客觀評估

一項發展中之機上系統將可使航空公司飛行員得以預期跑道道面情況及剎車能力。

歐文 譯

科技進步及航空業之飛安努力已顯著減少商業航空運輸失事事件，但一般跑道安全相關事件及跑道偏離事件則仍持續不斷。如何正確地評估跑道道面條件及剎車能力，並未如同其他類別失事事件之影響因素一樣獲得科技上的相同重視。本文提供發展中之機上系統的最新進度，該系統可於降落滾行初期截取參數進行即時分析，同時結合儲存之飛機降落性能資料，然後應用演算，協助飛行組員客觀瞭解實際跑道情況，並正確評估飛機之剎車能力。

這項資訊可能的顯示模式包括即時整合至飛行作業/飛機調度者追蹤工具，現有降落分析系統，及直接通知飛行組員等三種。

西南航空第1248班機於2005年12月的一個下雪夜晚在芝加哥Midway國際機場降落時衝出跑道，並成為報告污染跑道剎車能力缺失之案例。此次失事事件中波音737-700客機衝出試車防護柵欄和機場圍牆，造成一位汽車內年輕乘客死亡，並因此成為業界幾項主動作為與重新省思之觸媒。

世界飛安基金會已一再處理跑道安全議題，並於2009年減少跑道偏離風險一文中建議:應該發展一套通用、簡易之跑道情況報告系統以降低跑道偏離之風險。

美國NTSB在第1248班機失事報告中建議，美國FAA為運輸類飛機進行一項技術及運作可行性展示，期能為飛機裝配可計算、記錄及傳送剎車能力之裝備與程序，讓飛機在降落滾行中慢下來或停下來。

在與聯合航空合作下，Kongsberg航太公司已測試了類似NTSB失事報告中所提之機上系統，而這也是針對飛安基金會結論與建議之回應。這項裝配於聯合航空波音737機隊上之系統已和FAA威廉休斯技術中心(William J. Hughes Technical Center)合作執行驗證計劃。驗證已顯示Kongsberg航太系統展現預期成果。

為運輸類飛機加裝飛行資料計算剎車能力之系統似乎是一項直接了當的努力作為，但它不是。還有涉及使用簡易之技術及實務議題必須考量，包括:

・評估系統或模式之全面性;

・停止距離之指南內容建議資料之適用性;

・資料蒐集、飛行資料完整性與機密性。

有關全面性，降落滾行是一個多重因素的動態過程，包括不同階段中影響飛機剎車能力之環境條件。光要挑出與輪胎表面介面相關之剎車因素就是一個錯綜複雜任務。

解決這項挑戰之可能科學方法就是運用數學計算，

以模仿在確定環境條件下之降落滾行及其所有構成因素。然而，這不是一個實際可行的解決辦法，因為創造一個可含蓋所有變數及評估各因素間之關聯性將是一大挑戰。再者，即使能夠獲得所有需要之輸入參數，輸入參數之所需品質也是一項困難。

任何評估系統或模式之目標應是掌握降落滾行時之停止能力的本質，以配合飛機製造商所提供之停止距離指南資訊的運用。

至於適用性，航空公司之停止距離運作評估主要係依據飛機製造商之指南資訊。這些資訊儲放於快速參考手冊、飛行組員操作手冊及飛行計畫與性能手冊中。舉例而言，波音公司將其飛機之剎車係數及相關剎車動作種類分成乾、好、適中、及差等四個等級，並提供相應之降落距離。這符合FAA的起飛/降落性能評估航空規則訂定委員(TALPA ARC)之建議作為，但TALPA ARC則更要求另外兩個等級，包括「好至適中」與「適中至差」。雖然指南資訊詳細記載停止距離到呎為止，但必須瞭解的是資料並非絕對的，因為它們係依據經驗數據及資料推算而來。

因此，為模式提供輸入資料使其精確度超過飛機製造商指南內容將毫無意義。

至於資料蒐集，因為航空公司與飛行員工會間之協議嚴格規範飛行資料之運用，因此管理飛行資料之完整性、機密性及其架構很重要。當飛行資料換手並以全部或部分交至第三方時，資料有可能遭到更改及有意或無意的違反保密規定。任何減少飛行資料轉換之努力無論是完整性及保密性都是值得爭取的。

夥伴關係之開始

營運商飛行操作品保團體於2010年在大陸航空(自從與聯合航空合併)啟動一項剎車行動測試計劃，並與提供737測試機所需演算之Kongsberg航太系統合作執行。這項以透過機上計算獲得剎車動作資訊為目的之計畫很快就予以簡化並從原始資料消除動態噪音。

剎車動作測試之初期結果有助於確認2013年飛安世界Aero Safety World雜誌刊出之操作安全動作項目。因此聯合航空所有737NG飛機均載入這項測試資料，目前Kongsberg航太系統每天從機隊之每架次中取得資料。這是存放於飛機情況監視系統(ACMS)軟體之唯讀系統，運用先前降落之飛行資料計算出最大剎車能力。在每次降落滾行結束時，只有經計算之剎車動作資訊會以無法辨認模式傳送至地面站台作為研究之用。因此傳送之資訊無法反映飛行員之技巧與飛行技術。

在運用了簡化版本之波音飛機剎車係數計算後，機上原型系統偵測出摩擦限制剎車情況，也就是增加剎車壓力時已無法增加減速效果，這就是最大剎車能力點。剎車能力/剎車動作評估亦符合製造商指南資訊/建議資料。

與FAA合作

根據737初期測試所顯現之可喜成果，FAA技術中心與Kongsberg航太系統於2012確立了一項合作研究發展協議，以共同評估即時剎車動作資訊之運用與跑道滑溜情況報告。這項研究將協助FAA終端區域安全研究計劃，以調查降落飛機之飛行資料是否能正確及適時提供跑道滑溜之評估，以預防跑道失事事件。

現有系統無法蒐集先前所提飛機降落滾行之動態情況，但仍能蒐集降落滾行之本質，提供相關及明確資訊，也就是等於強化了飛機製造商所提供之降落距離建議資料的輸入參數品質。合作研究發展協議之本質係在分析討論幾項不同於傳統上以科學方式執行並完全模仿降落滾行之系統特性。這些特性包括:

・運用跑道的一部分;

・簡化環境條件;

・跑道坡度之影響;及

・轉換至其他飛機之可行性。

為了能在驗證過程中更清楚瞭解這些方面，進行以下簡短討論：

部分跑道

飛行組員是否需要考慮跑道全長或部分跑道以評估剎車能力？誠如所提，其他剎車因素中與輪胎表面介面有關之不同減速力量相當複雜。在實際降落滾行初期階段納入這項因素，剛開始聽起來學術趣味高於實務價值。然而，有數項支持此項作法之論點。

不管跑道道面情況如何或降落滾行初期剎車力道應用如何，飛行員在任何降落時都會覺得很棒，因為空氣阻力和反推力產生的減速會讓飛行員主觀感覺係踩剎車所致。當速度減至100海里以下時，就會感覺阻力效果減少。雖然在降落滾行中一直存在，但就實務而言，在地面速度較低時，可以忽略空氣阻力對減速之效果。

反推力的作用比較像是降落傘，而且在速度較大時作用較好。常見的做法是在飛機時速減至80至60海里時收回反推力器。因此，基於實務理由，在地面速度較低時，也

可以忽略反推力之減速效果。

冬天情況會產生輪胎摩擦熱，並在滾行結束前的整個降落滾行中因剎車動作減少而影響輪胎表面介面的狀況。這在積雪或結冰情況時特別明顯。事實上，在一些衝出跑道失事報告中，飛行員敘述他們感覺剎車動作在初期良好，但隨後變差。聯合航空737剎車動作測試計劃並未包括衝出跑道情況，但也從參與飛行員獲得類似報告，他們描述隨著降落滾行持續而心生跑道變滑溜的疑慮感。

這些測試顯示使用部分跑道進行即時評估能為飛行組員提供充足資訊，從本質上即時揭露剎車能力之關鍵環節。

表1

飛行員版本之矩陣			
剎車動作報告(飛行員報告)		相關跑道道面情況	跑道條件碼
名詞	定義		
乾		任何溫度:-乾	6
好	剎車減速在踩輪剎後正常。方向控制正常	任何溫度： -道面濕(平滑、開糟式或PFC跑道) 任何溫度及1/8(3.2mm)英寸或小於 -水 -融雪 -乾雪 -濕雪	5
好至適中	剎車減速與控制性介於好與適中之間	攝氏零下13度(華氏9度)或以下： -壓實雪	4
適中	剎車減速在踩輪剎後明顯降低。方向控制可能稍有降低	任何溫度： -濕(當跑道被報為濕時會滑溜) 攝氏零下3度(華氏27度)或以下及大於1/8英寸之 -乾或濕雪 高於零下攝氏13度或零下3度或低於: -壓實雪(任何深度，深度未報告)	3
適中至差	剎車減速及控制性介於適中與差之間。存在水漂之可能性。	任何溫度及大於1/8英寸 -水 -融雪 溫度高於攝氏零下3度 -1/8英寸及大於1/8英寸乾或濕雪。 -壓實雪(任何深度，深度未報告)	2
差	剎車減速在踩輪剎後有顯著降低。方向控制可能顯著降低。	攝氏零下3度或以下： -冰	1
無	剎車減速在踩輪剎後減至最小甚至沒有。方向控制無法確定。	任何溫度： -濕冰 -壓實雪上有水 -冰上有乾或濕雪 任何高於攝氏零下3度 -冰	0

PFC=透水孔摩擦道;PIREPs=飛行員報告
資料來源：Trond Are Johnsen

簡化環境條件

飛行組員需在詳細知道環境天氣情況與有能力及時間適切評估環境天氣情況之間有所權衡取捨。諸如氣溫、氣壓、風速及風向等內容之天氣情況報告僅能提供概略資訊，無法一直維持最新即時。風速及風向、氣壓等因素在飛機降落滾行減速時對停止能力之影響也同時降低。在降落滾行初始階段計算天氣情況影響會很複雜，而且很可能沒有用。理由是降落滾行末端提供了瞭解剎車能力之關鍵資訊。因此就Kongsberg航太系統而言，對環境天氣情況資訊蒐集之簡化作法已證明足夠。

跑道坡度通常也以建議資訊方式納入起降安全分析之環境條件考量中。然而，跑道坡度並不列入該系統之考量內，因為就實務理由，坡道並不重要。跑道坡度很少超過2%，而美國大部分機場之坡度小於1%。

飛機轉移性

剎車係數價值對所有種類尺寸飛機都一樣。這項原則已考慮在TALPA ARC建議中。不同尺寸之飛機在剎車動作時會有不同經驗值，儘管有相同客觀之跑道道面情況。這項分析不包括區間噴射機，但分析顯示飛機種類間，像是737系列與空中巴士320系列仍有共通性及轉移性。當律定類似剎車動作情況及使用飛機製造商指南內容來比較預估之降落距離時，兩種系列飛機有明確之相似處。

飛行員報告及回饋為剎車行動測試計劃初期階段之一部分內容。飛行員評估Kongsberg航太系統所偵測剎車動作情況小於好的狀況。降落資料及其回饋揭示了與實際天氣情況一致，顯示系統達到預期成效與目的。

作為目前第二階段驗證過程之一部分，FAA與麻州大學及一個研究團隊一起執行一項廣泛分析，從系統之資料評估當時天氣情況與剎車能力間之關係。

由於滑溜跑道並非僅為冬天問題，因此分析包括了熱帶地點之機場。分析基礎為聯合航空737機隊一年資料，並配合系統計算之飛機剎車動作數字。查閱歷史氣象資料以獲得每個機場每次有摩擦限制剎車條件之降落的日期與時間之當時天氣。

簡而言之，除非飛機製造商可以為任何不同之跑道情況演算出經確認完美的降落/停止距離，否則航空業之主要目標必須是發展符合指南內容與建議資料之系統。根據TALPA ARC矩陣(表1)目前這種建議資料之剎車動作分成六類。任何想要提供更高精確度之剎車能力資訊，也就是超越建議資料等級，將不符實務所需。然而，從飛機每次實際降落滾行中蒐集剎車係數之本質則可提供飛行員即時之資訊。

超越驗證

在航空業中，系統除非能把對的資料在對的時間提供給對的使用者，否則毫無價值。這需要有適當之使用者工具與介面的分配及整合方案。就聯合航空而言，後驗證活動涉及與簽派員工具之早期階段整合工作即將到來。Kongsberg航太系統之真正潛力在於統籌所有服勤中之飛機資訊，儘管從幾家大航空公司獲得資料應該已經足夠。有一個共同資訊庫可讓所有航空公司都受益。系統之力量就在於聚集所有收集之資訊。

儘管各航空公司之間在大眾旅行運輸業務上激烈競爭，但航空業在涉及安全議題上則已有長久之合作歷史。隨著有用之科技愈趨精進，現在正是透過各航空公司共同努力合作以期更精確有效地評估跑道道面情況與剎車能力之好時機。

譯自Aero Safety World November 2014

Objective Assessment

An on-board system in development would enable airline pilots to anticipate runway surface condition and braking capability.

TROND ARE JOHNSEN

Advances in technology and aviation industry safety initiatives have significantly reduced commercial air transport accidents, but runway safety related events generally, and runway excursions specifically, persist. Accurately assessing runway surface condition and braking capability have not received the same technological focus as contributing factors in other types of accidents. This article presents progress to date on an on-board system in development that would intercept flight data parameters for real-time analysis early in the landing roll, reference stored data representing the specific airplane's known landing performance and apply an algorithm that helps the flight crew to objectively recognize the actual runway condition and to accurately assess their airplane's braking capability.

Potential delivery modes for this information include near–real time "data push" inte-gration into flight operations/dispatcher flight following tools, existing landing analysis systems and directly informing the flight crew.

Southwest Airlines Flight 1248, which overran the runway while landing at Chicago Midway International Airport on a snowy night in December 2005, has come to exemplify the shortcomings in the reporting of braking capability on contaminated runways. This accident, which resulted in the death of a young passenger in an automobile that was struck by the Boeing 737-700 after the aircraft crashed through a blast fence and an airport perimeter fence, has served as a catalyst for several industry initiatives and renewed thinking.

Flight Safety Foundation has addressed runway safety repeatedly, and recommended in 2009's Reducing the Risk of Runway Excursions: Report of the Runway Safety Initiative that "a universal, easy-to-use method of runway condition reporting should be developed to reduce the risk of runway excursions."

The U.S. National Transportation Safety Board (NTSB), in its Flight 1248 accident report, recommended that the U.S. Federal Aviation Administration (FAA) "demonstrate the technical and operational feasibility of outfitting transport category airplanes with equipment and procedures required to routinely calculate, record and convey the airplane braking ability required and/or available to slow or stop the airplane during the landing roll."

In cooperation with United Airlines, Kongsberg Aeronautical has tested the prototype on-board system, similar to the one proposed in this NTSB accident report, and which also responds to the conclusions and recommendations of the FSF initiative. Installed on United's fleet of Boeing 737s, the system has been subjected to a validation program in cooperation with the FAA William J. Hughes Technical Center. The validation has shown that the Kongsberg Aeronautical system performs as expected and intended.

Outfitting transport category airplanes to use flight data to calculate braking ability may seem a straightforward undertaking, but it is not. There are technical as well as practical issues involving ease of use to consider, including:

- Comprehensiveness of assessment system or model;
- Applicability to guidance materials' advisory data for stopping distance; and,
- Data gathering, flight data integrity and confidentiality.

As to comprehensiveness, the landing roll is a dynamic process with a multitude of factors, including ambient conditions, contributing to the airplane's braking capability at different phases. To single out the braking factors associated with the tire-surface interface is an intricate task.

One scientific approach to this challenge might be to mathematically model and emulate the landing roll and all of its constituent factors for defined ambient conditions. It would hardly be a viable and practical solution, however, because it would be challenging to create a model capable of covering all of the variables and assessing interrelatedness of the factors. Furthermore, being able to obtain the required quality of input parameters would be difficult, even if all the needed input parameters could be acquired.

The objective of any assessment system or model should be to capture the essence of the landing roll, in terms of stopping capability, for use in conjunction with the stopping distance guidance information from the aircraft manufacturers.

As to applicability, airlines base their operational assessment of stopping distances primarily on airplane manufacturers' guidance, which is contained in the quick reference handbook, flight crew operations manual and the flight planning and performance manual. Boeing, for example, has classified its airplane braking coefficient and associated braking action categories as dry, good, medium and poor, and provided the corresponding landing distances. This complies with the FAA's Takeoff and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC) recommendation for an industry initiative except that the TALPA ARC called for two more intermediary categories — good to medium and medium to poor. Although guidance information details stopping distances down to exact feet, it is important to understand that the data are not absolute; they are based to an extent on empirical data as well as extrapolations.

Thus, providing data for input to a model at a level of accuracy beyond what is required for the aircraft manufacturers' guidance material would be meaningless.

As to data gathering, agreements between airlines and their pilot unions strictly govern the use of flight data; integrity, confidentiality and the framework for managing flight data are important. When flight data change hands and are transferred to a third party in full or in part, the data may become susceptible to compromise and breach of confidentiality, either intentionally or unintentionally. Any effort to reduce the amount of flight data subject to transfer is desirable in terms of both integrity and confidentiality.

Start of a Partnership

A braking action test program was launched at

Continental Airlines (since merged with United Airlines) in 2010 by the carrier's flight operational quality assurance group. The program's testing was conducted in cooperation with Kongsberg Aeronautical, which provided the algorithm that was adapted and uploaded into the Boeing 737 test aircraft. The program, which was designed to obtain braking action information through on-board calculations, was quickly streamlined and dynamic noise was eliminated from the source data.

Early results of the braking action test contributed to identifying operational safety action items, which were featured in AeroSafety World in 2013. Subsequently uploaded on all of United's 737NGs, the Kongsberg Aeronautical system now acquires data daily on every flight in this fleet. It is a "read only" system located within the aircraft condition monitoring system (ACMS) software and uses flight data from previous landings to calculate maximum braking capability. At the end of each landing roll, only the calculated braking action information, in deidentified form, was transmitted to a ground station for the research. The transmitted information therefore could not reflect on the skill and airmanship of the pilots.

Employing a streamlined version of the Boeing aircraft braking coefficient calculation, the on-board prototype system detects friction-limited braking situations — situations in which increased brake pressure does not yield increased deceleration, which is the point of maximum braking capability. Braking capability/braking action assessment also is aligned with the guidance material/advisory data for landing distance from the manufacturer.

Cooperation With FAA

Based on the promising results demonstrated through the early 737 tests, the FAA's technical center established a cooperative research and development agreement (CRDA) with Kongsberg Aeronautical in 2012 to jointly evalu- ate uses for braking action information in real-time, runway-slipperiness condition reporting. The research will assist the FAA Terminal Area Safety Research Program in investigating whether flight data on landing airplanes can provide an accurate and timely assessment of runway slipperiness to prevent runway accidents.

The current system does not capture all of the previously noted dynamic aspects of an airplane's landing roll. It does, however, capture the essence of the landing roll, thereby providing relevant and clear information — quality input parameters to the system that enhance the landing distance advisory data provided by airplane manufacturers. The essence of the CRDA was to analyze and discuss a few of the system's features that differentiate it from conventionally conducting a scientific, full emulation of the landing roll. Among these features are the following:

- Use of a portion of the runway;
- Simplified ambient conditions;
- The impact of runway slope; and,
- Transferability to other aircraft.

For a better understanding of these aspects within the validation process, a brief discussion follows.

Portion of Runway

Do flight crews need to consider the full length of the runway or just a portion to be able to assess braking capability? As noted, separating deceleration force associated with the tire-surface interface from other braking factors is complex. Incorporating this factor in the early phase of an actual landing roll at first sounds more academically interesting than practically valuable. There are several arguments that support such an approach, however.

Any landing, regardless of runway surface condition or the application of braking force at the early phase of the landing roll, can "feel good" to pilots because aerodynamic drag and reverse thrust produce deceleration forces subjectively perceived to result from the brake application. The diminishing impact of the drag will be felt when speed slows below 100 kt. Although present throughout the landing roll, the deceleration benefit from aerodynamic drag therefore can be disre- garded for practical purposes at lower ground speeds.

Reverse thrust works much like a parachute and is more effective at higher speed. A common practice is to stow the thrust reversers when the aircraft speed decreases to between 80 and 60 kt. Therefore, the deceleration benefit from reverse thrust also can be disregarded for practical purposes at lower ground speeds.

Winter conditions can create situations in which the friction heating of tires throughout the landing roll affects the tire-surface interface by reducing braking action toward the end of the landing roll. This is particularly valid with snow or icy conditions. In fact, in a number of runway overrun accident reports, pilots describe how they considered braking action good initially and believed that it deteriorated. The United 737 braking action test program did not involve runway overruns, but similarly received reports from participating pilots who described feeling “apprehension” when conditions became slippery as the landing roll progressed.

These tests showed that using just a portion of the runway to make instantaneous assessments could provide the flight crew ample information, essentially revealing critical aspects of braking ability in real time.

Simplified Ambient Conditions

There is a trade-off for flight crews between knowing ambient weather conditions in great detail and having the ability and time to properly assess them. Reports of meteorological conditions, such as temperature, air pressure, wind speed and wind direction, only provide approximate information and may not always be current. Wind and wind direction, air pressure, etc. have a declining impact on stopping capability as the aircraft slows during the landing roll. Accounting for the weather-condition impact at the initial phase of the landing roll would be complicated and, likely, in vain. The reason is that the end portion of the landing roll provides the information critical to understanding braking ability. Therefore, a simplified approach to gathering data on ambient weather conditions has proved sufficient in the Kongsberg Aeronautical system.

Runway slope also normally is taken into consideration among ambient conditions for takeoff and landing safety analysis by means of advisory data. However, runway slope is not a consideration in this system because the slope has, for practical purposes, an inconsequential effect. Runway slope rarely exceeds 2 percent, and most U.S. airports have slopes of less than 1 percent.

Aircraft Transferability

Braking coefficient values are the same for all types/sizes of aircraft. This principle was considered in TALPA ARC recommendations. Aircraft of different sizes may nevertheless experience differences in braking action, given the same objective runway surface conditions. This analysis did not include regional jets, but the analysis shows that there are commonalities and transferability between aircraft within categories, such as the 737 series and the Airbus A320 series. When comparing estimated landing distance, given similar braking action conditions and using aircraft manufacturer guidance material, there are clear parallels for these two aircraft series.

Pilot reports and feedback formed part of the initial phase of the braking action test program. Pilots evaluated situations in which the Kongsberg Aeronautical system detected braking action conditions that were less than good. Landing data and their feedback revealed consistency with actual and prevailing weather conditions, indicating that the system was performing as expected and intended.

As part of today’s Phase 2 validation process, FAA engaged the University of Massachusetts and a research group to perform an extensive analysis to assess the correlation between prevailing weather conditions and braking capability as derived from the system.

Because slippery runways are not just a winter problem, the analysis included airports in tropical locations. A foundation for the analysis was one year of information acquired from United’s 737 fleet, with the associated and system-calculated airplane-based braking action figures. Historic weather information was consulted to obtain prevailing conditions for each airport that corresponded to the date and time of every landing

Pilot Version of Matrix

Braking Action Report PIREPs			Runway Condition Code
Term	**Definition**	**Associated Runway Surface Condition**	
Dry		**Any temperature and:** • Dry	6
Good	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	**Any temperature and:** • Wet surface (smooth, grooved or PFC runway) • Frost **Any temperature and ⅛ in (3.2 mm) or less of:** • Water • Slush • Dry snow • Wet snow	5
Good to Medium	Brake deceleration and controllability is between *good* and *medium*.	**At or below -13°C (9°F) and:** • Compacted snow	4
Medium	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	**Any temperature when:** • Wet (when runway is reported as "slippery when wet") **At or below -3°C (27°F) and greater than ⅛ in of:** • Dry or wet snow **Above -13°C and at or below -3°C and:** • Compacted snow (any depth, depth not reported)	3
Medium to Poor	Brake deceleration and controllability is between *medium* and *poor*. Potential for hydroplaning exists.	**Any temperature and greater than ⅛ in of:** • Water • Slush **Temperature above -3°C and:** • ⅛ in and greater of dry or wet snow • Compacted snow (any depth, depth not reported)	2
Poor	Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	**At or below -3°C and:** • Ice	1
Nil	Braking deceleration is minimal to nonexistent for the wheel braking effort applied. Directional control may be uncertain.	**Any temperature and:** • Wet ice • Water on top of compacted snow • Dry or wet snow over ice **Temperature above -3°C and:** • Ice	0

PFC = porous friction course; PIREPs = pilot reports

Source: Trond Are Johnsen

Table 1

that involved frictionlimited braking conditions.

In summary, unless aircraft manufacturers can derive certified, perfect landing/stopping distances for any given variation of runway conditions, the aviation industry's primary goal must be to develop a system in compliance with guidance material and advisory data. Today, such advisory data is sorted into six "braking action" categories, according to the TALPA ARC matrix (Table 1, p. 38). Any attempt to furnish braking capability information with higher accuracy — beyond the level of advisory data — will not serve any practical purpose. Capturing the essence of the braking coefficient from the aircraft itself during each actual landing roll, however, could provide near-real time information to the flight crew.

Beyond Validation

In aviation, a system has no value unless it can provide the right data to the right users at the right time. This requires schemes for distribution and integration with appropriate user tools and interfaces. At United Airlines, upcoming and post-validation activities involve an early-phase integration with dispatcher tools.

The real potential in the Kongsberg Aeronautical system lies in pooling information from, ideally, all aircraft in service, although obtaining data from several large airlines may prove sufficient. With a common information pool, all airlines could benefit. The power of the system is in the aggregation of the collected information.

Even though airlines fiercely compete for the business of the traveling public, the aviation industry has a longstanding history of cooperation when it comes to safety. With such technology becoming available, it is time to more accurately and efficiently assess runway surface condition and braking capability through joint effort and cooperation among airlines.

From Aero Safety World November 2014