Airport Services Manual

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Airport Services Manual

Part 2
Pavement Surface Conditions

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AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the supplements to the *Catalogue of ICAO Publications and Audio-visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA		
No.	Date	Entered by

Foreword

The provisions in Annex 14, Volume I, require States to take action as necessary to remove contaminants from the movement area as rapidly and completely as possible so as to minimize their accumulation and, thus, to provide good friction characteristics and low rolling resistance. Further, the Annex calls for the pavement surface to be kept clear of any loose stones or other debris that might cause damage to aeroplane structures or engines or might impair the operation of aeroplane systems. There is a requirement to assess the condition of the pavement whenever it has not been possible to fully clear the contaminants and to make this information available to the appropriate units at the airport. There is also a requirement to measure periodically the friction characteristics of the runway and take appropriate actions whenever the friction characteristics are below certain levels specified by the State. The purpose of this manual is to provide assistance to States in ensuring that adequate measures are taken to overcome problems resulting from contaminants or debris on, or weathering of, the movement area.

It cannot be overemphasized that the goal of an airport authority should be the removal from the movement area of all contaminants and debris that adversely affect aeroplane performance. In this regard, continuing research has been directed towards improving the economy and efficiency of mechanical and chemical methods to remove contaminants from the movement area. There are, however, circumstances that justify a requirement for measurement of friction values and, therefore, the development of acceptable methods for these measurements.

The possibility of obtaining correlation between the friction values produced by different types of friction-measuring devices has been the subject of trials and discussions for some time. In 1972, ICAO approved a programme to determine the correlation between different ground equipment used to measure runway friction characteristics. As a result, a chart was developed showing the correlation between certain friction-measuring devices when used on snow- or ice-covered surfaces. The correlation between the friction-measuring devices when used on wet surfaces was unacceptable. Tests conducted in the United States in the 1990s indicated a somewhat different correlation between friction-measuring devices on compacted snow- or ice-covered paved surfaces, which was attributed to changes in test tire parameters. Extensive testing with new tires under self-wet conditions has resulted in statistical verification of an acceptable correlation between the various continuous friction-measuring devices.

This manual includes, *inter alia*, material concerning basic factors affecting friction, correlation between friction-measuring devices on paved surfaces, description of the devices, practices for measuring and reporting friction values on snow-, ice- and water-covered surfaces, collection and dissemination of pavement surface condition information, and clearance and removal of contaminants and debris from the movement area.

It is intended that this manual be kept up to date. Future editions will most likely be improved on the basis of experience gained and of comments and suggestions received from users of this manual. Therefore, readers are invited to give their views, comments and suggestions on this edition. These should be directed to the Secretary General of ICAO.

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Chapter 1

General

Note.— The terms contaminant *and* debris *are used in this manual with the following meanings. A contaminant is considered to be a deposit (such as snow, slush, ice, standing water, mud, dust, sand, oil, and rubber) on an airport pavement, the effect of which is detrimental to the friction characteristics of the pavement surface. Debris is fragments of loose material (such as sand, stone, paper, wood, metal and fragments of pavements) that are detrimental to aeroplane structures or engines or that might impair the operation of aeroplane systems if they strike the structure or are ingested into engines. Damage caused by debris is also known as FOD (foreign object damage).*

1.1 INTRODUCTION

1.1.1 There is general concern over the adequacy of the available friction between the aeroplane tires and the runway surface under certain operating conditions, such as when there is snow, slush, ice or water on the runway and, particularly, when aeroplane take-off or landing speeds are high. This concern is more acute for jet transport aeroplanes since the stopping performance of these aeroplanes is, to a greater degree, dependent on the available friction between the aeroplane tires and the runway surface, their landing and take-off speeds are high, and in some cases the runway length required for landing or take-off tends to be critical in relation to the runway length available. In addition, aeroplane directional control may become impaired in the presence of cross-wind under such operating conditions.

1.1.2 A measure of the seriousness of the situation is indicated by the action of national airworthiness authorities in recommending that the landing distance requirement on a wet runway be greater than that on the same runway when it is dry. Further problems associated with the take-off of jet aeroplanes from slush- or water-covered runways include performance deterioration due to the contaminant drag effect, as well as the airframe damage and engine ingestion problem. Information on ways of dealing with the problem of taking off from slush- or water-covered runways is contained in the *Airworthiness Technical Manual* (Doc 9051).

1.1.3 Further, it is essential that adequate information on the runway surface friction characteristics/aeroplane braking performance be available to the pilot and operations personnel in order to allow them to adjust operating technique and apply performance corrections. If the runway is contaminated with snow or ice, the condition of the runway should be assessed, the friction coefficient measured and the results provided to the pilot. If the runway is contaminated with water and the runway becomes slippery when wet, the pilot should be made aware of the potentially hazardous conditions.

1.1.4 Before giving detailed consideration to the need for, and methods of, assessing runway surface friction, or to the drag effect due to the presence of meteorological contaminants such as snow, slush, ice or water, it cannot be overemphasized that the goal of the airport authority should be the removal of all contaminants as rapidly and completely as possible and elimination of any other conditions on the runway surface that would adversely affect aeroplane performance.

1.2 IMPORTANCE OF RUNWAY SURFACE FRICTION CHARACTERISTICS/AEROPLANE BRAKING PERFORMANCE

1.2.1 Evidence from aeroplane overrun and run-off incidents and accidents indicates that in many cases inadequate runway friction characteristics/aeroplane braking performance was the primary cause or at least a contributory factor. Aside from this safety-related aspect, the regularity and efficiency of aeroplane operations can become significantly impaired as a result of poor friction characteristics. It is essential that the surface of a paved runway be so constructed as to provide good friction characteristics when the runway is wet. To this end, it is desirable that the average surface texture depth of a new

surface be not less than 1.0 mm. This normally requires some form of special surface treatment.

1.2.2 Adequate runway friction characteristics are needed for three distinct purposes:

a) deceleration of the aeroplane after landing or a rejected take-off;

b) maintaining directional control during the ground roll on take-off or landing, in particular in the presence of cross-wind, asymmetric engine power or technical malfunctions; and

c) wheel spin-up at touchdown.

1.2.3 With respect to either aeroplane braking or directional control capability, it is to be noted that an aeroplane, even though operating on the ground, is still subject to considerable aerodynamic or other forces which can affect aeroplane braking performance or create moments about the yaw axis. Such moments can also be induced by asymmetric engine power (e.g. engine failure on take-off), asymmetric wheel brake application or by cross-wind. The result may critically affect directional stability. In each case, runway surface friction plays a vital role in counteracting these forces or moments. In the case of directional control, all aeroplanes are subject to specific limits regarding acceptable cross-wind components. These limits decrease as the runway surface friction decreases.

1.2.4 Reduced runway surface friction has a different significance for the landing case compared with the rejected take-off case because of different operating criteria.

1.2.5 On landing, runway surface friction is particularly significant at touchdown for the spin-up of the wheels to full rotational speed. This is a most important provision for optimum operation of the electronically and mechanically controlled anti-skid braking systems (installed in most current aeroplanes) and for obtaining the best possible steering capability. Moreover, the armed autospoilers which destroy residual lift and increase aerodynamic drag, as well as the armed autobrake systems, are only triggered when proper wheel spin-up has been obtained. It is not unusual in actual operations for spin-up to be delayed as a result of inadequate runway surface friction caused generally by excessive rubber deposits. In extreme cases, individual wheels may fail to spin up at all, thereby creating a potentially dangerous situation and possibly leading to tire failure.

1.2.6 Generally, aeroplane certification performance and operating requirements are based upon the friction characteristics provided by a clean, dry runway surface, that is, when maximum aeroplane braking is achievable for that surface. A further increment to the landing distance is usually required for the wet runway case.

1.2.7 To compensate for the reduced stopping capability under adverse runway conditions (such as wet or slippery conditions), performance corrections are applied in the form of either increases in the runway length required or a reduction in allowable take-off mass or landing mass. To compensate for reduced directional control, the allowable cross-wind component is reduced.

1.2.8 To alleviate potential problems caused by inadequate runway surface friction, there exist basically two possible approaches:

a) provision of reliable aeroplane performance data for take-off and landing related to available runway surface friction/aeroplane braking performance; and

b) provision of adequate runway surface friction at all times and under all environmental conditions.

1.2.9 The first concept, which would only improve safety but not efficiency and regularity, has proved difficult mainly because of:

a) the problem of determining runway friction characteristics in operationally meaningful terms; and

b) the problem of correlation between friction-measuring devices used on the ground and aeroplane braking performance. This applies in particular to the wet runway case.

1.2.10 The second is an ideal approach and addresses specifically the wet runway. It consists essentially of specifying the minimum levels of friction characteristics for pavement design and maintenance. There is evidence that runways which have been constructed according to appropriate standards and which are adequately maintained provide optimum operational conditions and meet this objective. Accordingly, efforts should be concentrated on developing and implementing appropriate standards for runway design and maintenance.

1.3 NEED FOR ASSESSMENT OF RUNWAY SURFACE CONDITIONS

1.3.1 Runway surface friction/speed characteristics need to be determined under the following circumstances:

a) the dry runway case, where only infrequent measurements may be needed in order to assess surface texture, wear and restoration requirements;

b) the wet runway case, where only periodical measurements of the runway surface friction characteristics are required to determine that they are above a maintenance planning level and/or minimum acceptable level. In this context, it is to be noted that serious reduction of friction coefficient in terms of viscous aquaplaning can result from contamination of the runway, when wet, by rubber deposits;

c) the presence of a significant depth of water on the runway, in which case the need for determination of the aquaplaning tendency must be recognized;

d) the slippery runway under unusual conditions, where additional measurements should be made when such conditions occur;

e) the snow-, slush-, or ice-covered runway on which there is a requirement for current and adequate assessment of the friction conditions of the runway surface; and

f) the presence and extent along the runway of a significant depth of slush or wet snow (and even dry snow), in which case the need to allow for contaminant drag must be recognized.

Note.— Assessment of surface conditions may be needed if snowbanks near the runway or taxiway are of such a height as to be a hazard to the aeroplanes the airport is intended to serve. Runways should also be evaluated when first constructed or after resurfacing to determine the wet runway surface friction characteristics.

1.3.2 The above situations may require the following approaches on the part of the airport authority:

a) for dry and wet runway conditions, corrective maintenance action should be considered whenever the runway surface friction characteristics are below a maintenance planning level. If the runway surface friction characteristics are below a minimum acceptable friction level, corrective maintenance action must be taken, and in addition, information on the potential slipperiness of the runway when wet should be made available (see Appendix 5 for an example of a runway friction assessment programme);

b) for snow- and ice-covered runways, the approach may vary depending upon the airport traffic, frequency of impaired friction conditions and the availability of cleaning and measuring equipment. For instance:

1) at a very busy airport or at an airport that frequently experiences the conditions of impaired friction — adequate runway cleaning equipment and friction-measuring devices to check the results;

2) at a fairly busy airport that infrequently experiences the conditions of impaired friction but where operations must continue despite inadequate runway cleaning equipment — measurement of runway friction, assessment of slush contaminant drag potential, and position and height of significant snowbanks; and

3) at an airport where operations can be suspended under unfavourable runway conditions but where a warning of the onset of such conditions is required — measurement of runway friction, assessment of slush contaminant drag potential, and position and height of significant snowbanks.

1.4 CONTAMINANT DRAG

1.4.1 There is a requirement to report the presence of snow, slush, ice, or water on a runway, as well as to make an assessment of the depth and location of snow, slush or water. Reports of assessment of contaminant depth on a runway will be interpreted differently by the operator for the take-off as compared with the landing. For take-off, operators will have to take into account the contaminant drag effect and, if applicable, aquaplaning on take-off and accelerate-stop distance requirements based on information which has been made available to them. With regard to landing, the principal hazard results from loss of friction due to aquaplaning or compacted snow or ice, while the drag effects of the contaminant would assist aeroplane deceleration.

1.4.2 However, apart from any adverse effects from contaminant drag which may occur on take-off or loss of braking efficiency on landing, slush and water thrown up by aeroplane wheels can cause engine flame-out and can also inflict significant damage on airframes and engines. This is further reason to remove precipitants from the runway rather than, for instance, devoting special efforts towards improving the accuracy of measurement and reporting the runway friction characteristics on a contaminated runway.

1.5 EXPLANATION OF TERMS

1.5.1 It is not possible to discuss methods of measuring friction and assessing contaminant depth without