OpsTech Session 4

Runway Condition Assessment—Moving Toward an Automated Environment

Moderator:
Rob Kikillus, Airport Operations Manager, Seattle-Tacoma International Airport

Speakers:
Daniel Cohen-Nir, Senior Director—Safety, Airport Programs and Environmental Affairs, Airbus Americas, Inc.

Steve McKeown, CEO, Team Eagle LTD.

TPA19

TAMPA 2019
AIRPORTS COUNCIL INTERNATIONAL – NORTH AMERICA
ANNUAL CONFERENCE AND EXHIBITION
SEPTEMBER 15 – 17, 2019

#AIRPORTS19

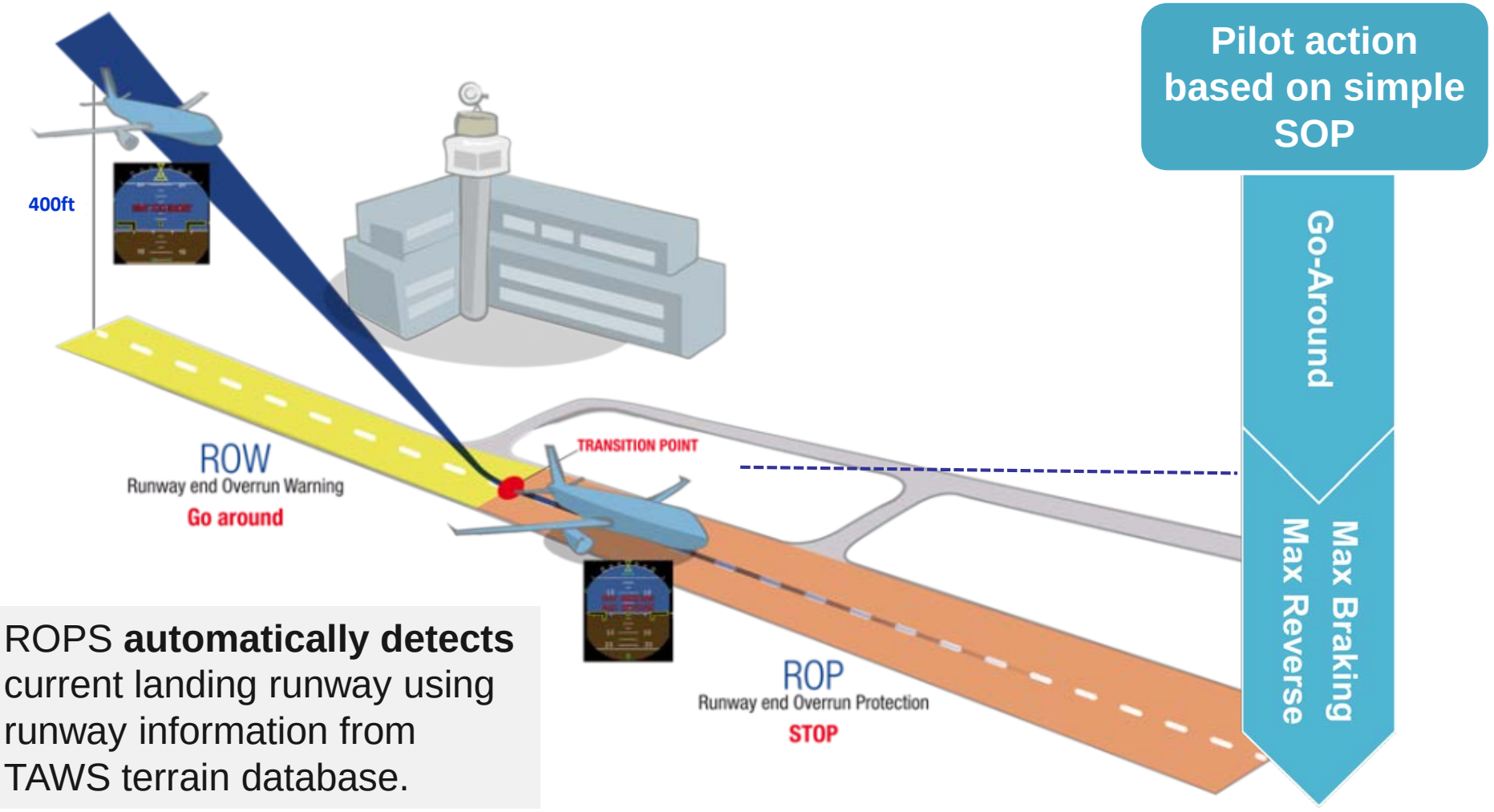
2019 ACI-NA Annual Conference and Exhibition

Dan Cohen-Nir

Senior Director, Airbus Americas

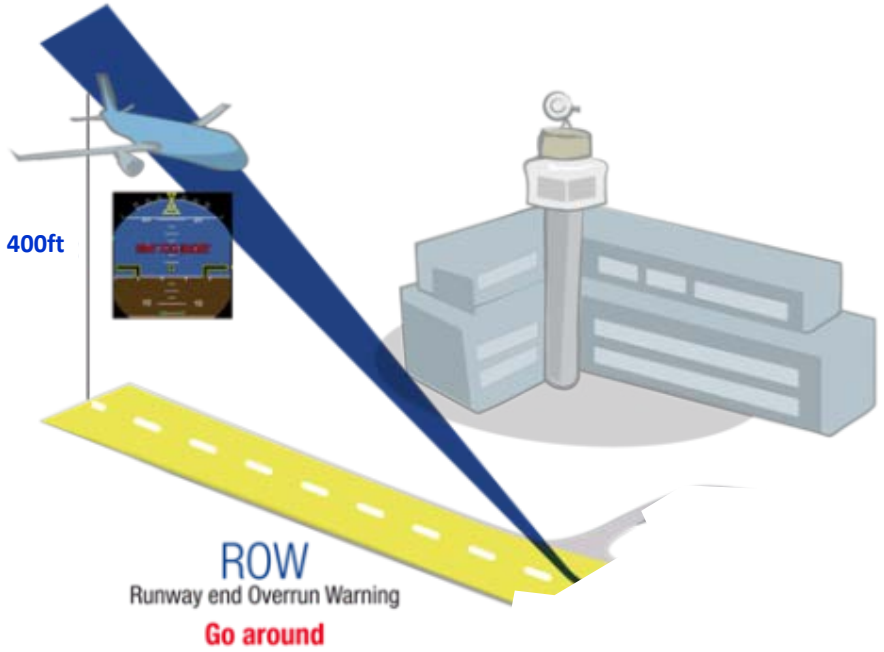
AIRBUS

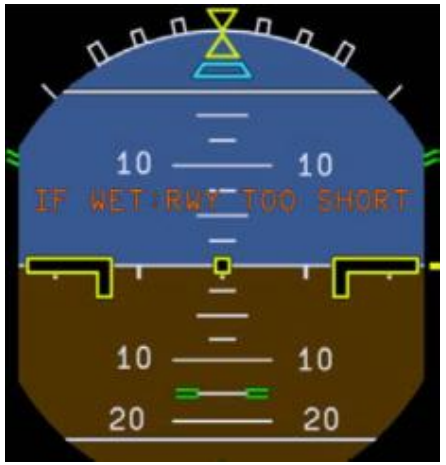
ROPS Combines Air and Ground Alerting

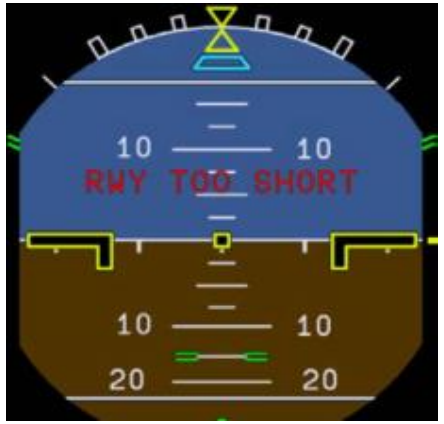


ROPS **automatically detects** current landing runway using runway information from TAWS terrain database.

ROW: Runway End Overrun Warning, during Air Phase





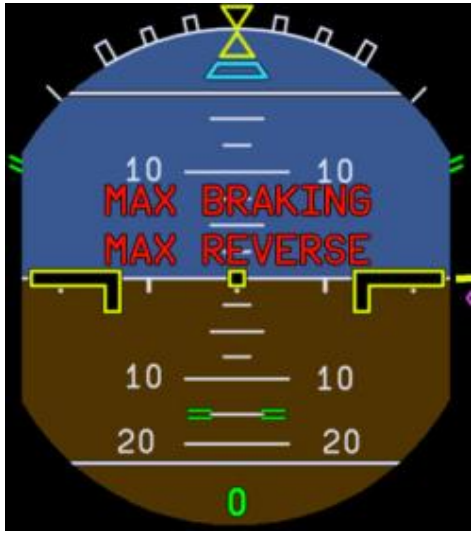


During the Air-Phase, ROPS performs a **real time in-flight landing distance assessment** for dry & wet runways with respect to detected landing distance available.

→ **If the estimated landing distance is longer than the runway length, ROPS triggers an alert to encourage the crew to go around**

"RUNWAY TOO SHORT"

ROP: Runway Overrun Protection, during Ground Phase

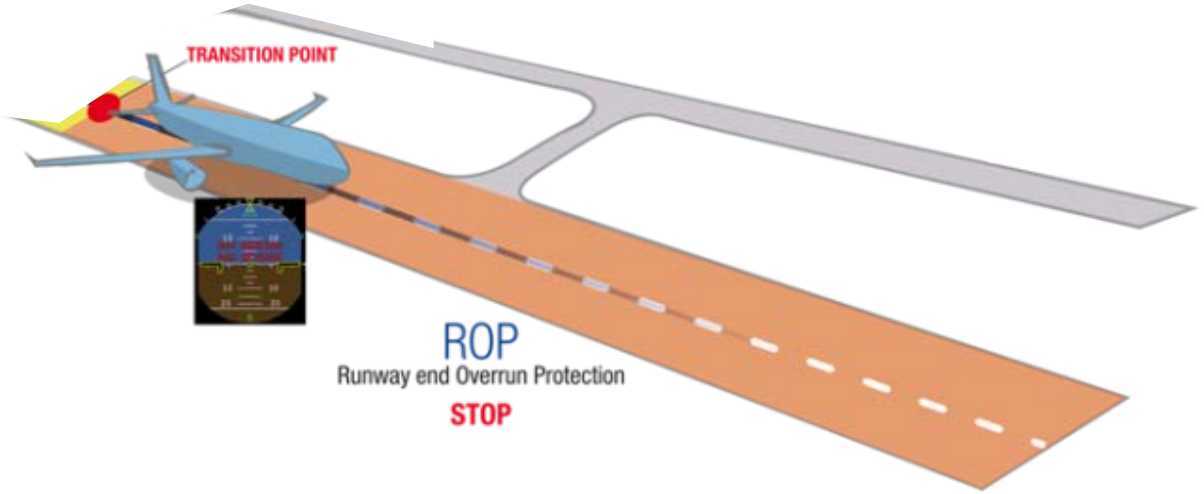


During the Ground-Phase, ROPS performs **a real time on-ground stopping distance assessment** with respect to detected landing distance available

→ **If the remaining runway length is assessed too short, ROP triggers an alert to encourage the crew to apply AND keep all available deceleration means**

BRAKE
MAX BRAKING
MAX BRAKING

SET MAX REVERSE
KEEP MAX REVERSE



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RunwaySense by NAVBLUE

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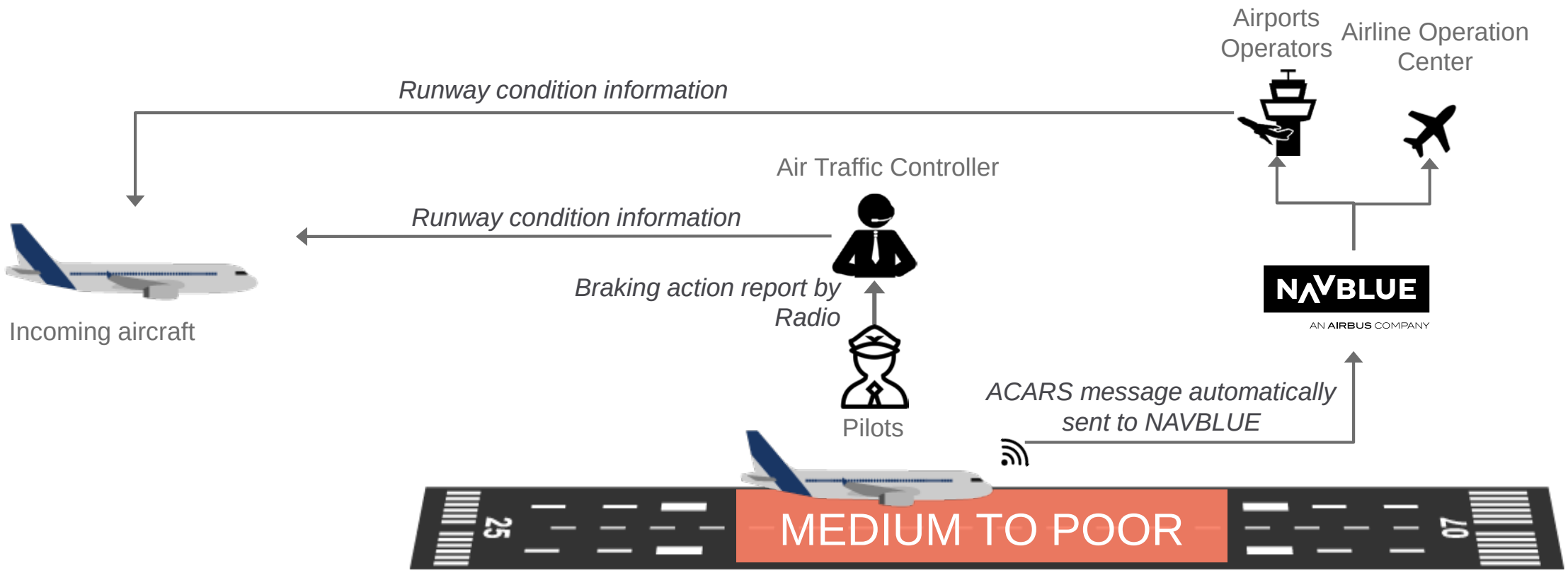
What is Runway Sense?

Use the aircraft to measure how slippery the runway was at landing and report this information back to airspace users



Pilot reports of braking action

Pilot Reports of Braking Action form a key component of the ICAO Global Reporting Format

But they can be subjective based on pilot experience and technique

No formal training on how to give a good PIREP

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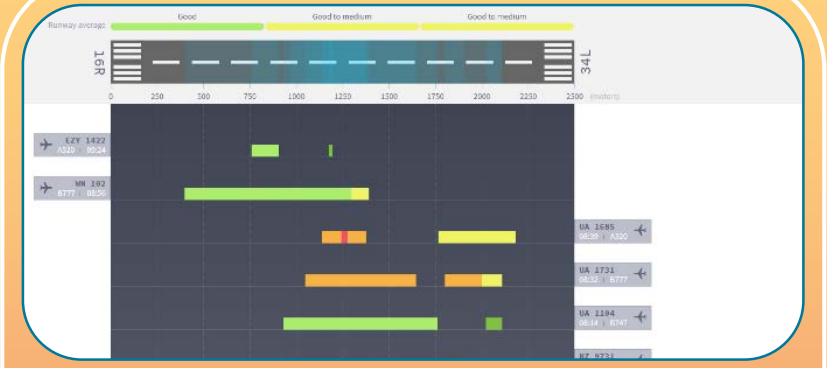
Assessment Criteria		Downgrade Assessment Criteria		
Runway Condition Description	Code	Mu (μ) [1]	Vehicle Deceleration or Directional Control Observation	Pilot Reported Braking Action
• Dry	6	40 or Higher	---	---
• Frost • Wet (Includes Damp and 1/8 inch depth or less of water) ***1/8 inch (3mm) depth or less of:*** • Slush • Dry Snow • Wet Snow	5	40 or Higher	Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.	Good
5° F (-15°C) and Colder outside air temperature: • Compacted Snow	4	39 to 30	Braking deceleration OR directional control is between Good and Medium.	Good to Medium
• Slippery When Wet (wet runway) • Dry Snow or Wet Snow (Any depth) over Compacted Snow ***Greater than 1/8 inch (3mm) depth of:*** • Dry Snow • Wet Snow ***Warmer than 5° F (-15°C) outside air temperature:*** • Compacted Snow	3	29 to 21	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.	Medium
Greater than 1/8 (3mm) inch depth of: • Water • Slush	2	29 to 21	Braking deceleration OR directional control is between Medium and Poor.	Medium to Poor
• Ice [2]	1	29 to 21	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.	Poor
• Wet Ice [2] • Slush over Ice • Water over Compacted Snow [2] • Dry Snow or Wet Snow over Ice [2]	0	20 or Lower	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.	Nil

RunwaySense BY NAVBLUE

ATSU Software Application

Braking Action Computation Function (BACF)



RunwaySense
Collaborative Web Platform

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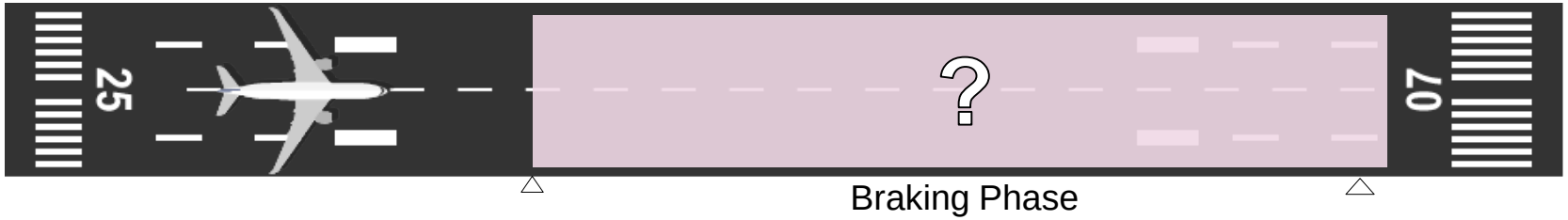
How Braking Action Computation Function (BACF) works

Use the data measured by the aircraft during its deceleration roll to identify the braking action level

Actual braking performance



Reference Aircraft Performance Model

In simple terms, BACF compares what the aircraft actually did to simulations of what the aircraft would have done for each reference runway state → find the best match

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Pilot Feedback on MCDU

FEEDBACK TO THE PILOT

- Situational awareness about how slippery the runway was and where
- (REQ) lets pilot know that information is available

AID FOR PIREP

- Can be used to consolidate the pilots' evaluation of the runway braking action for the PIREP

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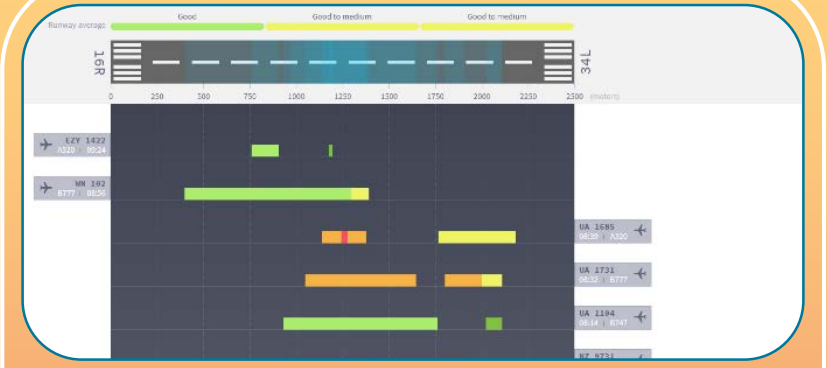
RunwaySense BY NAVBLUE



RunwaySense
Collaborative Web Platform

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Web-based collaborative platform built by NAVBLUE

ACARS MESSAGES ARE ROUTED TO NAVBLUE.

PARSE AND ENRICH THE DATA

CUSTOMIZED DASHBOARDS WITH REAL-TIME INFORMATION

OVERVIEW OF ALL RUNWAYS

TRENDING & DETAILED VIEW OF BRAKING ACTION REPORTS ON THE RUNWAY

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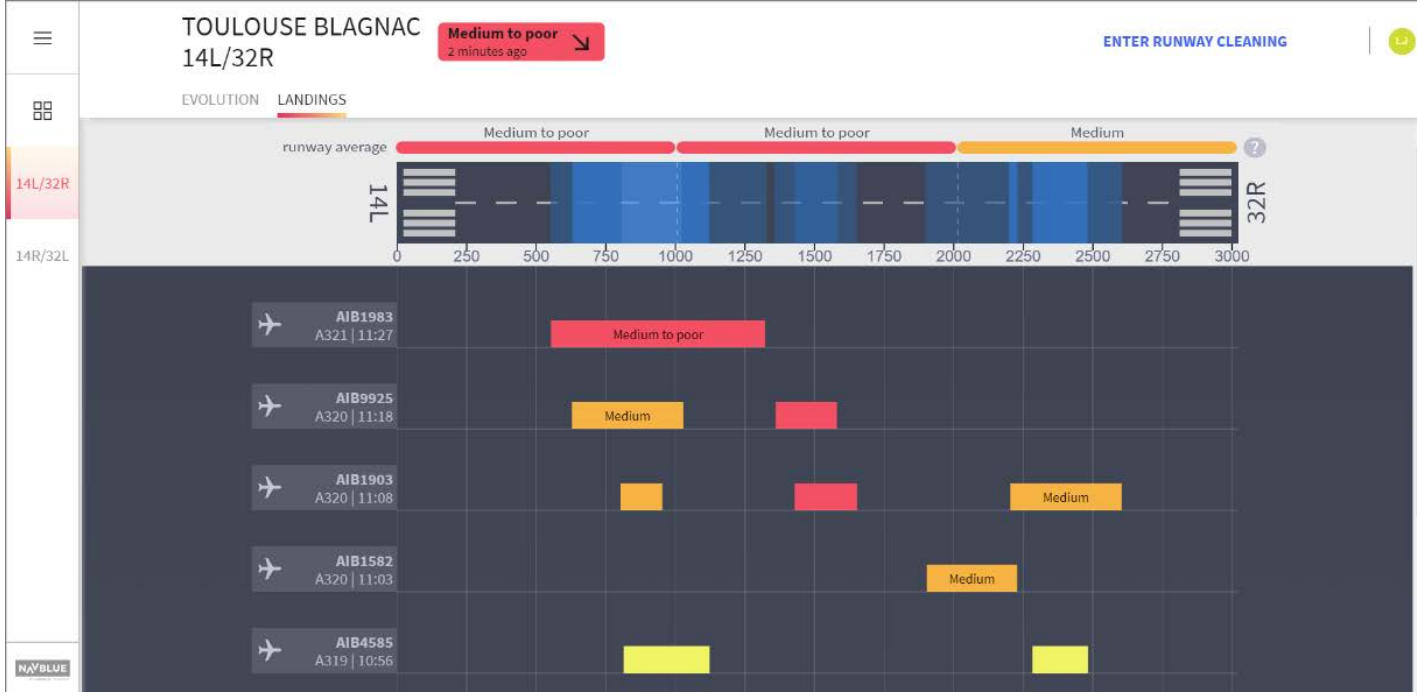

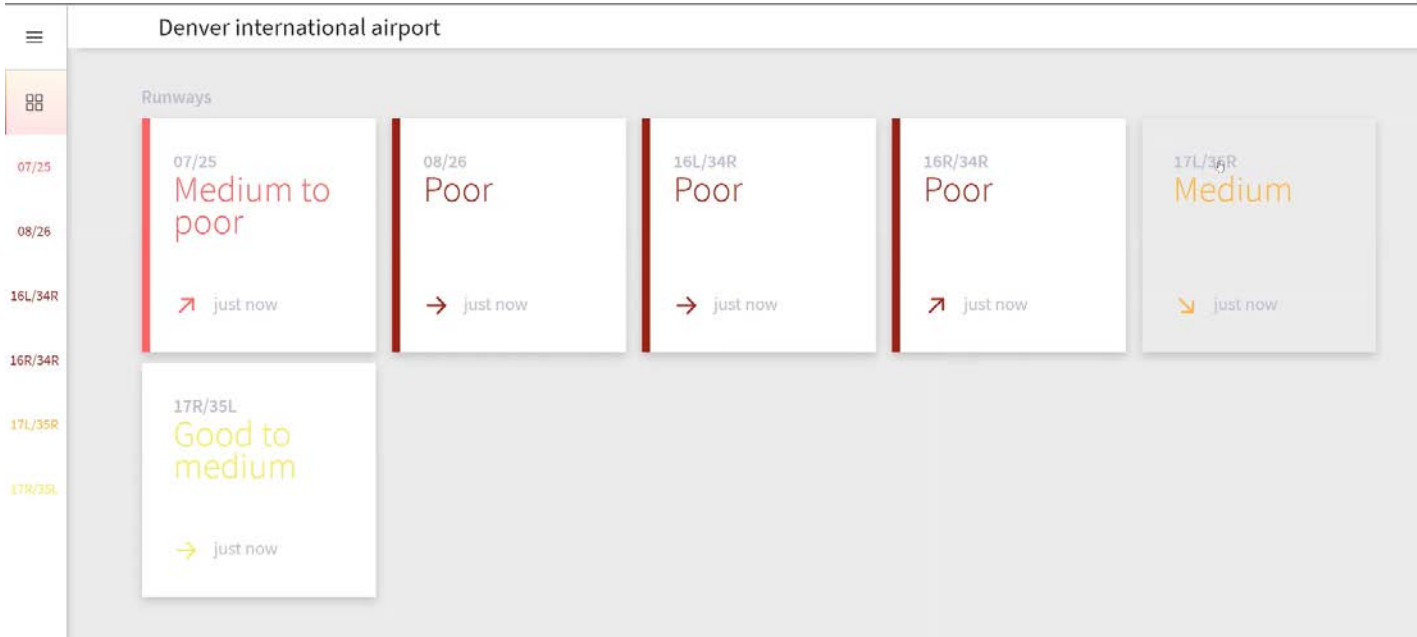

What’s the Benefit? Why Share the Data?

Optimize
Enhance Safety

FOR AIRLINES

- Pilot awareness of slippery conditions. Objective feedback for help with Pilot Braking Action Report.
- Awareness of slippery conditions, risk management within route network.

FOR AIRPORTS

- Real-time information about trend of runway condition.
- Optimize runway closures and cleaning based on slippery conditions.
- Optimize use of de-icing chemicals for slippery areas of runway.

FOR AIR TRAFFIC CONTROLLERS

- Awareness of current runway braking action.
- Collaboration with airport on slippery conditions and runway closures

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Why is it Free for Airlines?

The Safety Benefit of this technology can only be realized with a mass adoption of the onboard software

The value is not in one message, it is from the combination of 100s of messages.

Therefore Airbus & NAVBLUE decided to make the onboard software FOC, provided that airlines share the data with the RunwaySense platform.

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Participate as an Early Adopter

- Access to the RunwaySense platform and data for a trial period
- Comparison of RunwaySense data with current operations, runway cleanings, weather and friction measurements
- Workshops with NAVBLUE to understand how the data can best be used at your airport
- Participate and help shape the development of RunwaySense to best suit your operational needs

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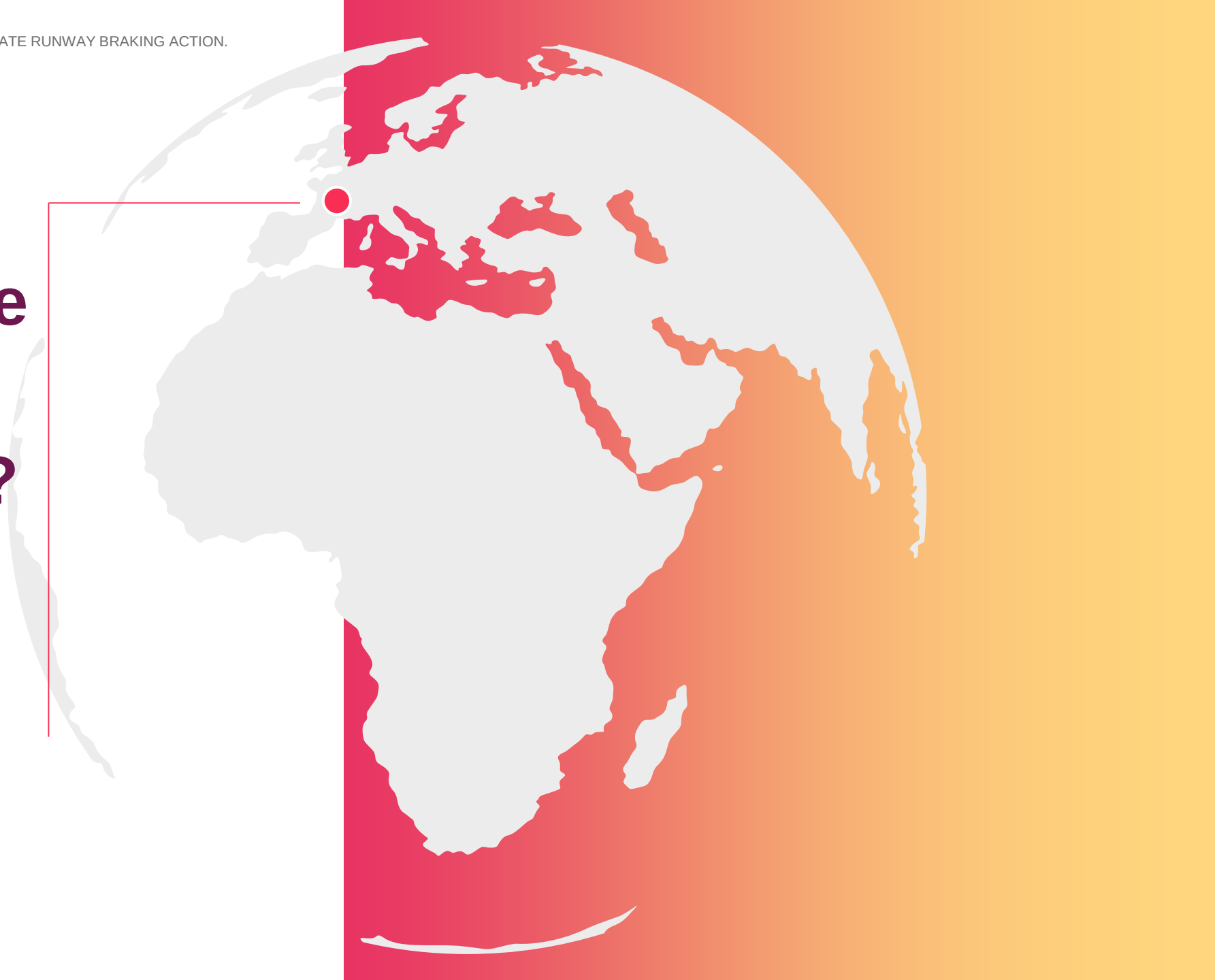
Interested to participate in the future of Runway Safety?

Contact NAVBLUE for more information on how to get RunwaySense

rops.support@navblue.aero



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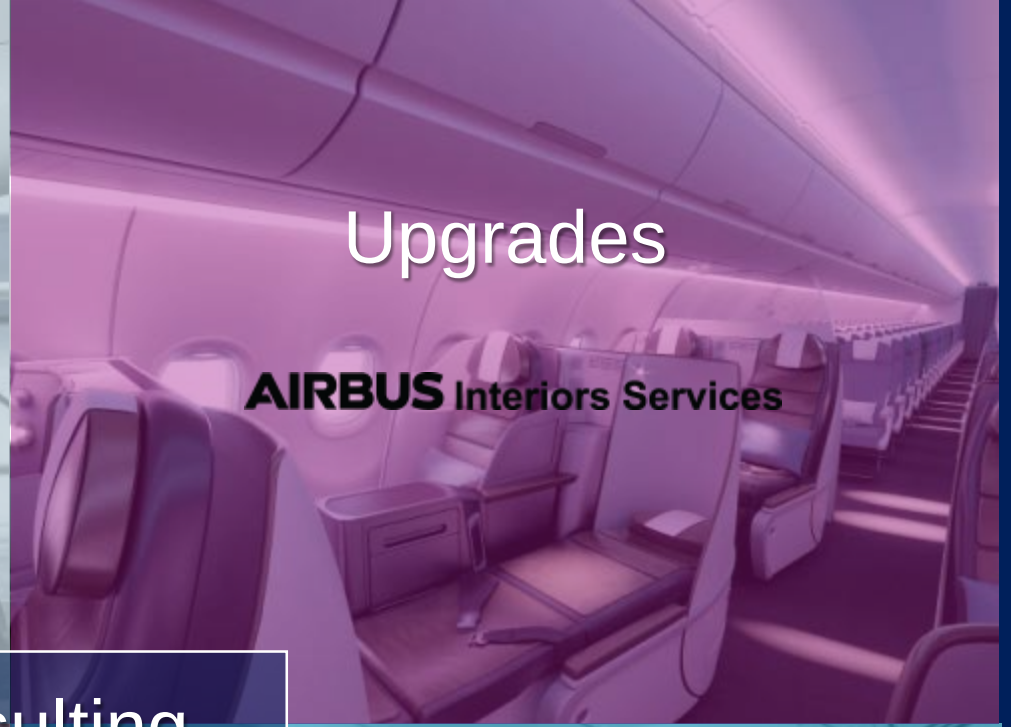
Maintenance

Flight Hour Services (FHS)

SATAIR



Upgrades

AIRBUS Interiors Services

Consulting

Flight Operations

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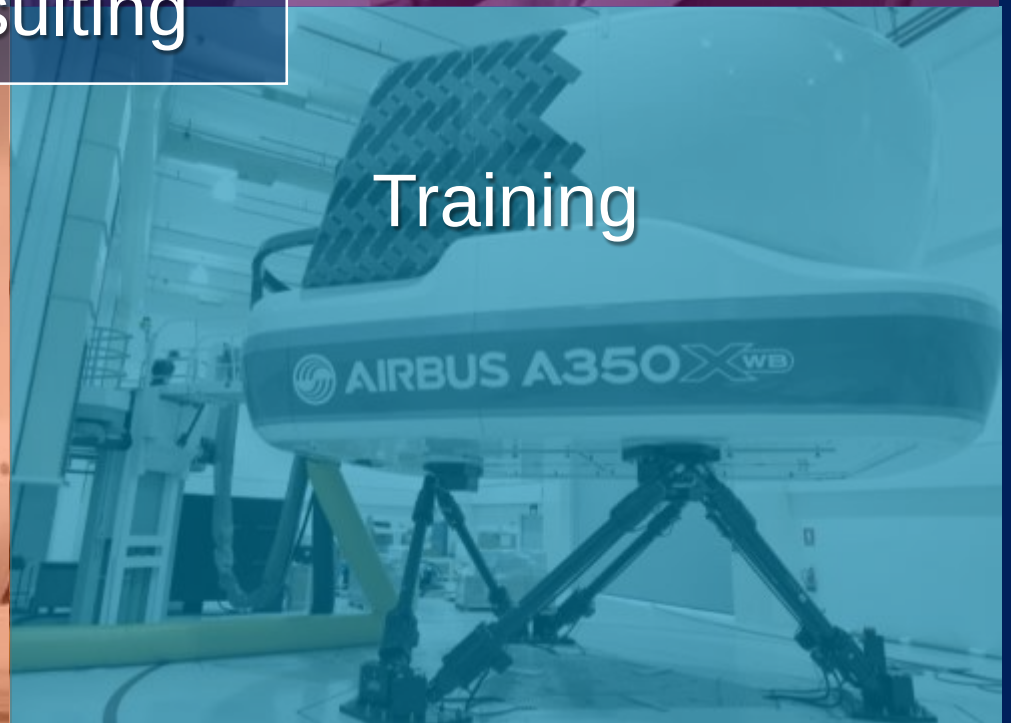

Training

Services byAirbus

Added Value Services

- Aircraft availability
- Optimised costs
- Increased revenue potential

Powered by skywise.

AIRBUS

A single platform for all aviation data sources

AIRBUS

Airport Compatibility: Useful links and handles

- *Website:* **airbus.com**
- *Technical Data:* **airbus.com/aircraft/support-services/airport-operations-and-technical-data.html**
- *Aircraft Characteristics Manuals:* **airbus.com/aircraft/support-services/airport-operations-and-technical-data/aircraft-characteristics.html**
- *Airport Front Desk:* **airport.compatibility@airbus.com**

For more information

AIRBUS


A380
A350 1000
A330
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50 YEARS
pioneering progress
AIRBUS

> < ICAO ADOP Montreal
July 18/19

Outline

Emerging Technologies

Possible Implementations

Summary

Emerging Technologies

Genesis

SW1248 12/05 MDW - overrun

Aviation Community Responses:

TALPA ARC, FAA, Transport Canada – CRDAs/BCIP

ICAO FTF

Goal – a better/safer '***global***' RCR reporting format

Emerging Technologies - Genesis

FAA, NTSB, EASA, Transport Canada recommendations:

- Explore RT in-aircraft, in situ WBC data solutions
- Explore RT in-ground-vehicle, in-situ WBC data solutions
- Maintain and hopefully improve objectively measured ‘slipperiness’ of runways

5/5/2016 : https://www.ntsb.gov/about/employment/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=A-11-028
5.5.4 b) https://www.easa.europa.eu/sites/default/files/dfu/Report%20Volume%201%20-%20Summary%20of%20findings%20and%20recommendations.pdf
https://www.brightonnow.ca/?p=664

Emerging Technologies - Genesis

All, as ***Decision Supporting Tools (DSTs)*** for basic:

Contaminant Coverage, Type, Depth, Aircraft WBC

Emerging Technologies - *Decision Supporting Tools*

1. Smart Cameras - objective measurement of contaminant coverage, type, and depth
2. In-aircraft objective deceleration measurement
3. In-aircraft early braking failure warning systems
4. Ex- Aircraft, global 24/7/365 monitoring of braking and steering failures
5. In-ground-vehicle, objective, maximum aircraft anti skid braking availability measurement
6. Integration of DSTs with in-RCR-vehicle, or cloud based NOTAM management systems

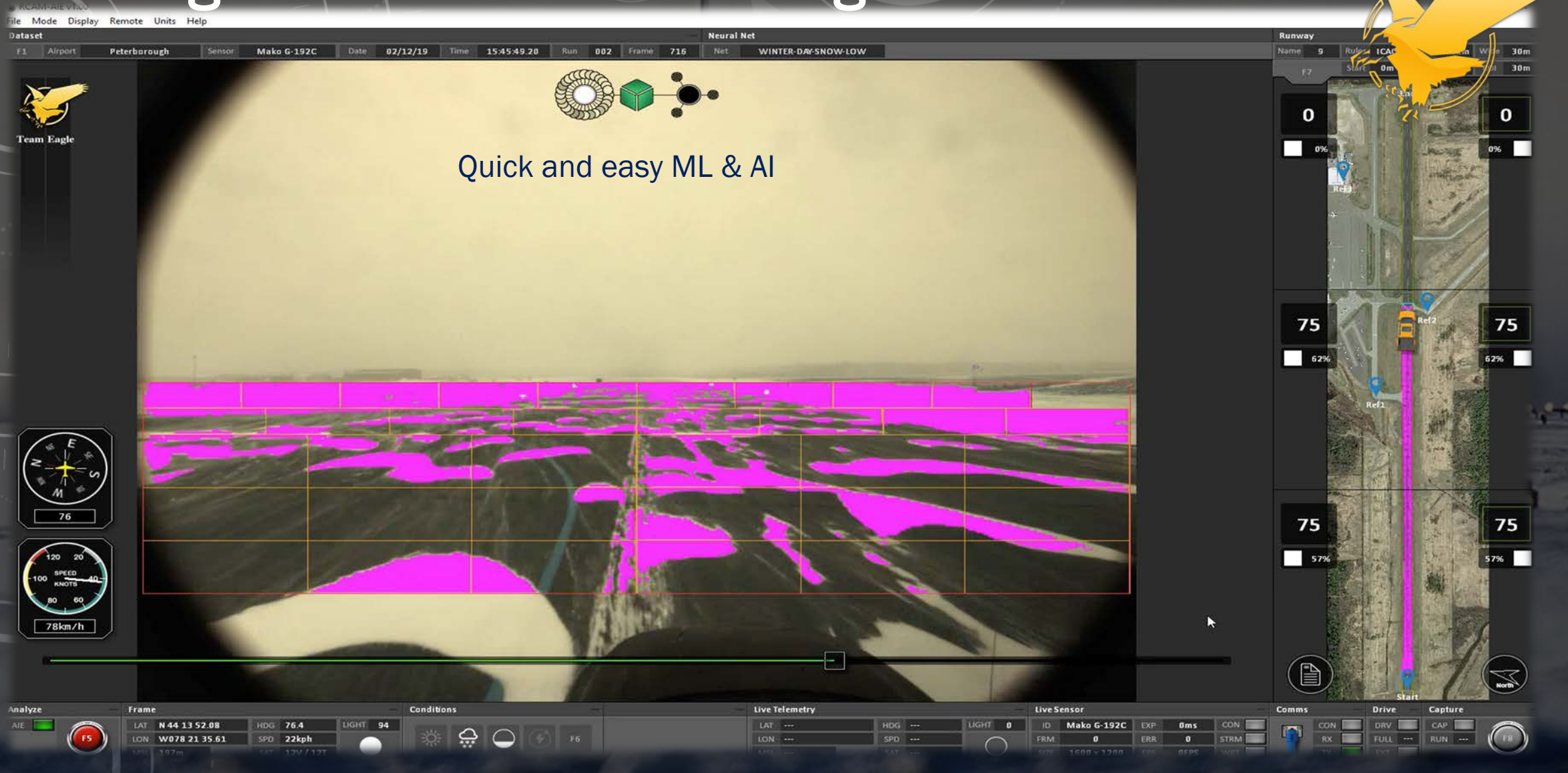
Emerging Technologies - *Decision Supporting Tools*

Smart Cameras - objective measurement of
% contaminant coverage

1. Using day/night visibility cameras, simple and straightforward machine learning and resulting AI, to provide measured % coverage across entire *and special sections of the runway*

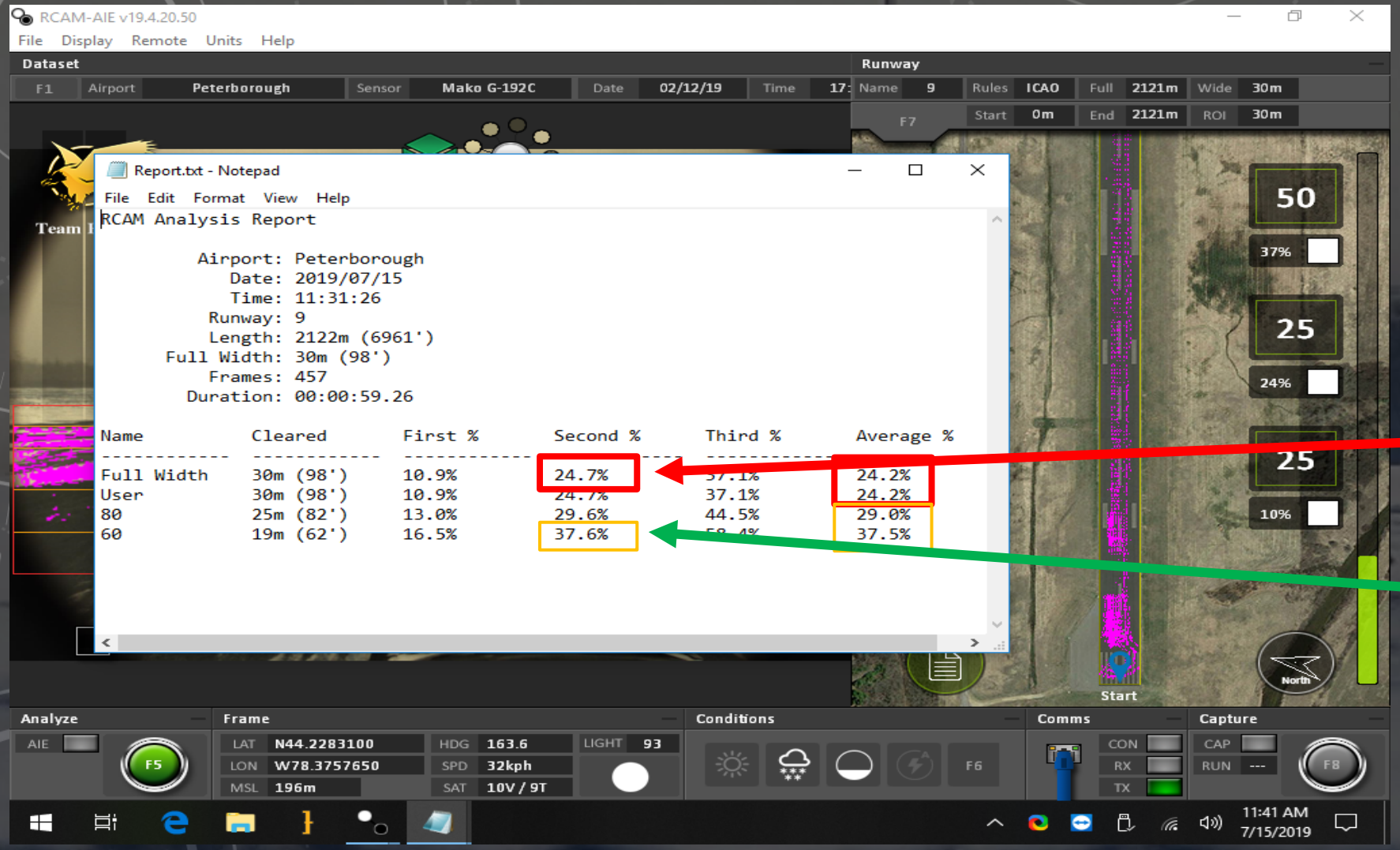
Emerging Technologies - *Decision Supporting Tools*

Measuring contaminant % coverage:



Emerging Technologies - *Decision Supporting Tools*

Measuring contaminant % coverage – AI information:



Use to:

Auto populate TALPA/GRF FICON fields

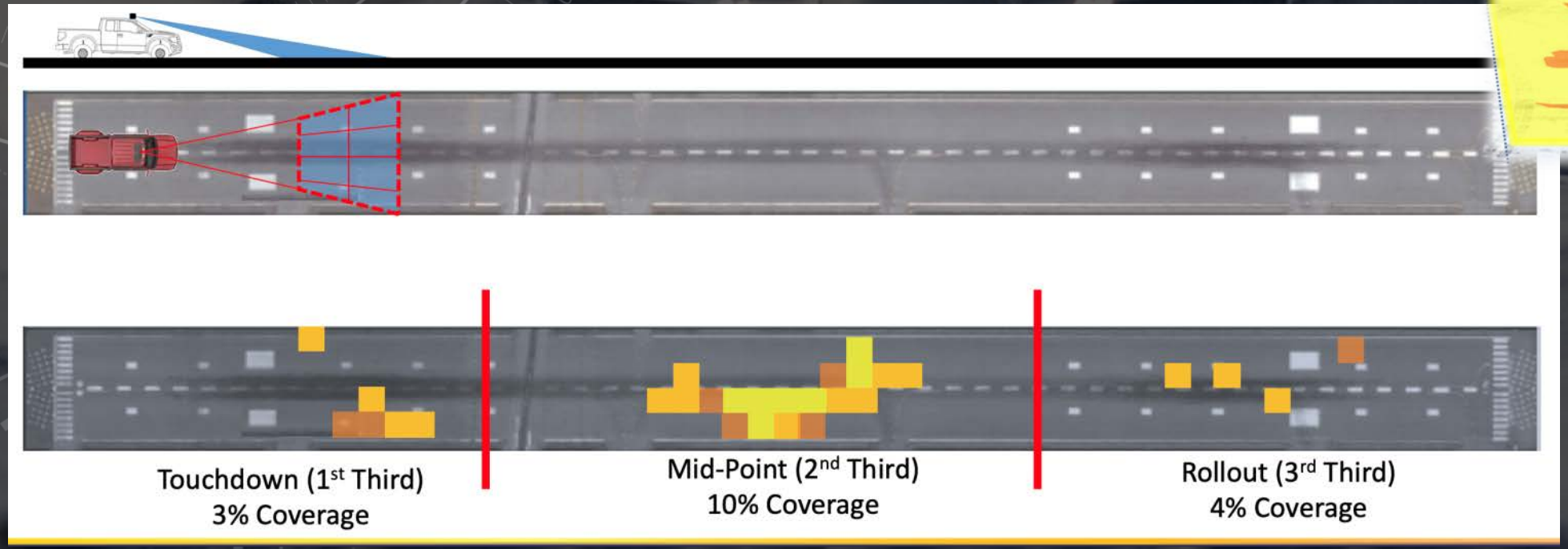
Safely *downgrade* RWYCCs

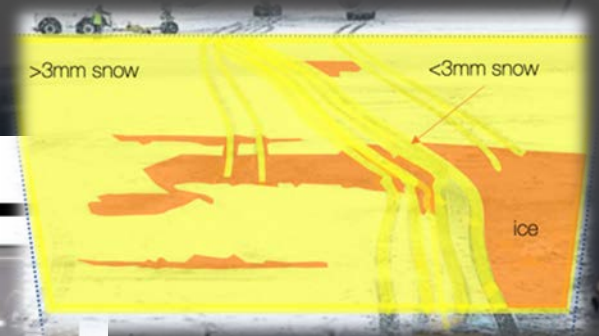
Commercialized Winter2018/19

Emerging Technologies - *Decision Supporting Tools*

Smart Cameras - objective measurement of contaminant type and depth

2. Using SWIR, ML and AI to measure H_2O contaminants (eventually all contaminants and why)





Color Blocks: % Coverage

Intensity: Type of H_2O & Depth (+/- 3mm)

Winter 19/20

Emerging Technologies - *Decision Supporting Tools*

Smart Cameras – safe low visibility RCR Team navigation

3. Using ‘gated aperture’ and/or flash LiDAR tech to enhance safer RCR vehicle navigation in low visibility conditions

Emerging Technologies - *Decision Supporting Tools*

‘Looking through’ obscuration:

- *snow,*
- *fog,*
- *heavy rains.*

For:
smart cameras
RCR Team safety

Emerging Technologies - *Decision Supporting Tools*

Smart Cameras – coincident RCR automatic autonomous FOD detection

4. Using smart camera ‘type and depth’ technology, ML and AI to auto-alert RCR Ops Teams to ‘possible FOD’ detection & location

Emerging Technologies - *Decision Supporting Tools*

In-aircraft deceleration - objective measurement

Interrogating FDR data for aircraft WBC experienced during landings.

Two variants:

i) by aircraft manufacturer (i.e. AIRBUS/NAVBLUE)

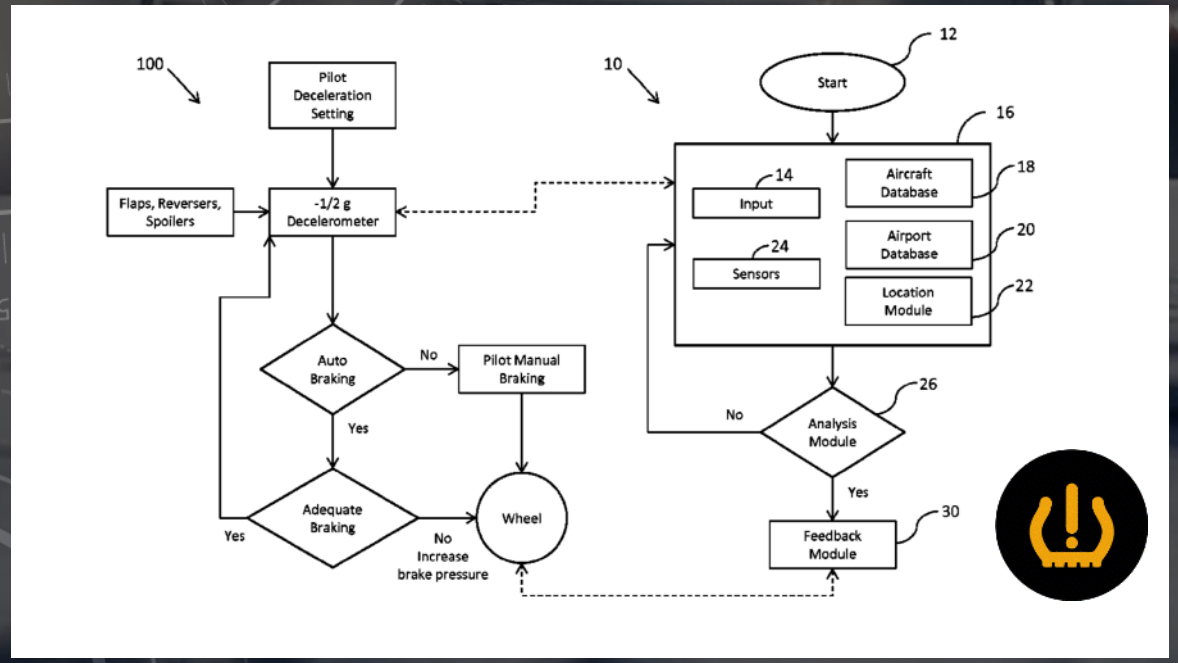
ii) aircraft manufacturer agnostic (i.e. AST/Zodiac Aerospace)

https://www.navblue.aero
https://www.aviationsafetytechnologies.com

Emerging Technologies - *Decision Supporting Tools*

In-aircraft (cockpit glass) earliest ‘low deceleration’ warning systems.

Both a post landing GRF DST and a real time warning to our pilots that their aircraft autobraking deceleration targets are not being met (braking failures).



Emerging Technologies - *Decision Supporting Tools*

Global 24/7/365 monitoring of landings

Using real time aircraft landing data, determine braking and steering slipperiness as well as current runway conditions

Globally, all airports

24/7/365 monitoring of all landings, contaminant affects, and surfaces

(wind velocity, precipitation or sandstorm ‘ON’ triggered by real-time micro-weather reporting, i.e. Climacell, IBM Watson, SUREWX, etc.)

Team Eagle

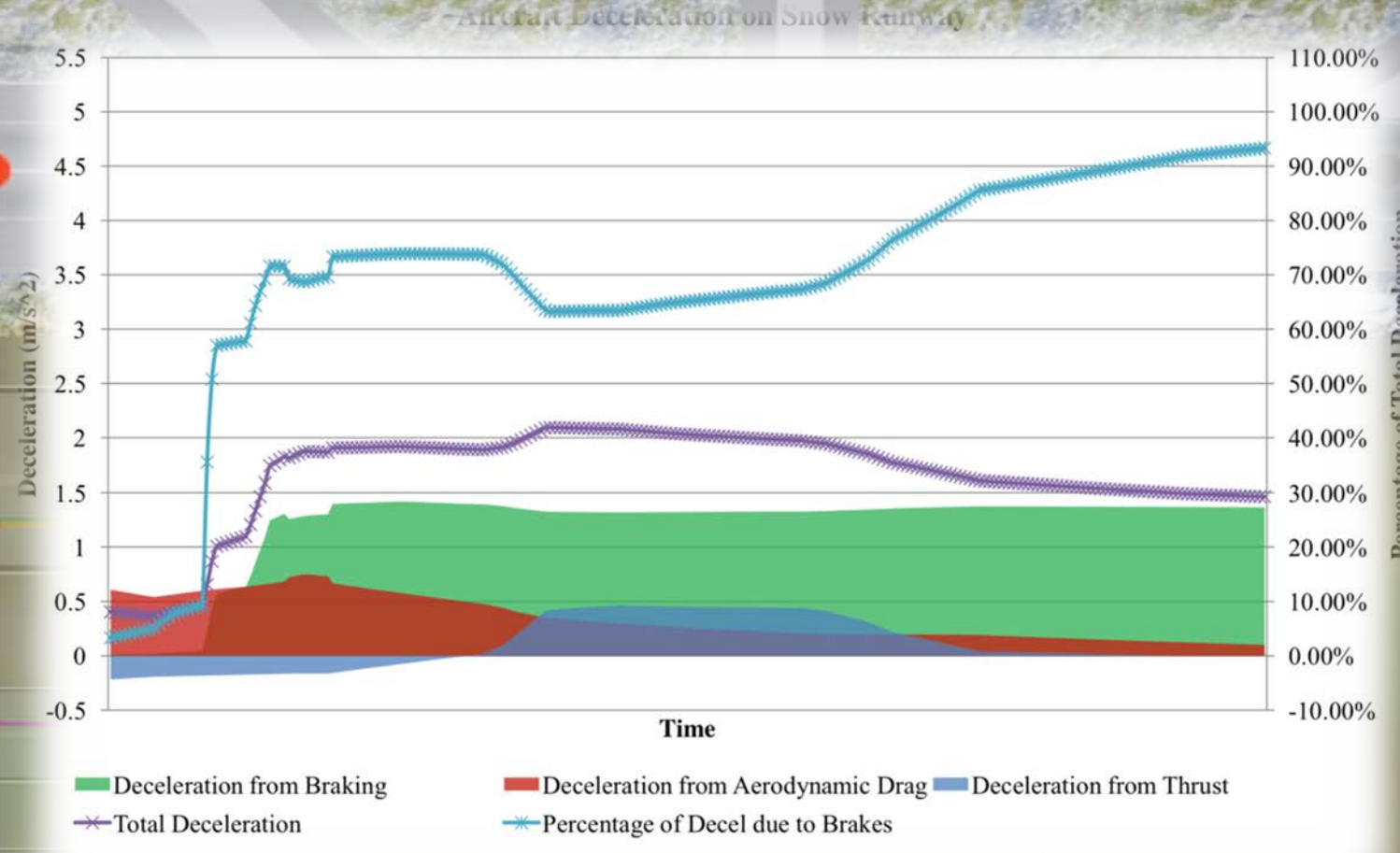
Emerging Technologies - *Decision Supporting Tools*

- ADEW – Aircraft Deceleration Early Warning
- Global 24/7/365 monitoring of landings
- Current binary yes/no identification of braking or directional control (steering) failures
- Real time alerting and confirmations of unsafe runway conditions
- ML and AI to alert to trending of deteriorating conditions (i.e. loss of texture, rubber, ‘slippery when wet’, +KPIs, +)

Team Eagle

BIG Data

1,000,000 movements per week



Emerging Technologies - *Decision Supporting Tools*

In-ground-vehicle max Mu_{acwbc} objective measurement

An aircraft anti-skid braking system and landing gear mounted into a RCR ground vehicle.

Measures in-situ contaminated runway maximum aircraft asbs braking availability (stopping and steering ‘slipperiness’) the full length of the runway

Insert 3 BAT slides

Emerging Technologies - *Decision Supporting Tools*

An aircraft anti-skid braking system and landing gear mounted into a ground vehicle.

Instead of runway friction, the BAT measures actual aircraft WBC availability – i.e. how long it will take an aircraft to stop using anti-skid wheel braking

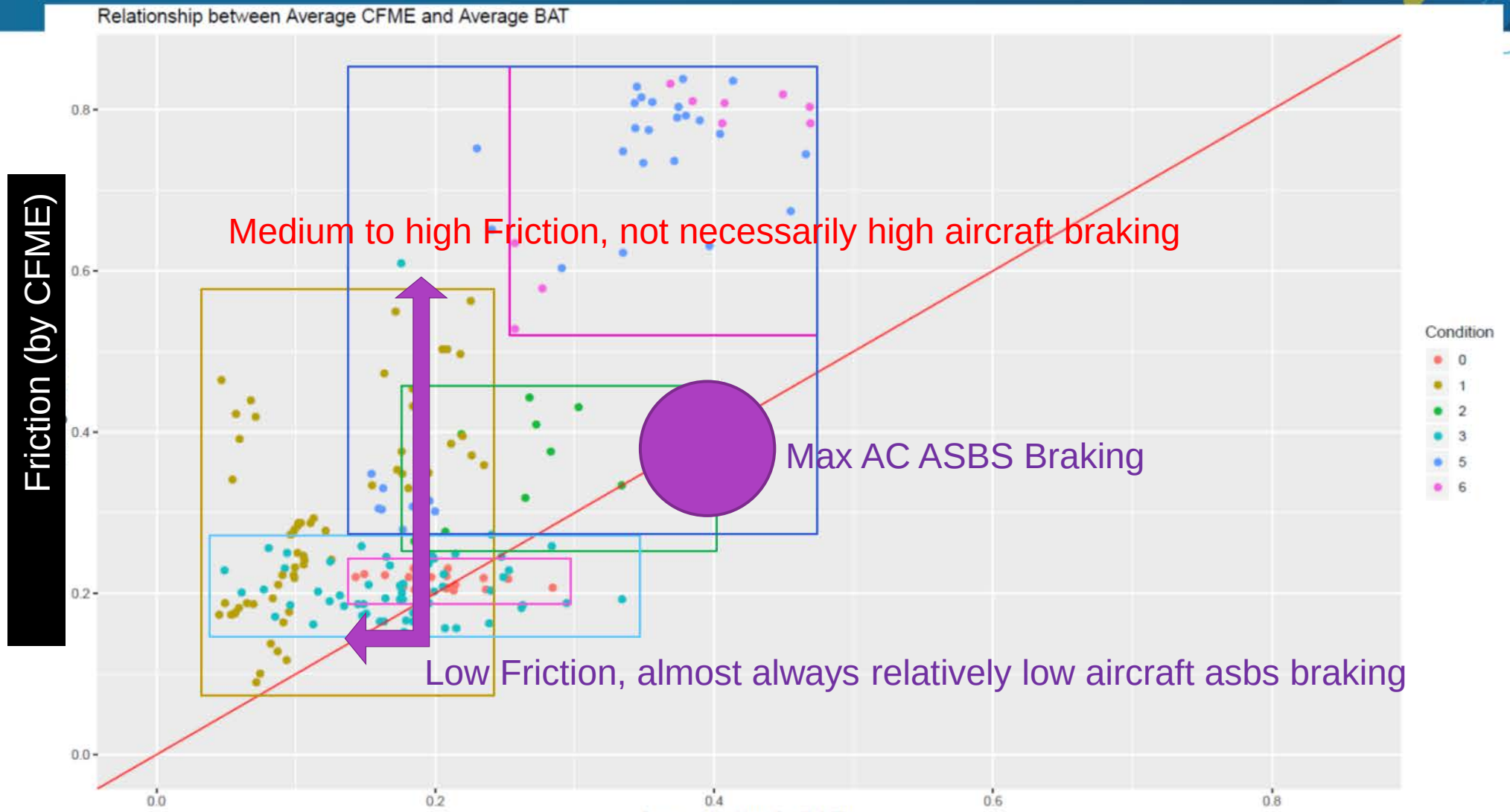
Emerging Technologies - *Decision Supporting Tools*

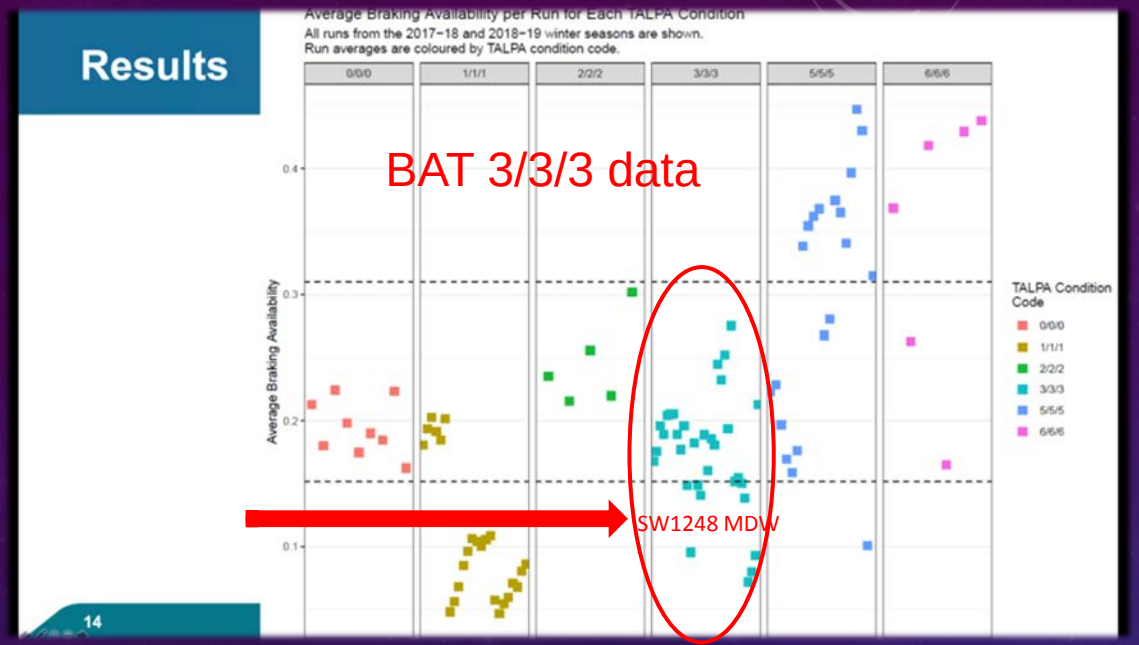
Anti-skid braking system

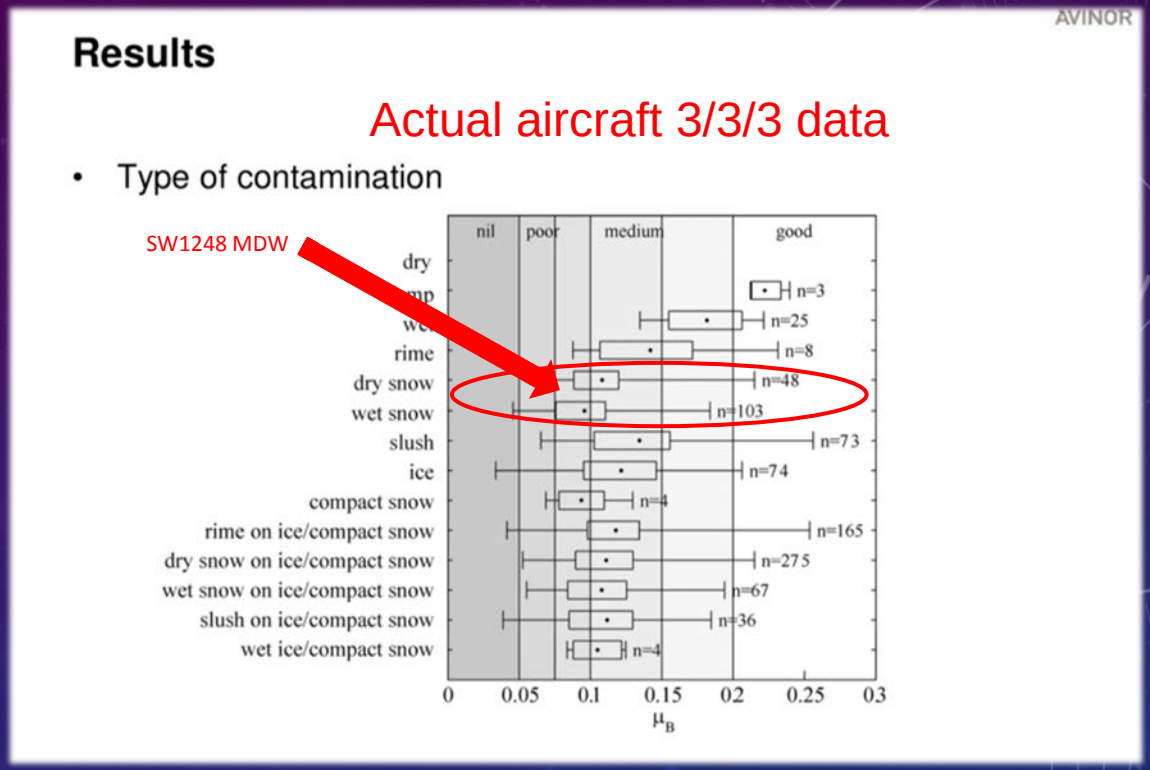
Landing Gear

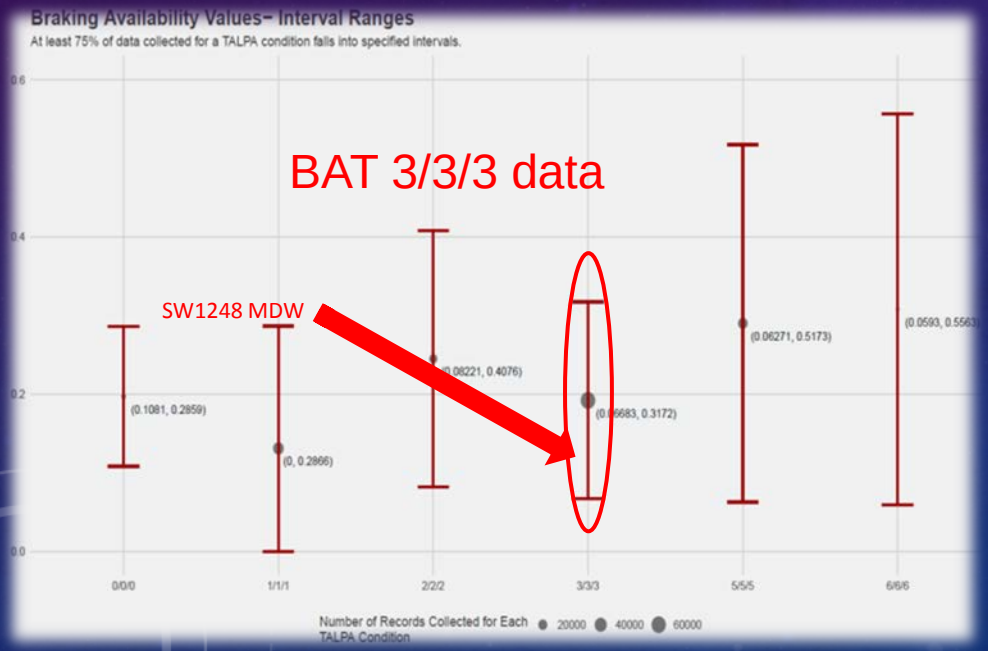
Ground vehicle with GRF RCR system

Results: Comparison between BAT and CFME

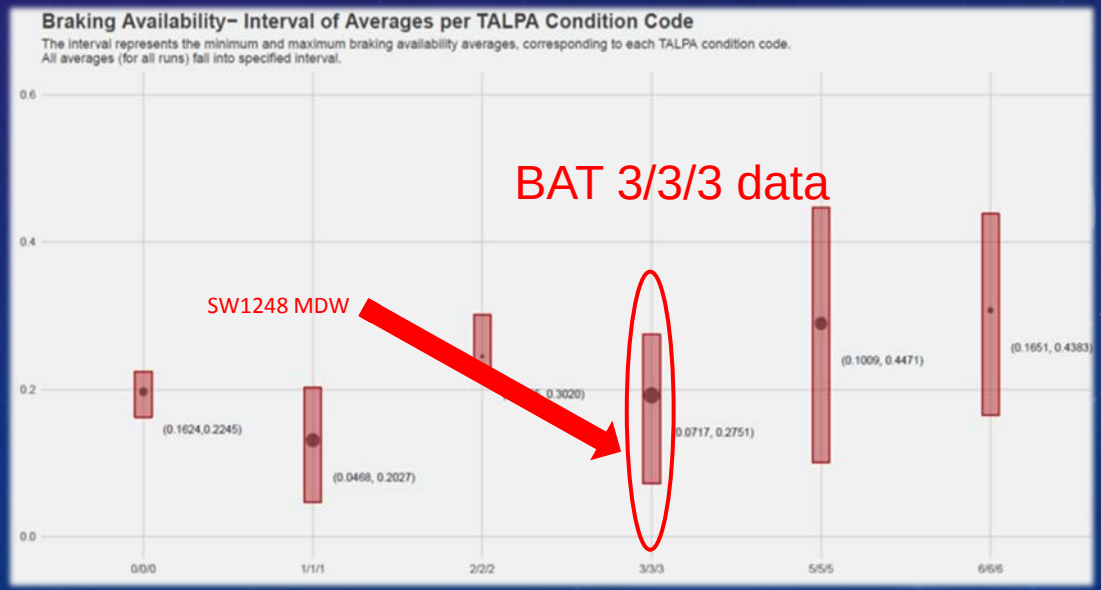








Implied WBC at 3/3/3 is .16
SW1248 WBC average .085



Emerging Technologies - *Decision Supporting Tools*

Braking availability also helps determine ‘steering’ ability.

Emerging Technologies - *Decision Supporting Tools*

Integration of DSTs with in-RCR-vehicle, or cloud based NOTAM mgmt systems

Integrating/using the information from the above objectively measuring DST sensors to inform our FICONs (manual or auto population of FICON fields) will provide straightforward and easily understood, safest downgrading criteria to provide most accurate and safe, objectively measured RWYCCs and SSD calculations

Example: MDW SW1248 12/05, today a 3/3/3, implied WBC .16, ‘Medium’, actual 12/05 average WBC .085, ‘Poor’

Emerging Technologies - *Decision Supporting Tools*

Global Airport GRF implementation assistance/tools

Suggested draft TC GRF FICON

Using measured Mu_{ac} (WBC) to support or downgrade RWYCC (from in-aircraft, in-ground vehicle, or ADS-B ML and AI)

Runway Condition Assessment Matrix (RCAM)

Assessment Criteria		Downgrade Assessment Criteria (Control/Braking Assessment Criteria)			
Runway Condition Description	RWYCC	WBC Mu	CRFI Range	Vehicle Deceleration Or Directional Control Observation	Pilot Braking Action
• DRY	6	> .40		---	---
• FROST • WET (The runway surface is covered by any visible dampness or water up to and including 1/8 inch (3mm) depth) **Up to and including 1/8 inch (3mm) depth:** • SLUSH • DRY SNOW • WET SNOW	5	.21 to .40	0.40 or Higher	Braking deceleration is normal for the wheel braking applied AND directional control is normal	GOOD
-15°C and Colder outside air temperature: • COMPACTED SNOW	4	.11 to .20	0.39 to 0.35	Braking deceleration OR directional control is between Good and Medium	GOOD TO MEDIUM
• SLIPPERY (WHEN) WET (wet runway) • DRY SNOW or WET SNOW (Any depth) ON TOP OF COMPACTED SNOW **Greater than 1/8 inch (3mm) depth of:** • DRY SNOW • WET SNOW **Warmer than -15°C outside air temperature:** • COMPACTED SNOW	3		0.34 to 0.30	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced	MEDIUM
Greater than 1/8 inch (3mm) depth of: • STANDING WATER • SLUSH	2	.06 to .10	.29 to 0.20	Braking deceleration OR directional control is between Medium and Poor	MEDIUM TO POOR
• ICE	1	.05 to .10	0.19 or Lower	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced	POOR
• WET ICE • SLUSH ON TOP OF ICE • WATER ON TOP OF COMPACTED SNOW • DRY SNOW or WET SNOW ON TOP OF ICE	0	≤ .05		Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain	LESS THAN POOR / NIL

Notes (1-4):

1) Refer to Section 6.5 - CRFI Information Presented in the RCAM, for an explanation of the relationship between CRFI and RWYCCs.

2) WBC values correlate with Pilot Braking Action Reports airplane braking coefficient.

*3) **CAUTION:** At temperatures near and above freezing (e.g., at -3°C and warmer), the runway surface condition may be more slippery than indicated by the RWYCC assigned by the RCAM assessment criteria. At these temperatures, airport and aerodrome operators should exercise vigilance and should downgrade the runway condition code if appropriate.*

*4) **CAUTION:** Heavy frost that has noticeable depth may have friction qualities similar to ice and downgrading the runway condition code accordingly should be considered. If driving a vehicle over the frost does not result in tire tracks down to bare pavement, the frost should be considered to have sufficient depth to consider a downgrade of the runway condition code.*

WBC Mu

Suggested draft FAA TALPA FICON

Runway Condition Assessment Matrix (RCAM)

Assessment Criteria		Downgrade Assessment Criteria			
Runway Condition Description	Code	WBC Mu	Mu (μ)	Deceleration Or Directional Control Observation	Pilot Reported Braking Action
• Dry	6	.40 or Higher	40 or Higher	---	---
• Frost • Wet (Includes Damp and 1/8" depth or less of water) **1/8" (3mm) depth or less of:** • Slush • Dry Snow • Wet Snow	5			Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.	Good
5° F (-15°C) and Colder outside air temperature: • Compacted Snow	4	< .40 to .20	39	Braking deceleration OR directional control is between Good and Medium.	Good to Medium
• Slippery When Wet (wet runway) • Dry Snow or Wet Snow (Any depth) over Compacted Snow **Greater than 1/8" (3mm) depth of:** •Dry Snow •Wet Snow **Warmer than 5° F (-15°C) outside air temperature:** •Compacted Snow	3	< .20 to .10	30	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.	Medium
Greater than 1/8" (3mm) depth of: • Water • Slush	2		29 to 21	Braking deceleration OR directional control is between Medium and Poor.	Medium to Poor
• Ice	1	< .10 to .05		Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.	Poor
• Wet Ice • Slush over Ice • Water on top of Compacted Snow • Dry Snow or Wet Snow over Ice	0	< .05	20 or Lower	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.	Nil

WBC (Mu_{ac}) values reconcile with **implied** WBCs of Braking Action Reports.

Table 6 http://www.bst-tsb.gc.ca/eng/rapports-reports/aviation/2015/a15q0075/a15q0075.html

Emerging Technologies - *Decision Supporting Tools*

Near future (w/i 3 years) Real Time Augmented and Mixed Reality

RTAMR for RCRg teams – all augmenting information provided to Operator (and other stakeholders, i.e. remote ATC) – ‘does the augmenting information agree with what the operator feels he/she is observing?’
Comprehensive situational awareness and safe navigation in low visibility conditions

Emerging Technologies - *Decision Supporting Tools*

Global GRF implementation training tools

FAA and some organizations have already created TALPA CBT programs

Governments in Canada (and likely others) are collaborating with Aerospace Co's, SMEs at Airports, and Universities to create GRF familiarization and RCR training centers of excellence.

Steve McKeown
Eagle Aerospace
A Team Eagle Company
stevem@eagle-aerospace.com
01 . 705 . 653 . 2956

*Thank You, **Safe** Travels!* ☺