



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: St. Paul, WI DGPS Site (864)
Inspector(s): CWO2 Marin Kaczmar
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REFERENCES

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

PURPOSE

- Validate advertised DGPS coverage of the St. Paul 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

ST. PAUL DGPS SITE PARAMETERS

Frequency	317 KHz
Forward Output Power	900 W
Transmission Rate	200 baud
Field Strength/Range	100 μ V/m at 241 km

SUMMARY

An Operational Assessment of the St. Paul Differential Global Positioning System (DGPS) site revealed that the provided coverage is consistent with the predicted coverage plot and advertised range. The signal strength measurements, throughout the predicted coverage area within the advertised range, were satisfactory. All RTCM messages were verified, evaluated, and are consistent with the requirements set forth by reference (3) and (4). The accuracy check result of .5 meters for Side A was within the 10 meter requirement as set forth by Reference (1) and (2). Upon return to base it was found that Side B data was corrupted and is unable to be made part of this report.

RESULTS

Signal Strength

A verification of the St. Paul DGPS coverage area was conducted from Green Bay, WI, NW to Minneapolis, St. Paul MN. The advertised signal strength range is 240 km. Figure 1 displays adequate signal strength within the advertised range of 240 km from the site and throughout the

predicted coverage area. Green points on Figure 1 represent areas of satisfactory signal strength, whereas areas of unsatisfactory signal strength are represented with red points. As seen in Table 1, far-field signal strength readings were taken from the western edge of the advertised range.

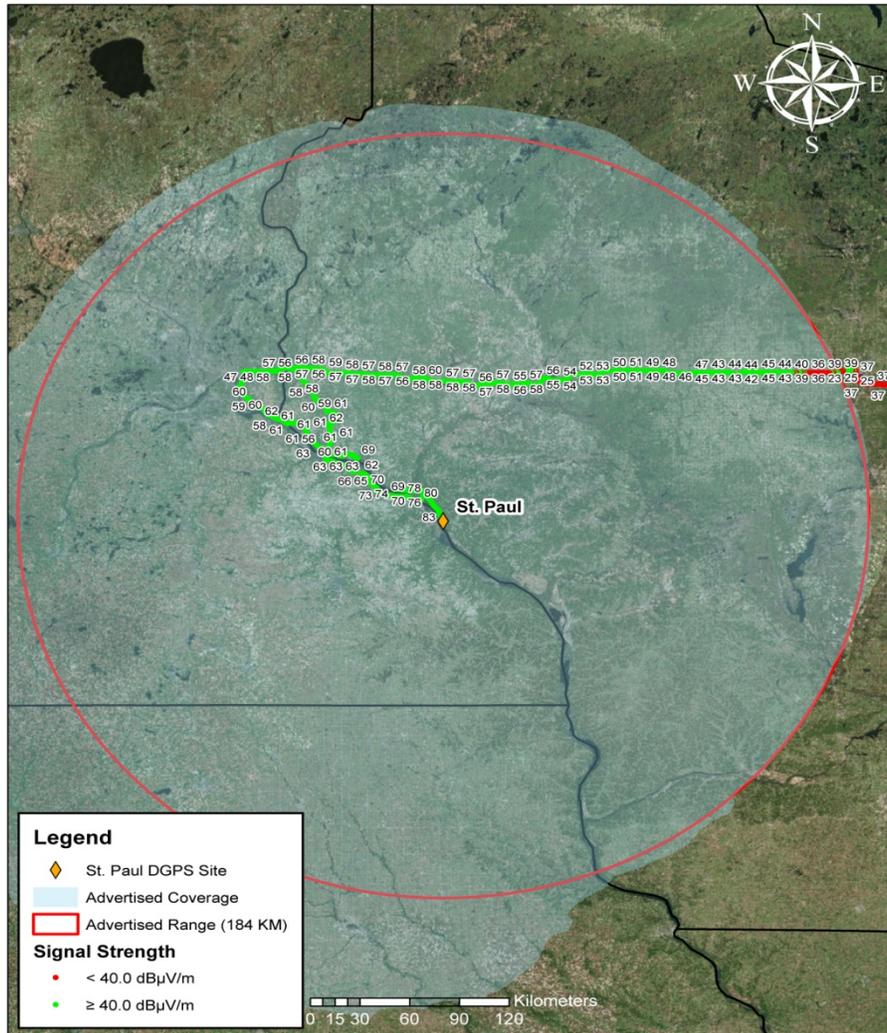


Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	37 dB μ V/m	12 dB μ V/m	44°56.7125 N, 89°50.718908930 W
B	38 dB μ V/m	13 dB μ V/m	

Table 1: East Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	N/A	N/A	N/A
B	N/A	N/A	

Table 2: South Far-Field Signal Strength Reading

RTCM Message Verification

Table 3 and Table 4 show RTCM message scheduling, receipt, and content collected during the assessment. RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with Reference (3). Receipt of all RTCM messages was validated utilizing a Remote Desktop Session, whereby the assessment team witnessed the on-time receipt of all messages on the active and standby Integrity Monitor computers. 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 (See Table 5 through Table7). Side A was 0.5021 meters, bearing 311° from the monument. Per Reference (1) and (2), the respective distance was well within advertised accuracy requirements. As seen in Table 8, a comparison between the GPS satellites in view at the St. Paul DGPS site and those at the NGS monument location was conducted 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 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 0.15603 meters, which is consistent with the findings observed in the field and is 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. GPS accuracy was 1.99 meters away from the monument, which is well within system parameters.

NGS Monument ID:	AC4948
Monument LAT:	44° 56' 59.34133" N
Monument LON:	092° 49' 13.06288" W
Distance from DGPS Site	102.1 km

Table 5: NGS Monument ID

Averaged LAT:	44° 56' 59.352108" N
Averaged LON:	092° 49' 13.080072" W
Antenna Distance from Monument:	0.5021 m (1.647306 ft)
Antenna Bearing from Monument:	311°

Table 6: Side A Accuracy Check Results

Averaged LAT:	N/A
Averaged LON:	N/A
Distance from Monument:	N/A
Bearing from Monument:	N/A

Table 7: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>											
Reference Station A	1	14	16	20	23	25	29	30	32			
Integrity Monitor A	7	9	10	11	16	19	23	26	27	28	30	
Reference Station B	5	7	9	10	11	16	19	23	26	27	28	
Integrity Monitor B	7	9	10	11	16	19	23	26	27	28	30	
NGS Monument Location, Side A	7	10	16	19	23	27	30	9				
NGS Monument Location, Side B	7	10	16	19	23	27	30	9				

Table 8: GPS Satellite Comparison

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