



*International Civil Aviation Organization*

**The Second Meeting of ICAO Asia/Pacific Performance Based Navigation  
Implementation Coordination Group (PBNICG/2)**

Bangkok, Thailand, 11-12 June 2015

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**Agenda Item 10: Issues and challenges regarding PBN implementations**

**PBN PROCEDURE SAFETY ASSESSMENT CHECKLISTS AND UTILIZATION**

(Presented by Secretariat)

**SUMMARY**

This paper presents PBN procedure safety assessment checklists which can be used by States in the Asia and Pacific Region and proposes participants to discuss further development, which enables to facilitate the usage of the checklists. Action by the meeting is in paragraph 3.1.

**1. INTRODUCTION**

1.1 During the First Meeting of ICAO Asia and Pacific PBN Implementation Coordination Group (PBNICG/1) which was held in Beijing China from 10 to 12 March 2015, the secretariat presented the PBN Safety Assessment Initial Checklists for RNP APCH and SID/STAR and proposed to develop a safety assessment assistant tool as a transitional method until ICAO global guidance material became available.

1.2 Recognizing the usefulness of the checklists as an interim material facilitating the PBN procedure safety assessment, the meeting agreed to enhance the proposed checklists with an instruction on how to use them and to develop a draft checklist for PBN en-route (see Action 1/22 of PBNICG/1).

**2. DISCUSSION**

PBN Procedure Safety Assessment Checklists

2.1 With the inputs from TMA Rapporteur and APAC Regional Officer, APAC RSO improved the checklists for RNP APCH and SID/STAR. The improvements are the clarification of checklist items, the provision of reference materials, the separation of a safety assessor, a procedure designer and a procedure reviewer, the distinction between a new and an amended procedure, etc. (see **Appendix A**).

2.2 Regarding the development of a checklist for en-route, checklist items are similar to those of SID/STAR but adjusted to reflect characteristics related to ATS route (see **Appendix B**). This checklist can be used when a qualitative method is sufficient for a new or an amended domestic and continental ATS route. However, a quantitative method has to be applied when a target route is established in high seas and/or separation between aircraft or ATS routes is less than recommended in ICAO documents such as PBN Manual (Doc 9613) and PANS-ATM (doc 4444). The quantitative safety assessment can be assisted by sub-regional En-route Monitoring Agency (EMA) which is

approved by Regional Airspace Safety Monitoring Advisory Group (RASMAG) of APANPIRG and provides airspace safety assessment, monitoring and implementation services for international airspace in the Asia/Pacific region.

Use of the Checklist

2.3 The proposed checklists can be used when identifying hazards in the procedures as they deal with possible items which may have deficiencies or gaps while developing PBN procedures and which may affect safety of operations during procedure application.

2.4 To identify hazards or find evidence of an unsafe condition, it is needed to form a safety assessment team which comprises of an airspace designer, an qualified procedure designer, air traffic controller, pilot as well as an expert of safety management (safety manager). The composition of the team may be changed depending on the scope of the procedures.

2.5 Once a hazard or an unsafe condition is identified, the safety assessment team evaluates and analyses the evidence of a hazard or an unsafe condition following the procedures which are published in ICAO Safety Management Manual (Doc 9859) and provides the owner of the procedures with outcomes of the analysis and mitigation measures if necessary. The whole process and the result of safety assessment have to be documented including the record of hazard (see **Appendix C**).

**3. ACTION BY THE MEETING**

3.1 The meeting is invited to:

- a) note the proposed PBN procedure safety assessment checklists in Appendix A and B and the proposed record of hazard template in Appendix C;
- b) discuss further development of the checklists and the template, which enables to facilitate the usage of the checklists; and
- c) Adopt them as regional guidance materials for safety assessment for PBN procedures and routes until ICAO global guidance material becomes available.

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## Appendix A. Checklists for Preparation of PBN Procedure Implementation Safety Assessment

### 1. RNP APCH

<b>PBN Procedure Safety Assessment Initial Checklist – RNP APCH</b>					
Assessor				<input type="checkbox"/> New	<input type="checkbox"/> Amended
Procedure Name			Date		
S : Satisfactory, U : Unsatisfactory, N/A : Not Available					
No.	Check Items	S	U	N/A	
1	Is the safety assessor independent of the flight procedure team and has s/he been involved with the process? ▪ Comments :				
2	Were proposed flight procedures/amendments designed by an qualified flight procedure designer and reviewed independently by another qualified flight procedure designer? ▪ Comments :				
3	Did procedure designers coordinate with stakeholders such as ATC, operators, etc., regarding new and/or amended flight procedures? ▪ Comments :				
4	Did relevant ATC facilities review the new and/or amended procedures based on the Letter of Agreement (LOA) between facilities? Is the amended LOA published and effective? ▪ Comments :				
5	Are the locations of waypoints and restrictions (speed, altitude, etc.) appropriate for the aircraft types expected to use these procedures? ▪ List aircraft categories considered: ▪ Comments :				
6	Are there any expected difficulties or possibilities of phonetic confusion in the names used for waypoints and procedure ? It is recommended that proximity check for like-sounding codes be done within 250NM for TMA waypoints using ICARD system. ▪ Comments :				
7	Are there any elements that may lead to misinterpretation or other difficulties while using the proposed procedures (e.g. textual description of the chart, local wind condition or temperature causing difficulties while climbing/descending, etc.)? ▪ Comments :				
8	In case of procedure amendment, was a review of safety incidents/accidents concerning the existing procedure conducted, with the view of mitigating them? Comments :				
9	Referring to ICAO Annex 4, 15 and Doc 8697, are there any errors on the chart(s)? (Items to focus on: Magnetic Bearings/True Headings, Distances, Climb/Descent Gradients, TAA/MSA, Magnetic Variation, Topography, Location of Obstacles, Coordinates, Restrictions, etc.) ▪ Comments :				

10	Were all obstacles evaluated when calculating OCA/H in the proposed procedures and properly documented? ▪ Comments :			
11	Were RAIM/GNSS availability and prediction (as necessary) considered while implementing the proposed procedures? ▪ Comments :			
12	If RAIM/GNSS availability/prediction information is provided by entities other than the ANSP, are there any agreements with those entities regarding the provision of this information? ▪ Comments :			
13	Are the descent rates and descent angle, if not the same as the optimum value, of proposed approach procedure appropriate to enabling aircraft to complete its approach? If not, were operators consulted and consent obtained? ▪ Comments :			
14	Do missed approach procedures enable aircraft to climb to the assigned altitude/s? Are climb gradients specified where the climb gradient exceeds the standard missed approach climb gradient of 2.5%? If so, have the operators been consulted? ▪ Comments :			
15	Do the proposed procedures take into account adequate separation between aircraft using these approaches and other aircraft using conventional approaches (ILS, VOR, NDB)? Was the standard operating procedure/operating manual updated? ▪ Comments :			
16	Have any alternative procedures been instituted if an aircraft conducting the proposed procedure/s is unable to complete the assigned procedure due to temporary GNSS signal abnormality, airborne system failures, technical problems or other difficulties? ▪ Comments :			
17	<b>For LNAV/VNAV Procedures:</b> Is the location of the altimeter setting source appropriate for the use of the Baro-VNAV approach procedure? ▪ Comments :			
18	<b>For LNAV/VNAV Procedure:</b> Is the published minimum temperature reasonable for the application of the Baro-VNAV procedure? ▪ Comments :			
19	Has implementation training been executed (or planned) for air traffic controllers on the use of the proposed procedures, including management of QNH in case of Baro-VNAV? ▪ Comments :			
20	Are there any criteria applied for the RNP APCH design using the minimum or maximum value in ICAO PANS-OPS (Doc 8168)? If so, are they documented properly? ▪ Comments :			

21	Are there any items requiring special authorization in the proposed procedures? If any, were sufficient reviews on criteria conducted and was the rationale for requiring such special authorization reasonable and necessary? ▪ Comments :			
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## 2. SID/STAR

PBN Procedure Safety Assessment Initial Checklist – SID/STAR				
Assessor		<input type="checkbox"/> New	<input type="checkbox"/> Amended	
Procedure Name		Date		
S : Satisfactory, U : Unsatisfactory, N/A : Not Available				
No.	Check Items	S	U	N/A
1	Is the safety assessor independent of the flight procedure team and has s/he been involved with the process? ▪ Comments :			
2	Were proposed flight procedures/amendments designed by an qualified flight procedure designer and reviewed independently by another qualified flight procedure designer? ▪ Comments :			
3	Did procedure designers coordinate with related entities such as ATC, Operators, etc., regarding new and/or amended flight procedures? ▪ Comments :			
4	Did related ATC facilities review and accept new and/or amended procedures based on the Letter of Agreement (LOA) between facilities? Is the amended LOA published and effective? ▪ Comments :			
5	Are the locations of waypoint and restrictions (speed, altitude, etc.) appropriate for the aircraft that is expected to use the procedures? ▪ Comments :			
6	Are there any expected difficulties or the possibility of confusion on the name of waypoints and procedures phonetically? It is recommended that proximity check for like-sounding codes should be done within 250NM for TMA waypoints using ICARD system. ▪ Comments :			
7	Are there any parts that may lead to mistakes or difficulties while using the proposed procedures (e.g. textual description of the chart, local wind condition or temperature causing difficulties while climbing/descending, etc.)? ▪ Comments :			
8	In case of procedure amendment, was a review of safety incidents/accidents concerning the existing procedure conducted, with the view of mitigating them? ▪ Comments :			

9	Referring to ICAO Annex 4, 15 and Doc 8697, are there any errors on the chart(s)? (check items : magnetic bearing/true heading, distance, climb/descent gradient, TAA/MSA, magnetic variation, topography, location of obstacle, coordinates, restrictions, etc.) ▪ Comments :			
10	Were all obstacles evaluated in the proposed procedures and properly documented? ▪ Comments :			
11	Were coverage and limitations of available avionics, ground navigational aids and GNSS considered while designing and validating the proposed procedures? ▪ Comments :			
12	Were traffic flows in the terminal area considered while designing the proposed procedures? ▪ Comments :			
13	Are climb/descent rates of the proposed procedures appropriate to enabling the climb/descent within the airspace? ▪ Comments :			
14	Does separation applied between instrument flight procedures of neighbouring airport(s), airspaces including special use airspaces (SUAs) and the proposed procedures satisfy separation criteria specified in ICAO PANS-ATM (Doc 4444)? ▪ Comments :			
15	Do the proposed procedures consider separation between aircraft using PBN procedures and aircraft using other procedures specified in ICAO PANS-ATM (Doc 4444)? ▪ Comments :			
16	Did the proposed procedures consider current and expected future airspace capacity? ▪ Comments :			
17	Are there any alternative methods when an aircraft conducting a proposed procedure is unable to conduct the procedure because of ground/satellite/airborne system failures, technical problems or other difficulties? ▪ Comments :			
18	Is there any training plan for air traffic controllers on the proposed procedures? Has the training been conducted? ▪ Comments :			
19	Are there any criteria applied for the SID/STAR design using the minimum or maximum value in ICAO PANS-OPS (Doc 8168)? If so, are they documented properly? Comments :			
20	Are there any items requiring special authorization in the proposed procedures? If any, were sufficient reviews on criteria conducted and was rationale for requiring special authorization reasonable? ▪ Comments :			

**Appendix B. Checklists for Preparation of PBN Procedure Implementation Safety  
Assessment - ATS Route**

<b>PBN Safety Assessment Initial Checklist – ATS Route</b>					
Assessor		<input type="checkbox"/> New	<input type="checkbox"/> Amended		
Route Designator		Date			
<b>S : Satisfactory, U : Unsatisfactory, N/A : Not Available</b>					
No.	Check Items	S	U	N/A	
1	Is the safety assessor independent of the flight procedure team and has s/he been involved with the process? Comments :				
2	Has proposed ATS route been reviewed independently by a qualified route designer? Comments :				
3	Did procedure designers coordinate with related entities such as ATC, Operators, etc., regarding the new and/or amended ATS route? ▪ Comments :				
4	Did related ATC facilities review new and/or amended procedures based on the Letter of Agreement (LOA) between facilities? Is the amended LOA published and effective? ▪ Comments :				
5	Are the locations of waypoint and restrictions (e.g. speed, altitude, etc.) appropriate for the aircraft that is expected to use the ATS route? ▪ Comments :				
6	Are there any expected difficulties or the possibility of confusion on the name of waypoints phonetically? It is recommended that proximity check for like-sounding codes should be done within 500NM for en-route waypoints using ICARD system. ▪ Comments :				
7	Is the designator of ATS route appropriate for its application, i.e. domestic or international? Is the duplicity of the name confirmed with neighbouring States? ▪ Comments :				
8	Are there any parts that may lead to mistakes or difficulties while using the proposed ATS routes (e.g. separation from other ATS routes and/or airspace including military controlled airspace, coordination with other facilities including military, identification of navigation specification, difference of turn performance, introduction of FRT, etc.)? ▪ Comments :				
9	In case of procedure amendment, was a review of safety incidents/accidents concerning the existing procedure conducted, with the view of mitigating them? ▪ Comments :				

10	Referring to ICAO Annex 4, 15 and Doc 8697, are there any errors on the AIP publication? (check items : magnetic bearing/true heading, distance, coordinates, restrictions, directions, etc.) ▪ Comments :			
11	Were all obstacles evaluated in the proposed ATS route and properly documented? ▪ Comments :			
12	Were coverage and limitations of available avionics, ground navigational aids and GNSS considered while designing and validating the proposed procedures? ▪ Comments :			
13	Does separation applied between instrument flight procedures of neighbouring airport(s), airspaces including special use airspaces (SUAs), neighbouring ATS routes and the proposed ATS route satisfy separation criteria specified in ICAO PANS-ATM (Doc 4444) and PANS-OPS (Doc 8168)? ▪ Comments :			
14	Do the proposed ATS route consider separation between aircraft using PBN procedures and aircraft using other procedures specified in ICAO PANS-ATM (Doc 4444)? ▪ Comments :			
15	Did the proposed ATS route consider current and expected future airspace capacity? ▪ Comments :			
16	Are there any alternative methods when an aircraft flying the proposed ATS route is unable to maintain the requirement of the route because of ground/satellite/airborne system failures, technical problems or other difficulties? ▪ Comments :			
17	Is there any training plan for air traffic controllers on the proposed ATS route? Has the training been conducted? ▪ Comments :			
18	Are there any items requiring special authorization on the use of the proposed ATS route, e.g. reduction of lateral separation between ATS routes? If any, were sufficient reviews on criteria conducted and was rationale for requiring special authorization reasonable? ▪ Comments :			

### Appendix C. Record on Identification, Analysis and Mitigation of Hazard

Identification No	Source	<input type="checkbox"/> Safety Report <input type="checkbox"/> Safety Review <input type="checkbox"/> Safety Assessment <input type="checkbox"/> Safety Audit <input type="checkbox"/> Safety Observation <input type="checkbox"/> Safety Survey <input type="checkbox"/> Sampling Survey <input type="checkbox"/> Others	
		Assessment Date	YYYY.MM.DD
Assessment Items	Name of IFP/SID/STAR/ATS route		
Category of Hazard	<input type="checkbox"/> Human Factors <input type="checkbox"/> Equipment <input type="checkbox"/> Operational <input type="checkbox"/> Environment		
Identification of Hazard(s)	Subject :		
	Details (includes a review of safety incidents of the existing procedure(s), if any) :		
Risk Analysis	Probability	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
	Severity	<input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/> E	
Outcome of Risk Analysis	Assessed Risk Index	<input type="checkbox"/> Unacceptable <input type="checkbox"/> Acceptable based on risk mitigation <input type="checkbox"/> Acceptable	
	(Probability & Severity, e.g. 3C)		
Mitigation Measures			
Outcome of Safety Reassessment			
Comments by Safety Assessment Team (If necessary)			
Date Completed	YYYY.MM.DD		

**Safety Risk Probability Table (SMM Manual (Doc 9859) Figure 2-11)**

Likelihood	Meaning	Value
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely Improbable	Almost inconceivable that the event will occur	1

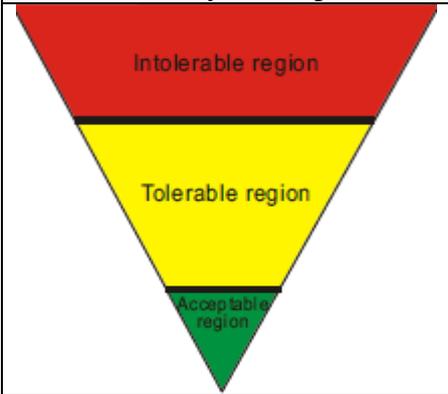
**Safety Risk Severity Table (SMM Manual (Doc 9859) Figure 2-12)**

Severity	Meaning	Value
Catastrophic	<ul style="list-style-type: none"> <li>Equipment destroyed</li> <li>Multiple deaths</li> </ul>	A
Hazardous	<ul style="list-style-type: none"> <li>A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely</li> <li>Serious injury</li> <li>Major equipment damage</li> </ul>	B
Major	<ul style="list-style-type: none"> <li>A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency</li> <li>Serious incident</li> <li>Injury to persons</li> </ul>	C
Minor	<ul style="list-style-type: none"> <li>Nuisance</li> <li>Operational limitations</li> <li>Use of emergency procedures</li> <li>Minor incident</li> </ul>	D
Negligible	<ul style="list-style-type: none"> <li>Few consequences</li> </ul>	E

**Safety Risk Assessment Matrix (SMM Manual (Doc 9859) Figure 2-13)**

Risk Probability	Risk Severity				
	Catastrophic <b>A</b>	Hazardous <b>B</b>	Major <b>C</b>	Minor <b>D</b>	Negligible <b>E</b>
Frequent <b>5</b>	<b>5A</b>	<b>5B</b>	<b>5C</b>	<b>5D</b>	<b>5E</b>
Occasional <b>4</b>	<b>4A</b>	<b>4B</b>	<b>4C</b>	<b>4D</b>	<b>4E</b>
Remote <b>3</b>	<b>3A</b>	<b>3B</b>	<b>3C</b>	<b>3D</b>	<b>3E</b>
Improbable <b>2</b>	<b>2A</b>	<b>2B</b>	<b>2C</b>	<b>2D</b>	<b>2E</b>
Extremely Improbable <b>1</b>	<b>1A</b>	<b>1B</b>	<b>1C</b>	<b>1D</b>	<b>1E</b>

**Safety Risk Tolerability Matrix (SMM Manual (Doc 9859) Figure 2-14)**

Tolerability Description	Assessed Risk Index	Suggested Criteria
 <p>Intolerable region</p>	<p><b>5A, 5B, 5C, 4A, 4B, 3A</b></p>	<p>Unacceptable under the existing circumstances</p>
<p>Tolerable region</p>	<p>5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D 2A, 2B, 2C, 1A</p>	<p>Acceptable based on risk mitigation. It may require management decision.</p>
<p>Acceptable region</p>	<p><b>3E, 2D, 2E, 1B, 1C, 1D, 1E</b></p>	<p>Acceptable</p>