AERONAUTICAL INFORMATION CIRCULAR P 046/2023

UNITED KINGDOM

UK Aeronautical Information Services
NATS Swanwick
Room 3115
Sopwith Way
Southampton SO31 7AY
aissupervisor@nats.co.uk
http://www.nats.aero/ais
matt.hine@caa.co.uk
(Content - CAA - Spectrum and Surveillance)

Date Of Publication
1 Jun 2023

Subject
Safety

RADIO FREQUENCY JAMMING IN THE UK - BACKGROUND AND NOTIFICATIONS

1 Introduction

1.1 Within the UK, certain entities such as law enforcement and the military will regularly conduct exercises and trials which incorporate Radio Frequency (RF) jamming. RF jamming is a technique through which wanted RF signals are deliberately blocked or interfered with in order to disrupt reception and information flow.

1.2 In recent years, remotely piloted aircraft systems (RPAS) capability has developed. In response to this, there has been a growing interest in developing and deploying technology to counter the potential misuse of RPAS, including RF jamming. Typically, this technology can inhibit the command and control (C2) and navigation systems of these aircraft via the use of powerful RF signals; however, the effect of such technology is not limited to the target and can impact other systems in close proximity to the deployment.

1.3 Some frequency bands used for C2 and navigation of RPAS systems are also used elsewhere in airborne systems, and as such, the CAA is required to mitigate the deployment of RF jamming equipment within the UK via proper notification and coordination with affected airspace users.

1.4 In recent years and in line with the expansion of the RPAS sector, the CAA has seen a dramatic increase in notification requests from the entities capable of carrying out RF jamming activities.

2 Aim

2.1 This AIC aims to provide airspace users with information regarding RF jamming, potentially impacted systems, means of notification and guidance on how aircraft equipment may respond.

3 Impacted Services

3.1 Jamming activity in the UK can impact a broad range of frequency bands and systems. Most of these do not affect the operation of aviation systems, however there are several common frequency bands or systems that could be impacted by regular jamming activity.

3.2 Industrial, Science and Medical (ISM) Band

3.2.1 ISM, also referred to as 'licence exempt' bands, encompass a collection of frequency bands used by Short Range Devices (SRD's). These bands enable a broad range of systems and products to operate without a radio licence. Systems utilising these bands are used under the provision that the frequencies are operated on a 'no interference, no protection' basis. Broadly, this means that the systems operating in these bands must not cause interference to other spectrum users but will not be protected from interference in return.

3.2.2 Systems operating in these bands typically include RPAS command and control, RPAS payload transmission (such as video), model aircraft control, some electronic conspicuity devices (such as FLARM and Pilot Aware), along with any Wi-Fi and Bluetooth enabled devices. This includes A full list of frequencies is provided in Ofcom Interface Requirements (IR) 2030.

3.2.3 Typically, notifications will include the impacted frequency bands and/or the systems and services that could be impacted. There are a number of mechanisms available for notifying airspace users of RF jamming, including Notice to Aviation (NOTAM), Aeronautical Information Circular (AIC), and CAA Skywise alert. Individual frequencies may not necessarily be identified in notifications due to the sensitive nature of some activities.

3.3 GNSS (GPS) and SBAS

3.3.1 There are a number of GNSS constellations and frequencies in use by a broad range of sectors in the UK. This includes systems listed in AIP ENR 4.3.

3.3.2 As GNSS constellations operate on a limited number of frequency bands, typically any GNSS jamming activity will impact most constellations and risk compromising most receivers within a certain range. This also includes SBAS services such as EGNOS, Generally, the impacted bands will be included on any notifications but as with notification of individual ISM frequencies, there may

be cases where this is not possible due to the sensitivity of the deployment.

3.3.3 Broadly there are 3 main frequency allocations in use by the range of constellations available. These include GPS, GLONASS and Galileo. The frequencies used by these systems are usually referred to as L1, L2 and L5. Often, GPS is used a generic reference to a system capable of receiving a service from multiple GNSS constellations.

3.3.4 Systems that utilise GNSS signals include (but are not limited to):

- GNSS based timing systems.
- GNSS based navigation systems.
- Surveillance and Conspicuity systems that derive their position from GNSS sources, such as CAP1391 devices and electronic situational awareness products.
- Moving maps. Please refer to CAA safety sense leaflet SS29 for more information on the use of these devices.
- Navigation systems for RPAS, including multiple device functions such as return home functions, geofencing capabilities, altitude indicators and general situational awareness. The documentation for a RPAS will contain more information on what positioning sources are used.

3.3.5 GNSS use may also be dependent on the current phase of flight and may be more critical in certain situations (for example when completing a RNAV (GNSS) approach). Please refer to CAP 773 for more information.

3.4 Other

3.4.1 Other relevant frequency bands and systems impacted by jamming activity will usually be highlighted in jamming notifications.

4 Types of jamming activity (military, police trials, operational deployment)

4.1 The nature of a jamming activity will vary dependent on its purpose. This AIC focusses on known, legitimate jamming activity undertaken by authorised entities in the UK, which the CAA are able to mitigate through means of notification or segregation. Other interference events, such as illegitimate jamming activity, RF interference from other sources or natural phenomena may also cause interference, especially with fragile signal systems such as GNSS.

4.2 Known, legitimate activity can range from trial and testing deployments covering large areas, through to operational deployments covering limited geographical areas around certain sites which have a limited risk of signal radiation. The most common types of deployments are described below:

4.3 Trial and Testing (Non-Operational) Deployments

These activities are regularly conducted and can incorporate wide area testing. Range and impact areas can vary but historically some military exercises can impact GNSS receivers up to 100NM from the location of the jamming source and up to 40,000FT AMSL in altitude.

4.4 Planned Operational Deployments

Lower power equipment is regularly deployed for operational reasons, often in conjunction with major events and mass gatherings. Deployments of this nature may be associated to existing airspace restrictions or specific locations. Operation of RF inhibition in this scenario is not guaranteed but is possible on an ad-hoc basis.

4.5 Unplanned Operational Deployments

Such deployments may be in response to a specific incident or threat.

5 Notification

5.1 Most jamming activity will typically be notified by NOTAM. As some activity has an associated impact area that can be geographically complex in nature, some activity will be accompanied by a specific AIC describing the specific impact.

5.2 Notifications will typically incorporate an approximate central location of the jamming activity and associated impact area which include lateral and vertical impact estimations. This can sometimes be a single or series of radius's for different altitudes. Alternatively, where jamming will only have an effect in a specified direction, impact estimations may take the form of a series of radius's between two arcs.

5.3 Given the broad range of performance for GNSS receivers in use, these estimations are typically based on a worst-case assumption in terms of receiver resilience. A range of characteristics can impact a receiver's response to interference, including:

5.3.1 Receiver performance (based on age, type, quality, resilience).

5.3.2 Receiver antenna placement (including internal devices such as tablets and some EC devices).

5.3.3 Receiver antenna masking (such as body masking from the aircraft).

5.4 Where possible and in order to provide a refined estimation, the CAA requests jamming sponsors to provide impact estimations based on a range of interference thresholds. This produces a set of 3 impact areas for a range of likelihoods which are published in associated notifications. Receiver thresholds are based on a range of receiver performance criteria including receiver resilience, antenna placement and airframe body masking. 'Green' estimations utilise a worst-case receiver performance scenario which is generally not reflective of modern receiver performance.

5.4.1 Green - Interference **unlikely** (Worst case scenario)

5.4.2 Amber - Interference **Possible**

5.4.3 Red - Interference **Probable**

5.5 Where relevant, NOTAMs will be duplicated as a Skywise alert, however operators should not rely on Skywise notifications and should ensure that suitable checks for such notifications are embedded into their flight planning processes. CAA documents such

as the Skyway Code and CAP 694 contain information on effective flight planning.

5.6 Typically, textual notifications for complex activities are accompanied by charts to illustrate the effect of the jamming activity. This will include the predicted impact at a range of altitudes. An example notification chart is included in Appendix B.

6 Jamming Overseas

6.1 For known state jamming activity overseas, please refer to the local AIP in the state of operation. Please note the CAA has issued a Safety Notice (SN-2022/002) regarding geographical areas where GNSS jamming has been reported.

7 Impact of Interference

7.1 The CAA provides advice and guidance to jamming sponsors to ensure adequate consideration is given to the impacted systems from jamming activity. Commonly impacted systems include, but are not limited to, the following.

7.2 GNSS Approaches

7.2.1 Please refer to CAP 733 for existing guidance on loss of GNSS and unpredicted short notice outages and failures when conducting an approach.

7.3 RPAS C2

7.3.1 In the event of interference to RPAS command and control, commands may cease to be received by the aircraft or may be corrupted. This may result in the aircraft not responding correctly to commands. Payload data (such as video transmitted to the operator) may also fail, become intermittent or corrupted. Operators should have established procedures to manage the loss of C2 in accordance with their operational safety case.

7.4 RPAS GNSS

7.4.1 GNSS interference may inhibit RPAS functions such as return to home or automated flight course. It may also impact geofencing capabilities and inhibit warnings. Operators should have established procedures to manage the loss of GNSS in accordance with their operational safety case.

7.5 Moving Maps

7.5.1 Moving maps applications may produce inaccurate or incorrect positions on the display. Loss of GNSS may also inhibit airspace warnings and other GNSS dependent functions. Operators should be prepared to revert to alternative forms of navigation in case of performance degradation.

7.6 ADS-B and EC Devices

7.6.1 As some electronic conspicuity devices (including ADS-B) utilise GNSS as a positioning source this data may be incorrect or inaccurate. In addition, some electronic conspicuity and situational awareness devices utilise ISM band frequencies to share information with other devices. These functions may be inhibited by jamming activity. Operators should be familiar with the potential impact of the loss of such equipment and the associated procedures.

7.7 Other GNSS

7.7.1 Additional systems may include those utilising GNSS derived time signals. This includes distributed systems such as MLAT. These systems are expected to have a variable level of resilience to GNSS signal loss.

8 Coordination

8.1 In all cases the CAA requests that the sponsor of an activity engages with local airspace stakeholders by the jamming sponsor directly, especially where an activation is not as likely to be notified to airspace users in a timely fashion (for example an ad-hoc operational deployment). Guidance has been provided for law enforcement jamming sponsors regarding what engagement should take place.

9 Advance Activity Forecast

9.1 The CAA is provided with an annual overview of large-scale military activities that may utilise RF jamming. Further details will be published closer to the event and details are subject to change. The current list of anticipated activity is published in Appendix A of this document. These events may not go ahead as planned but are presented to inform forward planning of significant events or activities.

10 Reporting performance issues caused by jamming

10.1 As described in section 7, interference will typically manifest itself as poor system performance, incorrect instrument readings or total failure of systems.

10.2 If these adverse effects are experienced, it is first recommended to check for NOTAMs or Skywise notifications for the area in which the effects were detected.

10.3 If jamming has not been published in NOTAMs or Skywise notifications, the CAA should be notified via the Spectrum email provided in section 11.2.

10.4 Notifying the CAA of these effects can help to provide evidence of either a greater impact than predicted, which can then be used to improve prediction methods, or illegal jamming activities which can then be reported to the correct UK authorities for further

action.

11 Reporting performance issues caused by jamming

11.1 For specific activities, emergency cease jamming contact details are provided in the associated NOTAM/AIC.

11.2 For general enquiries or advice, the CAA can be contacted on the address below: spectrum@caa.co.uk.

12 Appendix A - Anticipated Exercise 2023-24

Exercise Name	Anticipated Dates	Notes
Enduring Look	27/03/2023 - 31/03/2023	RAF Spadeadam and surrounding area
	24/04/2023 - 29/04/2023	
	31/07/2023 - 04/08/2023	
	18/09/2023 - 23/09/2023	
	13/11/2023 - 18/11/2023	

Note: *All exercises are subject to change and cancellation and are included to enable forward planning and deconfliction if required. Exercises are not confirmed until specifically notified.*

13 Appendix B - Example AIC Notification

AERONAUTICAL INFORMATION CIRCULAR P 024/2022

UNITED KINGDOM

UK Aeronautical Information Services
NATS Swanwick
Room 3115
Sopwith Way
Southampton SO31 7AY
aissupervisor@nats.co.uk
http://www.nats.aero/ais
stuart.rankin@caa.co.uk
(Content - CAA - Spectrum and Surveillance)

Date Of Publication
5 May 2022

Subject
Safety

Civil Aviation Authority

NOTIFICATION OF GNSS JAMMING TRIALS, NAVWAR TRIAL, SENNYBRIDGE 23 - 27 MAY 2022 AND 30 MAY - 3 JUNE 2022

1 Introduction

1.1 In accordance with UK procedures for the control of non-operational jamming, this note gives notification of radio jamming and signal interference activity, to intentionally provide interference to Global Navigation Satellite System (GNSS) signals, including the Global Positioning System (GPS).

1.2 This Circular includes the details and locations of the GNSS jamming, description of the predicted effects and a point of contact for further information or in case of emergency.

2 Dates, Times and Location

2.1 **Date**: 23 – 27 May and 30 May – 3 June 2022

2.2 **Location:** Jammers will be located within 1 NM from 520610N 0032918W

2.3 **Time:** The jamming will be limited to the daily hours of 0730-1700 UTC

2.4 **Duration and Pattern:** The trial is intended to be conducted in continuous serials throughout the day on each day. Multiple interference sources are likely to be operating simultaneously. Jamming (denial of service) and spoofing activities will be taking place during this exercise.

3 GPS Jamming

3.1 The areas within which a GNSS receiver is potentially likely to encounter jamming and/or interference with potential for incorrect readings is outlined below. The following scenarios are outlined:

Below 10,000 FT AMSL - No allowance is made for airframe masking or the reduction of antenna gain towards the horizon seen in all receiver systems. Therefore, the worst possible case for receiver vulnerability is considered.

Above 10,000 FT AMSL - 3 scenarios of interference are presented:

- 3.1.1 Interference, Jamming and Spoofing effect is **probable** (considers a reasonable interference scenario and receiver vulnerability);
- 3.1.2 Interference, Jamming and Spoofing effect is **possible**;
- 3.1.3 Interference, Jamming and Spoofing effect is **unlikely** (considers a worst possible case for receiver vulnerability).

The three scenarios presented above are based upon a range of assumptions and variables. These include the removal of assumptions regarding lack of airframe masking and antenna gain towards the horizon. The interference scenarios presented are supported by recent investigations into the actual interference caused to aircraft through review of ADS-B data. The CAA would welcome observations and feedback regarding this approach and any reports of interference experienced within the areas specified.

3.2 Text describing the predicted GNSS interference areas is supplemented with coverage graphics, representing the interference effect on GNSS receivers at 5000 FT AMSL, 10,000 FT AMSL, 20,000 FT AMSL, 30,000 FT AMSL, 40,000 FT AMSL.

3.3 The impact estimated at each level identified should be assumed to extend as illustrated to the level below it. E.G estimated coverage for 10,000 FT should be assumed down to 5000 FT. If further information is required on the interpretation of this data please contact the CAA using the contact information in section 5.1.

3.4 Predictions show that the coverage area where GNSS signals could be potentially impacted is as follows:

3.4.1 GNSS Jamming coverage area.

2 M AGL
Areas with clear line of sight to the transmitter site up to 5.4 NM.

25 M AGL
Areas with clear line of sight to the transmitter site up to 5.4 NM.

75 M AGL
Areas with clear line of sight to the transmitter site up to 5.4 NM.

1000 FT AMSL
In an arc clockwise from 110°T to 330°T to 16 NM.
To 5.4 NM in all other directions.

5000 FT AGL (PROBABLE)
In an area by straight lines between coordinates:
521808N 0034351W;
520253N 0043430W;
514516N 0043715W;
512550N 0035959W;
512956N 0032860W;
515826N 0030633W;
521808N 0034351W.

10,000 FT AMSL (PROBABLE)
In an area joined by straight lines between coordinates:
521808N 0034351W;
514550N 0052809W;
512811N 0053102W;
510759N 0045135W;
511917N 0032942W;
515539N 0030122W;
521808N 0034351W.

Probable interference at the following levels defined by their areas.
20,000 FT, 30,000 FT & 40,000 FT AMSL (PROBABLE)
In an area joined by straight lines between coordinates:
521100N 0033015W;
515307N 0040812W;
514257N 0040832W;
513850N 0040039W;
514029N 0034354W;
520509N 0031910W;
521100N 0033015W.

Possible interference at the following levels defined by their areas.
20,000 FT, 30,000 FT & 40,000 FT AMSL (POSSIBLE)
In an area joined by straight lines between coordinates:
520327N 0031557W;
511440N 0035811W;
511440N 0035811W;
511924N 0044633W;
513944N 0044610W;
521340N 0033519W;
520327N 0031557W.

Unlikely interference at the following levels defined by their areas.
20,000 FT AMSL (UNLIKELY)
In an area joined by straight lines between coordinates:
521808N 0034351W;
513644N 0055614W;
505532N 0060228W;
503546N 0052344W;
504851N 0035247W;
515539N 0030122W;
521808N 0034351W.

30,000 FT & 40,000 FT AMSL (UNLIKELY)
In an area joined by straight lines between coordinates:
515539N 0030122W;
502319N 0041143W;
501303N 0052149W;
503529N 0060526W;

514029N 0034354W;
521808N 0034351W;
515539N 0030122W.

3.5 Impact area may exceed the maximum height represented and should be assumed to continue beyond the altitude specified as described for the maximum altitude listed.

3.6 The following frequencies will be affected:
1559 MHz – 1612 MHz (GNSS L1/E1 band);
1215 MHz – 1256 MHz (GNSS L2 band);
1160 MHz – 1214 MHz (GNSS L5/E5 band).

4 Use of GNSS

4.1 Although GNSS equipment is an accepted means of compliance with B-RNAV and P-RNAV requirements, one of the conditions of its use is that the aircraft must carry serviceable radio navigation equipment in order to allow reversionary means of navigation. Operators of aircraft should not rely on GNSS for B-RNAV and P-RNAV operations in the areas predicted to be affected by the jamming trials and should be prepared to revert to the alternative means of navigation.

4.2 For IFR en-route and terminal area operations, only radio navigation equipment required by the rules for IFR operations should be used.

4.3 For VFR operations, conventional means of navigation including dead reckoning should always be used.

4.4 Operators of aircraft should be prepared for erroneous readings if cross checking with GNSS in the area predicted to be affected by the jamming trials.

4.5 Air Traffic Controllers should be alerted to the potential for aircraft to require navigation assistance during the period of the trial.

5 Points of Contact

5.1 General and non-urgent queries and feedback regarding these trials should be made in the first instance to:

Email: scpectrum@caa.co.uk

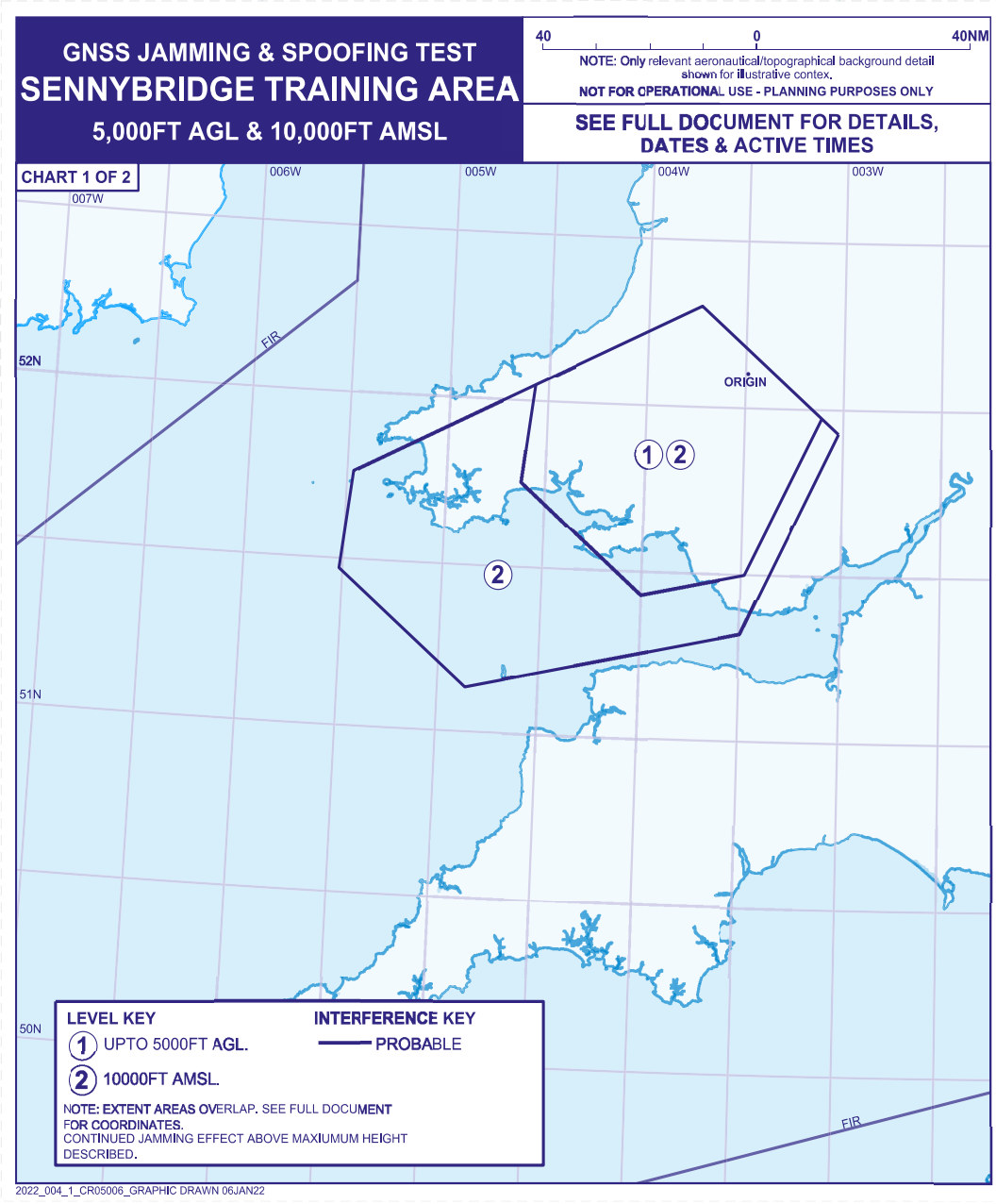
Please note, if providing any feedback on interference received, please include details of aircraft, equipment used and approximate location.

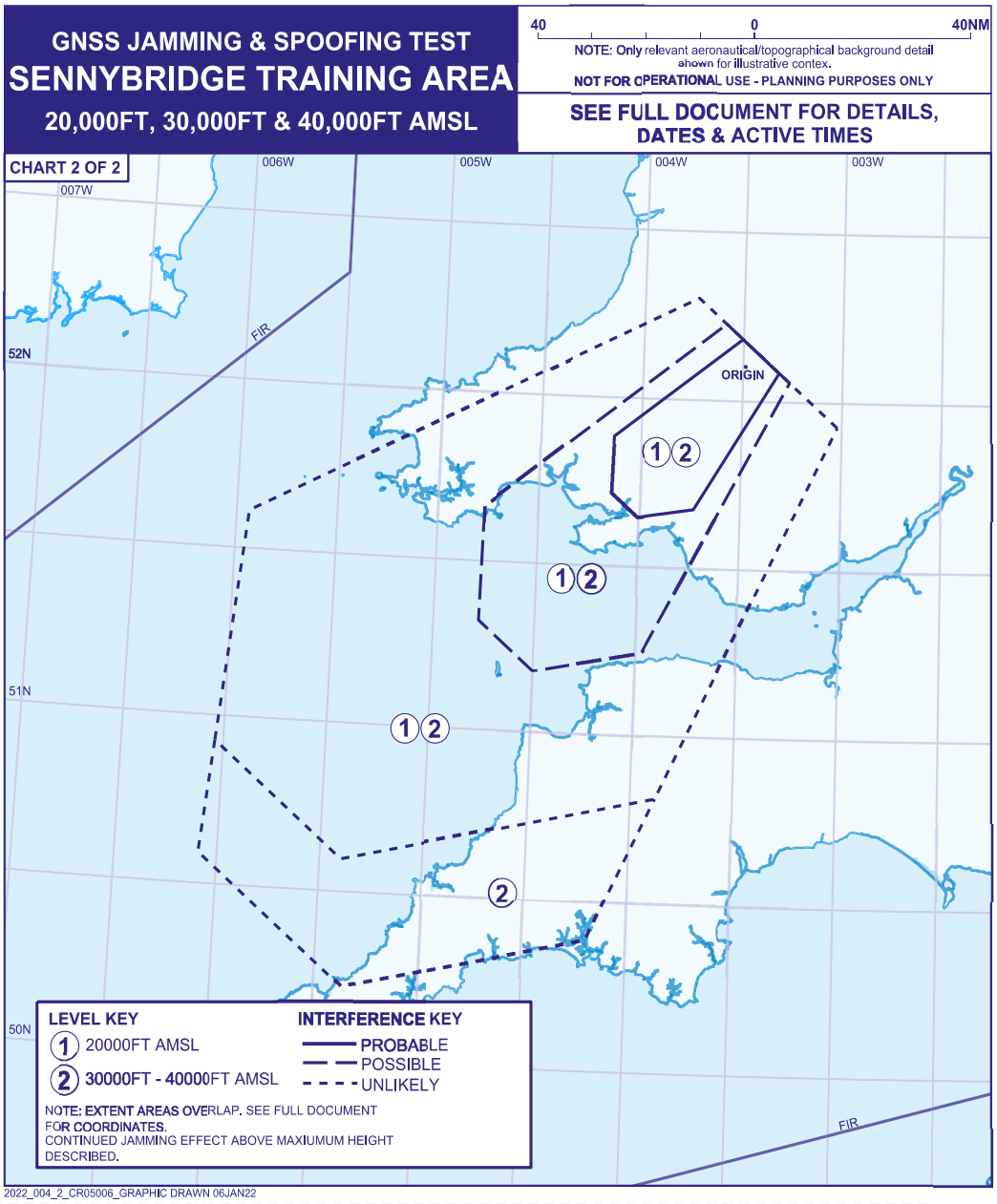
5.2 During the period of the exercise, the formal cease jamming contact number is:

Sennybridge Operations: 01874-635599
Trial Manager: 01980-951151

Note: *This number is only to be used in case of emergency in order to ask for jamming to cease. As with previous exercises, safety of life operations will at all times take precedence over exercise activities.*

6 Graphics


GNSS JAMMING & SPOOFING TEST
SENNYBRIDGE TRAINING AREA
5,000FT AGL & 10,000FT AMSL
40 0 40NM
NOTE: Only relevant aeronautical/topographical background detail shown for illustrative contex.
NOT FOR OPERATIONAL USE - PLANNING PURPOSES ONLY
SEE FULL DOCUMENT FOR DETAILS, DATES & ACTIVE TIMES
CHART 1 OF 2
007W
006W
005W
004W
003W
52N
51N
50N
FIR
ORIGIN
1 2
2
LEVEL KEY
1 UPTO 5000FT AGL.
2 10000FT AMSL.
INTERFERENCE KEY
PROBABLE
NOTE: EXTENT AREAS OVERLAP. SEE FULL DOCUMENT FOR COORDINATES.
CONTINUED JAMMING EFFECT ABOVE MAXIUMUM HEIGHT DESCRIBED.
2022_004_1_CR05006_GRAPHIC DRAWN 06JAN22


GNSS JAMMING & SPOOFING TEST
SENNYBRIDGE TRAINING AREA
20,000FT, 30,000FT & 40,000FT AMSL
40 0 40NM
NOTE: Only relevant aeronautical/topographical background detail shown for illustrative contex.
NOT FOR OPERATIONAL USE - PLANNING PURPOSES ONLY
SEE FULL DOCUMENT FOR DETAILS, DATES & ACTIVE TIMES
CHART 2 OF 2
007W
006W
005W
004W
003W
52N
51N
50N
FIR
ORIGIN
1 2
LEVEL KEY
1 20000FT AMSL
2 30000FT - 40000FT AMSL
INTERFERENCE KEY
PROBABLE
POSSIBLE
UNLIKELY
NOTE: EXTENT AREAS OVERLAP. SEE FULL DOCUMENT FOR COORDINATES.
CONTINUED JAMMING EFFECT ABOVE MAXIUMUM HEIGHT DESCRIBED.
2022_004_2_CR05006_GRAPHIC DRAWN 06JAN22