



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Gustavus DGPS Site (892)
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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 Gustavus DGPS site.
- Validate required RTCM message scheduling and delivery.
- Test differential correction accuracy versus a predetermined survey monument.

EQUIPMENT:

Hemisphere VS330 Receiver
Hemisphere R330 Receiver
Hemisphere R110 Receiver
Hemisphere A43 Antenna
Hemisphere A42 Antenna
MBA-2 Receive Antenna

GUSTAVUS DGPS SITE PARAMETERS:

Frequency	288 KHz
Forward Output Power	500 Watts
Transmission Rate	100 baud
Field Strength/Range	75 μ V/m (37.5 dB μ V/m) at 315 km

SUMMARY:

The Operational Assessment of the Gustavus DGPS site revealed that the provided coverage is not consistent with the predicted coverage plot and advertised range. The northern and southern Far-Field signal strength readings were below the required signal strength. The signal strength measurements through most of the predicted coverage area were satisfactory. Additionally, 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 and evaluated and are consistent with the requirements set forth by reference (3) and (4). Finally, accuracy measurements and

analysis proved that at a distance of approximately 75 km from the broadcast site, the horizontal accuracy is well within the accuracy requirements set forth by Reference (1) and (2).

RESULTS:

Signal Strength:

A verification of the Gustavus DGPS coverage area was conducted from Ketchikan, AK through Southeast Alaska’s Inside Passage and the Gulf of Alaska past Yakutat. The advertised signal strength range is 315 km. Figure 1 below displays adequate signal strength through most of the predicted coverage area with the exception of an area in the south. The signal strengths fall below acceptable levels near the advertised range. 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 southern and northern points of the advertised range from the site’s primary side (Table 1). The northern and southern FF reading was below the required 37.5 dBuV/m signal strength on both sides.

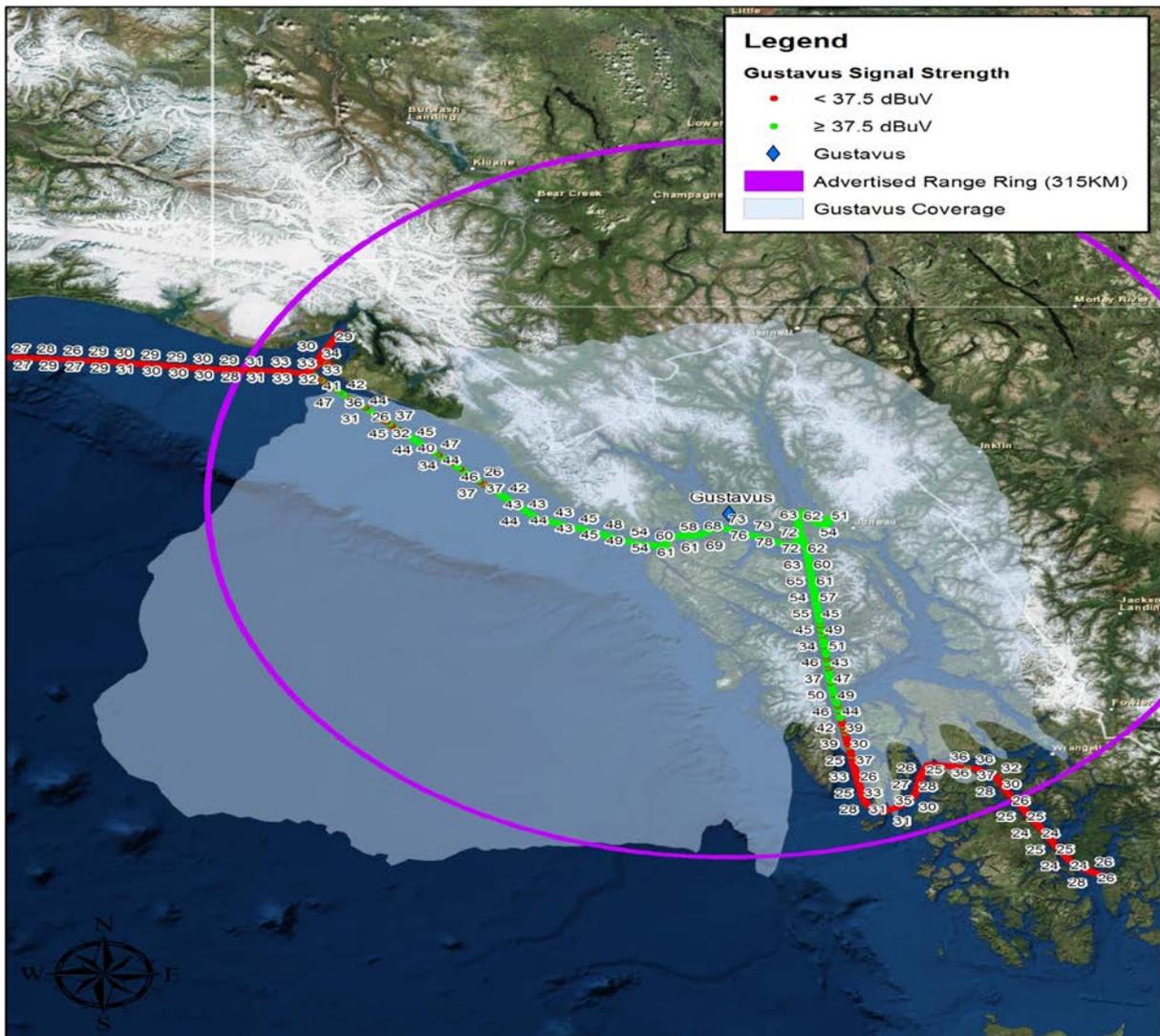


Figure 1: DNAV Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	31 dB μ V/m	18 dB	59° 31' 31.9" N, 140° 41' 38.9" W

Table 1: North Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	23 dB μ V/m	11 dB μ V/m	56° 05' 32.1" N, 132° 46' 22.6" W

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 (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 Hemisphere R110. 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 1.602 meters, bearing 300°, away from the monument while Side B was 1.367 meters, bearing 306°, away from the monument. As per Reference (1) and (2), both respective distances were well within

advertised accuracy requirements. A comparison between the GPS satellites in view at the Gustavus 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 RS and IM 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 0.05345 meters; Side B's average deviation was 0.07670 meters. These findings were much better than the findings observed in the field and are well within system parameters.

NGS Monument ID:	AI4908
Monument LAT:	58° 17' 56.74734" N
Monument LON:	134° 25' 9.76528" W
Distance from DGPS Site	75 km

Table 5 Monument ID

Averaged LAT:	58° 17' 56.7738" N
Averaged LON:	134° 25' 9.8502" W
Antenna Distance from Monument:	1.602 m (5.255 ft)
Antenna Bearing from Monument:	300°

Table 6: Side A Accuracy Check Results

Averaged LAT:	58° 17' 56.7738" N
Averaged LON:	134° 25' 9.8328" W
Distance from Monument:	1.367 m (4.484 ft)
Bearing from Monument:	306°

Table 7: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>											
Reference Station A	1	3	7	8	11	15	17	18	19	26	28	30
Integrity Monitor A	3	7	8	11	15	17	18	19	26	28	30	
Reference Station B	3	7	8	11	15	17	18	19	26	28	30	
Integrity Monitor B	3	7	8	11	15	17	18	19	26	28	30	
NGS Monument Location, Side A	1	7	8	11	15	17	18	19	24	26	28	30
NGS Monument Location, Side B	1	7	8	11	15	17	18	19	24	26	28	30

Table 8: GPS Satellite Comparison