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GNSS RFI in India: Challenges, Regulations, and Analysis thereof

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GNSS RFI in India: Challenges, Regulations, and Analysis thereof

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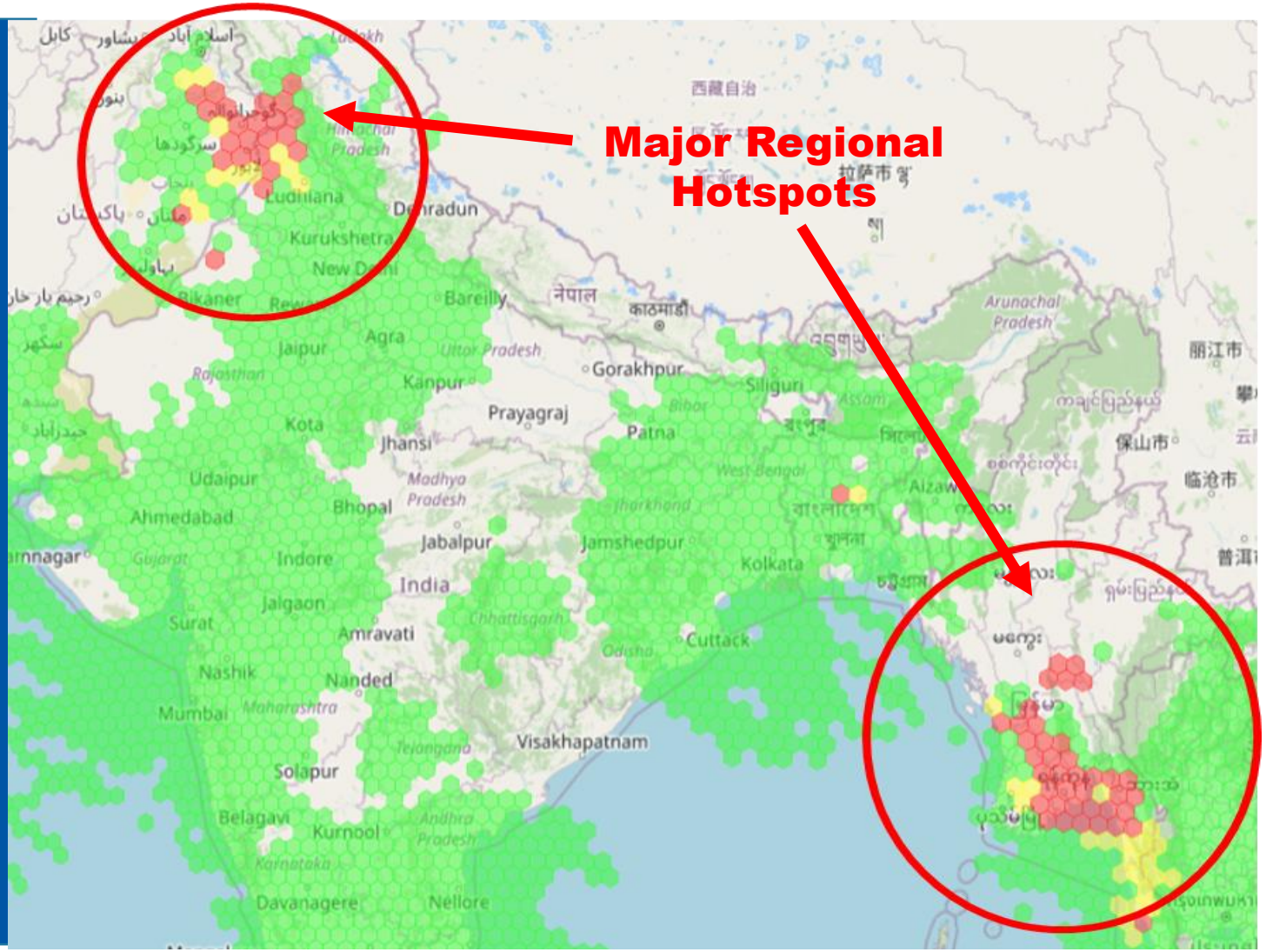
01

Introduction: GNSS Interference Challenges in Airspace



Source: https://gpsjam.org

Introduction: GNSS Interference Challenges in Airspace

October 2023

Several aircraft started reporting spurious GPWS warning in the vicinity of Amritsar Airport

6th October 2023

AAI received its first GNSS interference report from Qatar Airways (QTR8974, OTHH-VDPP), which experienced GPS disruption about 60NM from “BBS” drifting 1.5–2NM right of track.

24th November 2023

DGCA India, issued Advisory Circular ANSS AC 01 of 2023 to address GNSS Interference in Indian Airspace

4th December 2023

GNSS Section, AAI received GNSS Interference Incident Report from Amritsar ATC for Air India Express Flight No: IX-138, Sector: SHJ-ATQ, Route: A456, Phase of Flight: Descent & Approach. Flight experienced Multiple Terrain pull up warnings

12th December 2023

Advisory Caution NOTAM regarding GNSS Interference issued for areas in the vicinity of Amritsar Airport.

Advisory caution NOTAM is renewed periodically after assessment of frequency of GNSS Interference

14th February 2024

GNSS Interference Awareness Workshop was organized at GAGAN Complex, Bengaluru to create awareness and knowledge sharing.

Since December 2023, Various Airlines & Air Traffic Control Units are reporting GNSS Interference Incidents almost on daily basis.

02

Regulations to address GNSS Interference in Airspace

सत्यमेव जयते

भारत सरकार
नागर विमानन महानिदेशालय
Government of India
Directorate General of Civil Aviation

ADVISORY CIRCULAR

ANSS AC 01 of 2023
Ref. DGCA-21040/1/2023-ANS
Issue date: 24. 11.2023

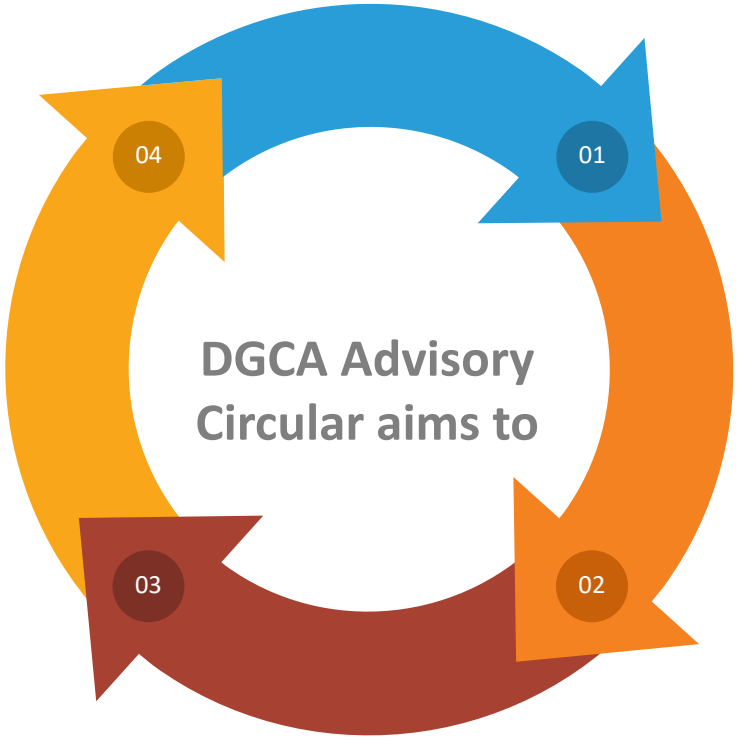
Sub: GNSS INTERFERENCE IN AIRSPACE

Web Link to the Advisory Circular

DGCA Advisory Circular ANSS AC 01 of 2023: Key Highlights

Recognizing the **growing reliance on GNSS-based systems** and the **associated risks of interference**, including jamming and spoofing, the DGCA India, issued **Advisory Circular ANSS AC 01 of 2023** on 24th November 2023.

Envisions creation of **Threat Monitoring and Analysis Network** for **preventive and reactive threat monitoring** for data and report analysis



Enhance **awareness among aviation stakeholders**

Provides a **reporting format** for reporting GNSS interference events**.**

Defining **roles and responsibilities** of stakeholders in addressing GNSS interference

Key Highlights: Roles & Responsibilities (Airlines, Pilots, ATC)

•Action by Aircraft Operators (Airlines)

- **Risk Awareness & Assessment** of potential impact of GNSS Interference.
- **Coordination & collaboration** with OEMs and ANSPs for root cause analysis of reported events.
- **Operational Preparedness** to operate in GNSS affected areas and air-routes
- **Regular Training & Communication** to flight crews and operations personnel.
- **Reporting and Analysis** of GNSS Interference Incidents

•Action by Pilots

- **Awareness & Monitoring** of the possibility and impact of GNSS interference.
- Actively monitoring of ATC frequencies, and preparation to revert to conventional navigation procedures.
- **Contingency Implementation in** cases of suspected or actual interference, prompt notification to ATC for assistance.
- **Event Reporting:** Report the interference event to the relevant authorities.

Action by Air Traffic Controllers

- **Monitor aircraft traffic** for unauthorized deviations and track distress frequency
- **Implement contingency** procedures if GNSS-based surveillance (e.g., ADS-B) becomes unreliable or is lost.
- **Provide navigation assistance**, cross-check with nearby aircraft, and broadcast interference reports as necessary.
- **Report** all interference events to the appropriate authorities.

GNSS Interference Event Reporting

•Reporting Requirement

- Mandatory for **Operators**, **Flight Crew**, **ANSPs**, and **Air Traffic Controllers**.
- Report any event of actual or suspected GNSS Interference leading to a safety occurrence.
- In accordance with GoI Aircraft Rules 1937, Rule 29E and DGCA-India CAR Sec 5 Series C Part 1.

•Reporting Format

- Pilot Reporting Form in e-AIP India ENR 4.3 Para 10.
- General reporting format for all is provided in Appendix 1 of the DGCA advisory circular.

•Reporting Channel

- Via email to:
  - Director (Air Safety), DGCA HQ, Email: sanit.dgca@nic.in
  - Director (AS & ANSS), DGCA HQ Email: jamwal.dgca@nic.in
  - Copy to GM CNS, GAGAN, AAI, CHQ Email: gmcnsgnss@aai.aero

Key Highlights: Roles & Responsibilities of ANSP

Action by ANSP

- Understanding **GNSS interference affects ATM/CNS systems** (including SBAS/GAGAN, ADS-B, and timing).
- Conduct **Safety risk assessments** for potential loss of these systems in specified airspace.
- Develop **contingency procedures** to mitigate interference, including actions for air traffic controllers and the **issuance of NOTAMs**.
- **Coordinate with military authorities** regarding GNSS jamming, informing airspace users via NOTAMs.
- Factor in GNSS interference when **rationalizing conventional navigation** and **surveillance infrastructure.**
- Maintain **essential navigation aids** (VOR, DME, ILS) and **interference-resilient surveillance systems**.
- Establish a mechanism to **collect, analyze, and report GNSS interference data** to airspace users and the DGCA.

03

Analysis of GNSS Interference Incident Reports

Reporting Format GNSS Interference Occurrence

Originator of Report	
Report Filed by	[] Aircraft Operator [] Flight Crew [] Air Navigation Service Provider [] Air traffic Controller [] Any other
Date and Time of Report (dd/mm/yyyy) and UTC	

Aircraft Operator Details	
Name	
Email address	

Flight Details	
Call sign of Aircraft (Flight No.)	
Flight Sector	
Airway/ Route of occurrence	
FIR code	
Flight Level or Altitude during event	
Phase of flight	
Aircraft Type	
Aircraft Registration	

General Flight Information

ATS Details	
Location of ATS Station (Location identifier)	
Surveillance Systems details	
Affected airspace Details	

Event Details	
Affected GNSS Element	[] GPS [] GLONASS [] GAGAN [] Any other. Pls Specify:
Coordinates of the first point of occurrence / Time (UTC):	UTC: Lat: Long:
Coordinates of the last point of occurrence / Time (UTC):	UTC: Lat: Long:
Duration of Observed Interference/outage:	

Interference Characteristics

Impact Details	
List of impacted systems:	
Observation of a "time shift" on clock (details of shift and recovery, if any)	
Observation of a "map shift" on navigation display (details of shift and recovery, if any)	
Enhanced ground proximity warning alerts:	
Degraded EPU (Estimated Position Uncertainity)/ Estimated Position Error	
Loss of automatic dependent surveillance (ADS) reporting capabilities (ADS-B out, ADSB-in, ADS-C) (details)	
Loss of GNSS-based landing capability.	
Large position errors (details):	
Loss of integrity (RAIM warning/alert):	
Complete outage (Both receivers):	
Loss of GPS1 or Loss of GPS 2	
Loss of satellites in view/details:	
Lateral indicated performance level change	From: To:
Vertical indicated performance level change	From: To:
Indicated Dilution of Precision changed	From: To:
information on PRN of affected satellites (if applicable)	
Low Signal-to-Noise (Density) ratio:	
Degraded PBN capability	
Switching to an alternate navigation mode (such as IRS updating or DME/DME)	
Any other observed impact:	
Automatic GNSS Systems Recovery (y/n)	

Impact Details

Other	
Any other relevant details:	

Note: All available details should be provided. Separate sheet may be attached for additional information/pictures, etc, if any.

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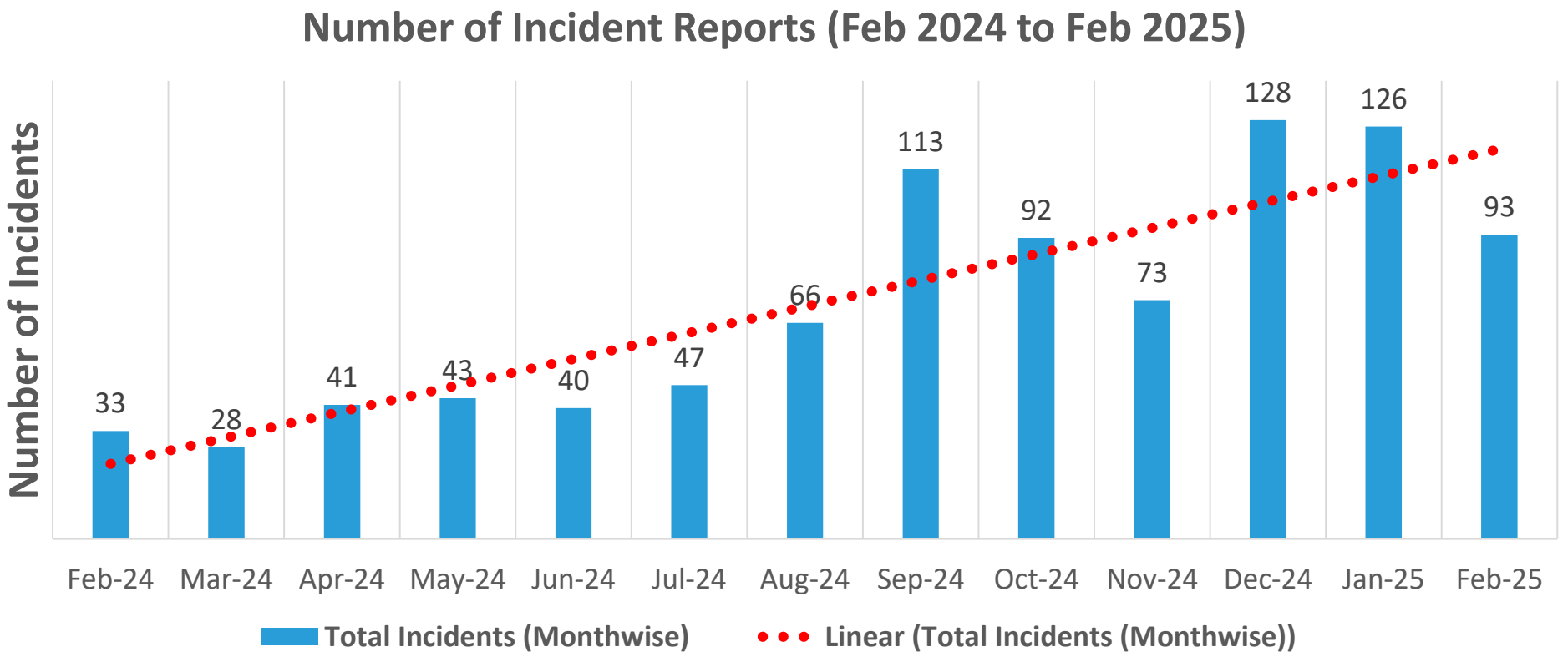
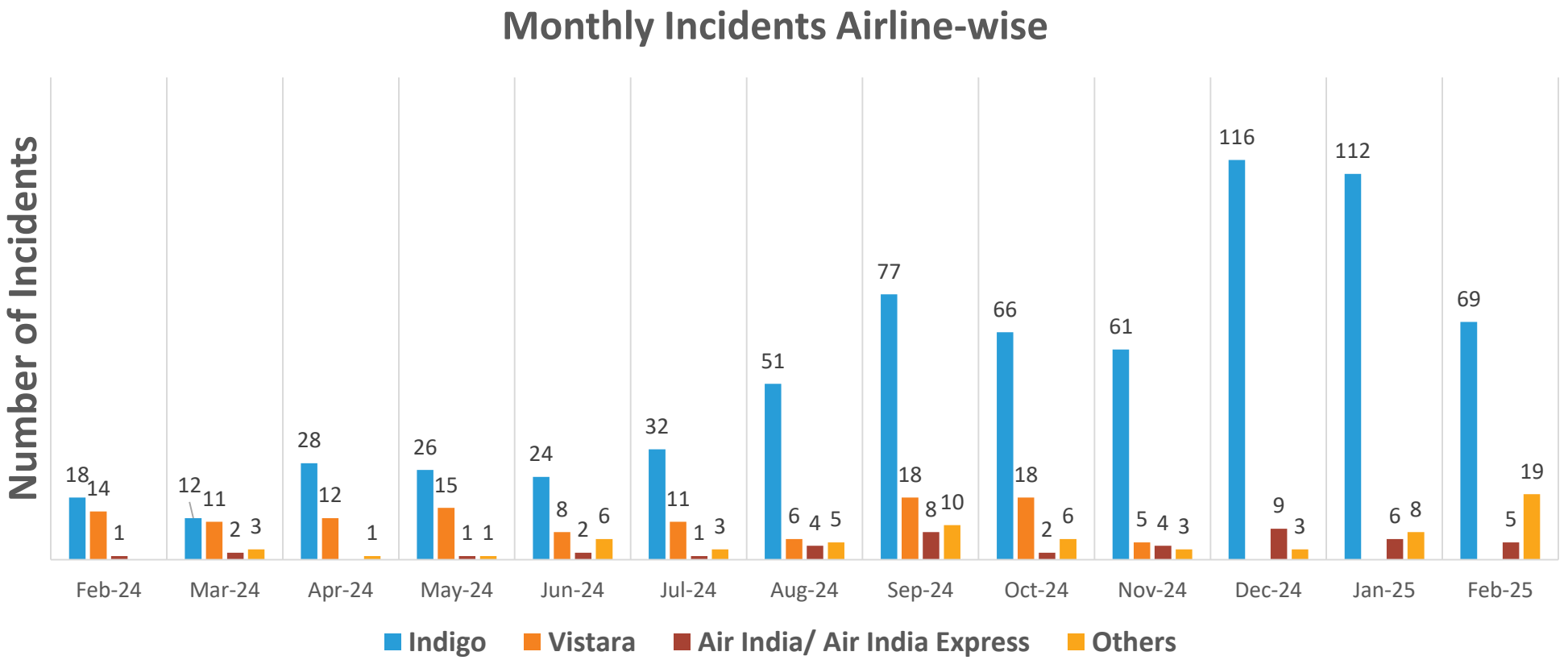
Analysis of GNSS Interference Incident Reports (contd.)

- Total **923 GNSS Interference Incidents** reported in last 1 year (Feb 2024 to Feb 2025)
- **Rising trend** in number of GNSS Interference Incidents



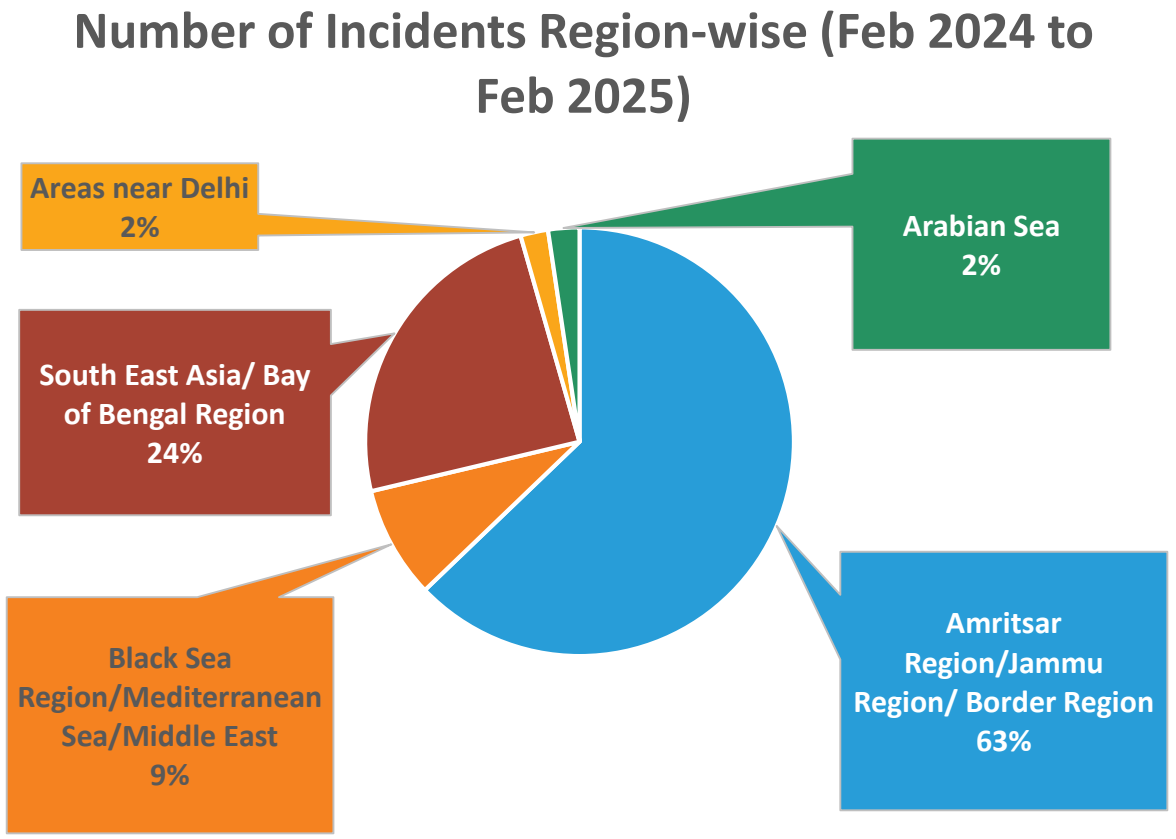
Analysis of GNSS Interference Incident Reports (contd.)

- **Indigo Airlines** reported maximum number of GNSS Interference Incidents.
- **Vistara Airlines** also reported significant number of GNSS Interference Incidents.



Analysis of GNSS Interference Incident Reports (contd.)

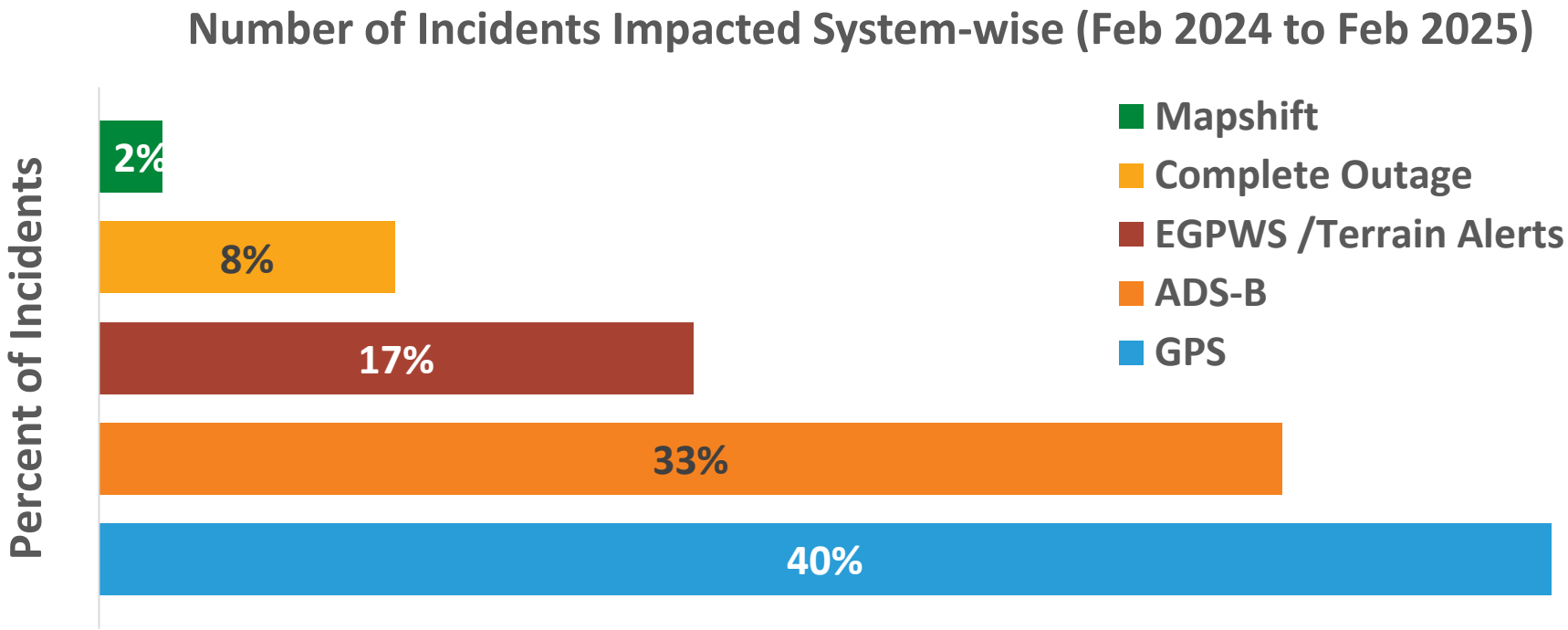
- Majority of the GNSS Interference is reported in **North-Western areas** particularly Amritsar/ Jammu Region and other adjoining Border Areas.
- GNSS Interference is also being reported in **South East Asia** and eastern part of **Bay of Bengal** Regions
- Flights operating in Europe bound Sectors reported incidents of GNSS Interference in **Black Sea & Mediterranean Regions.**



Note: The number of region-wise incidents have been determined based on location data, including sector, phase of flight, affected area, and available coordinates. In some cases the exact coordinates are not available.

Analysis of GNSS Interference Incident Reports (contd.)

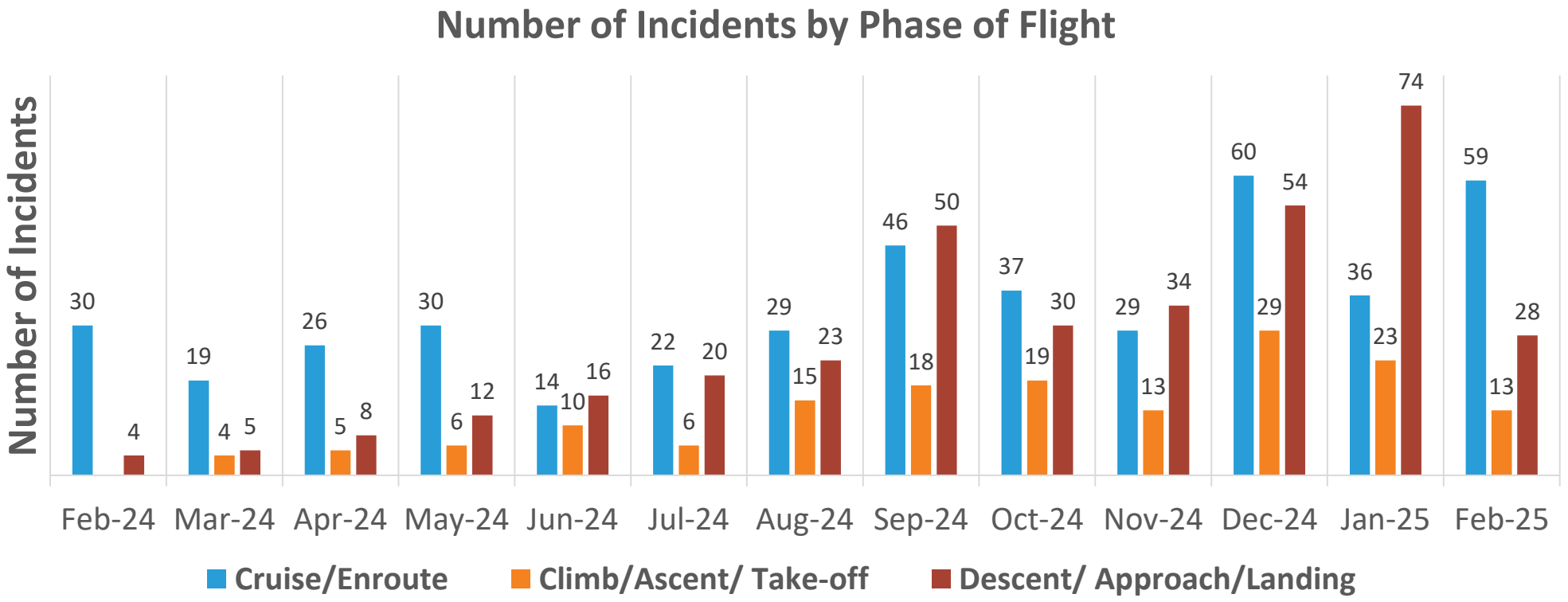
- **Loss of GPS** & **ADS-B** reporting and triggering **Enhanced Ground Proximity Alerts (EGPWS)** were the most frequently impacted.
- In most of the incidents there are **multiple systems** which are **impacted.**



Note: Details of impacted systems are not available in some of the GNSS Interference Incident Reports

Analysis of GNSS Interference Incident Reports (contd.)

- Most of the GNSS Interference Incidents in the vicinity of **Amritsar** reported in **Approach & Landing** phase.
- Interference reported on International routes majorly reported in **Cruise/Enroute** phase.

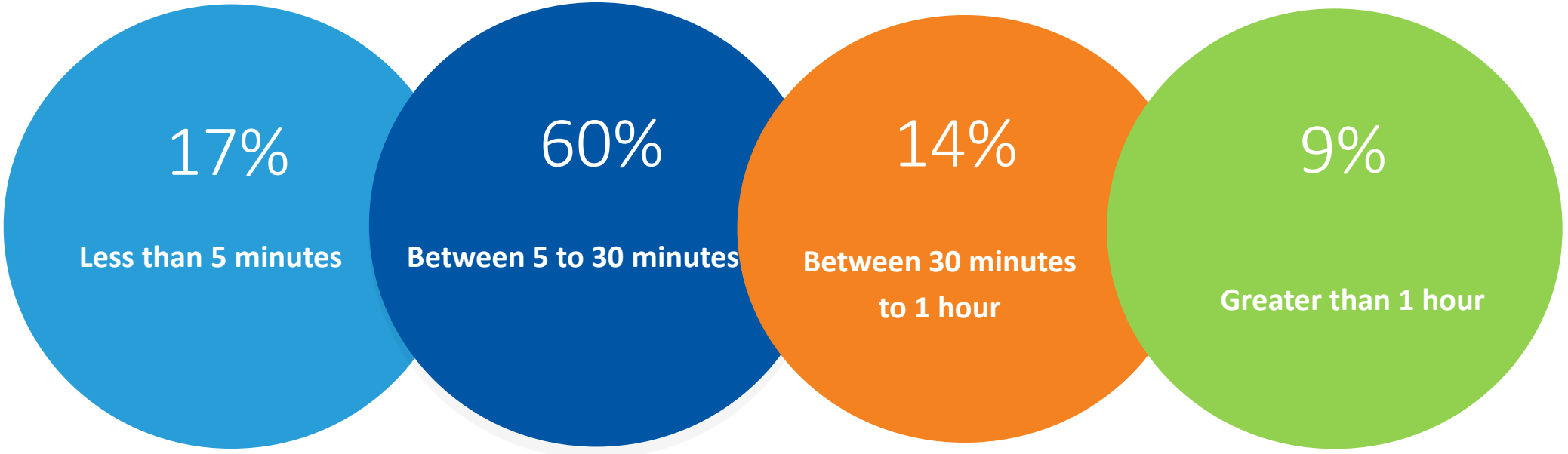


Note: Details of phase of flight are not available in some of the GNSS Interference Incident Reports

Analysis of GNSS Interference Incident Reports (contd.)

- Most events lasted between **5 to 30 minutes**, but some exceeded more than hour.
- Flights reported prolonged disruptions in **Black Sea & Mediterranean regions** & **South East Asian Regions**

Duration of GNSS Interference



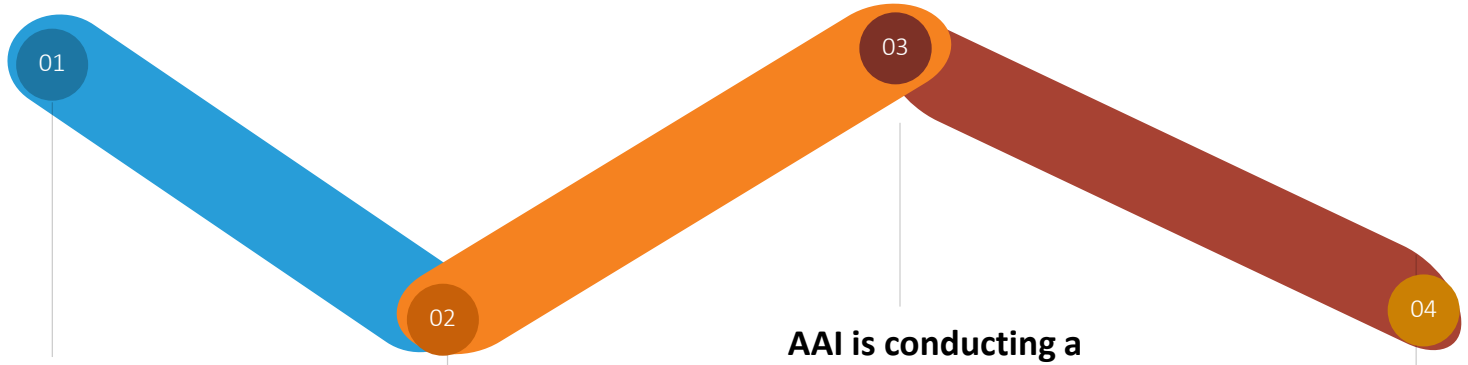
04

Steps taken to address GNSS RFI

GNSS Interference Awareness Workshop

Steps taken by India to address GNSS RFI

Acknowledging the critical impact of GNSS Radio Frequency Interference (RFI) on aviation safety, AAI has taken up a series of measures as detailed below:



GNSS Interference Awareness Workshop was organized on 14th February 2024 at the GAGAN Complex, Bengaluru, India to raise awareness among key aviation stakeholders.

Advisory caution NOTAM is in effect for areas in the vicinity of Amritsar since December 2023.

AAI is conducting a study to evaluate the impact of GNSS RFI on the rationalization and planning of conventional navigation and surveillance infrastructure.

Coordination with military authorities on activities potentially hazardous to civil aircrafts due to use of GNSS jammers.

Advisory Caution NOTAM

NOTAM

(G0266/25 NOTAMR G1426/24
Q) VIDF/QGAXX/I/BO/A/000/999/3142N07448E005
A) VIAR B) 2503101153 C) 2506102359
E) OBSERVATION OF EGPWS TERRAIN MAP SHIFT DUE TO SUSPECTED
DISTURBANCE OF GPS SIGNAL CAUSING TERRAIN WARNING HAS BEEN REPORTED
OCCASIONALLY IN VICINITY OF AMRITSAR AP. PILOTS TO EXER CTN AND TAKE
ALL MEASURES TO ENSURE SAFE AND EFFICIENT CONTINUATION OF NAV. IN
CASE OF NAVIGATIONAL DIFFICULTIES PILOTS TO NOTIFY ATC FOR
ASSISTANCE. FLIGHT CREW TO REPORT GNSS INTERFERENCE USING FORMAT
GIVEN IN PARA 10 OF ENR 4.3 IN EAIP INDIA TO THE REPORTING CHANNEL
GIVEN IN APPENDIX 3 OF DIRECTORATE GENERAL OF CIVIL AVIATION (DGCA)
ADVISORY CIRCULAR 01 OF 2023.)

Thank You

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Pilot reporting form in e-AIP India ENR 4.3 Para 10

GPS/GAGAN ANOMALY REPORTING FORM FOR USE BY PILOTS	
Originator of Report	
Organization	
Department	
Street address	
Zip-Code/city	
Name/surname	
Phone No	
E-Mail	
Date and time of report	
Description of Anomaly	
Affected GNSS element	[ ] GPS [ ] GAGAN
Aircraft type and registration	
Flight number	
Airway/route flown	
Coordinates of the first point of occurrence/time (UTC in dd/mm/yyyy@ hh:mm:ss)	UTC: ___ Lat: ___ Long: ___
Coordinates of the last point of occurrence/time (UTC in dd/mm/ yyyy@ hh:mm:ss)	UTC: ___ Lat: ___ Long:
Flight level or alti-tude at which it was detected	

Degradation of GNSS Performance	[ ] Large position errors (details): [ ] Loss of integrity (RAIM warning/alert) [ ] Complete outage [ ] Loss of satellites in view (details): [ ] Lateral indicated performance level changed from ___ to ___ [ ] Vertical indicated performance level changed from ___ to ___ [ ] Indicated dilution of precision changed from ___ to ___ [ ] information on PRN of affected satellites (if applicable) [ ] Low signal-to-noise (density) ratio [ ] GPS 1 Invalid/GPS 2 Invalid [ ] Degraded PBN capability [ ] Switching to an alternate navigation mode (such as IRS updating or DME/DME) [ ]Observation of a "map shift" on navigation display [ ] Enhanced ground proximity warning alerts [ ] Sustained loss of automatic dependent surveillance (ADS) reporting capabilities [ ] Loss of GNSS-based landing capability. [ ] Any other error (details):
Problem Duration	[ ] Continuous [ ] Intermittent

BACK

General Reporting Format DGCA-India Advisory Circular

Reporting Format GNSS Interference Occurrence

Originator of Report	
Report Filed by	[] Aircraft Operator [] Flight Crew [] Air Navigation Service Provider [] Air traffic Controller [] Any other
Date and Time of Report (dd/mm/yyyy) and UTC	
Aircraft Operator Details	
Name	
Email address	
Flight Details	
Call sign of Aircraft (Flight No.)	
Flight Sector	
Airway/ Route of occurrence	
FIR code	
Flight Level or Altitude during event	
Phase of flight	
Aircraft Type	
Aircraft Registration	
ATS Details	
Location of ATS Station (Location identifier)	
Surveillance Systems details	
Affected airspace Details	
Event Details	
Affected GNSS Element	[] GPS [] GLONASS [] GAGAN [] Any other. Pls Specify:
Coordinates of the first point of occurrence / Time (UTC):	UTC: Lat: Long:
Coordinates of the last point of occurrence / Time (UTC):	UTC: Lat: Long:
Duration of Observed Interference/outage:	

Impact Details	
List of impacted systems:	
Observation of a "time shift" on clock (details of shift and recovery, if any)	
Observation of a "map shift" on navigation display (details of shift and recovery, if any)	
Enhanced ground proximity warning alerts:	
Degraded EPU (Estimated Position Uncertainity)/ Estimated Position Error	
Loss of automatic dependent surveillance (ADS) reporting capabilities (ADS-B out, ADSB-in, ADS-C) (details)	
Loss of GNSS-based landing capability.	
Large position errors (details):	
Loss of integrity (RAIM warning/alert):	
Complete outage (Both receivers):	
Loss of GPS1 or Loss of GPS 2	
Loss of satellites in view/details:	
Lateral indicated performance level change	From: To:
Vertical indicated performance level change	From: To:
Indicated Dilution of Precision changed	From: To:
information on PRN of affected satellites (if applicable)	
Low Signal-to-Noise (Density) ratio:	
Degraded PBN capability	
Switching to an alternate navigation mode (such as IRS updating or DME/DME)	
Any other observed impact:	
Automatic GNSS Systems Recovery (y/n)	
Other	
Any other relevant details:	

Note: All available details should be provided. Separate sheet may be attached for additional information/pictures, etc, if any.

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