



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site:	Isabela DGPS Site (817)
Inspector(s):	LCDR Guillermo Vega, LT Michael Brashier
Date:	05-09 Aug 2013

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 Isabela DGPS site.
- Validate required RTCM message scheduling and delivery.
- Test differential correction accuracy versus a predetermined survey monument.

EQUIPMENT:

Trimble SPS461 Receiver
Trimble GA 530 Antenna

ISABELA DGPS SITE PARAMETERS:

Frequency	295 KHz
Forward Output Power	900 W
Transmission Rate	100 baud
Field Strength/Range	75 μ V/m at 125 km

RESULTS:

Signal Strength:

NAVCEN conducted a verification of the Isabela DGPS coverage area by circumnavigating the main island of Puerto Rico via highway and also the waters off the southeastern shore via Coast Guard small boat. Figure 1 below illustrates adequate signal strength throughout most of the advertised coverage area. There is an area of low signal strength inside the southeast range ring. Analysis revealed low signal strength beyond the southeast range ring. This area, while outside the advertised range, is predicted to have adequate coverage by NAVCEN's COAST coverage prediction software. Green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points. The advertised signal strength range is 125 km. Far-field (FF) signal strength readings were taken at the north east and

southeast points of the advertised range, 125 km away (Table 1). The FF readings were above the required 37.5 dB μ V/m signal strength on both sides.

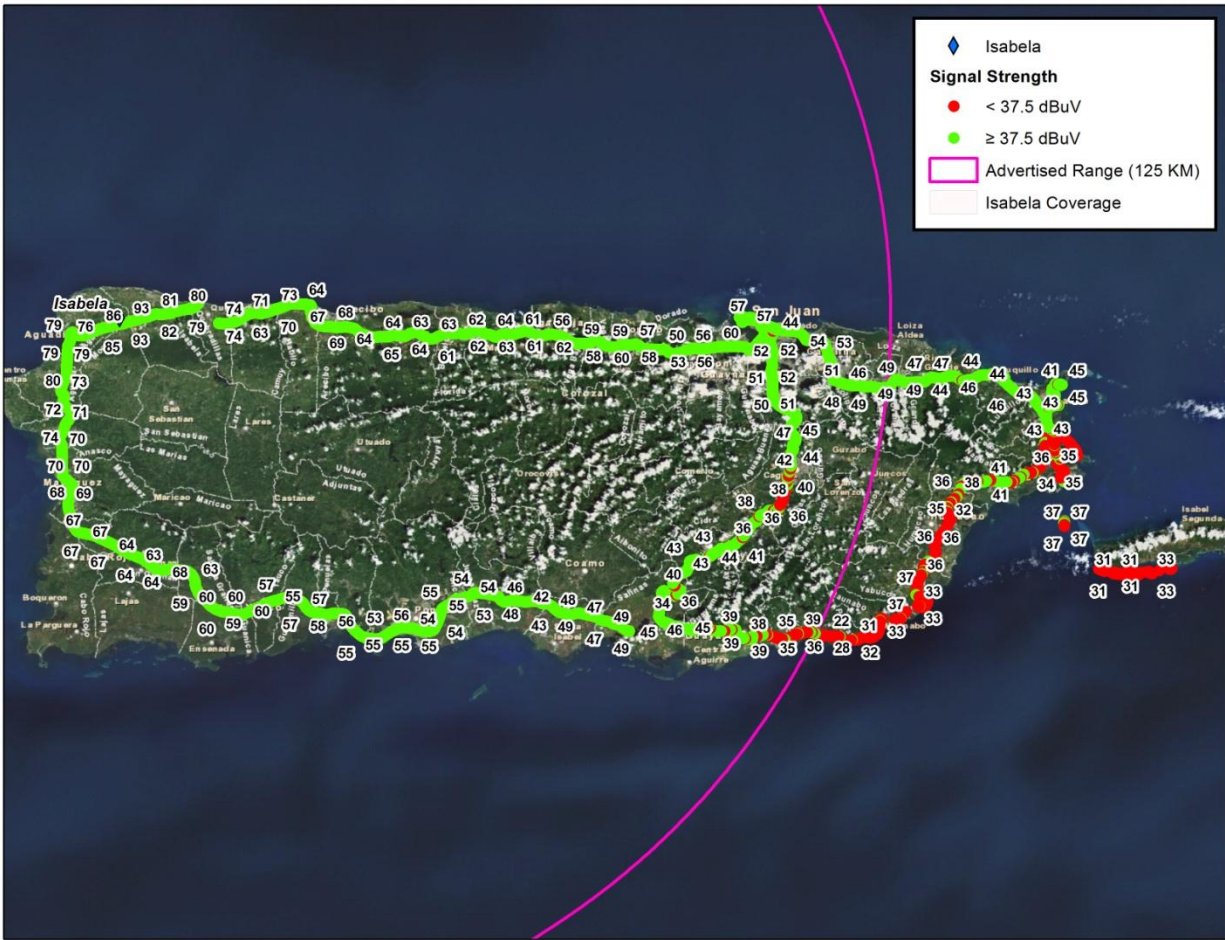


Figure 1: DNAV Signal Strength Results

	POSITION	Trimble SPS461	
Side A SS	18° 24' 41.55"N 65° 53' 24.55"W	46 dB μ V/m, 31 SNR	
Side B SS	18° 24' 41.55"N 65° 53' 24.55"W	46 dB μ V/m, 32 SNR	

	POSITION	Trimble SPS461	
Side A SS	17° 58' 56.85"N 66° 00' 15.10"W	40 dB μ V/m, 25 SNR	
Side B SS	17° 58' 56.85"N 66° 00' 15.10"W	40 dB μ V/m, 25 SNR	

Table 1: 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 validated with the DGPS watch and is in accordance with the Reference (3). Receipt of all RTCM messages was validated utilizing the NCS system whereby the assessment team witnessed the on-time receipt of all messages on the active and standby Integrity Monitor computers. All message content was observed and validated for accuracy IAW Reference (4).

On side A the position data contained in message type 3 had a 53ft disparity from the known position of the equipment. Furthermore, on both side A and side B the position data of the Card Sound site broadcast in message type 7 had a 1.6km disparity from the known position of the Card Sound site.

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Inaccurate by 53ft
<i>Type 5 (ensure message is not being transmitted)</i>	N	N	N/A
<i>Type 7</i>	Y	Y	Card Sound position inaccurate by 1.6km
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	N	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	Card Sound position inaccurate by 1.6km
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	N	Y	Y

Table 4: Side B RTCM Message Validation

Accuracy Validation:

Positional accuracy was collected for 10 minutes on each side and checked against [NGS monument BBBG63](#) located on the pier at the Coast Guard base in San Juan. See table 5 and 6 below. The results are within the advertised 10m accuracy with 2.723 meters on side A and 2.778 on side B. These accuracy numbers are 300% higher than the 37 previous accuracy checks on other DGPS sites. Another accuracy check will be performed on the next OA of the Isabela site after an impending tower replacement.

NGS Monument ID:	BBBG63
Monument LAT:	18.45915909
Monument LON:	-66.1160392

Averaged LAT:	18.4591598
Averaged LON:	66.11606481
Distance from DGPS Site:	100.8km
Antenna Distance from Monument	2.723 meters / 8.933feet*
Antenna Bearing from Monument	90°

Table 5: Side A Accuracy Check Results

Averaged LAT:	18.4591604
Averaged LON:	66.1160653
Distance from DGPS Site:	100.8km
Antenna Distance from Monument	2.778 meters / 9.144 feet*
Antenna Bearing from Monument	90°

Table 6: Side B Accuracy Check Results

*Accuracy data was found to be corrupted. A new accuracy check is scheduled.

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	2	4	5	10	12	13	15	17	25	26	
Integrity Monitor A	2	4	5	10	12	13	15	17	25	26	
Reference Station B	1	4	7	8	9	11	17	20	28	32	
Integrity Monitor B	2	4	5	10	12	13	15	17	25	26	
NGS Monument Location, Side A	1	4	7	8	9	11	17	20	28	32	
NGS Monument Location, Side B	1	4	7	8	9	11	17	20			

Table 7: GPS Satellite Comparison

SUMMARY:

The Operational Assessment of the Isabela DGPS site revealed that the site provided adequate coverage within the advertised range. The Far-Field signal strength readings were well within the required signal strength. Additionally, a review of the output/reflected power and near-field signal strength levels was conducted and found to be satisfactory. NAVCEN’s COAST coverage prediction software did not accurately predict coverage for specific areas on the southeast portion of Puerto Rico, the south side of the island of Vieques, and the waters between the two. These areas are outside of the advertised range ring. All messages were verified and evaluated. Type 3 and type 7 messages contained erroneous data relating to the position of the Isabela site and the adjacent Card Sound site. Finally, accuracy measurements and analysis were completed and found to be within advertised parameters but significantly higher than the average of other DGPS sites. Isabela is scheduled to have a new tower installed within a year. Another accuracy check will be completed following the install.