Summary: Agenda for Presentation

- Information-Gathering
- Other Initiatives (TALPA ARC; ICAO FTF; French DGAC)

Conclusions and Recommendations Regarding:

- Taxonomies and Definitions
- Runway Condition Reporting
- Functional Friction
- Operational Friction

Summary: Information Review

- Questionnaires and Some Personal Contacts
- Other Initiatives (TALPA ARC; ICAO FTF; French DGAC)
- References and Documents

Type	Type of Organization	Number of Contacts	Number of Responses
Functional Friction	Civil Aviation Authorities	14	6
	Airports	45	15
Operational Friction	Civil Aviation Authorities	13	6
	Airports	39	16
	Air Carriers	23	12
	Aircraft Manufacturers	6	3
	Associations	3	0

Other Initiatives

- TALPA ARC - Led by FAA with Wide Representation
  - Holistic Approach from Runway Inspectors to Pilots Using the Data
  - Developed Runway Condition Assessment Table
  - Friction Measurements Downgraded in Significance - Primary Focus is on Defining the Runway Surface Condition
  - If Implemented, This Would Lead to Significant Changes in the Current RCR Format and Approach
  - Offers Potential to Simplify RCR as Only 7 “Codes” Identified

- ICAO FTF
  - Agreed that Common, Global Reporting Format is Required
  - Still Discussion Regarding Most Appropriate Path to Reach This, Including Role of Ground Friction Measurements
  - May Need to Have 2 Sets of Definitions – One for Aircraft Performance & Another for Runway Inspectors

- French DGAC
  - Extensive Questionnaire Survey – Supported Results from RuFAB

Options for Harmonization of Taxonomies

Several Options:

- Maintain Status Quo – Not Suitable

- Most Feasible/Logical Approach is Based on Aircraft Performance
  - TALPA ARC Approach is Logical
  - Incorporate Different Criteria for Definitions Related to Aircraft Performance (Need to be Quantitative) versus Runway Surface Inspections (Need to be Simple for an Operational Environment)

- Taxonomies Used for Investigation of Aircraft Incidents and Accidents:
  - Quite General and Not Suitable for RCR
  - Won't Provide a Logical Way Forward

Basic Definitions

<u>Runway State and What Constitutes a Contaminant:</u>

- Aviation Community Trending Towards a 3-Point Scale
  - Dry, Wet, and Contaminated

- Wet – Definitions are Essentially Equivalent

- Contaminants – Only Significant Difference Is:
  - Which Ones are Specifically Named; and How to Deal with the Others?
  - Sanded Surfaces, or Sand; Ice Control Chemicals; Layered Contaminants; Others

- Damp – Needed? Damp Would be Considered to be Wet, BUT:
  - Various Aircraft Performance Standards Require Definition for Damp

Challenges & Issues for RCR

Parameters That Should be Reported:

Parameter	Comments in relation to SNOWTAM Form
Contaminant type	Contaminant list included in the SNOWTAM BUT the contaminants in the list are not fully defined, or aligned with other reporting requirements.
Contaminant depth	Included in the SNOWTAM
Contaminant location	Not included in the SNOWTAM
Contaminant spread (i.e., the area coverage of the contaminant)	Not included in the SNOWTAM
Cleared width - also termed maintained path width	Included in the SNOWTAM
Offset of the maintained path from the runway centreline	Not included in the SNOWTAM
Surface temperature	Not included in the SNOWTAM. Would be an added requirement from the TALPA ARC recommendations.

BMT Fleet Technology

Challenges & Issues for RCR

Accuracy That is Required :

- Little Information Available – Made Recommendations

Measurable Parameter	Suggested Minimum Accuracy
Runway maintained path	0.5 m
Offset of the runway maintained path from the centreline	0.5 m
Contaminant surface distribution as a percentage of each third of the entire maintained path	10%
Contaminant surface distribution as a percentage of the entire maintained path	10%
Runway full width and maintained path contaminant depth - liquid	1 mm
Maintained path contaminant depth - dry (loose) snow	2 mm
Maintained path contaminant depth - wet snow	1 mm
Maintained path contaminant depth - slush	0.5 mm
Contaminant type differentiation	Liquid, slush, wet snow, dry snow, compact snow, ice, frost, sanded (gritted) ice, sand (grit), ice control chemical (liquid, prill or granular)
Windrow maximum height	≥ 5 cm
Windrow maximum width	≥ 10 cm
Contaminant boundary location	± 3 m

Challenges & Issues for RCR

What Constitutes a "Significant" Change?:

- Little Information Available – Made Recommendations

Measurable Parameter	Estimated Change in Condition
Maintained path width	≥ ± 3m
Offset of the maintained path from the centerline (if any)	≥ ± 3m
Contaminant type	Reclassification of ≥ 10% of reportable path surface
Contaminant depth	≥ ± 10%
Contaminant location	≥ ± 100m for ≥ 25% of contaminant deposition
Contaminant spread	≥ ± 10%
Friction measurement	≥ ± .05 of measurement scale (μ, g, etc.)

Challenges & Issues for RCR

Formats and Specific Definitions:

- Reporting Format – ICAO SNOWTAM Should be Updated – Produced Recommendations

- Frost:
  - Very Significant Contaminant for Aircraft Performance (Based on TALPA ARC)
  - Only One Definition Available for It (Canada)
  - Made Recommendations Regarding This

- Present Definitions Contain Mix of Scientific/Quantitative and Descriptive/Qualitative Terms:
  - Scientific/Quantitative: Measurable and Repeatable; Needed in Various Standards for Aircraft Performance Assessments
  - Descriptive/Qualitative: Feasible for Use at an Active Airport

- Produced Table of Recommendations with 2 Sets of Definitions

Challenges & Issues for RCR

<u>"Summer" Vs "Winter" Reporting:</u>

- Not Possible to Divide by Season:
  - Frozen Contaminants Can Occur in Summer
  - Liquid Contaminants Can Occur in Winter

- ICAO Categorizes Reporting by Type of Contaminant, Not by Season
  - 2 Formats: NOTAM and SNOWTAM

- But RCR Varies – Typically Formal Procedures (Snow Plans) in Place for Winter; Summer RCR is Essentially Ad-Hoc

- Issue Should be Addressed

Challenges & Issues for RCR

Layered Contaminants:

- Runway Inspectors Report “What They See”
- Many Cases Possible in Practice; Only Limited Number Defined at Present (e.g., TALPA ARC)
- Friction Measurements Would Identify Slippery Conditions Produced by Layered Contaminants
- Recommendations Made in RuFAB Project Regarding Categories for Layered Contaminants

Challenges & Issues for RCR

How to Observe or Ideally Measure the Required Parameters?:

- No Off-The-Shelf Technology Presently Available – Parameters Estimated Visually at Present at Airports

- Research Being Done for Highways that Should be Monitored
  - Not Mature – Needs Further Development
  - Contaminant Depth is Most Difficult Parameter to Measure Remotely

Findings: Functional Friction Assessments

General Synopsis - Standards are Not Consistent Among States:

- Almost All Countries Have Criteria Based on Friction Measurements
  - Specify Maintenance Planning and Action Levels
  - May Specify Design Objective for New Pavements

- Norway is Only Exception w/r to Friction – Recently (July, 2009) Instituted Standards Based Only on Pavement Texture and Geometry Characteristics

- ICAO:
  - Most Countries Follow ICAO to a Limited Extent
  - Device Equivalency Table is Out of Date

- Significant Variations Among Countries With Respect to:
  - Device(s) Used – Typically Only One Allowed, but up to Three
  - Measurement Tire(s) Used
  - Water Film Depth(s) Used
  - Test Speed(s)

Findings: Operational Friction Measurements

General Synopsis - Divergence of Views:

- Present - Range of Practices w/r to Friction Measurements:
  - Reporting Friction: Some Countries Report the Values (Some Under Regulation) and Others Only Provide General Information
  - No Common Approach for Using This Information
- General View That Friction Readings Do Not Correlate With Aircraft Performance in Many Conditions, and/or Correlate Well
- TALPA ARC – Recommended that Friction Measurements be De-Emphasized and RCR be Re-Focussed on Runway Surface Condition
- ICAO FTF – Consensus Not Reached, But Agreed That a Common Reporting Format is Required

Findings: Operational Friction Measurements

General Synopsis - Divergence of Views:

- Devices Not Suitable for All or Many Surfaces
  - General View That Devices Can’t Provide Data on All Surfaces

- No Requirement to Relate Aircraft Performance to a Friction Index

- Some Airlines Use Friction Measurements for Performance Assessments; Others Don’t

Summary of Recommendations for EASA

- Monitoring of Other Initiatives
  - TALPA ARC – Supporting Documentation; Recent Field Trials
  - ICAO FTF
  - French DGAC Study
- Fundamental Decision Required Regarding Role of Friction Measurements – View of Project Team is That:
  - Friction Measurements are Valuable Potentially BUT
  - Changes are Required w/r to the Present Devices and Approach
- Taxonomies and Definitions
  - Recommendations Provided in Project
  - Should be Assessed Through Consultation with Users

Summary of Recommendations for EASA

- Training
  - Pilots – How to Use and Interpret Runway Condition Reports
  - Runway Inspectors – Certification Requirements; Common Training Courses to Harmonize RCR

- Technologies For Measuring the Runway Surface Condition
  - Ideally, This Should be a Joint Effort
  - There is a Need for Technologies to Measure Rather Than Observe the Surface Conditions
  - These will be Especially Required if Current Trends are Maintained
  - EASA Should Monitor, and Perhaps Foster the Development of These Technologies

Functional Friction Assessments

Work Included:

- Review of Friction Measuring Devices
- Methods for Scientific And Technical Harmonization
- Alternative Methods for Functional Friction Assessments
- Recommended Stepwise Procedure for Harmonization of Devices
- Investigated Updating the Device Equivalency Table (Table A1) in ICAO Annex 14, Volume 1

Functional Friction Assessments

<u>Review of Friction-Measuring Devices:</u>

- Basic Types: Fixed-Slip; Side-Force; Variable Slip; Locked Wheel
  - Fixed-Slip & Side-Force Commonly Used at Airports

Functional Friction Assessments

Review of Friction-Measuring Devices Cont'd:

- Within these Types, Many Variations in Design Parameters - Variations Include:
  - Braking Slip or Side Force Angle – Numerical Models Available to Account for Effect of these Variations
  - Derivation of Friction Coefficient; Tire Inflation Pressure; Tire Parameters; Self-Wetting System – Understand the Phenomenon But Usable Numerical Models Not Available

- Net Result & Conclusion:
  - Different Readings from the Different Devices
  - Only Braking Slip and Slip Angle Variations Can be Accounted For With a Model
  - Would Need to Standardize the Other Parameters for Harmonization

Functional Friction Assessments

<u>Review of Friction-Measuring Devices Cont'd:</u>

- Quality Issues Regarding the Devices' Technical Performance
  - Time-Stability: Results Vary from Year to Year
  - Single Device Repeatability
  - Device Family – Different Readings from Different Devices of the Same Device Family

- Significance for Harmonization:
  - Quality Issues Can Not be "Corrected For" In a Harmonization Process
  - Device Quality Problems Have to be "Filtered Out" with a Stringent Quality Control Process

Functional Friction Assessments

<u>Previous Harmonization Attempts:</u>

- More than 14 Different Attempts in Last 20 Years (IFI, EFI, IRFI, ESDU, etc)

- All Had Some Success But The Results Were Inadequate for Harmonization:
  - o Uncertainties in the Measurements Themselves
  - o Inadequacies in the Models

- Uncertainties in the Reference
  - Reference Device – Device Not Stable
  - Reference Surface – Surfaces Change

- Net Result: Generally-Accepted Model/Approach for Harmonization is Not Available

Functional Friction Assessments

Alternative Methods:

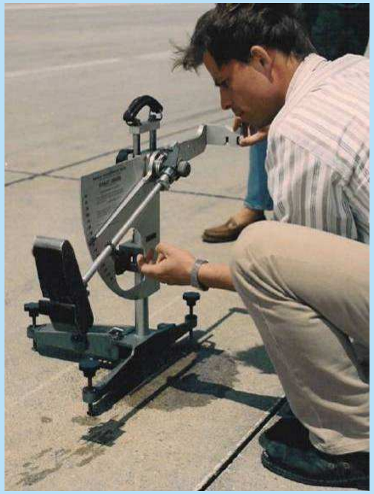
- Theoretical Approach Based on Pavement Micro- and Macro-textures – Limitation is that There is No Efficient Way to Measure MicroTexture
- Aircraft-Based Measurement Approach: Proof-of-Concept Developed but is in the Early Stages – Presently Being Trialed at an Airport
- Criteria Based on Pavement Texture and Geometrical Properties: System has Been Implemented in Norway (July, 2009) – Should be Monitored
- Other Methods (Accoustical; Optical; From Other Tribology Applications) – Nothing Usable Now But Should be Monitored
- Net Conclusion: Friction Measurements are the Only Proven Method at Present

Functional Friction Assessments

<u>Recommended Stepwise Procedure</u> – Various Steps & Checks:

- Establish Quality Criteria for the Devices & Screen Them - Time-Stability, Repeatability & Reproducibility – Recommendations in Report

- Establish Reference for the Calibrations and Harmonization:
  - Small Scale (0.6m x 0.6m) Surfaces – Texture and Friction Checked and Measured Using the DF Tester & CT Meter



- Recommendation:
  - Should be Tried Out

Functional Friction Assessments

Updating the Device Equivalency Table in ICAO Annex 14, Volume 1:

- Only Established Harmonization Methods (ESDU; IFI) Would be Suitable as a Basis for Updating the Table
- Due to a Lack of Time Stability for the Devices, Any of these Methods Would Produce Significantly Different Values From Year to Year
- Net Conclusion: Not Recommended to Update it Now

	Minimum	Maintenance	Construction	New Grooved
SFT-TC79-E1551-100 (2000)	0.32	0.40	0.56	0.62
SFT-TC79-E1551-100 (2001)	0.46	0.54	0.72	0.79
SFT-TC79-E1551-100 (2003)	0.50	0.55	0.70	0.76

Summary of Recommendations for EASA

<u>Functional Friction Assessments:</u>

- Objective of Harmonization – Correlation Among Devices, or to Aircraft?
  - Propose That it is Limited to Just Among Devices

- Testing, Procedures and Specifications – Ideally as a Joint Effort with Others
  - Develop Agreed Standards (Quality Control, Testing Protocols, etc)
  - Establish Frequent Testing Program with Devices to Ensure Compliance to Quality Standards

- Reference for Calibration and Harmonization - Ideally as a Joint Effort
  - Develop Standard Surfaces & Reference Friction & Texture Values
  - Conduct Trial Calibration/Harmonization Program

- Updates to ICAO Device Equivalency Table – Joint Effort
  - Establish Updated Values for Table

Operational Friction Assessments

<u>Issues Affecting the Application of Friction Measurements:</u>

- Regulatory Framework
- Technical Performance of the Devices
- Complexities Regarding the Friction Measurement Process
- Lack of High-Level Criteria for Friction-Measuring Devices

Issues

<u>Regulatory Framework:</u>

- Aircraft Certification – Requirements Vary Among Regulators:
  - FAA: Dry and Wet
  - EASA: Dry, Wet, Ice, Snow, Slush and Standing Water

- Operational Assessments of Aircraft Performance:
  - Regulators: Must be Checked at Takeoff but a Check at Landing is Not Required – Intended to be Addressed by Updates to Regulation
  - Airlines: Use Various Methods to Define Aircraft Performance

- No Requirement to Specify Aircraft Performance in Relation to a Friction Index

- Net Result: Friction Indices Generally Not Included in the Regulatory Framework, With a Few Exceptions (e.g., Canada & CRFI)

Issues for Using Friction Operationally

Technical Performance of the Devices:

- Devices Give Different Readings on the Same Surface

- Operational Limitations with all Devices (e.g., Stated in AIPs):
  - Devices Generally Suitable for “Solid-Type” Surfaces (Compacted Snow, Ice)
  - Devices Generally Not Suitable for “Fluid or Fluid-Type” Surfaces (Wet, Slush, Wet or Loose, Thick Snow)

- Quality Issues: Time-Stability; Repeatability of a Device; Repeatability and Reproducibility of a Device Family

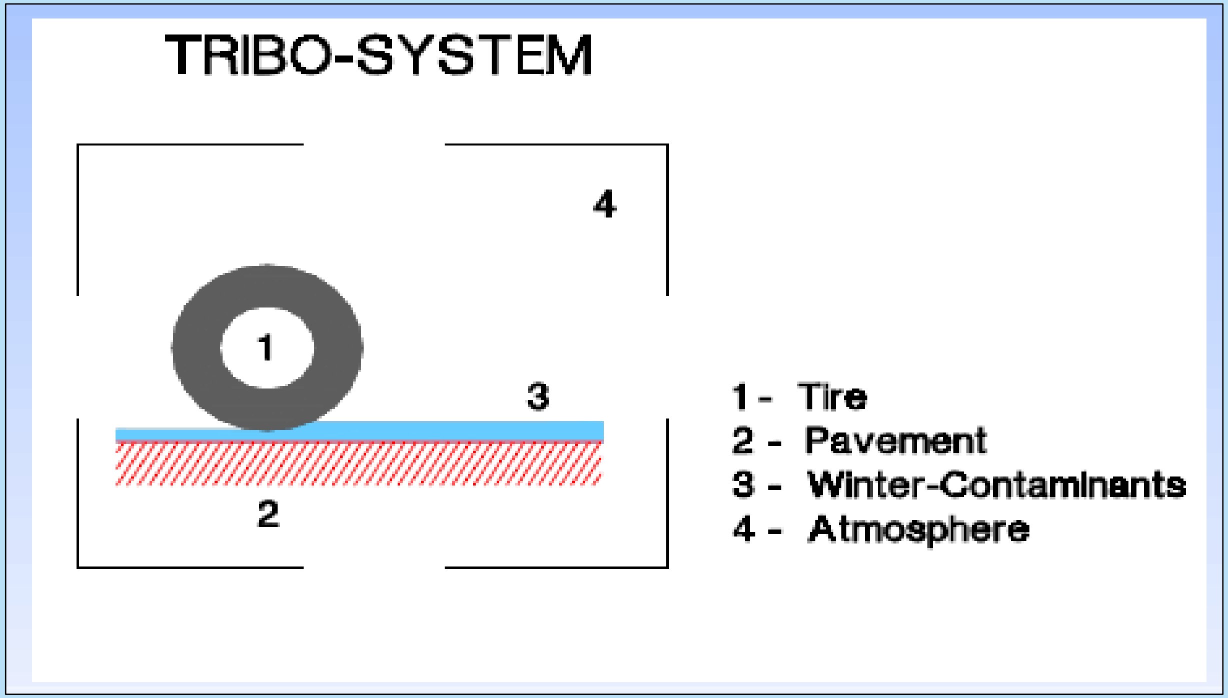
- Practical Limitations: Limited Time Available for Surveys; Non-Uniform Conditions; Conditions Can Change Rapidly With Time

- Net Result: Devices Can’t Provide Reliable Data in Many Cases of Concern

Issues

<u>Complexities Regarding Friction Measurement:</u>

- Friction is a “System” Measurement – Depends on the Tire, the Surface, the Pavement, the Meteorological Conditions



Issues

Complexities Re: Friction Measurement – Different Processes:

- Material on Surface May Fail, e.g. By Shear – Ice & Packed Snow
  - Results Vary With Contact Pressure and Vertical Load

- Properties of Material on Surface May Change
  - e.g., “Dry” Snow May Become “Wet” in the Tire Contact Zone

- Tire Pressure Variations Between Devices, and/or Aircraft Tires:
  - e.g., Pressure Effects Affecting Degree of Expulsion of Fluid in Tire Contact Zone

- Contaminant Drag – Affects Different Devices Differently

- Hydroplaning, for Liquid Contaminants – Affects Different Devices Differently

- Net Result – Different Trends for Different Devices And Aircraft

Issues for Friction Devices

Lack of High-Level Performance Criteria:

- Historically, Have Mainly Attempted to Apply Existing Devices (for Functional Measurements) to Operational Friction Applications
  - o Result: Correlation is Coarse Between Devices and Aircraft

- Devices Developed Using Best Judgments But, Criteria Not Available to Guide Manufacturers to Get Good Correlation With Aircraft
  - Measurement Principle (Fixed-Slip, Side Force, etc) & Sensing Approach (Torque vs Force, or Both; Contaminant Drag)
  - Tire Design & Properties – Need to Have an Aircraft Tire?
  - Tire Parameters – Vertical Load, Contact Pressure, Inflation Pressure
  - Slip Ratios and Speeds That Are Required
  - Requirement for an Anti-Skid System, That Emulates an Aircraft Anti-Skid System?

- Net Result – Clear Guidance Not Available to Produce Better Devices

Summary of Recommendations for EASA

Operational Friction Assessments:

- Fundamental Decision Needed Regarding Role of Friction Information

- Fresh Approach is Needed – Opinion of Project Team That Friction Measurements are Potentially Valuable But Improvements Required

- Friction-Measuring Devices – Ideally, as a Joint Effort With Others
  - Develop High-Level Criteria for Devices
  - Consultation With Users and Regulators
  - Research & Testing to Develop High-Level Criteria
  - Consultation With Device Manufacturers

Summary of Recommendations for EASA

Runway Condition Assessment, Measurement and Reporting:

- Fundamental Decision Needed Regarding Type & Focus of Information
- Improvements Required? For Example, Depths, Surface Temperature
- Numerous Recommendations Regarding Reporting Format, How to Define Parameters (Depth % Cover, etc), Auditing, Human Factors & Ensuring Adequate Time and Access for Runway Inspections

Other Recommendations – For Others or For Collaboration With Others

Recommendations:

- Updating of ICAO Documents
- Updates to ICAO SNOWTAM
- Functional Friction Harmonization Trials
- High-Level Criteria for a Friction-Measuring Device
- Technologies for Measuring the Runway Surface Condition