STPA Analysis of Aircraft Landing Phase with Focus on Runway Excursion

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Introduction
Classic Approach
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

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

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
- Inadequate or Late Use of Deceleration Devices
- Non-Adherence to SOP and Callouts
- Adverse Weather
- Wet or Contaminated Runway Surface
1. The landing runway threshold is crossed at a height of 50 feet in landing configuration with the reference speed.
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

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].
## STPA Development

### Unsafe Control & Scenarios

<table>
<thead>
<tr>
<th>Flight Crew</th>
<th>Control Action</th>
<th>Unsafe Control Action (Not Providing)</th>
<th>Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Request another runway for the Air Traffic Controller</td>
<td>UCA-1: Crew does not ask for a longer runway due to a specific landing distance re-assessment result during approach [H-1].</td>
<td><strong>Scenario 1</strong>: Crew does not reassess the landing distance during approach, resulting in a landing at a runway shorter than required [H-1]. <strong>Scenario 2</strong>: 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].</td>
</tr>
</tbody>
</table>
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 a 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 Required

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

<table>
<thead>
<tr>
<th>Landing Distance Available (meters)</th>
<th>Touchdown Zone Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 1,200 to 2,400</td>
<td>750</td>
</tr>
<tr>
<td>More than 2,400</td>
<td>900</td>
</tr>
</tbody>
</table>

- **RBAC 121:**