DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Bakersfield, CA DGPS Site (795)
Inspector(s): CWO3 Louie Baytan
Date: 13 Apr 2015

REFERENCES

(1) Differential Global Positioning System (DGPS) Concept of Operations, COMDTINST 16577.2 (AUG 1995).
(2) 2014 Federal Radio Navigation Plan.
(3) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
(4) Radio Technical Commission for Maritime Services (RTCM) Recommended Standards for Differential Global Navigation Satellite System (GNSS) Service, Version 2.3.

PURPOSE

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

EQUIPMENT

Trimble SPS461 Receiver
Trimble GA 530 Antenna
Dell PF4XRA00 Laptop

BAKERSFIELD DGPS SITE PARAMETERS

Frequency	305 KHz
Forward Output Power	800 W
Transmission Rate	100 baud
Field Strength/Range	75µV/m (37.5 dBµV/m) at 275 km

SUMMARY

An Operational Assessment of the Bakersfield, CA DGPS site revealed that the provided coverage is consistent with the predicted coverage plot and advertised range. Both southern and eastern far-field signal strength readings were well within the required signal strength. The signal strength measurements, through most of the predicted coverage area within the advertised range, were satisfactory. Exceptions to this can be found in a short segment east of Los Angeles, which may be due to terrestrial masking. 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 in accordance with requirements set forth by reference (3) and (4). The adjacent site information (Lompoc, CA) was found to be offset by 1.81 km. NAVCEN engaged with DGPS Product Line and verified that the beacon locations were updated as of 15 May 2015. Finally, accuracy measurements and analysis proved that at a distance of approximately 265.7 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 Bakersfield, CA DGPS coverage area was conducted from San Diego, CA, along the California coast up to Bakersfield, CA, then east to Needles, CA. The advertised signal strength range is 275 km. Figure 1 displays adequate signal strength through most of the planned route in the advertised range and the predicted coverage area. Green points represent areas of satisfactory signal strength, where as areas of unsatisfactory signal strength are represented with red points. As seen in Table 1 and Table 2, far-field signal strength readings were taken at southern and eastern points of the advertised range from Side A of the site. Both northern and southern far-field readings were well above the required 37.5 dBµV/m signal strength on both sides.

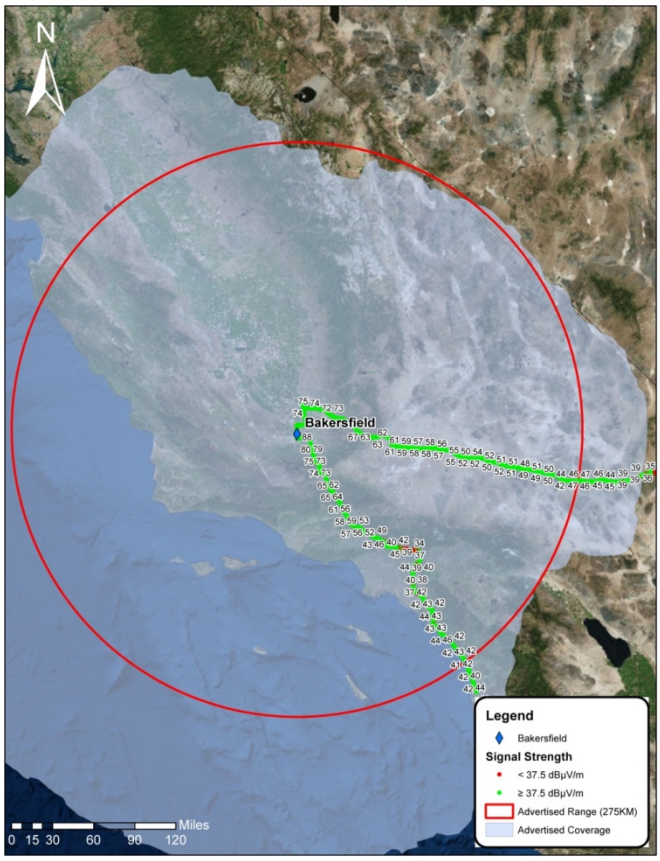

Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	38 dBµV/m	31 dBµV/m	33° 08’ 27.84” N, 117° 19’ 57.86” W
B	N/A	N/A	

Table 1: South Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	46 dBµV/m	32 dBµV/m	34° 43’ 34.71” N, 116° 08’ 20.03” W
B	N/A	N/A	

Table 2: East Far-Field Signal Strength Reading

RTCM Message Verification

Table 3 and Table 4 show RTCM message scheduling, receipt, and content collected during the assessment. RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with 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).

As seen in Tables 3 and 4, the RTCM Type 7 position information for the Lompoc, CA DGPS site in was offset by 1.81 km from the site’s known position on both Side A and Side B.

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	Y – Lompoc position offset by 1.81 km
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	Y – Lompoc position offset by 1.81 km
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 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 (See Table 5 through Table 7). Side A was

0.5917 meters, bearing 209.01° from the monument, while Side B was 0.5568 meters, bearing 205.2331º from the monument. Per Reference (1) and (2), both respective distances were well within advertised accuracy requirements. As seen in Table 8, a comparison between the GPS satellites in view at the Bakersfield, CA DGPS site and those at the NGS monument location was conducted 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 Reference Station and Integrity Monitor GPS receivers at the site were mainly different from 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 0.33509 meters; Side B's average deviation was 0.33719 meters. Both findings were consistent with the findings observed in the field and are well within system parameters.

NGS Monument ID:	**BBCR82**
Monument LAT:	33° 12' 31.67560"N
Monument LON:	117° 23' 40.09661"W
Distance from DGPS Site	265.7 km

Table 5: NGS Monument ID

Averaged LAT:	33° 12' 31.65885"N
Averaged LON:	117° 23' 40.10771"W
Antenna Distance from Monument:	0.5917 m (1.95261ft)
Antenna Bearing from Monument:	209.01°

Table 6: Side A Accuracy Check Results

Averaged LAT:	33° 12' 31.65929"N
Averaged LON:	117° 23' 40.1058"W
Distance from Monument:	0.5568 m (1.83744ft)
Bearing from Monument:	205.2331º

Table 7: Side B Accuracy Check Results

Antenna Location	***GPS Satellites Tracked (PRN)***										
Reference Station A	1	13	16	20	23	31	32				
Integrity Monitor A	1	4	7	13	16	20	23	31	32		
Reference Station B	3	6	15	16	18	21	22	26	27	29	
Integrity Monitor B	1	4	7	13	16	20	23	31	32		
NGS Monument Location, Side A	1	3	9	16	23	31	32				
NGS Monument Location, Side B	1	3	9	16	23	31	32				

Table 8: GPS Satellite Comparison

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