Objective Measurement of Aircraft ASBS Braking Availability on Contaminated Runways

Runway Surface Conditions Assessment and Reporting
DGAC Paris 15 Symposium
31 March – April 1st 2016

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Outline

- Aim
- Background/History
- Issues/Challenges
- Development of New Aircraft and Ground Vehicle Based RCR Technologies
- Remaining Challenges
- Summary / Opportunities / Recommendations

Aim

Summarize our understanding of the current challenges to create viable, (safe and useable), Runway Condition Reporting (RCR) on contaminated runways, and discuss potential solutions.

Background / History

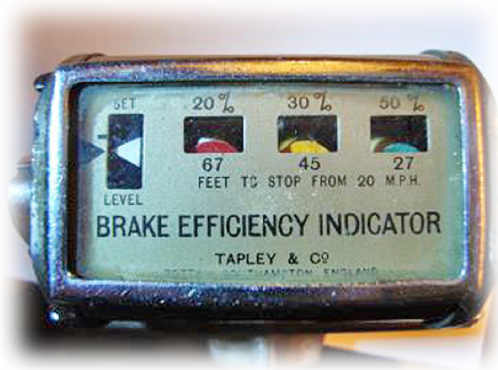
What did/do Pilots need from an RCR?

See!

Steer?

STOP?

History – All was good!



Locked Wheel ‘RWY Mü is good”

Gambar 1 Alat Mu-Meter

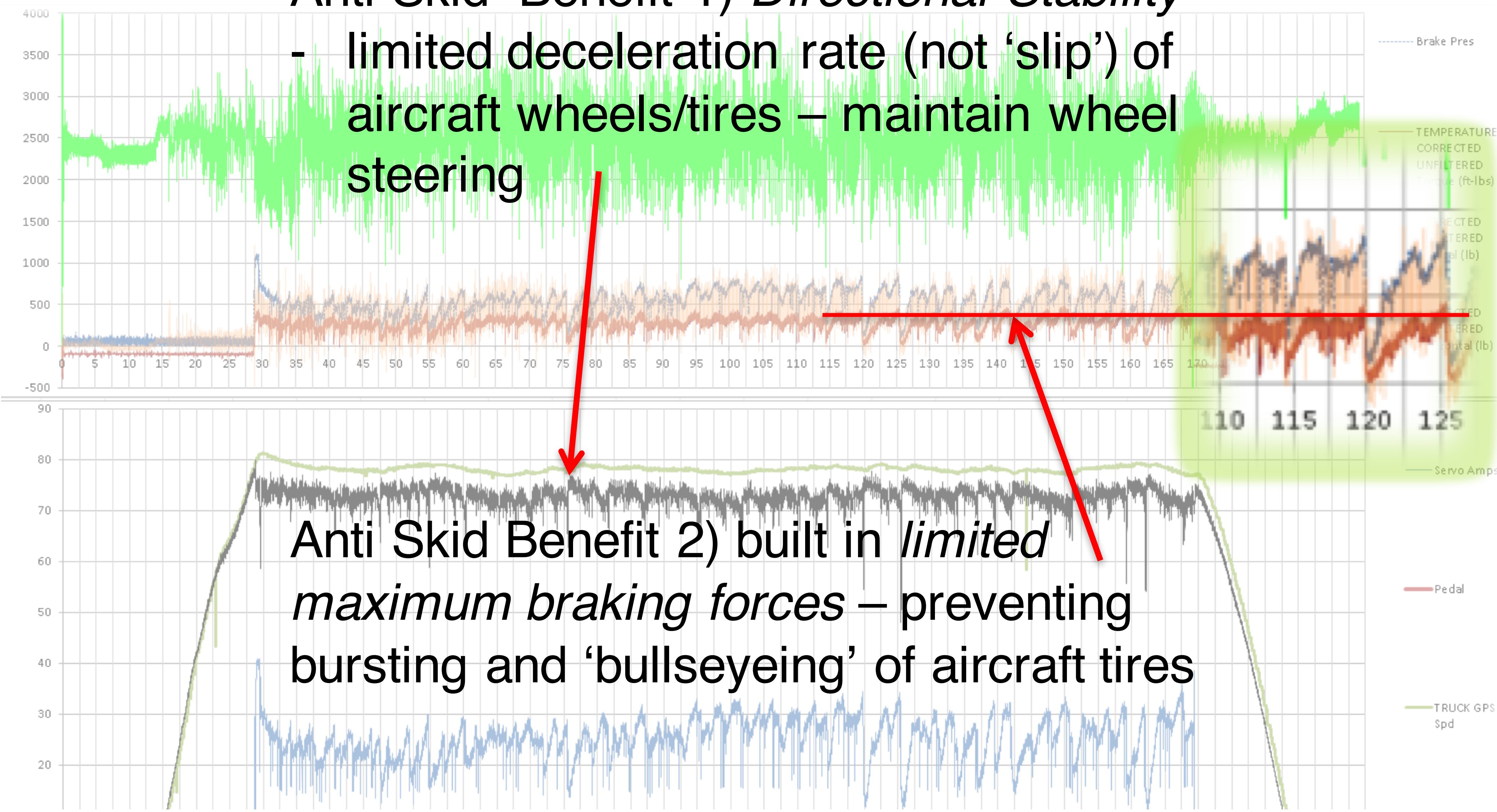
Runway surface friction … ‘Runway Mü is good’

PIREP $Mü_{AC}$ ‘Braking Action is good’

New Challenges – #1 - early 1960’s -aircraft *anti skid braking systems* technology is adopted

Anti Skid Benefit 1) *Directional Stability*

- limited deceleration rate (not ‘slip’) of aircraft wheels/tires – maintain wheel steering



Anti Skid Benefit 2) built in *limited maximum braking forces* – preventing bursting and ‘bullseyeing’ of aircraft tires

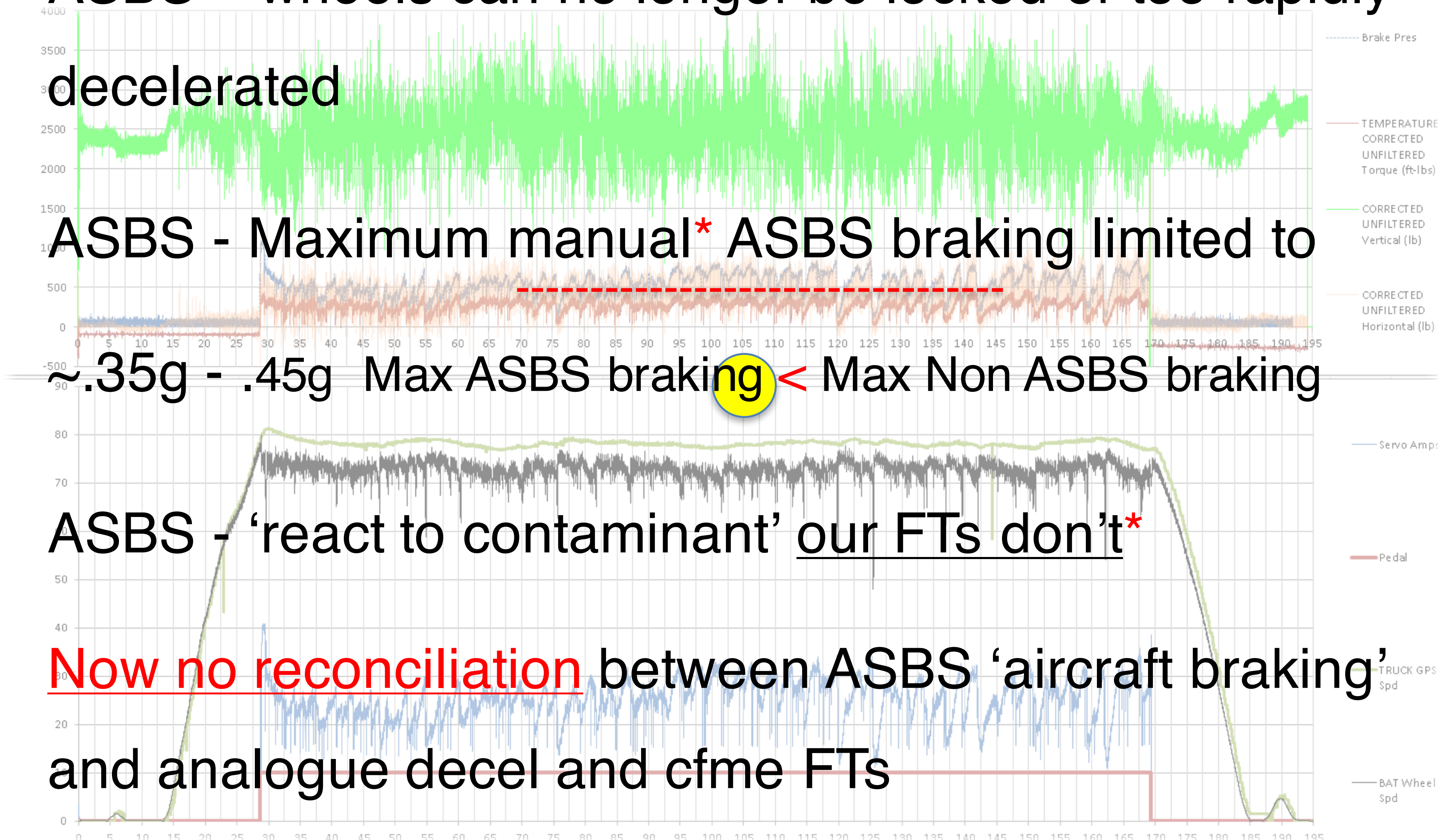
ASBS – New Challenges

ASBS – wheels can no longer be locked or too rapidly decelerated

ASBS - Maximum manual* ASBS braking limited to ~.35g - .45g Max ASBS braking < Max Non ASBS braking

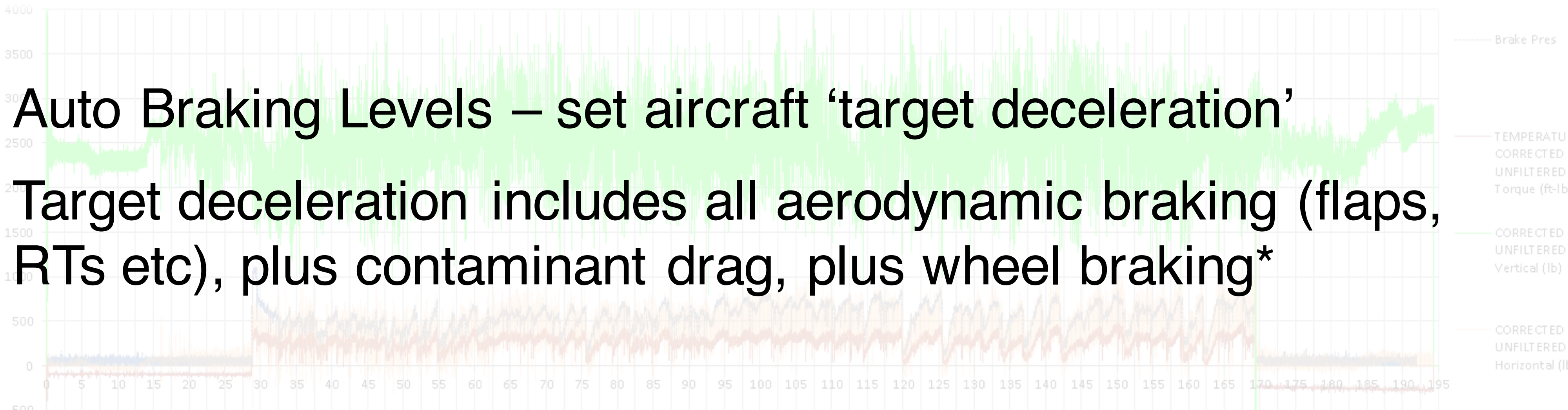
ASBS - ‘react to contaminant’ our FTs don’t*

Now no reconciliation between ASBS ‘aircraft braking’ and analogue decel and cfme FTs



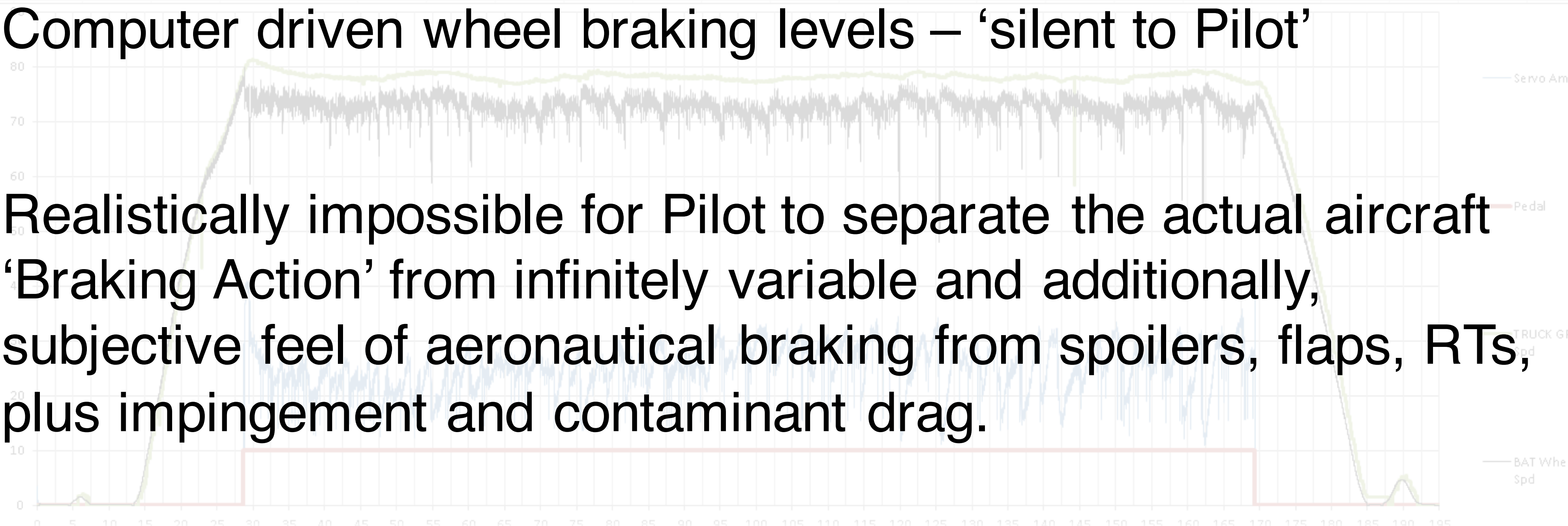
Challenge #2 – introduction of ‘Auto Braking’

(and airlines adopting AB in SOPs on contaminated runways)



Auto Braking Levels – set aircraft ‘target deceleration’

Target deceleration includes all aerodynamic braking (flaps, RTs etc), plus contaminant drag, plus wheel braking*



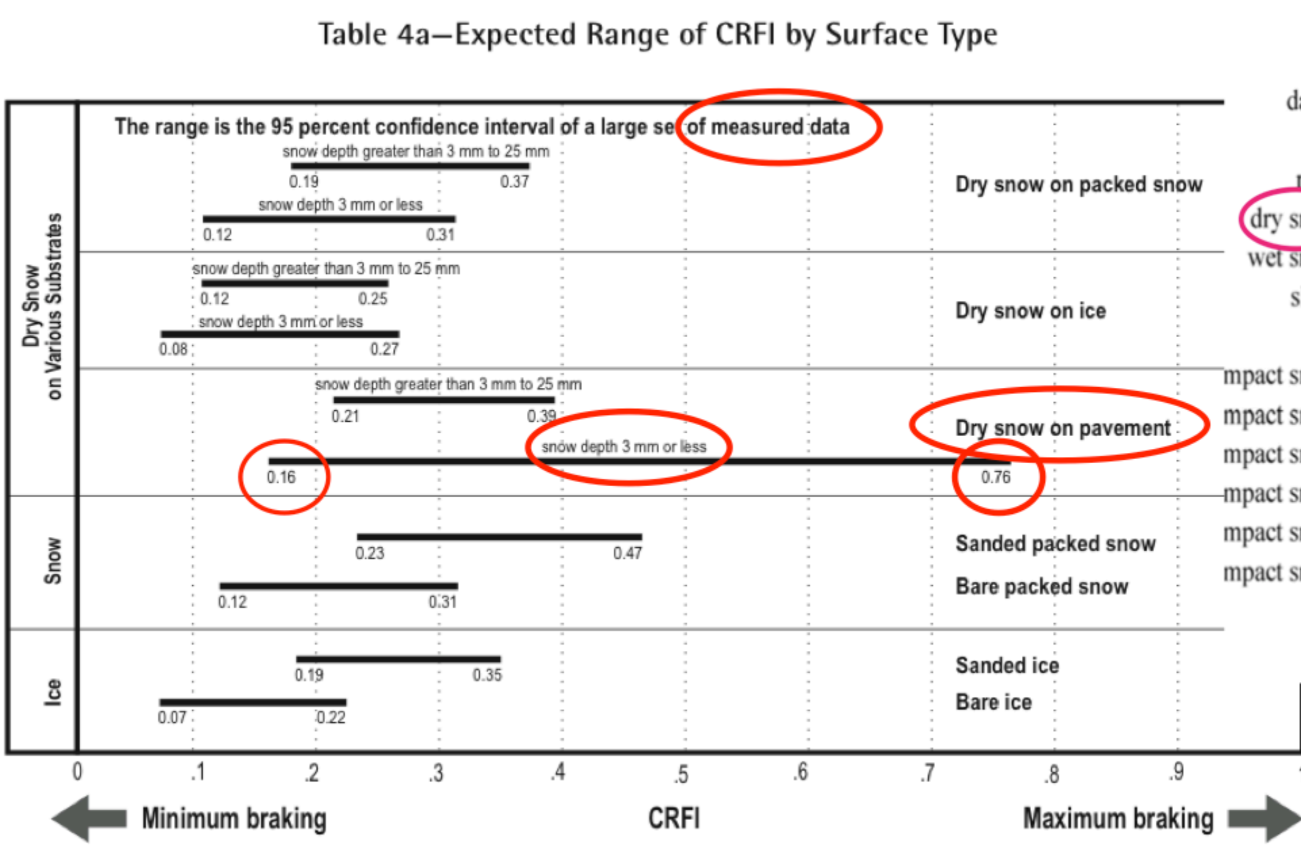
Computer driven wheel braking levels – ‘silent to Pilot’

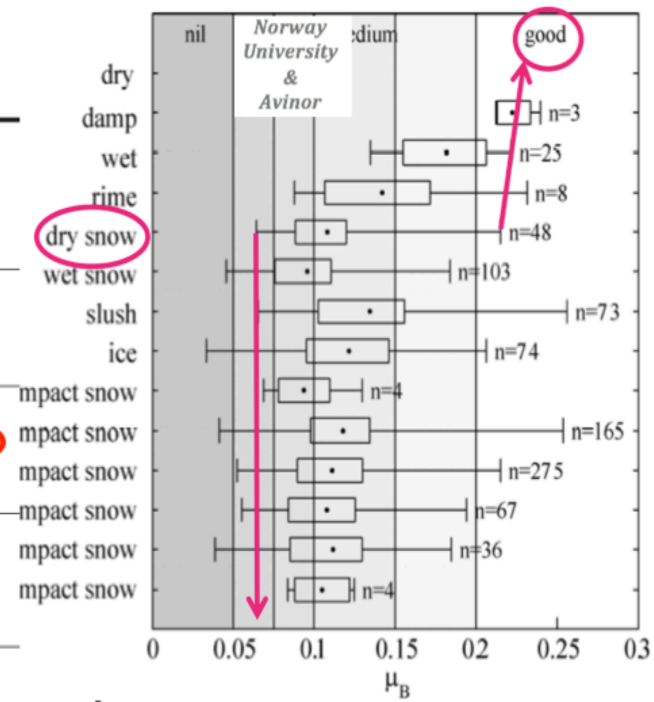
Realistically impossible for Pilot to separate the actual aircraft ‘Braking Action’ from infinitely variable and additionally, subjective feel of aeronautical braking from spoilers, flaps, RTs, plus impingement and contaminant drag.

Challenge #3 'Observables'

Observables like snow depth, type and coverage are good indicators of what a Pilot can expect to 'see' on a runway.

Observables are not sufficient by themselves to predict directional stability or stopping distances required.

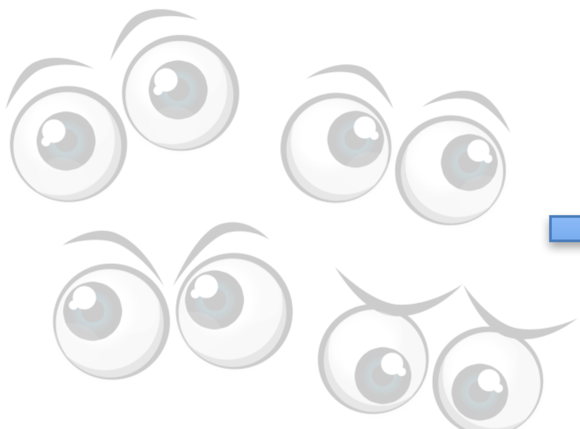




~.08ü (NIL) to .76ü (GOOD)

Possible Solutions
New Technologies

How might we go from just ‘See? RCRs’,
to “See?, Steer?, Stop?, RCRs



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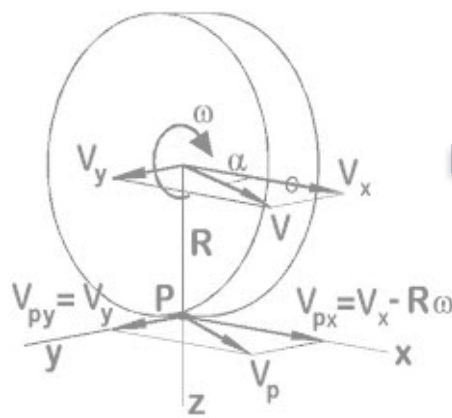

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$Mü_{ACB}$

Observables

Friction Braking/Steering Ellipse
(Training)

Max Manual Aircraft Braking

Some* In-Aircraft Technologies

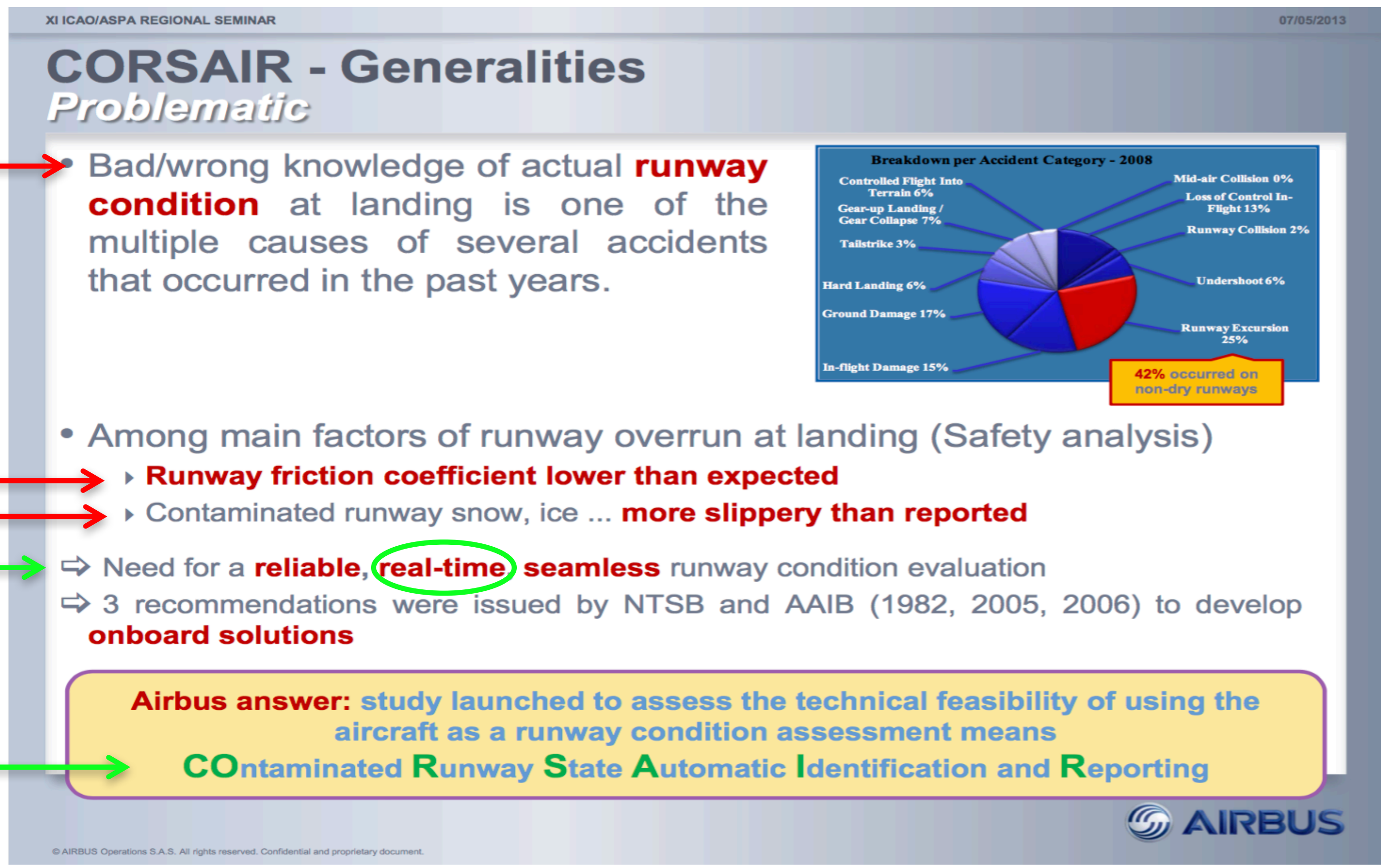
- Airbus: ROW, ROPS, BTV, Corsair
- Boeing: SAAFER
- AST: SafeLand
- Team Eagle: BAT Lite
- Zodiac: BASS
- All of these are ‘in-aircraft’ technologies that measure actual* aircraft deceleration and/or aircraft wheel braking achieved

In-Aircraft Technologies

.... and why:

AIRBUS

Cockpit
Real Time Landing Prep √
Real Time ROWs √
Mitigation callouts √



Ground Vehicle RCR Technology

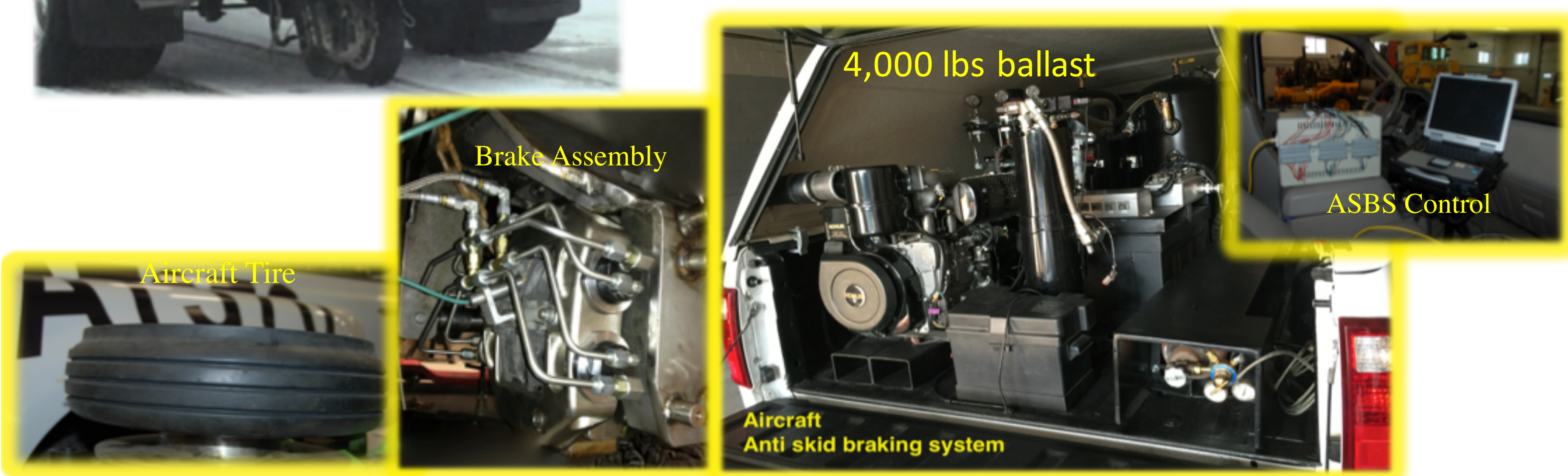
New technology tests for actual aircraft maximum anti skid braking availability.

‘Can I safely stop this aircraft?’

Ground Vehicle RCR Technology

Schematic description:

- Aircraft Tire
- Ballasted Mass Transfer
- Emulative aircraft wheel braking assembly
- Aircraft ASBS
- ASBS algorithmic computer control



Ground Vehicle RCR Technology

- Applies Maximum Manual ASBS braking forces to the wheel
- Sensors continuously measure weight on tire patch and in-situ maximum ASBS braking force generated over the entire length of runway.

In thirds: avg a = avg f ÷ avg m over 1st 2nd and 3rd section of runway

Ground Vehicle RCR Technology

Contaminant Drag

Since the technology measures total longitudinal deceleration forces, as well as ASBS braking forces, the technology can also provide departing Pilots contaminant drag values for take off performance calculations.

Ground Vehicle RCR Technology

- This technology also includes a separate FAA approved CFME FT
- The CFME is used to evaluate the real time effectiveness of any underlying de-icing chemicals and surface interface conditions
- This SA reduces over-application of chemicals and helps make this technology a *revenue positive* consideration for many airports

Ground Vehicle RCR Technology

For wet runways:

*PPP

Remaining Challenges

Our ground and aircraft braking availability technologies can only report what is found where they touch the runway.

Maximum ASBS braking availability is only known to aircraft systems where more braking has been asked for than our braking system has delivered.

The veracity of RCRs can change quickly over time.

Summary

1. Our new TALPA RCAM RWYCC formats acceptably describe what the Pilot will SEE.

2. New ground and aircraft braking sensing technologies will see maximum wheel braking available comprehensively and where asked for respectively, identifying both directional stability and Pilot's ability to stop the aircraft. STEER & STOP

3. After ground vehicle based RCR for first plane, aircraft based systems may sense and update deteriorating conditions over time if more braking is asked for than delivered. Updating or validating GBV RCR.

Recommendation

We now have the technologies to advise our Pilots what they will see as they approach, if they will be able to steer, and how much of the runway in front of them they will need to stop.

We suggest the most practical way to take advantage of these technologies would be to add a column to our TALPA RCAMs, for downgrading only, and only populated when available, titled and described as maximum aircraft braking available. **Max Mü$_{AC}$**

When a Max Mü$_{AC}$ technology has been approved or certified by a State. Transport Canada and the FAA are completing operationalization testing and a CRDA respectively on the ground vehicle unit.

In contaminant:
Only when maximum manual ASBS braking has been asked for and a Max Mü$_{AC}$ has been noted, value entered here for possible downgrade only.

TABLE 1-1. OPERATIONAL RUNWAY CONDITION ASSESSMENT MATRIX (RCAM) BRAKING ACTION CODES AND DEFINITIONS

Airport Operator Assessment Criteria		Control/Braking Assessment Criteria		
Runway Condition Description	**Code**	Max Mü$_A$	**Deceleration or ectional Control Observation**	**Pilot Reported Braking Action**
• Dry	6		---	---
• Frost • Wet (Includes damp and less than 1/8 inch depth of water) ***Less than 1/8 inch (3mm) depth of:*** • Slush • Dry Snow • Wet Snow	5	>.40	g deceleration is normal e wheel braking effort AND directional control is normal.	Good
-15ºC and Colder outside air temperature: • Compacted Snow	4		king deceleration OR onal control is between Good and Medium.	Good to Medium
• Slippery When Wet (wet runway) • Dry Snow or Wet Snow (any depth) over Compacted Snow ***1/8 inch depth or greater of:*** • Dry Snow • Wet Snow ***Warmer than -15ºC outside air temperature:*** • Compacted Snow	3	>.30 ≤.40	king deceleration is eably reduced for the raking effort applied OR nal control is noticeably reduced.	Medium
1/8 inch depth or greater of: • Water • Slush	2	>.20 ≤.30	king deceleration OR onal control is between Medium and Poor.	Medium to Poor
• Ice	1	>.10 ≤.20	king deceleration is icantly reduced for the raking effort applied OR rectional control is gnificantly reduced.	Poor
• Wet Ice • Water on top of Compacted Snow • Dry Snow or Wet Snow over Ice	0	≤.10	deceleration is minimal -existent for the wheel ing effort applied OR nal control is uncertain.	Nil

Operational RCAM Version 2014.1

Note: The unshaded portion of the RCAM is associated with how an airport operator conducts a runway condition assessment.
Note: The shaded portion of the RCAM is associated with the pilot's experience with braking action.
Note: The Operational RCAM illustration will differ from the RCAM illustration used by Airport Operators.

Thank you!

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