



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Sandy Hook, NJ DGPS Site (804)
Inspector(s): ENS Ryan Quarry & CWO Wayne Horn
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REFERENCES

- (1) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
- (2) Radio Technical Commission for Maritime Services (RTCM) Recommended Standards for Differential Global Navigation Satellite System (GNSS) Service, Version 2.3.
- (3) Differential Global Positioning System (DGPS) Concept of Operations, COMDTINST 16577.2 (AUG 1995).
- (4) 2014 Federal Radio Navigation Plan.

PURPOSE

- Validate advertised DGPS coverage of the Sandy Hook 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
Dell Latitude E3620 Laptop

SANDY HOOK DGPS SITE PARAMETERS

Frequency	286 KHz
Forward Output Power	900 W
Transmission Rate	200 Bps
Field Strength/Range	100 μ V/m (40 dB μ V/m) at 185 km

SUMMARY

The Operational Assessment of the Sandy Hook Differential Global Positioning System (DGPS) site revealed that the provided coverage is consistent with the advertised range. The signal strength verification within the advertised range was satisfactory. The northern far-field signal strength readings were above the required 100 μ V/m signal strength threshold; the southern readings fell below the 100 μ V/m signal strength threshold. 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, evaluated and are consistent with the requirements set forth by Reference (1) and (2). Finally, accuracy measurements and analysis proved that at a distance of approximately 16 km from the broadcast site, the horizontal accuracy is within the 10 meter accuracy requirement as set forth by Reference (3) and (4).

RESULTS

Signal Strength

A verification of the Sandy Hook DGPS coverage area was conducted from Virginia Beach, VA along a northerly route of the coastline to Belfast, ME. The advertised signal strength range is 185 km. Green points represent areas of signal strength above $40 \text{ dB}\mu\text{V/m}$, whereas areas of below $40 \text{ dB}\mu\text{V/m}$ are represented with red points. Figure 1 displays adequate signal strength throughout the majority of the predicted coverage area of the site. There is an area of terrestrial masking in southern New Jersey, but it is unlikely a maritime user would find the signal unusable. As seen in Table 1 and Table 2, far-field signal strength readings were taken at northern and southern points of the route. The northern reading was collected inside the range ring while the southern point was collected outside the range ring. The northern far-field readings were above the required $40 \text{ dB}\mu\text{V/m}$ signal strength on both sides. The southern far-field readings were below the required $40 \text{ dB}\mu\text{V/m}$ signal strength on both sides; the signal was strong enough to be easily acquired by the receiver and provided sub-meter accuracy.

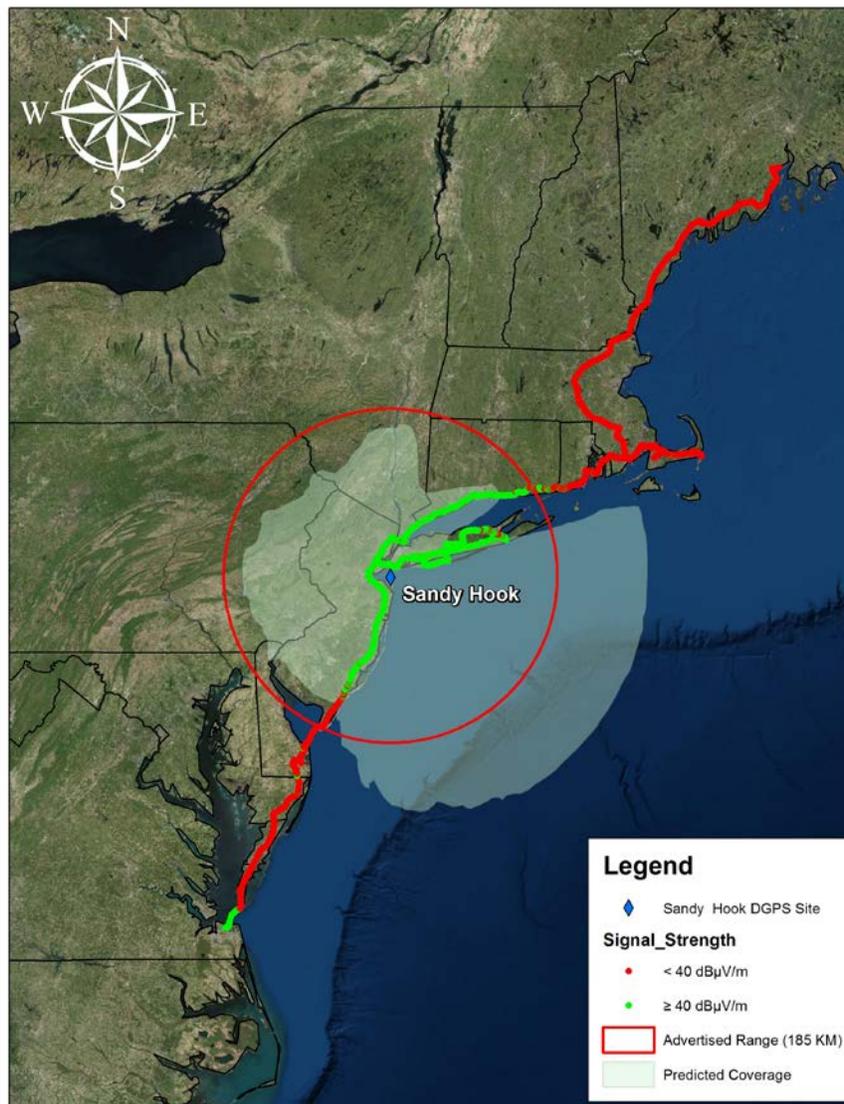


Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	42 dB μ V/m	24 dB μ V/m	41° 19.10103' N, 072° 21.58796' W
B	42 dB μ V/m	25 dB μ V/m	

Table 1: North Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	34 dB μ V/m	18 dB μ V/m	38° 58.08563' N, 074° 57.56743' W
B	35 dB μ V/m	20 dB μ V/m	

Table 2: South Far-Field Signal Strength Reading

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 6 and 7). Side A was 3.308 m meters, bearing 254.5181° from the monument while Side B was 3.627 meters, bearing 252.5611° from the monument. As per Reference (3) and (4), both respective distances were within advertised accuracy requirements. A comparison between the GPS satellites in view at the Sandy Hook DGPS site and at the NGS monument location was conducted (Table 8) 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 Reference Station and Integrity Monitor GPS receivers at the site were near 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 0.09348 meters; Side B's average deviation was 0.04612 meters. Both findings were consistent with the findings observed in the field and are within system parameters.

NGS Monument ID:	BBDM39
Monument LAT:	40° 36' 45.78159" N
Monument LON:	074° 3' 39.92633" W
Distance from DGPS Site	16 km

Table 5: NGS Monument ID

Averaged LAT:	40° 36' 45.7530" N
Averaged LON:	074° 03' 40.0623" W
Distance from Monument:	3.308 m (10.853018 ft)
Bearing from Monument:	254.5181°

Table 6: Side A Accuracy Check Results

Averaged LAT:	40° 36' 45.7464" N
Averaged LON:	074° 03' 40.0739" W
Distance from Monument:	3.627 m (11.8996 ft)
Bearing from Monument:	252.5611°

Table 7: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	1	7	8	9	11	16	23	27	28	30	
Integrity Monitor A	1	3	6	7	8	9	11	16	19	23	25
Reference Station B	1	7	8	9	11	16	23	27	28	30	
Integrity Monitor B	3	6	7	13	16	19	23	25			
NGS Monument Location, Side A	1	7	8	9	11	16	23	27	28	30	
NGS Monument Location, Side B	1	7	8	9	11	16	27	30			

Table 8: GPS Satellite Comparison

RECOMMENDATION

The accuracy check results, while within system parameters, raised some concern considering the minimal distance from the DGPS site. The hardware and software configuration of the site was checked upon returning from the assessment, and no problems were found. DGPS Management personnel suspect the location of the monument is not correct, and have reached out to NGA to provide feedback.

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