Egyptian Air Navigation Circular

EAC

No. 172_5

PBN Operational Approval

November, 2016

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Part A: General

172.5.1Purpose and Scope:

This circular shall apply to an air navigation service provider and airspace users on how to implement PBN applications, and how to ensure that the performance requirements are appropriate for the planned application.

172.5.2 Related ECARs:

(a) ECAR 172.141
(b) ECAR 172.157

172.5.3 Related references:

- ICAO Annexes (6,10,11,15)
- ICAO Doc.9613- Performance based Navigation Manual
- ICAO Doc. 8168 – Volume II

172.5.4 Definitions:

Aircraft-based augmentation system (ABAS).An augmentation system that augments and/or integrates theInformation obtained from the other GNSS elements with information available on board the aircraft.

Approach procedure with vertical guidance (APV). An instrument procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.

Navigation specification. A set of aircraft and aircrew requirements needed to support Performance-based Navigation operations within a defined airspace. There are two kinds of navigation specification:

RNAV specification. A navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV, e.g. RNAV 5, RNAV 1.

RNP specification. A navigation specification based on area navigation that includes the requirement for onboard performance monitoring and alerting, designated by the prefix RNP, e.g. RNP 4, RNP APCH.

RNAV operations.Aircraft operations using area navigation for RNAV applications. RNAV operations include the use of area navigation for operations which are not developed in accordance with this manual.

RNAV system.A navigation system which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Note.— An RNAV system may be included as part of a flight management system (FMS).

RNP operations.Aircraft operations using an RNP system for RNP navigation applications.

RNP route. An ATS route established for the use of aircraft adhering to a prescribed RNP navigation specification.

RNP system.An area navigation system which supports on-board performance monitoring and alerting.

Satellite-based augmentation system (SBAS).A wide coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter.

Standard instrument arrival (STAR).A designated instrument flight rule (IFR) arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced.

Standard instrument departure (SID).A designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences.

172.5.5PBN background:

a) The PBN concept specifies that aircraft RNAV and RNP system performance requirements be defined in terms of the accuracy, integrity, continuity and functionality, which are needed for the proposed operations in the context of a particular airspace concept. The PBN concept represents a shift from sensor-based to PBN. Performance requirements are identified in navigation specifications, which also identify the choice of navigation sensors and equipment that may be used to meet the performance requirements. These navigation specifications are defined at a sufficient level of detail to facilitate global harmonization by providing specific implementation guidance for States and operators.

b) The PBN concept is made up of three interrelated elements: the navigation specification, the NAVAID infrastructure, and the navigation application.

1. The NAVAID infrastructure relates to space or ground-based NAVAIDs that are mentioned in each navigation specification
2. Navigation specifications which require on-board performance monitoring and alerting are termed RNP specifications. Those that do not require on-board performance monitoring and alerting are known as RNAV specifications.
3. Navigation application is when a navigation specification and associated NAVAID infrastructure are applied to ATS routes, IAPs and/or defined airspace volume, in accordance with the airspace concept. Examples of how the navigation specification and NAVAID infrastructure may be used together in a navigation application include RNAV or RNP SIDs and STARs, RNAV or RNP ATS routes, and RNP approach procedures.

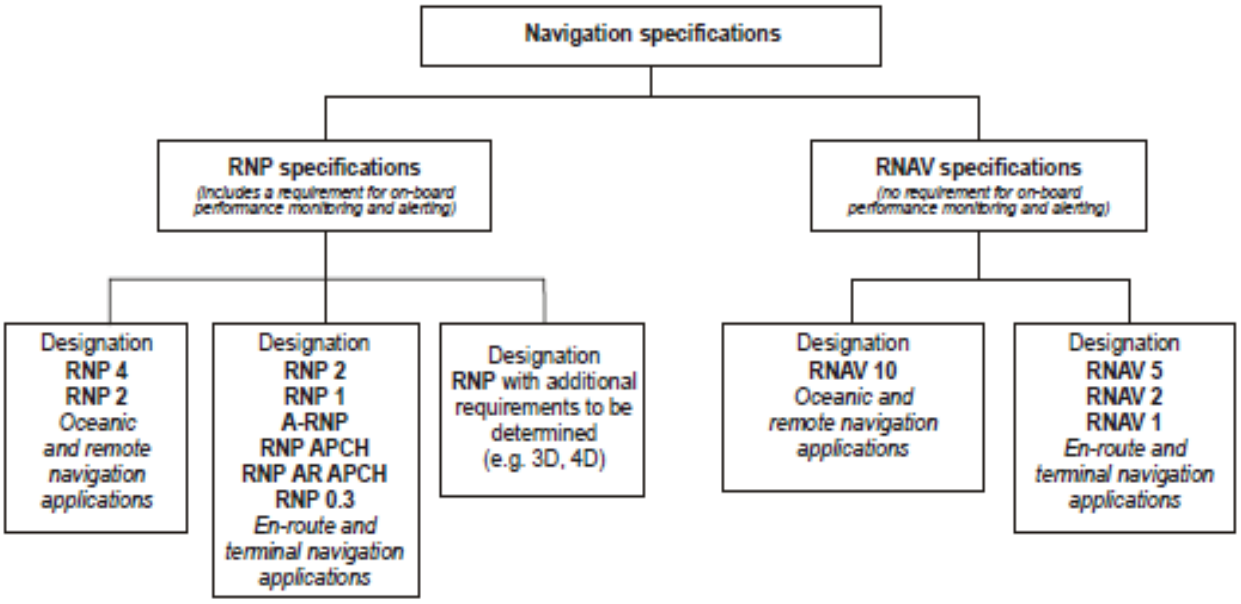
172.5.7 Designation of RNAV and RNP Specifications:

a) Two types of navigation specification exists according to the below figure:

(1) **RNAV**: A navigation specification which does not require an on board performancemonitoring and alerting function (OPMA).

(2) **RNP**: A navigation specification that does require an on board performance monitoring and alerting function (OPMA).

b) Because specific performance requirements are defined for each navigationspecification, an aircraft approved for an RNP specification is not automatically approved for all RNAV specifications. Similarly, an aircraft approved for an RNP orRNAV specification having a stringent accuracy requirement (e.g. RNP 0.3 specification)is not automatically approved for a navigation specification having a less stringent accuracy requirement (e.g. RNP 4).



172.5.9 Safety and performance criteria:

Safety policy and safety criteria for the airspace concept and the entire PBN implementation must be established.System performance criteria should be set so that it is possible to determine when the new airspace concept has met its “objectives”. Examples of performance criteria include reducing the maximum number of crossing points to be permitted within a sector; reducing track mileage on STARs; reducing noise emissions over the noise measurement point; increasing terminal airspace capacity by 20 per cent, increasing flight efficiency or reducing fuel burn.

The safety assessment needs to be carried out throughout the development and implementation process. This includes the identification of hazards and appropriate mitigations while developing and validating the airspace concept.

Egyptian regulation ECAR Part 19 and related circulars require that any new system, procedure or operation that has an impact on the safety of Air Traffic Services (ATS) shall be subject to a risk assessment and mitigation process to support its safe introduction and operation. Safety-significant changes to existing systems must also be addressed in the same way. The result of the assessment should be documented and this is typically achieved by developing a Safety Case. The term 'Safety Case' is used in respect of a set of one or more documents that include claims, arguments and evidence that a system meets its safety requirements. A Safety Case provides all the documentation and references necessary to demonstrate, both to Egyptian Civil Aviation Authority that a new system or a change to an existing system is tolerably safe and will meet specified Safety Objectives.

Part B: Implementing RNAV/RNP Operations

172.5.11Implementing RNAV 5

(a) Purpose of implementing RNAV5:-

1) This circular provides guidance for implementing RNAV 5 in the en-route phase of flight andprovides the ANSP with an ICAO recommendation on the implementation requirements, avoiding the proliferation ofstandards and the need for multiple regional approvals. It provides the operator with criteria to enable operation in airspace where the carriage of RNAV meeting 5 NM lateral accuracy is already required (e.g. ECAC B-RNAV). It avoidsthe need for further approvals in other regions or areas needing to implement RNAV with the same lateral accuracy andfunctional requirements.
2) While primarily addressing requirements of RNAV operation in an ATS surveillance environment, RNAV 5 implementation has occurred in areas where there is no ATS surveillance. This has required an increase in route spacing commensurate with the assurance of meeting the SSR.
3) The RNAV 5 specification does not require an alert to the pilot in the event of excessive navigation errors. Since the specification does not require the carriage of dual RNAV systems, the potential for loss of RNAV capability requires an alternative navigation source.

(b) Implementation Consideration:-

1. NAVAID infrastructure

1.1. State may prescribe the carriage of RNAV 5 on specific routes or for specific areas/flight levels of its airspace.

1.2. RNAV 5 systems permit aircraft navigation along any desired flight path within the coverage of station referenced NAVAIDs (space or terrestrial) or within the limits of the capability of self-contained aids, or a combination of both methods.

1.3. RNAV 5 operations are based on the use of RNAV equipment which automatically determines the aircraft position in the horizontal plane using input from one or a combination of the following types of position sensors, together with the means to establish and follow a desired path:

i. VOR/DME;
ii. DME/DME;
iii. INS or IRS; and
iv. GNSS.

1.4. The ANSP must assess the NAVAID infrastructure in order to ensure that it is sufficient for the proposed operations, including reversionary modes. It is acceptable for gaps in NAVAID coverage to be present; when this occurs, route spacing and obstacle clearance surfaces need to take account of the expected increase in lateral track-keeping errors during the “dead reckoning” phase of flight.

2. Communications and ATS surveillance.

2.1. Direct pilot to ATC (voice) communications is required.

2.2. When reliance is placed on the use of ATS surveillance to assist contingency procedures, its performance should be adequate for that purpose.

2.3. Radar monitoring by the ATS may be used to mitigate the risk of gross navigation errors, provided the route lies within the ATS surveillance and communications service volumes and the ATS resources are sufficient for the task.

3. Obstacle clearance and route spacing:-

3.1. Detailed guidance on obstacle clearance is provided in PANS-OPS (Doc 8168), Volume II; the general criteria in Parts I and III apply, and assume normal operations.

3.2. The State is responsible for route spacing and should have ATS radar surveillance and monitoring tools to support detection and correction of navigation errors. The

State should refer to applicable ICAO guidance material regarding route spacing between RNAV 5 routes or between RNAV 5 routes and conventional routes.

3.3. Where traffic density is lower, route spacing may be reduced. In an ATS radar surveillance environment, the route spacing will depend on acceptable ATC workload and availability of controller tools. One regional RNAV 5 implementation
adopted a standard route spacing of 16.5 NM for same-direction traffic and 18 NM for opposite-direction traffic in a radar environment.

3.4. The route design should account for the navigation performance achievable using the available NAVAID infrastructure, as well as the functional capabilities required by the navigation specification. Two aspects are of particular importance: spacing between routes in turns and along track distance between leg changes.

3.4.1. ***Spacing between routes in turns***

Automatic leg sequencing and associated turn anticipation is only a recommended function for RNAV 5. The track followed in executing turns depends upon the true airspeed, applied bank angle limits and wind. These factors, together with the different turn initiation criteria used by manufacturers, result in a large spread of turn performance. Studies have shown that for a track change of as little as 20 degrees, the actual path flown can vary by as much as 2 NM. This variability of turn performance needs to be taken into account in the design of the route structure where closely spaced routes are proposed.

3.4.2. ***Along track distance between leg changes.***

i. The turn can start as early as 20 NM before the waypoint in the case of a large track angle change with a "fly-by" turn; manually initiated turns may overshoot the following track.

ii. The track structure design needs to ensure leg changes do not occur too closely together. The required track length between turns depends upon the required turn angle.

4. Additional considerations

4.1. Many aircraft have the capability to fly a path parallel to, but offset left or right from, the original active route. The purpose of this function is to enable offsets for tactical operations authorized by ATC.

4.2. Many aircraft have the capability to execute a holding pattern manoeuvre using their RNAV system, which can provide flexibility to ATC in designing RNAV operations.

5. **Publication**:-

5.1. The AIP should clearly indicate the navigation application is RNAV5.The requirement for the carriage of RNAV 5 equipment in specific airspace or on identified routes should be published in the AIP. The route should rely on normal descent profiles and identify minimum segment altitude requirements. The navigation data published in the EgyptianAIP for the routes and supporting NAVAIDs must meet the requirements of Annex 15 — Aeronautical Information Services. All routes must be based upon WGS-84 coordinates.

5.2. The available NAVAID infrastructure should be clearly designated on all appropriate charts (e.g. GNSS, DME/DME and VOR/DME). Any navigation facilities that are critical to RNAV 5 operations should be identified in the relevant publications.

5.3. A navigation database does not form part of the required functionality of RNAV 5. The absence of such a database necessitates manual waypoint entry, which significantly increases the potential for waypoint errors. En-route charts should support gross error checking by the pilot by publishing fix data for selected waypoints on RNAV 5 routes.

6. Controller training

6.1. The air traffic controllers providing control services in airspace where RNAV 5 is implemented should have completed training in the following areas:

6.2. ***Core training***

(a) How area navigation systems work (in the context of this navigation specification):
i) include functional capabilities and limitations of this navigation specification;
ii) Accuracy, integrity, availability and continuity; and
iii) GPS receiver, RAIM, FDE, and integrity alerts;
(b) Flight plan requirements;
(c) ATC procedures:
i) ATC contingency procedures;
ii) Separation minima;
iii) Mixed equipage environment (impact of manual VOR tuning);
iv) Transition between different operating environments; and
v) Phraseology.

7. **Navigation service monitoring**

Navigation service monitoring should be consistent with Doc 9613, Volume II, Part A, and Chapter 4.

8. ATS system monitoring.

8.1. Monitoring of navigation performance is required for two reasons:

a) Demonstrated "typical" navigation accuracy provides a basis for determining whether the performance of the ensemble of aircraft operating on the RNAV routes meets the required performance; and
b) The lateral route spacing and separation minima necessary for traffic operating on a given route are determined both by the core performance and upon normally rare system failures.

8.2. If an observation/analysis indicates that a loss of separation or obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps should be taken to prevent a recurrence. Overall system safety needs to be monitored to confirm that the ATS system meets the required SSR.

8.3. Radar observations of each aircraft's proximity to track and altitude are typically noted by ATS facilities and aircraft track-keeping capabilities are analyzed.

8.4. A process should be established allowing pilots and controllers to report incidents where navigation errors are observed. If an observation/analysis indicates that a loss of separation or obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence.

172.5.13Implementing RNAV 1 and RNAV2

(a) Purpose of implementing RNAV 1 and RNAV 2 :-
1) The RNAV 1 and 2 specification is applicable to all ATS routes, including routes in the en-route domain, SIDs and STARS. It also applies to IAPs up to the FAF.
2) The RNAV 1 and 2 specification is primarily developed for RNAV operations in a radar environment (for SIDs, radar coverage is expected prior to the first RNAV course change). The RNP 1 specification (DOC 9613- Volume II, Part C, and Chapter 3) is intended for similar operations outside radar coverage. However, RNAV 1 and RNAV 2 may be used in a non-radar environment or below minimum vectoring altitude if the implementation ensures appropriate system safety and accounts for lack of on-board performance monitoring and alerting.
3) RNAV 1 and RNAV 2 routes are intended to be conducted in DCPC environments.
4) This circular does not address all requirements that may be specified for particular operations. These requirements are specified in other documents, such as operating rules, AIPs and the Regional Supplementary Procedures (Doc 7030). While operational approval primarily relates to the navigation requirements of the airspace, the pilot is still

required to take account of all operational documents relating to the airspace before conducting flights into it.

(b) Implementation Consideration:-

1. NAVAID infrastructure

1.1. The route design should take account of the navigation performance, which can be achieved with theavailable NAVAID infrastructure, and the functional capabilities required by this circular. While the aircraft's navigation equipment requirements for RNAV 1 and RNAV 2 are identical, NAVAID infrastructure impacts the achievable performance. Accommodation of existing user equipment should be considered a primary goal. The following navigation criteria are defined: GNSS, DME/DME and DME/DME/IRU. Where DME is the only navigation service used for position updates, gaps in DME coverage can prevent position update. Integration of IRUs can permit extended gaps in coverage.

Note. — Based on evaluated IRU performance, the growth in position error after Reverting to IRU can be expected to be less than 2 NM per 15 minutes

1.2. If an IRU is not carried, then the aircraft can revert to dead reckoning. In such cases, additional protection, in accordance with PANS-OPS (Doc 8168, Volume II), will be needed to cater for the increased error. GNSS should be authorized whenever possible and limitations on the use of specific system elements should be avoided.

1.3. The NAVAID infrastructure should be validated by modeling, and the anticipated performance should be adequately assessed and verified by flight inspection. The assessments should consider the aircraft capability described in this specification. For example, a DME signal can only be used if the aircraft is between 3 NM and 160 NM from thefacility, below 40 degrees above the horizon (as viewed from the facility) and if the DME/DME include angle is between30 degrees and 150 degrees. The DME infrastructure assessment is simplified when using a screening tool whichaccurately matches ground infrastructure and aircraft performance, as well as an accurate representation of the terrain. Guidance material concerning this assessment can be found in PANS-OPS (Doc 8168, Volume II) and the Manual on Testing of Radio Navigation Aids (Doc 8071).

1.4. DME signals are considered to meet SIS accuracy tolerances where signals are received, regardless ofthe published coverage volume. Field strength below the minimum requirement or where co-channel or adjacent channel interference may exist, are considered receiver errors. Errors resulting from multipath of the DME signal should be identified by the ANSP. Where such errors exist and are not acceptable to theoperation, the ANSP may identify such NAVAIDs as not appropriate for RNAV 1 and RNAV 2 applications (to be inhibited by the pilot) or may not authorize the use of DME/DME or DME/DME/IRU. The individual components of theNAVAID infrastructure must meet the performance requirements detailed in Annex 10 — Aeronautical Telecommunications. NAVAIDs that are not compliant with Annex 10 should not be published in the State AIP. If significant performance differences are measured for a published DME facility, RNAV 1 and RNAV 2 operations in airspace affected by that facility may need to be limited to GNSS.

1.5. For an RNAV 1 or RNAV 2 operation where reliance is placed upon IRS, some aircraft systems will revert to VOR/DME-based navigation before reverting to inertial coasting. The impact of VOR radial accuracy, when the VOR is within 40 NM from the route and there is insufficient DME/DME NAVAID infrastructure, must be evaluated by the ANSP to ensure that it does not affect aircraft position accuracy.

1.6. ANSPs should ensure that operators of GNSS-equipped aircraft and, where applicable, SBAS-equipped aircraft, have access to a means of predicting the

availability of fault detection using ABAS (e.g. RAIM). This prediction service may be provided by the ANSP, airborne equipment manufacturers or other entities. Prediction services can before receivers meeting only the minimum TSO performance or be specific to the receiver design. The prediction service should use status information on GNSS satellites, and should use a horizontal alert limit appropriate to the operation(1 NM for RNAV 1 and 2 NM for RNAV 2). Outages should be identified in the event of a predicted, continuous loss of ABAS fault detection of more than five minutes for any part of the RNAV 1 and RNAV 2 operations. If the prediction service is temporarily unavailable, ANSPs may still allow RNAV 1 and RNAV 2 operations to be conducted, considering the operational impact of aircraft reporting outages or the potential risk associated with an undetected satellite failure when fault detection is not available.

1.7. Since DME/DME RNAV systems must only use DME facilities identified in the AIP and itmust indicate facilities inappropriate for RNAV 1 and RNAV 2 operations in the AIP, including those facilities associated with an ILS or MLS that use a range offset.

Notes:

1. *Database suppliers may exclude specific DME facilities when the RNAV routes are within reception range of these facilities, and which could have an adverse effect on the navigation solution from the aircraft's navigation database.*
2. *Where temporary restrictions occur, the publication of restrictions on the use of DME Should be accomplished by use of a NOTAM to identify the need to exclude the DME.*

2. Communications and ATS surveillance.
Where reliance is placed on the use of radar to assist contingency procedures, its performance should be adequate for that purpose, i.e. radar coverage, its accuracy, continuity and availability should be adequate to ensure separation on the RNAV 1 and RNAV 2 ATS route structure and provide contingency in cases where several aircraft are unable to achieve the navigation performance prescribed in this navigation specification.
3. Obstacle clearance and route spacing and Separation Minima:-
   3.1. Obstacle clearance guidance is provided in PANS-OPS (Doc 8168, Volume II, Part III); the general criteria in Part I apply, and assume normal operations.
   3.2. State may prescribe either an RNAV 1 or an RNAV 2 ATS route. Route spacing for RNAV 1 and RNAV 2depends on the route configuration, air traffic density and intervention capability — see Attachment B on Doc 9613, Volume II. Until specific standards and ATM procedures are developed, RNAV 1 and RNAV 2 applications can be implemented based on ATS radar surveillance. Separation Minima for RNAV 1 are included in PANS-ATM (Doc 4444, Chapter 5).

4. Additional considerations

4.1. For procedure design and infrastructure evaluation, the normal FTE limits of 0.5 NM (RNAV 1) and 1 NM (RNAV 2) defined in the operating procedures are assumed to be 95 per cent values.

4.2. Many aircraft have the capability to fly a path parallel to, but offset left or right from, the original active route. The purpose of this function is to enable offsets for tactical operations authorized by ATC.

4.3. Many aircraft have the capability to execute a holding pattern man oeuvre using their RNAV system. The purpose of this function is to provide flexibility to ATC in designing RNAV operations. Where the RNAV system does not provide holding functionality, the pilot is expected to manually fly the RNAV holding pattern.

5. **Publication**:-

5.1. The AIP should clearly indicate whether the navigation application is RNAV 1 or RNAV 2. The route should rely on normal descent profiles and identify minimum segment altitude requirements. The navigation data published in the Egyptian AIP for the routes and supporting NAVAIDs must meet the requirements of Annex 15. All routes must be based upon WGS-84 coordinates.

5.2. The available NAVAID infrastructure should be clearly designated on all appropriate charts (e.g. GNSS, DME/DME or DME/DME/IRU).

5.3. Any DME facilities that are critical to RNAV 1 or RNAV 2 operations should be identified in the relevant publications.

6. Controller training

6.1. Air traffic controllers who provide RNAV terminal and approach control services in airspace where RNAV 1and RNAV 2 is implemented, should have completed training that covers the items listed below.

6.2. ***Core training***

(a) How area navigation systems work (in the context of this navigation specification):
i) include functional capabilities and limitations of this navigation specification;
ii) Accuracy, integrity, availability and continuity; and
iii) GPS receiver, RAIM, FDE, and integrity alerts and
iv) Way point fly-by versus fly-over concept (and differences in turn Performance);

(b) Flight plan requirements;

(c) ATC procedures:
i) ATC contingency procedures;
ii) Separation minima;
iii) Mixed equipage environment (impact of manual VOR tuning);
iv) Transition between different operating environments; and
v) Phraseology.

6.3. **Training specific to this navigation specification Core training**

(A) RNAV STARs, SIDs:
i) related control procedures;
ii) Radar vectoring techniques;
iii) Open and closed STARs; RAIM, FDE,
iv) Altitude constraints; and
v) Descend/climb clearances.

(B) RNP approach and related procedures;

(C) RNAV 1 and RNAV 2 related phraseology; and

(D) Impact of requesting a change to routing during a procedure.

7. Navigationservicemonitoring

Navigation service monitoring should be consistent with Doc 9613, Volume II, Part A, and Chapter 4.

8. ATS system monitoring.

8.1. Lateral navigation accuracy provides a basis for determining the lateral route spacing and separation minima necessary for traffic operating on a given route. When available, radar observations of each aircraft's proximity to track and altitude are typically noted by ATS facilities and aircraft track-keeping capabilities are analyzed.

8.2. If an observation/analysis indicates that a loss of separation or obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence. Overall system safety needs to be monitored to confirm that the ATS system meets the required SSR.

172.5.15 Implementing RNP 2

a) **Purpose of implementing RNP 2**

1. RNP 2 is primarily intended for a diverse set of en-route applications, particularly in geographic areas with little or no ground NAVAID infrastructure, limited or no ATS surveillance, and low to medium density traffic.
2. The target traffic is primarily transport category aircraft operating at high altitude, whereas, continental applications may include a significant percentage of GA aircraft.
3. This circular does not address all the requirements that may be specified for particular operations. These requirements are specified in other documents, such as national operating rules, AIPs and the Regional Supplementary Procedures (Doc 7030). While operational approval primarily relates to the navigation requirements of the airspace, operators and pilots are still required to take account of all operational documents relating to the airspace before conducting flights into it.

b) **IMPLEMENTATION CONSIDERATIONS**

1. NAVAID infrastructure

1.1 The RNP 2 specification is based upon GNSS.

1.2 Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support operations along the RNP 2 ATS route. The on-board RNP system, GNSS avionics, the ANSP or other entities may provide a prediction capability. The AIP should clearly indicate when prediction capability is required and an acceptable means to satisfy that requirement.

1.3 RNP 2 shall not be used in areas of known GNSS signal interference.

1.4 The ANSP must undertake an assessment of the NAVAID infrastructure. The infrastructure should be sufficient for the proposed operations, including reversionary navigation modes the aircraft may apply.

2. Communications and ATS surveillance

This navigation specification is primarily intended for environments where ATS surveillance is either not available or limited. Communications performance on RNP 2 routes will be commensurate with operational considerations such as route spacing, traffic density, complexity and contingency procedures.

3. Obstacle clearance, route spacing and separation minima

3.1 Guidance on obstacle clearance is provided in PANS-OPS (Doc 8168, Volume II); the General criteria in Parts I and III apply, and assume normal operations.

3.2 The route spacing supported by this circular will be determined by a safety study for the Intended operations which will depend on the route configuration, air traffic density and Intervention capability, etc. Horizontal separation standards are published in PANS-ATM (Doc 4444).

4. **Publication**

An RNP 2 route should rely on normal flight profiles and identify minimum segment altitude requirements. The navigation data published in the Egyptian AIP for the routes must meet the requirements of Annex 15 — *Aeronautical Information Services*. All RNP 2 routes must be based upon WGS-84 coordinates.

5. **Controller training**

Air traffic controllers providing services where RNP 2 operations are implemented should complete training covering the following items.

5.1 Core training

a) How area navigation systems work (in the context of this navigation specification):

I. Functional capabilities and limitations of this navigation specification;

II. Accuracy, integrity and continuity, including on-board performance monitoring and alerting; and

III. GNSS receiver, RAIM, fault detection and integrity alerts;

b) Flight plan requirements;

c) ATC procedures:

(1) ATC contingency procedures;

(2) separation minima;

(3) mixed equipage environment;

(4) transition between different operating environments; and

(5) Phraseology.

5.2 Training specific to this navigation specification

a) RNP 2 ATS route control requirements (in either ATS surveillance or procedural control environments)

Descend/climb clearances; and

I. Route reporting points;

b) RNP 2 related phraseology; and

c) Impact of requesting an in-flight change to route.

6. **Navigation service monitoring**

Navigation service monitoring should be consistent with ICAO Doc. 9613, Volume II, Part A, Chapter 4.

7. **Monitoring and investigation of navigation and system errors**

(a) Lateral navigation accuracy provides a basis for determining the lateral route spacing and horizontalseparation minima necessary for traffic operating on a given route. When available, observations of each aircraft'sproximity to track and altitude, based on ATS surveillance (e.g. radar, multilateration or automatic dependence ATSsurveillance), are typically noted by ATS facilities, and aircraft track-keeping capabilities are analyzed.

(b) If an observation/analysis indicates that a loss of separation or obstacle clearance has occurred, thereason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence.Overall system safety needs to be monitored to confirm that the ATS system meets the required SSR.

172.5.17 Implementing RNP 1

a) Purpose of implementing RNP 1

1) The RNP 1 specification provides a means to develop routes for connectivity between the en-route structure and terminal airspace with no or limited ATS surveillance, with low to medium density traffic.

2) This circular provides ICAO guidance for implementing RNP 1 for arrival and departure procedures. Within this circular, arrival and departure procedures are referred to as SIDs and STARs, but are intended to also apply to initial and intermediate approach segments. This circular does not address all the requirements that may be specified for particular operations. These requirements are specified in other documents, such as national operating rules, AIPs and the *Regional Supplementary Procedures* (Doc 7030). While operational approval primarily relates to the navigation requirements of the airspace, operators and pilots are still required to take account of all operational documents relating to the airspace before conducting flights into it.

b) **Implementation Considerations**

1. NAVAID infrastructure considerations

1.1 The RNP 1 specifications are based upon GNSS. While DME/DME-based RNAV systems are capable of RNP 1 accuracy, this navigation specification is primarily intended for environments where the DME infrastructure cannot support DME/DME area navigation to the required performance. The increased complexity in the DME infrastructure requirements and assessment means it is not practical or cost-effective for widespread application.

1.2 ANSPs should ensure operators of GNSS-equipped aircraft have the means to predict fault detection using ABAS (e.g. RAIM). Where applicable, ANSPs should also ensure operators of SBAS-equipped aircraft have the means to predict fault detection. This prediction service may be provided by the ANSP, airborne equipment manufacturers or other entities. Prediction services can be available for receivers meeting only the minimum TSO performance or be specific to the receiver design. The prediction service should use status information on GNSS satellites, and should use a horizontal alert limit appropriate to the operation (1 NM within 30 NM from the airport and 2 NM otherwise). Outages should be identified in the event of a predicted, continuous loss of ABAS fault detection of more than five minutes for any part of the RNP 1 operation.

1.3 RNP 1 shall not be used in areas of known navigation signal (GNSS) interference.

1.4 The ANSP must undertake an assessment of the NAVAID infrastructure. It should be shown to be sufficient for the proposed operations, including reversionary modes.

2. Communications and ATS surveillance considerations

This navigation specification is intended for environments where ATS surveillance is either not available or limited.RNP 1 SIDs/STARs are primarily intended to be conducted in DCPC environments.

3. Obstacle clearance, route spacing and separation minima

3.1 Detailed guidance on obstacle clearance is provided in PANS-OPS (Doc 8168, Volume II); the general criteria in Parts I and III apply, and assume normal operations.

3.2 Route spacing for RNP 1 depends on the route configuration, air traffic density and intervention capability. Horizontal separation minima are published in PANS-ATM (Doc 4444, Chapter 5).

4.**Additional considerations**

4.1 For procedure design and infrastructure evaluation, the normal FTE limit of 0.5 NM defined in the operating procedures is assumed to be a 95 per cent value.

4.2 The default alerting functionality of a TSO-C129a sensor (stand-alone or integrated), Switches between terminal alerting (±1 NM) and en-route alerting (±2 NM) at 30 miles from the ARP.

5. **Publication**

The procedure should rely on normal descent profiles and identify minimum segment altitude requirements. The navigation data published in the Egyptian AIP for the procedures and supporting NAVAIDs must meet the requirements of Annex 15 — *Aeronautical Information Services*. All procedures must be based upon WGS-84 coordinates.

6. **Controller training**

Air traffic controllers who provide RNP terminal and approach control services, where RNP 1 is implemented, should have completed training that covers the items listed below.

6.1 Core training

a) How area navigation systems work (in the context of this navigation specification):
   i) Functional capabilities and limitations of this navigation specification;
   ii) Accuracy, integrity, availability and continuity including on-board performance Monitoring and alerting;
   iii) GPS receiver, RAIM, FDE, and integrity alerts; and
   iv) Waypoint fly-by versus fly-over concept (and different turn performance);

b) Flight plan requirements;

c) ATC procedures;

i) ATC contingency procedures;
ii) Separation minima;
iii) Mixed equipage environment (impact of manual VOR tuning);
iv) Transition between different operating environments; and
v) Phraseology.

6.2 Training specific to this navigation specification

a) RNP 1 STARs, SIDs, related control procedures:
i) Radar vectoring techniques (where appropriate);
ii) Open and closed STARs;
iii) Altitude constraints; and
iv) Descend/ climb clearances;
b) RNP approach and related procedures;
c) RNP 1 related phraseology; and
d) Impact of requesting a change to routing during a procedure.

7. **Navigation service monitoring**
Navigation service monitoring should be consistent with ICAO Doc. 9613 Volume II, Part A, and Chapter 4.

8. **Monitoring and investigation of navigation and system errors**
(a) Lateral navigation accuracy provides a basis for determining the lateral route spacing and horizontal separation minima necessary for traffic operating on a particular procedure. When available, radar observations of each aircraft's proximity to track and altitude are typically noted by ATS facilities, and aircraft track-keeping capabilities are analyzed.
(b) If an observation/analysis indicates that a loss of separation or obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence. Overall system safety needs to be monitored to confirm that the ATS system meets the required SSR.

172.5.19Implementing Baro-VNAV

(a) Purpose of implementing Baro-VNAV:-
1) This navigation specification addresses those systems based upon the use of barometric altitude and RNAV information in the definition of vertical flight paths, and vertical tracking to a path.
2) This circular provides guidance to ANSPs implementing IFPs where Baro-VNAV is authorized for RNPAPCH approaches and RNP AR APCH, where approved. For the ANSP, it provides a consistent ICAO recommendation on what to implement.

(b) Implementation Consideration:-

1. Application of Baro-VNAV

Baro-VNAV is intended to be applied where vertical guidance and information are provided to the pilot on IAPs containing a vertical flight path defined by a vertical path angle. Baro-VNAV may also be defined by altitude constraints but only for flight phases other than approach. Guidance for operational use is provided in PANS-OPS (Doc 8168) Volume I.

2. Obstacle clearance

Detailed guidance on obstacle clearance for the FAS is provided in PANS-OPS (Doc 8168), Volume II; the general criteria in Parts I and III apply, and assume normal operations.

3. Additional considerations

3.1. NAVAID infrastructure considerations

The procedure design does not have unique infrastructure requirements. These criteria are based upon the use of barometric altimetry by an airborne RNP system whose performance capability supports the required operation. The procedure design should take into account the functional capabilities required by this circular.

3.2. Publication considerations

Charting should follow the Standards of Annex 4 -*Aeronautical Charts*, for the designation of an RNAV procedure where the vertical flight path is specified by a GPA. The charting designation will remain consistent with the current convention (e.g. if the lateral procedure is predicated on GNSS, the charting will indicate RNAV (GNSS)).

3.3. **Monitoring and investigation ofnavigation and system errors**

if an observation/analysis indicates that a loss of separation or obstacle clearance hasoccurred, the reason for theapparent deviation from track or altitude should be determined and steps taken to prevent a recurrence.

3.4. Navigation error reports .

3.4.1 The ECAA may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in cancellation of theapproval for use ofthatequipment.

3.4.2 Information that indicates the potential for repeated errors may require modification of an operator 'straining program. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or license review.

3.5. Service provider assumptions .

It is expected that ANSPs will provide data and information to enable correct and accurate altimeter settings on boardthe aircraft, as well as local temperature. These data must be from measurement equipment at the airport where theapproach is to take place. The specific medium for transmission of these data and information to the aircraft may includevoice communications, ATIS or other media. In support of this, it is also expected that service providers will assure the accuracy, currency and availability of meteorological data supporting baro-VNAV operations.

3.6. ATC coordination .

It is expected that ATC will be familiar with aircraft baro-VNAV capabilities, as well as issues associated with altimeter setting and temperature data required by the aircraft.

172.5.21 Implementing RNP APCH

(a) Purpose of implementing RNP APCH Operations down to LNAV or LNAV/VNAV minima:-

1) RNP APCH is the general ICAO designator for PBN approach procedures that are not Authorization required operations.
2) For existing stand-alone and multi-sensor RNP systems using GNSS, assures automatic compliance with this ICAO specification. An operational approval to this standard allows an operator to conduct RNP APCH operations down toLNAV or LNAV/VNAV minima globally.
3) The multi-sensor systems may use other sensor combinations such as DME/DME orDME/DME/IRU that provide the navigation performance acceptable for RNP APCH. However, such cases arelimited due to the increased complexity in the NAVAID infrastructure requirements and assessment, and are not practical or cost-effective for widespread application.

(b) Implementation Consideration:-

1. NAVAID infrastructure

1.1. The RNP APCH specification is based on GNSS to support RNP APCH operations down to LNAV or LNAV/VNAV minima.

1.2. The missed approach segment may be based upon the conventional NAVAID (e.g. VOR, DME, NDB).

1.3. The acceptability of the risk of loss of RNP APCH capability for multiple aircraft due to satellite failure or loss of on-board monitoring and alerting functions (e.g. RAIM holes), must be considered by the responsible airspace authority.

2. Communications and ATS surveillance.

RNP APCH does not include specific requirements for communications or ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance and operating procedures.

3. Obstacle clearance and route spacing and Separation Minima:-

3.1. Detailed guidance on obstacle clearance is provided in PANS-OPS (Doc 8168, Volume II); the general criteria in Parts I and III apply, and assume normal operations.

3.2. Missed approach procedures may be supported by either RNAV or conventional segments (e.g. based onNDB, VOR, and DME).

3.3. Procedure design must take account of the absence of a VNAV capability on the aircraft.

4. Publication:-

The AIP should clearly indicate that the navigation application is RNP APCH. The procedure design should rely on normal descent profiles and the Egyptian publication should identify minimum segment altitude requirements, including an lateral navigation OCA(H). If the missed approach segment is based on conventional means, NAVAID facilities that arenecessary to conduct the approach must be identified in the relevant publications. The navigation data published in the AIP for the procedures and supporting NAVAIDs must meet the requirements of Annex 4 — *Aeronautical Charts*, and Annex 15 — *Aeronautical Information Services* (as appropriate). All procedures must be based upon WGS-84coordinates.

5. Controller training

Air traffic controllers, who provide control services at airports where RNP APCH operations down to LNAV or LNAV/VNAV minima have been implemented, should have completed training that covers the items listed below.

5.1. Core training

a) How area navigation systems work (in the context of this navigation specification):

i) Include functional capabilities and limitations of this navigation specification;

ii) Accuracy, integrity, availability and continuity including on-board performance monitoring andalerting;

iii) GPS receiver, RAIM, FDE, and integrity alerts; and

iv)Waypoint fly-by versus fly-over concept (and different turn performances);

b) Flight plan requirements;

c) ATC procedures;

i) ATC contingency procedures;

ii) Separation minima;

iii) mixed equipage environment;

iv) Transition between different operating environments; and

v) Phraseology.

5.2. Training specific to this navigation specification:
a) Related control procedures:— radar vectoring techniques (where appropriate);
b) RNP approach and related procedures:
i) Including T and Y approaches; and
ii) Approach minima;
c) Impact of requesting a change to routing during a procedure.

6. Navigation service monitoring

Navigation service monitoring should be consistent with ICAO Doc. 9613, Volume II, Part A, and Chapter 4.

7. ATS System Monitoring

If an observation/analysis indicates that a loss of obstacle clearance has occurred, the reason for the apparent deviationfrom track or altitude should be determined and steps taken to prevent a recurrence.

172.5.23 Implementing Advanced RNP (A-RNP)

(a) Purpose of implementing ADVANCED RNP (A-RNP) :-

1) This circular 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.
2) The qualification and operational authorizations 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.
3) This circular does not address all the requirements that may be specified for operation on a particular route or in a particular area. These requirements are specified in other documents such as operating rules, AIPs and the Regional Supplementary Procedures (Doc 7030). 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 appropriate State authority before conducting flights into that airspace.

(b) Implementation Consideration:-

1. NAVAID infrastructure

1.1. A-RNP is based upon GNSS. Multi-DME ground infrastructure is not required but may be provided based.

1.2. ANSPs should ensure operators relying on GNSS are required to 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. The on-board RNP system, GNSS avionics, the ANSP or other entities, may provide a prediction capability The AIP should clearly indicate when prediction capability is required and acceptable means to satisfy that requirement.

2. Communications and ATS surveillance.

2.1 ATS surveillance by ATS may be used to mitigate the risk of gross navigation errors, provided that the procedure lies within the ATS surveillance and communications service volumes, and the ATS resources are sufficient for the task. For certain A-RNP navigation applications, radar surveillance may be required

when reliance is placed on the use of ATS surveillance to assist contingency procedures, its performance should be adequate for that purpose.

2.2 Where ATS surveillance relies upon the same system that supports the navigation function (e.g. ADS), consideration has to be given to the risks associated with loss of navigation function, the impact on the ATS surveillance function and the requirement for appropriate mitigation techniques. This will typically be addressed through the regional or local State safety case prepared in support of the application.

3. Obstacle clearance and route spacing:-

3.1. Guidance for the application of A-RNP is provided in PANS-OPS (Doc 8168) and PANS-ATM (Doc 4444). It should be noted that the application of navigation accuracies of less than 1.0 NM, or where the operational requirement dictates a navigation accuracy greater than 1.0 NM with tenths of nautical miles, will be determined by the availability of appropriate procedure design and route spacing criteria.

3.2 Parallel offset considerations

Where parallel offsets are applied and a course change exceeds 90 degrees, the navigation system can be expected to terminate the offset no later than the fix where the course change occurs. The offset may also be terminated if the route segment ends at a hold fix.

4. Procedure validation

4.1. Guidance on procedure validation is provided in The Quality Assurance Manual for Flight Procedure Design (Doc 9906), Volume I — Flight Procedure Design Quality Assurance System, and Volume V — Validation of Instrument Flight Procedures..

4.2. Guidance on the flight inspection is provided in the Manual on Testing of Radio Navigation Aids (Doc 8071).

5. Publication:-

5.1. The AIP should clearly indicate the navigation application is A-RNP.

5.2. The navigation data published in the AIP for the procedures and supporting NAVAIDs must meet the requirements of Annex 15 — Aeronautical Information Services and Annex 4 — Aeronautical Charts (as appropriate). The original data defining the procedure should be available to the operators in a manner suitable to enable the operator to verify their navigation data. The navigation accuracy for all A-RNP procedures should be published in the AIP.

6. Controller training

6.1. Air traffic controllers, who will provide control services for navigation applications using RNP, should have completed training that covers the items listed below.

6.2. Core training

(a) How area navigation systems work (in the context of this navigation specification) in achieving reliable, repeatable and predictable procedures:

i) Include functional capabilities and limitations of this navigation specification;

ii) Accuracy, integrity and continuity including on-board performance monitoring and alerting;

iii) Availability of ATS and infrastructure;

iv) GNSS receiver, RAIM, FDE, and integrity alerts; and

v)Leg transitions, relative turn performance of waypoint fly-by versus fly-over concept; Flight plan requirements including the applicability of A-RNP to RNAV 1, RNAV 2, RNAV 5, RNP APCH, RNP 1, and RNP 2 navigation applications;

(b) ATC procedures:
i) ATC contingency procedures;
ii) Separation minima;
iii) Mixed equipage environment;
iv) Transition between different operating environments; and
v) Phraseology (consistency with PANS-ATM); and
vi) ATC intervention considerations.

6.3. Training specific to this navigation specification
(a) Related control procedures:
i) Vectoring techniques (where appropriate);
ii) RF leg limitations including ground speed constraints;
(b) RNP approach and related procedures:
i) Approach minima;
ii) Potential negative impact of issuing an amended clearance for a procedure when the aircraft is already established on the procedure due to possible difficulty in complying with revised procedure requirements. Sufficient time needs to be allowed for the crew to accomplish navigation systems reprogramming requirements, e.g. a change to the en-route or runway transition;
(c) RNP en route:
i) FRT as a computed turn by the aircraft versus a unique en-route path segment;
(d) Parallel offsets. RNP systems termination of offsets and return to original flight plan;
(e) Lateral performance associated with route or procedure.

7**. Navigation service monitoring** .
Navigation service monitoring should be consistent with Doc 9613, Volume II, Part A, and Chapter 4.

8. **Monitoring and investigation of navigation and system errors**
Lateral navigation accuracy provides a basis for determining the lateral route spacing and horizontal separation minima necessary for traffic operating on a given route. When available, observations of each aircraft's proximity to track and altitude, based on ATS surveillance (e.g. radar, multilateration or automatic dependence surveillance), are typically noted by ATS facilities, and aircraft track-keeping capabilities are analyzed. If an observation/analysis indicates that a loss of separation or obstacle clearance has occurred, the reason for the apparent deviation from track or altitude should be determined and steps taken to prevent a recurrence.

172.5.25FurtherInformation: .
Further practical guidance to ANSPs and airspace users on how to implement RNAV and RNP applications, and how to ensure that the performance requirements are appropriate for the planned application is contained in the ICAO publication "performance Based Navigation (Doc 9613)".