**DGCA-IP/4**

INTERNATIONAL CIVIL AVIATION ORGANIZATION
WESTERN AND CENTRAL AFRICAN OFFICE

**First Meeting of Directors General of Civil Aviation**

(Abuja, Nigeria, 19 B 21 March 2002)

**Agenda Item 1: Strategies for the elimination of deficiencies in the AFI Region**

# GNSS PROCEDURES IMPLEMENTATION IN THE AFRICA-INDIAN OCEAN REGION

(Presented by Innovative Solution International (ISI))

**INFORMATION PAPER**


**SUMMARY**

This paper presents a GNSS-based NPAs implementation model and an action plan for consideration by the meeting, with a view to accelerating the benefits than can be derived from the use of GNSS technologies in the region.

Action by the meeting is in paragraph 6.


**REFERENCES**

Annex 4 — *Aeronautical Charts*
Annex 11 — *Air Traffic Services*
Annex 14 — *Aerodromes*
Annex 15 — *Aeronautical Information Services*
*Global Air Navigation Plan for CNS/ATM Systems* (Doc 9750)
*Aeronautical Chart Manual* (Doc 8697)
*Procedures for Air Navigation Services — Aircraft Operations* (Doc 8168)

## 1. BACKGROUND

1.1 ICAO has, in recent years, encouraged the development of practical global navigation satellite system (GNSS) applications as part of the transition toward new communications, navigation and surveillance/air traffic management (CNS/ATM) systems. In addition, requests have been received from time to time from aircraft operators to encourage the development of GNSS procedures, especially at aerodromes with limited navigation infrastructure.

1.2 In response to the above encouragement, the following GNSS Procedure Implementation Model, as endorsed by the ICAO Council, is proposed for consideration in the Africa-Indian Ocean Region.

This model would provide for the design and implementation of GNSS procedures for States using ICAO PANS-OPS criteria. The product, as presented, can be tailored to the specific needs of each State; the full package includes material on:

a) the development of GNSS instrument approach procedures for agreed runways;

b) WGS-84 surveys;

c) the development of standard instrument arrival (STAR) and departure (SID) procedures in conjunction with GNSS approach procedures;

d) the modification of airspace structure design to meet GNSS procedure requirements;

e) the development and preparation for publication of all relevant charts;

f) flight verification (inspection) of the GNSS procedures;

g) the drafting of essential national GNSS legislation (regulations);

h) GNSS procedure design PANS-OPS training; and

i) on-site training to familiarize air traffic controllers, pilots, airworthiness and maintenance staff with GNSS.

A more detailed description of the GNSS Procedure Implementation Model, as presented to and endorsed by the ICAO Council (C-DEC 164/11), is at the appendix to this working paper.

## 2. GNSS PACKAGE FOR AFRICAN STATES

2.1 The above-mentioned GNSS Procedure Implementation Model meets all ICAO global CNS/ATM implementation objectives and delivers early and long-term benefits for aircraft operators and States. It provides a cost-effective method of decision-making that is based on collaboration and cooperation between all stakeholders, incorporating the needs of each. The GNSS Procedure Implementation Model culminates in a GNSS instrument approach capability for all airports where it is applied. It is further described in the appendix hereto.

2.2 The major objective of the proposed GNSS implementation model is to achieve harmonized GNSS procedures in States, significantly improving the effective use of airspace and providing safety, operational and economic benefits to users.

2.3 GNSS procedures, using a similar GNSS model, have been successfully implemented at more than 30 airports in the southern region of Africa. The project began in early 2001 and was completed within one year. The operational benefits of this capability are now being realized by the airports, airlines, and passengers.

## 3. GNSS IMPLEMENTATION MODEL BENEFITS

3.1 GNSS instrument approaches offer important benefits to operators and Civil Aviation Authorities (CAAs) as compared to conventional approaches. GNSS procedures provide operators with enhanced:

a) *Safety* — GNSS non-precision approaches (NPAs) offer excellent position awareness via moving map displays and stabilized descents. These combine to minimize the potential for controlled flight into terrain (CFIT) accidents, which typically occur during the final descent on or near the extended runway centreline;

b) *Dependabilty* — The GNSS system is virtually always operational and reduced landing minima are available in many cases. These characteristics combine to reduce the number of delays, cancellations and diversions to alternates;

d) *Efficiency* — GNSS NPAs offer optimized approach routing, thus reducing flight time and cost;

e) *Global application* — GNSS is global in scope and has the potential to support all phases of flight, resulting in a seamless global navigation system and eliminating the need for a variety of ground and airborne equipment, each meeting specific requirements;

f) *Remote areas* — GNSS can provide accurate guidance in remote and oceanic areas where it is either impractical or impossible to provide reliable and accurate ground-based guidance, even in areas well-served by ground-based aids. GNSS brings this capability within economic reach of all aircraft operators. This will allow States to design en-route and terminal airspace for maximum capacity and to reduce delays;

g) *Route flexibility* — The availability of accurate GNSS-based guidance on departure supports efficient noise abatement procedures. It allows greater flexibility in routing, providing the possibility of lower climb gradients and higher payloads where terrain is a restricting factor;

h) *Accurate approach guidance* — GNSS can provide more accurate approach guidance and, in many cases, vertical guidance; these features reduce visual maneuvering and enhance safety. The ability to provide better approaches to more runways without any airport infrastructure cost will increase the usability of many airports and reduce delays, diversions and cancellations due to bad weather;

i) A*pproach capability* — The potential of providing instrument approach capability at all international airports;

j) *Decommissioning of traditional navigation aids* — The availability of GNSS guidance will allow the phased decommissioning of certain traditional ground-based navigation aids. States can now avoid the cost of replacing some traditional aids.

## 4. REGIONAL GNSS ACTIVITIES

4.1 Note was taken of the valuable WGS-84 survey work completed by some West African States and ASECNA and the development of GNSS procedures. However, regional calibration units might consider procuring equipment for flight verification of GNSS procedures.

## 5. PROPOSED ACTION PLAN

5.1 Based on the endorsement of the GNSS Procedures Implementation Model by the ICAO Council and its proven successful implementation in the southern region of Africa, it is proposed that:

a) a GNSS implementation model be implemented for West African and ASECNA States;

b) a task team, under the leadership of the ICAO Regional Director for Western and Central Africa and with full participation and endorsement by West African States and ASECNA, as well as support from Innovative Solution International (the technical provider of these services), be established to develop the implementation plan;

c) the GNSS Procedures Implementation Model Plan developed by the task team:

1) be tailored to the needs and requirements of the region;

2) be in full compliance with ICAO and APIRG planning and policy documents and directives;

3) include provisions for funding and executing the said plan, taking into consideration actions already completed in furtherance of this task (e.g. WGS-84 surveys); and

4) include funding methods;

d) the implementation of this plan be completed within one year from the start date; and

e) the GNSS Implementation Model Task Team prepare the implementation plan for adoption and action by the appropriate body

## 6. ACTION BY THE MEETING

6.1 The Directors General of Civil Aviation are invited to take note, comment and exchange views on the above-mentioned GNSS implementation model and the proposed action plan. The meeting may wish to note that acceptance would accelerate the realization of the benefits of GNSS technologies in the region.

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# APPENDIX

# PROCEDURE IMPLEMENTATION MODULE

## 1. WGS-84 SURVEYS

An airport survey establishing primary and other airport survey control points in WGS-84 is needed before procedures can be developed. Included in this survey will be the runway threshold coordinates and an obstacle survey that will comply with the obstacle clearance areas identified in ICAO's Annex 14 — *Aerodromes*. The survey shall also comply with the publication specifications given in Annexes 4 — *Aeronautical Charts* and 15 — *Aeronautical Information Services*. Data received from this survey will be used to support the ongoing geographical analysis, procedure calculations and development.

## 2. GNSS INSTRUMENT APPROACH PROCEDURES

GNSS non-precision approach (NPA) will be developed for all relevant runway ends and no ground infrastructure will be required. The NPA can be upgraded to a precision approach at a relatively low cost when applicable ICAO criteria are approved. The GNSS approach procedure design will be optimized to the extent possible for efficiency, standardization, airspace and international boundaries. The approach procedure will be constructed in the standard ICAO PANS-OPS configuration.

## 3. GNSS STANDARD INSTRUMENT ARRIVAL (STAR) AND DEPARTURE (SID) PROCEDURES

All GNSS STARS and SIDs will be developed using ICAO PANS-OPS criteria.

SIDs: A departure procedure will be developed for each identified runway and to accommodate as many aircraft categories possible. The development of these procedures will take into consideration obstacle clearance, ATS, airspace structure, aircraft performance and noise abatement. RNAV departure procedures will be developed to link the aerodrome with a specified point, normally to where the en-route phase of the flight commences;

STARs will be developed for locations where its application would facilitate efficient air traffic routing and management. The results of an air traffic study and terminal configuration, along with local air traffic management preferences, will be used to determine and develop the STAR for each runway. The STAR will then be designed and implemented to be compatible with efficient traffic flow and ATM needs, connecting the en-route area with the NPA.

## 4. GNSS AIRSPACE

The current ATS airspace will be redefined in reference to WGS-84 coordinates. A study of the existing airspace will be undertaken to ensure optimal development of GNSS. Existing airspace structure and coordination fixes will be used when possible, but not to the extent of compromising optimal air traffic flow or safety. An optimized airspace structure will be developed in coordination with local air traffic specialists.

## 5. GNSS INSTRUMENT APPROACH, STAR AND SID PROCEDURE CHARTS

"Jeppesen-like" charts will be developed for all GNSS instrument approaches, STARs and SIDs. These charts will be prepared in accordance with the ICAO's *Aeronautical Chart Manual* (Doc 8697). Documentation and revisions for inclusion to the AIPs will be provided. Geographical coordinates indicating latitude and longitude will be published in terms of the WGS-84 geodetic reference system.

## 6. GNSS INSTRUMENT APPROACH, STAR AND SID PROCEDURE FLIGHT VERIFICATION

Flight verification/validation of each GNSS procedure is necessary for both safety and flyability purposes. It is a final process in the procedure design activity that provides quality checks prior to the commissioning of the procedure.

### Safety

The true location of each way-point defining the approach must be validated. The flight verification/ validation is required to confirm approach elements such as way-point location, alignment, and obstacle clearance.

### Flyability

Flight verification/validation allows the evaluation of descent gradients, way-point sequence, turn radius and cockpit workload. It also permits the optimization of the approach and ensures the most efficient implementation.

## 7. TRAINING

Training will be provided to address the requirements of many different aviation professionals. To meet these requirements, training elements for four different categories of participants will be targeted:

a) pilots and CAA staff requiring a general knowledge of GNSS;

b) ATC, CAA flying inspectors and other staff needing a familiarity with GNSS procedures;

c) airworthiness staff responsible with airborne certification requirements; and

d) CAA staff responsible for approving GNSS procedures.

To address these training requirements, a suite of modular training courses was designed that ensures that each training participant has access to the training that best suits his or her needs.

**GNSS Instrument Approach Procedure Design Course**

This course is designed for aviation professionals who require a detailed understanding of aviation procedure design, so that they may review, evaluate, authorize, inspect and approve GNSS procedures using PANS-OPS criteria.

**Satellite Navigation Course**

This course is designed for aviation professionals who need a general level of familiarization with use of GNSS. It is also intended to acquaint pilots using GNSS for en-route and approach procedure navigation.

## 8. GNSS LEGISLATION

All international and regional requirements and regulations that must be complied with to effect operational capability, interoperability and harmonization for approval of GNSS procedures will be identified. GNSS legislation will then be developed to meet regional and national requirements.

## 9. QUALITY ASSURANCE (QA)

A management approach centred on quality, based on participation of relevant parties and aiming at long-term success through client satisfaction and benefits to the aviation society, was adopted. The QA document sets out the specific quality practices, resources and sequence of activities for the relevant GNSS procedure development, WGS-84 survey, training and legislation modules of the package.

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