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GPS SPOOFING

DOCUMENT	FOD/GPS SPOOFING/01
EDITION	01
REVISION	00
ISSUE DATE	15th Jan 2025

TECHNICAL OPERATIONS DIVISION FLIGHT OPERATIONS DEPARTMENT

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EFFECTIVE DATE	15th Jan 2025		

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MAIN TABLE OF CONTENTS	
CHAPTER #	**CHAPTER**
00	PRELIMINARY PAGES
01	GPS Signal Interference

LIST OF EFFECTIVE PAGES

CHPTER No	Topic	Date	Page No.
Chapter 00	Title Page	15th Jan 2025	1
	Intentionally Left Blank	15th Jan 2025	2
	Approval	15th Jan 2025	3
	Intentionally Left Blank	15th Jan 2025	4
	Main Table of Contents	15th Jan 2025	5
	List Of Effective Pages	15th Jan 2025	6
Chapter 01	GPS Signal Interference on B777	15th Jan 2025	7
	Categories of interference	15th Jan 2025	8
	Effects of GPS Interference on FMC	15th Jan 2025	9
	Effects of GPS Interference on 'GPWS Look Ahead Terrain'	15th Jan 2025	10
	Recommended Crew Mitiga-tion for GPS Interference	15th Jan 2025	11
	Evaluate the FMC update status	15th Jan 2025	12
	Departure/Arrival Airports & GPS Interference	15th Jan 2025	13
	Destination Airport affected by GPS signal interference	15th Jan 2025	14

GPS SIGNAL INTERFERENCE ON B777

This document contains following topics:

1- Background Information
2- Categories of interference
3- Potential Flight Deck Effects & Awareness
   a. Effects of GPS Interference on FMC
   b. Effects of GPS Interference on 'GPWS Look Ahead Terrain'
   c. Effects of GPS Interference on ADS-B
   d. Effects of GPS Interference on Time/Clock

4- Recommended Crew Mitigation for GPS Interference
   a. Evaluate the status of the MMRs
   b. Evaluate the FMC update status
   c. MMR RESET PROCEDURE
5- Departure/Arrival Airports & GPS Interference
   a. Departure Airport affected by GPS signal interference
   b. Destination Airport affected by GPS signal interference

Background Information

Reports of GPS RFI– Radio Frequency Interference - jamming and spoofing are increasing. These occurrences are currently concentrated in specific regions; however, they can occur worldwide. Interference with GPS signals can have an effect on multiple systems on the 777. This information aims to identify and provide guidance to operators and flight crew for mitigating these effects.

GPS uses signals from satellites to determine an accurate position. GPS data is used in many
Functions on the 777, including:

- Flight Management Computer (FMC)
- GPWS Look-Ahead Terrain

- ADS-B
- Time/clock

Occurrences of GPS interference can result in missing or erroneous information. This interference comes from many sources, including portable devices, GPS jammers, and GPS repeaters.

NOTE: Flight control systems and functions are not affected by GPS interference.

Categories of interference

Intentional interference includes jamming and spoofing. Occurrences can be due to:

- Geopolitical conflict
- Protection of sensitive areas or personnel such as military, government sites, or VIP movements.
- Personal privacy devises

Jamming causes a loss of measurement and therefore a degradation of the position/ velocity/ time (PVT) solution.

Spoofing is a fake signal that causes the receiver to output misleading data, such as an incorrect position or time.

Potential Flight Deck Effects-FDEs &Awareness

There are several potential FDEs possible with GPS interference. The following list contains examples and is not an exhaustive list. Some effects have aural or visual alerts, others do not:

Effects of GPS Interference on FMC:

Jamming causes an increase in ANP which impacts navigation capability. Enabling radio updating when there are sufficient radio navigation facilities will help maintain a lower ANP. For certain Multi Mode Receiver (MMR), loss of GPS signal or GPS signal jamming for a period in excess of 12 minutes can result in one or more of these EICAS messages:

- GPS
- GPS L
- GPS R
- RUNWAY SYS
- GND PROX SYS
- TERR POS

The GPS spoofing effects on FMC in following manner:

- Inaccurate GPS position input to the FMC in the air or on the ground.
- An FMC generated flight path can be affected, such as LNAV or VNAV.
- During spoofing, the shown ANP value may momentarily change to a much higher value, then it returns to the actual value. On the ground if spoofing is encountered while the FMC is powering up, although the system may show a small ANP, the position can be inaccurate and it may not match the gate or stand location. Comparing the FMC position with the actual location of the gate or stand location will reveal if the FMC position is corrupted.
- NAV UNABLE RNP advisory message can show if ANP exceeds RNP. This alert must be considered valid.
- The two GPS receivers may be affected differently due to spoofing. This may result in FMC alerting message VERIFY POSITION when the primary and secondary FMCs use independent navigation sources and the two FMC position difference becomes greater than the current RNP value and greater than 0.4 nm.
- FMC fuel predictions can be inaccurate.

Effects of GPS Interference on 'GPWS Look Ahead Terrain':

Jamming causes a loss of GPS position data. When the GPS signal is no longer available, the GPWS uses IRS data as a backup and the TERR POS message shows on EICAS and on the ND. When the IRS horizontal position uncertainty exceeds limits, the terrain is removed from the ND. TERR FAIL shows on the ND, and look ahead alerting does not function.

The GPS spoofing effects on 'GPWS look ahead Terrain' in following manner:

- False GPWS Look Ahead Terrain alerts can occur. A complete list of these is in the FCOM Chapter 15.
- Terrain warnings can occur at any altitude.
- Terrain display on ND can be inaccurate.
- For a GPWS Look Ahead Terrain warning at a cruise altitude that is clearly above the highest known actual terrain in the area, pilot discretion can be used in determining the alert, including persistent alerts, to be false.
- The basic GPWS is still operational. Basic GPWS Alerts are valid.
- GPWS Look Ahead Terrain can be disabled. Refer to FCOM Chapter 15 Warning Systems.

Effects of GPS Interference on ADS-B:

- Jamming causes a loss of ADS-B capability. Coordination with ATC is necessary.
- Erroneous position data to ADS-B.
- If an ADS-B advisory message shows, it must be considered valid.
- All TCAS alerts must be considered valid.

Effects of GPS Interference on Time/Clock:

- Jamming can result in the loss of GPS time source.
- Inaccurate time and date information.
- FMC ETA and RTA function can be affected.

Recommended Crew Mitigation for GPS Interference

Do the following steps if any effects of GPS signal interference occur and operating above minimum safe altitude:

Ground proximity (GND PROX) Terrain Override (TERR OVRD) Switch……OVRD WARNING: Ground proximity alerts that occur are valid.

NOTE: If descending below minimum safe altitude set the ground proximity (GND PROX) Terrain (TERR) Override (OVRD) Switch to NORM

Do the following steps if any GPS signal interference has occurred and the aircraft is no longer in the area of suspected GPS signal interference:

(GND PROX) (TERR OVRD) Switch……. Normal (OVRD not visible)

Evaluate the status of the MMRs:

A- Check if the calculated position of both MMRs has recovered.

B- MMR L and MM R calculated positions (both) have recovered if both of the following are true:
- **GPS L and GPS R calculated position are displayed on POS REF 3/3 and**
- **GPS L, GPS R, or GPS EICAS messages not shown.**

C- If either MMR L, MMR R, or both MMRs have not recovered, complete the MMR RESETPROCEDURE (step given below) for the effected MMRs.

D- If both MMR have recovered, go to the **"Evaluate if FMC update status is GPS"** (step given below).

NOTE: To identify the affected MMR, check on POS REF 3/3 page if GPS L or GPS R is blank. (A blank GPS requires a reset)

WARNING: Non recovered MMRs may cause erroneous EGPWS alerts. If any erroneous EGPWS alert occurs outside the area of suspected GPS interference, or the Terrain display is obviously incorrect or corrupted, reset either MMR.

Evaluate the FMC update status:

Evaluate if the FMC update status is GPS - an MMR is providing a GPS update to the
FMC:

A- FMC update status is GPS if the either of the following are true:
- FMC position update status shows "GPS" on ND
- FMC position update source shows "GPS" on POS REF 2/3 page

B- If the FMC update status is not GPS, complete the "MMR RESET PROCEDURE" (step given below)for either MMR.

MMR RESET PROCEDURE:

NOTE: Resetting of a tripped circuit breaker is not recommended (a tripped circuit breaker is one that is open without crew action due to an electrical overload situation).

WARNING: Only reset MMRs individually (one at a time), as required.

MMR L or R Circuit Breaker (as required) ……Pull

Some or all of the following EICAS messages may show:
- ADS-B OUT L or ADS-B OUT R
- GPS L, GPS R, or GPS
- NO LAND 3
- SINGLE SOURCE ILS GND PROX SYS

Wait for 15 seconds.

MMR L or R Circuit Breaker (respective side) ……Push

NOTE: The MMR may take up to 10 minutes to fully reset.
If both MMRs have recovered, FMC update status is GPS, and System Date is correct, continue with normal operations.

NOTE: A Tech Log entry must be made for GPS signal interference.

NOTE: If a MMR was reset inflight, a specific Tech Log entry must be made that includes the text: MMR (L and/or R) was reset inflight.

Departure/Arrival Airports & GPS Interference

This procedure provides guidance for situations where GPS signal interference may lead to erroneous ground proximity warnings and alerts for look-ahead obstacles and terrain peaks.

TERR OVRD switch to OVRD will inhibit look ahead alerts (enhanced modes).

NOTE: All basic GPWS modes continue to function during GPS signal interference. If an alert occurs, it is valid.

Departure Airport affected by GPS signal interference

1. POS INIT page: Enter the present position on the SET INERTIAL POS line by
   using the parking stand coordinates only.
2. GRD PROX-TERR override switch…OVRD (GRD proximity alerts that occur
   are valid).
3. Inhibit GPS.
4. Enable radio updating.
5. SID requires GNSS for departure. ATC must be informed about the GPS Un-serviceability.

At top of climb and when out of the area of GPS signal interference.

1. GRD PROX-TERR override switch…normal (normal not visible)
2. Enable GPS.
3. Inhibit radio updating.

Destination Airport affected by GPS signal interference

NOTE: RNP approaches are not authorized

Prior to Top Descent:

1. (GRD PROX) (TERR) override OVRD switch…OVRD.
2. Inhibit GPS.
3. Enable radio updating.

NOTE: For all ILS approaches, manually select RNP 1 on progress page 4.