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OPERATON OF AIRCRAFT

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AIRWORTHINESS APPROVAL AND OPERATIONAL CRITERIA FOR ADVANCED RNP (A-RNP) INCLUDING APV BARO-VNAV OPERATIONS

PURPOSE

1. *Advanced RNP (A-RNP): used to support RNP operations in en-route continental airspace and on SIDs, STARs and approach procedures. A-RNP requirements include RNP 0.3 in final approach; RNP 1 or 2 in en-route continental; RNP 1 in SIDs, STARs, initial/intermediate approaches and missed approaches.*

2. *This AIC provides the method to be used to obtain airworthiness approval of an Area Navigation (RNAV) system based on a Global Navigation Satellite System (GNSS) stand-alone receiver or multisensory system including at least one GNSS sensor in order to conduct Advanced- RNP (A-RNP) operations.*

3. *This AIC identifies the airworthiness and operational requirements for Advanced RNP (A-RNP) operations including APV BARO-VNAV operation. Operational compliance with these requirements will be addressed through the SA-AIP, and shall require a specific operational approval.*

4. *This AIC also defines operational criteria necessary to conduct safely Advanced RNP (A-RNP) operations in South African airspace.*

5. *This specification provides guidance for the implementation of RNP operations predicated on the performance and capabilities included in A-RNP. For the ANSP, it provides a consistent recommendation with respect to the system and operational requirements and where, and how, to implement this navigation specification. For the operator, it provides specific criteria to qualify for operations on RNP ATS routes, SIDs, STARs or approaches.*

6. *The qualification and operational authorisations span oceanic, en-route, terminal area and approach operations, significantly reducing the amount of individual assessments associated with multiple, existing navigation Specifications (or new ones that may be added), to only those aspects of operator criteria or operational examination that are not covered by the A-RNP qualification or operator approval.*
7. *While operational approval primarily relates to the navigation requirements of the airspace, operators and flight crew are still required to take account of all operational documents relating to the airspace that are required by the South African Civil Aviation Authority (SACAA) before conducting flights into that airspace.*

8. *An applicant may elect to use an alternative means of compliance. However, those alternative means of compliance must meet safety objectives that are acceptable to the SACAA. Use of the terms shall and must apply only to an applicant who elects to comply with this AIC in order to obtain airworthiness approval or to demonstrate compliance with the operational criteria.*

BACKGROUND

9. *Navigation specifications have mostly been derived from existing guidance material and criteria that are associated with specific types of applications, e.g. departure/arrival, approach, en-route, continental, oceanic, or remote area. The result is that for all stakeholders a separate activity is needed for each navigation specification with regard to aircraft qualification and operational approval. This navigation specification departs from that trend and provides for a single assessment of aircraft eligibility that will apply to more than one navigation accuracy requirement and multiple applications across all phases of flight. With respect to the lateral navigation accuracy and functional requirements that pertain to other navigation applications, those shown in Table 1 are considered as being addressed in full by this navigation specification.*

Navigation specification	
RNAV 5	Refer to SA-CATS 91 05
RNAV 1	Refer to SA-CATS 91 05
RNAV 2	Refer to SA-CATS 91 05
RNP 1 (Basic RNP 1)	Refer to SA-CATS 91 05
RNP APCH	Refer to SA-CATS 91 05

Table 1: Navigation Specifications

10. *For en-route and terminal applications, this navigation specification has requirements that only address the lateral aspects of navigation. For approaches, the lateral navigation accuracy and functional requirements are also addressed, while the VNAV requirements along the FAS are as described within the RNP APCH navigation specification in SA-CATS 91.05 and South African AIP.*

11. *This navigation specification, in common with others, may be associated in terms of an airspace design through either routes or IFPs with other functional elements captured in this AIC as shown in Table 2.*

Description	Performance/Functionality
RNP Scalability	Optional outside final approach
Higher Continuity	Optional
Radius to Fix (RF)	Required
FRT	Optional
Baro-VNAV	Optional

Table 2: Navigation Specification Performance/Functionality

12. *An A-RNP aircraft qualification can be more broadly applicable to multiple navigation specifications without the need for re-examination of aircraft eligibility. This enables an operator's approved procedures, training, etc., to be common to multiple navigation applications. The A-RNP aircraft qualification will also facilitate multiple operational specification approvals.*

SCOPE

13. *A-RNP is designed for operation in oceanic/remote airspace, on the continental en-route structure as well as on arrival and departure routes and approaches. The operation relies solely on the integrity of the RNP system without recourse to conventional means of navigation, such as VOR or NDB.*

14. *Where conventional navigation may not be available, reversionary operation must be achieved through dual RNP system equipage. Dual RNP requirement will be indicated on the applicable charts.*

15. *Operators and Aircraft owners shall ensure that they have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support the required navigation accuracy along the RNP route or procedure, prior to commencement.*

A-RNP NAVIGATION SPECIFICATION

16. ***Approval process***

16.1 This A-RNP navigation specification does not in itself constitutes regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are to be certified by their State of Manufacture. Operators are to be approved in accordance with their national operating regulations.
This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

16.2 The A-RNP navigation specification provides technical and operational criteria but does not imply a need for recertification if an aircraft has been assessed in a prior qualification. Any operator with RNP operational approvals consistent with this navigation specification may conduct RNP or RNAV operations whose designated navigation accuracy is 0.3 (final approach only), 1, 2 and 5 NM, and which may have specified functional attributes, e.g. RF legs or FRTs (see Appendices 1 and 2 to Part C of Volume II of ICAO Doc 9613). It is expected that with A-RNP, the manufacturer's airworthiness approval/assessment will only be performed once and will be considered applicable to multiple applications. For the operators it is expected that operator procedures, maintenance, dispatch and other operations processes that satisfy the A-RNP criteria will be considered acceptable for RNAV 1, RNAV 2, RNAV 5, RNP 2, RNP 1 and RNP APCH. However, it is still recognized that the State/regulator granting the operational approval will still perform an assessment of the operator with due consideration given (i.e. credit) for any prior examinations and approvals, resulting in an abbreviated review and shorter approval cycle.

16.3 For other applications besides the ones just addressed, there may be additional requirements associated with the operation that will be factored into the assessment and reviews for the operational approval, even though the aircraft navigation performance may be satisfactory.

16.4 Existing manufacturer compliance findings and operator approvals that follow regulatory guidance consistent with the navigation specifications for RNAV 1, RNAV 2, RNAV 5, RNP APCH Part A, RNP 1, and RNP 2 are not impacted by this navigation specification for the associated operations. If a manufacturer or operator has already obtained such approvals, a re-examination of the aircraft or operator for those operations relative to A-RNP by the SACAA is unnecessary. In this latter case, the manufacturer and operator may only need to undertake the A-RNP airworthiness qualification and operator criteria to facilitate acceptance and flexibility for new applications predicated upon A-RNP capability or performance not covered by existing navigation specifications.

Notes:

i) Detailed information on operational approvals is provided in Volume I, Attachment C of ICAO Doc 9613.

ii) Where appropriate, the SACAA may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality are applicable to the current request for operational approval.

17. Aircraft eligibility

17.1 The aircraft eligibility has to be determined through the demonstration of compliance against the relevant airworthiness criteria and the requirements of 19. The aircraft OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their NAA (e.g. EASA, FAA), and the approval can be documented in manufacturer documentation (e.g. service letters). AFM entries are not required provided the SACAA accepts the manufacturer documentation.

17.2 The aircraft OEM or the holder of installation approval for the aircraft should document the demonstration of compliance with the A-RNP capability and highlight any limitations of functionality and performance.

Note. — Requests for approval to use optional functionality (e.g. FRT) should address the aircraft and operational requirements as described in the appropriate functional attachment to Volume II of ICAO Doc 9613.

18. Operational approval

18.1 Description of aircraft equipment

The operator must have a configuration list and an MEL detailing the required aircraft equipment for A-RNP operations. The optional TOAC capability must be documented if included in the approval.

18.2 Training documentation

18.2.1 Commercial operators must have a training programme addressing the operational practices, procedures and training items related to A-RNP operations (e.g. initial, upgrade or recurrent training for flight crew, dispatcher's or maintenance personnel).

Note. — Operators need not establish a separate training programme or regimen if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of A-RNP covered within their training programme.

18.2.2 Private operators must be familiar with the practices and procedures identified in 25, "Pilot knowledge and training".

18.3 OMs and checklists

18.3.1 OMs and checklists for commercial operators must address information/guidance on the SOP detailed in 23. The appropriate manuals should contain navigation operating instructions and contingency procedures,

where specified. When required by the SACAA, the operator must submit their manuals and check lists for review as part of the application process. For each A-RNP application, equipment configurations, selected flight guidance modes and crew procedures must be defined.

18.3.2 Private operators should operate using the practices and procedures identified in 25, "Pilot knowledge and training".

18.4 MEL considerations Any MEL revisions necessary to address A-RNP provisions must be approved by the SACAA. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

18.5 Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft's configuration and the aircraft's qualification for this A-RNP navigation specification. Additionally, the operator must submit their maintenance programme, including a reliability programme for monitoring the equipment, for approval by the SACAA.

Note. — The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration, e.g. SBs, does not invalidate current operational approvals.

18.6 Approval documentation
The approval will identify the equipment configuration and any limitations for each type of operations for which the operator is approved. A-RNP capabilities must be declared, including RNP scalability, FRT, TOAC, and higher continuity, e.g. dual independent navigation systems. The approval documentation must reflect any changes in aircraft configuration.

19. *Aircraft requirements*

19.1 This section describes the aircraft performance and functional criteria for aircraft to qualify for applications requiring A-RNP. Aircraft eligible for A-RNP operations must meet all of the requirements of this chapter. The significant functional and performance requirements for A-RNP described herein are for RF legs, parallel offsets, RNAV holding, and the options for scalability, higher continuity, FRTs and TOAC.

19.2 Approved RNP AR systems are considered to meet the system performance monitoring and alerting requirements without further examination. However, this navigation specification contains additional functional requirements that are not included with the RNP AR APCH navigation specification, e.g. RF, RNAV holding, parallel offset and FRT. If such capabilities have been demonstrated and are contained in an approved RNP AR system, documentation of compliance may be all that is necessary. If such capabilities are added to an RNP AR system or part of a new RNP system, they will be subject to typical regulatory reviews, demonstrations, tests and approval.

19.3 Communications and ATS surveillance equipment must be appropriate for the navigation application.

19.4 Some features/requirements may be required in one flight phase and optional or unnecessary in another. No distinctions are made regarding this flight phase association in providing a general set of criteria spanning all phases and navigation applications. Where such differences are deemed important, or the operational need is for one application, a more application-specific navigation specification, e.g. RNP 1 should be used instead.

20. *On-board performance monitoring and alerting*

20.1 General

20.1.1 On-board performance monitoring and alerting is required. This section provides the criteria for a TSE form of performance monitoring and alerting (as described in Volume II, Part A, Chapter 2, 2.3.10 of ICAO Doc 9613) that will ensure a consistent evaluation and assessment of compliance that can be applied across all of the possible applications.

20.1.2 The aircraft navigation system, or aircraft navigation system and flight crew in combination, is required to monitor the TSE, and to provide an alert if the accuracy requirement is not met or if the probability that the TSE exceeds two times the accuracy value is larger than 10^{-5}. To the extent operational procedures are used to satisfy this requirement, the crew procedure, equipment characteristics, and installation will be evaluated for their effectiveness and equivalence. Examples of information provided to the flight crew for awareness of navigation system performance include "EPU", "ACTUAL", "ANP", and "EPE". Examples of indications and alerts provided when the operational requirement is or can be determined as not being met include "UNABLE RNP", "Nav Accur Downgrad", GNSS alert, loss of GNSS integrity, TSE monitoring (real time monitoring of NSE and FTE combined), etc. The navigation system is not required to provide both performance and sensor-based alerts, e.g. if a TSE-based alert is provided, a GNSS alert may not be necessary.

20.2 System performance

20.2.1 Accuracy: During operations in airspace or on routes or procedures designated as RNP, the lateral TSE must be within the applicable accuracy (±0.3 NM to ±2.0 NM) for at least 95 per cent of the total flight time. The along track error must also be within ± the applicable accuracy for at least 95 per cent of the total flight time. To satisfy the accuracy requirement, the 95 per cent FTE should not exceed one half of the applicable accuracy except for a navigation accuracy of 0.3 NM where the FTE is allocated to be 0.25.

Note. — The use of a deviation indicator is an acceptable means of compliance for satisfying the FTE part of the lateral TSE with the scaling commensurate with the navigation application.

20.2.2 Integrity: Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness guidance material (i.e. 1×10^{-5} per hour).

20.2.3 Continuity: Loss of function is classified as a minor failure condition for applications predicated on this navigation specification. Where a State or application establishes a classification of major, the continuity requirement may be typically satisfied by carriage of dual independent navigation systems.

20.2.4 SIS: For GNSS RNP system architectures, the aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than two times the applicable accuracy (2 × RNP) exceeds 1×10^{-7} per hour.

Notes:

i) The lateral TSE includes positioning error, FTE, PDE and display error. For procedures extracted from the on-board navigation database, PDE is considered negligible due to the navigation database requirements (24), and pilot knowledge and training (25).

ii) For RNP systems where the architecture is an integrated, multi-sensor capability and where GNSS integrity is incorporated into a 2 × RNP integrity alert consistent with RTCA/EUROCAE DO-236/ED-75 when performance cannot be met, a separate GNSS integrity alert is not required.

21. ***Criteria for specific navigation services***

21.1 This section identifies unique issues for the navigation sensors.

21.2 GNSS. The sensor must comply with the guidelines in FAA AC 20-138() or FAA AC 20-130A. For systems that comply with FAA AC 20-138(), the following sensor accuracies can be used in the total system accuracy analysis without additional substantiation: GNSS sensor accuracy is better than 36 metres (95 per cent), and augmented GNSS (GBAS or SBAS) sensor accuracy is better than 2 metres (95 per cent). In the event of a latent GNSS satellite failure and marginal GNSS satellite geometry, the probability the TSE remains within the procedure design obstacle clearance volume must be greater than 95 per cent.

Note. — GNSS-based sensors output a HIL, also known as a HPL (see FAA AC 20-138() and RTCA/DO-229D for an explanation of these terms). The HIL is a measure of the position estimation error assuming a latent failure is present. In lieu of a detailed analysis of the effects of latent failures on the TSE, an acceptable means of compliance for GNSS-based systems is to ensure the HIL remains less than twice the navigation accuracy, minus the 95 per cent of FTE, during the RNP operation.

21.3 IRS. An IRS must satisfy the criteria of US 14 CFR Part 121, Appendix G, or equivalent. While Appendix G defines the requirement for a 2 NM per hour drift rate (95 per cent) for flights up to 10 hours, this rate may not apply to an RNP system after loss of position updating. Systems that have demonstrated compliance with Part 121, Appendix G, can be assumed to have an initial drift rate of 8 NM/hour for the first 30 minutes (95 minutes) without further substantiation. Aircraft manufacturers and applicants can demonstrate improved inertial performance in accordance with the methods described in Appendix 1 or 2 of FAA Order 8400.12A.

Note. — Integrated GPS/INS position solutions reduce the rate of degradation after loss of position updating. For "tightly coupled" GPS/IRUs, RTCA/DO-229C, Appendix R, provides additional guidance.

21.4 DME. For RNP procedures and routes, the RNP system may only use DME updating when authorised by the SACAA. The manufacturer should identify any operating constraints (e.g. manual inhibit of DME) in order for a given aircraft to comply with this requirement.

Notes:

i) This is in recognition of where DME infrastructure and capable equipped aircraft are available; the SACAA will establish a basis for aircraft qualification and operational approval to enable use of DME when required.

This is not intended to imply a requirement for implementation of DME infrastructure or the addition of RNP capability using DME for RNP operations.

ii) *This does not imply an equipment capability must exist providing a direct means of inhibiting DME updating. A procedural means for the flight crew to inhibit DME updating or executing a missed approach if reverting to DME updating may meet this requirement.*

21.5 VHF VOR station. For RNP procedures, the RNAV system must not use VOR updating. The manufacturer should identify any operating constraints (e.g. manual inhibit of VOR) in order for a given aircraft to comply with this requirement.

Note. — This does not imply an equipment capability must exist providing a direct means of inhibiting VOR updating. A procedural means for the flight crew to inhibit VOR updating or executing a missed approach if reverting to VOR updating may meet this requirement.

21.6 For multi-sensor systems, there must be automatic reversion to an alternate RNAV sensor if the primary RNAV sensor fails. Automatic reversion from one multi-sensor system to another multi-sensor system is not required.

22. ***Functional requirements***

22.1 *Displays — guidance, situation and status*

Item	***Function/Feature***	***Description***
a)	*Continuous display of deviation.*	*1. The navigation system must provide the capability to continuously display to the pilot flying, on the primary flight instruments for navigation of the aircraft, the aircraft position relative to the RNP defined path.* *2. For operations where the required minimum flight crew is two pilots, the means for the pilot not flying to verify the desired path and the aircraft position relative to the path must also be provided.* *1. The display must allow the pilot to readily distinguish whether the cross-track deviation exceeds the navigation accuracy (or a smaller value).* *4. The numeric display of deviation on a map display with an appropriately scaled deviation indicator is generally considered acceptable for monitoring deviation.* *5. Moving map displays without an appropriately scaled deviation indicator may be acceptable depending on the task, flight crew workload, display characteristics, flight crew procedures and training.*
b)	*Identification of the active (To) Waypoint.*	*The navigation system must provide a display identifying the active waypoint either in the pilot's primary optimum field of view, or on a readily accessible and visible display to the flight crew.*
c)	*Display of distance and bearing.*	*The navigation system must provide a display of distance and bearing to the active (To) waypoint in the pilot's primary optimum field of view. Where not viable, a readily accessible page on a control display unit, readily visible to the flight crew, may display the data.*
d)	*Display of ground speed and time.*	*The navigation system must provide the display of ground speed and time to the active (To) waypoint in the pilot's primary optimum field of view. Where not viable, a readily accessible page on a control display unit, readily visible to the flight crew, may display the data.*
e)	*Desired track display.*	*The navigation system must have the capability to continuously display to the pilot flying the aircraft desired track. This display must be on the primary flight instruments for navigation of the aircraft.*

Item	Function/Feature	Description
f)	Display of aircraft track.	The navigation system must provide a display of the actual aircraft track (or track angle error) either in the pilot's primary optimum field of view, or on a readily accessible and visible display to the flight crew.
g)	Failure annunciation.	The aircraft must provide a means to annunciate failures of any aircraft component of the RNP system, including navigation sensors. The annunciation must be visible to the pilot and located in the primary optimum field of view.
h)	Slaved course selector.	The navigation system must provide a course selector automatically slaved to the RNP computed path.
i)	Display of distance to go.	The navigation system must provide the ability to display distance to go to any waypoint selected by the flight crew.
j)	Display of distance between flight plan waypoints.	The navigation system must provide the ability to display the distance between flight plan waypoints.
k)	Display of deviation.	The navigation system must provide a numeric display of the lateral deviation with a resolution of 0.1 NM or less.
l)	Display of active sensors.	The aircraft must display the current navigation sensor(s) in use. It is recommended that this display be provided in the primary optimum field of view. Note. — This display is used to support operational contingency procedures. If such a display is not provided in the primary optimum field of view, crew procedures may mitigate the need for this display if the work load is determined to be acceptable.

22.2 Path definition and flight planning

Item	Function/Feature	Description
a)	Maintaining tracks and leg transitions.	The aircraft must have the capability to execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators: ARINC 424 path terminators • IF • CF • DF • TF • RF, see Appendix 1 to Part C, Volume II • CA • Course from an FA • VA • Course from an FM • VM • VI • HM Where approval is sought for FRT in association with this navigation specification, the RNP system must have the capability to create FRTs between route segments, based upon the data contained in the aircraft navigation system database — see Appendix 2 to Part C, Volume II of ICAO Doc 9613.

Item	Function/Feature	Description
a)	*Maintaining tracks and leg transitions.* ***continued***	*Notes:* *1. Path terminators and the FRT are defined in ARINC 424, and their application is described in more detail in RTCA/EUROCAE documents DO-236B/ED-75Band DO-201A/ED-77.* *2. The list of path terminators includes a number that introduce variability in the flight path to be flown by the aircraft. For all RNP applications, the preferred path terminators are IF, DF, TF, and RF. Other path terminators may be used on the understanding that they will introduce less repeatability, predictability and reliability of aircraft lateral path performance.* *3. For the VA, VM and VI path terminators, if the aircraft is unable to automatically execute these leg transitions, they should be able to be manually flown on a heading to intercept a course or to go direct to another fix after reaching a procedure-specified altitude.*
b)	*Leg transition.*	*Fly-by and fly-over fixes. The aircraft must have the capability to execute fly-by and fly-over fixes .For fly-by turns, the navigation system must limit the path definition within the theoretical transition area defined in EUROCAE ED-75B/ RTCADO-236B.The fly-over turn is not compatible with RNP flight tracks and will only be used when there is no requirement for repeatable paths.* *FRTs: Where approval is sought for FRTs, the aircraft must have the capability to execute the function in accordance with Appendix 2 to Part C, Volume II of ICAO Doc 9613.*
c)	*Intercepts.*	*The RNP system should provide the ability to intercept the final approach at or before the FAF.* *This functional capability must provide the pilot with the ability to rejoin the published final approach track following a period when the aircraft has been flown manually or in AFCS heading mode, following ATC vectors to support final approach sequencing.* *The implementation method and visual information (MCDU and primary displays (map display/EHSI)) shall be sufficient to enable the correct re-acquisition of the track with a minimum of manual intervention on the MCDU. Due account must be taken of the workload associated with there-acquisition and the impact of errors in leg sequencing.*
d)	*Holding.*	*A holding procedure will only normally be required at defined holding points on entry to terminal airspace. However, holding may be required by ATC at any point. A hold shall be defined by a point, the turn direction, an inbound track and an outbound distance. This data may be extracted from the database for published holds or maybe manually entered for ad hoc ATC holds.* *Note. — It is highly desirable that the RNP system provide a holding capability that includes the computation of the hold flight path, guidance and/or cues to track the holding entry and path.* *The system with the minimum of crew intervention must be capable of initiating, maintaining and discontinuing holding procedures at any point and at all altitudes.*

Item	Function/Feature	Description
e)	Parallel offset.	Parallel off sets provide a capability to fly off set from the parent track, as defined by the series of waypoints. The turn defined for the parent track (fly-by or FRT) shall be applied in the offset track. Parallel offsets are applicable only for en-route segments and are not foreseen to be applied on SIDs, STARs or approach procedures. The activation of an offset shall be clearly displayed to the flight crew and the cross-track deviation indication during the operation of the offset will be to the offset track.
f)	Offset execution.	The system should be capable of flying tracks offset by up to 20 NM from the parent track. The presence of an offset should be continuously indicated; Tracks offset from the parent track shall be continued for all ATS route segments and turns until either: – Removed by the crew; or – Automatically cancelled following: • Amendment of the active flight plan by executing a "Direct-To"; • Commencement of a terminal procedure; • Where a course change exceeds 90°, the RNP system may terminate the offset at the fix where the course change occurs. The offset may also be terminated if the route segment ends at a hold fix. The flight crew shall be given advance notice of this cancellation. The cross-track off set distance should be manually entered into the RNP system to a resolution of 1 NM or better. Where parallel offsets are applied, the lateral track keeping requirement of RNP must be maintained referenced to the offset track. Where FRTs are applied, the offset track must be flown with the same turn radius as the parent track. The cross-track offset distance should be manually entered into the RNP system to a resolution of 1 NM or better. Where parallel offsets are applied, the lateral track-keeping requirement of RNP must be maintained referenced to the offset track.
g)	Entry and recovery from offsets.	Transitions to and from the offset track must maintain an intercept angle of between 30° and 45°.

Item	Function/Feature	Description
h)	Capability for a "direct-to" function.	The navigation system must have a "direct-to" function the flight crew can activate at any time. This function must be available to any fix. The navigation system must also be capable of generating a Geodesic path to the designated "To" fix without "S-turning" and without undue delay.
i)	Altitudes and/or speeds associated with published terminal procedures.	Altitudes and/or speeds associated with published terminal procedures must be extracted from the navigation database.
j)	Capability to load procedures from the navigation database.	The navigation system must have the capability to load the entire procedure(s) to be flown into the RNP system from the on-board navigation database. This includes the approach (including vertical angle), the missed approach and the approach transitions for the selected airport and runway.
k)	Means to retrieve and display navigation data.	The navigation system must provide the ability for the flight crew to verify the procedure to be flown through review of the data stored in the on-board navigation database. This includes the ability to review the data for individual waypoints and for NAVAIDs.
l)	Magnetic variation.	For paths defined by a course (e.g. CF and FA path terminators), the navigation system should use the appropriate magnetic variation value in the navigation database.
m)	Changes in navigation accuracy.	The RNP system should automatically retrieve and set the navigation accuracy for each leg segment of a route or procedure from the on- board navigation database. When a change occurs to a smaller navigation accuracy, e.g. from RNP1.0 to RNP 0.3, the change must be complete by the first fix defining the leg with the smaller navigation accuracy requirement. The timing of this change must also consider any latency in alerting from the RNP system. When the RNP system cannot automatically set the navigation accuracy for each leg segment, any operational procedures necessary to accomplish this must be identified. Note.— One acceptable means to meet this requirement may be to require the flight crew to manually set the smallest navigation accuracy the route or procedure uses before commencing the route or procedure (i.e. prior to the IAF). If the navigation accuracy for the RNP system has been set manually by the flight crew and following an RNP system change to the navigation accuracy required (e.g. the next flight path segment contains a different navigation accuracy), the RNP system should provide an alert to the flight crew.
n)	Automatic leg sequencing.	The navigation system must provide the capability to automatically sequence to the next leg and display the sequencing to the flight crew in a readily visible manner.

22.3 System

Item	Function/Feature	Description
a)	Design assurance.	The system design assurance must be consistent with at least a major failure condition for the display of misleading lateral or vertical guidance in RNP applications.
b)	Navigation database.	The aircraft navigation system must use an on-board navigation database, containing current navigation data officially promulgated for civil aviation, which can be updated in accordance with the AIRAC cycle; and allow retrieval and loading of procedures into the RNP system. The stored resolution of the data must be sufficient to achieve negligible PDE. The on-board navigation database must be protected against flight crew modification of the stored data. When a procedure is loaded from the database, the RNP system must fly the procedure as published. This does not preclude the flight crew from having the means to modify a procedure or route already loaded into the RNP system. However, the procedures stored in the navigation database must not be modified and must remain intact within the navigation database for future use and reference. The aircraft must provide a means to display the validity period for the on-board navigation database to the flight crew. The equipment should not permit the flight crew to either manually or automatically select a route that is not supported. A route is not supported if it incorporates an FRT and the equipment does not provide FRT capability. The RNP system should also restrict pilot access to routes requiring FRTs if the equipment can support the route, but the aircraft is not otherwise equipped (e.g. the aircraft does not have the required roll steering autopilot or flight director installed). Note. — An alternate means of satisfying this requirement is to remove such routes from the navigation database.

22.4 Optional capability

Item	Function/Feature	Description
a)	RNP scalability	The RNP system must be capable of manual or automatic entry and display of navigation accuracy requirements in tenths of NM between 0.3 and 1.0 NM. The RNP system must provide lateral deviation displays and alerting appropriate to the selected navigation accuracy and application. Notes: 1. One means by which this can be achieved is as described in RTCA MOPSDO-283A. Another means is to develop lateral deviation displays and alerting as per RTCA/EUROCAE MASPS DO-236B/ED-75B.

Item	Function/Feature	Description
a)	RNP scalability **continued**	2. It is recognised that aircraft and equipment that are based upon GNSS standards such as RTCA DO-208() and DO-229() have RNP capabilities for lateral deviation and alerting that are generally associated with navigation accuracies of 0.3, 1.0, and 2.0 NM only. Such capability exists in a large portion of the aircraft fleet but may not be extended to other navigation accuracies or the means of compliance specified herein. Additionally, some of this fleet does provide the capability to select other navigation accuracies. Therefore, before a manufacturer implements or an operator applies this functional capability, it is recommended that they determine the effects of the resolution of a number of issues including: a) How their aircraft and systems will be affected or accommodated operationally when different navigation accuracy requirements are needed; b) Is there a basis for implementing improved functionality or operating procedures; and c) How such systems will need to be qualified, used by the flight crew and operationally approved.

23. **Operating procedures**

Airworthiness certification alone does not authorise A-RNP operations. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

23.1 **Pre-flight planning**

23.1.1 Operators and pilots intending to conduct RNP operations requiring A-RNP capability should indicate the appropriate application in the flight plan.

23.1.2 The on-board navigation data must be current and appropriate to the route being flown and for potential diversions. Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including suitability of navigation facilities used to define the routes and procedures for flight.

23.1.3 Operators using GNSS equipment should confirm the availability of RAIM by using RAIM availability prediction software taking account of the latest GNSS NOTAMs. Operators using SBAS augmentation should also check the relevant SBAS NOTAMs to determine the availability of SBAS. Notwithstanding pre-flight analysis results, because of unplanned failure of some GNSS or DME elements (or local interference), pilots must realise that integrity availability (or GNSS/DME navigation altogether) may be lost while airborne which may require reversion to an alternate means of navigation. Therefore, pilots should assess their capability to navigate in case of failure of the primary sensor or the RNP system.

Please note: SBAS is not currently certified in South Africa.

23.2 **General operating procedures**

23.2.1 Operators and pilots should not request or file A-RNP routes, SIDs, STARs or approaches unless they satisfy all the criteria in the relevant SACAA documents. The pilot should comply with any instructions or procedures identified by the manufacturer, as necessary, to comply with the performance requirements in this AIC.
Note. — Pilots are expected to adhere to any AFM limitations or operating procedures required to maintain the RNP for the operation.

23.2.2 At system initialization, pilots must confirm the navigation database is current and verify that the aircraft position has been entered correctly. Pilots must not fly an A-RNP route, SID, STAR or approach unless it is retrievable by name from the on-board navigation database and conforms to the chart.
An A-RNP route, SID, STAR or approach should not be used if doubt exists as to the validity of the procedure in the navigation database.

Note. — Flight crew may notice a slight difference between the navigation information portrayed on the chart and their primary navigation display. Differences of 3 degrees or less may result from equipment manufacturer's application of magnetic variation and are operationally acceptable.

23.2.3 Cross-checking with conventional NAVAIDs is not required as the absence of integrity alert is considered sufficient to meet the integrity requirements. However, monitoring of navigation reasonableness is suggested, and any loss of RNP capability shall be reported to ATC. While operating on A-RNP Routes, SIDs STARs or approaches, pilots are encouraged to use flight director and/or autopilot in lateral navigation mode, if available. Flight crew should be aware of possible lateral deviations when using raw path steering data or Navigation Map Displays for lateral guidance in lieu of flight director. When the dispatch of a flight into A-RNP operations is predicated on use of the autopilot/flight director at the destination and/or alternate, the dispatcher/flight crew must determine that the autopilot/flight director is installed and operational.

23.3 Manual entry of RNP

If the navigation system does not automatically retrieve and set the navigation accuracy from the on-board navigation database for each leg segment of a route or procedure, the flight crew's operating procedures should ensure the smallest navigation accuracy for the route or procedure is manually entered into the RNP system.

23.4 SID specific requirements

23.4.1 Prior to flight, pilots must verify their aircraft navigation system is operating correctly and the correct runway and departure procedure (including any applicable en-route transition) are entered and properly depicted. Pilots who are assigned an A-RNP departure procedure and subsequently receive a change of runway, procedure or transition must verify the appropriate changes are entered and available for navigation prior to take-off. A final check of proper runway entry and correct route depiction, shortly before take-off, is recommended.

23.4.2 Engagement altitude. The pilot must be able to use RNP equipment to follow flight guidance for lateral navigation no later than 153 m (500 ft) above the airport elevation. The altitude at which guidance begins on a given route may be higher (e.g. climb to 304 m (1 000 ft) then direct to …).

23.4.3 Pilots must use an authorised method (lateral deviation indicator/navigation map display/flight director/autopilot) to achieve an appropriate level of performance.

23.4.4 GNSS aircraft. When using GNSS, the signal must be acquired before the take-off roll commences. For aircraft using FAA TSO-C129a equipment, the departure airport must be loaded into the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using FAA TSO-C145a/C146a equipment, if the departure begins at a runway waypoint, then the departure airport does not need to be in the flight plan to obtain appropriate monitoring and sensitivity.

23.5 STAR specific requirements

23.5.1 Prior to the arrival phase, the flight crew should verify that the correct terminal route has been loaded. The active flight plan should be checked by comparing the charts with the map display (if applicable) and the MCDU. This includes confirmation of the waypoint sequence, reasonableness of tracks and distances, any altitude or speed constraints, and, where possible, which waypoints are fly-by and which are fly-over. If required by a route, a check will need to be made to confirm that updating will exclude a particular NAVAID. A route must not be used if doubt exists as to the validity of the route in the navigation database.

Note. — As a minimum, the arrival checks could be a simple inspection of a suitable map display that achieves the objectives of 23.5.1.

23.5.2 The creation of new waypoints by manual entry into the RNP system by the flight crew would invalidate the route and is not permitted.

23.5.3 Where the contingency procedure requires reversion to a conventional arrival route, necessary preparations must be completed before commencing the RNP route.

23.5.4 Route modifications in the terminal area may take the form of headings or "direct to" clearances and the flight crew must be capable of reacting in a timely fashion.
This may include the insertion of tactical waypoints loaded from the database. Manual entry or modification by the flight crew of the loaded route, using temporary waypoints or fixes not provided in the database, is not permitted.

23.5.5 Pilots must verify their aircraft navigation system is operating correctly, and the correct arrival procedure and runway (including any applicable transition) are entered and properly depicted.

23.5.6 Although a particular method is not mandated, any published altitude and speed constraints must be observed. Approaches using temporary waypoints or fixes not provided in the navigation database are not permitted.

23.6 Contingency procedures

23.6.1 The pilot must notify ATC of any loss of the RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If unable to comply with the requirements of an A-RNP SID or STAR, pilots must advise ATS as soon as possible. The loss of RNP capability includes any failure or event causing the aircraft to no longer satisfy the A-RNP requirements of the route.

23.6.2 In the event of communications failure, the flight crew should continue with the A-RNP SID or STAR in accordance with the published lost communications procedure.

24. Navigation database

24.1 Navigation data management is addressed in ICAO Annex 6, Part 1 Chapter 7. In support of this, the operator must obtain the navigation database from a supplier complying with RTCA DO 200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data, and the database must be compatible with the intended function of the equipment. Regulatory authorities recognize compliance to the referenced standard using an Letter of Authorisation (LOA) or other equivalent document.

24.2 Discrepancies that invalidate an RNP Route, SID or STAR must be reported to the navigation data base supplier and the affected route, SID or STAR must be prohibited by an operator's notice to its flight crew.

24.3 For RNP procedures, the database supplier is discouraged from substitution of path terminators in lieu of those specified in the original AIP data. Where this is necessary, there must be coordination with the SACAA to gain operational acceptability and approval for such substitutions.

24.4 Aircraft operators should consider the need to conduct ongoing checks of the operational navigation databases in order to meet existing quality system requirements.

25. Pilot knowledge and training

The training programme should provide sufficient training (e.g. simulator, training device, or aircraft) on the aircraft's RNP system to the extent that the pilots are familiar with the following:

a) The meaning and proper use of aircraft equipment/navigation suffixes;

b) Procedure characteristics as determined from chart depiction and textual description:

- *i) Depiction of waypoint types (fly-over, fly-by, RF and FRT), altitude and speed restrictions and path terminators as well as associated aircraft flight paths; and*
- *ii) Required navigation equipment for operation on RNP routes, SIDs, and STARs;*

c) RNP system-specific information:

- *i) Levels of automation, mode annunciations, changes, alerts, interactions, reversions, and degradation;*
- *ii) Functional integration with other aircraft systems;*
- *iii) The meaning and appropriateness of route discontinuities as well as related flight crew procedures;*
- *iv) Monitoring procedures for each phase of flight (for example, monitor PROG or LEGS page);*
- *v) Types of navigation sensors (GNSS) used by the RNP system and associated system prioritization/weighting/logic;*
- *vi) Turn anticipation with consideration to speed and altitude effects;*
- *vii) Interpretation of electronic displays and symbols; and*

viii) *Automatic and/ or manual setting of the required navigation accuracy;*

d) *Understand the performance requirement to couple the autopilot/flight director to the navigation system's lateral guidance on RNP procedures, if required;*

e) *The equipment should not permit the flight crew to select a procedure or route that is not supported by the equipment, either manually or automatically (e.g. a procedure is not supported if it incorporates an RF leg and the equipment does not provide RF leg capability). The system should also restrict pilot access to procedures requiring RF leg capability or FRTs if the system can select the procedure, but the aircraft is not otherwise equipped (e.g. the aircraft does not have the required roll steering auto pilot or flight director installed);*

f) *RNP equipment operating procedures, as applicable, including how to perform the following actions:*

i) *Verify currency and integrity of aircraft navigation data;*
ii) *Verify successful completion of RNP system self-tests;*
iii) *Initialize navigation system position;*
iv) *Retrieve and fly a SID or a STAR with appropriate transition;*
v) *Adhere to speed and/or altitude constraints associated with a SID or STAR;*
vi) *Select the appropriate STAR or SID for the active runway in use and be familiar with procedures to deal with a runway change;*
vii) *Verify waypoints and flight plan programming;*
viii) *Perform a manual or automatic runway update (with take-off point shift, if applicable);*
ix) *Fly direct to a waypoint;*
x) *Fly a course/track to a waypoint;*
xi) *Intercept a course/track. (Fly vectors, and rejoin an RNP route/procedure from the "heading" mode);*
xii) *Determine cross-track error/deviation. More specifically, the maximum deviations allowed to support A-RNP must be understood and respected;*
xiii) *Where applicable, the importance of maintaining the published path and maximum airspeeds while performing RNP operations with RF legs or FRTs;*
xiv) *Insert and delete route discontinuity;*
xv) *Remove and reselect navigation sensor input;*
xvi) *When required, confirm exclusion of a specific NAVAID or NAVAID type;*
xvii) *When required by the State aviation authority, perform gross navigation error check using conventional NAVAIDs;*
xviii) *Change arrival airport and alternate airport;*
xix) *Perform parallel offset function if capability exists. Pilots should know how offsets are applied, the functionality of their particular RNP system and the need to advise ATC if this functionality is not available;*
xx) *Perform RNAV holding function;*
xxi) *Flight crew contingency procedures for a loss of RNP capability; and*
xxii) *Manual setting of the required navigation accuracy;*

Note. — Operators are strongly encouraged to use manufacturer recommended training and operating procedures.

g) *Operator-recommended levels of automation for phase of flight and workload, including methods to minimize cross-track error to maintain route centre line; and*

h) *R/T phraseology for RNAV/RNP applications.*

26. ***Oversight of operators***

26.1 The SACAA will consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in the cancellation of the approval for the use of that equipment.

26.2 Information that indicates the potential for repeated errors may require modification of an operator's training programme and, at the discretion of the SACAA, may result in the establishment of operator RNP monitoring programmes.

27. ***Abbreviations***

AFCS - Automatic Flight Control System
AFM – Aircraft Flight Manual
ANP - Actual Navigation Performance
ANSP – Air Navigation Service Provider
APCH – Approach
APV – Approach Procedure with Vertical Guidance
A-RNP – Advanced-Required Navigation Performance
ATC – Air Traffic Control
ATS – Air Traffic Services

DME – Distance Measuring Equipment
EHSI – Electronic Horizontal Situation Indicator
EPE – Estimated Position Error
EPU – Estimated Position Uncertainty

FAF – Final Approach Fix
FAS – Final Approach Segment
FRT – Fixed Radius Transition
FTE – Flight Technical Error

HIL – Horizontal Integrity Limit
HPL – Horizontal Protection Level

IAF – Initial Approach Fix
INS – Inertial Navigation System
IRS – Inertial Reference System

MCDU – Multifunction Control and Display Unit
MEL – Minimum Equipment List

NAA – National Airworthiness Authority
NSE – Navigation System Error

OEM – Original Equipment Manufacturer
OM – Operations Manual

PDE – Path Definition Error

RF – Radius to Fix
RNAV – Area Navigation

SB – Service Bulletin
SBAS – Satellite Based Augmentation Systems
SID – Standard Instrument Departure
SIS – Signal In Space
SOP – Standard Operating Procedures
STAR – Standard Instrument Arrival
STC – Supplemental Type Certificate

TOAC – Time Of Arrival Control
TSE – Total System Error

VHF – Very High Frequency
VNAV – Vertical Navigation
VOR – VHF Omnidirectional Radio Range

28. ***Glossary***

Active Waypoint *- The waypoint to/from which the navigational guidance is being provided.*

Along Track Distance (ATD) Fix *- A distance in nautical miles (NM) to the active waypoint along the specified track. An ATD fix will not be used where a course change is made.*

Course Set *- Guidance set from information provided by the GPS equipment that assists the pilot in navigating to or from an active waypoint on a heading/bearing.*

Dead Reckoning (DR) *- The navigation of an aircraft solely by means of computations based on airspeed, course, heading, wind direction and speed, ground speed and elapsed time.*

Direct To *- A method used with the GPS equipment to provide the necessary course from present position directly to a selected waypoint. This is not the course waypoint to waypoint.*

En Route Domestic *- The phase of flight between departure and arrival terminal phases, with departure and arrival points within the South African Airspace.*

En Route Oceanic *- The phase of flight between the departure and arrival terminal phases with an extended flight route over the high seas.*

En Route Operations *- The phase of navigation covering operations between departure and arrival terminal phases. The en route phase of navigation has two subcategories: en route domestic and en route oceanic.*

Fly By Waypoint *- A waypoint which requires turn anticipation to allow tangential interception of the next segment of a route or procedure. or.*

Fly Over Waypoint *- A waypoint at which a turn is initiated in order to join the next segment of a route or procedure.*

Geodetic Datum *- The numerical or geometrical quantity or set of such quantities (mathematical model) which serves as a reference for computing other quantities in a specific geographic region such as the latitude and longitude of a point.*

Global Navigation Satellite Systems (GNSS) *- An "umbrella" term adopted by the International Civil Aviation Organization (ICAO) to encompass any independent satellite navigation system used by a pilot to perform onboard position determinations from the satellite data.*

Global Positioning system (GPS) *- a U.S. space-based positioning, velocity and time system composed of space, control, and user elements. The space element, when fully operational will be composed of 24 satellites in six orbital planes. The control element consists of five monitor stations, three ground antennas and a master control station. The user element consists of antennas and receiver-processors that provide positioning, velocity, and precise timing to the user.*

Integrity *- The probability that the system will provide accurate navigation as specified or timely warnings to users when GPS data should not be used for navigation.*

Minimum en-route altitude (MEA) *- The altitude for an en-route segment that provides adequate reception of relevant navigation facilities and ATS communications complies with the airspace structure and provides the required obstacle clearance.*

Minimum obstacle clearance altitude (MOCA) *- The minimum altitude for a defined segment of flight that provides the required obstacle clearance.*

Non-precision Approach Operations *- Those flight phases conducted on charted Standard Instrument Approach Procedures (SIAPs) commencing at the initial approach fix and concluding at the missed approach point or the missed approach holding point, as appropriated.*

Oceanic Airspace *- Airspace over the oceans of the world, considered international airspace, where oceanic separation and procedures per the International Civil Aviation Organization (ICAO) are applied. Responsibility for the provisions of air traffic control service in this airspace is delegated to various countries, based generally upon geographic proximity and the availability of the required resources.*

Receiver Autonomous Integrity Monitoring (RAIM) *- A technique whereby a civil GPS receiver/processor determines the integrity of the GPS navigation signals using only GPS signals or GPS signals augmented with altitude. This determination is achieved by a consistency check among redundant pseudo range measurements. At least one satellite in addition to those required for navigation must be in view for the receiver to perform the RAIM function.*

Selective Availability (SA) *- A method by which the U.S. Department of Defence can artificially create a significant time and positioning error in the satellites. This feature is designed to deny an enemy the use of precise GPS positioning data.*

Supplemental Air Navigation System *- An approved navigation system that can be used in conjunction with, or in addition to a primary air navigation system.*

TO - FROM Navigation *- RNAV equipment in which the desired path over the ground in defined as a specific (input quantity) course emanating either to or from a particular waypoint. The equipment functions like a conventional VOR receiver where the CDI needle and the "to/from" indicator responds to movement of the OBS. In this equipment the aircraft may fly either TO or FROM any single designated waypoint.*

TO - TO Navigation *- RNAV equipment in which a path is computed that connects two waypoints. In this equipment, two waypoints must always be available, and the aircraft is usually flying between the two waypoints and TO the active waypoint. In this equipment the CDI needle functions like its tracking a localizer signal; that is movement of the OBS has no effect on the CDI needle or the "to/from".*

Turn Anticipation *- The capability of RNAV systems to determine the point along a course, prior to a turn waypoint, where a turn should be initiated to provide a smooth path to intercept the succeeding course within the protected airspace and to enunciate the information to the pilot.*

User-selectable Navigation Database *- A navigation database having user defined contents accessible by the pilot and/or the navigation computer during aircraft operations in support of navigation needs. This database is stored electronically and is typically updated at regular intervals, such as the AIRAC 28 day cycle. It does not include data that can be entered manually by the pilot or operator.*

Waypoint (wp) *- A Specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. Waypoints are identified as either Fly-by waypoint or fly-over waypoint.*

World Geodetic System (WGS) *- A consistent set of parameters describing the size and shape of the earth, the positions of a network of points with respect to the centre of mass of the earth, transformations from major geodetic datum, and the potential of the earth (usually in terms of harmonic coefficients).*

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