International Civil Aviation Organization

WORKING PAPER

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ASSEMBLY — 39TH SESSION

TECHNICAL COMMISSION

Agenda Item 36: Aviation safety and air navigation implementation support

RISK INDEX – ALGORITHM TO ASSESS PROBABILITY

(Presented by Argentina)

EXECUTIVE SUMMARY

This paper provides ICAO and its Member States with a computing tool that allows objectively determining the probability of occurrence of an identified hazard and its possible consequences.

Strategic Objectives:	This working paper relates to the Safety Strategic Objective.
Financial implications:	None
References:	

[1] English and Spanish versions provided by Argentina.

1. INTRODUCTION

1.1 When analyzing safety events, it is essential to make an objective assessment of both the *hazard* and the *probability of occurrence* of such events. The combination of both values facilitates the interpretation of the relationship between a particular event and the context in which it occurs, thus enabling the adoption of the most appropriate mitigation measures to solve the situation.

1.2 The objective assessment of events is particularly relevant considering that the less subjective the analysis is, the more accurate the measures will be.

1.3 In this context Civil Aviation Administration in Argentina (ANAC), through the *Departamento Vigilancia del Sistema de Seguridad Operacional*, has developed a computing tool based on a simple algorithm that allows to objectively assess the probability of occurrence of a safety event (identified hazard), and its possible consequences. This is an initial work, susceptible of improvements.

1.4 The guiding concepts and tables in this project have been taken from the Safety Management Manual (ICAO Doc. 9859).

2. PREVENTIVE SAFETY STRATEGY ANALYSIS

2.1 Organizations that follow a preventive strategy for safety management estimate that accident risk can be minimized by two actions:

- Detecting vulnerabilities before they fail, and

- Adopting the necessary measures to reduce risks

2.2 The strategy outlined here intends to be simple and economic, and consists in detecting those events which remain in a latent condition (they have not been made evident through their consequences yet), in order to be proactive in determining and implementing appropriate mitigation measures to avoid accidents or incidents.

3. PROPOSAL

3.1 In order to reduce this subjectivity, an algorithm has been developed by means of a computing tool based on Microsoft Excel, in order to assess the probability of occurrence of an event based on the level of exposure, considering similar events occurred in a given period of time, either in the RWY, the TWY or the APRON.

3.2 Once the frequency has been determined (frequent, occasional, remote, improbable or extremely improbable), the team of experts assigns a severity level to the informed event (catastrophic, hazardous, major, minor or negligible). With these two values the critical level is determined (critical, moderate or acceptable).

3.3 The basis and grounds for the development of the algorithm are presented below.

4. MODEL TERMS

4.1 In order to establish the basis of the model in terms of probability, the number of movements or operations in an aerodrome during a calendar year is taken as a pattern (for instance 2015), and it is used as the calculating basis for the following year (2016). Therefore, it is possible to calculate the amount of time an operative aircraft has been exposed to existing hazards.

4.2 On average, runway (RWY) operative occupation for take-off or landing is 90 seconds, for taxiing is 150 seconds and for apron operations (APRON) is 210 seconds. When the operative time of an aerodrome is also available (H24 or HJ), it is possible to calculate the operative frequency and by assigning a percentage, also the possibility of an unwanted event occurring.

4.3 This tool also allows increasing the probability of occurrence in cases in which the same event has already occurred in a given period of time.

5. CALCULATING THE POSSIBILITY OF THE FREQUENCY OF OCCURRENCE

5.1 The proposal includes a computing tool (based on Microsoft Excel) in order to estimate the possibility of the frequency of occurrence of an event based on the exposure level, taking into account similar events occurred in a given period of time. For that reason, it is necessary to emphasize that an event may or may not have evident consequences, so it should be taken into account that the occurrence of a consequence occurs or does not occur. From a strict point of view, the probability calculation places these occurrences in the group of mutually exclusive events (two events are mutually exclusive when the occurrence of one of them prevents the other from happening).

5.2 We will name Occurrence “p” and No Occurrence “q” so that:

$$p + q = 1$$

5.3 This means that the possibility of an event occurring or not equals 1, meaning certainty. In other words, performing an arithmetic operation, the possibility that an event occurs can be expressed as follows:

$$p = 1 - q$$

5.4 Considering “q” as the No Occurrence of a consequence of a specific type of hazard, and assuming that a number of hazards have not had consequences individually, all of them (identified as “q”) can be included in a “Q.” In an equation:

$$Q = q.\ q.\ q \ldots\ldots q = qn$$

“n” equals the number of times exposed to a specific hazard.

5.5 If p= 1-q, drawing a parallel, the following can be written: P= 1 – Q, what means that P is the total possibility of an occurrence in a given period of time. Therefore, P= 1 - Q can be expressed as P= 1 -qn, and as q= 1 –p, thus obtaining the following equation:

$$P = 1 - (1 - p)n$$

5.6 So “p” is the individual possibility of occurrence of a specific event in a particular aerodrome, “n” is the number of times the same event was noticed in a given period of time, and “P” is the possibility of occurrence of the given event, in a particular aerodrome, considering previous similar events.

6. TABLES TO USE THE MODEL

6.1 By using any calculation form (for instance MS-Excel) a tool can be designed in order to facilitate the calculation of the possibility of occurrence of the different events for each aerodrome, as well as including previous records of the same event.

6.2 The value obtained is compared to the available reference table or to the one that has been adopted, for instance:

Probability		**P**
Frequent	5	0,7
Occasional	4	0,5
Remote	3	0,1
Improbable	2	0,01
Extremely Improbable	1	0,001

6.3 Considering the severity of the consequence determined by the qualified team and the support of the Tolerability Matrix (ICAO Doc 9859), the Risk Index (IR) can be obtained, what in turn provides the critical level of the event.

Tolerability Matrix			**Severity**				
			Catastrophic	**Hazardous**	**Major**	**Minor**	**Negligible**
			A	**B**	**C**	**D**	**E**
Probability	**Frequent**	**5**	**5A**	**5B**	**5C**	**5D**	**5E**
	Occasional	**4**	**4A**	**4B**	**4C**	**4D**	**4E**
	Remote	**3**	**3A**	**3B**	**3C**	**3D**	**3E**
	Improbable	**2**	**2A**	**2B**	**2C**	**2D**	**2E**
	Extremely improbable	**1**	**1A**	**1B**	**1C**	**1D**	**1E**

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