International Civil Aviation Organization

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WORKING PAPER

ASSEMBLY — 37TH SESSION

TECHNICAL COMMISSION

Agenda Item 46: Other business to be considered by the Technical Commission

CURRENT ASPECTS OF CREATING A GLOBAL VORTEX FLIGHT SAFETY SYSTEM

(Presented by the Russian Federation)

EXECUTIVE SUMMARY

The problem of trailing vortices is a topical civil aviation problem both from the point of view of flight safety and airspace capacity. This document draws the Assembly's attention to information about the potential threats to flight safety, connected with aircraft trailing vortices, and also to proposals regarding the future activity of ICAO aimed at creating a global vortex flight safety system to reduce the existing risks of flight safety and increase aircraft capacity.

Action: The Assembly proposes:

a) requests the Council to initiate the work of ICAO on problems of vortex safety in order to develop new SARPs and instruction material for separation minima when there is turbulence in the trail line, and the classification of aircraft according to the category of turbulence in the tail line;

b) recommends that the ICAO Council commission the ICAO Wake Turbulence Study Group (WTSG) with studying the issue of developing the guidelines for the procedure for certifying aircraft and their specifications, depending on the level of danger of the trailing vortex, whilst at the same time creating an ICAO database for trailing vortex turbulence; and

c) requests the ICAO Council to prepare a report for the 38th Session of the ICAO Assembly on the progress of preparing SARPs and instruction material regarding vortex flight safety.

Strategic Objectives:	This working paper relates to Strategic Objective A.
Financial implications:	The resources to implement the measures indicated in this document should be included within the work of the ICAO Wake Turbulence Study Group (WTSG).
References:	Doc 9426, *Air Traffic Services Planning Manual* Doc 9902, *Assembly Resolutions in Force* (as of 28 September 2007) Doc 8168, Procedures for Air Navigation Services Doc 7030, *Regional Supplementary Procedures*

* Russian version provided by the Russian Federation.

1. INTRODUCTION

1.1 The efforts of the international aviation community are aimed at increasing flight safety levels in international civil aviation all over the world. The International Civil Aviation Organization (ICAO) plays a leading role in this task. Resolution A36-7 acknowledges that an active approach, including measures to determine and manage flight safety risks, plays an extremely important role in ensuring the future increase in flight safety levels.

2. CURRENT VOTEX SAFETY PROBLEMS

2.1 Despite the efforts of the international aviation community, the problem of ensuring vortex flight safety remains an ongoing problem. Over the past three years there have been two air disasters and several incidents with different levels of severity caused by aircraft entering trailing vortex turbulence.

2.2 One of the disasters caused by an aircraft entering a trailing vortex took place on 13 September 2007 at Reno Stead Airport (USA) involving an Aero Vodochody L-39 Albatross aircraft. During the Reno National Championship Air Races flying competition, the L-39 aircraft entered the trailing vortex of a Rockwell T-2B (Buckeye) which was flying in front of it, lost control, turned over and crashed into the ground. The pilot was killed.

2.3 Another similar disaster took place on 4 November 2008 involving a Mexican Learjet 45 XC-VMC aircraft when landing at Benito Juarez International Airport (Mexico City). The Learjet 45 entered the trailing vortex of a Boeing-767-300 and crashed into the centre of the city. Twenty people were killed on board the plane and five on the ground. Around 40 people were injured. The disaster was caused by the Learjet 45 crew who did not maintain the along-track separation interval for the trailing vortex turbulence behind the Boeing-767-300 due to a fast landing speed. Instead of the ICAO safe following distance for a light aircraft behind a heavy aircraft, which is the equivalent of 5 nautical miles (9.3 km), the Learjet 45 followed the Boeing 767-300 at a distance of 4.1 NM (7.6 km), which dangerously lead it to enter into the trailing vortex, loss of control and crash land from a height of 726 m.

2.4 According to information from the Transport Safety Board (TSB) in Canada, between 1999 and 2009 in North American airspace alone there were at least 74 cases recorded of aircraft entering a trailing vortex during flights. To one extent or another, this led to the destabilization of the flight and, in some cases, to passengers being injured. In particular, on 10 January 2008 when switching from FL350 to FL370 an Airbus A319-114 belonging to Air Canada entered the trailing vortex of a Boeing 747-400 belonging to United Airlines which was flying ahead of it. Despite the fact that there was a separation of 10.7 NM between the two aircraft, which is significantly higher than the minimum horizontal separation, the A319-114 entered an area of trailing vortex turbulence from the Boeing 747-400 and was affected by serious aerodynamic disturbance. There was then an aircraft roll of 27.8 degrees. When the aircraft roll reached its highest level, the captain of the aircraft switched off the autopilot and the automatic throttle to correct the situation. This was accompanied by four over swings of the aircraft whilst rolling, which ranged from a few degrees to 55º. As a result of the incident, eight passengers and members of the crew received minor injuries and three passengers were seriously injured by falling objects.

2.5 The introduction of super-heavy aircraft such as the Airbus A380 over the past three years has also led to flight incidents connected with trailing vortexes. In particular, on 11 January 2009 an Airbus A-320 belonging to “Armavia” entered the trailing vortex of an Airbus A-380 which was flying above it under RVSM conditions in Georgian airspace. Having entered the trailing vortex, the A-320 was

affected by aerodynamic disturbance in the form of a major roll. The autopilot was switched off, while the Airbus A-320 aircraft roll reached 44.7 degrees. Only the timely intervention of the aircraft crew avoided a possible catastrophe.

2.6 Another incident connected with trailing vortex turbulence involved an Airbus A380 on 3 November 2008 and a SAAB 340B-229. The SAAB 340B-229, containing 2 members of the flight crew, 1 steward and 33 passengers, performed an independent approach to land at Sydney airport in Australia at runway 34 right (34R). At the same time, at the landing strip at runway 34 left (34 L) approximately 3.7 NM (7 km) ahead and to the left of the SAAB, the Airbus A380-800 was also preparing to land. The strong crosswind (35 knots) led to the trailing vortex of the Airbus A380 drifting to the final section of the landing approach of the SAAB. As a result of entering the trailing vortex, the SAAB 340B-229 performed an uncontrolled roll of 52 degrees to the left with a pitching motion of 8 degrees downwards. Immediately after this the aircraft turned over its wing with a banking angle of 21 degrees to the right. As a result of exceeding the operational parameters, the function for switching off the commands stopped issuing the steering commands on autopilot. The crew switched off the autopilot, were able to regain control of the aircraft and landed the aircraft manually. One passenger received minor injuries when the aircraft overturned.

2.7 These examples once again show that the problem of ensuring vortex flight safety is still very topical, and the efforts taken in this area are still not efficient or effective enough. The practice of examining air accidents shows that the air crew are unable to combat disturbance caused by trailing vortexes, and that they often have a vague understanding of the possible effect of a trailing vortex on an aircraft. It is not possible to learn how to cope in a trailing vortex in real flight conditions on account of the lack of specialist flight simulators. Nevertheless, when an aircraft enters a trailing vortex, the pilot needs to make the right decision very quickly. In this respect, as you would imagine, work to create an on-board system to warn the crew that the aircraft is entering a trailing vortex similar to the TCAS systems is still extremely important.

2.8 The problem of vortex flight safety, apart from anything else, is very important from a financial point of view. Following the world financial crisis, the issue of ensuring capacity at large airports has once again become important. According to information from EUROCONTROL, around fifteen of the main airports in Europe are at the limit of their functional capacity, and one of the main factors restricting the required number of take-off and landing operations is the need to ensure separation intervals between aircraft in trailing vortex turbulence. In this respect, the development of systems to monitor and forecast vortex conditions near airports which would allow for us to switch to new procedures and regulations for flights in trailing vortex turbulence remains an important task.

3. PROGRESS IN CREATING A VORTEX FLIGHT SAFETY SYSTEM

3.1 At the moment aviation experts in a number of countries have developed a knowledge base for the nature of trailing vortex turbulence and the way it affects aircraft, and have created mathematical modelling methods for trailing vortexes, as well as reliable measurement methods. A lot of work has been done in this area but there is still a need for reliable and effective instruments for the practical implementation of modern technology to ensure vortex flight safety. These issues are being examined by large national projects to set up air traffic control systems, such as NextGen (USA), and SESAR (EU). A Russian vortex flight safety system is being developed within the State Civil Aviation Flight Safety Program, approved by the Russian Federation Government.

3.2 The design principles and architecture of the national flight vortex safety systems which are being developed comply with the provisions of document A36-WP/193 “Current vortex flight safety problems in civil aviation”, presented by the Russian Federation at the 36th ICAO Assembly. The similarity of the architecture and technical solutions will potentially allow for the construction of a single vortex safety system within the global aeronautical system.

3.3 One of the ways of increasing airspace capacity is by reviewing the separation minima introduced by ICAO at the start of the 1970s. Many experts believe that the ICAO aircraft separation intervals for trailing vortex turbulence do not fully comply with modern-day requirements. The three aircraft categories introduced by the ICAO (heavy, medium, and light), to characterize the level of danger of the aircraft trailing vortex, provide an approximate reflection of the modern international fleet of aircraft, but do not take into consideration the introduction of the new super-heavy aircraft, the effect of which (from the point of view of trailing vortexes) has not been fully studied and may involve a number of potential problems.

3.4 Moreover, preliminary research shows that the separation intervals, for example for the “medium” category, are unduly conservative and could be significantly reduced without affecting flight safety. This would require a “recategorization” process, i.e. a detailed review of the existing aircraft categories with an increase in the number of vortex aircraft categories in order to give the take-off and landing systems greater operational flexibility.

3.5 The introduction at airports of reliable all-weather trailing vortex warning systems will allow for a switch to dynamically changing separation intervals (depending on the specific pair of aircraft and the weather conditions at the time) in the near future due to the increase in traffic volume. We would like to point out that these systems are based on infrared lidars and x-band radars which are sufficiently well developed. A huge amount of research has been done into these systems and a lot of factual material has been collected. Therefore, many aviation experts believe that time will dictate the need to move forward with the program for the real implementation of a trailing vortex monitoring and forecasting system as well as improvements to the application of vortex separation standards, which in future will help restore the capacity of airports with all of the economic advantages which this entails.

4. DISCUSSION

4.1 Carrying out work on the vortex recategorization of aircraft requires the development under the aegis of ICAO of a single methodology for the recategorization procedure. The main principles for this are as follows:

a) using the intensity of the trailing vortex as a measure of the danger involved, rather than the maximum take-off weight of the aircraft;

b) not allowing aircraft to enter more intense vortices than those which exist at the moment; and

c) using the induced banking angle as a measure of the danger involved in the aircraft entering the trailing vortex.

4.2 The process for reducing the circulation of a trailing vortex should be implemented using the models tested within the joint research carried out by the USA, European countries and the Russian Federation.

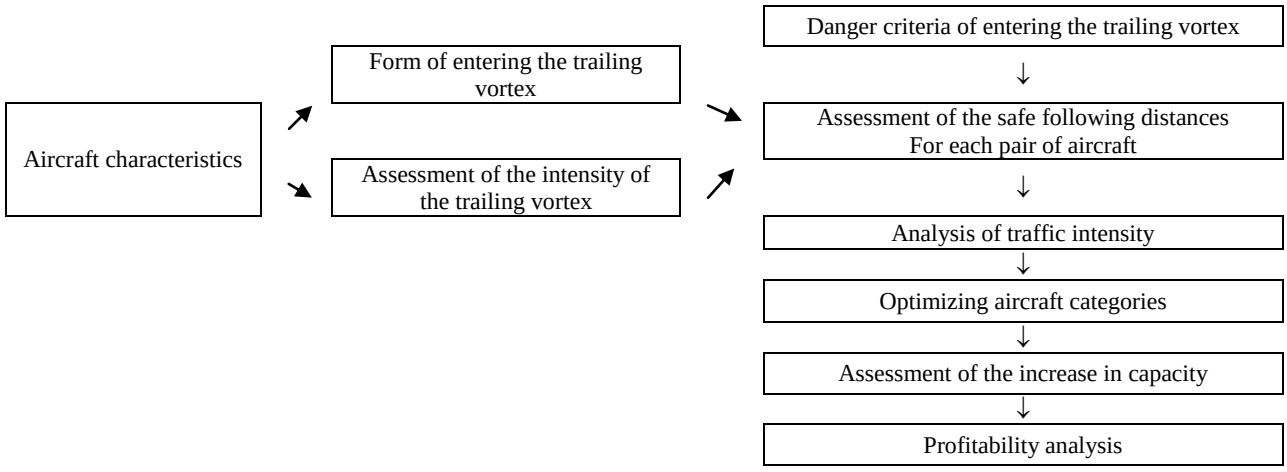

Figure 1. Methodology for recategorizing the separation regulations for the aircraft fleet for trailing vortex turbulence

4.3 The many practical applications of the vortex flight safety system should be based on the system of background information needed to calculate the trailing vortices for the aircraft, as well as on determining the stability and manageability of the aircraft in trailing vortex turbulence and determining safe trailing intervals. These applications include software systems for the vortex recategorization procedure, on-board systems to warn when the aircraft is entering a trailing vortex, ground-based systems for monitoring and forecasting vortex conditions near the airport, and regional air traffic control centres, as well as specialist aviation simulators. This system of background information should be included in the ICAO database for aircraft vortex turbulence, which is similar to the ICAO database for noise and emissions.

4.4 To provide a single methodological approach when assessing the level of vortex danger for an aircraft, a procedure should be prepared for its certification according to the level of danger of the trailing vortex (similar to the certification of aircraft based on noise and emissions).

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