Recommendation 3.7.1 Establish and implement one consistent method of contaminated runway surface condition assessment and reporting by the aerodrome operator for use by aircraft operators. Ensure the relation of this report to aircraft performance as published by aircraft manufacturers.

The AMC to ADR.OPS.A proposed in NPA 2011-11 lists reportable conditions in terms of natural deposits on runways. It also requires reporting of contamination depth by thirds of the runway as required. It encourages the use of friction devices for hard contaminants and precludes the reporting of friction coefficients for slush, wet snow or wet ice.

While so far the guidance is adequate, it also includes a table for determination of braking action proposed to be removed by an ICAO State Letter Annex 14 May 2011. This table is no longer considered to be state of the art, and does not allow runway condition reporting that relates to aircraft performance. This leaves the task of making a performance-relevant assessment to the flight crew, which is not always in full possession of complete, timely and accurate information that permits to draw the correct conclusions on how the performance assessments for takeoff and landing should be made.

The FAA TALPA ARC (described in the manufacturer guidance material) proposes a way of transferring some of that responsibility to the airport personnel with clear directives on how to merge all available information into a report that usefully describes the prevailing runway state on which a performance calculation can be directly based. Some manufacturers already present their data in a format compatible with this reporting method and format.

Recommendation 3.7.2 Establish and implement one consistent method of calculation of crosswind limits for use by aircraft manufacturers and aircraft operators.

CS 25.237 prescribes that "*A 90º cross component of wind velocity, demonstrated to be safe for takeoff and landing, must be established for dry runways and must be at least 37 km/h (20 kt) or 0·2 V_{SR0}, whichever is greater, except that it need not exceed 46 km/h (25 kt).*" Manufacturers publish for this maximum dry runway crosswind component a demonstrated value in the AFM, but it is not considered a limitation since it simply reflects the maximum crosswind encountered during the flight test campaign.

For wet runways, the AMC 25.109 on Accelerate-Stop Distance prescribes that "*exceptional skill is not required to maintain directional control on a wet runway with a 19 km/h (ten knot) crosswind from the most adverse direction. For demonstration purposes, a wet runway may be simulated by using a castering nosewheel on a dry runway. Symmetric braking should be used during the demonstration, and both all-engines-operating and critical-engine-inoperative reverse thrust should be considered. The brakes and thrust reversers may not be modulated to maintain directional control. The reverse thrust procedures may specify a speed at which the reverse thrust is reduced to idle in order to maintain directional controllability.*" Typically, manufacturer guidance on maximum crosswind on wet runway exceeds the regulatory 10kts.

For contaminated runways, AMC 25.1591 simply states "*The provision of performance information for contaminated runways should not be taken as implying that ground handling characteristics on these surfaces will be as good as can be achieved on dry or wet runways, in particular following engine failure, in crosswinds or when using reverse thrust.*" Most manufacturers provide guidance on the maximum crosswind component on contaminated runways in the operational documentation.

The lack of regulation on the way of establishing the published maximum crosswind components for wet and contaminated runways has led to the development of varying methods used by manufacturers, usually based on calculation and simulation since demonstration in flight test is not reasonable or practicable.

Regulation should be developed in cooperation with manufacturers to define the assumptions based on which the maximum crosswind guidance should be established, including but not limited on such aspects as:

- centre of gravity,
- castering nose wheel,
- symmetrical braking,
- margin on rudder authority,
- asymmetric power (engine failure, reverse),
- Maximum allowable deviation from centreline,
- Accountability for gust,
- Aircraft speed.

Recommendation 3.7.3 It is recommended that aircraft operators always conduct an in-flight assessment of the landing performance prior to landing. Note: Apply margin to these results.

EU-OPS 1.400 reads as follows:

"Approach and landing conditions
Before commencing an approach to land, the commander must satisfy himself/herself that, according to the information available to him/her, the weather at the aerodrome and the condition of the runway intended to be used should not prevent a safe approach, landing or missed approach, having regard to the performance information contained in the Operations Manual."

Reference is made to the Operations Manual; Performance is in part B, described in Appendix 1 to EU-OPS 1.1045. For landing, paragraph 4.1. (h) states that the aircraft operator has to include for compliance with subparts F (general) and G (class A) "*landing field length (dry, wet, contaminated) including the effects of an in-flight failure of a system or device, if it affects the landing distance*".

Note that the requirement 1.400 is in subpart D (Operational Procedures) and is thus technically excluded from this requirement. Further this does not prescribe the performance basis on which the data has to be established, or the factors that need to be applied to the data. EU-OPS 1.475:

"*(b) An operator shall ensure that the approved performance Data contained in the Aeroplane Flight Manual is used to determine compliance with the requirements of the appropriate Subpart, supplemented as necessary with other data acceptable to the Authority as prescribed in the relevant Subpart. When applying the factors prescribed in the appropriate Subpart, account may be taken of any operational factors already incorporated in the Aeroplane Flight Manual performance data to avoid double application of factors.*"

Data described in the CS25.125 does not include any safety margins or operational factors. These are specified in EU-OPS 1.515, which refers to 1.475(a) that clearly makes it a pure dispatch or re-dispatch requirement, in line with the requirements of ICAO Annex 6. Paragraph 1.515(d) has been interpreted such that it requires dispatch factors to be used in flight, but in fact it is a reflection of Annex 6, Part 1, Attachment I, Point 7.1.1.3 dealing with a dispatch where the landing mass exceeds the maximum landing weight on the most favourable runway in still air. The in-flight check is thus specific to this type of operation. It means that only in that case does the commander have to check performance in-flight for the actual runway, aircraft weight and outside condition based on EU-OPS 1.510 (go-around), and 1.515 a (factors) and b (parameters to consider). It is a way of mitigating the perceived increased risks of an operation undertaken with reduced margins, and the only case where the RLD is mandated as an in-flight reference. EU-OPS 1.400, which is otherwise applicable, does not specify what performance reference or factors to apply.

However, the core of the problem is technical. The landing distances currently to be considered according to dispatch requirements for landing are inconsistent and non-rational:

- Margin on dry is 67%
- Margin on wet is variable, since the 15% increase on the dry runway certified landing distance does not reflect the physics of friction on a wet runway. If we construct a wet runway landing distance in line with CS25.125 using the wet runway friction of CS25.109 defined for the ASD at takeoff and manufacturer recommended procedures, the real margin at SL is around 30-40% decreasing with increasing altitude, downhill slope etc. Comparable margins to dry only exist on wet when reverse thrust is used, which also poses the problem of aircraft not equipped with efficient reverse thrust.
- The nominal margin on contaminated is just 15% on the certified distance, but the airborne distance in accordance with CS25.1591 is more realistic than for dry, even if the speed bleed-off in the flare was considered too large by the TALPA ARC. On the other hand, the nature of runway contamination introduces an increased uncertainty regarding the actual friction vs. the assumed one.

A rationale for the existing dispatch factors can no longer be traced, but they cover two types of issues:

- Physical parameters neglected in the determination of the certified landing distances (like runway slope within +/-2° and outside air temperature deviation from ISA),
- Operational uncertainties and variability (like actual wind, increased approach speed, flare technique, minor failures, runway friction issues...)

It can be argued that the latter contributors to the safety margin required can be reduced the closer the performance assessment is made to the time of landing and actual conditions are known more accurately. Furthermore, manufacturers are publishing operational data in their operational documentation that allows to varying degrees removing some "unknowns" from the dispatch data with a computation with a consistent and realistic airborne distance, for the planned approach speed, published average runway slope and forecast temperature. Based on such data and a reasonable estimation of the effect of a statistically distributed occurrence of the remaining variabilities, a required in-flight margin of 15% can be rationalised. This, together with an improved runway condition reporting, is the basis for the FAA TALPA ARC proposals.

Unfortunately, the use of such improved data for the in-flight landing performance assessment generates contradictions with dispatch requirements and resulting operational issues.

The purpose of this recommendation is for EASA to mandate the harmonised publication of landing performance data for in-flight use with an adapted safety margin, and to adjust the dispatch requirements accordingly to avoid the potential operational issues linked to the consideration of runway contamination at dispatch.

Recommendation 3.7.10 Sponsor research on the impact of fluid contaminants of varying depth on aircraft stopping performance, also accounting for the impact of lower aquaplane speeds of modern aircraft tyres. EASA should research the impact of lower aquaplane speeds of modern aircraft tyres on aircraft performance.

Background

The speed at which modern aircraft tyres such as radial and H-type tyres start to aquaplane is much lower than for a classical cross-ply tyre. The lower aquaplane speed of modern tyres has been demonstrated by theoretical models and full-scale experiments.

To estimate the aquaplane speed of an aircraft tyre often use is made of the empirical relation $V_p=9\sqrt{p}$, with p the tire pressure in psi and V_p in kts. This equation is simply known as Horn's equation for dynamic aquaplaning which was the result of NASA research in the sixties. This equation was derived using aircraft cross-ply tyres that were commonly used in the sixties and later years. What the simple equation derived by Horne failed to show is the influence of other factors. Important is the influence of the tire footprint on the aquaplaning speed. The longer and the more narrow this footprint becomes, the higher the aquaplane speed will be as it then takes more time to remove water between the tire footprint and the surface. Modern aircraft tyres have different footprints than the classical cross-ply tyres of the same dimensions, at the same pressure and under the same loading. This explains the differences in aquaplane speeds.

The lower aquaplane speeds of modern aircraft tyres can have an impact on aircraft performance and should addressed during certification.

Sources:

Hydroplaning of modern aircraft tyres, NLR-TP-2001-242, 2001 (http://www.atsi.eu/eCache/ATS/15/600.pdf)

Hydroplaning of H-Type Aircraft Tyres," SAE Technical Paper 2004-01-3119, 2004.