

**Subject:** **Global Navigation Satellite System Outage and Alterations Leading to Communication / Navigation / Surveillance Degradation**

**Revision:**

This SIB revises EASA SIB 2022-02R3 dated 05 July 2024.

**Ref. Publications:**

- Commission Regulation (EU) [965/2012](#) of 05 October 2012.
- Commission Regulation (EU) [376/2014](#) of 03 April 2014.
- Commission Regulation (EU) [2017/373](#) of 1 March 2017.
- EUROCONTROL Guidelines on a Process for Civil and Military GNSS Interference Testing [EUROCONTROL-GUID-190](#) Edition Number 2.0 dated 06 March 2023.

**Applicability:**

National Competent Authorities (NCA), Air Traffic Management/Air Navigation Service (ATM/ANS) providers, air operators, aircraft and equipment manufacturers, organisations involved in the design or production of ATM/ANS equipment.

**Description:**

Since February 2022, there has been an increase in jamming and/or spoofing of Global Navigation Satellite Systems (GNSS). EASA has 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 or geopolitical risk zones such as the south and eastern Mediterranean, Black Sea, Middle East, Baltic Sea, and Arctic area.

The list of affected flight information regions (FIR) is published on the EASA website at:

[Global Navigation Satellite System \(GNSS\) Outages and Alterations | EASA](#)

Jamming is an intentional radio frequency interference (RFI) with GNSS signals. This interference prevents receivers from locking onto 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 incorrect position, navigation, and timing (PNT) data.

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This is information only. Recommendations are not mandatory.



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. This should allow for quick recognition of the problem and reaction with mitigation measures. On the other hand, detection of spoofing may be 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 safety information bulletin, jamming and spoofing are discussed as suspected causes, regardless of their actual cause.

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 the safety the flight, and sometimes leading aircraft to deviate from Air Traffic Control (ATC) clearances. 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 could generate (including when aided by Satellite Based Augmentation Systems (SBAS) and/or Ground Based Augmentation Systems (GBAS)):

- Temporary or non-recoverable failure or degradation of PNT information provided by GNSS possibly resulting in:
  - Loss of or misleading:
    - Terrain Awareness and Warning Systems (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);
    - surveillance function (e.g. corrupted Automatic Dependent Surveillance-Broadcast (ADS-B)).
  - 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;

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- Inability to maintain GNSS-based Area Navigation (RNAV) and/or Required Navigation Performance (RNP).

The combination of two or more of the issues listed above may have cumulative adverse effects on flight safety. Additionally, 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 of errors.

GNSS jamming and spoofing can also affect ground-based systems, especially when they use GNSS as their main source for timing.

Based on this information, and following the analysis of more recent jamming and spoofing related occurrences, the Agency revises this SIB to update its recommendations. In particular, this revision addresses:

- Pilot-ATC phraseology (Appendix 1 of this SIB);
- Integration of EFB technology;
- New operational and training requirements; and
- ATC capacity management.

This SIB is revised in its entirety, and no revision bars are used.

At this time, the safety concern described in this SIB is not considered to be an unsafe condition that would warrant Safety Directive (SD) action under Commission Regulation (EU) [965/2012](#), Annex II, ARO.GEN.135, nor under Commission Regulation (EU) [2017/373](#), Annex II, point ATM/ANS.AR.A.025, or Airworthiness Directive (AD) action under Regulation (EU) [748/2012](#), Part 21.A.3B.

This SIB is considered to be an interim information and further SD or AD actions may follow in case an unsafe condition is determined with regard the GNSS jamming or spoofing addressed by this SIB.

#### Recommendation(s):

To address the identified issues EASA recommends the implementation of the following mitigating measures. These measures are to be considered for the flight information regions [published on EASA website](#) and should be extended to any other area where GNSS jamming and/or spoofing is identified. Some recommendations for aircraft operators are separated for jamming as compared with spoofing, due to the specificities of the two different cases.

#### NCA's should:

- Ensure that contingency procedures are established in coordination with ATM/ANS providers, aerodrome operators and airspace users, and that existing non-GNSS-based navigation infrastructure, particularly Instrument Landing Systems (ILS), Distance Measuring Equipment (DME) stations and Very High Frequency Omnidirectional Range (VOR) stations are made available and kept operational as required;

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- Implement appropriate and proactive mitigating measures as a matter of high priority, including verification of the issuance of NOTAMs (e.g. describing affected areas and related limitations);
- Facilitate the establishment by ATM/ANS service providers of a process to collect information on GNSS degradations, in coordination with the relevant National Telecommunications Authorities, and promptly notify the related outcomes to air operators, aerodrome operators and to other airspace users;
- Consider measures at national level, by involving appropriate and competent entities, to avoid the proliferation, sale, circulation and operation of unauthorized transmitters that cause or have the potential to cause harmful interference to GNSS signals;
- When applicable, encourage civil-military coordination prior to testing or use of GNSS disturbance systems<sup>1</sup>;
- Ensure that the content of this SIB is duly considered by air operators, aerodrome operators, ATM/ANS providers, aircraft and equipment manufacturers, and organisations involved in the design or production of ATM/ANS equipment;
- Evaluate the impact on aerodromes with GNSS-only approach and departure procedures and ensure that information on suitable alternate aerodromes is readily available.

**ATM/ANS providers should:**

- Establish a process to collect information on GNSS degradations, in coordination with the relevant CAs, National Telecommunications Authorities, and promptly notify the related outcomes to air operators and to other airspace users;
- Assess the potential impact of loss or anomalies of GNSS-based timing on CNS systems and ensure that there are technical solutions and procedures in place for continuous safe operation of ATS surveillance systems;
- Adhere to the procedures on the provision of information to airspace users as appropriate (e.g. through voice communication, ATIS, issuing NOTAMs, AIP);
- Consider keeping a ground navigation infrastructure operational, such as ILS, DME, and/or VOR in support of conventional and performance-based navigation procedures;
- Make sure that the surveillance coverage is resilient to GNSS interference;
- Be prepared to provide navigation assistance to aircraft (including vectoring where radar or independent surveillance is available and validated) as long as needed;
- Ensure that the communications and surveillance coverage and performance meet the needs for vectoring provision in case of GNSS jamming or spoofing;
- Ensure that contingency plans include procedures to be followed in case of large-scale GNSS short-term and long-term jamming and/or spoofing events;
- Consider implementing local GNSS RFI detection and GNSS status monitoring systems in addition to network-level capabilities, as needed;
- Reinforce the flight path monitoring of the traffic to prevent any deviation from ATC clearances (e.g. navigation track and level);
- Assess regularly whether the ATC unit capacity and applicable separation minima remain appropriate;

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<sup>1</sup> Refer to EUROCONTROL “[Guidelines on a Process for Civil and Military GNSS Interference Testing](#)” for further guidance.



- Ensure that GNSS jamming or spoofing topic is included in the Air Traffic Controller (ATCO) training, highlighting the identified operational scenarios to recognise, react in a timely manner to different jamming and spoofing cases;
- Ensure that ATCOs recognise standard phraseology (presented in the Appendix 1 to this SIB) to react clearly and consistently to a call related to spoofing and jamming;
- Implement the instructions and guidance provided by the organisations involved in the design or production of ATM/ANS equipment on how to operate and maintain their products, when affected by GNSS jamming and spoofing in the operations manuals.

#### **Air operators should:**

- Ensure that flight crews are aware, trained and prepared to recognise and adequately respond to an encounter of GNSS interferences during flight;
- Ensure that flight crews are aware of the importance of prompt reporting by means of a special air-report (AIREP) to air traffic services of any observed interruption, degradation or anomalous performance of GNSS equipment or related avionics (e.g. map shifts, suspected GNSS spoofing, lost or misleading position, time anomalies, and their duration);
- 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 in order to recognise and 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.
- Consider longer approach legs due to the implementation of contingency procedures and possible longer holding trajectories in congested areas in the fuel planning and inflight re-planning policy as well as in the inflight fuel management policy;
- 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;
- Ensure that pilots recognise standard phraseology (presented in the Appendix 1 to this SIB) to react clearly and consistently to a call related to spoofing and jamming;

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- Consider the use of EFB applications that support the depiction of GNSS RFI affected areas on the cockpit (See Appendix 2 of this SIB).

#### **GNSS jamming specific recommendations for Air operators:**

- 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;
  - verify 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;
  - report (AIREP) any observed irregularities to air traffic services if the event is unexpected, if safety is potentially affected, or if ATC assistance is needed; and
  - use the standard phraseology presented in Appendix 1 to this SIB to include clear and consistent calls related jamming effects.

#### **GNSS spoofing specific recommendations for Air operators:**

- Ensure that flight crews and relevant flight operations personnel:
  - are aware of possible GNSS spoofing;
  - when possible, monitor aircraft position using non-GNSS nav aids 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 (AIREP) to air traffic services any observed irregularities if the event is unexpected, if safety is potentially affected, or if ATC assistance is needed;
  - use the standard phraseology presented in Appendix 1 to this SIB to include clear and consistent calls related to spoofing effects.

#### **Aircraft and equipment manufacturers, should:**

- Assess the effects of jamming and spoofing on their products considering cumulative effects of multiple systems being affected simultaneously;
- Provide guidance to air operators on how to detect suspected GNSS spoofing events when using their products;
- Provide guidance to air operators on how to 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);
- Provide instructions and guidance to air operators on how to operate and maintain their products, when affected by GNSS jamming and spoofing, and implement the recommendations in the standard operating and maintenance procedures.

#### **Organisations involved in the design or production of ATM/ANS equipment, should:**

- Assess the effects of jamming and spoofing on their products considering cumulative effects of multiple systems being affected simultaneously;

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- Support ATM/ANS providers, by giving guidance on how to detect suspected GNSS jamming and spoofing events, when using their products;
- Provide instructions and guidance to ATM/ANS providers on how the Air Traffic Safety Electronics Personnel (ATSEP) should operate and maintain their products, when affected by GNSS jamming and spoofing.

All parties concerned are reminded of their obligations to report any event impacting safety according to Regulation (EU) No. [376/2014](#).<sup>2</sup>

Air operators 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 point ORO.GEN.160 (b) of Regulation (EU) No [965/2012](#).

**Contact(s):**

For further information contact the EASA Safety Information Section, Certification Directorate, E-mail: [ADs@easa.europa.eu](mailto:ADs@easa.europa.eu).

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<sup>2</sup> Please check [Global Navigation Satellite System \(GNSS\) Outages and Alterations | EASA](#), Reporting and Further Information.

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## Appendix 1 - Phrases to communicate with ATC and Flight Information Services (FIS) in clear and unambiguous manner

Note: Updates introduced in the phraseology are highlighted in **bold**, while deleted phraseology is indicated using ~~strikethrough~~.

Circumstances	Phraseologies	Applicable to	
		ATC	FIS
GNSS service status			
... use <b>REPORTED</b> when information is received from aircraft operating in the respective area	<p>a) GNSS [<del>REPORTED</del>] UNRELIABLE (or GNSS MAY NOT BE AVAILABLE) [DUE TO (<i>reason, e.g.</i> INTERFERENCE, or <b>JAMMING, or SPOOFING</b>)]};</p> <p>1) IN THE VICINITY OF (<i>location</i>) (<i>radius</i>) [BETWEEN (<i>levels</i>)];</p> <p>or</p> <p>2) IN THE AREA OF (<i>description</i>) (or IN (name) FIR) [BETWEEN (<i>levels</i>)];</p>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
... when planned activities or interferences affect the GNSS availability for specific operations for a duration of time	b) <del>BASIC</del> GNSS (or SBAS, or GBAS) UNAVAILABLE FOR ( <i>specify operation</i> ) [FROM ( <i>time</i> ) TO ( <i>time</i> ) (or UNTIL FURTHER NOTICE)];	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
... the reason depends on the information available to pilot	<p>*c) <del>BASIC</del> GNSS UNAVAILABLE (<b>or UNRELIABLE</b>) [DUE TO (<i>reason, e.g.</i> LOSS OF RAIM or RAIM ALERT, <b>or INTERFERENCE or JAMMING or SPOOFING</b>)]};</p> <p>*d) GBAS (or SBAS) UNAVAILABLE ;</p>		
	e) CONFIRM GNSS NAVIGATION;	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	*f) AFFIRM GNSS NAVIGATION.		
	'*' denotes pilot transmission.		
RNAV			
...RNAV arrival or departure procedure cannot be accepted by the pilot	*a) UNABLE (designator) DEPARTURE [or ARRIVAL] DUE RNAV TYPE;		
...pilot is unable to comply with an assigned terminal area procedure	*b) UNABLE ( <i>designator</i> ) DEPARTURE [or ARRIVAL] ( <i>reasons e.g.</i> INTERFERENCE, or <b>JAMMING, or SPOOFING</b> ));		

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...ATC unable to assign an RNAV arrival or departure procedure requested by the pilot due to the type of on-board RNAV equipment

**c) UNABLE TO ISSUE (designator) DEPARTURE [or ARRIVAL] DUE RNAV TYPE;**

...ATC unable to assign an arrival or departure procedure requested by the pilot

**d) UNABLE TO ISSUE (designator) DEPARTURE [or ARRIVAL] (reasons *e.g.* INTERFERENCE, or JAMMING, or SPOOFING));**

...confirmation whether a specific RNAV arrival or departure procedure can be accepted

**e) ADVISE IF ABLE (designator) DEPARTURE [or ARRIVAL];**

...informing ATC of RNAV degradation or failure

**\*f) (~~aircraft call sign~~) UNABLE RNAV DUE EQUIPMENT;**

...informing ATC of no RNAV capability

**\*g) (~~aircraft call sign~~) NEGATIVE RNAV;**

**‘\*’ denotes pilot transmission**

**Terrain alert**

.... after a flight crew starts to deviate from any ATC clearance or instruction to initiate climb in response to a terrain alert warning

**\*a) (aircraft call sign) TERRAIN ALERT, (suggested pilot action, if possible).**

**Note 1: — possible action — PULL UP due to GNSS INTERFERENCE, JAMMING, or SPOOFING;**

**Note 2: — the TAWS / EGPWS requires an immediate GNSS-based escape maneuver (“GNSS PULL UP”)**

**\*c) GNSS PULL UP, PASSING (*level*)[*intentions*];**

**b) ATTENTION ALL AIRCRAFT IN VICINITY OF (or AT) (*significant point or location*), TERRAIN ALERT CLIMB [IN PROGRESS] FROM (*level*) or PASSING (*level*) (*followed as necessary by specific instructions, clearances, traffic information, etc*)**

**‘\*’ denotes pilot transmission**

**...when due to GNSS INTERFERENCE flight crew experiences time anomalies**

**\*a) REQUEST TIME CHECK;**

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**b) TIME (time in minutes and seconds, followed by the word NOW);**

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## Appendix 2 – EFB GNSS Interference Map

Some providers already propose solutions using near real-time data uploaded to the cockpit, presenting a recent (but not instantaneous) view of RFI along the route, on an EFB application. This can allow better anticipation from the crew.

EASA supports the use of those applications and recognises that they may be classified as type B as per AMC1 CAT.GEN.MPA.141(b) of the Air Operations Regulation (Reg. (EU) [965/2012](#)).

The use of a type B EFB application is subject to an operational approval in accordance with Subpart M of Annex V (Part-SPA) of the Air Operations Regulation, under responsibility of the operator and its Competent Authority.

All existing EFB criteria from the regulation apply (for commercial operations, CAT.GEN.MPA.141 and its AMC, and subpart M of Part-SPA), using the specific considerations for In-Flight Weather (IFW) applications (AMC9 SPA.EFB.100(b)(3)) by analogy to GNSS RFI layers.

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