



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Potato Point DGPS Site (895)
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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 Potato Point 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

POTATO POINT DGPS SITE PARAMETERS:

| | |
|----------------------|--|
| Frequency | 298 KHz |
| Forward Output Power | 500 Watts |
| Transmission Rate | 100 baud |
| Field Strength/Range | 75 μ V/m (37.5 dB μ V/m) at 185 km |

SUMMARY:

The Operational Assessment of the Potato Point DGPS site revealed that the provided coverage is *not* consistent with the predicted coverage plot and advertised range. There were myriad pockets of inadequate signal strength throughout the coverage area particularly inside Prince William Sound. 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 111 Km from the

broadcast site, the horizontal accuracy is within the accuracy requirements set forth by Reference (1) and (2).

RESULTS:

Signal Strength:

A verification of the Potato Point DGPS coverage area was conducted from M/V Kennicott as she transited Prince William Sound. The advertised signal strength range is 185 km. Figure 1 below displays adequate signal strength throughout most of Prince William Sound however the area to the west near Whittier, AK, and the southwest and southeast far field areas do not match predicted coverage nor the advertised range. Green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points.

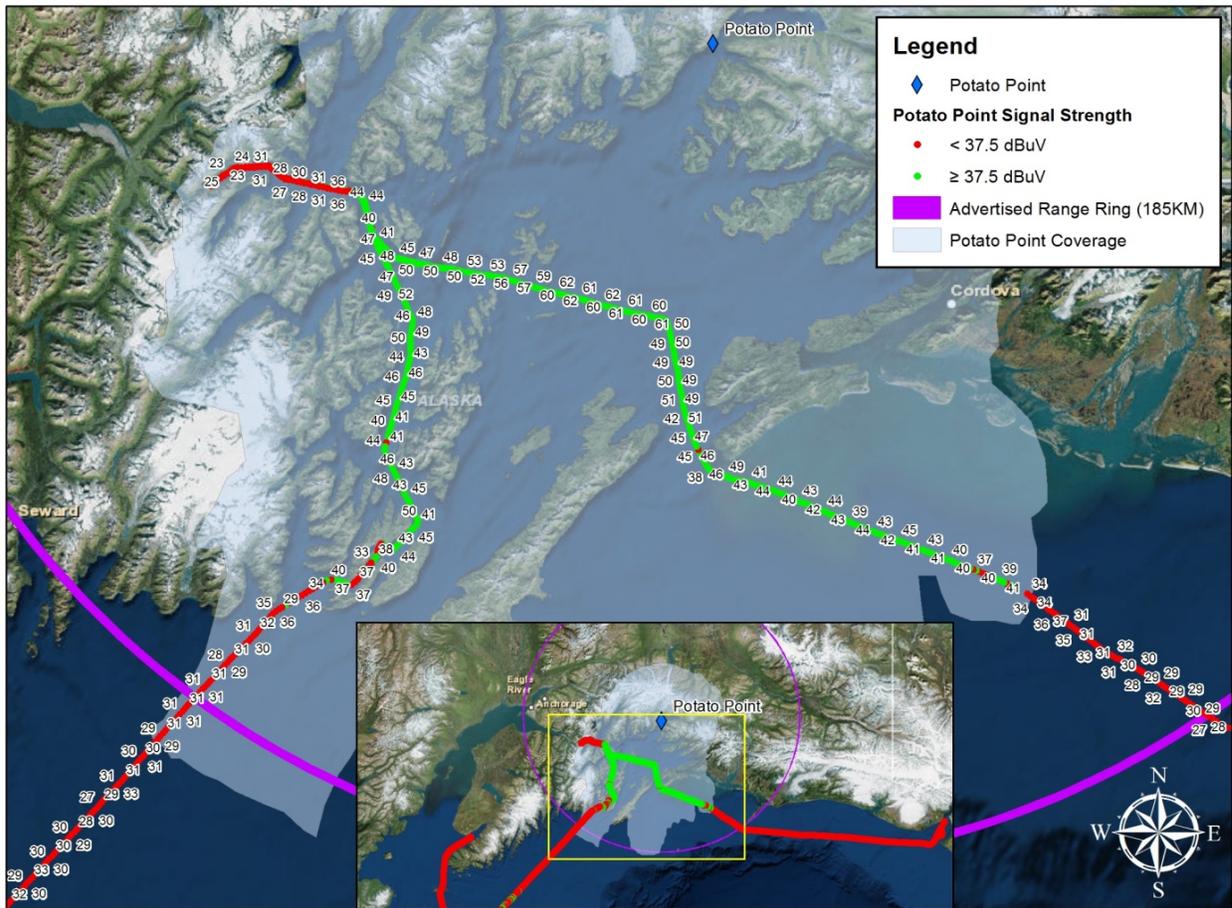


Figure 1: DNAV Signal Strength Results

| Side | Signal Strength | Signal to Noise ratio | Position |
|------|-----------------|-----------------------|------------------------------------|
| A | 31 dB μ V/m | 17 dB μ V/m | 59° 41' 22.3836" -144° 39' 14.601" |
| | | | |

Table 1: Southeast Far-Field Signal Strength Reading

| Side | Signal Strength | Signal to Noise ratio | Position |
|------|-----------------|-----------------------|-------------------------------------|
| A | 28 dB μ V/m | 16 dB μ V/m | 59° 29' 24.7554" -149° 11' 42.1146" |
| | | | |

Table 2: Southwest 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 1.568 meters away from the monument bearing 261°. Side B was also 1.568 meters away bearing 261°. 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 Potato Point 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 on Side A were almost identical to those tracked at the NGS monument location. On

Side B the IMB receiver was tracking several satellites common to both locations. However RefSta B was tracking only one satellite that was common to both locations. A two dimension radial review of the same time period was completed for the integrity monitors. Side A's average deviation was 0.14062 meters; Side B's average deviation was 0.10595 meters. Both findings are well within system parameters.

| | |
|-------------------------|----------------------|
| NGS Monument ID: | BBCV98 |
| Monument LAT: | 60° 46' 34.26603" N |
| Monument LON: | 148° 40' 52.63108" W |
| Distance from DGPS Site | 111.7 km |

Table 5: Monument ID

| | |
|--|--------------------|
| Averaged LAT: | 60° 46' 34.2588" N |
| Averaged LON: | 148° 40' 52.734" W |
| Antenna Distance from Monument: | 1.568 m (5.144 ft) |
| Antenna Bearing from Monument: | 261° |

Table 6: Side A Accuracy Check Results

| | |
|--------------------------------|--------------------|
| Averaged LAT: | 60° 46' 34.2588" N |
| Averaged LON: | 148° 40' 52.734" W |
| Distance from Monument: | 1.568 m (5.144 ft) |
| Bearing from Monument: | 261° |

Table 7: Side B Accuracy Check Results

| <i>Antenna Location</i> | <i>GPS Satellites Tracked (PRN)</i> | | | | | | | | | | | |
|-------------------------------|-------------------------------------|----|----|----|----|----|----|----|----|----|----|----|
| Reference Station A | 3 | 5 | 7 | 8 | 10 | 13 | 16 | 23 | 26 | 27 | 28 | 30 |
| Integrity Monitor A | 3 | 5 | 7 | 8 | 10 | 13 | 16 | 19 | 26 | 27 | 28 | 30 |
| Reference Station B | 5 | 16 | 18 | 21 | 29 | | | | | | | |
| Integrity Monitor B | 3 | 5 | 6 | 7 | 8 | 10 | 13 | 16 | 19 | 27 | 28 | 30 |
| NGS Monument Location, Side A | 3 | 5 | 7 | 8 | 10 | 13 | 19 | 21 | 26 | 27 | 28 | 30 |
| NGS Monument Location, Side B | 3 | 5 | 7 | 8 | 10 | 13 | 19 | 21 | 26 | 27 | 28 | 30 |

Table 8: GPS Satellite Comparison