



DGPS SITE OPERATIONAL ASSESSMENT

NDGPS Site:	<i>Detroit DGPS Site (838)</i>
Inspector(s):	LT Christian Hernaez, CWO3 William Iozzino
Date:	20JUN12

PURPOSE:

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

REFERENCE: (1) DGPS Concept of Operations, COMDTINST 16577.2 (AUG 1995).
(2) Broadcast Standard for the USCG DGPS Navigation Service, COMDTINST M1677.1 (APR 1993).
(3) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

EQUIPMENT:

Trimble SPS461 Receiver
Trimble GA 530 Antenna
Potomac Instruments 4100 FIM meter

PARAMETERS:

Frequency	319 KHz
Forward Output Power	250 W
Transmission Rate	100 baud
Field Strength/Range	100 μ V/m (40 dB μ V/m) at 161 km

RESULTS

Signal Strength:

A verification of the Detroit Differential GPS (DGPS) coverage area was conducted from Alpena, MI, along the southwest coast of Lake Huron, the west coast of Lake St. Clair, and the south coast of Lake Erie. The advertised signal strength range is 161 km. Figure 1 below displays adequate signal strength, beyond the advertised range of 161 km from the site and throughout the 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 northern and southern points of the advertised range from both sides of the site (Table 1 and Table 2). Both northern and southern FF readings were well above the required 40 dB μ V/m signal strength on both sides.



Figure 1: DNAV Signal Strength Results

	POSITION	Trimble SPS461	4100 FIM Meter
Side A SS	43° 42' 33.0"N 082° 36' 25.3"W	50 dB μ V/m, 25 SNR	51.8 dB μ V/m
Side B SS	43° 42' 33.0"N 082° 36' 25.3"W	50 dB μ V/m, 25 SNR	51.6 dB μ V/m

Table 1: North Far-Field Signal Strength Reading

	POSITION	Trimble SPS461	4100 FIM Meter
Side A SS	41° 45' 19.1"N 081° 17' 31.2"W	51 dB μ V/m, 26 SNR	54.1 dB μ V/m
Side B SS	41° 45' 19.1"N 081° 17' 31.2"W	51 dB μ V/m, 26 SNR	53.8 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 validated with the DGPS watch and is in accordance with the Reference (2). 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. RTCM Type 5 messages were received on both Side A and Side B at an interval of 900 and sync time of 800 as shown in Tables 3 and 4; however, all RTCM Type 5 messages should be turned off. The OA team worked with the DGPS watch to unscheduled the RTCM Type 5 messages. All message traffic is now in accordance with Reference (3).

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Y
<i>Type 5 (ensure message is not being transmitted)</i>	Y (corrected)	Y (corrected)	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>	Y (corrected)	Y (corrected)	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 0.27783 meters, bearing 166.599°, away from the monument while Side B was 0.49716 meters, bearing 156.4033°, away from the monument. Both respective distances were well within advertised accuracy requirements. A comparison between the GPS satellites in view at the Detroit 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. Overall, the total number of satellites in view at the DGPS site location was greater than that at the NGS monument. However, the satellites seen at the NGS monument were also seen at the DGPS site. A two dimension radial review of the same time period was completed for the integrity monitors. Side A’s average deviation was 0.13319 meters; Side B’s average deviation was 0.10305 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. GPS accuracy was 1.15788 meters away from the monument. Therefore, the DGPS site is effectively improving the positional solution by over 80%.

NGS Monument ID:	BBCB16
Monument LAT:	43° 24' 54.89125" N
Monument LON:	084° 32' 17.59513" W

Averaged LAT:	43° 24' 54.9" N
Averaged LON:	084° 32' 17.598" W
Distance from DGPS Site:	171 km
Antenna Distance from Monument:	0.27783 m (0.911561 ft)
Antenna Bearing from Monument:	166.599°

Table 5: Side A Accuracy Check Results

Averaged LAT:	43° 24' 54.906" N
Averaged LON:	089° 32' 17.604" W
Distance from DGPS Site:	171 km
Distance from Monument:	0.49716 m (1.631181 ft)
Bearing from Monument:	156.4033°

Table 6: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>											
Reference Station A	6	13	14	16	20	23	25	29	30	31	32	
Integrity Monitor A	6	13	14	16	20	23	25	29	30	31	32	
Reference Station B	6	13	14	16	20	23	25	29	30	31	32	
Integrity Monitor B	3	6	13	14	16	20	23	25	29	30	31	32
NGS Monument Location, Side A	16	20	23	29	30	31	32					
NGS Monument Location, Side B	6	13	16	20	23	29	30	31	32			

Table 7: GPS Satellite Comparison

SUMMARY:

The Operational Assessment of the Detroit DGPS site revealed that the provided coverage is consistent with the predicted coverage plot and advertised range. Both northern and southern Far-Field signal strength readings were well within the required signal strength. Additionally, the signal strength measurements, throughout the predicted coverage area, were satisfactory. All RTCM messages were verified and evaluated and are consistent with the requirements set forth by reference (2) and (3). A review of several analysis plots was completed and found the signal strength alarm threshold for Side A to be set slightly high (by 1 dB μ V/m). System Support will adjust the Side A signal strength alarm threshold from 136 dB μ V/m to 135 dB μ V/m. Finally, accuracy measurements and analysis proved that at a distance of approximately 171 km from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy requirements set forth by Reference (1) and (2).