DGPS SITE OPERATIONAL ASSESSMENT

NDGPS Site: *Rock Island DGPS Site (863)*

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PURPOSE:

- Validate advertised DGPS coverage of the Rock Island DGPS site.
- Validate required RTCM message scheduling and delivery.
- Conduct Field Intensity Measurement (FIM) readings post Nautel TX install.
- 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 M16577.1 (APR 1993).
(3) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

EQUIPMENT: STARLINK DNAV-212 DGPS Receiver
Hemisphere R110 USB DGPS Receiver
Trimble MBA-2 Receive Antenna
Potomac Instruments 4100 FIM meter

PARAMETERS:

Frequency	311 KHz
Forward Output Power	900W
Transmission Rate	200 baud
Field Strength/Range	100µV/m (40.0 dBµV/m) at 241 km

RESULTS

Signal Strength:

A verification of the Rock Island Differential GPS (DGPS) coverage area was conducted from Minneapolis, MN, along the Mississippi River, to St. Louis, MO. The advertised signal strength range is 241 km. Figure 1 below displays adequate signal strength to approximately 241 km from the site; green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points. The signal strength remained above the minimum of 40.0 dBµV/m all the way to St. Louis, MO. Far-field (FF) signal strength readings were taken at northern and southern points along the DNAV route from both sides of the site (Table 1 and Table 2). The northern FF reading was slightly lower than the required 40 dBµV/m on both sides. This may have been due to the elevated terrain surrounding the point of reference.

At a point approximately two miles south of the northern reference point, the signal strength increased to 42 dBµV/m at 14 SNR. The southern FF reading was well above the required 40 dBµV/m signal strength on both sides.

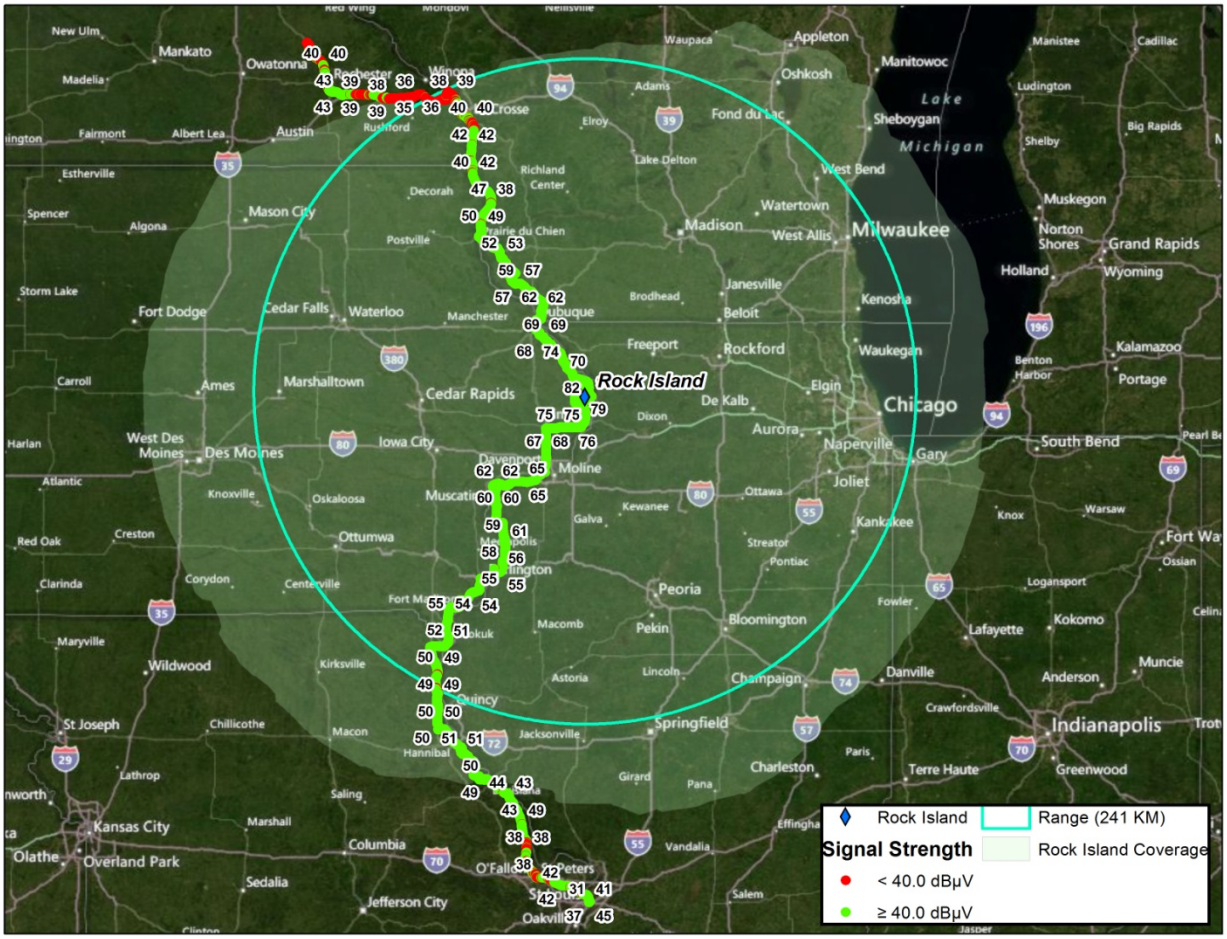

Figure 1: DNAV Signal Strength Results

	POSITION	Starlink DNAV 212, MBA 2 Antenna	4100 FIM Meter
Side A SS	43° 58.4556'N 091° 25.638'W	36 dBµV/m, 11 SNR	34.7 dBµV/m
Side B SS	43° 58.4556'N 091° 25.638'W	36 dBµV/m, 11 SNR	34.8 dBµV/m

Table 1: North Far-Field Signal Strength Reading

	POSITION	Starlink DNAV 212, MBA 2 Antenna	4100 FIM Meter
Side A SS	40° 02.8233'N 091° 30.938'W	48 dBµV/m, 14 SNR	47.7 dBµV/m
Side B SS	40° 02.8233'N 091° 30.938'W	48 dBµV/m, 16 SNR	47.8 dBµV/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 was able to see the on-time receipt of all messages on the active and standby Integrity Monitor computers. A review of the RTCM message content found an inaccurate Type 7 message for the Rock Island site, site number 863. Type 7 message positions are required to be within .3 km of latitude and .6 km of longitude away from the referenced broadcast antenna as per Reference (3). The Type 7 RTCM message for site 863 is 0.5 km of latitude and 1.6 km of longitude away from the site (863). All other message content was verified and accurate.

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

Table 3: Side A RTCM Message Validation

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

Table 4: Side B RTCM Message Validation

Accuracy Validation:

Positional data was collected for 10 minutes per side using a Hemisphere RPR 210 DGPS receiver with a Trimble MBA-2 DGPS Receive antenna. The data was then post processed and compared to a National Geodetic Survey (NGS) marker to verify the horizontal accuracy of the broadcast correction. Side A was 0.70 meters, bearing 196.79º, away from the monument while Side B was 0.75 meters, bearing 270.72º, away from the monument. Both respective distances were well within advertised accuracy requirements. Additionally a two dimension radial review for the same time period was completed for the integrity monitors. Side A's average deviation was 0.13571 meters; Side B's average deviation was 0.24175 meters. Both findings were consistent with the finding observed in the field and are well within system parameters.

NGS Monument ID:	**BBBP72**
Monument LAT:	40º 52’ 51.03025” N
Monument LON:	091º 01’ 28.26213” W

Averaged LAT:	40º 52’ 51.00861852” N
Averaged LON:	091º 01‘ 28.270762” W
Distance from DGPS Site:	142.34 km
Antenna Distance from Monument:	.70 m (2.29 ft)
Antenna Bearing from Monument:	196.79º

Table 5: Side A Accuracy Check Results

Averaged LAT:	40º 52’ 51.0305551” N
Averaged LON:	091º 01’ 28.294212” W
Distance from DGPS Site:	142.37 km
Distance from Monument:	0.75 m (2.46 ft)
Bearing from Monument:	270.72º

Table 6: Side B Accuracy Check Results

SUMMARY:

The Operational Assessment of the Rock Island DGPS site revealed that the provided coverage is consistent with the predicted coverage plot and advertised range. The northern Far-Field signal strength reading was slightly lower than advertised but based on the surrounding terrain and the signal strength in the surrounding area, the assessment team is confident the coverage is sufficient. Per Reference (2) and (3), an RTCM Type 7 provides the radio beacon locations for the beacon currently being used, and three adjacent beacons. The location data resolution for these positions is “coarse” (0.3 km in latitude and 0.6 km in longitude). After review of the RTCM type 7 messages from Rock Island, the positional information provided for beacon 863 is outside the coarse distances. NAVCEN DGPS System Support will work with DGPS PL engineers to update the RTCM Type 7 positional information for said site. All other RTCM messages were consistent with the required standards. Finally, accuracy measurements and analysis proved that at a distance of approximately 142 km from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy requirements set forth by Reference (1) and (2).