1.0 Purpose

This advisory circular provides guidance of the key requirements, principles and standards applying to Availability, Reliability, Continuity and Integrity Standards for CNS Facilities.

CNS (Communication, Navigation, and Surveillance) equipment is essential for the safe and efficient operation of air traffic management (ATM) systems. These systems are responsible for providing critical communication, navigation, and surveillance capabilities between aircraft and ground control. Therefore, ensuring high **availability** and **reliability** of CNS equipment is a fundamental requirement for maintaining the safety, security, and efficiency of air traffic operations.

The values for each of the basic parameters stated in this Advisory Circular, as relevant to each service type, shall be checked and calculated for analysis and corrective action taken.

2.0 Reference

2.1 Civil Aviation (Radio Navigation Aids) Regulations.

2.2 Civil Aviation (Communication Procedures) Regulations.

2.3 Civil Aviation (Communication Systems) Regulations.

2.4 Civil Aviation (Communication Systems) (Amendment) Regulations, 2024

2.5 Civil Aviation (Surveillance and Collision Avoidance systems) Regulations.

2.6 Civil Aviation (Aeronautical Radio Frequency Spectrum Utilization) Regulations.

2.7 Equipment Technical Manuals**.**

3.0 Procedures

To review the performance targets for each facility, every CNS provider shall be required to generate the following:

3.1 Availability

The percentage of time that a system or equipment is operational and ready for use. It reflects how often the system is functional and accessible for use by air traffic control (ATC) or aircraft during operations. High availability indicates fewer periods of downtime and maintenance.

$$\textbf{Availability} = \frac{\textbf{Uptime + Downtime}}{\textbf{Uptime}}$$

3.1.1 All CNS facilities shall provide high level of operational availability. In many cases, achievement of the necessary availability levels shall require the use of design features such as redundancy and/or duplication of facilities, automatic changeover from main to standby facility in the event of a fault, remote monitoring and maintenance capability. This performance parameter is to be calculated for the duration of one calendar year.

3.1.2 Availability is a measure of the operational availability of the system to users over the total time period that is required by users. It is normally quoted over the period of an average year or longer, and takes into account the time the service will be unavailable as a result of both unscheduled failures and scheduled or unscheduled maintenance.

a) Availability **Calculations:**

Ao = Ta/Tt

Where;

Ao = Operational Availability,

Ta = the total time that the service is actually available, and

Tt = the total time period that the service is required to be available.

b) Factors important in providing a high degree of facility availability are:

(i) facility reliability

(ii) equipment designs providing good component accessibility and maintainability

(iii) quick response of maintenance personnel to failures

(iv) adequate training of maintenance personnel

(v) efficient logistic support

(vi) provision of adequate test equipment

(vii) standby equipment and/or utilities

c) As indicated in (b) (vii) above, provision of standby power is necessary for many CNS services and facilities where continuity of service is a critical requirement. All CNS facilities shall have no-break standby power supply systems to ensure continuity.

4.0 Mean Time Between Failures (MTBF)

4.1 This parameter is to be calculated for each channel of the facility and for the complete facility. MTBF is the actual operating time of a facility divided by the total number of failures of the facility during that period of time.

Note

a) The operating time is in general chosen so as to include at least five and preferably more facility failures in order to give reasonable measure of confidence in the figure arrived.

b) This parameter is to be calculated for each channel and for the complete facility.

4.1.1 MTBF calculation: -

T- Total time for five failures of the channel.

MTBF= **T**/5

Note: If total number of failures is less than five in a calendar year, MTBF need not be calculated by station and only the number of failures in the calendar need be sent**.**

4.1.2 It may be seen that adjustment of MTBF will produce the desired degree of reliability. Factors which affect MTBF and hence facility reliability are:

a) Inherent equipment reliability

b) Degree and type of redundancy

c) Reliability of the serving utilities such as power and telephone or control lines

d) Degree and quality of maintenance

e) Environmental factors such as temperature and humidity

4.1.3 With regard to items (a) and (b), ANS provider shall take action to procure equipment having high reliability and adequate redundancy.

5.0 Reliability

The ability of equipment to perform its required functions under specified conditions without failure over a designated period. A system with high reliability will function correctly with minimal need for repairs and without malfunctions that disrupt operations.

$$\text{Reliability} = \frac{\text{Mean Time Between Failures (MTBF)}}{\text{Total Operating Time}}$$

5.1 Reliability is the probability that the ground installation operates within the specified tolerances.

5.1.1 Calculation

The reliability R in percentage is given by;

$R = 100\, e^{-t/m}$

Where;

e = base of natural logarithms

t = time period of interest

m= MTBF

5.1.2 It may be noted that reliability increases as MTBF increases. For high degree of reliability and for operational significant values of t, CNS provider shall have a large MTBF.

5.1.3 Reliability should be calculated for both individual facilities, and for the total population of a particular type. Calculating both values provides information on the type as a whole, and also allows identification of individual facilities which may be under performing.

5.1.4 Importance of Availability and Reliability for CNS Equipment

CNS equipment ensures the safe management of air traffic and provides the tools necessary for pilots and air traffic controllers to communicate, navigate, and track aircraft. Failures or periods of unavailability can compromise safety, lead to operational delays, or cause critical incidents. Therefore, strict standards must be maintained to ensure that CNS equipment is both available and reliable.

1.0 Continuity

Refers to the ability of CNS equipment to operate without interruption or failure over a specified period. For air traffic systems, continuity is essential to ensure that air traffic control (ATC) services are consistently available and operational, without disruptions that could compromise safety or efficiency.

Where a service has duplicated or redundant facilities including standby power supply with automatic changeover or remote configuration, or main/standby capability, an additional parameter termed **continuity** shall also be quoted. **Continuity** is a measure of time that a service takes to changeover from the main to standby facility, or to re-configure itself following a fault, including a power supply fault or failure. All CNS facilities services shall require continuity.

2.0 Integrity

Refers to the accuracy, reliability, and trustworthiness of the data provided by CNS equipment. The integrity of these systems ensures that the information communicated between air traffic controllers and aircraft, as well as navigational guidance and surveillance data, is accurate, consistent, and free from errors, malicious tampering, or corruption.

This is a measure of the ability of the service to provide a warning to users when the service should not be used, or when the error has occurred in the data transfer or computation. Integrity may be computed and presented in a variety of ways, e.g., as a Go/No Go warning based on internally measured parameters that utilize built-in test equipment or self monitoring systems. Integrity values for CNS facilities are often stated as a probability of the loss of integrity over a number of events.

3.0 Action

The **continuity** and **integrity** of CNS (Communication, Navigation, and Surveillance) equipment are critical to ensuring the safe, reliable, and efficient operation of air traffic management systems. These systems support essential air traffic services, including communication between air traffic controllers and pilots, accurate navigation for aircraft, and real-time surveillance of aircraft in flight. To meet the stringent safety and operational requirements, the continuity and integrity of CNS equipment must be maintained at the highest standards.

CNS maintenance personnel are to ensure that CNS facilities in which such capability is provided in the equipment, change over or shut down occurs in the event signal in space parameters or other operational parameters are out of tolerance. Non occurrence of above, if reported/detected shall be investigated, immediate corrective action taken and full reports to this effect sent to the Authority.

4.0 Performance Parameters

The table below provides values of the performance parameters for a number of service types. Efforts shall be made to achieve the quoted values.

Service	Availability (%)	Reliability (hours)
Communication	>97.2	>1000
Radar data	>97.2	>1000
Navigational aids	>97.2	>1000

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