

STPA Analysis of Aircraft Landing Phase with Focus on Runway Excursion



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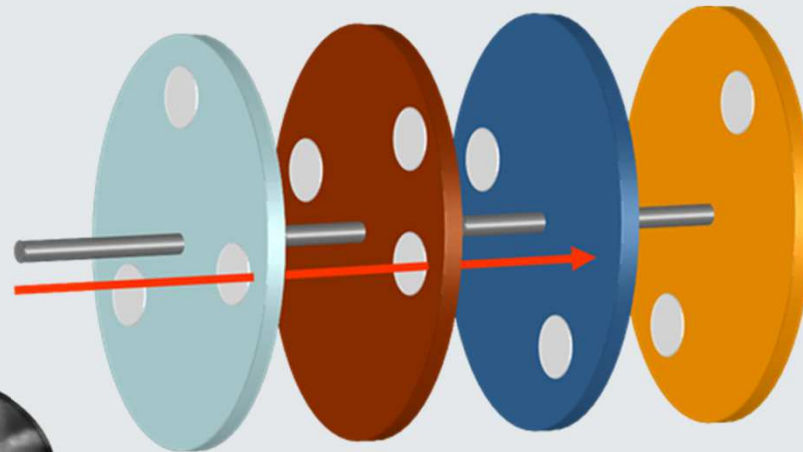
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Introduction

Classic Approach





Initiatives - Commercial Aviation Safety Team

The **Commercial Aviation Safety Team** was created in 1997 in order to reduce the U.S. commercial aviation fatal accident rate by 80 percent over a 10-year period ending in 2007.

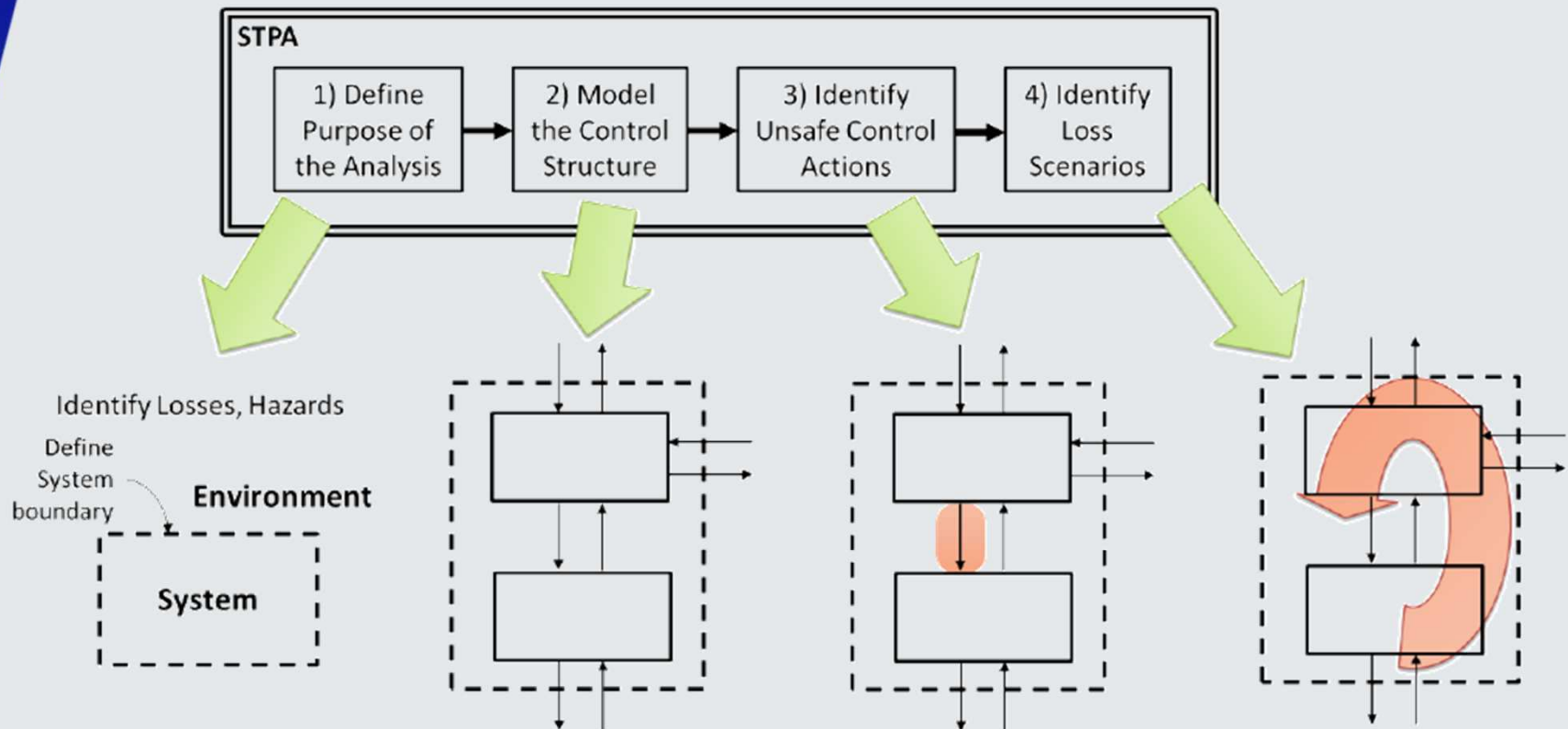
Nowadays, it is moving beyond the historic approach of examining past accident data towards a **more proactive approach focusing on detecting risk and implementing mitigation strategies** before accidents or serious incidents occur.

Current goal: to reduce the remaining U.S. commercial fatality risk by 50 percent from 2010 to 2025, and continue to work with our international partners to reduce fatality risk in worldwide commercial aviation.



Introduction

Systemic Approach



Source: STPA Handbook by Nancy Leveson (March 2018).



Introduction - Objective



To apply the STPA technique to an aircraft approach/landing procedure in order to find the Aviation System vulnerabilities related with runway excursions.

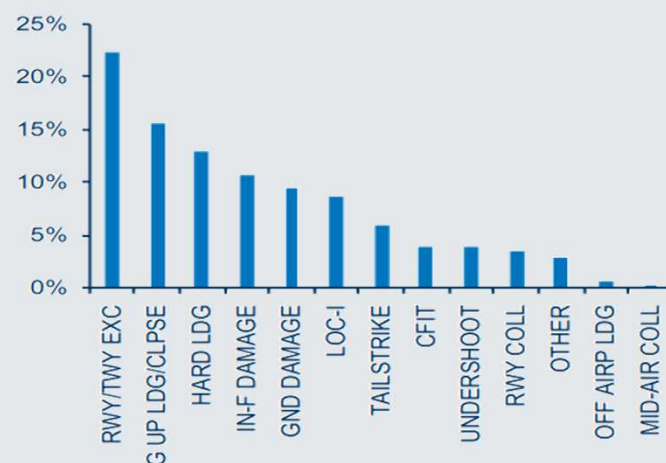
Runway excursion is a veer off or overrun off the runway surface. It occurs when an aircraft departs the runway in use during the take-off or landing run.



Introduction

Runway Excursion

Accident Category Distribution (2013-2017)
Distribution of accidents as percentage of total



From 2013 to 2017, there have been 76 runway excursion accidents worldwide with 8 fatalities according to the IATA Safety Report 2017.



Introduction

Runway Excursion Precursors

**Deficiencies in
Airport Facilities**

**Unstable
Approaches**

**Long
Touchdowns**

**Adverse
Weather**

**Inadequate or Late Use
of Deceleration Devices**

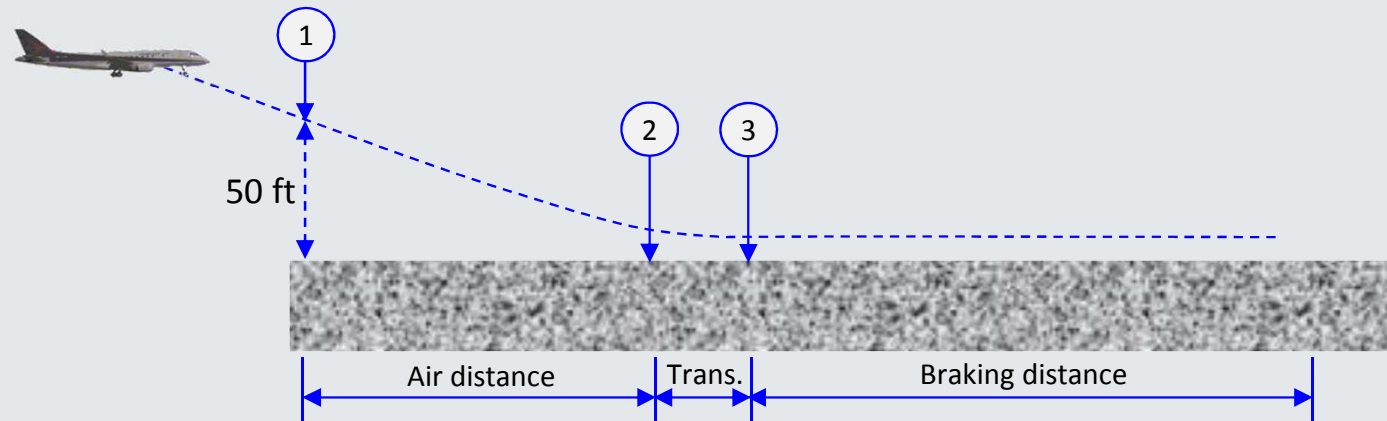
**Wet or Contaminated
Runway Surface**

**Non-Adherence to
SOP and Callouts**



Introduction

Standard Landing

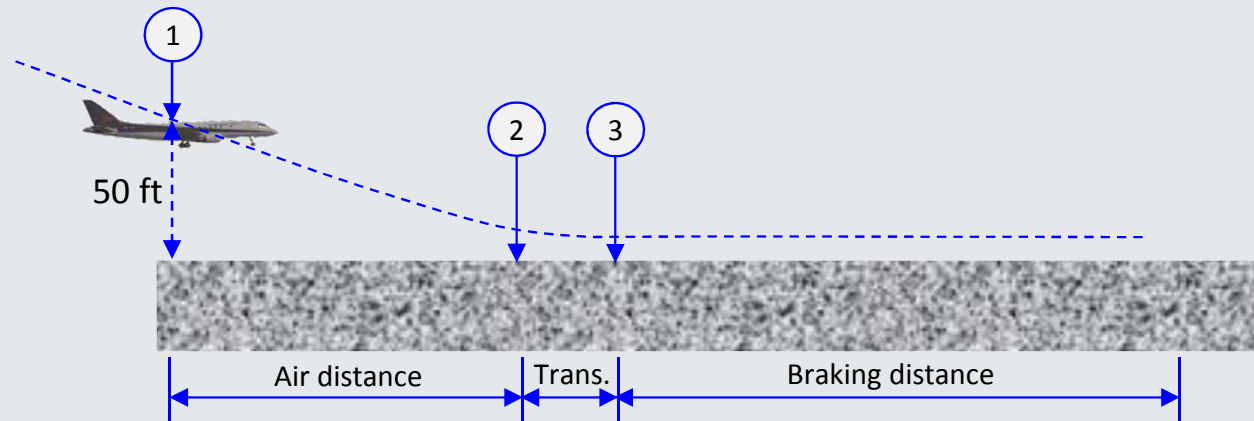


1. The landing runway threshold is crossed at a height of 50 feet in landing configuration with the reference speed.



Introduction

Standard Landing

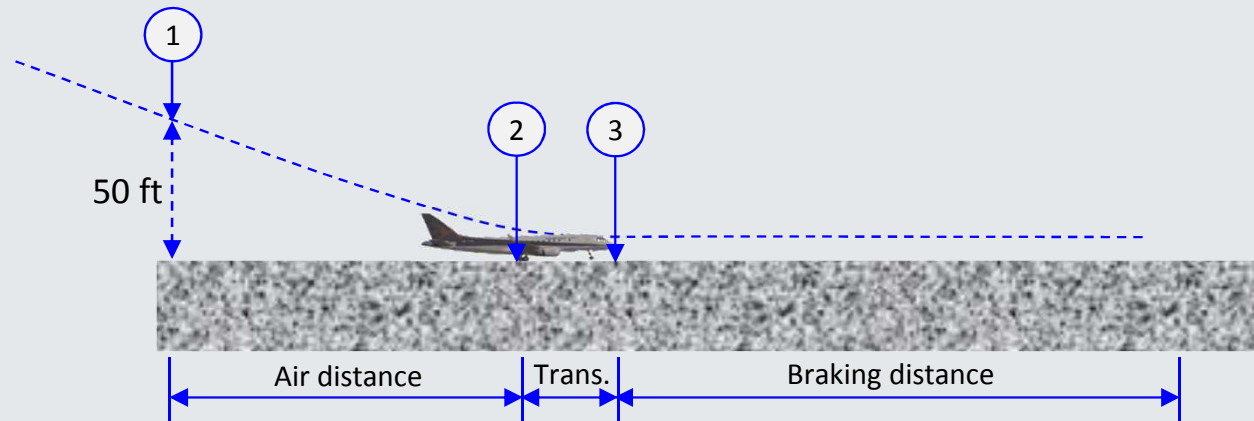


2. Touch down around at the aiming point (1,000 feet), followed by Ground Spoiler Deployment.



Introduction

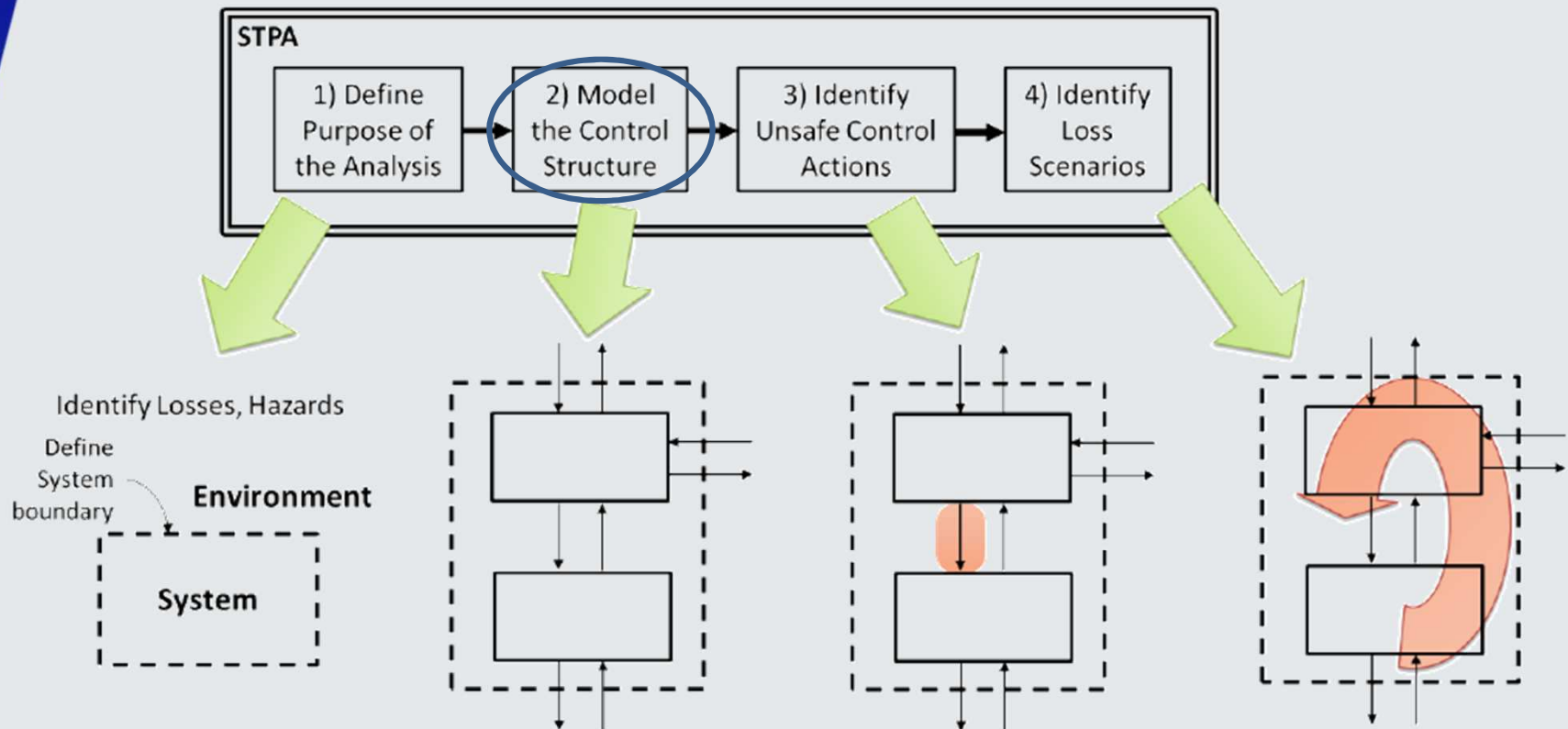
Standard Landing



3. Brake application through normal brakes and engine thrust reverse, when available.



STPA Development



Source: STPA Handbook by Nancy Leveson (March 2018).





STPA Development

Analysis' Purpose

1. Losses:

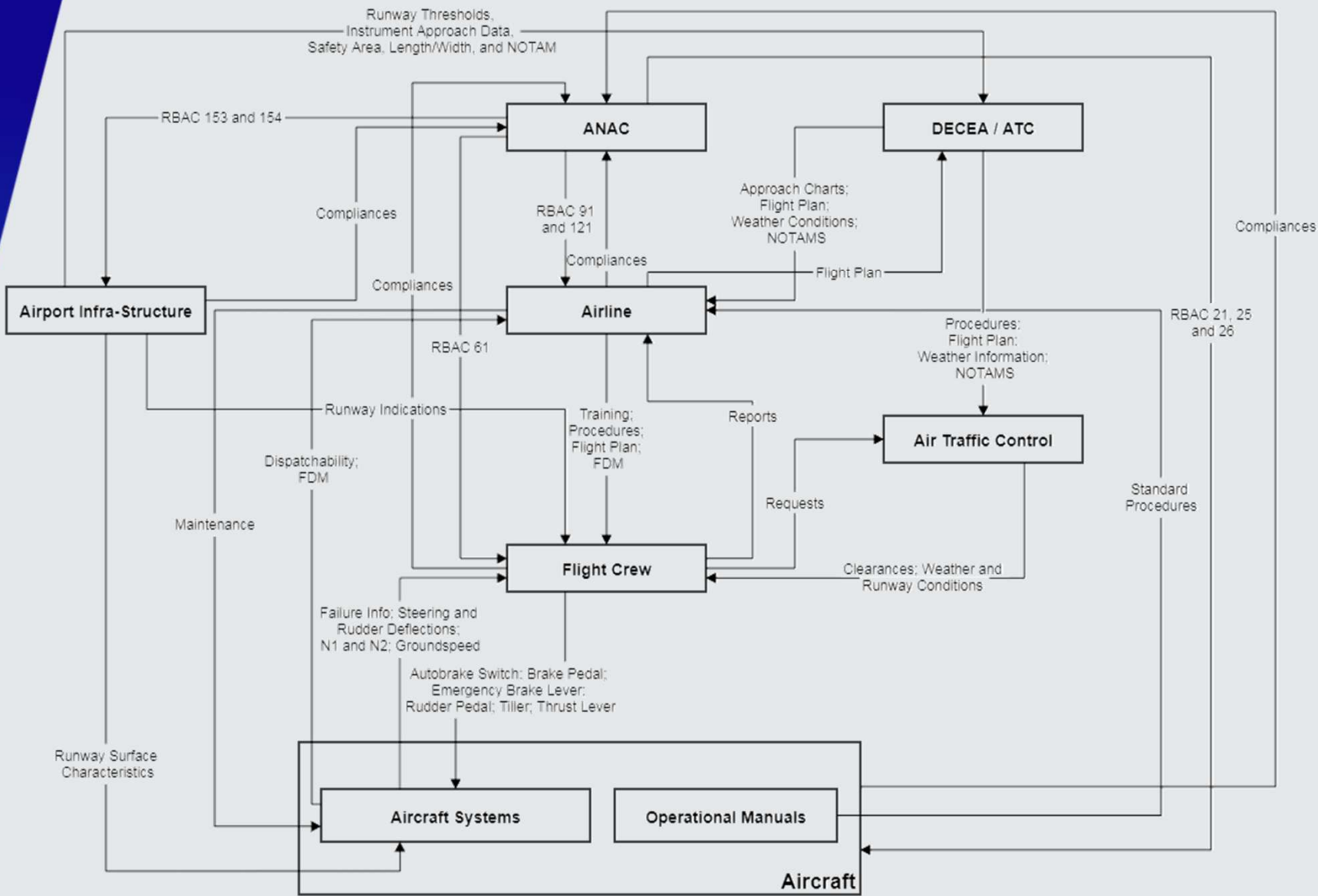
- L-1: Death or injury to persons.
- L-2: Damage to the aircraft.
- L-3: Damage to airport infra-structure and/or proximities.

2. System Level Hazards:

- H-1: Aircraft does not stop before the runway end [L-1, L-2, L-3].
- H-2: Aircraft veers to a runway side [L-1, L-2, L-3].



Safety Control Structure



STPA Development

Unsafe Control & Scenarios

Flight Crew		
Control Action	Unsafe Control Action (Not Providing)	Scenarios
Request another runway for the Air Traffic Controller	UCA-1: Crew does not ask for a longer runway due to a specific landing distance re-assessment result during approach [H-1].	<p>Scenario 1: Crew does not reassess the landing distance during approach, resulting in a landing at a runway shorter than required [H-1].</p> <p>Scenario 2: Crew reassesses the landing distance during approach based on an incorrect information regarding the runway conditions, resulting in difficulties to decelerate the aircraft [H-1].</p>





Initiatives - Commercial Aviation Safety Team

Safety Enhancements:

- **[SE215] Landing Distance Assessment:** To improve their awareness of landing distance margin and the factors and variables that can affect it, flight crews should assess landing performance based on conditions actually existing at time of arrival.
- **[SE222] Airplane-based Runway Friction Measurement and Reporting:** researches shall be conducted by the aviation community to enable development, implementation, and certification of on-board aircraft system technologies to assess airplane braking action and provide the data in real time to the pilot, other aircraft crews, air traffic controllers, and the airport operators.



Summary



STPA is methodology able to analyze complex systems and include the human being as part of the system as well as the causes of a specific behavior.

It has a oriented way to see the hole system and the interaction among its components.



Next Steps

The Brazilian Commercial Aviation Safety Team was created in 2011 and has four working groups:



**Controlled Flight
Into Terrain**



Mid-Air Collision



Loss of Control



Runway Excursion



Next Steps

Example of Outcome

■ RBAC 154:


Landing Distance Available (meters)	Touchdown Zone Length (m)
From 1,200 to 2,400	750
More than 2,400	900



Landing Distance Required

■ RBAC 121:

Landing inside the touchdown zone does not guarantee a safe landing!



Runway Excursion
Tool Kit - Runway Excursion - Info 2

Precisamos conversar sobre ponto de toque

O fator contribuinte mais comumente observado em saídas de pista é o chamado "pouso longo". Em mais da metade das saídas de pista da aviação comercial regular desde 2006, a aeronave tocou a pista mais de 600 metros após a cabeceira. No entanto, em grande parte desses casos, o toque ocorreu dentro da chamada "zona de toque". Se as duas informações parecem conflitantes à primeira vista, é necessário que façamos uma revisão de conceitos importantes.

Zona de toque

Segundo o RBAC 154, a zona de toque é demarcada por pares de retângulos simétricos ao eixo da pista, dispostos a cada 150 metros a partir da cabeceira. Os retângulos podem ser simples, como na figura 1(a), ou múltiplos, com codificação de distância remanescente.

O número de pares e, conseqüentemente, a extensão da zona de toque, dependerá da distância de pouso disponível (LDA, ou "landing distance available").

Pistas com LDA entre 1200 e 2400 metros devem ter 5 pares (750 metros) e pistas com LDA igual ou maior a 2400 metros, 6 pares (900 metros).

Ponto de visada

Popularmente conhecida como "marca de 1000" ou "aiming point", o ponto de visada é sinalizado na pista por um par de retângulos maiores do que as marcações de zona de toque, como mostrado na figura 1(a). Sua localização depende da LDA.

Para pistas com LDA entre 1200 e 2400, o ponto de visada deve estar a 300 metros da cabeceira; para pistas com LDA igual ou maior que 2400 metros, 400 metros.

O ponto de visada é o ponto a ser utilizado como "alvo" ou referência para a aproximação final.

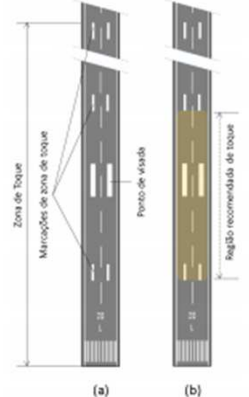


Figura 1(a) - Marcações de pista conforme RBAC 154
Figura 1(b) - Região recomendada de toque



THANKS

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