

- In-depth data study conducted on runway excursion accidents from 1995 to March 2008
- Aimed to investigate causes and identify high-risk areas
- Landing excursions outnumber takeoff excursions approximately **4 to 1**



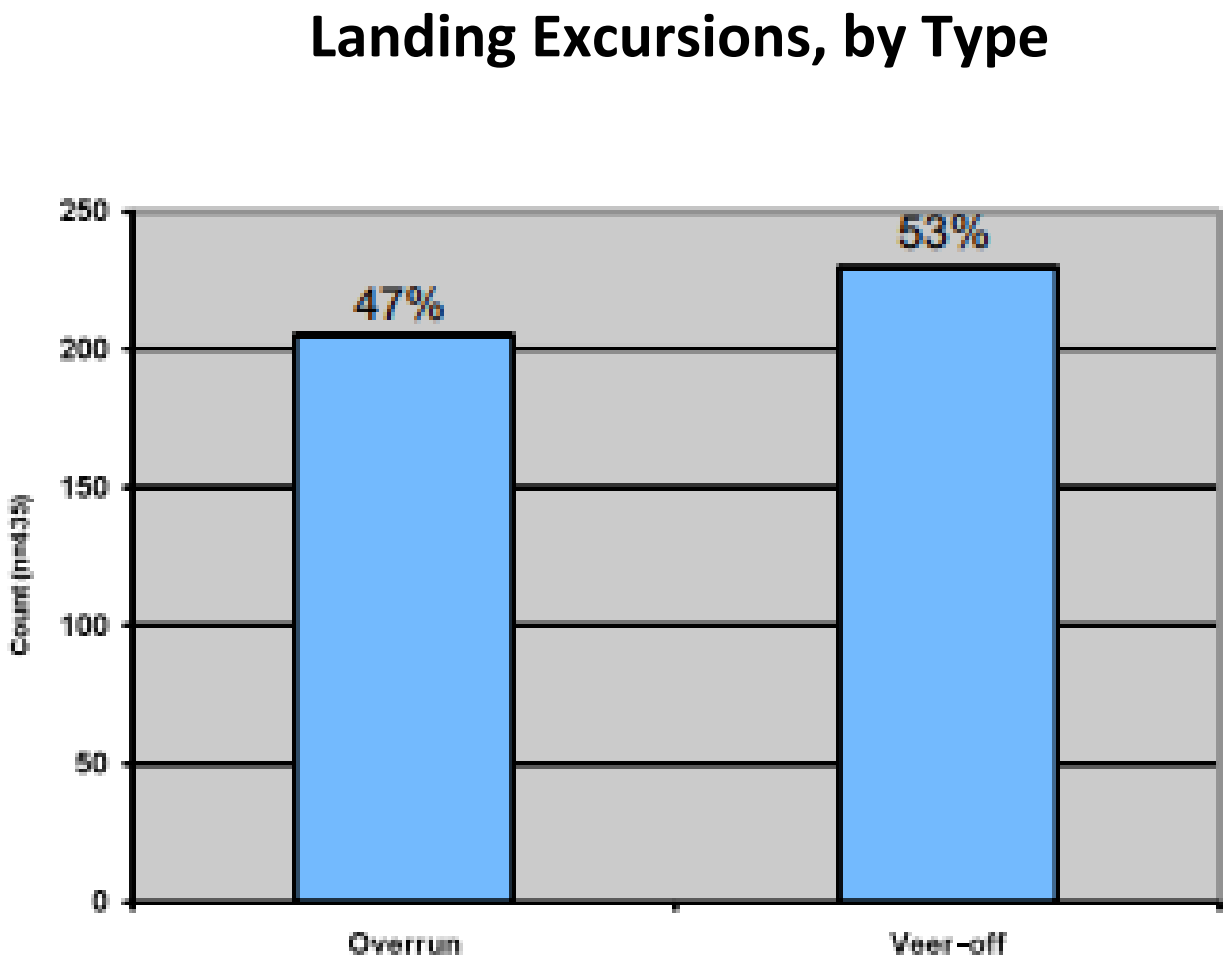
Data

- Almost two-thirds of the takeoff excursions are overruns



Data

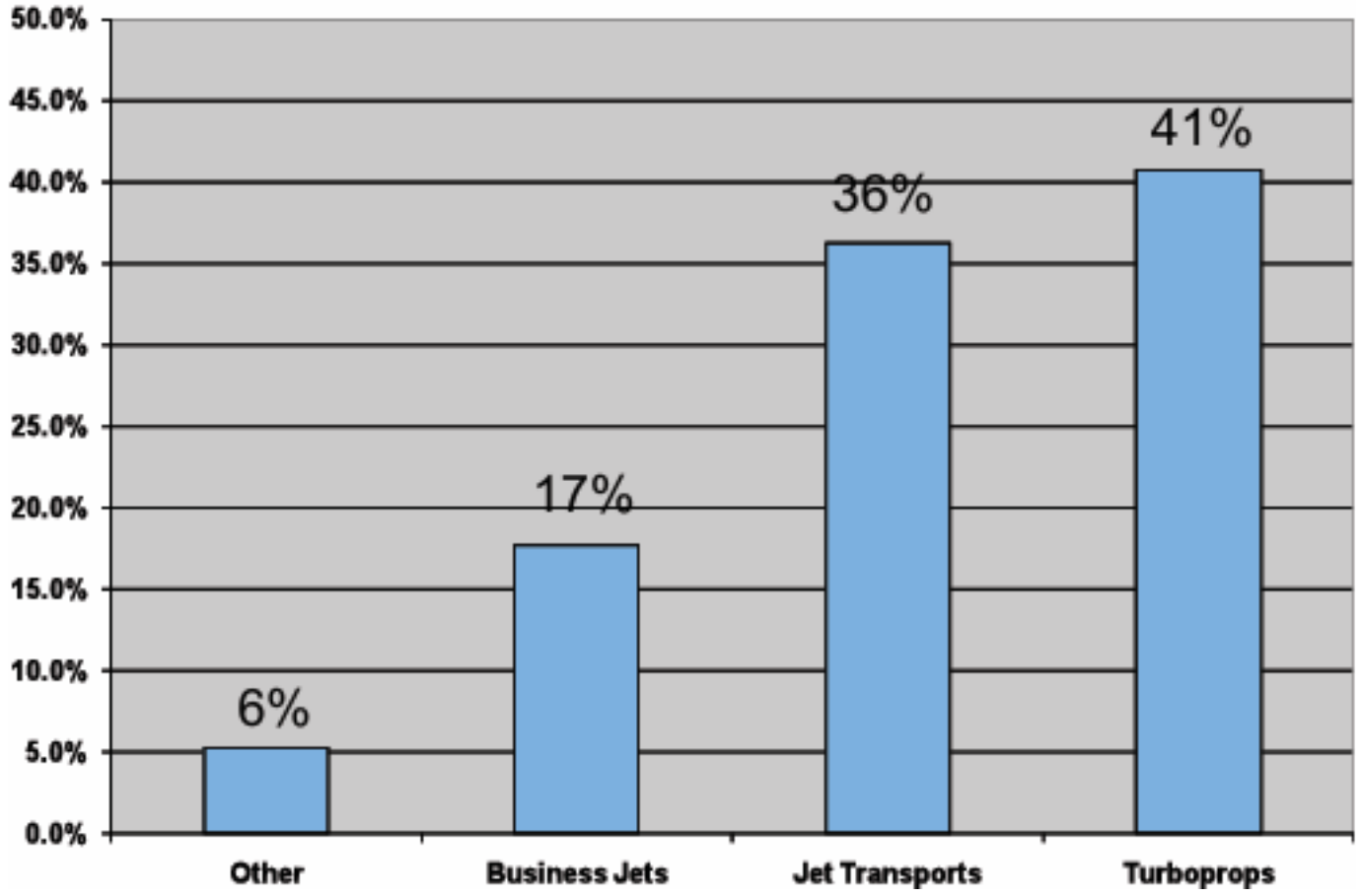
- Landing excursion overruns and veer-offs occur at nearly the same rate



Data

- Among aircraft fleet types, turboprops are involved in the largest percentage of takeoff excursions, followed closely by jet transports.

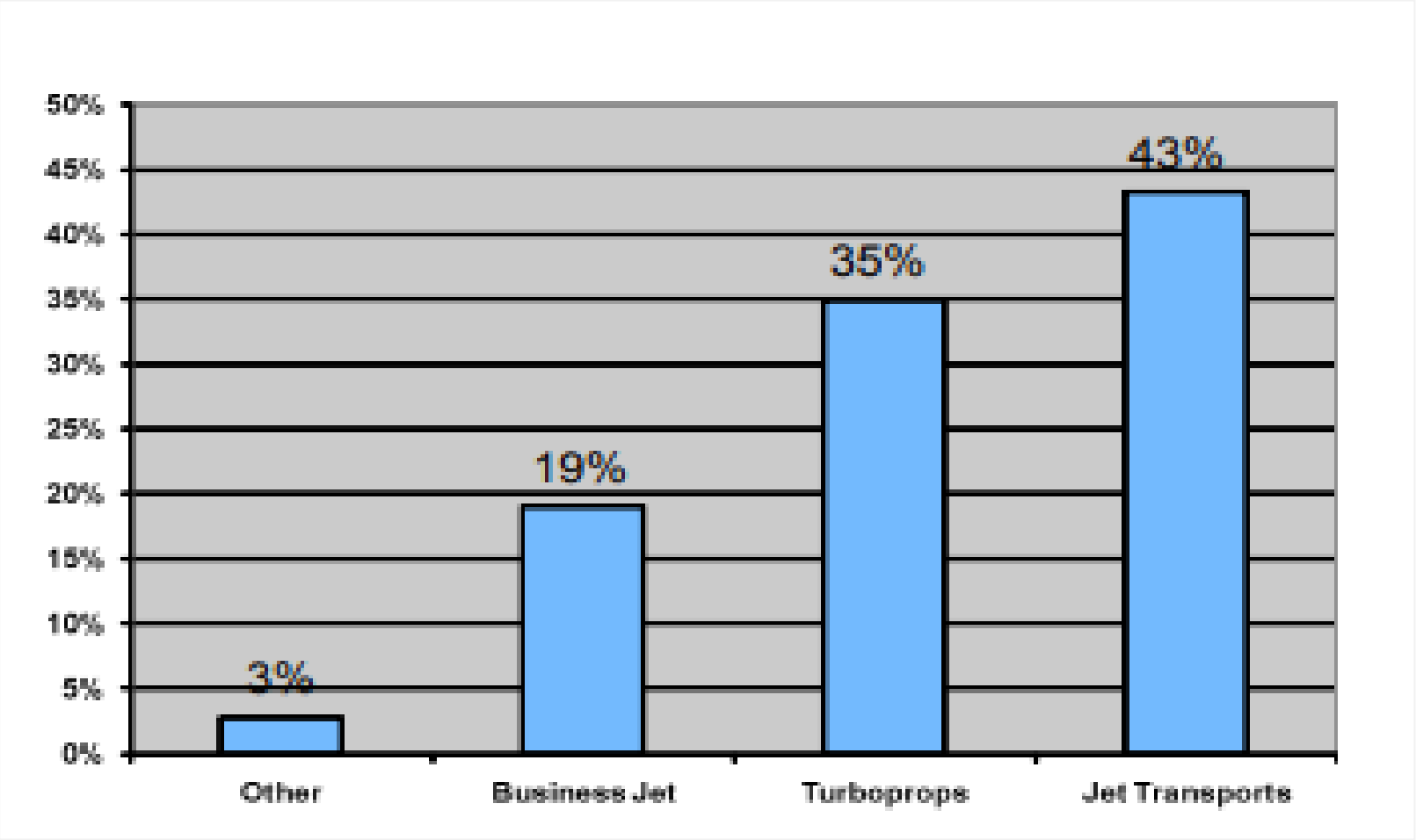
Takeoff Excursions, by Fleet CompositionComposition



Data

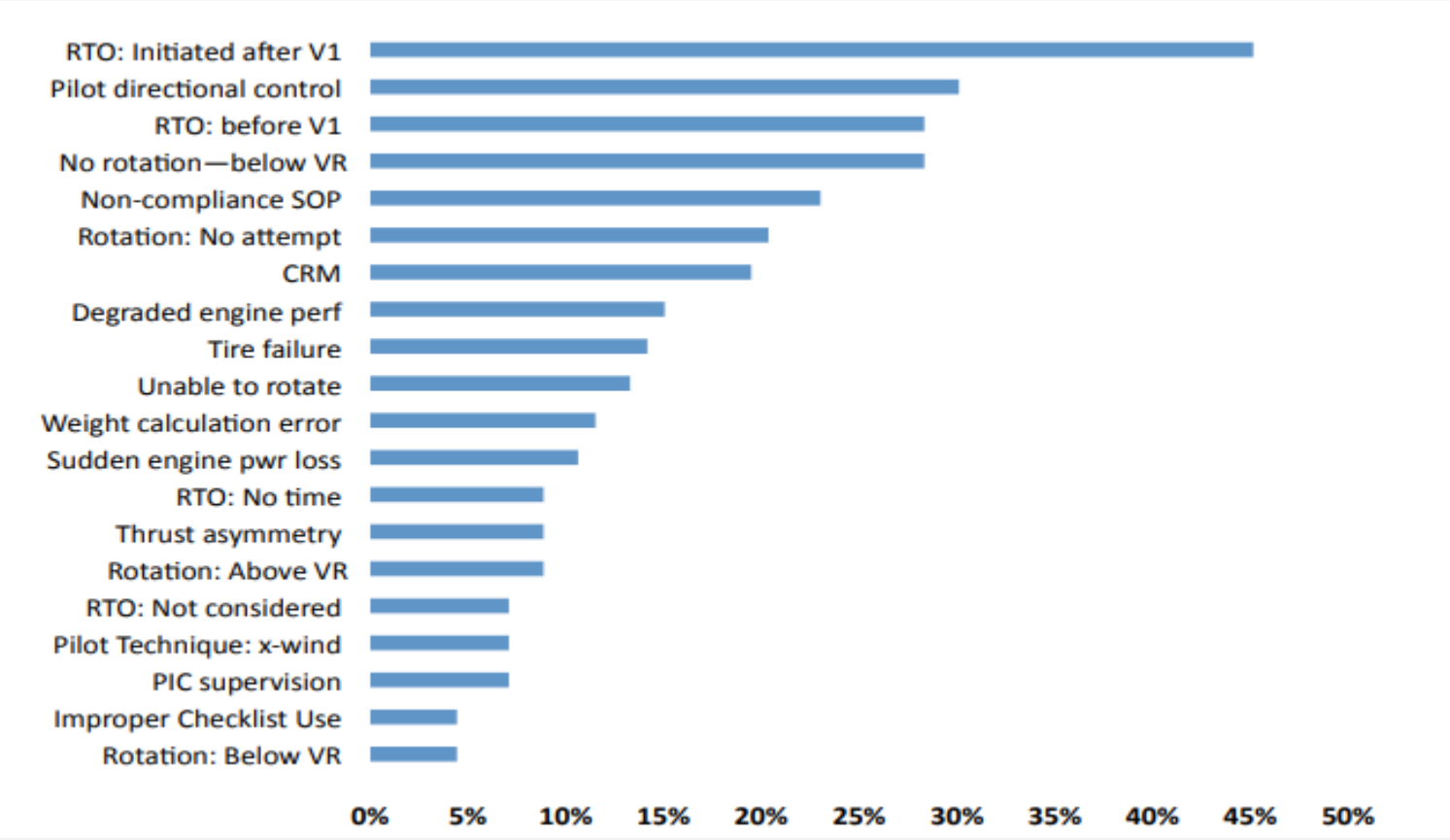
- For landing excursions, the proportions between jet transports and turboprops were approximately reversed — jets were involved in more excursions than turboprops

Landing Excursions, by Fleet



Data

Takeoff Excursion Risk Factors

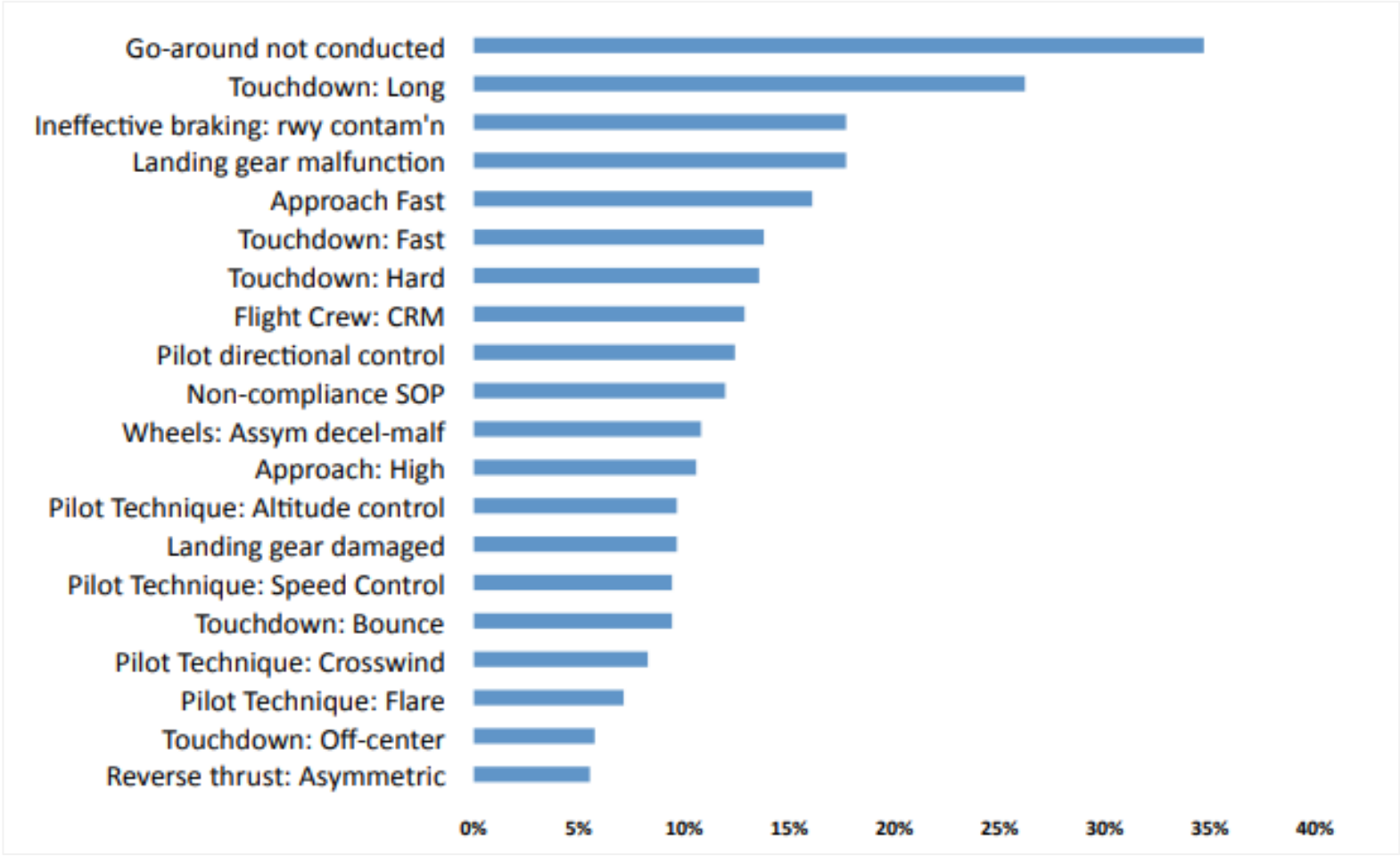


Top risk factors for takeoff excursions:

- Rejected takeoff (RTO) initiated at speed > V1
- Loss of pilot directional control
- Rejection of takeoff before reaching V1

Data

Landing Excursion Top Risk Factors



Top risk factors for landing excursions:

- Go-around not conducted
- Touchdown long
- Landing gear malfunction
- Ineffective braking (e.g., hydroplaning, contaminated runway)

Common Risk Factors in Runway Excursion Events

Runway excursion events can happen on takeoff or landing. They are typically the result of one or more of the following operational factors and circumstances

- **Flight Operations**
- **Air Traffic Management**
- **Airport**
- **Aircraft Manufacturers**
- **Regulators**

Takeoff Excursion Risk Factors:

- Rejected takeoff (RTO) initiated at speed greater than V1
- Crew noncompliance with standard operating procedures (SOPs)
- Failure of crew resource management (CRM)
- Tire failure
- Aircraft weight calculation error
- Sudden engine power loss
- RTO — no time to abort before veer-off
- Thrust asymmetry
- Pilot technique — crosswind
- Failure of pilot-in-command (PIC) supervision of first officer

Common Risk Factors in Runway Excursion Events

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Air Traffic Management

Airport

Aircraft Manufacturers

Regulators

Landing Excursion Risk Factors:

- Go-around not conducted
- Touchdown long
- Ineffective braking — runway contamination
- Landing gear malfunction
- Approach fast & Touchdown fast or hard
- Approach high
- Pilot technique — glide slope/altitude control/Speed control
- Touchdown — bounce or off-center
- Pilot technique — crosswind or flare

Common Risk Factors in Runway Excursion Events

Runway excursion events can happen on takeoff or landing. They are typically the result of one or more of the following operational factors and circumstances

Flight Operations

Air Traffic Management

Airport

Aircraft Manufacturers

Regulators

- Lack of awareness of the importance of stabilized approaches
- Lack of awareness of stabilized approach criteria
- Failure to descend aircraft appropriately for the approach
- Failure to allow aircraft to fly appropriate approach speeds
- Failure to select the appropriate runway based on the wind
- Late runway changes (e.g., after final approach fix)
- Failure to provide timely or accurate wind/weather information to the crew
- Failure to provide timely or accurate runway condition information to the crew

Common Risk Factors in Runway Excursion Events

Runway excursion events can happen on takeoff or landing. They are typically the result of one or more of the following operational factors and circumstances

Flight Operations

Air Traffic Management

Airport

Aircraft Manufacturers

Regulators

- Runways not constructed and maintained to maximize effective friction and drainage
- Late or inaccurate runway condition reports
- Not closing a runway when conditions dictate
- Incorrect or obscured runway markings
- Inappropriate obstacle assessments

Common Risk Factors in Runway Excursion Events

Runway excursion events can happen on takeoff or landing. They are typically the result of one or more of the following operational factors and circumstances

Flight Operations

Air Traffic Management

Airport

Aircraft Manufacturers

Regulators

- Lack of appropriate operational and performance information for operators that accounts for the spectrum of runway conditions they might experience

Common Risk Factors in Runway Excursion Events

Runway excursion events can happen on takeoff or landing. They are typically the result of one or more of the following operational factors and circumstances

Flight Operations

Air Traffic Management

Airport

Aircraft Manufacturers

Regulators

- Lack of a regulatory requirement to provide flight crews a consistent format of takeoff and landing data for all runway conditions
- Inadequate regulation for the provision of correct, up-to-date and timely runway condition reports
- No international standard for measuring and reporting runway conditions

Multiple Risk Factors

- **Runway excursion risk increases with multiple risk factors**
- **Synergistic effect observed, where two risk factors more than double the risk**
- **Utilizing safety management system (SMS) methodology can combine risk indicators**
- **Identifying increased-risk operations through SMS**
- **Applying mitigation strategies can effectively reduce runway excursion risk**

Landing Excursion Risk Factor Interactions

- **The data analysis on landing excursion incidents reveals the following key points:**
- **1. Reliable Data: Larger numbers make landing excursion data less prone to inaccuracies.**
- **2. Strong Associations: Significant associations exist between factors in veer-offs and overruns.**
- **3. Touchdown Impact: "Touchdown hard/bounce" is crucial in veer-offs, while "Touchdown long/fast" is more relevant to overruns.**
- **4. Approach Importance: Factors beyond a stabilized approach may play a significant role in veer-off accidents.**
- **These findings emphasize the importance of specific factors in understanding and preventing landing excursion incident.**

Landing Excursion Risk Factor Interactions

- **Correlations: "Touchdown long/fast" strongly correlates with unstabilized approaches in overruns.**

- **Wind Factors: Tailwinds are linked to overruns, while crosswinds are associated with veer-offs.**

Recommended Mitigations

The prevention strategies embrace five areas:

- **Flight Operations**
- **Airport Operators**
- **Air Traffic Management**
- **Aircraft Manufacturers**
- **Regulators**

Policies

- Operators should have a process for actively monitoring their risk during takeoff and landing operations
- Operators should define training programs for takeoff and landing performance calculations
- Operators should have an ongoing process to identify critical runways within their operations
- Operators should stress that CRM and adherence to SOPs are critical in RTOs
- Operators should implement, train, and support a no-fault go-around policy

Recommended Mitigations

The prevention strategies embrace five areas:

- **Flight Operations**
- **Airport Operators**
- **Air Traffic Management**
- **Aircraft Manufacturers**
- **Regulators**

Standard Operating Procedures (SOPs)

- Management and flight crews should mutually develop and regularly update SOPs
- Operators should define criteria and required callouts for a stabilized approach
- Operators should define criteria that require a go-around
- Operators should ensure that flight crews understand that landing with a tailwind on a contaminated runway is not recommended

Recommended Mitigations

The prevention strategies embrace five areas:

- **Flight Operations**
- **Airport Operators**
- **Aircraft Manufacturers**
- **Air Traffic Management**
- **Regulators**

Policies

- Ensure that all runway ends have a runway end safety area (RESA) as required by International Civil Aviation Organization (ICAO)
- Define criteria to determine when to close a runway to prevent runway excursions
- Ensure that runways are constructed and maintained to ICAO specifications
- Ensure that aircraft rescue and fire fighting (ARFF) personnel are trained and available at all times during flight operations
- Ensure that ARFF personnel are familiar with crash/fire/rescue procedures for all aircraft types serving the airport

Recommended Mitigations

The prevention strategies embrace five areas:

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- **Regulators**

Standard Operating Procedures (SOPs)

- Ensure that visual aids, specifically touchdown zone location and markings, are visible and in accordance with ICAO
- Ensure that infrastructure restrictions such as changes to the published takeoff run available (TORA) and runway width available are communicated in a timely and effective manner
- Ensure that runway conditions are reported in a timely manner
- Provide an active process that ensures adequate runway braking characteristics
- Mitigate the effects of environmental (e.g., snow, ice, sand) and other deposits (e.g., rubber and de-icing fluids) on the runway

Recommended Mitigations

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ATM/ATC has two primary roles in reducing the risk of runway excursions:

1. Provide air traffic services that allow flight crews to fly a stabilized approach

1. Provide flight crews with timely and accurate information that will reduce the risk of a runway excursion

Recommended Mitigations

The prevention strategies embrace five areas:

- **Flight Operations**
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- **Air Traffic Management**
- **Aircraft Manufacturers**
- **Regulators**

Policies

- Ensure all ATC/ATM personnel understand the concept and benefits of a stabilized approach
- Encourage joint familiarization programs between ATC/ATM personnel and pilots
- ATC/ATM and operators should mutually develop and regularly review and update arrival and approach procedures
- Require the use of aviation English and ICAO phraseology

Recommended Mitigations

The prevention strategies embrace five areas:

- **Flight Operations**
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- **Air Traffic Management**
- **Aircraft Manufacturers**
- **Regulators**

Standard Operating Procedures (SOPs)

- Controllers should assist flight crews in meeting stabilized approach criteria by:
  - Positioning aircraft to allow a stabilized approach
  - Avoiding late runway changes, especially after the final approach fix
  - Providing approaches with vertical guidance
  - Not using speed control inside the final approach fix
- Controllers should:
  - Select the preferred runway in use based on wind direction
  - Communicate the most accurate meteorological and runway condition information available to flight crews in a timely manner

Recommended Mitigations

The prevention strategies embrace five areas:

- **Flight Operations**
- **Airport Operators**
- **Air Traffic Management**
- **Regulators**
- **Aircraft Manufacturers**

- Develop a policy to ensure the provision of correct, up-to-date and timely runway condition reports
- Develop a policy to standardize takeoff and landing data format as a function of runway condition provided to airlines by aircraft manufacturers
- Develop a standard measurement system for runway condition reporting

Recommended Mitigations

The prevention strategies embrace five areas:

- **Flight Operations**
- **Airport Operators**
- **Air Traffic Management**
- **Regulators**
- **Aircraft Manufacturers** → Manufacturers should provide appropriate operational and performance information to operators that account for the spectrum of runway conditions they might experience.

Conclusions & Recommandations

A mishandled rejected takeoff (RTO) increases the risk of takeoff runway excursion

- **Operators should emphasize and train for proper execution of the RTO decision**
- **Training should emphasize recognition of takeoff rejection issues:**
  - **Sudden loss or degradation of thrust**
  - **Tire and other mechanical failures**
  - **Flap and spoiler configuration issues**
- **Training should emphasize directional control during deceleration**
- **CRM and adherence to SOPs are essential in time-critical situations such as RTOs**

Takeoff performance calculation errors increase the risk of a takeoff runway excursion

- **Operators should have a process to ensure a proper weight-and-balance, including error detection**
- **Operators should have a process to ensure accurate takeoff performance data**

Conclusions & Recommandations

Unstable approaches increase the risk of landing runway excursions

- **Operators should define, publish, and train the elements of a stabilized approach**
- **Flight crews should recognize that fast / high / hard /long touchdowns are major factors leading to landing excursions**
- **ATC/ATM personnel should assist aircrews in meeting stabilized approach criteria**

Failure to recognize the need for and to execute a go-around is a major contributor to runway excursion accidents

- **Operator policy should dictate a go-around if an approach does not meet the stabilized approach criteria**
- **Operators should implement and support no-fault go-around policies**
- **Training should reinforce these policies**

Conclusions & Recommandations

Combinations of risk factors (such as abnormal winds plus contaminated runways or unstable approaches plus thrust reverser issues) synergistically increase the risk of runway excursions

The survivability of a runway excursion depends on the energy of the aircraft as it leaves the runway surface and the terrain and any obstacles it will encounter prior to coming to a stop

Contaminated runways increase the risk of runway excursions

Establishing and adhering to standard operating procedures (SOPs) will enhance flight crew decision making and reduce the risk of runway excursions

Universal standards related to the runway and conditions, and comprehensive performance data related to aircraft stopping characteristics, help reduce the risk of runway excursions

THANK YOU