



ESDU 10002

Issued May 2013
With Amendments A and B
September 2015

Introduction to worked examples of tyres rolling or braking on dry or precipitate contaminated runways. Application of ESDU 05011 and ESDU 13007



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INTRODUCTION TO WORKED EXAMPLES OF TYRES ROLLING OR BRAKING ON DRY OR PRECIPITATE CONTAMINATED RUNWAYS. APPLICATION OF ESDU 05011 AND ESDU 13007

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1. NOTATION

The notation in this Data Item is defined in References 2 to 4 and 9.

2. BACKGROUND INFORMATION TO THE WORKED EXAMPLES

The ESDU method for modelling aircraft performance as affected by tyres rolling or braking on a runway contaminated with water, slush snow or ice is introduced in Reference 2. The method for modelling an unbraked tyre in yaw on a dry or water-covered surface is described in Reference 9. Whilst these give the full details of the technical process involved, this background information for the worked examples document and the worked examples given in References 5 to 7, 12 and 13 set out ways and means whereby practical problems facing a user are illustrated.

Aircraft may be operated today on runways which can be either dry, damp or wet. In the case of a wet runway, aircraft operate up to a water depth of 3 mm. The information allowing the aircraft to operate on a wet runway is contained in the AFM (Aircraft Flight Manual) when used in conjunction with the Operational Regulation in place. The determination of whether the water on the runway is within the 3 mm limit is the responsibility of the Airport Authority.

Should one wish to operate an aircraft on a runway which is contaminated, in other words with deposits of water of a depth greater than 3 mm, or slush, snow, ice or a combination thereof, then additional performance data have to be made available. This information may be contained in the AFM or other related documents. Again, the determination of the nature of the contaminant and its extent is the responsibility of the Airport Operator.

For operations on water-covered runway surfaces, the potential planing of one or more aircraft tyres should be considered. Reference 11 provides a method for predicting the speed at which a tyre planes, whilst Reference 14 is an application of the method.

For both the aircraft manufacturer and the Airport Operator there is a regulatory basis governing the determination of performance data for operating an aircraft on a contaminated surface and the determination of the conditions at any time under which a flight might take place.

Historically, due to restrictions imposed by limitations in data, as a result of an imperfect understanding of the subject, self-imposed safeguards have generally militated against such operations taking place. It is the purpose of the worked examples given in References 5 to 7, 12 and 13 to show that with the more complete understanding afforded by References 2 and 9, more accurate data can be obtained, both with regard to aircraft performance data and the determination of the characteristics and effect of a contaminant on a particular runway.

3. REGULATORY BASIS

3.1 Aircraft

The European Aviation Safety Agency (EASA) documents CS 25.1591 and AMC 25.1591, References 16 and 17, provide a regulatory basis for the determination of aircraft performance data on contaminated runway surfaces. (JAR 25X1591 and AMJ 25X1591, References 18 and 19, previously provided such details.) In 2009 this advisory regulation allowed a manufacturer to produce acceptable aircraft data, although other equivalent methods were permitted, subject to regulatory agreement. These methods could be summarised as being crude, but generally conservative. Reference 2 provides a much more rational method.

3.2 Airport

Airport Operators use procedures agreed upon by their respective national authority to determine the nature of water or other contaminant on a runway. These procedures are not subject to international agreement, but do not vary greatly from country to country and generally limit operations to not more than 3 mm of water, or other contaminant. To determine the runway condition, Airport Operators make widespread use of runway friction measuring devices, which are used at comparatively low speeds.

4. PROBLEMS LIKELY TO BE FACED

4.1 Aircraft Manufacturer

This can be summarised by stating that no manufacturer wishes to carry out full-blown testing with an aircraft on a variety of difficult to find runway surface conditions, the costs and time needed for such an exercise are likely to be large. Consequently the manufacturer may wish to synthesise the information based on related testing, either model or full-scale, that allows sufficiently accurate information to be prepared. The data can be simplistic in that it only covers the worst case, or it may detail all likely surface conditions.

It is clear that the determination of performance data for a contaminated surface will be based on the normal aircraft performance information, modified by different drag and braking forces. In producing the aircraft data, it is likely that only uniform distribution of a contaminant will be considered.

4.2 Airport Operator

A runway condition survey, using a friction measuring device, may provide some limited information that has to be simplified before dissemination to aircraft about to use a particular runway. The user may have difficulty in deciding the exact nature of any contaminant, also its depth and will have a particular problem with any variation in nature or depth over the length of the runway.

4.3 Aircraft Operator

The despatch of an aircraft when a runway is contaminated requires the captain to use the information provided in the acceptable documentation supplied by the manufacturer, used in conjunction with information coming from the airport authority regarding the condition of the runway. In many cases the information to be used may be conservative, such that larger than necessary penalties are incurred, or the information is generalised in such a way that it is difficult to relate it to the conditions at hand. In these eventualities the captain will have to use judgement as to what is considered safe, whilst under commercial pressures to operate the aircraft without a complete understanding of the exact penalties. Better quality information would alleviate some of these concerns.

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