Risk Assessment Methodology for Runway End Safety Area (RESA) at Canadian Airports

Hamid Shirazi, P.E.
Richard Speir, P.E.

APPLIED RESEARCH ASSOCIATES, INC.
An Employee Owned Company

Joe MacKay, Hons. B.B.A.

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Overview

- Background
- RESA alternatives
- Risk assessment methodology
- Findings from historic events
- Conseqeunce modeling
- Canadian airports' questionnaire

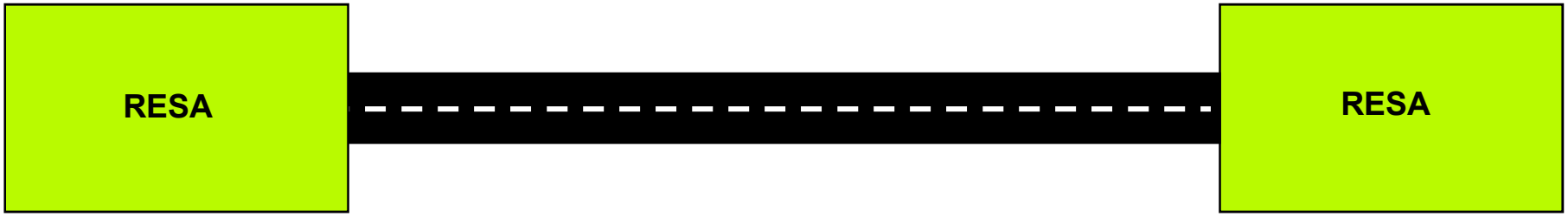
Background: Runway End Safety Area (RESA)

- Transport Canada (TC) Notice of Proposed Amendment (NPA) 2010-012 in 2010.
- TP312 4th Edition: TC *recommends* a RESA at certified airports where the runway is longer than 1,200m (3,937ft)
- Current NPA: TC will *require* a RESA if
  - runway length > 1,200m; or
  - an instrument runway is utilized by scheduled passenger-carrying operations using aircraft with more than nine (9) passenger seats.
- Independent risk assessment study to
  - document RESA's safety benefits
  - establish an implementation criteria for RESA

Background: Runway End Safety Area (RESA)

- Capable of supporting airplanes as well as snow removal and AARF vehicles under dry conditions
- Free of objects and obstacles
- Rectangular shaped
- 150m long, twice the width of the runway

Many airports Do not Meet RESA standards



RESA Alternatives

To comply with RESA standards, the following alternatives are considered:

- Extend the runway
- Relocate the runway
- Implement declared distances
- Use engineered material arresting system (EMAS)

Non-Standard RESA

- What if an airport cannot comply with the standard RESA requirements?
- Which runway end at my airport is more critical and how much more critical it is?
- If funding multiple airports, which airport should get the priority for funding?

The Answer is to Conduct Risk Analysis to Quantify Various Scenarios!

Types of Accidents

- Landing Overrun (LDOR)
- Takeoff Overrun (TOOR)
- Landing Undershoot (LDUS)

Risk Assessment Methodology

Risk = Probability* Severity* Exposure

Level	Probability
Level 0	Rare/impossible
Level 1	Remote/Unlikely
Level 2	Occasional
Level 3	Probable-likely
Level 4	Frequent- Almost certain

Level	Exposure
Level 0	No Exposure
Level 1	Seldom
Level 2	Occasional
Level 3	Frequent
Level 4	Constant

Level	Personnel	Equipment
Level 0	No injury (None)	No Damage (None)
Level 1	First aid injury, no disability or lost time (Negligible)	Minor damage, potential downtime or slow-down (Negligible)
Level 2	Lost time injury, no disability (Minor)	Minor Damage, leads to organizational slowdown/minor downtime (Minor)
Level 3	Disability/Severe injury (Major)	Major damage, results in major slowdown/downtime (Major)
Level 4	Fatal, life threatening (Fatal)	Loss of critical equipment, or shutdown of organization (Destroyed)

Risk index	Risk level	Description
0 – 10	Level 1 (low)	*Minimum Risk*. Proceed after considering all elements of risk.
11- 30	Level 2 (medium)	*Moderate Risk*. Continue after taking action to manage overall level of risk.
>30	Level 3 (high)	*High Risk*. **STOP** and take risk management measures.

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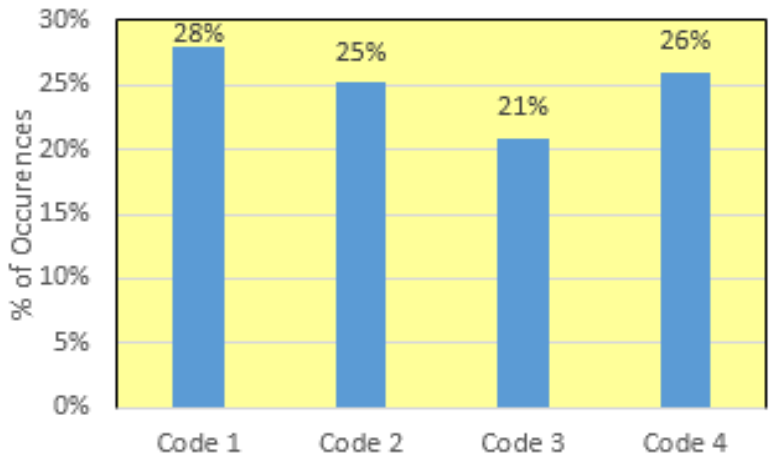
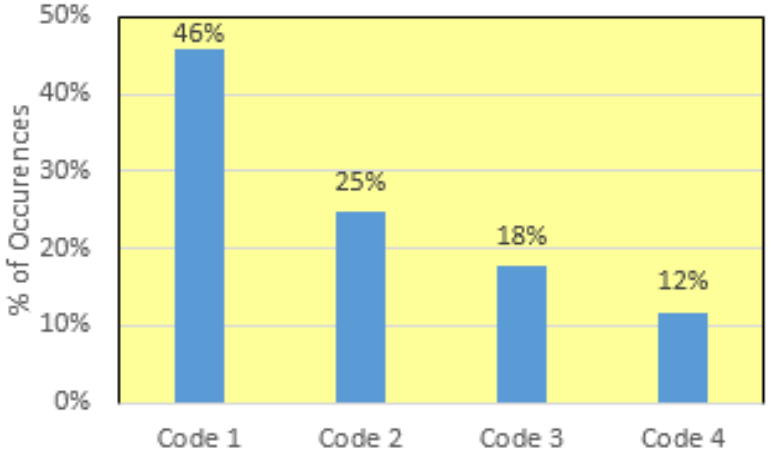
Risk Assessment: Probability

- Probability: What are the odds of aircraft going off the runway
- Probability will be assessed by finding historic accident frequency ratios according to:
  - Different ICAO runway lengths: Code 1 to 4
    - Code 1: less than 800m
    - Code 2: between 800 and 1200m
    - Code 3: between 1200m and 1800m
    - Code 4: more than 1800m
  - Different aircraft types: A to F categorized according to:
    - Wingspan, and
    - Main gear wheel span
  - Different types of operation: Commercial, Private, Government
    - Commercials further refined per CARs (701 to 705)
  - Different runway surface types
    - Paved (AC and PCC)
    - Grass/Sod
    - Sand/gravel

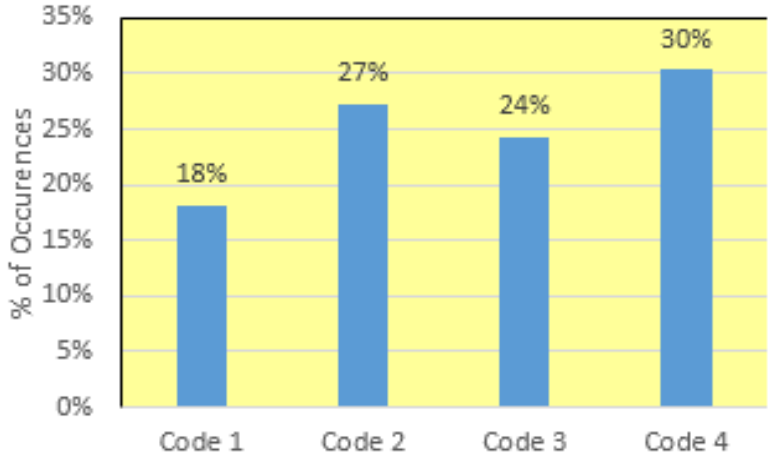
Historic Occurrences According to Runway Codes



a) Landing overrun



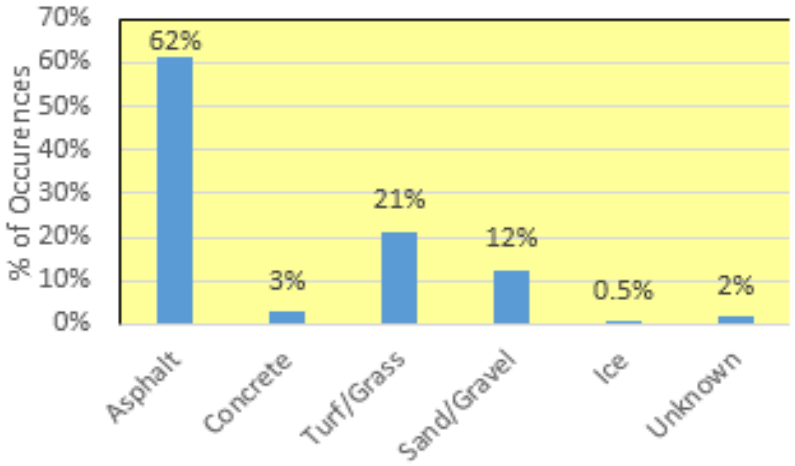
b) Takeoff overrun



c) Landing undershoot

Code	The greater of TODA and ASDA
1	Less than 800 m
2	800 m up to but not including 1200 m
3	1200 m up to but not including 1800 m
4	1800 m and over

Historic Occurrences According to Runway Surface



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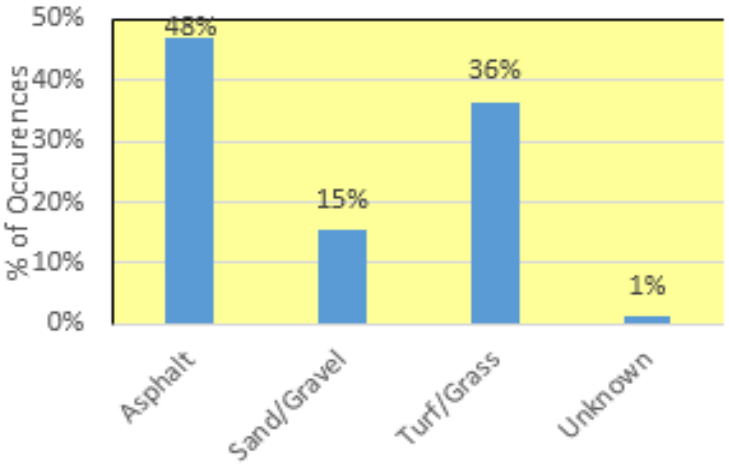
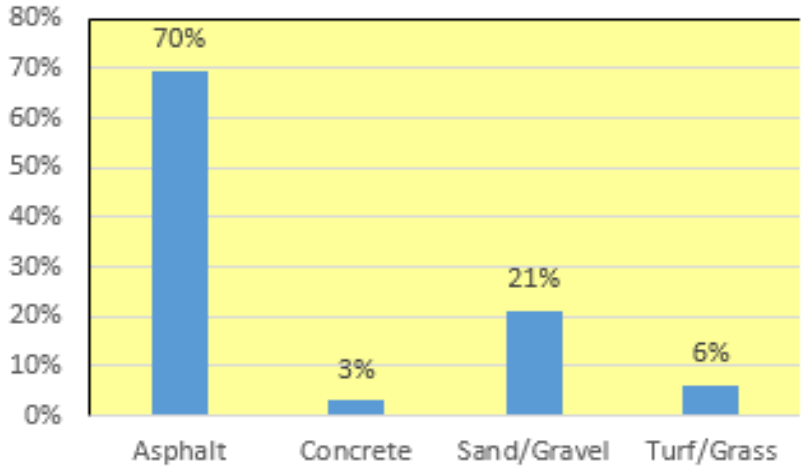
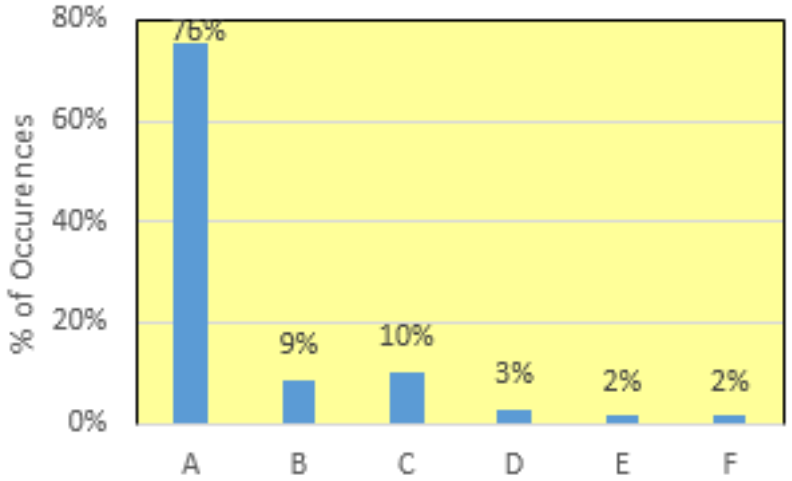


b) Takeoff overrun



c) Landing undershoot

Historic Occurrences According to Aircraft Codes



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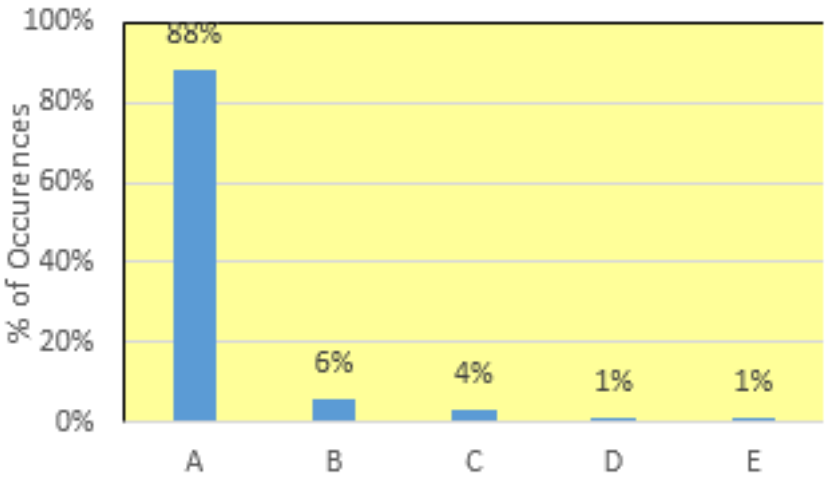
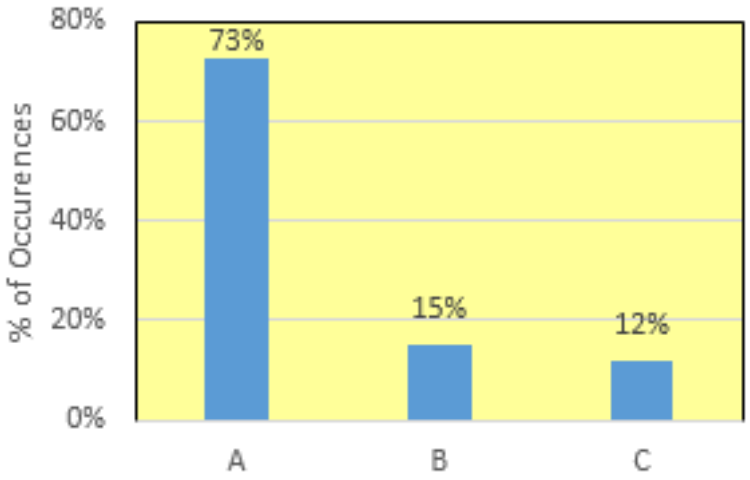


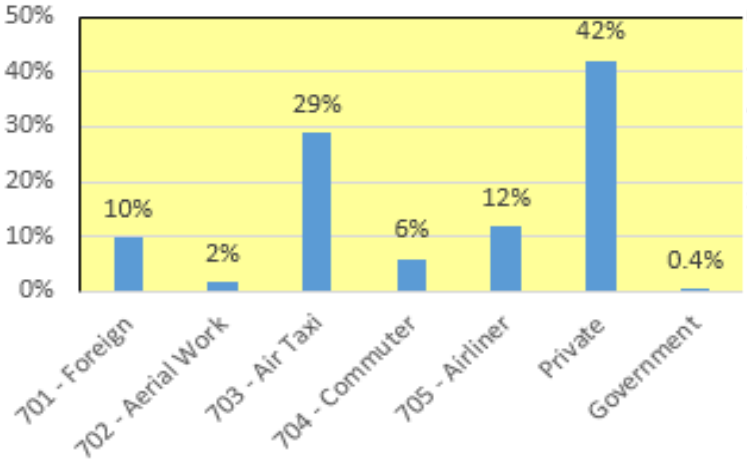
b) Takeoff overrun

Code	Wing span	Outer main gear wheel span
A	up to but not including 15m	up to but not including 4.5m
B	15m up to but not including 24m	4.5m up to but not including 6m
C	24m up to but not including 36m	6m up to but not including 9m
D	36m up to but not including 52m	9m up to but not including 14m
E	52m up to but not including 65m	9m up to but not including 14m
F	65m up to but not including 80m	14m up to but not including 16m



c) Landing undershoot

Historic Occurrences According to Operator Types



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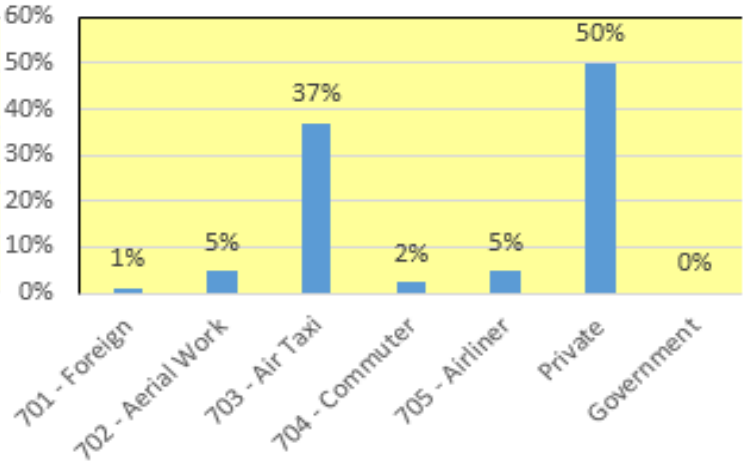

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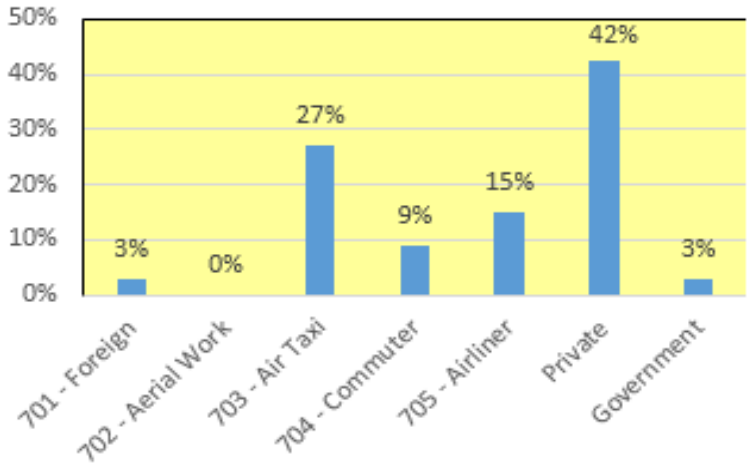


c) Landing undershoot

Risk Assessment: Severity

- Severity is measured in terms of levels of human injury and aircraft damage
- Severity assessment is based on the concept of "*worst credible outcome*"
- Possible outcomes include various levels of injuries and damages. The worst credible one is the level resulting in highest risk.
- A consequence modeling methodology was developed based on *various types of obstacles* that may exist at runway ends.

Modeling Consequences

Obstacle Types Defined According to Maximum Collision Speed Causing Severe Damages and/or Death

- **Type 1: Maximum speed is nil**

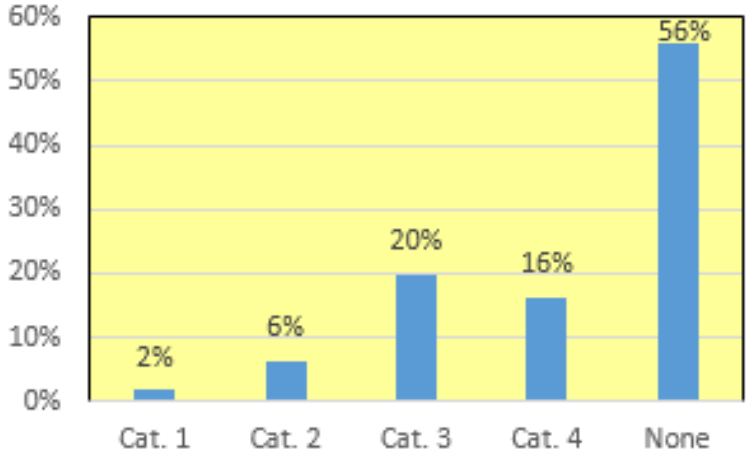
  (e.g., cliff, concrete wall).
- **Type 2: Maximum speed is 5 knots**

  (e.g., brick buildings, large ditches).
- **Type 3: Maximum speed is 20 knots**

  (e.g. small ditches, fences).
- **Type 4: Maximum speed is 40 knots**

  (e.g., frangible structures, localizers)

Obstacle Categories Collided with at Runway Ends



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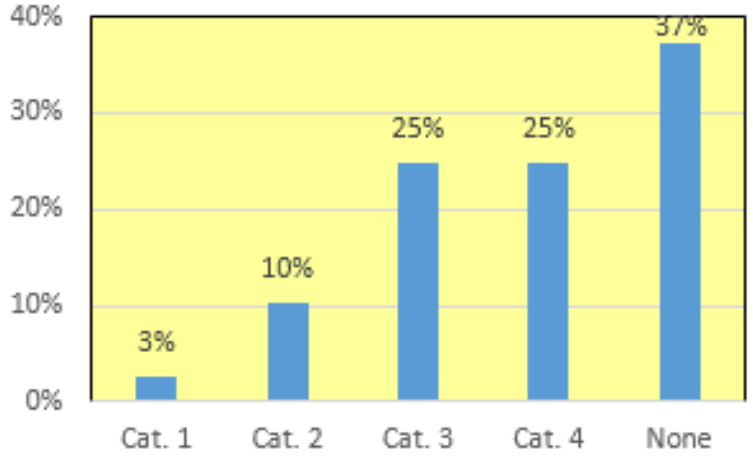
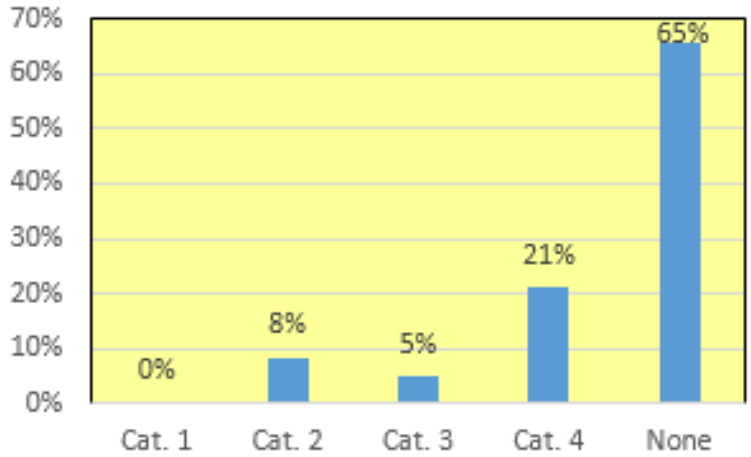
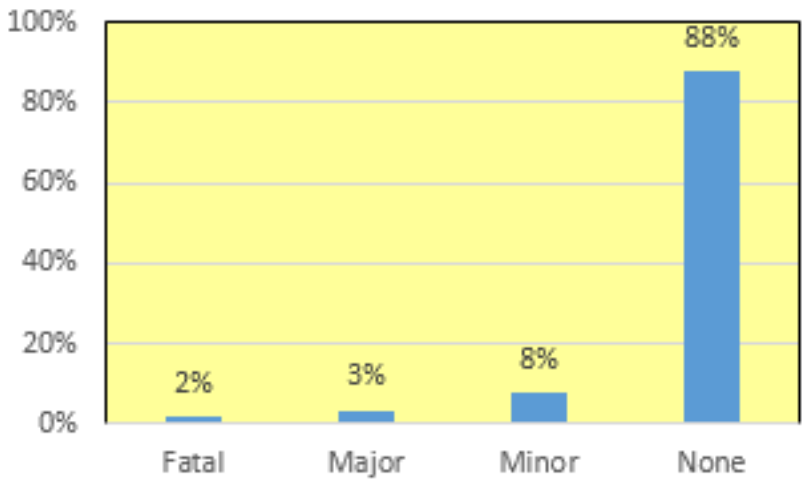


b) Takeoff overrun



c) Landing undershoot

Historic Level of Injuries Incurred



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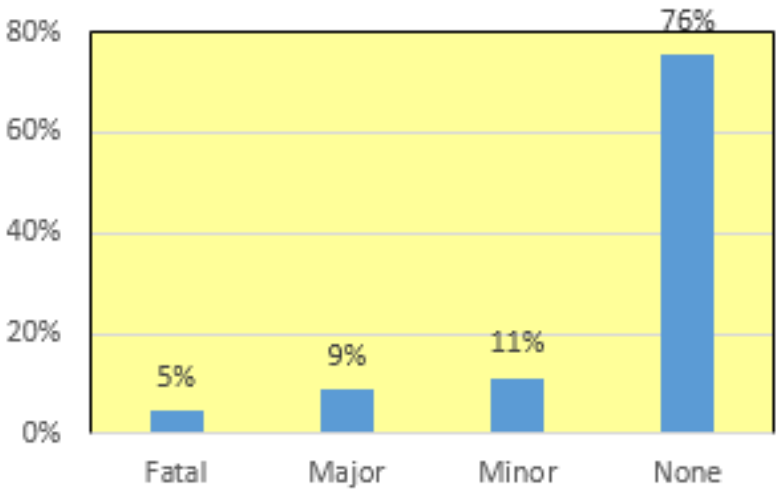
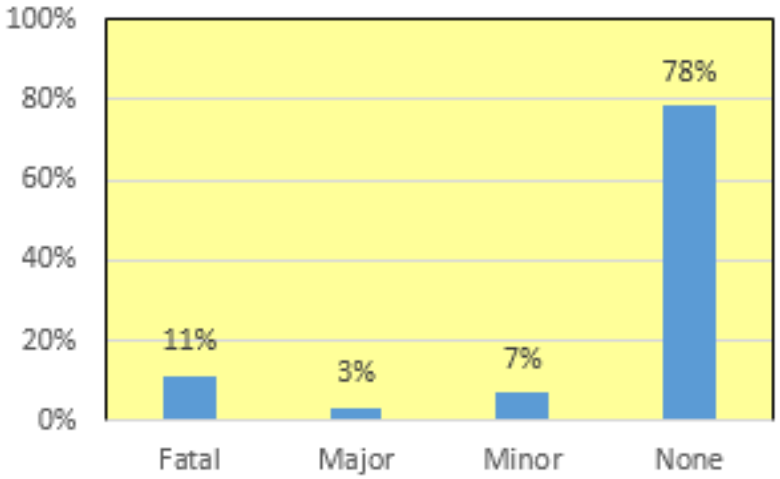
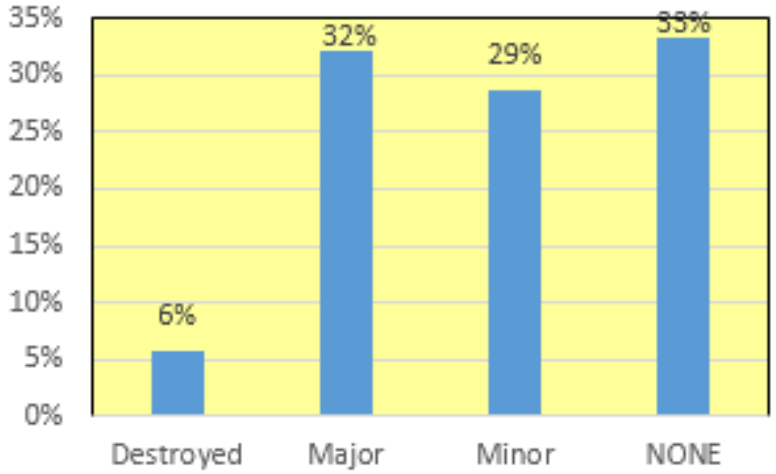


b) Takeoff overrun



c) Landing undershoot

Historic Level of Damages Incurred



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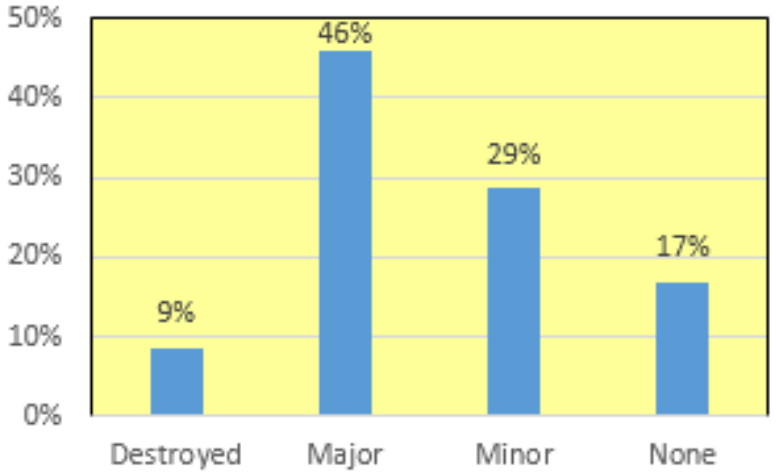

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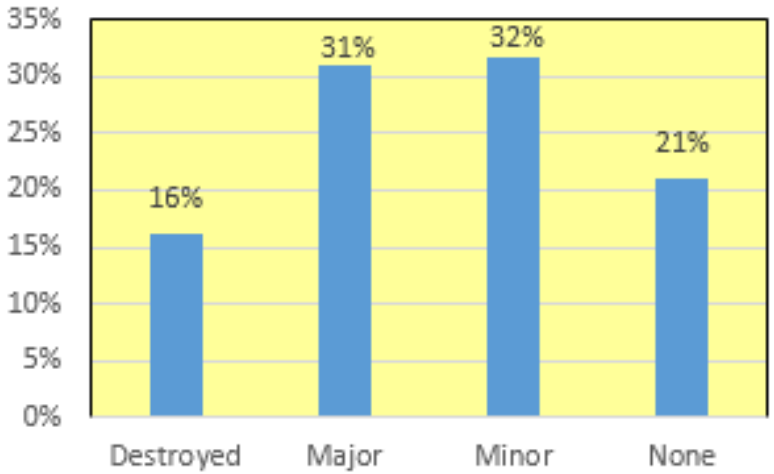
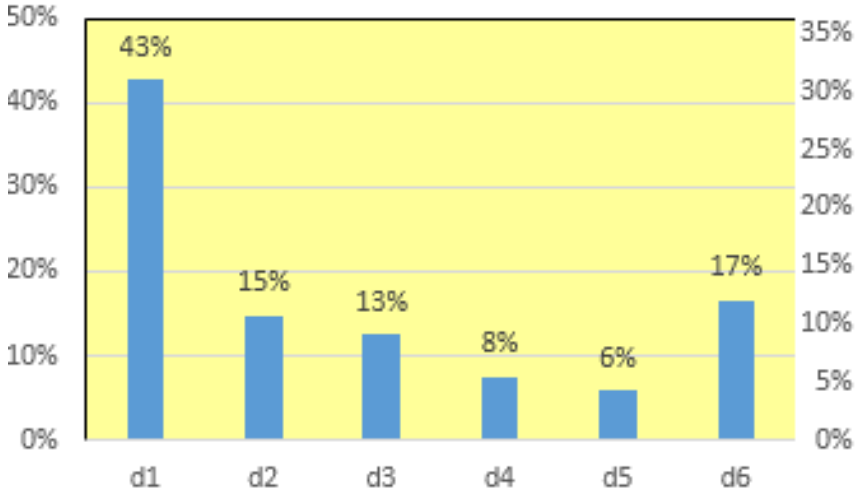


c) Landing undershoot

Risk Assessment: Exposure

- Exposure is modeled using obstacle distance from the runway end
- The closer an obstacle is to the runway end, the higher is the obstacle's exposure thus the higher risk
- Aircraft traveled distances off the runway were assessed in 6 categories (d_1 to d_6) with 30m intervals
- 1076 historic events worldwide were analyzed

Historic Distances off the Runway



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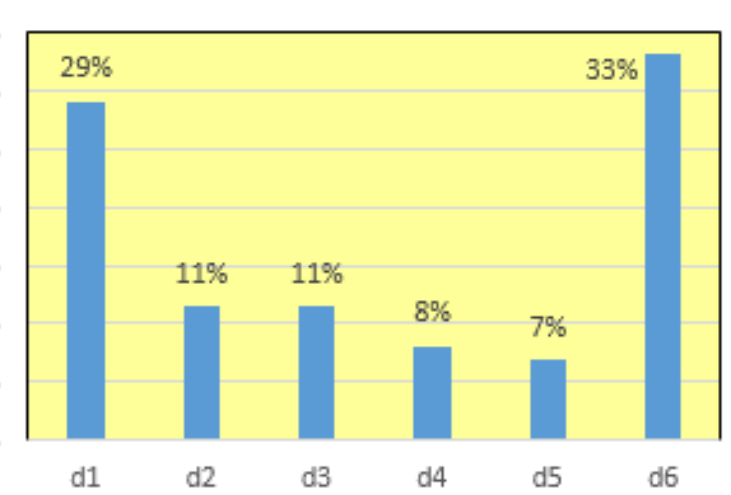
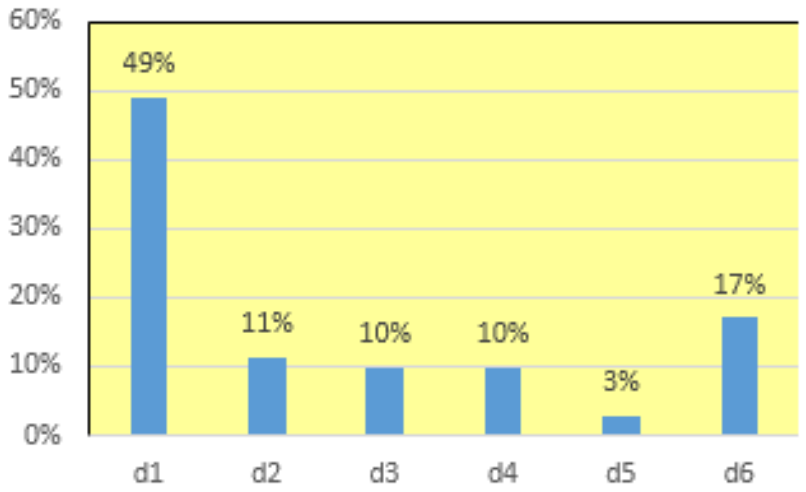


b) Takeoff overrun

d1	0-30m
d2	30-60m
d3	60-90m
d4	90-120m
d5	120-150m
d6	>150m



c) Landing undershoot

Canadian Airports' RESA Questionnaire

- Questionnaire has been distributed to all Canadian airports
- Relevant airport movement and RESA condition are being collected for the past 20 years
- Risk Analysis will be performed based on both existing RESA conditions as well as standard conditions to arrive at Risk levels
- Safety gains are measured with a standard RESA

Questions?

Contact

Richard Speir, P.E.
Vice President
Applied Research Associates, Inc.
Telephone: (410) 540-9949 #11
Email: rspeir@ara.com

Joe MacKay
Director, Aviation
WSP Canada Inc.
Telephone: (519) 571-3255 #404
Email: joe.mackay@wspgroup.com

Hamid Shirazi, P.E.
Senior Engineer
Applied Research Associates, Inc.
Telephone (410) 540-9939 #27
Email: hshirazi@ara.com