



## **DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT**

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**NDGPS Site:** Annette Island DGPS Site (889)  
**Inspector(s):** LT Michael Brashier, CWO3 Louie Baytan  
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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 Annette Island 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

### **ANNETTE ISLAND DGPS SITE PARAMETERS:**

Frequency	323 KHz
Forward Output Power	500 Watts
Transmission Rate	100 baud
Field Strength/Range	75 $\mu$ V/m (37.5 dB $\mu$ V/m) at 315 km

### **SUMMARY:**

The Operational Assessment of the Annette Island DGPS site revealed that the provided coverage is somewhat consistent with the predicted coverage plot and advertised range. The northern Far-Field signal strength readings were above the required level. The signal strength measurements within the advertised range were satisfactory overall however there were pockets of inadequate signal strength likely attributable to the mountainous terrain. 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 34 km from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy requirements set forth by Reference (1) and (2).

**RESULTS:**

**Signal Strength:**

A verification of the Annette Island DGPS coverage area was conducted from Ketchikan, AK through Southeast Alaska’s Inside Passage to Juneau. The advertised signal strength range is 315 km. Figure 1 below displays adequate signal strength beyond the advertised range of 315 km however there are sporadic areas of inadequate signal strength 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 the northern point of the advertised range from the site’s primary side (Table 1). The northern FF reading was above the required 37.5 dB $\mu$ V/m signal strength.

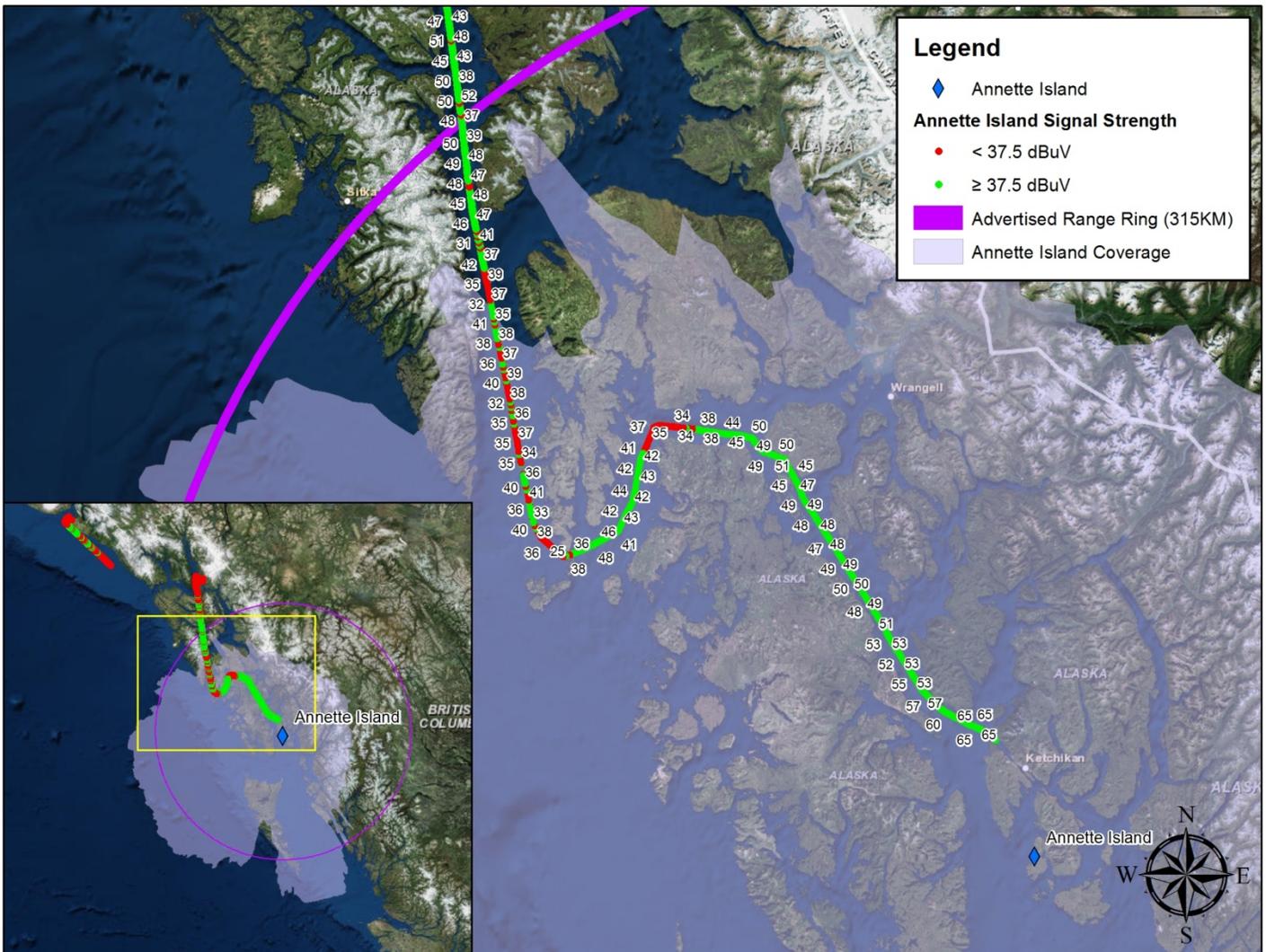


Figure 1: DNAV Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	42 dB $\mu$ V/m	25 dB $\mu$ V/m	57° 3' 28.3536", -134° 39' 37.3176"

Table 1: North 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 0.3745 meters, bearing 002.4729 ° from the monument while Side B was 0.3846 meters bearing 005.2428° 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 Annette Island 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 0.08542 meters; Side B's average deviation was 0.10937 meters.

<b>NGS Monument ID:</b>	<b>AI4914</b>
Monument LAT:	55° 19' 58.66178" N
Monument LON:	131° 37' 31.81928" W
Distance from DGPS Site	34 km

Table 5 Monument ID

<b>Averaged LAT:</b>	55° 19' 58.673892" N
<b>Averaged LON:</b>	131° 37' 31.81836" W
<b>Antenna Distance from Monument:</b>	.3745 m (1.228675 ft)
<b>Antenna Bearing from Monument:</b>	002.4729°

Table 6: Side A Accuracy Check Results

<b>Averaged LAT:</b>	55° 19' 28.67418" N
<b>Averaged LON:</b>	131° 37' 31.81728" W
<b>Distance from Monument:</b>	.3846 m (1.261811 ft)
<b>Bearing from Monument:</b>	005.2428°

Table 7: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>											
Reference Station A	3	5	7	8	15	26	27	28	30			
Integrity Monitor A	3	5	7	8	15	26	27	28	30			
Reference Station B	3	5	7	8	15	26	27	28	30			
Integrity Monitor B	3	5	7	8	15	26	27	28	30			
NGS Monument Location, Side A	1	7	8	11	15	17	18	24	26	28	30	
NGS Monument Location, Side B	1	7	8	11	15	17	18	24	26	28	30	

Table 8: GPS Satellite Comparison