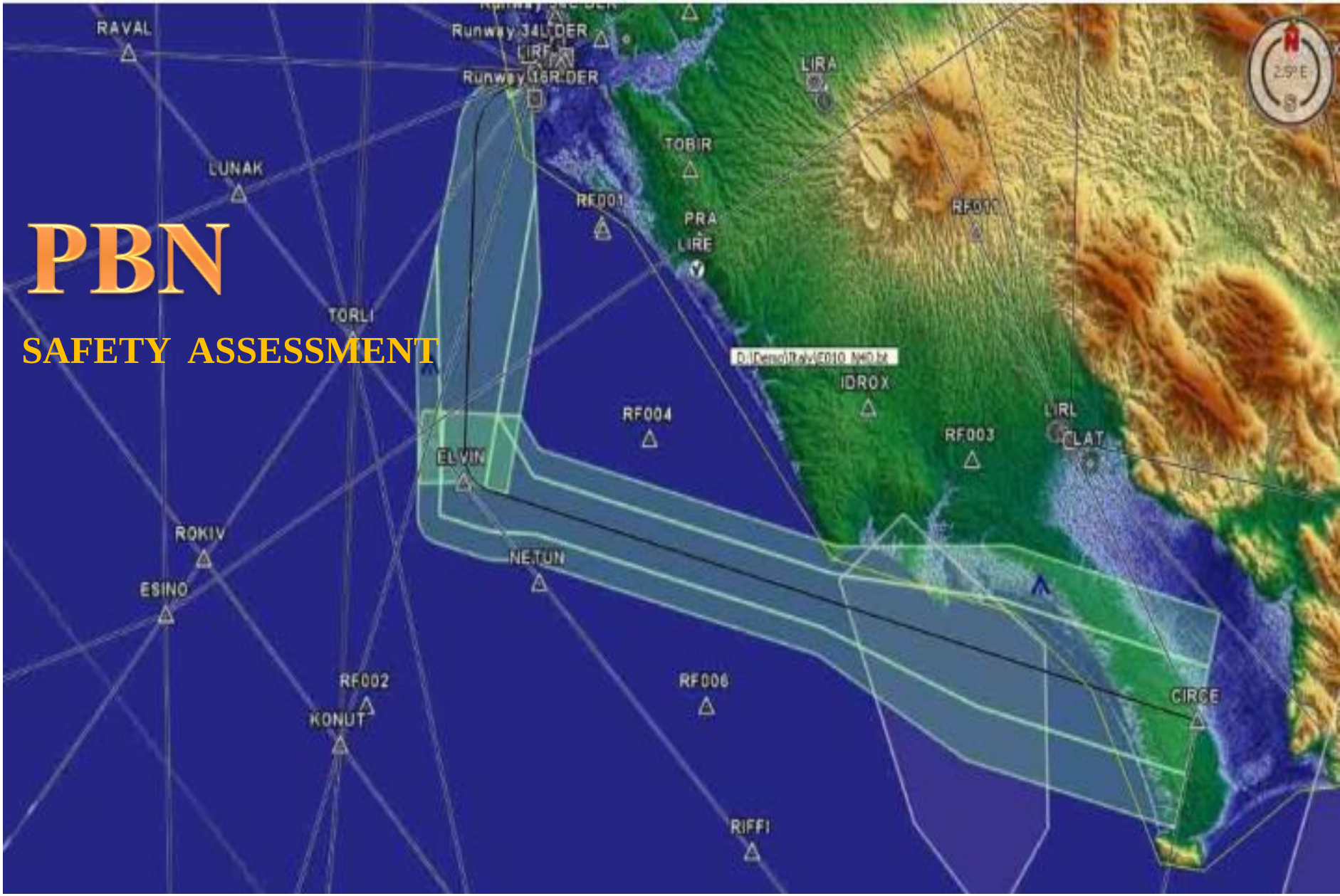


PBN

SAFETY ASSESSMENT

I.R. IRAN

Presented by

MOHAMMAD KARIMI

PBN SAFETY ASSESSMENT

Key documents related to Safety Assessment

- **Annex 19 Safety Management**
  - Doc 9859 Safety Management Manual
- **Annex 11 Air Traffic Services**
  - Doc 4444 PANS-ATM
- **Doc 8168 PANS-Aircraft Operations**
  - Doc 9906 Quality Assurance Manual for Flight Procedure Design
  - Doc 9613 PBN Manual
  - Doc 9992 Manual on the Use of PBN in Airspace Design
- **Doc 9734 Safety Oversight Manual**
  - Doc 10068 Manual on the Development of Regulatory Framework for Instrument Flight Procedure Design Service

PBN SAFETY ASSESSMENT

What is safety assessment

❖ Definition of safety

- The state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level (Annex 19, Doc 9859)
- "Freedom from unacceptable risk " (Doc 9906).
  - A system can only be considered to be safe for operational use if its inherent risks have been identified, assessed and agreed to be below predefined limits.
  - If such a commitment is reached, the system can be considered as acceptably safe

PBN SAFETY ASSESSMENT

- **Definition of safety assessment (Doc 9906 Vol I Ch.7)**
  - A formal process by which an organization may ensure that risks associated with a system change have been properly identified and mitigated prior to going into operation.
  - The results and conclusions of a safety assessment are usually described in a safety case.
    - The safety case is the documented assurance of the achievement and maintenance of safety.

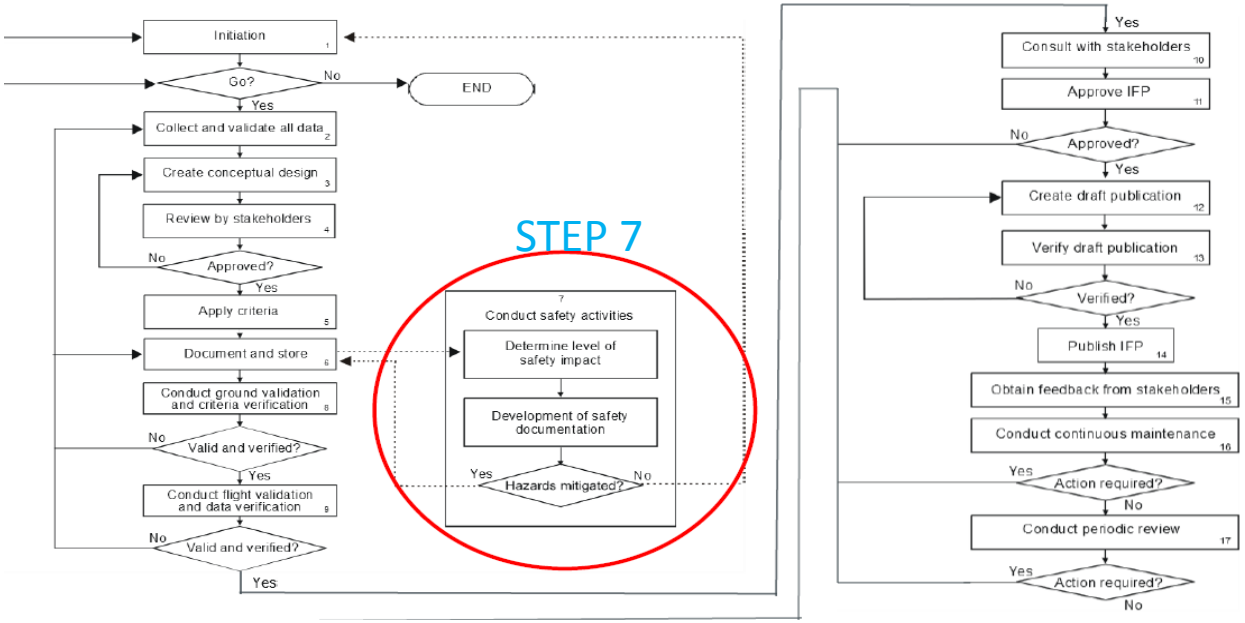
PBN SAFETY ASSESSMENT

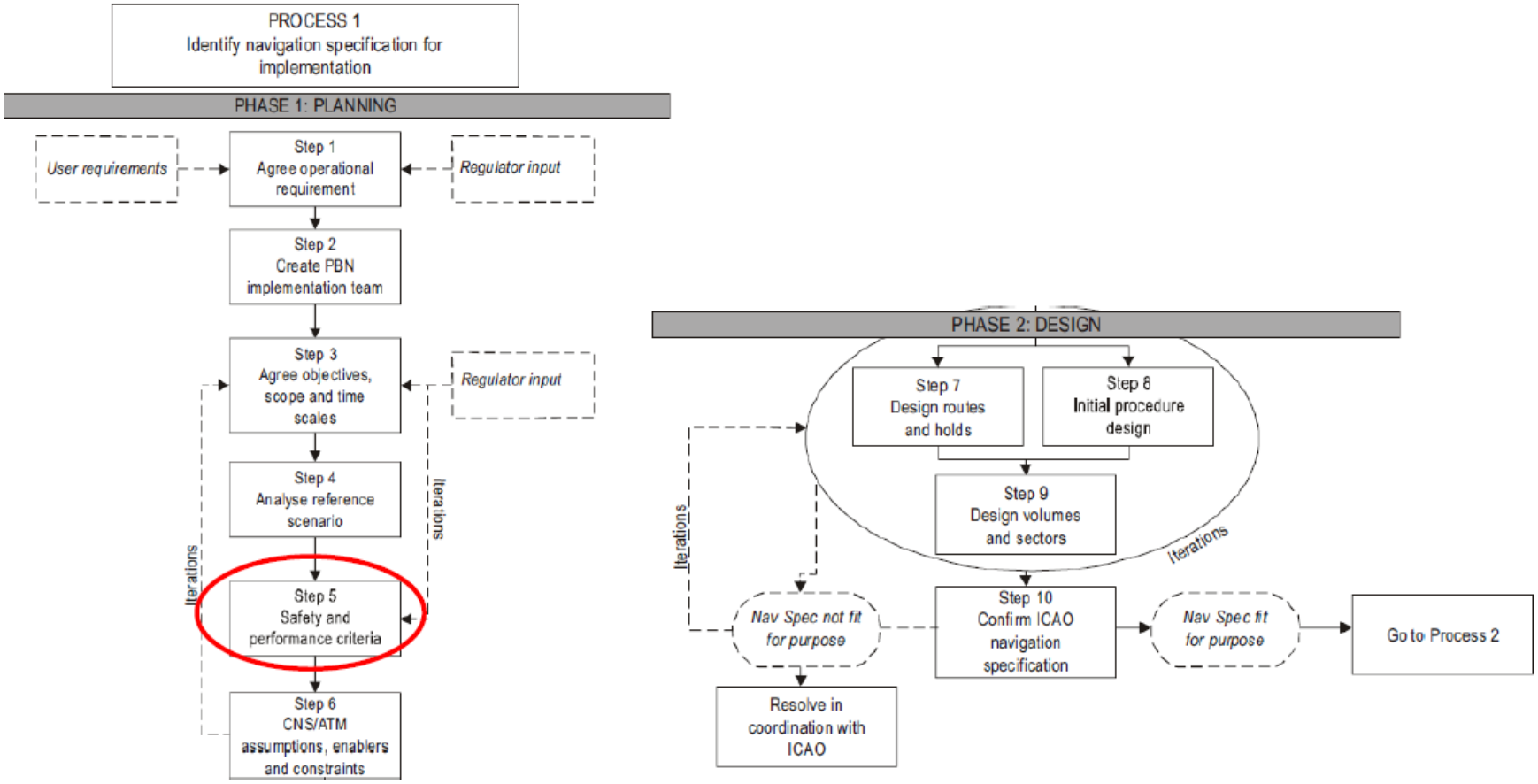
- **Assessing the type of safety case needed (Doc 9906 Vol I Ch.7)**
  - Conduct a preliminary hazard analysis to determine the likely hazards that may arise from the change.
  - May be accomplished by measuring the impact in various domains, such as:
    - Operational consequences of the change;
    - Operational consequences for external partners;
    - Level of new functionality introduced in contrast to the existing systems;
    - Number of technical systems affected by the change;
    - Amount of training or amount of additional staffing needed; and
    - Complexity of the transition from the existing system.

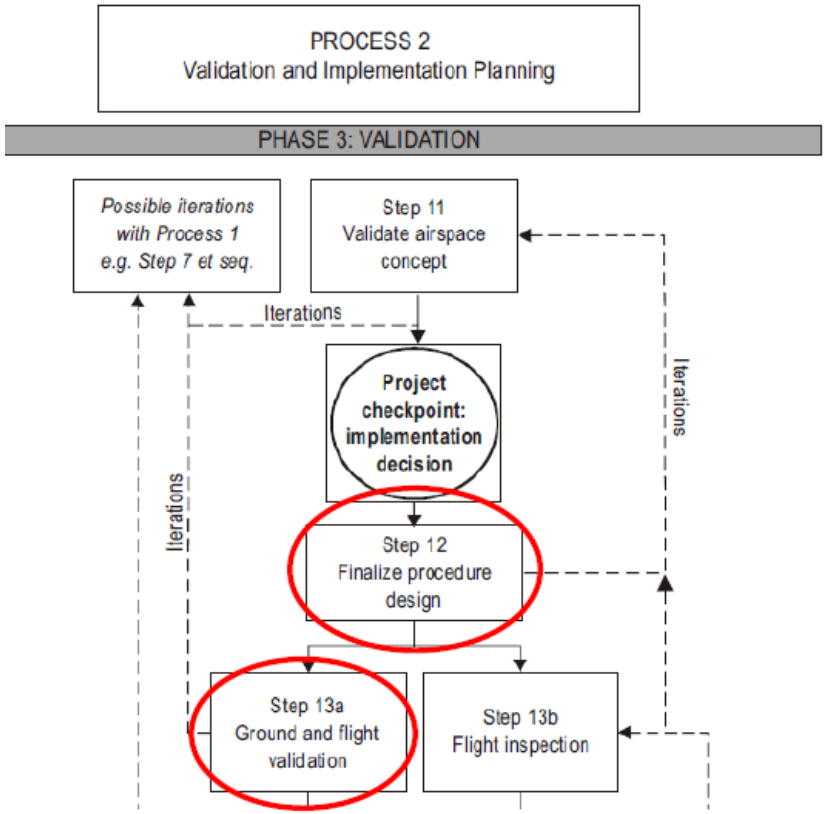
ANNEX 19 DOC9859 DOC9913 DOC10068 DOC9734 DOC9906 DOC9992

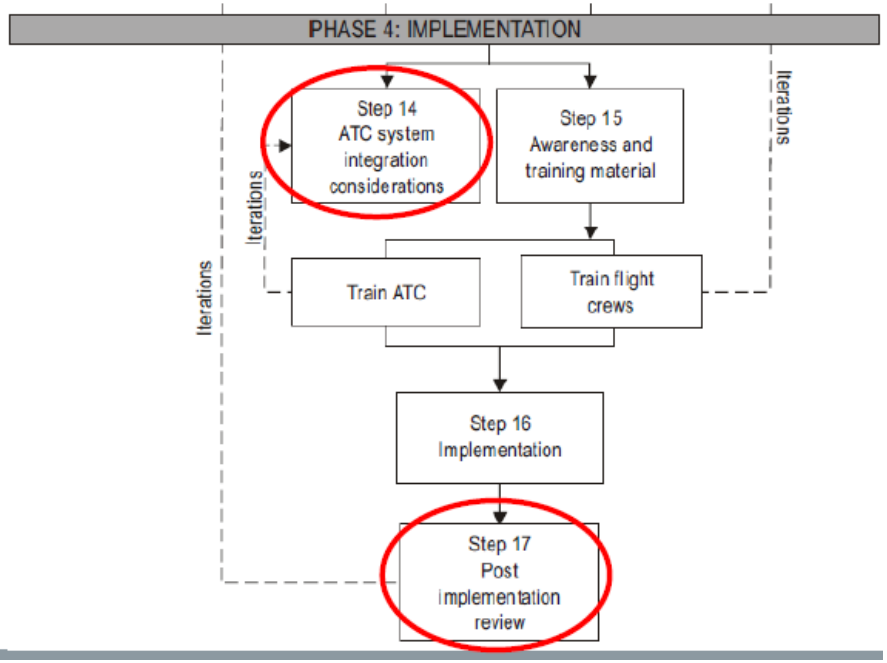
Safety Assessment in IFP Process

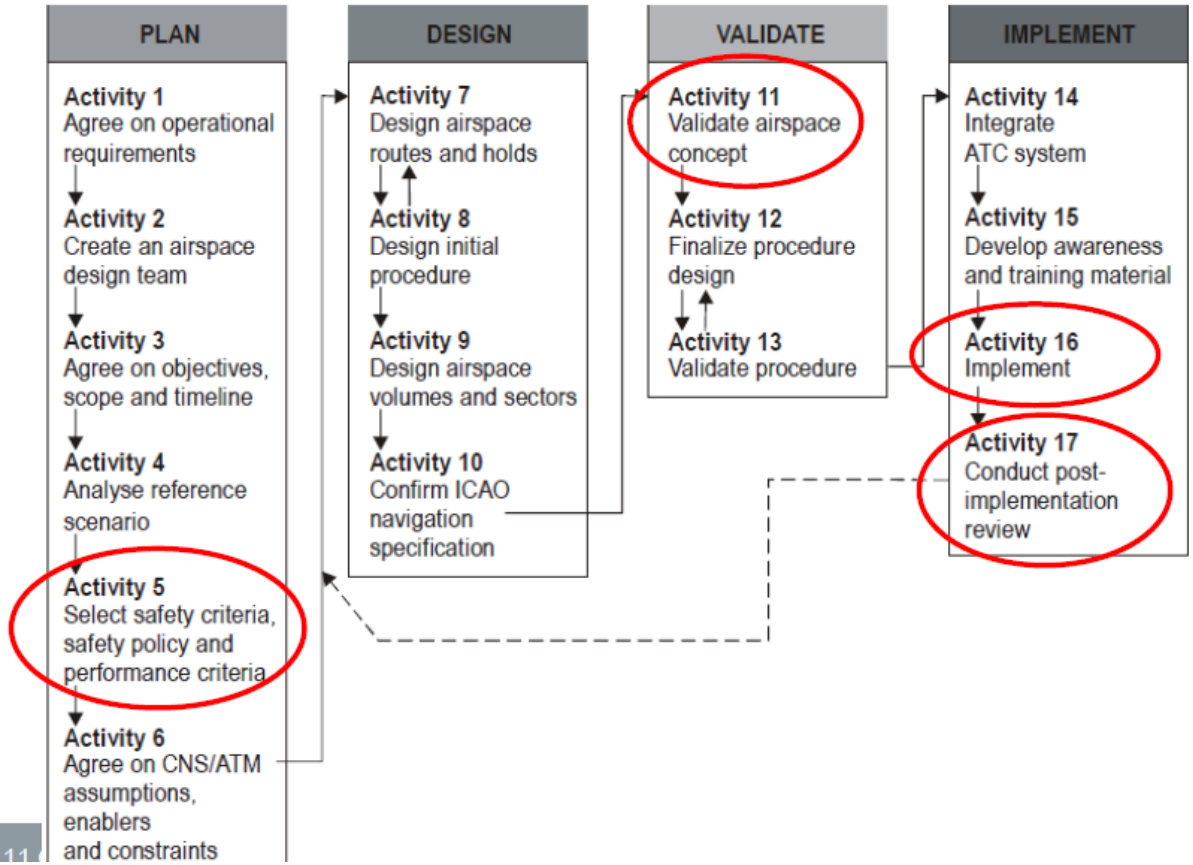
❖ Doc 9906 - IFP Process Flow Diagram




PROCESS 1
Identify navigation specification for implementation
PHASE 1: PLANNING
User requirements
Step 1
Agree operational requirement
Regulator input
Step 2
Create PBN implementation team
Step 3
Agree objectives, scope and time scales
Regulator input
Step 4
Analyse reference scenario
Step 5
Safety and performance criteria
Step 6
CNS/ATM assumptions, enablers and constraints
Iterations
Iterations
PHASE 2: DESIGN
Step 7
Design routes and holds
Step 8
Initial procedure design
Step 9
Design volumes and sectors
Iterations
Iterations
Nav Spec not fit for purpose
Step 10
Confirm ICAO navigation specification
Nav Spec fit for purpose
Go to Process 2
Resolve in coordination with ICAO


PROCESS 2
Validation and Implementation Planning
PHASE 3: VALIDATION
Possible iterations with Process 1 e.g. Step 7 et seq.
Step 11 Validate airspace concept
Iterations
Project checkpoint: implementation decision
Step 12 Finalize procedure design
Step 13a Ground and flight validation
Step 13b Flight inspection
Iterations
Iterations


PHASE 4: IMPLEMENTATION
Step 14 ATC system integration considerations
Step 15 Awareness and training material
Iterations
Iterations
Train ATC
Train flight crews
Step 16 Implementation
Step 17 Post implementation review
Iterations


PLAN
Activity 1
Agree on operational requirements
Activity 2
Create an airspace design team
Activity 3
Agree on objectives, scope and timeline
Activity 4
Analyse reference scenario
Activity 5
Select safety criteria, safety policy and performance criteria
Activity 6
Agree on CNS/ATM assumptions, enablers and constraints
DESIGN
Activity 7
Design airspace routes and holds
Activity 8
Design initial procedure
Activity 9
Design airspace volumes and sectors
Activity 10
Confirm ICAO navigation specification
VALIDATE
Activity 11
Validate airspace concept
Activity 12
Finalize procedure design
Activity 13
Validate procedure
IMPLEMENT
Activity 14
Integrate ATC system
Activity 15
Develop awareness and training material
Activity 16
Implement
Activity 17
Conduct post-implementation review


Doc 9992
AN/494
Manual on the Use of Performance-based Navigation (PBN) in Airspace Design
Approved by the Secretary General and published under his authority
First Edition — 2013
International Civil Aviation Organization

Checklists for Preparation of PBN Procedure Implementation Safety Assessment

1. RNP APCH

PBN Procedure Safety Assessment Initial Checklist – RNP APCH					
Assessor		□ New		□ 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 :				

RNP APCH CHECKLISTS

PBN Procedure Safety Assessment Initial Checklist – RNP APCH					
Assessor		□ New		□ Amended	
Procedure Name		Date			
S : Satisfactory, U : Unsatisfactory, N/A : Not Available					
No.	Check Items		S	U	N/A
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	**For LNAV/VNAV Procedures**: Is the location of the altimeter setting source appropriate for the use of the Baro-VNAV approach procedure? ▪ Comments :				
18	**For LNAV/VNAV Procedure:** Is the published minimum temperature reasonable for the application of the Baro-VNAV procedure?Comments :				

RNP APCH CHECKLISTS

PBN Procedure Safety Assessment Initial Checklist – RNP APCH					
Assessor		□ New		□ Amended	
Procedure Name			Date		
S : Satisfactory, U : Unsatisfactory, N/A : Not Available					
No.	Check Items		S	U	N/A
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 :				

RNP APCH CHECKLISTS

2. SID/STAR

PBN Procedure Safety Assessment Initial Checklist – SID/STAR					
Assessor		□ New		□ 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 :				

SID/STAR CHECKLISTS

PBN Procedure Safety Assessment Initial Checklist – SID/STAR					
Assessor		□ New	□ Amended		
Procedure Name		Date			
S : Satisfactory, U : Unsatisfactory, N/A : Not Available					
No.	Check Items	S	U	N/A	
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 :				

SID/STAR CHECKLISTS

3 ATS Route

PBN Safety Assessment Initial Checklist – ATS Route					
Assessor		□ New		□ Amended	
Route Designator		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	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 :				

ATS ROUTE CHECKLISTS

PBN Safety Assessment Initial Checklist – ATS Route					
Assessor		□ New	□ Amended		
Route Designator		Date			
S : Satisfactory, U : Unsatisfactory, N/A : Not Available					
No.	Check Items		S	U	N/A
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 :				

ATS ROUTE CHECKLISTS

Appendix. Record on Identification, Analysis and Mitigation of Hazard

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

RECORD , ANALYSIS AND MITIGATION OF HAZARD

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

RISK PROBABILITY

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

Severity	Meaning	Value
Catastrophic	• Equipment destroyed • Multiple deaths	A
Hazardous	• 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 • Serious injury • Major equipment damage	B
Major	• 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 • Serious incident • Injury to persons	C
Minor	• Nuisance • Operational limitations • Use of emergency procedures • Minor incident	D
Negligible	• Few consequences	E

RISK SEVERITY

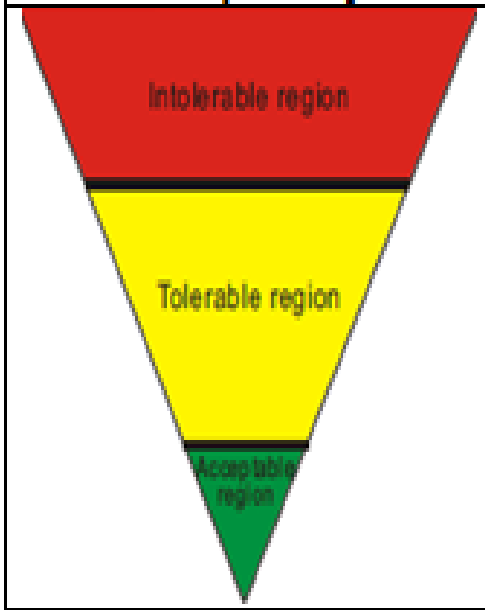
Safety Risk Assessment Matrix (SMM Manual (Doc 9859) Figure 2-13)

Risk Probability		Risk Severity				
		Catastrophic **A**	Hazardous **B**	Major **C**	Minor **D**	Negligible **E**
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4D	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

RISK ASSESSMENT MATRIX

SAFETY RISK TOLERABILITY

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

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


Thank
you