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**Approval of Civil Aviation Safety Bulletin 2024-01 Issue 01 Rev.00**  
**Global Navigation Satellite System Outage and Alterations Leading to**  
**Navigation-Surveillance Degradation.**

Civil Aviation Safety Bulletin is applicable to All Stakeholders to be aware of the potential safety and capacity impacts of GNSS interference, jamming, and spoofing issued by the Civil Aviation Authority DGCAR. It provides guidance and implement recommendations to permission holders and aviation users of change to current regulations. This CASB provides guidance, information and recommendation to all Oman AOC holders, regarding operations in a GPS/GNSS disrupted environment.

Safety Bulletin **2024-01** is issued in reference to:

- ICAO State letter Ref E 3/5-24/54 Issued: 30 April 2024 *Subject: Aviation safety concerns regarding interference to the Global Navigation Satellite System (GNSS)*
- Safety Information Bulletin SIB No. 2022-02R3 Issued: 05 July 2024 *Subject: Global Navigation Satellite System Outage and Alterations Leading to Communication / Navigation / Surveillance Degradation*
- SAFO Safety Alert for Operators SAFO 24002 issued 01/25/24 *Subject: Recognizing and Mitigating Global Positioning System (GPS) / Global Navigation Satellite System (GNSS) Disruptions*
- CAR OPS 1, CAR OPS 2, CAR OPS 3, CAR OPS 4, CAR M and CAR 100.

The CAA DGCAR will ensure the application of this CASB by continuously monitoring and assessing the situation through oversight activities or if needed internal AIC.

This Civil Aviation Safety Bulletin will be effective from the Date of issue.

13/08/2024

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**Subject: Civil Aviation Safety Bulletin 2024-01 Issue 01 Rev.00 on Global Navigation Satellite System Outage and Alterations Leading to Navigation-Surveillance Degradation.**

**1. Purpose:**

This CASB advises AOC holders on the possible GNSS outages or disturbances near geographical areas surrounding the conflict zones, including the south and eastern Mediterranean and Black Sea, Baltic Sea, and Arctic area.

**2. Applicability:**

All OMAN AOC holders operating to destinations, or overflying airspace near the aforementioned geographical areas.

**3. Description:**

Since February 2022, there has been an increase in jamming and/or spoofing of Global Navigation Satellite Systems (GNSS). Aviation Organization and Agencies had analysed recent data from the Network of Analysts and open sources and has concluded that GNSS jamming and/or spoofing has shown further increase in the severity of its impact, as well as an overall growth of intensity and sophistication of these events. This issue particularly affects the geographical areas surrounding conflict zones, but it is also encountered in the south and eastern Mediterranean, Black Sea, Middle East, Baltic Sea, and Arctic area.

To facilitate Operators, a list of affected non-exhaustive flight information (FIR) regions is published on the EASA website<sup>1</sup> as a study base for GNSS Outage and Alterations.

Jamming is an intentional radio frequency interference (RFI) with GNSS signals. This interference prevents receivers from locking on satellites signals and has the main effect of rendering the GNSS system ineffective or degraded for users in the jammed area.

Spoofing involves broadcasting counterfeit satellite signals to deceive GNSS receivers, causing them to compute inaccurate position, navigation, and timing (PNT) data.

There are no specific flight crew alerts that would indicate which kind of interference is being experienced – jamming or spoofing. Nevertheless, the effects of jamming are typically immediate and noticeable by the flight crew, as systems fail to receive GNSS signals.

<sup>1</sup> [https://www.easa.europa.eu/en/domains/air-operations/global-navigation-satellite-system-outages-and-alterations#FIRs\\_affected](https://www.easa.europa.eu/en/domains/air-operations/global-navigation-satellite-system-outages-and-alterations#FIRs_affected)



This should allow for quick recognition of the problem and reaction with mitigation measures.

On the other hand, detection of spoofing is more difficult and not immediate for the flight crew, thus posing more safety risk than jamming. Depending on aircraft-system integration, various side effects of jamming have been observed which could be attributed to spoofing and vice-versa. For the purposes of this civil aviation safety bulletin, jamming and spoofing are discussed as suspected causes, regardless of their actual cause.

The following non-exhaustive list provides observed symptoms of suspected GNSS spoofing:

- Incoherence in navigation position, such as GNSS/FMS position disagree alerts;
- Abnormal differences between Ground Speed and True Airspeed;
- Aircraft clock changes (e.g., incorrect time);
- Spurious Terrain Awareness and Warning System (TAWS) alerts;
- Potential deviation of hybrid position (IRS/GNSS).

The effects of GNSS jamming and/or spoofing have been observed by crews in various phases of flight, in some cases leading to re-routing or diversions, to ensure safe continuation of flight, and triggering spurious TAWS alerts. Under the present conditions, it is not possible to predict GNSS interference or its effects. The magnitude of the issues generated by these interferences depends upon the extent of the area concerned, on the duration, on the traffic density, on the phase of flight, and on how dependent the aircraft systems are on GNSS signals.

The following non-exhaustive list provides examples of issues that a degradation of GNSS signal (including Satellite Based Augmentation Systems (SBAS) and Ground Based Augmentation Systems (GBAS)) could generate:

- Temporary or non-recoverable failure or degradation of PNT information provided by GNSS, possibly resulting in:
  - Loss of or misleading TAWS (e.g., spurious PULL UP alerts triggered by predictive TAWS during cruise, descent, approach, and landing phase
  - that in some cases resulted in high vertical rate uncoordinated climbs, note that traffic alerts are deprioritised over TAWS PULL UP alerts);
  - Loss of Airborne Collision Avoidance System (ACAS);
  - Loss of or misleading surveillance function (e.g., corrupted Automatic Dependent Surveillance-Broadcast (ADS-B);
  - Loss of or misleading information on a Synthetic Vision Systems (SVS), weather uplink functions, predictive wind shear, and other surface functionalities;



- Inconsistent flight guidance possibly resulting in route divergence, uncommanded turns, and deviations from the ATC clearances or instructions received, which could potentially lead to airspace infringements, loss of traffic separation, insufficient terrain/obstacle clearance, etc.;
  - Inconsistent, or potentially misleading aircraft position, GNSS altitude, and calculated ground or wind speed on the navigation display or on the Electronic Flight Bag (EFB);
  - Inconsistent, or potentially misleading aircraft position and/or GNSS altitude, later in the flight after having exited the affected area, e.g., during approach;
  - Loss or misleading time and/or date dependent systems (e.g., clock, fuel computation system, flight management system, discarded Controller Pilot Data Link Communication (CPDLC) messages).
- Inability to use GNSS for navigation, including waypoint navigation;
  - Inability to use GNSS for navigation after exiting the affected area or for the remainder of the flight;
  - Inability to maintain GNSS based Area Navigation (RNAV) and/or Required Navigation Performance (RNP).

Repeated or widespread disruptions of the GNSS signals can lead to increased workload of both flight crews and air traffic controllers that can cause cognitive overload or confusion and increase the risk for errors. The combination of two or more of the issues listed above may have cumulative adverse effects on flight safety. GNSS Jamming and Spoofing also can affect ground-based systems, especially when they use GNSS as their only source for timing.

#### 4. Recommendation(s):

To address the identified issues the CAA of Oman recommends the implementation of the following mitigating measures. These measures are to be considered to be extended to any area particularly where GNSS jamming and/or spoofing is already been identified. Some recommendations are now separated for jamming as compared with spoofing, due to the specificities of the two different cases.



#### 4.1 Action to be Taken

AOC holders should consider the following measures:

- Promptly report disruption to appropriate ATS units, followed by a detailed written report post flight through normal safety channels such as special air safety report (ASR) when safety effects are encountered;
- Ensure that flight crews are aware, trained and prepared to recognize and adequately respond to an encounter of GNSS interferences during flight;
- Ensure that, Prior to departure, the flight crews are aware of the potential risk locations, check for any relevant Notices to Air Missions (NOTAMs), plan fuel contingencies, and research alternative conventional arrival/approach procedures at the destination and all alternate airports. When available, operators should plan to use conventional Navigational Aids (NAVAIDs) in these locations;
- Evaluate different possible scenarios based on the type of operations in order to provide the flight crew with timely information to increase awareness of jamming and spoofing;
- Ensure that GNSS jamming or spoofing topic is included in the flight crew ground recurrent training and training of other relevant operations personnel, especially when operating in the mentioned areas, highlighting the identified operational scenarios to recognise, react in a timely manner to different jamming and spoofing cases;
- Assess operational risks and limitations linked to the loss of on-board GNSS capability, including any on-board systems requiring inputs from a reliable GNSS signal, e.g., impact on TAWS;
- Maintain contact with aircraft or equipment manufacturers for instructions and guidance on how to operate and maintain their products, when exposed to jamming or spoofing, and implement the recommendations in the standard operating and maintenance procedures;
- Ensure that any system used as a backup to GNSS is not inoperative according to the Minimum Equipment List, before commencing a flight into known affected areas, with the exception of one flight if necessary to reach a station, where the repair can be done;
- Ensure that systems, used as a backup for an inoperative system according to the Minimum Equipment List, are not reliant on GNSS, before commencing a flight into affected areas, with the exception of one flight if necessary to reach a station where the repair can be done;
- Ensure, whenever possible (e.g., airspaces that are not oceanic or remote), in the flight planning for flights into affected areas, the availability of alternative non-GNSS based procedures for the whole flight, regardless of the type of operation. This should be complemented with information regarding the ability to receive radar vectoring in the airspaces to be transited;
- If subject to Flight Data Monitoring (FDM) requirements and necessary data are available, use FDM programme to identify and assess GNSS jamming and spoofing events.



## 4.2 GNSS jamming or spoofing specific recommendations for AOC holder

### 4.2.1 GNSS jamming specific recommendations for AOC holders:

- Ensure that flight crews and relevant flight operations personnel:
  - are aware of possible GNSS jamming;
  - verify the aircraft position by non-GNSS means, when flights are operated in proximity to the affected areas;
  - check that the navigation aids essential to the operation for the intended route and approach are available;
  - remain prepared to revert to a non-GNSS procedure where appropriate; and
  - Report (ASR) any observed irregularities to air traffic services.

### 4.2.2 GNSS spoofing specific recommendations for AOC holders:

- Ensure that flight crews and relevant flight operations personnel:
  - are aware of possible GNSS spoofing;
  - when possible, monitor aircraft position using non-GNSS NAVAIDs and all available automatic navigation accuracy calculations, including the Estimated Position Uncertainty (EPU) figure;
  - monitor the GNSS time versus non-GNSS time sources;
  - closely monitor the ATC frequencies in the vicinity of spoofing area;
  - apply the manufacturer's instructions and guidance for the aircraft type on detecting and dealing with suspected spoofing;
  - report (ASR) to air traffic services any observed irregularities.

All parties concerned are reminded of their obligations to report any occurrence impacting safety according to Civil Aviation Authority Regulation Directorate. All AOC holders are also reminded to report the suspected GNSS spoofing and higher risk jamming occurrences to aircraft manufacturers and support their investigations by providing relevant information in compliance with Regulation CAR 100.

## 5. Queries:

Any queries or requests for further guidance as a result of this CASB should be addressed to CAA/DGCAR of the Sultanate of Oman.

E-mail: [asr.submission@caa.gov.om](mailto:asr.submission@caa.gov.om)

## 6. Cancellation

This Civil Aviation Safety Bulletin will remain in force until further notice.

