

ATTACHMENT

to ISPACG Information Paper titled:

SASP Consideration of Contingency and Weather Deviation Events in a Reduced Horizontal Separation Environment

The *following* ten (10) pages contain ICAO SASP-WG/27 – WP 18



International Civil Aviation Organization

WORKING PAPER

SEPARATION AND AIRSPACE SAFETY PANEL (SASP)

TWENTY SEVENTH WORKING GROUP MEETING

Oklahoma City, USA (09 to 20 November 2015)

Agenda Item 2: En-route separation minima and procedures - horizontal

Consideration of Contingency and Weather Deviation Procedures and Events When Assessing Reduced Horizontal Procedural Separation Standards

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SUMMARY

The objective of this paper is to establish that operational scenarios such as aircraft contingencies and emergencies, and weather deviations that require the aircraft to deviate from cleared track or altitude before receiving a clearance, must be addressed when planning criteria and procedures for the introduction of reduced horizontal procedural separation standards.

1. INTRODUCTION

1.1 The objective of this paper is to establish that operational scenarios such as aircraft contingencies and emergencies, and weather deviations that require the aircraft to deviate from cleared track or altitude before receiving a clearance, must be addressed when planning criteria and procedures for the introduction of reduced horizontal separation standards to be applied in procedural airspace.

1.2 Specifically, the paper proposes that the *Procedures for Air Navigation Services – Air Traffic Management* (ICAO Doc 4444, PANS-ATM), paragraph 15.2 (Special Procedures For In-Flight Contingencies In Oceanic Airspace) be reviewed and revised, as necessary, when planning for the introduction of reduced horizontal separation standards. Paragraph 15.2.1 through 15.2.2.4 contain general procedures for aircraft diversions, turn-backs and deviation from cleared altitude. Paragraph 15.2.3 contains “Weather deviation procedures” for events that occur when controller-pilot communications have been established and also for events that occur when a revised clearance cannot be obtained prior to the aircraft deviating from its cleared track or altitude to avoid weather (e.g., convective weather (thunder storms), clear air turbulence).

1.3 SASP-WG/WHL/26 conducted discussions of reduced horizontal procedural separation standards to be developed for publication in ICAO Doc 4444. It is anticipated that this discussion will continue in SASP-WG/WHL/27 and in the SASP meetings that follow. This paper is presented to support the discussion of this subject.

2. DISCUSSION

Reduced airspace in which to maneuver during contingencies and weather deviations

2.1 As oceanic separation standards have been introduced, the airspace in which aircraft can execute contingency maneuvers or maneuver to avoid convective weather without conflicting with other aircraft has been significantly reduced. For example, lateral separation in the Pacific Region was 100 nautical miles (NM) until the 2000 timeframe when it was reduced to 50 NM and then subsequently to 30 NM between eligible aircraft. Also, in West Atlantic Route System (WATRS) airspace, lateral separation was reduced in 2008 from 90 NM to 50 NM and a new track system implemented using 50 NM track spacing.

2.2 Since the SASP is considering the development of Standards and Recommended Practices (SARPS) (e.g., Communications, Navigation and Surveillance (CNS) requirements) and guidance that will possibly further reduce horizontal separation in procedural airspace and, therefore, possibly the size of the airspace in which an aircraft can maneuver during contingencies and weather deviations, the paragraphs below were developed to highlight the necessity to consider this factor and its effect on existing ICAO Doc 4444 procedures during the development process.

General Procedures (ICAO Doc 4444, paragraphs 15.2.1-15.2.2.4)

2.3 During operations in oceanic and remote areas, aircraft are called upon to deviate from cleared track and/or altitude in order to execute contingency procedures. Aircraft contingencies include turn-backs and diversions to an alternate airport as well as deviations from assigned altitude necessitated by aircraft system failure or malfunction, passenger medical emergencies and disturbances, and other events. Examples of aircraft system malfunctions include, but are not limited to, engine shut down, pressurization system malfunction and low fuel temperature.

2.4 For most contingency events, the aircraft is able to obtain an air traffic control (ATC) clearance prior to departing from cleared track and/or altitude. There are, however, events where the nature of the contingency is such that the aircraft is required to depart from its cleared track and/or altitude prior to obtaining an ATC clearance in order to address the contingency at hand. Example data from North Atlantic (NAT) operations is provided below.

Example: North Atlantic Central Monitoring Agency (CMA) Data – Contingency Events

2.5 The NAT CMA is responsible to the NAT Safety Oversight Group for tasks associated with monitoring and reporting on NAT operations, including monitoring the level of risk as a consequence of operational errors and in-flight contingencies. The NAT CMA provides data to support the on-going work of NAT sub-groups including the NAT Scrutiny Group and the NAT Mathematicians' Working Group.

2.6 Prior to 2012 the CMA produced a report that specifically tracked contingencies in the NAT (e.g. diversions and turn-backs). After 2012, it was determined that, since the vast majority of contingency maneuvers are undertaken with an ATC clearance, it was only necessary to track contingencies that resulted in a Gross Navigation Error (GNE) or Large Height Deviation (LHD).

2.7 The following observations were made in the diversion and turn-back event data from 2012:

- a) 130 diversions or turn-back events were recorded in the NAT Region in 2012.
- b) 115 of these events occurred in NAT Minimum Navigation Performance Specification (MNPS) Airspace (approximately 10 per month).

- c) 15 events were recorded in NAT MNPS Airspace where the pilot executed contingency procedures in accordance with Doc 4444 to divert, turnback and/or depart from cleared altitude prior to obtaining an ATC clearance.

Note: The NAT CMA Turn-back and Diversion data was also reviewed for years 2006 through 2009 during planning for the application of reduced horizontal separation in the NAT using FANS 1/A (or equivalent) Controller-Pilot Data Link Communication (CPDLC) and Automatic Dependent Surveillance – Contract (ADS-C). In that period, 144 contingency events occurred per year with approximately 35 per year initiated under Pilot-In-Command (PIC) authority. (NAT SARSIG/10 – IP/04 (13/10/09) refers.)

Current ICAO Doc 4444 In-Flight Contingency Procedures for Oceanic Airspace

2.8 ICAO Doc 4444, paragraph 15.2.2.3 contains guidance to the pilot on contingency procedures that should be followed when the aircraft is required to deviate from track and/or altitude prior to obtaining a revised ATC clearance. (See Attachment A). The guidance calls for the pilot to leave assigned track by initially turning at least 45 degree right or left in order to acquire a same-direction or opposite-direction track offset of 15 NM from assigned track. In addition, when able to maintain altitude, the pilot is advised to climb or descend 500 feet (ft.) when at or below Flight Level (FL) 410 or 1,000 ft. when above FL410.

2.9 ICAO Doc 4444, paragraph 15.2.2.3.1 provides guidance on overshooting the 15 NM offset track particularly when turning back in the opposite direction.

Issues to be addressed in ICAO Doc 4444, paragraph 15.2 when assessing reduced horizontal separation standards

2.10 It is proposed that the SASP consider the following actions:

- a) Conduct a general review and revision, as necessary, of ICAO Doc 4444 “General procedures” (paragraphs 15.2.1-15.2.2.4) and any other ICAO documents that may be affected when assessing provisions for the application of reduced horizontal separation.
- b) Review and revise, as necessary, paragraph 15.2.2.3 a) guidance calling for a 15 NM offset when the aircraft is forced to deviate prior to obtaining a revised clearance.
- c) Review and revise, as necessary, paragraph 15.2.2.3 b) 2) guidance calling for the aircraft to maintain cleared altitude until 10 NM from cleared track before climbing or descending 500 ft. when at/below FL 410 or 1,000 ft. when above FL 410.
- d) Review and revise, as necessary, paragraph 15.2.2.3.1 b) guidance for an aircraft turning to maintain an opposite direction offset resulting in the potential for that aircraft to infringe on another aircraft’s airspace while executing the turnback maneuver.

ICAO Doc 4444, paragraph 15.2.3 (Weather deviation procedures)

2.11 Convective weather systems can significantly affect oceanic operations, particularly in areas of the world that are susceptible to convective weather (e.g., WATRS, the Caribbean Sea, the South China Sea and the Pacific inter-tropical convergence zone). A convective weather system is problematic in that the system can affect multiple routes and, therefore, multiple aircraft operating in proximity to one another.

2.12 As noted in paragraph 2.1 of this paper, as reduced oceanic separation standards have been introduced, the airspace in which aircraft can maneuver to avoid convective weather without conflicting with other aircraft has been significantly reduced and this factor should be considered when further reductions are being assessed.

2.13 Operating experience has shown that many deviations from track to avoid convective weather are on the order of 15-20 NM, however, larger deviations are commonly experienced. It is not uncommon for pilots to have to deviate using PIC authority because a clearance is not available due to other traffic. (See Attachment B, Example Weather Deviation Events in Airspace where the U.S. Provides ATC).

2.14 ICAO Doc 4444, paragraph 15.2.3 Weather Deviation Procedures provides guidance to the pilot and controller for situations in which the pilot must deviate from track to avoid convective weather. Paragraph 15.2.3.2 provides guidance on actions to be taken when controller-pilot communications are established. Paragraph 15.2.3.3 provides guidance for situations in which the aircraft is unable to obtain a revised clearance prior to deviating.

2.15 Paragraph 15.2.3.2.2 specifically provides guidance to the controller when there is conflicting traffic and ATC is unable to provide separation. The guidance calls for the controller to:

- a) advise the pilot of inability to issue clearance for the requested deviation;
- b) advise the pilot of conflicting traffic; and
- c) request the pilot's intentions.

2.16 Paragraph 15.2.3.3 provides guidance for situations in which the aircraft must deviate to avoid convective weather and a revised clearance cannot be obtained. Significant measures include:

- a) establishing communications with and alerting nearby aircraft;
- b) watching for conflicting traffic both visually and by reference to ACAS (if equipped);
- c) for deviations greater than 10 NM, initiating a level change in accordance with Table 15-1 (i.e., climbing or descending 300 ft. based on the direction of flight and the direction of the deviation); and,
- d) continuing to keep ATC advised of intentions.

Issues and factors related to weather deviation procedures

2.17 It is proposed that the SASP consider the following questions factors related to weather deviation procedures when considering provisions for reduced horizontal separation:

- a) Will reduced horizontal separation standards increase the probability that aircraft will be required to maneuver under PIC authority in order to avoid convective weather because an ATC clearance is not available?
- b) Are the existing ICAO Doc 4444 Weather Deviation Procedures adequate to support the safety of the operation when reduced separation standards are applied in procedural airspace? (This question is asked under the assumption that SASP will review Doc 4444 paragraph 15.2.3.3 during its assessment of reduced separation standards).
- c) What SARPS or guidance can the SASP provide to air navigation service providers (ANSPs) and pilots to maintain an equivalent level of safety when weather deviations are required and reduced horizontal separation standards are applied?
- d) What measures can ANSPs take to mitigate the effect of convective weather in those situations where convective weather affects a wide area of airspace?

3. ACTION BY THE MEETING

3.1 The SASP is invited to:

- a) review and comment on the information provided;
- b) establish a task to review and revise, as necessary, ICAO Doc 4444, paragraph 15.2 (Special Procedures for In-Flight Contingencies In Oceanic Airspace) and any other ICAO documents that may be affected as it develops reduced horizontal procedural separation standards (Paragraphs 2.10 and 2.17 refer);
- c) consider the suggested actions related to contingency procedures and events (Paragraph 2.10 refers);
- d) consider the questions and issues related to weather deviation procedures and events (Paragraph 2.17 refers); and
- e) if practicable, include in the collision risk modelling for the development of reduced horizontal procedural separation minima the effect of events such as aircraft in-flight contingencies and weather deviations that are initiated when an ATC clearance is not available.

ATTACHMENTS

- Attachment A ICAO Doc 4444 paragraph 15.2 (Special Procedures for In-Flight Contingencies in Oceanic Airspace)
- Attachment B Example Weather Deviation Events in Airspace where the U.S. Provides ATC

ATTACHMENT A**ICAO Document 4444 (PANS-ATM)****15.2 SPECIAL PROCEDURES FOR IN-FLIGHT
CONTINGENCIES IN OCEANIC AIRSPACE****15.2.1 Introduction**

15.2.1.1 Although all possible contingencies cannot be covered, the procedures in 15.2.2 and 15.2.3 provide for the more frequent cases such as:

- a) inability to comply with assigned clearance due to meteorological conditions, aircraft performance or pressurization failure;
- b) en-route diversion across the prevailing traffic flow; and
- c) loss of, or significant reduction in, the required navigation capability when operating in an airspace where the navigation performance accuracy is a prerequisite to the safe conduct of flight operations.

15.2.1.2 With regard to 15.2.1.1 a) and b), the procedures are applicable primarily when descent and/or turnback or diversion is required. The pilot shall take action as necessary to ensure the safety of the aircraft, and the pilot's judgement shall determine the sequence of actions to be taken, having regard to the prevailing circumstances. Air traffic control shall render all possible assistance.

15.2.2 General procedures

15.2.2.1 If an aircraft is unable to continue the flight in accordance with its ATC clearance, and/or an aircraft is unable to maintain the navigation performance accuracy specified for the airspace, a revised clearance shall be obtained, whenever possible, prior to initiating any action.

15.2.2.2 The radiotelephony distress signal (MAYDAY) or urgency signal (PAN PAN) preferably spoken three times shall be used as appropriate. Subsequent ATC action with respect to that aircraft shall be based on the intentions of the pilot and the overall air traffic situation.

15.2.2.3 If prior clearance cannot be obtained, until a revised clearance is received the following contingency procedures should be employed and the pilot shall advise air traffic control as soon as practicable, reminding them of the type of aircraft involved and the nature of the problem. In general terms, the aircraft should be flown at a flight level and on an offset track where other aircraft are least likely to be encountered. Specifically, the pilot shall:

- a) leave the assigned route or track by initially turning at least 45 degrees to the right or to the left, in order to acquire a same or opposite direction track offset 15 NM (28 km) from the assigned track centreline. When possible, the direction of the turn should be determined by the position of the aircraft relative to any organized route or track system. Other factors which may affect the direction of the turn are:
 - 1) the direction to an alternate airport;
 - 2) terrain clearance;
 - 3) any strategic lateral offset being flown; and
 - 4) the flight levels allocated on adjacent routes or tracks;
- b) having initiated the turn:

- 1) if unable to maintain the assigned flight level, initially minimize the rate of descent to the extent that is operationally feasible (pilots should take into account the possibility that aircraft below on the same track may be flying a 1 or 2 NM strategic lateral offset procedure (SLOP)) and select a final altitude which differs from those normally used by 150 m (500 ft) if at or below FL 410, or by 300 m (1 000 ft) if above FL 410; or
 - 2) if able to maintain the assigned flight level, once the aircraft has deviated 19 km (10 NM) from the assigned track centreline, climb or descend to select a flight level which differs from those normally used by 150 m (500 ft), if at or below FL 410, or by 300 m (1 000 ft) if above FL 410;
- c) establish communications with and alert nearby aircraft by broadcasting, at suitable intervals on 121.5 MHz (or, as a backup, on the inter-pilot air-to-air frequency 123.45 MHz) and where appropriate on the frequency in use: aircraft identification, flight level, position (including the ATS route designator or the track code, as appropriate) and intentions;
 - d) maintain a watch for conflicting traffic both visually and by reference to ACAS (if equipped);
 - e) turn on all aircraft exterior lights (commensurate with appropriate operating limitations); and
 - f) keep the SSR transponder on at all times.

15.2.2.3.1 When leaving the assigned track:

- a) if the intention is to acquire a same direction offset track, the pilot should consider limiting the turn to a 45 degree heading change, in order not to overshoot the offset contingency track; or
- b) if the intention is to acquire and maintain an opposite direction offset track, then:
 - 1) operational limitations on bank angles at cruising altitudes will normally result in overshooting the track to be acquired. In such cases a continuous turn should be extended beyond 180 degrees heading change, in order to re-intercept the offset contingency track as soon as operationally feasible; and
 - 2) furthermore, if executing such a turnback in a 56 km (30 NM) lateral separation route structure, extreme caution pertaining to opposite direction traffic on adjacent routes must be exercised and any climb or descent, as specified in 15.2.2.3 b) 2), should be completed preferably before approaching within 19 km (10 NM) of any adjacent ATS route.

15.2.2.4 EXTENDED RANGE OPERATIONS BY AEROPLANES WITH TWO-TURBINE POWER-UNITS (ETOPS)

If the contingency procedures are employed by a twin-engine aircraft as a result of an engine shutdown or failure of an ETOPS critical system, the pilot should advise ATC as soon as practicable of the situation, reminding ATC of the type of aircraft involved, and request expeditious handling.

15.2.3 Weather deviation procedures

15.2.3.1 GENERAL

Note.— The following procedures are intended for deviations around adverse meteorological conditions.

15.2.3.1.1 When the pilot initiates communications with ATC, a rapid response may be obtained by stating “WEATHER DEVIATION REQUIRED” to indicate that priority is desired on the frequency and for ATC response. When necessary, the pilot should initiate the communications using the urgency call “PAN PAN” (preferably spoken three times).

15.2.3.1.2 The pilot shall inform ATC when weather deviation is no longer required, or when a weather deviation has been completed and the aircraft has returned to its cleared route.

15.2.3.2 ACTIONS TO BE TAKEN WHEN CONTROLLER-PILOT
COMMUNICATIONS ARE ESTABLISHED

15.2.3.2.1 The pilot should notify ATC and request clearance to deviate from track, advising, when possible, the extent of the deviation expected.

15.2.3.2.2 ATC should take one of the following actions:

- a) when appropriate separation can be applied, issue clearance to deviate from track; or
- b) if there is conflicting traffic and ATC is unable to establish appropriate separation, ATC shall:
 - 1) advise the pilot of inability to issue clearance for the requested deviation;
 - 2) advise the pilot of conflicting traffic; and
 - 3) request the pilot’s intentions.

15.2.3.2.3 The pilot should take the following actions:

- a) comply with the ATC clearance issued; or
- b) advise ATC of intentions and execute the procedures detailed in 15.2.3.3.

15.2.3.3 ACTIONS TO BE TAKEN IF A REVISED
ATC CLEARANCE CANNOT BE OBTAINED

Note.— The provisions of this section apply to situations where a pilot needs to exercise the authority of a pilot-in-command under the provisions of Annex 2, 2.3.1.

If the aircraft is required to deviate from track to avoid adverse meteorological conditions and prior clearance cannot be obtained, an ATC clearance shall be obtained at the earliest possible time. Until an ATC clearance is received, the pilot shall take the following actions:

- a) if possible, deviate away from an organized track or route system;
- b) establish communications with and alert nearby aircraft by broadcasting, at suitable intervals: aircraft identification, flight level, position (including ATS route designator or the track code) and intentions, on the frequency in use and on 121.5 MHz (or, as a backup, on the inter-pilot air-to-air frequency 123.45 MHz);

- c) watch for conflicting traffic both visually and by reference to ACAS (if equipped);

Note.— If, as a result of actions taken under the provisions of 15.2.3.3.1 b) and c), the pilot determines that there is another aircraft at or near the same flight level with which a conflict may occur, then the pilot is expected to adjust the path of the aircraft, as necessary, to avoid conflict.

- d) turn on all aircraft exterior lights (commensurate with appropriate operating limitations);
- e) for deviations of less than 19 km (10 NM) remain at a level assigned by ATC;
- f) for deviations greater than 19 km (10 NM), when the aircraft is approximately 19 km (10 NM) from track, initiate a level change in accordance with Table 15-1;
- g) when returning to track, be at its assigned flight level when the aircraft is within approximately 19 km (10 NM) of the centre line; and
- h) if contact was not established prior to deviating, continue to attempt to contact ATC to obtain a clearance. If contact was established, continue to keep ATC advised of intentions and obtain essential traffic information.

Table 15-1

<i>Route centre line track</i>	<i>Deviations > 19 km (10 NM)</i>	<i>Level change</i>
EAST 000° – 179° magnetic	LEFT RIGHT	DESCEND 90 m (300 ft) CLIMB 90 m (300 ft)
WEST 180° – 359° magnetic	LEFT RIGHT	CLIMB 90 m (300 ft) DESCEND 90 m (300 ft)

ATTACHMENT B

Examples of Weather Deviation Events in Airspace where the U.S. Provides ATC

(50 NM lateral separation, 10-minute longitudinal separation and 50 NM track spacing applied)

Date	Event Description	Comments
3 Nov 2011	Aircraft cleared via Route X southbound F370. At 1522 flight requested deviation 20NM left due to weather. Deviation was not available due to parallel traffic on Route Y southbound at F370. Deviation was not available at any other altitude. Controller offered deviation to the right at F370. However, the pilot could not turn right due to thunderstorm activity. At 1526z, aircraft declared emergency and deviated 40NM left. Controller issued traffic information to aircraft. Aircraft reported back on route at 1543z and standard separation was established (50NM lateral required).	
24 Oct 2011	Aircraft was southbound on Route X at F350. At 1412z requested deviation around weather 15NM left. Deviation could not be approved as requested due to another aircraft southbound F350 on a parallel airway – 8 minutes in front (10 minutes required). Aircraft was ADS-C connected and a lateral deviation event was triggered at 1412:49z. Aircraft deviated 10NM left without a clearance and separation was lost with another aircraft. At 1414:11z the controller cleared aircraft to F340, upon reaching F340, cleared to deviate up to 15NM left. Aircraft reported at 1422:07z back on route at F340. Captain of aircraft telephoned facility to explain that the deviation was necessary for aircraft safety.	
18 Jan 2014	The following deviation was made due to weather without ATC clearance. Aircraft northbound at F360 on Route X deviated 20NM right exercising emergency command authority. Traffic was parallel northbound on Route Y at F360. It was not determined if the pilot followed the published emergency weather deviation procedure. Conflicting aircraft was cleared to F380 and deviating aircraft was issued clearance to deviate at that time.	
24 Feb 2014	This is an emergency weather deviation without an ATC clearance. Pilot exercised command authority to deviate 15NM right of Route X around convective weather. ATC was unable to approve deviation due to traffic at same altitude on Route X 13 minutes in trail (15 minutes required). Separation was lost with the other aircraft. Traffic information was issued. Closest proximity was 13 minutes longitudinal separation (15 minutes required). Pilot followed the proper weather deviation procedure and descended to F347 until established back on route.	
19 June 2015	Aircraft A was southbound on Route X over TASNI 1452z FL350. Aircraft B was southbound on Route Y GRAMN 1506z FL350. At 1520z Aircraft A requested 60NM right deviation for weather. At 1521z ATC denies deviation right due to traffic but offers a left deviation. At 1523z Aircraft A exercises command authority, advises deviating right and descending 300 feet. At 1525z Aircraft B is given reroute west of course to avoid Aircraft A. At 1543 Aircraft A reports back on course. Loss of separation occurred with Aircraft B.	