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ASSEMBLY — 37TH SESSION

TECHNICAL COMMISSION

Agenda Item 30: Runway Safety

FOREIGN OBJECT DEBRIS

(Presented by Belgium on behalf of the European Union and its Member States[2] and by the other States Members of the European Civil Aviation Conference[3], and by EUROCONTROL)

EXECUTIVE SUMMARY

The absence of a globally accepted definition and taxonomy for Foreign Object Debris (FOD), with its consequences for consistent recording, analysis and cost estimation, is an obstacle to the development of a better understanding and mitigation of FOD's safety and other impacts. The advent of capable but relatively expensive technology-based systems for FOD monitoring and detection has reinforced the need for such an understanding, and for robust FOD data and analyses to take their place in airport safety management systems.

Action: The Assembly is invited to:

a) note the findings of the work undertaken by the European States, described in this Working Paper;
b) agree on the need for a globally agreed definition and taxonomy for FOD, as the basis for the subsequent development of the better management of FOD's safety and other impacts, and its integration into airport safety management systems; and
c) call on ICAO to lead the development of a common global FOD definition and taxonomy, in concert with its Member States, and interested organisations and drawing on the work undertaken by Europe;

Strategic Objectives:	This working paper relates to Strategic Objective A (Enhance global civil aviation safety) as it results in enhanced runway safety.
References:	Annex 14 — *Aerodromes* and ICAO Doc 9137, Airport Services Manual

[1] English and French versions provided by Belgium.
[2] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.
[3] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Iceland, Monaco, Montenegro, Norway, Republic of Moldova, San Marino, Serbia, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, and Ukraine.

1. INTRODUCTION

1.1 The effective management of Foreign Object Debris (FOD) at an airport is important primarily in relation to safety, and raises in that context sensitive issues of responsibility and liability. But it also has considerable actual or potential significance in relation to airline and airport economics, runway capacity, the environment and the passenger experience.

1.2 Persuaded that FOD management deserves more attention than it typically receives, and conscious of the emergence of new, technology-based systems for the automated monitoring and detection of FOD on runways, the European States have recently examined the FOD phenomenon. This paper, derived from that examination, describes current obstacles to the sound analysis and understanding of FOD impacts, and proposes some initial action at the global level to address them.

2. THE FOD ISSUES

2.1 FOD can appear in different lights to different parties. For airlines, it may be seen in the main as a cost management issue (aircraft repairs and maintenance), while for airports it may be a matter of "good housekeeping", ideally as an element of a systems approach to safety management. Primarily however, FOD is a potentially very serious safety risk, presenting both a direct hazard to aircraft operations, and an indirect threat should the delays and disruption to which a FOD event gives rise causes essential safety procedures to be rushed (the "hurry up" effect).

2.2 FOD is also an economic issue. Its day-to-day management (sweeping etc.) carries a cost in itself, and when not detected and removed, FOD imposes maintenance and repair costs on airlines, through damage to aircraft jet engines, propeller blades, tyres, and fuselage skins. Very considerable additional costs follow when an aircraft needs to be taken out of service, perhaps at no notice, for unscheduled maintenance and repairs made necessary by FOD damage.

2.3 Unless isolated instances of FOD are detected and able to be cleared between aircraft movements, conventional FOD management procedures may involve the periodic temporary closure of a runway which, depending on the volume of traffic at the airport, may reduce runway capacity and lead to a loss of airport revenue, and to delays to inbound and outbound aircraft. This may in turn generate a negative passenger perception of the airport and of airline reliability. Flight delays consequent on runway closures for physical inspection and clearance of FOD may also give rise to additional fuel burn, on the ground and in the air, and thus to additional emissions. One manufacturer of automated FOD monitoring and detection systems has suggested that a 19-minute runway closure at a busy airport may result in up to 134 tonnes of additional CO2. A major engine manufacturer is understood to have estimated that 30% of the blades on the average aero-engine will have been repaired following FOD damage, decreasing fuel efficiency by up to 0.5%. Fuel consumption and CO2 emissions are directly linked.

2.4 Finally, FOD management raises questions around the integration of FOD occurrence reporting data into other data streams available within an airport's safety management system. These questions arise most pointedly where an airport has implemented an automated FOD monitoring and detection system, with the direct data transfer and integration possibilities which these systems bring.

3. FOD REGULATION, DATA AND COSTS

3.1 There is today little international regulation of the management of FOD. 'Foreign Object Debris' is not a term presently defined or used in ICAO documentation, although as a phenomenon it is encompassed by Annex 14 of the Chicago Convention, as an aerodrome maintenance issue. Since the coming into effect in November 2009 of Amendment 10 to Annex 14, paragraph 9.4.2 of that Annex requires that –

"The surfaces of all movement areas including pavements (runways, taxiways, aprons and adjacent areas) shall be inspected and their conditions monitored regularly as part of an aerodrome preventive and corrective maintenance programme with the objective of avoiding and eliminating any loose objects/debris that might cause damage to aircraft or impair the operation of aircraft systems."

3.2 ICAO guidance in Doc. 9137 (*Airport Services Manual*) indicates that runways should receive a full visual inspection between two and four times each day. This ICAO Standard and the related guidance have been adopted by many countries as part of their national requirements and advice to operators.

3.3 Consistent with the scarcity of international regulation of its management, there is at present no globally accepted definition of FOD, nor any common taxonomy for its discussion. As a consequence, certainly within Europe but surely also more widely, FOD data are not at present able to be gathered or recorded in a consistent manner and useful comparative analyses of the FOD phenomenon are extremely difficult.[4] Different safety reporting requirements tend to promote different perspectives on FOD management amongst airlines, maintenance organisations, air navigation service providers and airport operators.

3.4 All of this stands in the way of a sound understanding and effective mitigation of FOD's safety and other impacts. The advent in recent years of new, technology-based FOD monitoring and detection systems for use on runways has reinforced the need for these definitional, taxonomic and data difficulties to be resolved, and for properly robust FOD analysis to take its place within an airport's safety management system. Effective FOD management, like all safety disciplines, should be risk-based and should see FOD data integrated with other safety data streams.

3.5 There is in Europe little information in the public domain about the costs imposed by FOD and little evidence of calculations being made at either State or airport level of FOD's economic impact. The replacement of an advanced aero-engine is extremely expensive and even its repair might cost 20% of its original purchase price. The replacement of two or three fan blades on a sophisticated engine can itself cost a considerable sum. Yet modern maintenance outsourcing practices may leave airlines with poor visibility of where and how their maintenance costs arise and of the particular cost burden of FOD.

3.6 The FOD cost studies most often cited are those undertaken by Boeing in 1998, which estimated the cost of FOD damage to the aerospace industry at US$4b per year, and in 2008 by consultants SRI Insight which broadly consistent with the earlier Boeing estimate suggested that FOD events at the world's largest three hundred airports may impose on airlines collectively direct costs possibly as high as US$20m per airport per year *before* indirect costs are considered. Those advancing such estimates concede that the data are vulnerable, in part another consequence of there being no common FOD definition or taxonomy, and clearly these estimates must be treated with some caution. But even if they are seriously adrift, they are nonetheless of a sufficient magnitude to be considered a strong argument for taking pains to ensure that FOD management is fully effective and efficient.

4. TOWARDS A DEFINITION AND TAXONOMY OF FOD

4.1 The data difficulties are the first barrier to a better understanding and management of FOD, and to effective mitigation of its adverse safety, economic and environmental impacts. The principal reason for these difficulties lies in the absence of a universally adopted definition of FOD and of a common taxonomy for discussing its different types and their handling. These need to be developed and agreed at the global level.

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[4] A recent and promising development is the incorporation in Version 5 of the 'European Co-ordination Centre for Accident and Incident Reporting System' (ECCAIRS), due for release by the end of 2010, of specific data fields and some taxonomy for recording FOD occurrences.

4.2 Work towards an agreed FOD definition will need to address its principal physical characteristics, amongst them the material of which the object consists (including any distinction between animate/inanimate); its location, and persistence in that location; its potential to cause harm, and to what/whom; and its size, i.e. whether a size limit can be identified below which all FOD might be declared non-hazardous. On the basis of this approach and the analysis arrived at by the European study, and taking into account that there are different types of FOD and that different methodologies may be used for dealing with each of them, the following tentative definition of FOD as a possible starting point for discussion in a wider forum is proposed:

"Any object, animate or inanimate, in an inappropriate location on the movement area, that has the potential to injure humans and damage aircraft and vehicles."

4.3 The related FOD taxonomy issue needs to be addressed on a risk-management basis; an effective FOD management regime will equip airport managers with a means of deciding when the risk posed by FOD warrants intervention. It will first be necessary to identify as many as possible of the potential *sources* of FOD and then to draw up a list of examples of its main *types*. The European study included work in both of these areas. The next step is to identify which types of FOD are most often encountered and to gauge their inherent potential to cause harm, taking into account such factors as mass and density.

4.4 The need for FOD decisions to be risk-based arises especially acutely where an airport has deployed a technology-based system, as only through the use of such systems, arguably, can (near) continuous "monitoring" of the runway be achieved.

5. NEW TECHNOLOGIES

5.1 Automated FOD monitoring and detection systems which have become available in recent years typically employ radar and/or electro-optical sensors to detect newly deposited FOD items rapidly, including at night and in poor weather, and to provide operational staff with alerts. Their manufacturers offer a range of pricing and performance options from which an airport may choose on the basis of its particular requirements.[5]

5.2 These systems are capable but relatively expensive and their acquisition may be feasible only at larger airports, enjoying more generous financing. It seems clear that they can enhance the effectiveness of FOD monitoring and detection, although their close integration into the airport's safety management system is necessary if their benefits are to be fully realized.

5.3 The implementation of such systems may have also an impact on the aerodrome operation, which should be evaluated on a case by case basis. The performance of automated FOD detection and monitoring systems is high and when a FOD is detected, the traffic may be suspended to allow the removal of the FOD. Such removal would be performed quicker than for a classical inspection because the FOD location is determined. Nevertheless, the number of suspensions could be so frequent, due to the high detection capacity, that they would risk having an adverse impact on airport operations. Unnecessary suspension of aircraft operations at airports should be avoided by ensuring that only those objects which have the potential to injure humans and damage aircraft and vehicles need to be removed and can therefore lead to a suspension of operations of aircraft. So, a balance must be found between detection and number of removals. For that, any detection and monitoring system must include an

[5] In September 2009 the FAA issued an Advisory Circular for US airports setting out minimum performance specifications for such systems. The European Organization for Civil Aviation Equipment (EUROCAE) has recently established a group to look at proposed technical specifications. The ICAO Secretariat is also contemplating the generation of guidance on the use of these systems.

identification process of the object and more information must be provided to allow for the correct definition of an object on the movement area as a FOD.

6. CONCLUSIONS

6.1 The absence of a globally accepted FOD definition and taxonomy, with its adverse consequences for FOD's consistent recording, analysis and costing, is the first obstacle to the development of a proper understanding and mitigation of FOD's safety and other impacts. The advent of capable but relatively expensive technology-based systems for FOD monitoring and detection has reinforced the need for such an understanding, and for robust FOD data and FOD analyses to take their proper place in airport safety management.

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