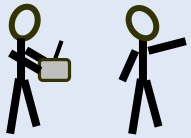
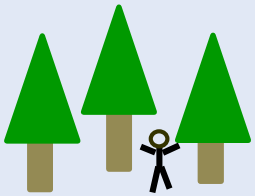




GPS Interference Testing

FEMA Government Sector UAS Working Group
Friday, 13 November 2020

Curt D. Johnson, Technical Writer, Safety Warden, & Remote Pilot

North Carolina Emergency Management

What should you do if you need to conduct a UAV mission in a GPS Interference Testing area?

1. Look for GPS Interference Testing NOTAMs before each mission.
2. If there is GPS testing anywhere near your area, then plot it on Google Earth.
3. **If your mission is within the affected airspace, then do not conduct it.**
   a. You could cause a far more worse problem with a flyaway in comparison to whatever you are trying to accomplish.
   b. Treat GPS interference testing like a limiting factor, such as the visibility requirement (if visibility is <3 miles, then can't fly).
4. **If your UAV loses GPS or receives inaccurate GPS, it could:**
   a. Record an inaccurate home point.
   b. Be extremely difficult to handle
   c. Not accurately plot where it is on your control station's moving map
   d. If you are operating near a No Fly Zone (e.g. a prison), your UAV might mistakenly think that it has encountered that zone
   e. Not be able to conduct a photogrammetry/mapping mission

BACKGROUND: GPS Interference Testing

"Operational Impacts of Intentional GPS Interference" by the Tactical Operations Committee (TOC) of the Radio Technical Committee for Aeronautics (RTCA)

- **NOTE:** This report only covered the impact of GPS interference on commercial and general aviation. It did **not** cover the impact of GPS interference testing on **unmanned aircraft**. Nevertheless, we can still learn from it. The authors were aware that unmanned aerial vehicles (UAVs) rely on GPS and were concerned that:
  - UAV operators are probably not taking into account GPS interference in their future strategies and business plans
  - The FAA may not fully grasp how critical GPS is to UAVs for such abilities as geofencing, navigation, lost-link/return to station functions, and [**photogrammetry**].

  Thus, the task group recommended, "*The FAA should engage with these users to conduct outreach and education, and to determine other necessary mitigations.*"

BACKGROUND: GPS Interference Testing

"Operational Impacts of Intentional GPS Interference" by the Tactical Operations Committee (TOC) of the Radio Technical Committee for Aeronautics (RTCA)

- **Why?:** *"The [Department of Defense] DoD is mandated by Title 10, Section 2281, to provide a GPS system that is reliable and available for civil use. The DoD is also required by National Security Presidential Directive 39 to train and test U.S. military forces and national security capabilities in operationally realistic conditions that include denial of GPS. Intentional GPS interference, also referred to as jamming or testing, is carried out by the DoD in support of their directive."*:
  - Conducted *"in coordination with military exercises, system testing, and research and design of new systems."*
  - *"conducted to ensure weapons systems can operate in a GPS degraded environment as GPS is inherently vulnerable due to its low signal power. Military aircraft must be able to navigate and their weapons operate in a degraded environment which can only be replicated in a realistic environment that includes purposeful denial of the signal."*

https://www.rtca.org/sites/default/files/intentional_gps_interference_approved.pdf

https://www.gps.gov/policy/legislation/uscode/#:~:text=Title%2010%20of%20the%20U.S.,free%20of%20direct%20user%20fees.

https://fas.org/irp/offdocs/nspd/nspd-39.htm

BACKGROUND: GPS Interference Testing

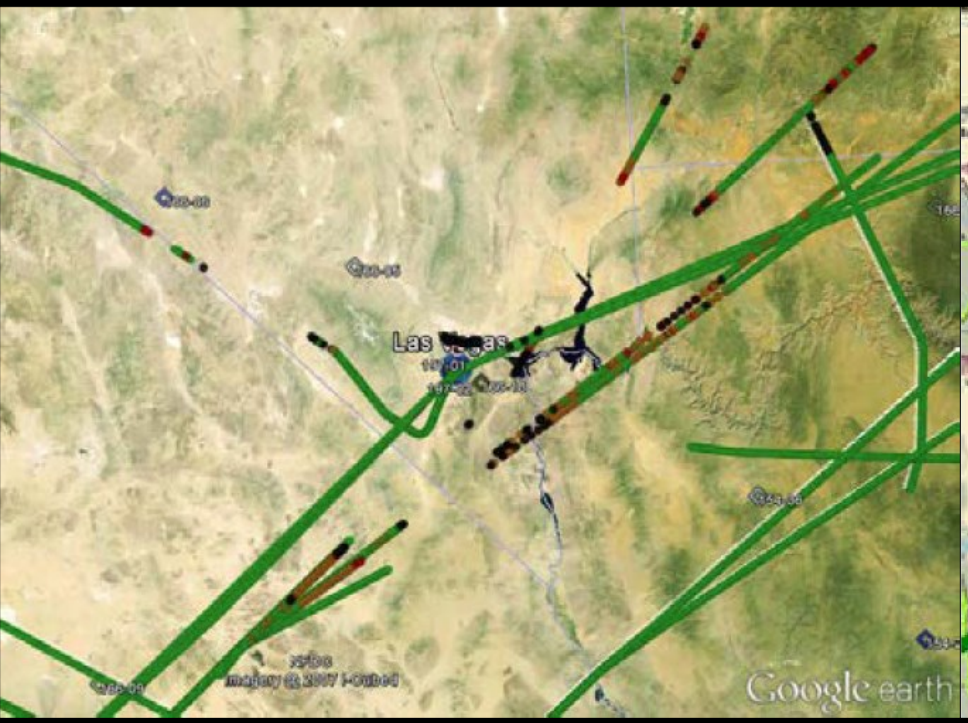
"Operational Impacts of Intentional GPS Interference" by the Tactical Operations Committee (TOC) of the Radio Technical Committee for Aeronautics (RTCA)

- **What?:** **"***The GPS interference that the DoD conducts intentionally degrades or denies the GPS signal for training and testing. Interference can also result in the loss of GPS as a reliable position source for navigation or surveillance by all civil users.***":**
  - *The effects may include complete loss of GPS navigation, position errors, loss of ADS-B* [Automatic Dependent Surveillance-Broadcast] *and/or impact to GPS-dependent systems such as TAWS* [Terrain Avoidance and Warning System]*, ELTs* [Emergency Locator Transmitter]*, etc."*
  - *The interference normally originates from a ground-based system but can also be produced from airborne platforms like a helicopter or airplane. Each event is unique as the location of the interference transmitter, surrounding terrain, and power output (wattage)…"*
  - The authors validated that GPS interference has impacted some operations by studying pilot reports, SBS data analysis, and the interference contours. "*It is clear that different aircraft, real-time conditions (e.g., environment, flight attitude, interference antenna orientation), and equipment combinations will cause variations in the degradation of GPS satellite tracking, which results in scenarios where one aircraft loses navigation and ADS-B capability and another aircraft flying at the same time and in the same area experiences no issues.*"

ADS-B tracking maps of aircraft traversing a GPS interference testing area color coded as follows:

- **Green:** Acceptable GPS reception
- **Not green to black:** Unacceptable GPS reception
- **No marker:** No GPS reading

Several aircraft's ADS-B tracking faded out and eventually lost GPS reception while other aircraft were not affected.



An aircraft's faded out ADS-B track that was shifted by 1.6 nautical miles (NM) (1.85 miles).

Images used with permission from the Radio Technical Committee for Aeronautics (RTCA)

Does GPS interference testing affect UAVs?

1. **Report Drone Accident: Pilot submitted UAS accident and incident reports to make flying safer.** (https://reportdroneaccident.com/)
   a. Very few of the submitters reported checking to determine if a nearby GPS Interference Testing was being conducted during the time of the accident.
   b. So, this will require comparing submitted entries with posted GPS Interference Testing, which I did not do for this presentation.
   c. 3DR Solo – Accident – 2017-06-22 report (https://reportdroneaccident.com/712/3dr-solo-accident-2017-06-22/) stated that GPS Interference Testing was being conducted in the area.

BACKGROUND: GPS Interference Testing

"Operational Impacts of Intentional GPS Interference" by the Tactical Operations Committee (TOC) of the Radio Technical Committee for Aeronautics (RTCA)

- **How are pilots warned?:** The FAA informs pilots of each GPS interference test in advance via a Notice to Airmen (NOTAM), which includes a center point (geographic coordinates as well as a distance and bearing from a NAVAID) and radius-defined concentric circles to circumscribe the affected airspace at set elevations:
  - 50 ft Above Ground Level (AGL)
  - 4,000 ft AGL
  - 10,000 ft Mean Sea Level (MSL)
  - Flight Level (FL) 250 [25,000 ft MSL]
  - FL400 (40,000 ft MSL) and up.

FEDERAL AVIATION ADMINISTRATION

FLIGHT ADVISORY
GPS INTERFERENCE TESTING

MARINE SPECIAL OPERATIONS COMMAND (MARSOC) 20-05

08 – 16 November 2020
Ivanhoe, NC

GPS testing is scheduled as follows and may result in unreliable or unavailable GPS signal.

A. Location: Centered at 343855N0781754W or the ILM VOR 317 degree radial at 28NM.
34˚ 38’ 55” N, 078˚ 17’ 54” W

B. Dates and times **(Dates and times are based on GMT (Z).):**

08 – 16 NOV 20 DLY 0000Z – 0600Z
7:00 pm EST – 1:00 am EST

317˚ magnetic radial = 310˚ True N bearing + 7˚ magnetic variation at the ILM VOR

If mag var is **westerly**, then True N bearing **+** Mag var
If mag var is **easterly**, then True N bearing **-** Mag var

Each VOR’s magnetic variation is posted:
https://www.airnav.com/navaids/

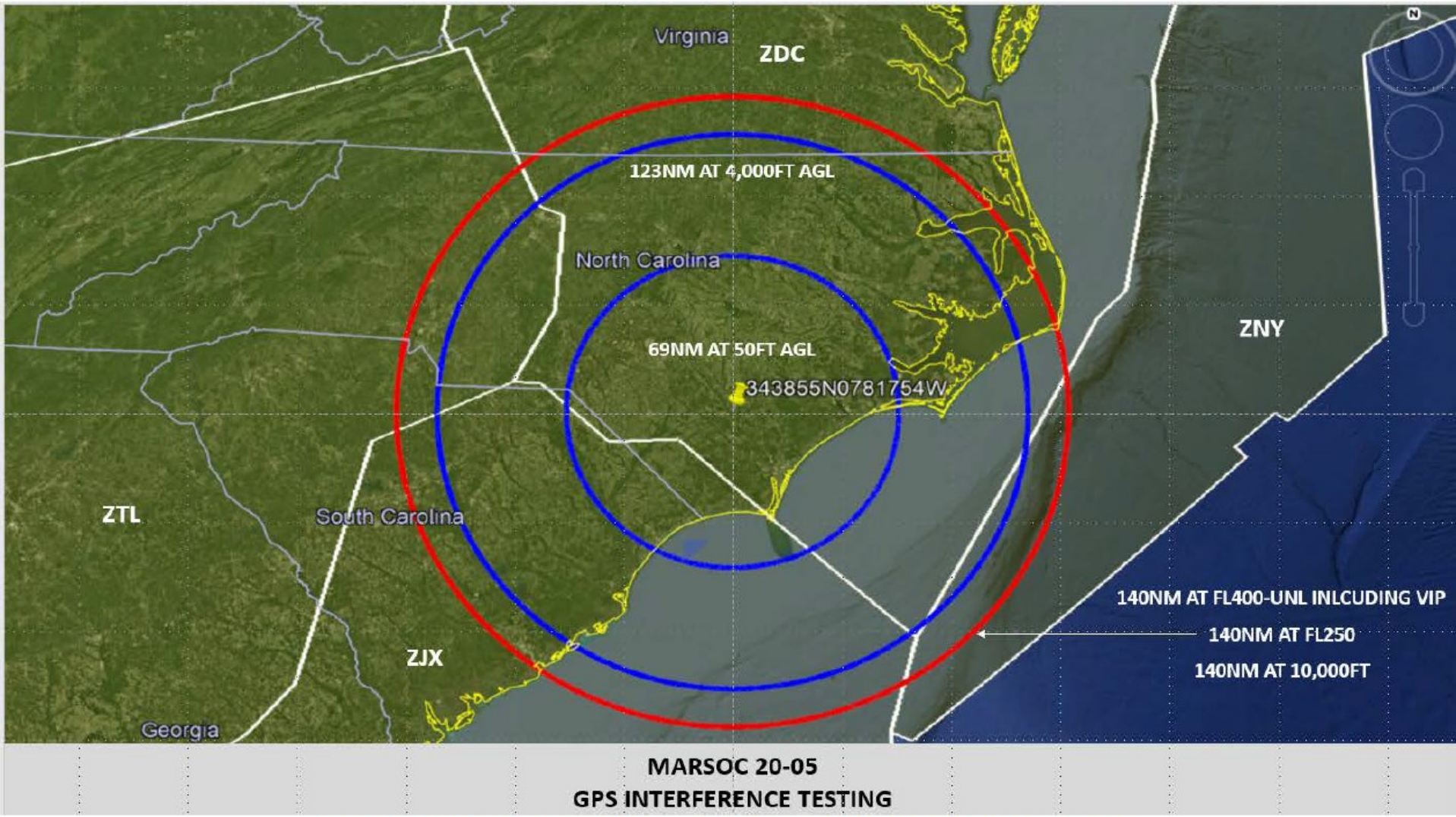
C. Duration: Each event may last the entire requested period.

There could be periods between 7 pm to 1 am when there is no GPS interference.

D. NOTAM INFO: NAV GPS (MARSOC GPS 20-05) (INCLUDING WAAS, GBAS, AND ADS-B) MAY NOT BE AVBL WI A 140NM RADIUS CENTERED AT 343855N0781754W (ILM317028) FL400-UNL,
140NM RADIUS AT FL250,
140NM RADIUS AT 10000FT,
123NM RADIUS AT 4000FT AGL,
69NM RADIUS AT 50FT AGL.

FAA GPS Anomaly Reporting Form
https://www.faa.gov/air_traffic/nas/gps_reports/

E. Pilots are encouraged to report anomalies in accordance with the Aeronautical Information Manual (AIM) paragraphs 1-1-13 and 5-3-3.



MARSOC 20-05 GPS INTERFERENCE TESTING

BACKGROUND: GPS Interference Testing

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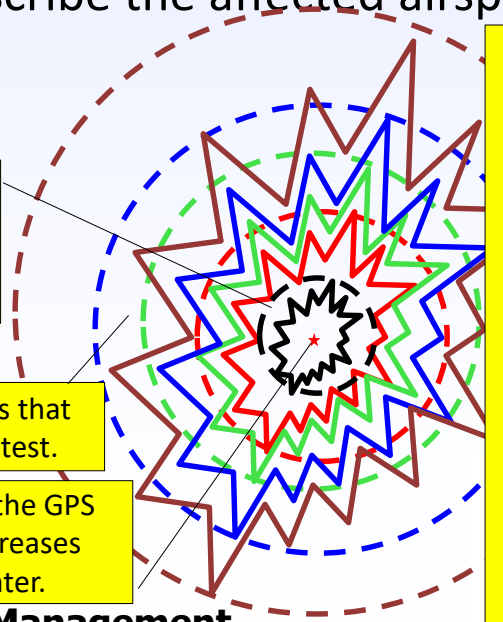
- **How are pilots warned?:** The FAA informs pilots of each GPS interference test in advance via a Notice to Airmen (NOTAM), which includes a center point (geographic coordinates as well as a distance and bearing from a NAVAID) and radius-defined concentric circles to circumscribe the affected airspace at set elevations:
  - 50 ft Above Ground Level (AGL)
  - 4,000 ft AGL
  - 10,000 ft MSL
  - Flight Level (FL) 250 [25,000 ft MSL]
  - FL400 (40,000 ft MSL) and up.

Interference contours or bug splats: show where aviation certified GPS receivers are **not** expected to experience GPS interference outside of the contour.

Each circle includes areas that are not impacted by the test.

The severity of the GPS interference increases towards the center.



Thus, there is a major difference in the degree of GPS interference encountered by aircraft within any NOTAM defined elevation circle between:

- Aircraft that cross an interference contour

~vs~

- Aircraft that cross outside of an interference contour

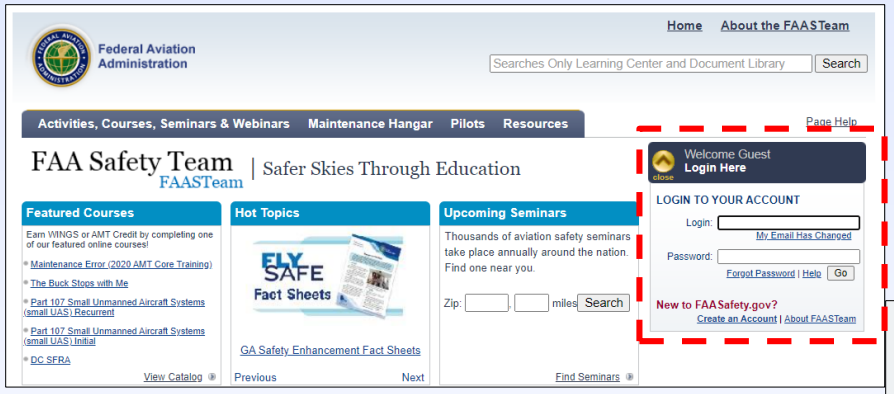
N★C DPS DEPARTMENT OF PUBLIC SAFETY

North Carolina Emergency Management

https://www.rtca.org/sites/default/files/intentional_gps_interference_approved.pdf

How to receive upcoming GPS Interference Testing NOTAMs by email

1. **FAA Safety Team** (https://www.faasafety.gov/default.aspx)

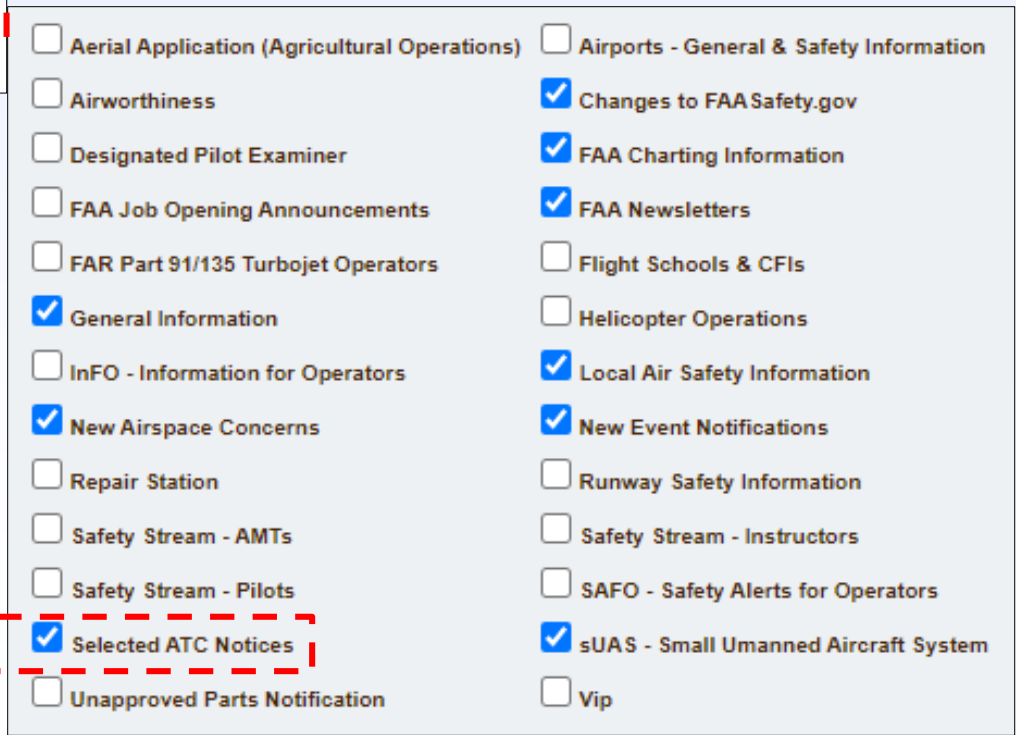


a. **Create an account**.

b. Select the "**My Preferences and Profile**" option.

   1). Select the "**Selected ATC Notices**" option.

   2). Press the **[Save]** button.



The FAA usually sends out the email notifications late Friday afternoon to evening for tests that will start on the following Sunday or Monday.

How to look up scheduled GPS Interference Testing

1. **NAVCEN Approved GPS TESTING**
   (https://www.navcen.uscg.gov/pdf/gps/gpsnotices/GPS_Interference.pdf)

APPROVED GPS TESTING (UPDATED NOVEMBER 12, 2020)

TEST PERIOD APPROVED BY DEPARTMENT OF DEFENSE, EXACT DATES AND TIMES OF TESTING, DURING APPROVED PERIOD, WILL BE DETERMINED BY TEST RANGE EVENT PLANNERS AND SUBJECT TO CHANGE.

Area	Range	Date(s)	BNM/LNM
YUMA, AZ YPG_AZ GPS 20-33	137 NM	12 NOVEMBER 2020 - 20 NOVEMBER 2020	NO
WILMINGTON, NC MARSOC GPS 20-04	69 NM	11 OCTOBER 2020 - 16 NOVEMBER 2020	YES
CAMP SHELBY, MS MARSOC GPS 20-03	52 NM	08 NOVEMBER 2020 - 16 NOVEMBER 2020	YES
WILMINGTON, NC MARSOC GPS 20-05	69 NM	08 NOVEMBER 2020 - 16 NOVEMBER 2020	YES
WHITE SANDS MISSILE RANGE, NM WSMRNM GPS 20-29	160 NM	05 NOVEMBER 2020 - 20 NOVEMBER 2020	NO
FT. POLK, LA FTPKLA GPS 20-62	84 NM	12 NOVEMBER 2020 - 20 NOVEMBER 2020	YES
YUMA, AZ YPG_AZ GPS 20-33	137 NM	12 NOVEMBER 2020 - 20 NOVEMBER 2020	NO

How to look up GPS Interference Testing NOTAMs

1. **FAA Public Notices** (https://www.faasafety.gov/SPANS/notices_public.aspx)

   NOTE: The FAA no longer post **past** GPS Interference Testing NOTAMs on the opening retrieval page.

   But, you can search for past GPS Interference Tests by entering "GPS Interference Testing" followed by the testing location (e.g. Fort Bragg) and year or month (e.g. 2019) on the webpage's Search engine. Unfortunately, the retrieved NOTAMs do not display the date and include NOTAMs for sites and dates that were not requested.

How to look up GPS Interference Testing that is occurring in North Carolina

1. **NC Geodetic Survey** (https://ncgs.state.nc.us/)

Geodetic News

FAA issues notice of GPS interference testing

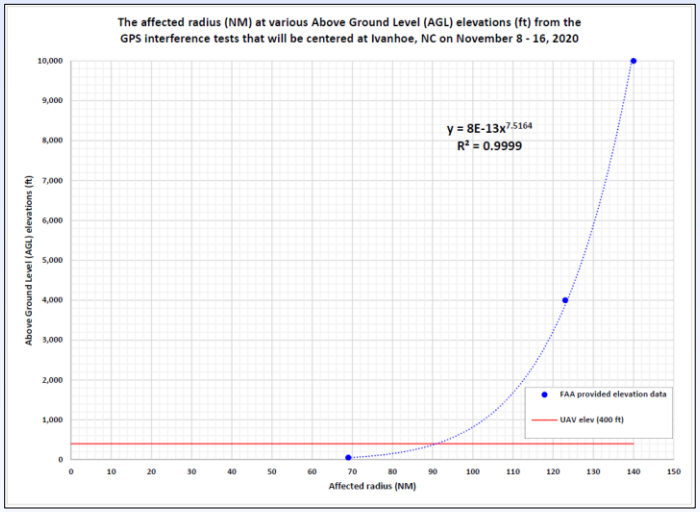
Monday, November 9, 2020

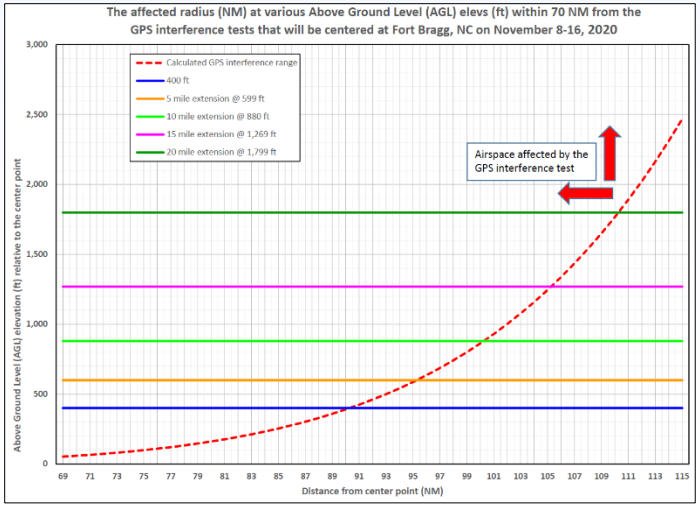
The Federal Aviation Administration (FAA) has issued the following notice of GPS interference testing that may result in unreliable or unavailable GPS signal:

FLIGHT ADVISORY: GPS Interference Testing
MARINE SPECIAL OPERATIONS COMMAND (MARSOC) 20-05
08 – 16 November 2020 / Ivanhoe, NC

This test will be centered at 34.648611°, -78.298333° and extend outward and upward like a bowl affecting the GPS signal 69 Nautical miles (NM) away at 50 ft Above Ground Elevation (AGL) relative to the center point's (CP's) ground elevation (~80 ft mean sea level or MSL), 123 NM away at 4,000 ft AGL, and so on. These tests will be conducted daily 0000 Z - 0600 Z (7:00 pm EST – 1:00 am EST) November 8-16 with the following caveat: "Each event may last the entire requested period."

The FAA does not provide an affected radius figure of interest to remote pilots for 400 ft AGL. Based on the notice's data, NCGS estimates this radius to be 90 NM. Since this radius is relative to the CP's ground elevation, the radius needs to be extended by 5 NM for UAV operations at higher ground elevations where the combined ground elevation difference (remote site elevation – CP elevation) + UAV flight elevation approaches or exceeds 600 ft, 10 NM for 880 ft, 15 NM for 1,270 ft, and 20 NM for 1,800 ft. NCGS recommends adding a wide buffer (>10 NM) to any radius figure for operations near 400 ft AGL.





What should you do if you need to conduct a UAV mission in a GPS Interference Testing area?

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