International Civil Aviation Organization

WORKING PAPER

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TECHNICAL COMMISSION

Agenda Item 27: ICAO Global Aviation Safety Plan

THE URGENCY OF WAKE TURBULENCE SAFETY PROBLEMS IN CIVIL AVIATION

(Presented by the Russian Federation)

EXECUTIVE SUMMARY

This paper examines the problem of wake turbulence from the viewpoint of flight safety and increasing airspace capacity. The paper briefly describes a systems approach to a resolution of this problem and how it is applied in practice. Given the urgency of wake turbulence problems in civil aviation, the Russian Federation proposes that the ICAO Technical Work Programme be amended to include the development of basic requirements for airborne and ground wake turbulence prevention and indication systems.

Action: The Assembly is invited to:

a) agree that the problem of wake turbulence safety requires study from both the practical scientific and economic points of view;
b) recommend that the Council examine the possibility of including the development of basic requirements for airborne and ground components of an integrated wake turbulence safety system in the ICAO Technical Work Programme; and
c) recommend that the ICAO Council intensify its efforts in the area of wake turbulence safety.

Strategic Objectives:	This working paper relates to Strategic Objective A.
Financial implications:	
References:	Doc 9848, *Assembly Resolutions in Force (as of 8 October 2004)* Doc 8168, Procedures for Air Navigation Services Doc 9426, *Air Traffic Services Planning Manual* Doc 7030, *Regional Supplementary Procedures*

[1] English and Russian versions provided by the Russian Federation.

1. INTRODUCTION

1.1 One of the fundamental tasks of the International Civil Aviation Organization (ICAO) is that of enhancing the safety of international civil aviation around the world. As an active participant in the resolution of flight safety issues, ICAO can claim a role as coordinator in the implementation of various safety initiatives being undertaken around the world. The role of ICAO in the Global Aviation Safety Plan (GASP) is to facilitate the exchange of flight safety information between governments and industry and to strive to ensure that the various programmes being undertaken in the field are complementary rather than competing and oriented towards multi-faceted systems solutions to both regional and global safety problems facing civil aviation. Resolution A33-16 confirmed the necessity of implementing the ICAO accident prevention programme and also endorsed the concept of concentrating the safety-related activities of ICAO on those safety initiatives, planned or currently under way, that offer the best safety dividend in terms of reducing the accident rate.

2. AIRCRAFT ACCIDENTS AND INCIDENTS ASSOCIATED WITH WAKE TURBULENCE

2.1 Flight safety analysis indicates that most aviation accidents occur due to runway overruns, mechanical or system failure or malfunction, abnormal landing and turbulence. One substantial factor affecting flight safety is the risk of flying into the wake turbulence of another aircraft. Flying into a wake vortex can cause uncontrollable roll rates of 200 degrees/sec, altitude losses of up to 200 m. or more, and lateral G forces of 0.5 – 0.9, ultimately resulting in loss of control in flight. The paradox is that the wake vortex itself is invisible and cannot be detected visually by the pilot. It is important to note that a wake vortex can hang in the air for several minutes and extend many kilometers behind the aircraft. The world aviation community is at present concentrating on resolving wake turbulence safety problems associated with the entry into service of a new generation of wide-bodied aircraft (Airbus A380, Boeing B787, Antonov An-124-100, Antonov An-225).

2.2 According to British specialists, at Heathrow Airport (London) there is one incident caused by a wake turbulence encounter for every 150 take-offs and landings. ADREP data from 1997 to 2003 show that 125 accidents involving aircraft with maximum certificated take-off masses (MTOW) of over 5700 kg. occurred because of en-route turbulence, and three of those accidents resulted in human casualties.

2.3 In April 2004, NASA presented a report on an aircraft accident involving an Airbus A300-600 operated by American Airlines. On 12 November 2001, the A300-600 took off from John F. Kennedy Airport and executed the departure procedure. At an altitude of 800 m., the aircraft entered a strong wake vortex from a Boeing B747-400 operated by Japan Airlines, which led to a loss of controllability. The accident investigation revealed the swift and dangerous effect of wake turbulence on the aircraft. The transition from emergency to disaster lasted 8 sec. The accident took the lives of 251 passengers, nine crew members and five persons on the ground.

2.4 Similar accidents happened in the Soviet Union in 1979 and 1987, when Yakovlev Yak-40s entered the wake vortices of, respectively, a Mil Mi-6 helicopter and an Ilyushin Il-76 aircraft. These accidents cost, respectively, fifty-five and five lives.

2.5 On 13 August 2005, in airspace under the responsibility of the Shannon area control centre (Ireland), there was an incident involving a Boeing B757-200 and an Airbus A340-500. The investigation revealed that the A340-500, which was in the lead, crossed the flight level of the B757-500. The latter encountered the wake vortex of the Airbus, was thrown into an extremely strong, uncontrollable bank of up to 45 degrees and lost 400 feet of altitude. According to ground radar data, the actual longitudinal separation between the two aircraft was twice that required (at the time of the incident, the vertical separation was 1000 ft. and the horizontal separation was 9 miles). Several passengers were injured in the incident.

3. ICAO ACTIVITIES IN THE AREA OF WAKE TURBULENCE SAFETY

3.1 Wake turbulence is a pressing problem for civil aviation from the standpoint of both flight safety and airspace capacity. It is an important factor that must be taken into account as aviation continues to grow. This problem affects airspace users, airport services and air navigation service providers.

3.2 For many years, ICAO focused its turbulence-related work on wind shear and the development of linear and temporal separation between aircraft on take-off and landing (*Air Traffic Services Planning Manual* (Doc 9426)). To promote safety, the United States implemented a wake vortex advisory system (WVAS), which was a combination of the vortex warning system (VWS) and the vortex advisory system (VAS). The WVAS could solve wake turbulence problems at some airports and issue forecasts that made it possible to set corrective separation minima, which in turn optimized the traffic flow in any given situation.

3.3 Attention must be given to the absence of effective, reliable means of assessing and locating wake turbulence. To this end, ICAO cooperates with the developers of appropriate integrated (airborne and ground modules) flight safety systems comprising ground and airborne components together with meteorological services and other systems, which will significantly enhance flight safety.

3.4 At the present time, wake turbulence is the focus of attention in many states on various levels. Wake turbulence coordinating councils have been established: WakeNet-Europe, WakeNet-USA. The Russian Federation is also presently creating a coordination council to deal with this issue. Conferences, seminars and workshops on wake turbulence safety are being held. In November 2005, the issue of reviewing wake turbulence separation standards was examined at the Eurocontrol experimental centre in Bretigny (France). At the worldwide symposium, “Flying through Congested Airspace”, which was organized by ICAO in September 2006 in cooperation with McGill University, one of the conclusions noted the importance of developing wake turbulence forecasting technology. In 2003, the United States (FAA), Eurocontrol, the Joint Aviation Authorities (JAA) and aircraft designers set up a special expert group to study aspects of wake turbulence associated with the operation of the Airbus A380. The group proposed increasing separation from the Airbus A380 in accordance with the mass of the aircraft flying behind it.

3.5 In December 2005, the European Air Navigation Planning Group (EANPG/47) examined an incident involving an Airbus A340-500 and a Boeing B757-200. It noted that having aircraft climb one behind the other is common practice in air traffic control. The group focused its attention on the need for scientific studies of problems resulting from wake turbulence encounters associated with the implementation of RVSM. In accordance with ICAO's Strategic Objective A (Safety) it is proposed that there be timely reporting of wake turbulence incidents, that they be analyzed and the resulting information widely disseminated to increase understanding of the nature of wake turbulence and the hazards associated with it.

3.6 Practical experience has demonstrated that the present minimum longitudinal separation is too conservative in various weather conditions. It has been noted that wind and turbulence often lead to significant displacement and dispersal of wake vortices; on the other hand, weak winds and the absence of turbulence can allow intense vortices to hang in the air for longer than the time predicted in separation procedures.

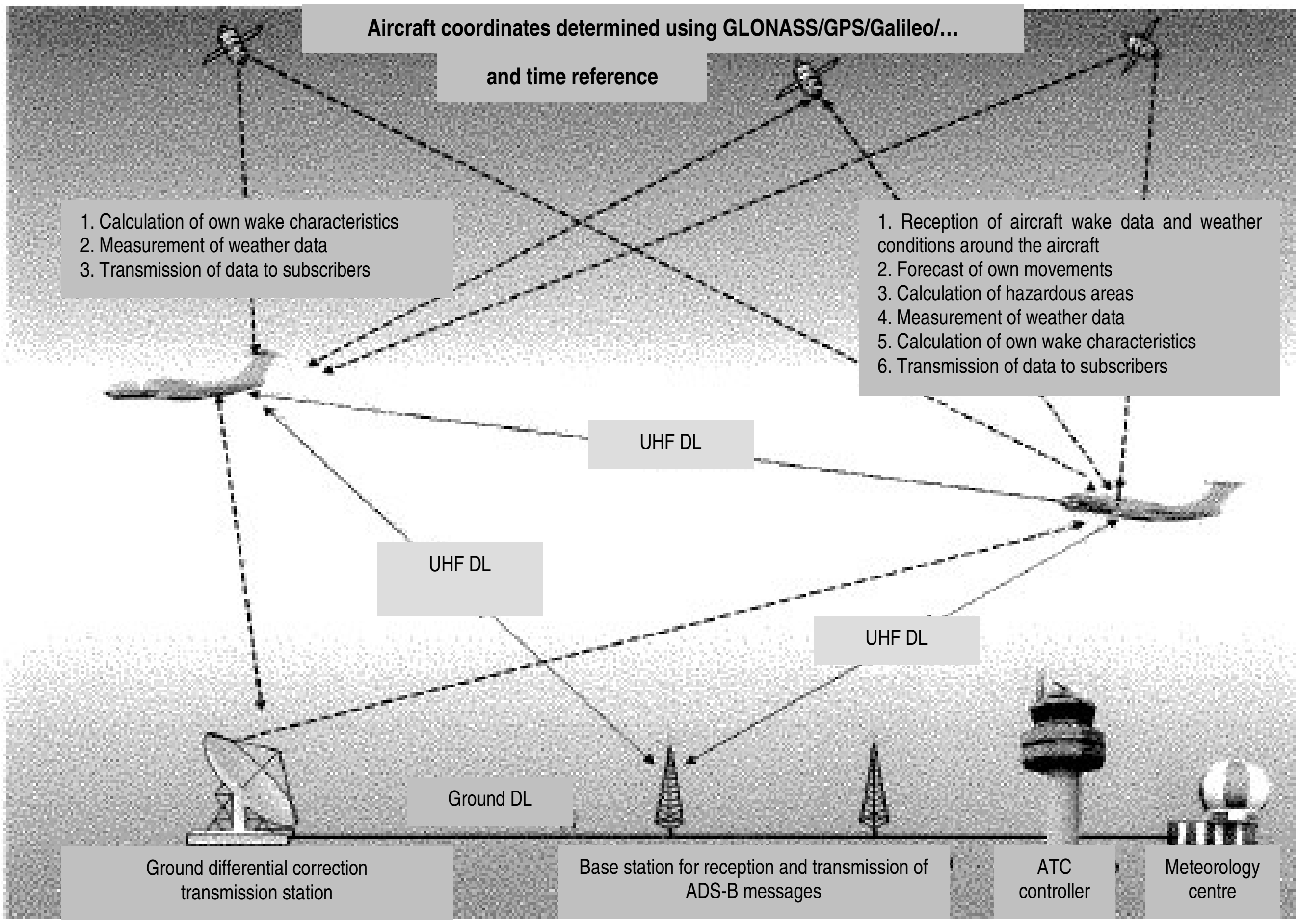
3.7 Facts and statistics convincingly demonstrate the seriousness of the problem and the urgency of finding a solution. The situation is made more serious by the constant growth of air traffic, the congestion of hub airports, the capacity limitations of major air routes and the increasing work loads of air traffic controllers and flight crews. We believe that ICAO's activity in the area of wake turbulence safety must be directed towards an active resolution of the problem through the development of rules, procedures and recommendations for wake turbulence safety.

4. ECONOMIC ASPECTS

4.1 As regards the economic aspects of wake turbulence safety, compliance with existing ICAO separation standards limits the capacity of airports and airways. For example, in 2000, 19 per cent of total departure delays resulted from compliance with longitudinal separation standards. As air traffic density continues to increase, it is expected that by 2010, complying with existing ICAO standards will increase the number of delays by 40 percent over the 2000 levels. According to data from the National Air and Space Laboratory NLR (Netherlands), airlines and airports in the European Community and the United States are expected to lose a total of about 4 billion US dollars annually.

5. DISCUSSION

5.1 In order to resolve the above-mentioned problems, the Russian Federation has developed a model of a wake turbulence safety system, using data transmission and surveillance in accordance with ICAO CNS/ATM technologies. The key element of this system is the vortex visualization sub-system, which is a hardware-software complex that provides pilots and controllers with information on the vortex situation and warns them of possible hazardous wake turbulence conditions. The main principle on which the sub-system is based is "each party can see the vortices behind everyone." The aircraft are the main source of information for the system. Each aircraft provides data on its own parameters – configuration, wake vortex, actual load, flight performance and weather conditions (pressure, temperature, wind direction and speed, atmospheric turbulence). Information on aircraft positions and data on the vortex conditions, which are needed in order to determine areas of dangerous vortex activity, are provided to all aircraft and to the air traffic controller's work station by data link using automatic dependant surveillance-broadcast technology (ADS-B). Specific transmissions use Mode 4 UHF data link in accordance with the standards set by ICAO and the European Telecommunication Standards Institute.



5.2 Instrumental methods and forecasting algorithms used on the aircraft and at the ground ATC centre can be used to forecast vortex conditions. A visual presentation of the vortex situation is presented on the cockpit display, giving the pilot the wake turbulence information needed to manoeuvre effectively if necessary to prevent the aircraft from encountering a wake vortex.

5.3 The information arriving at the ATC controller's work station helps the controller make correct decisions in controlling the phase of flight for which he or she is responsible. The provision of this type of information eliminates ambiguity and makes it possible for the pilot to take timely steps to prevent the aeroplane from entering a dangerous wake turbulence zone and enables the controller to facilitate this process. Specialized simulators have been built to train the pilot in making wake turbulence avoidance decisions.

5.4 The Russian integrated wake turbulence safety system uses commercially available equipment and the ICAO CNS/ATM technology, including modern aviation meteorological support technology. The airborne module of the system is easy to integrate into the flight navigation systems of various generations of aeroplanes. Similar technical means of enhancing wake turbulence safety have been taken in Europe (ATC-Wake programme) and the USA (WakeVAS programme). According to expert evaluations, implementation of the basic elements of the wake turbulence safety system will begin in Russia and a number of other countries as early as 2009. Introduction of the system will enable the pilot to make sound independent decisions to ensure wake turbulence safety. This will practically eliminate wake vortex encounters and will make it possible to reduce aircraft separation.

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