



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Savannah DGPS Site (818)
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Date: 08MAR13

REFERENCES:

- (1) DGPS Concept of Operations, COMDTINST 16577.2 (AUG 1995)
- (2) 2010 Federal Radio Navigation Plan
- (3) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
- (4) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

PURPOSE:

- Validate advertised DGPS coverage of the Savannah DGPS site.
- Validate required RTCM message scheduling and delivery.
- Test differential correction accuracy versus a predetermined survey monument.

EQUIPMENT:

DNAV 212 Receiver
Raven INVICTA Receiver
MBA-2 Receive Antenna
Trimble SPS461 Receiver
Trimble GA 530 Antenna
Potomac Instruments 4100 FIM meter

SAVANNAH DGPS SITE PARAMETERS:

| | |
|----------------------|--|
| Frequency | 319 KHz |
| Forward Output Power | 900 W |
| Transmission Rate | 100 baud |
| Field Strength/Range | 75 μ V/m (37.5 dB μ V/m) at 298 km |

RESULTS:

Signal Strength:

A verification of the Savannah DGPS coverage area was conducted from Myrtle Beach, SC, along the coast to Savannah, GA; northwest to Macon GA along Hwy 16; through Savannah, GA, to Canaveral Groves, FL. The advertised signal strength range is 298 km. Figure 1 below displays inadequate signal strength in a small northeast coastal section of the coverage area with signal strength well above adequate throughout the rest and extending well south of predicted coverage area. Green points represent areas of satisfactory signal strength. Areas of

unsatisfactory signal strength are represented with red points. Far-field (FF) signal strength readings were taken at the northern and southern points of the advertised range from both transmitter sides of the site. Table 1 shows that the North FF reading was not within the required 37.5 dB μ V/m. OA team took multiple readings within the area with negative results. Table 2 shows that the South FF reading was well above the required signal strength of 37.5 dB μ V/m.



Figure 1: DNAV Signal Strength Results

| | POSITION | Trimble SPS461 | 4100 FIM Meter |
|-----------|-----------------------------------|---------------------------|-------------------|
| Side A SS | 33° 34' 37.9"N 079° 01' 35.7"W | 31.5 dB μ V/m, 12 SNR | 31.5 dB μ V/m |
| Side B SS | 33° 34' 37.9"N 079° 01' 35.7"W | 32.0 dB μ V/m, 12 SNR | 32.0 dB μ V/m |

Table 1: North Far-Field Signal Strength Reading

| | POSITION | Trimble SPS461 | 4100 FIM Meter |
|-----------|-----------------------------------|---------------------------|-------------------|
| Side A SS | 29° 28' 50.5"N 081° 07' 37.7"W | 49.2 dB μ V/m, 26 SNR | 49.2 dB μ V/m |
| Side B SS | 29° 28' 50.8"N 081° 07' 37.7"W | 49.6 dB μ V/m, 28 SNR | 49.6 dB μ V/m |

Table 2: South Far-Field Signal Strength Reading

RTCM Message Verification:

RTCM message scheduling, receipt, and content were checked during the assessment (Table 3 and 4). RTCM message scheduling on both Side A and Side B was coordinated with the DGPS watch and is in accordance with the Reference (3). Receipt of all RTCM messages was validated utilizing a Raven INVICTA receiver, whereby the assessment team witnessed the on-time receipt of all messages. All message content was verified and is in accordance with Reference (4).

| Message Type | Received | Scheduled | Content Verified/Accurate |
|---|-----------------|------------------|----------------------------------|
| <i>Type 3</i> | Y | Y | Y |
| <i>Type 5 (ensure message is not being transmitted)</i> | N | N | N/A |
| <i>Type 7</i> | Y | Y | Y |
| <i>Type 9</i> | Y | Y | Y |
| <i>Type 16</i> | Y | Y | Y |

Table 3: Side A RTCM Message Validation

| Message Type | Received | Scheduled | Content Verified/Accurate |
|---|-----------------|------------------|----------------------------------|
| <i>Type 3</i> | Y | Y | Y |
| <i>Type 5 (ensure message is not being transmitted)</i> | N | N | N/A |
| <i>Type 7</i> | Y | Y | Y |
| <i>Type 9</i> | Y | Y | Y |
| <i>Type 16</i> | Y | Y | Y |

Table 4: Side B RTCM Message Validation

Accuracy Validation:

Positional data was collected for 10 minutes per side using the Trimble SPS461. The data was then post processed and compared to a National Geodetic Survey (NGS) marker to verify the horizontal accuracy of the broadcast correction (Table 5 and 6). Side A was 0.4612 meters, bearing 161.841667, away from the monument while Side B was 0.4515 meters, bearing 161.841667, away from the monument. As per Reference (1) and (2), both respective distances were well within advertised accuracy requirements. A comparison between the GPS satellites in view at the Savannah DGPS site and at the NGS monument location was conducted (Table 7) to identify any differences in the GPS satellite geometry used at the respective locations; any differences in geometry could lead to accuracy discrepancies. In this case, the satellites being tracked by the RS and IM GPS receivers at the site were almost identical to those tracked at the NGS monument location. A two dimension radial review of the same time period was completed for the integrity monitors. Side A's average deviation was 0.08356 meters; Side B's average deviation was 0.12821 meters. Both findings were consistent with the findings observed in the field and are well within system parameters. Furthermore, a comparison between the uncorrected GPS position and the NGS Monument was conducted to see how effective the DGPS corrections were.

| | |
|-------------------------|---------------------|
| NGS Monument ID: | BBCD02 |
| Monument LAT: | 31° 3' 28.04512" N |
| Monument LON: | 81° 25' 23.35994" W |

| | |
|--|-----------------------|
| Averaged LAT: | 31 ° 03' 28.030932"N |
| Averaged LON: | 081° 25' 23.354508" W |
| Distance from DGPS Site: | 123.4 km |
| Antenna Distance from Monument: | 0.4612m (1.464236 ft) |
| Antenna Bearing from Monument: | 161.841667° |

Table 5: Side A Accuracy Check Results

| | |
|---------------------------------|------------------------|
| Averaged LAT: | 31° 03' 28.032012" N |
| Averaged LON: | 81° 25' 23.352384" W |
| Distance from DGPS Site: | 123.4 km |
| Distance from Monument: | 0.4434 m (1.454722 ft) |
| Bearing from Monument: | 161.841667° |

Table 6: Side B Accuracy Check Results

| <i>Antenna Location</i> | <i>GPS Satellites Tracked (PRN)</i> | | | | | | | | | | |
|-------------------------------|-------------------------------------|----|----|----|----|----|----|----|----|----|--|
| Reference Station A | 3 | 6 | 14 | 16 | 20 | 23 | 29 | 30 | 31 | 32 | |
| Integrity Monitor A | 6 | 14 | 16 | 20 | 23 | 29 | 30 | 31 | 32 | | |
| Reference Station B | 3 | 6 | 14 | 16 | 20 | 23 | 29 | 30 | 31 | 32 | |
| Integrity Monitor B | 6 | 14 | 16 | 20 | 23 | 29 | 30 | 31 | 32 | | |
| NGS Monument Location, Side A | 3 | 6 | 14 | 16 | 20 | 23 | 30 | 31 | 32 | | |
| NGS Monument Location, Side B | 3 | 6 | 16 | 20 | 23 | 30 | 31 | 32 | | | |

Table 7: GPS Satellite Comparison

SUMMARY:

The Operational Assessment of the Savannah DGPS site revealed that the provided coverage is not consistent with the predicted coverage plot and advertised range. The Southern Far-Field Signal strength reading exceeded the predicted coverage area within the advertised range. The Northern Far-Field signal strength readings did not meet the required signal strength in the predicted coverage area within the advertised range. A review of the output/reflected power and near-field signal strength levels was conducted and found to be satisfactory. All RTCM messages were verified and evaluated and are consistent with the requirements set forth by reference (2) and (3). Finally, accuracy measurements and analysis proved that at a distance of approximately 123.4 km SE from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy requirements set forth by Reference (1) and (2).