This presentation is aimed at operational managers, flight crewmembers, and safety managers

The purpose is to provide educational guidance and to disseminate lessons learned from recent accidents.

It is not intended to be 100% comprehensive, nor over ride manufacturer's guidance or regulatory requirements.

Other material in the Runway Excursion Risk Reduction toolkit, to include web links and other presentations, should be researched for additional information.

The primary source of data in this presentation is the FSF Reducing the Risk of Runway Excursion report 2009, included in this toolkit.

Many areas of the instructor notes are drawn from industry experience to stimulate discussion.

Purpose of This Presentation

Runway excursions are the most common types of accidents

Purpose:

- To identify the threats and errors that lead to runway excursions
- To share the lessons learned from past accidents

Objective:

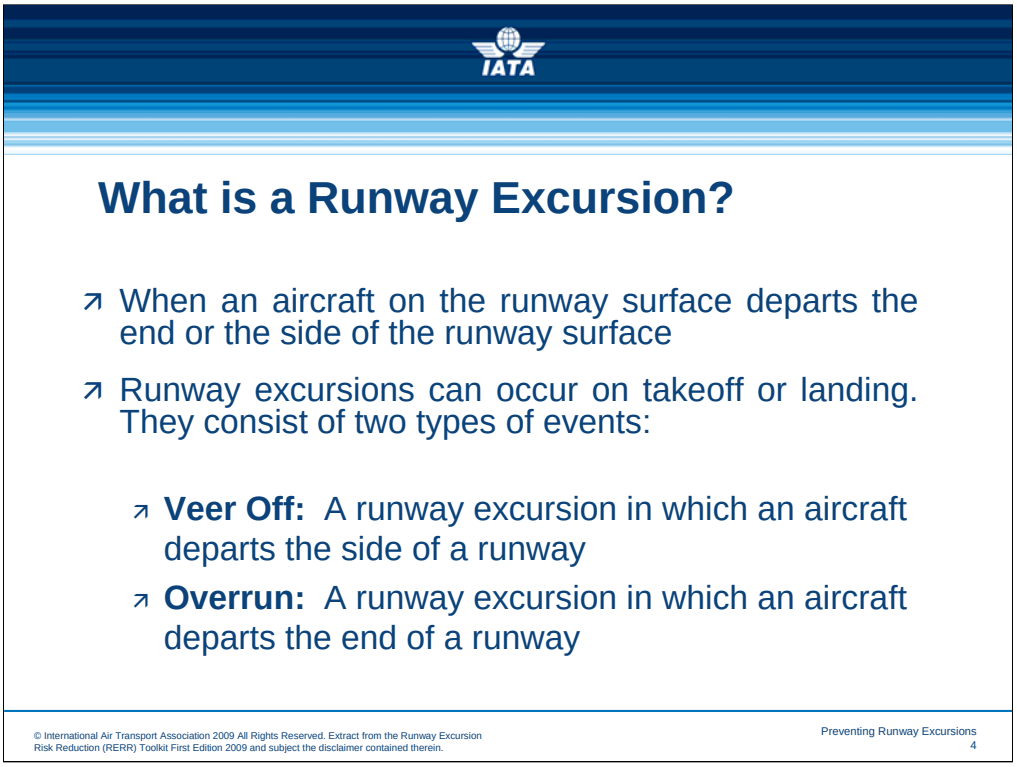
- To reduce the rate of these types of accidents in the future

Runway excursions have been more than 27% of the hull losses in the previous 5 years in the commercial airline industry.

<note: there are additional presentations in this tool kit under supporting document listing each accident from 2004-2008>

Overview

- What is a Runway Excursion
- Runway Excursion Analysis
- Takeoff Risk Factors
- Landing Risk Factors



Note: runway excursions do not include events where the aircraft is being taxied.

This definition was created by the FSF in the Reducing the Risk of Runway Excursions report.

The consequences of a runway excursion are related to the conditions surrounding the runway.

Aircraft speed at the time of excursion has a considerable effect on the subsequent damage and consequences.

This airport is Madira, Portugal.

- What is a Runway Excursion
- Runway Excursion Analysis
- Takeoff Risk Factors
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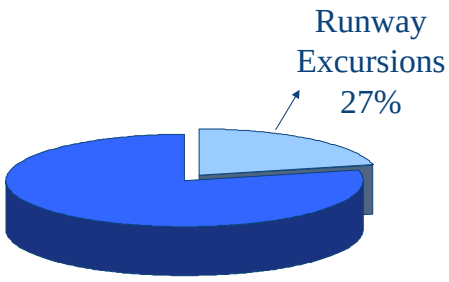
Commercial Transport Accident History
IATA Safety Reports 2004-2008

There were 501 total commercial accidents during this period:

- ↗136 of these accidents were runway excursions
- ↗17 runway excursion accidents involved fatalities
- ↗This resulted in a total of 463 passenger and crew fatalities



Runway excursion accidents were 139 of 501 accidents, or 27.7% were runway excursions

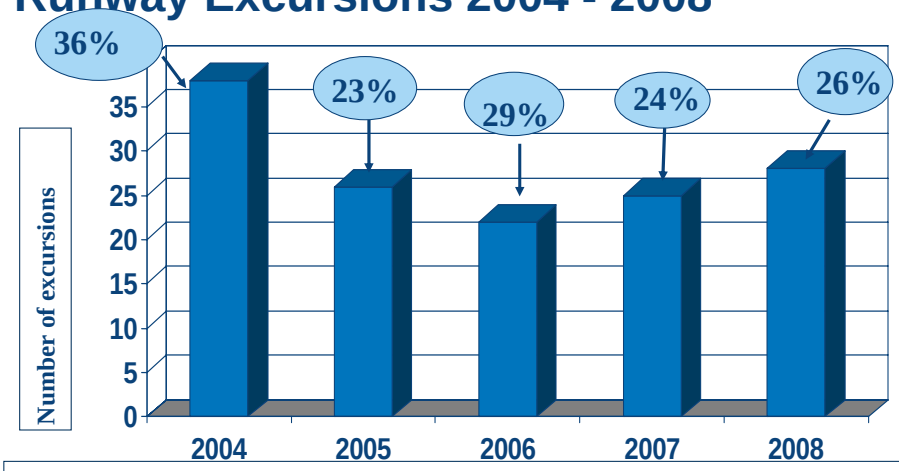
Fatalities from runway excursions were 662 of 3512 (18.8%) in this 5 year period

Runway excursions are the #1 cause of accidents in commercial aviation.

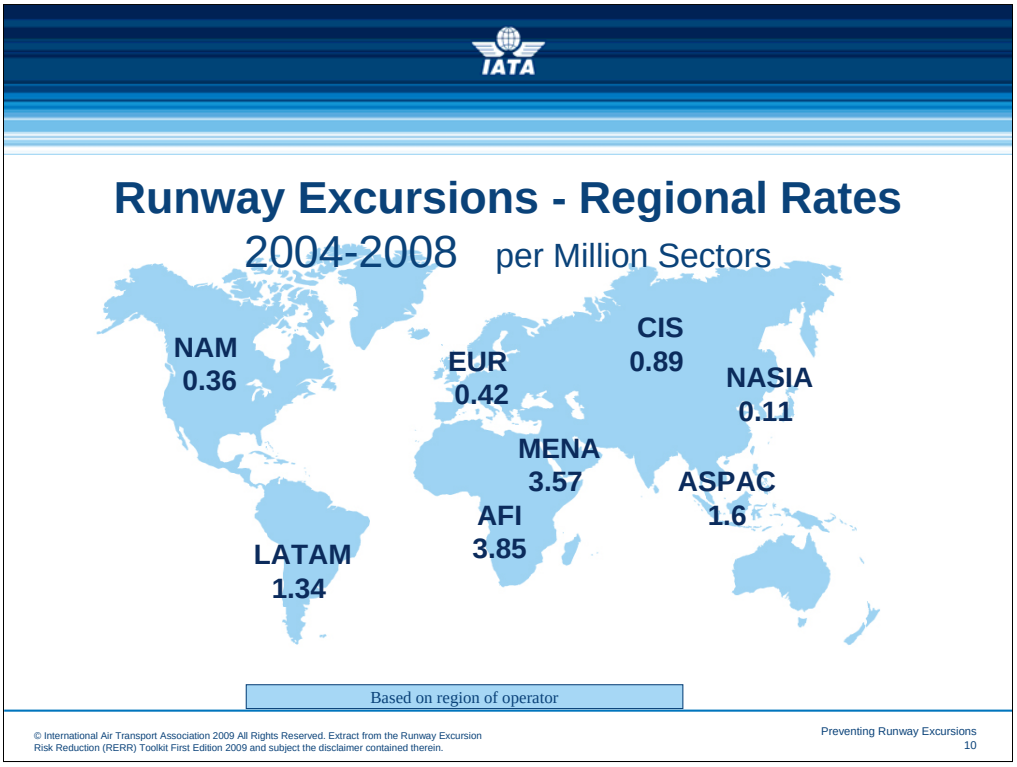
<data source is the IATA annual accident report 2004-2008>

Note that these accident numbers only address commercial jet and turboprop accidents. Later in this presentation, data from the FSF report reflects industry wide accidents and includes other types of aircraft.

Runway Excursions 2004 - 2008



The % is relative to the total number of accidents during that year



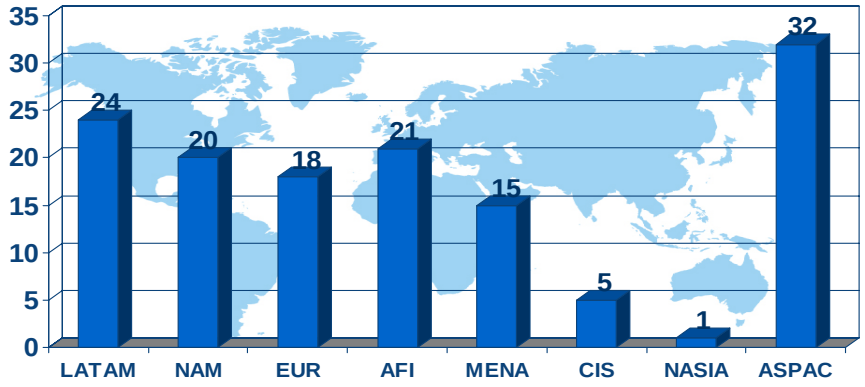
This is the rate of excursions from 2004-2008 in commercial operations by region.

Note that this rate is runway excursions only, and is based on the number of accidents divided by the number of operations in each region.

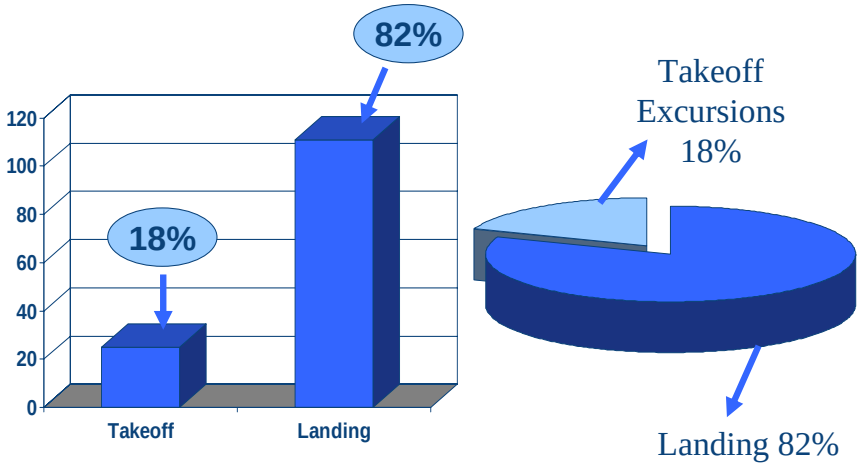
<data source is the IATA annual accident report 2004-2008>

Runway Excursions - Regional Occurrences

2004-2008 accident count



Phase of Flight



- What is a Runway Excursion
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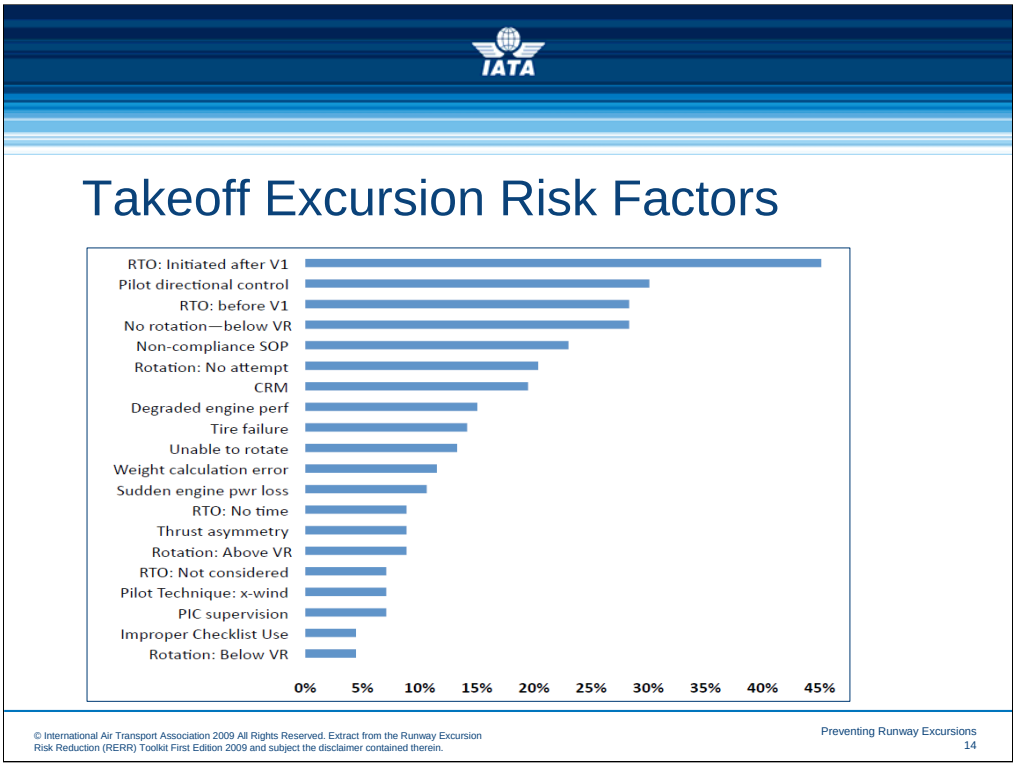


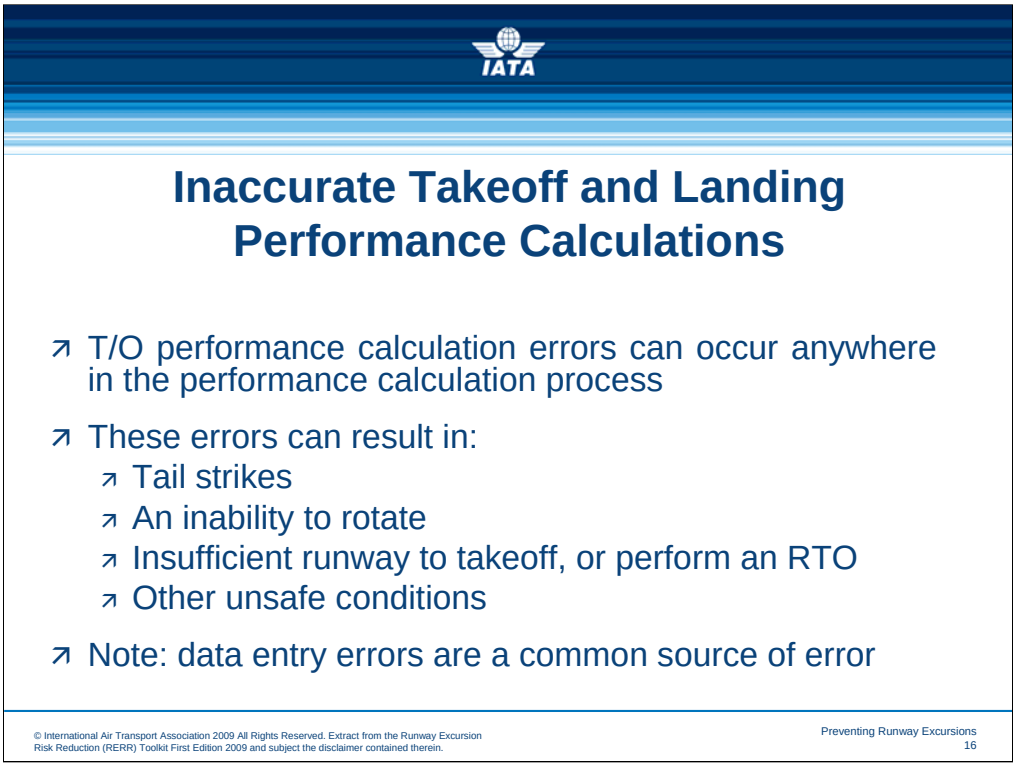
Notice that most of the risk factors can be grouped into RTO decision making, directional control, tire failure, weight and balance calculation, and CRM categories.

<Data chart is Figure 10 in the FSF Reducing the Risks of Runway Excursion report 2009>

Primary Takeoff Threats

- Inaccurate takeoff and landing performance calculations
- Improper Rejected Takeoff (RTO) accomplishment. Go, No/Go Decisions
- Loss of aircraft directional control during takeoff
- Increased risk due to multiple factors

<Instructor note: The FSF definition of a threat is the following: “A threat or hazard is any situation, event, or circumstance that may affect the safety of flight:Threats are not errors,
but they increase the potential for error”. For example, a snow covered runway, or a strong crosswind, are threats. These risks can be mitigated safely with planning and training. Also refer to the FSF Threat and Error Management presentation included on this CD for more information on Threats and Errors (TEM)>.



There are many types of threats, and corresponding errors, that can result in performance calculation errors.

Takeoff performance calculation errors can include:

•Wrong data used in the calculation (meteorological data errors such as temperature, density altitude, wind, QNH, etc)

•Wrong runway data (runway slope, length, contamination, etc)

•Errors in the calculation by operations personnel (wrong flight information, wrong flight load or fuel, etc)

•Typographical errors in onboard electronic flight bags, FMC/FMS data entry, etc.

Data entry errors may occur at any points in the takeoff or landing performance process.

•For example, a pilot might forget to add the fuel quantity in the FMS gross weight entry.

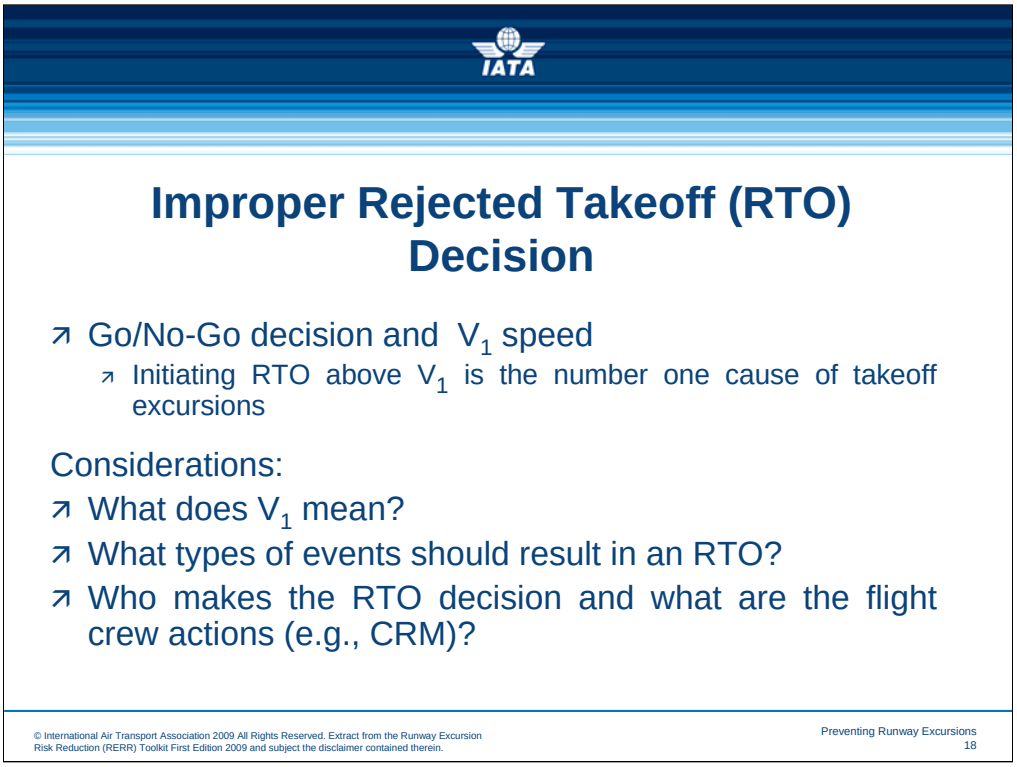
•Personnel might transpose two digits (e.g., entering 114,000 pounds instead of 141,000 pounds).

•Every data entry in the calculation and data entry process is a source of errors, and the process should be examined to determine opportunities to validate the data.

•Note that the entry of takeoff speeds or thrust settings, even when based on accurate data, is another potential source of errors that may result in an incident. For example, setting Vr at 136 instead of 163, or an EPR limit at 1.27 instead of 1.74.

Lessons Learned

- Always perform a reasonableness check (regardless of the source of the takeoff data)
  - Check the T/O speeds, runway length, thrust setting
- Independently verify the other crew member's actions
- Always follow SOP



Go/No-Go decision and V1 speed

In many cases, V1 indicates the maximum speed at which deceleration must begin, or an abort is not possible using the remaining runway.

Data shows that a number of runway excursions occur when the RTO is initiated at a speed higher than V1, virtually ensuring a runway excursion.

< refer to the FSF Reducing the risk of runway excursions report, Appendix III, figure 16 >

SOPs for the go/ no-go must consider the consequences of aborting at or above V1.

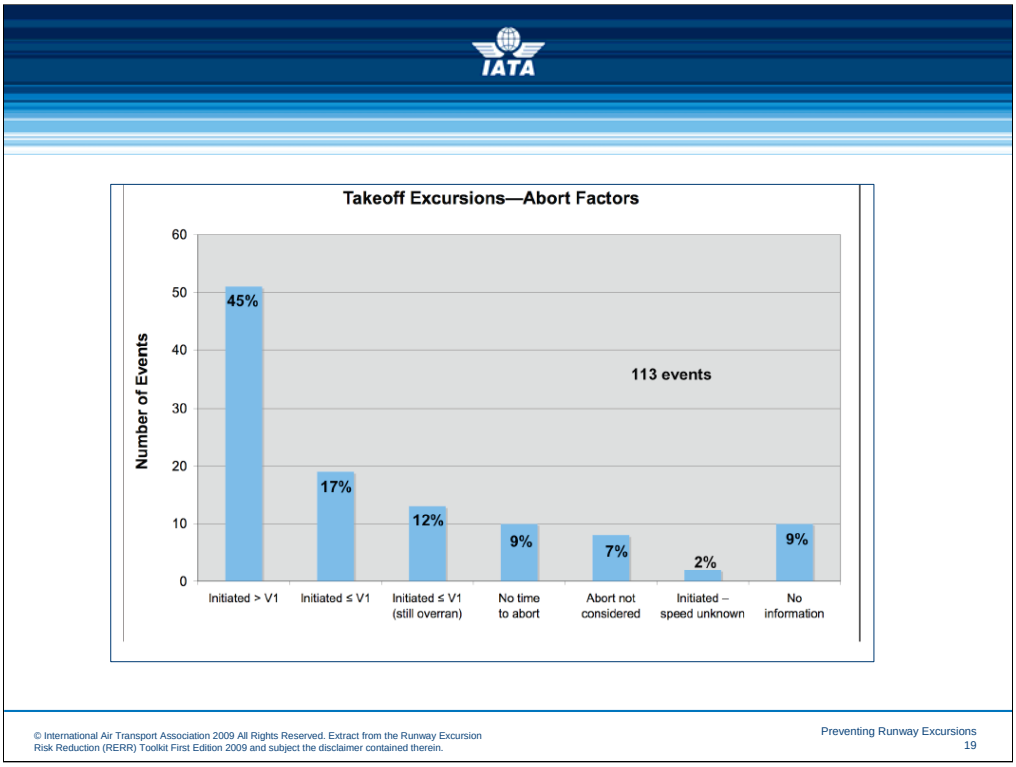
The training process must stress:

- the importance of the go/no-go decision, and the factors that contribute to that decision.
- the danger of an RTO at high speeds (V1), and especially at high gross weights, must be fully understood.
- this training should include discussions with the entire flight crew regarding the decision process and SOP's.
- the importance of a pre-takeoff crew briefing, and which events require an RTO by carrier SOP, should be highlighted.

Safety Events and RTO (What event should we Reject? i.e. Hydraulic Failure, Tire Failure,)

SOPs should cover the entire RTO process to include:

- Who monitors specific systems and indications (the flying pilot, non-flying pilot, additional crewmembers, etc)
- What callouts should be made, and what is the appropriate terminology, etc
- Does the captain make the decision, or the flying pilot (if the FO is flying)? This should be specified in SOP's
- Who is responsible for each required action, and to monitor the accomplishment of all required actions



<refer to the FSF Reducing the risk of runway excursions report, Appendix III, figure 16>

Effects of Crosswind and Contamination of runway

Discuss the effects of crosswinds during takeoff, especially when combined with a contaminated runway, referring to the manufacturer's guidance for these conditions.

<note additional information is available in the FSF report in tables 3 and 4 regarding risk factor interactions>

Directional control at Low speed RTO

Discuss:

- the effects of high asymmetric thrust at low speeds
- he manufacturer's minimum control speed (Vmcg), understanding that an immediate thrust reduction (on remaining engine(s)) following an engine failure may be required to control the aircraft at low speeds.
- the use of asymmetric reverse thrust during RTOs should be in accordance with the manufacturer's guidance, and practiced during simulator training.

Effect of Tire Failure

The effects of a tire failure during takeoff varies depending on the speed at which the tire fails. Manufacturer's guidance, and the air carrier's experience, should determine the SOPs for when an abort should and should not occur. Note that a tire failure, or multiple tire failures, may also result in the loss of braking on that tire, making a successful RTO at very high speeds more difficult.

Lessons Learned

- Understand what V_1 means, especially regarding RTO capabilities
- Review what types of events should result in RTO
  - Be prepared for engine failures, tire failures, and other mechanical events
- Review RTO procedures during before take-off briefing
- Review the effects of runway condition and wind on directional control

- What is a Runway Excursion
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Primary Landing Threats

- Un-stabilized approaches
- Failure to make a go-around decision
- Abnormal touchdowns and pilot technique
- Contaminated runways and meteorological factors
- Landing performance calculation errors
- Mechanical malfunctions during landing
- Non-compliance with CRM and SOP

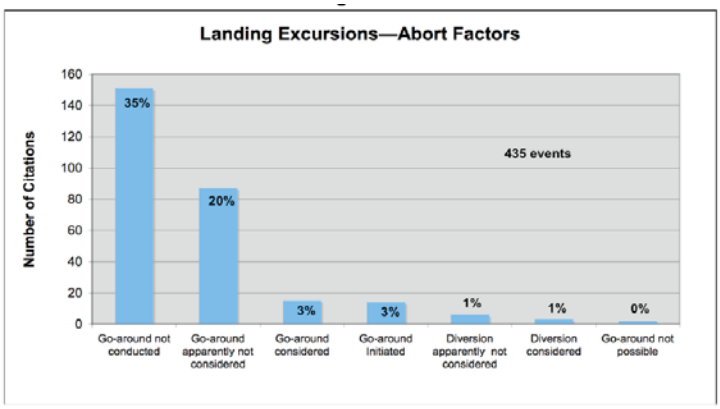
Un-Stabilized Approaches

- A stable approach is an essential element for a safe landing
- 29% of runway excursions followed an unstable approach
- The typical chain of events includes:
  - A high and fast approach
  - A long/fast touchdown
  - A failure to recognize the need for a go-around

Failure to Make A Go-Around

- Excessively focused on accomplishing a landing, even with an obviously high or fast approach
- In 35% of landing runway excursions, pilot did not conduct a go-around regardless of existence of strong cues (i.e. assertion from FO, GPWS warning, path deviation, etc)
- In many landing excursions, the pilot did not consider go-around

Runway Excursion vs Go-Around Decision Data



Note that “go around not conducted”, and “go around apparently not considered” total 55% of these events.

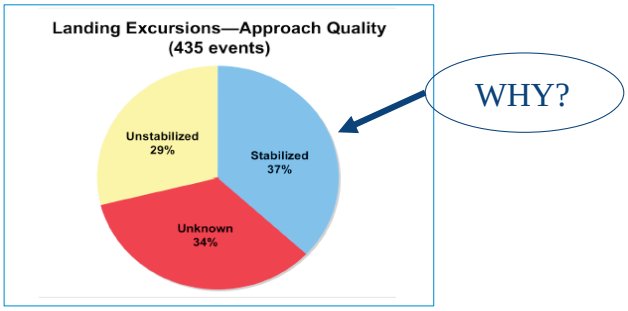
<data source is FSF Reducing the Risk of Runway Excursions Report, Appendix III figure 41>

Lessons learned

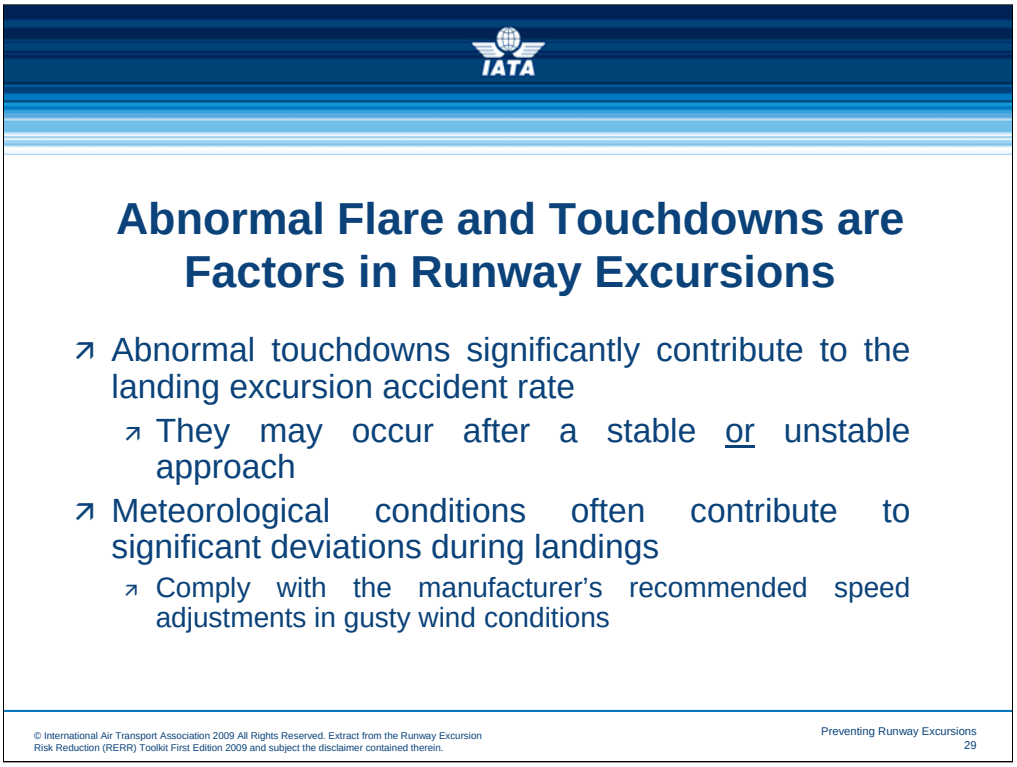
- Discuss the threats during the approach briefing
- Go around if you violate stabilized approach criteria
- Comply with company SOP regarding non-flying pilot go-around call outs
- Go-arounds should be considered as an option throughout the approach, flare, and touchdown

Abnormal Touchdowns and Pilot Technique

- Landings from stabilized approach can still result in a runway excursion



<Data source is the FSF Reducing the Risk of Runway Excursions Appendix III figure 38>



<comments below are extracted from the FSF Reducing the Risk of Runway Excursions Report, Appendix 3, page 35>

"**Pilot Technique.** Piloting skills are often found to be a factor in landing excursions.

Most refer to pilots' difficulties with flying stabilized approaches in terms of speed and altitude control. Accident reports also make frequent

reference to problems maintaining directional control, but the underlying reasons are not usually evident,

implying a deficiency in piloting technique. "

Landing Excursion Top Risk Factors

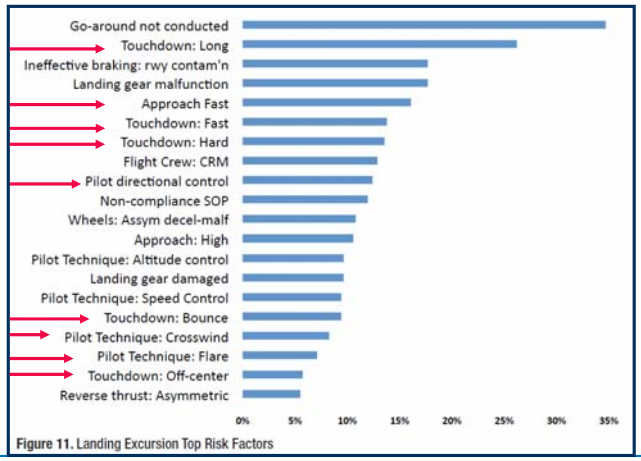


Figure 11. Landing Excursion Top Risk Factors

Notice how many of these risks involve abnormal touchdowns and pilot techniques.

<Data source is FSF Reducing the Risk of Runway Excursions Report, Figure 11>

Lessons Learned

- Select the best runway for the existing conditions
- Optimize the use of aircraft stopping capabilities (i.e., auto brakes, maximum flap settings, auto ground spoilers, etc)
  - Do not delay deceleration on contaminated runways
- Be aware of all factors used in calculating landing performance (i.e, whether reverse thrust is used, etc)
- Brief the threats; in adverse weather or runway conditions, be ready and prepared to make a go-around
- A go-around should be conducted at any time significant deviations are recognized during the flare and touchdown

Contaminated Runway and Meteorological Factors

- Contaminated runway (wet or icy) is a contributing factor in 32% of excursions
- Wind can affect both directional control of the aircraft and deceleration performance
  - Cross winds were present in more than 67% of the landing excursions
  - Steady tailwinds occurred in more than 50% of all accidents
- The combination of a contaminated runway and a tailwind or crosswind is a major contributing factor in accidents

It is obvious that the presence of a tailwind significantly increases the risk of a runway excursion

Some accidents had tailwinds gusts of up to 10 knots, further increasing the risk.

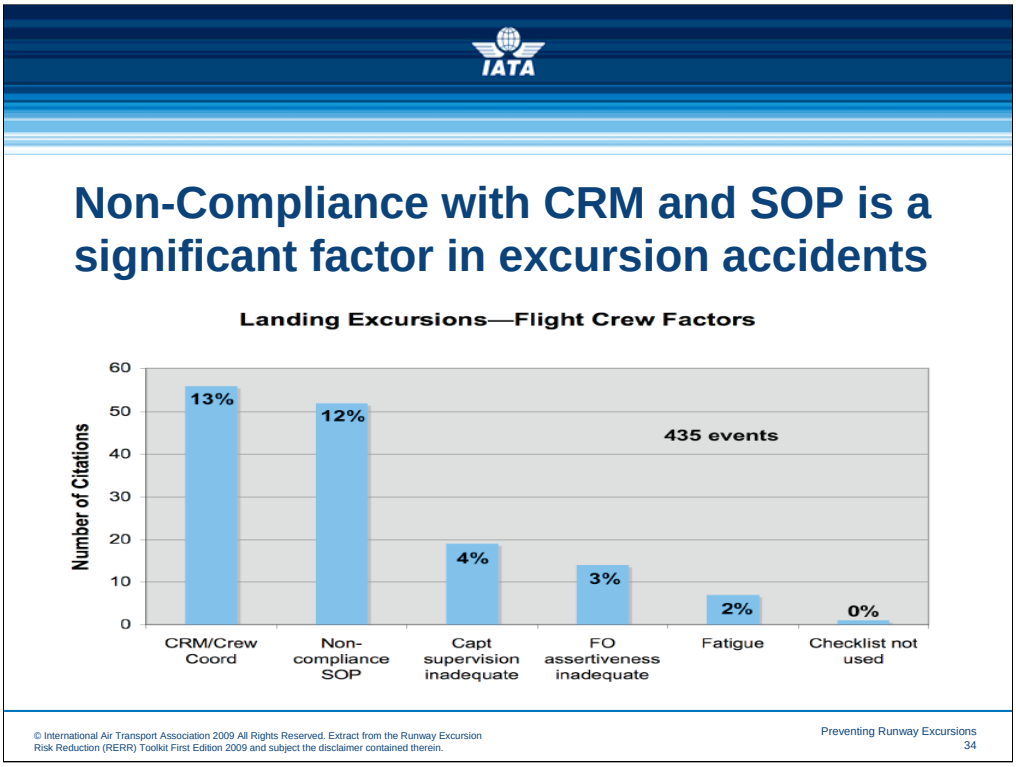
<data source is the FSF Report Appendix 3 page 25>

Mechanical Malfunctions During Landing (Engine Reverser, Brakes)

- Flight crew needs to be ready for malfunctions
- Asymmetrical reverse may result in directional control difficulties
- Improper use of reverse system (i.e. late deployment, or cycling of reversers) is a factor in 6% of accidents
- Landing performance calculations should consider the loss of engine reverse during landing (especially on contaminated runways)
  - During contaminated runway landings, use maximum reverse thrust, combined with wheel brakes, until at a safe taxi speed. A contaminated runway may result in the same effect as a wheel brake mechanical failure.

Most reverser failures are identified during landing– this implies that a failure of one reverser should be considered in pre-landing calculations and briefings.

Some aircraft manufacturers do not recommend the use of asymmetric reverse. Therefore in these cases, the loss of one reverser can result in the loss of both.



<data source is FSF report appendix 3 figure 50>

Some factors identified include the following:

•Inadequate monitoring for F/O (PF) by Captain

•F/O's reluctance to intrude on Captain's authority (inadequate assertion by F/O)

•Failing to perform required "call outs"

•Not executing checklist

•Not initiating go-around with losing sight of runway

<Items below extracted from FSF report appendix 3 page 37>

The factor "Non-compliance SOP includes:

•Failing to perform required callouts

•Not executing checklists

•Not initiating a go-around or missed approach when losing sight of the runway

•Not arming spoilers (most common error)

Lessons Learned

- Be aware of increased risk with crosswinds or tailwinds, especially on contaminated runways
- Be ready always for mechanical malfunctions
- Always follow SOP and exercise good CRM

Summary

- Runway excursions are approximately 27% of all accidents
- These accidents can be prevented through training, awareness of the threats, and in applying good judgment to reduce the risk

End of presentation.