Global Positioning System (GPS) Standard Positioning Service (SPS) Performance Analysis Report

Submitted To

Federal Aviation Administration
GPS Product Team

1284 Maryland Avenue SW
Washington, DC 20024

Report #63
October 31, 2008
Reporting Period: 1 July – 30 September 2008

Submitted by

William J. Hughes Technical Center
NSTB/WAAS T&E Team
Atlantic City International Airport, NJ 08405

EXECUTIVE SUMMARY

The GPS Product Team has tasked the Navigation Branch at the William J. Hughes Technical Center to document the Global Positioning System (GPS) Standard Positioning Service (SPS) performance in quarterly GPS Performance Analysis (PAN) Reports. The report contains the analysis performed on data collected at twenty-eight Wide Area Augmentation System (WAAS) Reference Stations. This analysis verifies the GPS SPS performance as compared to the performance parameters stated in the SPS Specification (October 2001).

This report, Report #63, includes data collected from 1 July through 30 September 2008. The next quarterly report will be issued 31 January 2009.

Analysis of this data includes the following standards and categories: PDOP Availability, NANU Summary and Evaluation, Service Availability, Service Reliability, Position and Range Accuracy and Solar Storm Effects on GPS SPS performance.

PDOP availability is based on Position Dilution of Precision (PDOP). Utilizing the weekly almanac posted on the US Coast Guard navigation web site, the coverage for every 5^{o} grid point between 180W to 180E and 80S and 80N was calculated for every minute over a 24-hour period for each of the weeks covered in the reporting period. For this reporting period, the global availability based on PDOP less than six for the CONUS was 99.984% or better.

NANU summary and evaluation was achieved by reviewing the “Notice: Advisory to Navstar Users” (NANU) reports issued between 1 July and 30 September 2008. Using this data, we compute a set of statistics that give a relative idea of constellation health for both the current and combined history of past quarters. A total of twenty-two outages were reported in the NANU’s this quarter. Twenty-one outages were scheduled while one was unscheduled.

The quarterly service availability standard was verified using 24-hour position accuracy values computed from data collected at one-second intervals. All of the sites achieved a 100% availability, which exceeds the SPS “average location” value of 99% and the “worst-case location” value of 90%.

Calculating the 24-hour 95% horizontal and vertical position error values verified the accuracy standards. The User Range Error and Service Reliability standards were verified for each satellite from 24-hour accuracy values computed using data collected at the following six sites: Boston, Honolulu, Los Angeles, Miami, San Juan and Juneau. This data was also collected in one-second samples. All sites achieved 100% reliability; meeting the SPS specification. The maximum range error recorded was 16.243 meters on Satellite PRN 27. The SPS specification states that the range error should never exceed 30 meters for less than 99.79% of the day for a worst-case point and 99.94% globally. The maximum RMS range error value of 2.310 recorded on satellite 7. The SPS specification states that RMS URE cannot exceed 6 meters in any 24-hour interval.

Geomagnetic storms had little to no effect on GPS performance this quarter. All sites met all GPS Standard Positioning Service (SPS) specifications on those days with the most significant solar activity.

This quarter we’ve added a new section covering the GPS-SPS accuracy performance of IGS stations from around the world. The IGS is a voluntary federation of many worldwide agencies that pool resources and permanent GNSS station data to generate precise GNSS products. During the evaluation period, the maximum 95% horizontal and vertical SPS errors are 2.62 meters at Maspalomas and 6.08 meters at New Norcia, respectively. GLPS was not evaluated this period due to no data being available.

From the analysis performed on data collected between 1 July and 30 September 2008, the GPS performance met all SPS requirements that were evaluated. There were no significant problems to report for the duration of the quarter.

TABLE OF CONTENTS

LIST OF FIGURES

7

LIST OF TABLES

1.0 Introduction

1.1 Objective of GPS SPS Performance Analysis Report

In 1993, the FAA began monitoring and analyzing Global Positioning System (GPS) Standard Positioning Service (SPS) performance data. At present, the FAA has approved GPS and WAAS for IFR operations and is developing Local Area Augmentation (LAAS), which is an additional GPS augmentation system. In order to ensure the safe and effective use of GPS and its augmentation systems within the NAS, it is critical that characteristics of GPS performance as well as specific causes for service outages be monitored and understood. To accomplish this objective, GPS SPS performance data is documented in a quarterly GPS Analysis report. This report contains data collected at the following twenty-eight WAAS reference station locations:

- Bethel, AK
- Billings, MT
- Fairbanks, AK
- Cold Bay, AK
- Kotzebue, AK
- Juneau, AK
- Albuquerque, NM
- Anchorage, AK
- Boston, MA
- Washington, D.C.
- Honolulu, HI
- Houston, TX
- Kansas City, KS
- Los Angeles, CA
- Salt Lake City, UT
- Miami, FL
- Minneapolis, MI
- Oakland, CA
- Cleveland, OH
- Seattle, WA
- San Juan, PR
- Atlanta, GA
- Barrow, AK
- Merida, Mexico
- Gander, Canada
- Tapachula, Mexico
- San Jose Del Cabo, Mexico
- Iqaluit, Canada

The analysis of the data is divided into the four performance categories stated in the Standard Positioning Service Performance Specification (October 2001). These categories are:

- PDOP Availability Standard
- Service Availability Standard
- Service Reliability Standard
- Positioning, Ranging and Timing Accuracy Standard

The results were then compared to the performance parameters stated in the SPS.

1.2 Summary of Performance Requirements and Metrics

Table 1-1 lists the performance parameters from the SPS and identifies those parameters verified in this report.

1.3 Report Overview

Section 2 of this report summarizes the results obtained from the coverage calculation program developed by the GPS test team. The SPS coverage area program uses the GPS satellite almanacs to compute each satellite position as a function of time for a selected day of the week. This program establishes a 5-degree grid between 180 degrees east and 180 degrees west, and from 80 degrees north and 80 degrees south. The program then computes the PDOP at each grid point (1485 total grid points) every minute for the entire day and stores the results. After the PDOP's have been saved the 99.99% index of 1-minute PDOP at each grid point is determined and plotted as contour lines (Figure 2-1). The program also saves the number of satellites used in PDOP calculation at each grid point for analysis.

Section 3 summarizes the GPS constellation performance by providing the "Notice: Advisory to Navstar Users" (NANU) messages to calculate the total time of forecasted and actual satellite outages. This section also evaluates the Service Availability Standard using 24-hour 95% horizontal and vertical position accuracy values.

Section 4 summarizes service reliability performance. It will be reported at the end of the first year of this analysis because the SPS standard is based on a measurement interval of one year. Data for the quarter is provided for completeness.

Section 5 provides the position accuracies based on data collected on a daily basis at one-second intervals. This section also provides the statistics on the range error, range error rate and range acceleration error for each satellite. The overall average, maximum, minimum and standard deviations of the range rates and accelerations are tabulated for each satellite.

In Section 6, the data collected during solar storms is analyzed to determine the effects, if any, of GPS SPS performance.

Section 7 provides an analysis of GPS-SPS accuracy performance from a selection of high rate IGS stations around the world.

Appendix A provides a summary of all the results as compared to the SPS specification.

Appendix B provides the geomagnetic data used for Section 6.

Appendix C provides a PAN Problem Report.

Appendix D provides a glossary of terms used in this PAN report. This glossary was obtained directly from the GPS SPS specification document (October 2001).

Table 1-1 SPS Performance Requirements

PDOP Availability Standard	**Conditions and Constraints**	**Evaluated in This Report**
≥ 98% global Position Dilution of Precision (PDOP) of 6 or less ≥ 88% worst site PDOP of 6 or less	• Defined for position solution meeting the representative user conditions and operating within the service volume over any 24-hour interval. • Based on using only satellites transmitting standard code and indicating "health" in the broadcast navigation message (sub-frame 1).	✓
Service Availability Standard	**Conditions and Constraints**	
≥ 99% Horizontal Service Availability average location ≥ 99% Vertical Service Availability average location	• 36 meter horizontal (SIS only) 95% threshold. • 77 meter vertical (SIS only) 95% threshold. • Defined for position solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.	✓
≥ 95.87% global average on worst-case day	• Based on using only satellites transmitting standard code and indicating "healthy" in the broadcast navigation message (sub-frame 1).	✓
Service Reliability Standard	**Conditions and Constraints**	
≥ 99.94% global average	• 30-meter Not-to-Exceed (NTE) SPS SIS URE. • Standard based on a measurement interval of one year; average of daily values within the service volume. • Standard based on 3 service failures per year, lasting no more than 6 hours each.	✓
≥ 99.79% single point average	• 30-meter Not-to-Exceed (NTE) SPS SIS URE. • Standard based on a measurement interval of one year; average of daily values from the worst-case point within the service volume. • Standard based on 3 service failures per year, lasting no more than 6 hours each.	✓

Accuracy Standard	Conditions and Constraints	
Global Average Positioning Domain Accuracy • ≤ 13 meters 95% All-in-View horizontal error (SIS only) • ≤ 22 meters 95% All-in-View vertical error (SIS only)	• Defined for position solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours averaged over all points within the service volume.	✓
Worst Site Positioning Domain Accuracy • ≤ 36 meters 95% All-in-View Horizontal Error (SIS only) • ≤ 77 meters 95% All-in-View Vertical Error (SIS only)	• Defined for position solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours for any point within the service volume.	✓
Time Transfer Accuracy • ≤ 40 nanoseconds time transfer error 95% of time (SIS only)	• Defined for time transfer solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours averaged over all points within the service volume.	✓
SPS SIS URE STANDARD	**Conditions and Constraints**	
≤ 6 meters RMS SIS SPS URE across the entire constellation	• Average of the constellation's individual satellite SPS SIS RMS URE values over any 24-hours interval, for any point thing the service volume.	✓

2.0 PDOP Availability Standard

PDOP Availability: *The percentage of time over any 24-hour interval that the PDOP value is less than or equal to its threshold for any point within the service volume.*

Dilution of Precision (DOP): *The magnifying effect on GPS position error induced by mapping GPS ranging errors into position within the specified coordinate system through the geometry of the position solution. The DOP varies as a function of satellite positions relative to user position. The DOP may be represented in any user local coordinate desired. Examples are HDOP for local horizontal, VDOP for local vertical, PDOP for all three coordinates, and TDOP for time. .*

PDOP Availability Standard	Conditions and Constraints
≥ 98% global Position Dilution of Precision (PDOP) of 6 or less ≥ 88% worst site PDOP of 6 or less	• Defined for position solution meeting the representative user conditions and operating within the service volume over any 24-hour interval. • Based on using only satellites transmitting standard code and indicating "health" in the broadcast navigation message (sub-frame 1).

Almanacs for GPS weeks used for this coverage portion of the report were obtained from the Coast Guard web site (www.navcen.uscg.mil). Using these almanacs, an SPS coverage area program developed by the GPS test team was used to calculate the PDOP at every 5^o point between longitudes of 180W to 180E and 80S and 80N at one-minute intervals. This gives a total of 1440 samples for each of the 2376 grid points in the coverage area. Table 2-1 provides the global averages and worst-case availability over a 24-hour period for each week. Table 2-1 also gives the global 99.9% PDOP value for each of the thirteen GPS Weeks. The PDOP was 3.26127 or better 99.9% of the time for each of the 24-hour intervals.

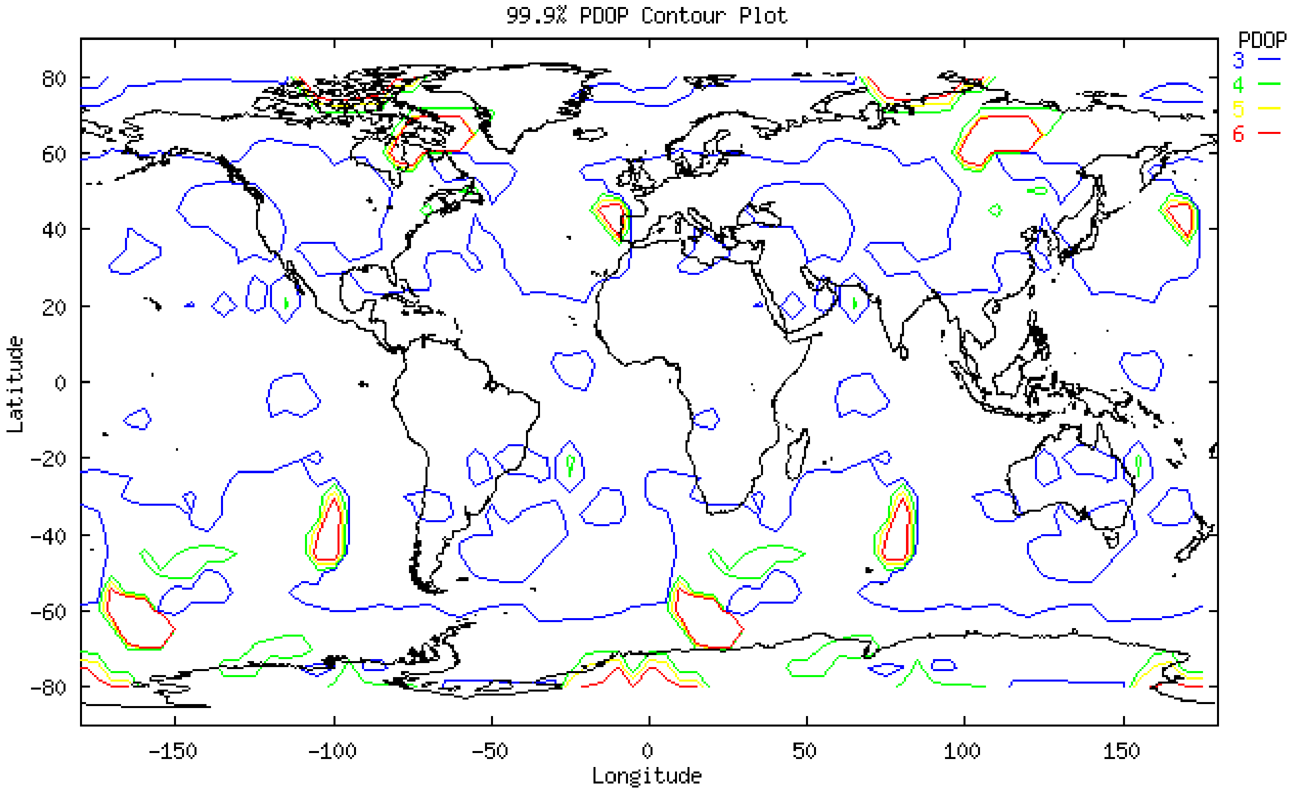
Figure 2-1 is a contour plot of PDOP values over the entire globe. Inside each contour area, the PDOP value is greater than or equal to the contour value shown in the legend for that color line. That areas' value is also less than the next higher contour value, unless another contour line lies within the current area. A single "DOP hole" where the PDOP value is greater than 6 was evaluated for satellite visibility for one 24-hour interval from the week shaded in Table 2-1. The histogram in figure 2-2 shows the satellite visibility at the DOP hole position for the 24 hour interval in question.

The GPS coverage performance evaluated met the specifications stated in the SPS.

Table 2-1 PDOP Availability Statistics

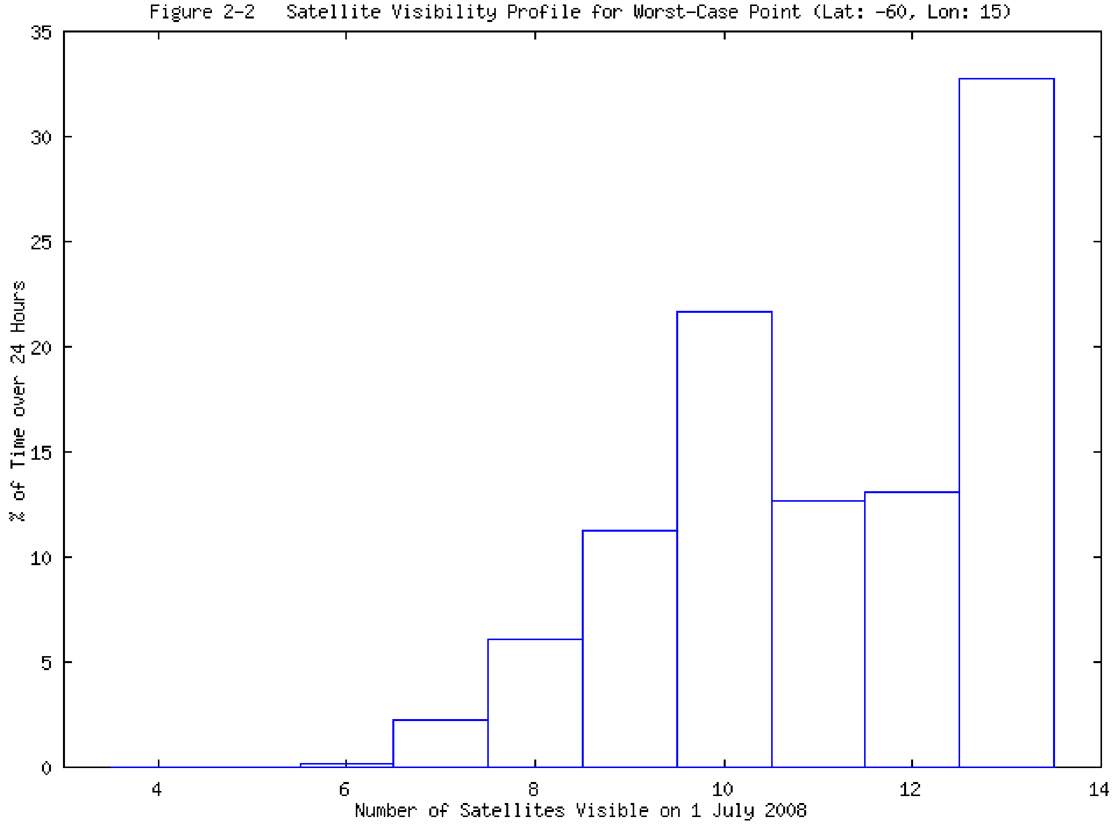
Date Range of Week	Global 99.9% PDOP Value*	Global Average* (Spec: ≥ 98%)	Worst-Case Point (Spec: ≥ 88%)
1-5 July	3.19334	99.987	99.167
6-12 July	3.11464	99.992	99.167
13-19 July	3.07719	99.993	99.167
20-26 July	3.10198	99.995	99.167
27 July – 2 Aug	3.09748	99.993	99.167
3-9 Aug	3.05618	99.996	99.167
10-16 Aug	3.16037	99.996	99.236
17-23 Aug	3.12914	99.996	99.236
24-30 Aug	3.12604	99.993	99.167
31 Aug - 6 Sept	3.12869	99.997	99.236
7-13 Sept	3.06399	99.997	99.306
14-20 Sept	3.05945	99.997	99.236
21-27 Sept	3.06977	99.993	99.236

Figure 2-1 PDOP Availability Plot (24-Hour Period: 1 July 2008)



Developed by FAA William J. Hughes Technical Center

Figure 2-2 Satellite Visibility Profile for Worst-Case Point (Lat: -60, Lon: 15)



3.0 NANU Summary and Evaluation

NANU: Notice Advisory to NAVSTAR Users - a periodic bulletin alerting users to changes in the satellite system performance.

3.1 Satellite Outages from NANU Reports

Satellite availability performance was analyzed based on published "Notice: Advisory to Navstar Users" messages (NANU's). During this reporting period, 1 July through 30 September 2008, there were a total of twenty-two reported outages. Twenty-one of these outages were maintenance activities and were reported in advance. One was an unscheduled outage. A complete listing of outage NANU's for the reporting period is provided in Table 3-1. A complete listing of the forecasted outage NANU's for the reporting period can be found in Table 3-2. Canceled outage NANU's are provided in Table 3-3.

Table 3-1 NANUs Affecting Satellite Availability

NANU #	PRN	Type	Start Date	Start Time	End Date	End Time	Total Unscheduled	Total Scheduled	Total
2008062	32	FCSTSUMM	1-Jul	14:12	1-Jul	22:38		8.43	8.43
2008064	4	FCSTSUMM	10-Jul	20:09	11-Jul	1:53		5.73	5.73
2008069	20	FCSTSUMM	18-Jul	16:34	18-Jul	23:26		6.87	6.87
2008070	16	FCSTSUMM	21-Jul	16:13	21-Jul	19:15		3.03	3.03
2008071	5	FCSTSUMM	23-Jul	1:05	23-Jul	8:24		7.32	7.32
2008075	19	FCSTSUMM	24-Jul	19:07	24-Jul	21:57		2.83	2.83
2008076	31	FCSTSUMM	28-Jul	13:18	28-Jul	16:24		3.10	3.10
2008077	17	FCSTSUMM	29-Jul	20:39	30-Jul	2:47		6.13	6.13
2008081	21	FCSTSUMM	31-Jul	13:11	31-Jul	16:43		3.53	3.53
2008082	22	FCSTSUMM	4-Aug	14:31	4-Aug	17:26		2.92	2.92
2008083	18	FCSTSUMM	5-Aug	14:06	5-Aug	16:55		2.82	2.82
2008086	28	FCSTSUMM	7-Aug	18:58	8-Aug	1:22		6.40	6.40
2008090	14	FCSTSUMM	26-Aug	16:31	26-Aug	20:58		4.45	4.45
2008095	31	FCSTSUMM	28-Aug	10:40	28-Aug	16:42		6.03	6.03
2008096	11	FCSTSUMM	2-Sep	18:46	2-Sep	21:23		2.62	2.62
2008099	7	FCSTSUMM	5-Sep	18:03	5-Sep	21:35		3.53	3.53
2008100	20	FCSTSUMM	9-Sep	14:01	9-Sep	16:42		2.68	2.68
2008104	23	FCSTSUMM	12-Sep	15:11	12-Sep	18:08		2.95	2.95
2008105	25	UNUSABLE	26-Aug	22:19	16-Sep	0:14	481.92		481.92
2008106	17	FCSTSUMM	16-Sep	15:26	16-Sep	19:39		4.22	4.22
2008107	12	FCSTSUMM	16-Sep	23:46	17-Sep	5:54		6.13	6.13
2008108	28	FCSTSUMM	18-Sep	15:37	18-Sep	18:55		3.30	3.30
Total Actual Unscheduled and Scheduled Downtime and Total Actual Downtime							**481.92**	**95.03**	**576.95**

Table 3-2 NANUs Forecasted to Affect Satellite Availability								
NANU #	PRN	Type	Start Date	Start Time	End Date	End Time	Total	Comments
2008063	4	FCSTDV	10-Jul	20:00	11-Jul	9:30	13.50	See Nanu 2008064
2008065	20	FCSTDV	18-Jul	16:15	19-Jul	7:00	14.75	See Nanu 2008069
2008066	5	FCSTDV	23-Jul	1:00	23-Jul	17:00	16.00	See Nanu 2008071
2008067	16	FCSTMX	21-Jul	15:30	22-Jul	3:30	12.00	See Nanu 2008070
2008068	19	FCSTMX	24-Jul	18:30	25-Jul	6:30	12.00	See Nanu 2008075
2008072	31	FCSTMX	28-Jul	13:00	29-Jul	1:00	12.00	See Nanu 2008076
2008073	21	FCSTMX	31-Jul	13:00	1-Aug	1:00	12.00	See Nanu 2008081
2008074	17	FCSTDV	29-Jul	20:30	30-Jul	11:00	14.50	See Nanu 2008077
2008078	22	FCSTMX	4-Aug	13:30	5-Aug	1:30	12.00	See Nanu 2008082
2008079	18	FCSTMX	5-Aug	14:00	6-Aug	2:00	12.00	See Nanu 2008083
2008080	28	FCSTDV	7-Aug	18:50	8-Aug	9:30	14.67	See Nanu 2008086
2008084	5	UNUSUFN	5-Aug	23:38	N/A	N/A	N/A	See Nanu 2008122
2008085	28	FCSTMX	7-Aug	18:58	8-Aug	1:22	6.40	
2008087	31	FCSTDV	28-Aug	10:40	29-Aug	0:30	13.83	See Nanu 2008095
2008088	14	FCSTMX	26-Aug	15:30	27-Aug	3:30	12.00	See Nanu 2008090
2008089	25	FCSTMX	27-Aug	12:00	27-Aug	17:30	5.50	CANC
2008092	25	UNUSUFN	26-Aug	22:19	N/A	N/A	N/A	See Nanu 2008105
2008093	11	FCSTMX	2-Sep	18:00	3-Sep	6:00	12.00	See Nanu 2008096
2008094	7	FCSTMX	5-Sep	18:00	6-Sep	6:00	12.00	See Nanu 2008099
2008097	20	FCSTMX	9-Sep	13:30	10-Sep	1:30	12.00	See Nanu 2008100
2008098	23	FCSTMX	12-Sep	15:00	13-Sep	3:00	12.00	See Nanu 2008104
2008101	17	FCSTMX	16-Sep	15:00	17-Sep	3:00	12.00	See Nanu 2008106
2008102	28	FCSTMX	18-Sep	15:00	19-Sep	3:00	12.00	See Nanu 2008108
2008103	12	FCSTDV	16-Sep	23:30	17-Sep	14:00	14.50	See Nanu 2008107
2008109	29	FCSTMX	23-Sep	20:30	24-Sep	8:30	12.00	CANC
2008110	15	FCSTMX	25-Sep	20:00	26-Sep	8:00	12.00	CANC
					Total Forecast Downtime		293.65	

Table 3-3 NANUs Canceled					
NANU#	PRN	Type	Start Date	Start Time	Comments
2008091	25	FCSTCANC	26-Aug	21:45	See Nanu 2008089
2008112	29	FCSTCANC	19-Sep	20:06	See Nanu 2008109
2008113	15	FCSTCANC	19-Sep	20:09	See Nanu 2008110

Satellite Reliability, Maintainability, and Availability (RMA) data is being collected based on published "Notice: Advisory to Navstar Users" messages (NANU's). This data has been summarized in Table 3-4. The "Total Satellite Observed MTTR" was calculated by taking the average downtime of all satellite outage occurrences. Schedule downtime was forecasted in advance via NANU's. All other downtime reported via NANU was considered unscheduled. The "Percent Operational" was calculated based on the ratio of total actual operating hours to total available operating hours for every satellite.

Table 3-4 GPS Block II/IIA Satellite RMA Data		
Satellite Reliability/Maintainability/Availability (RMA) Parameter	1 Apr - 30-Sep	1 October, 1999- 30 Sept 2008
Total Forecast Downtime (hrs):	293.65	7339.55
Total Actual Downtime (hrs):	576.95	25831.89
Total Actual Scheduled Downtime (hrs):	95.03	3791.98
Total Actual Unscheduled Downtime (hrs):	481.92	22039.91
Total Satellite Observed MTTR (hrs):	25.08	44.38
Scheduled Satellite Observed MTTR (hrs):	4.32	8.96
Unscheduled Satellite Observed MTTR (hrs):	481.92	138.62
# Total Satellite Outages:	22	582
# Scheduled Satellite Outages:	21	423
# Unscheduled Satellite Outages:	1	159
Percent Operational -- Scheduled Downtime:	99.86	99.83
Percent Operational -- All Downtime:	99.97	98.83

3.2 Service Availability Standard

Service Availability: The percentage of time over any 24-hour interval that the predicted 95% positioning error is less than its threshold for any given point within the service volume.

• **Horizontal Service Availability:** The percentage of time over any 24-hour interval that the predicted 95% horizontal error is less than its threshold for any point within the service volume.
• **Vertical Service Availability:** The percentage of time over any 24-hour interval that the predicted 95% vertical error is less than its threshold for any point within the service volume.

Service Availability Standard	Conditions and Constraints
≥ 99% Horizontal Service Availability average location ≥ 99% Vertical Service Availability average location	• 36 meter horizontal (SIS only) 95% threshold. • 77 meter vertical (SIS only) 95% threshold. • Defined for position solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.
≥ 95.87% global average on worst-case day	• Based on using only satellites transmitting standard code and indicating "healthy" in the broadcast navigation message (sub-frame 1).

To verify availability, the data collected from receivers at the twenty-eight WAAS sites was reduced to calculate 24-hour accuracy information and reported in Table 3-5. The data was collected at one-second intervals between 1 July and 30 September 2008.

Table 3-5 Accuracies Exceeding Threshold Statistics

Site	Total Number of Seconds of SPS Monitoring	Instances of 24-hour Threshold Failures	Quarters Service Availability %
Albuquerque	7941248	0	100%
Anchorage	7943083	0	100%
Atlanta	7940534	0	100%
Barrow	7929255	0	100%
Bethel	7931026	0	100%
Billings	7923746	0	100%
Boston	7943103	0	100%
Cleveland	7943292	0	100%
Cold Bay	7707639	0	100%
Fairbanks	7912146	0	100%
Gander	7925979	0	100%
Honolulu	7941210	0	100%
Houston	7940822	0	100%
Iqaluit	7940410	0	100%
Juneau	7256174	0	100%
Kansas City	7935823	0	100%
Kotzebue	7929181	0	100%
Los Angeles	7943110	0	100%
Merida	7794578	0	100%
Miami	7942085	0	100%
Minneapolis	7942463	0	100%
Oakland	7942982	0	100%
Salt Lake City	7328486	0	100%
San Jose Del Cabo	7858066	0	100%
San Juan	7942181	0	100%
Seattle	7923111	0	100%
Tapachula	7815254	0	100%
Washington, DC	7940552	0	100%
Global Average over Reporting Period = 100% (SPS Spec. > 95.87%)			

4.0 Service Reliability Standard

***Service Reliability:** The percentage of time over a specified time interval that the instantaneous SIS SPS URE is maintained within a specified reliability threshold at any given point within the service volume, for all healthy GPS satellites.*

Service Reliability Standard	Conditions and Constraints
≥ 99.94% global average	• 30-meter Not-to-Exceed (NTE) SPS SIS URE. • Standard based on a measurement interval of one year; average of daily values within the service volume. • Standard based on 3 service failures per year, lasting no more than 6 hours each.
≥ 99.79% single point average	• 30-meter Not-to-Exceed (NTE) SPS SIS URE. • Standard based on a measurement interval of one year; average of daily values from the worst-case point within the service volume. • Standard based on 3 service failures per year, lasting no more than 6 hours each.

Table 4-1 shows a comparison to the service reliability standard for range data collected at a set of six receivers across North America. Although the specification calls for yearly evaluations, we will be evaluating this SPS requirement at quarterly intervals. Additional range analysis results can be found in table 5-2 on page 21. The maximum User Range Error recorded this quarter was 16.243 meters at Miami on satellite PRN 27.

Table 4-1 Service Reliability Based on User Range Error

Date Range of Data Collection	Site	Number of Samples This Quarter	Number of Samples where SPS URE > 30m NTE	Service Reliability Percentage
1 July – 30 Sept 2008	**Boston**	65,037,338	0	100%
1 July – 30 Sept 2008	**Honolulu**	68,094,546	0	100%
1 July – 30 Sept 2008	**Los Angeles**	67,673,605	0	100%
1 July – 30 Sept 2008	**Miami**	65,712,063	0	100%
1 July – 30 Sept 2008	**San Juan**	68,064,628	0	100%
1 July – 30 Sept 2008	**Juneau**	61,727,447	0	100%
1 July – 30 Sept 2008	**Global**	396,309,627	0	100%

5.0 Accuracy Standard

Positioning Accuracy: The statistical difference, at a 95% probability, between position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.

• **Horizontal Positioning Accuracy:** The statistical difference, at a 95% probability, between horiz position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.
• **Vertical Positioning Accuracy:** The statistical difference, at a 95% probability, between vertical position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.

Accuracy Standard	Conditions and Constraints
Global Average Positioning Domain Accuracy • ≤ 13 meters 95% All-in-View horizontal error (SIS only) • ≤ 22 meters 95% All-in-View vertical error (SIS only)	• Defined for position solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours averaged over all points within the service volume.
Worst Site Positioning Domain Accuracy • ≤ 36 meters 95% All-in-View Horizontal Error (SIS only) • ≤ 77 meters 95% All-in-View Vertical Error (SIS only)	• Defined for position solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours for any point within the service volume.
Time Transfer Accuracy • ≤ 40 nanoseconds time transfer error 95% of time (SIS only)	• Defined for time transfer solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours averaged over all points within the service volume.
SPS SIS URE STANDARD	**Conditions and Constraints**
≤ 6 meters RMS SIS SPS URE across the entire constellation	• Average of the constellation’s individual satellite SPS SIS RMS URE values over any 24-hours interval, for any point thing the service volume.

5.1 Position Accuracy

The data used for this section was collected for every second from 1 July through 30 September 2008 at the selected WAAS locations.

Table 5-1 provides the 95% and 99.99% horizontal and vertical error accuracies for the quarter. Every twenty-four hour analysis period this quarter passed both the worst-case and global position accuracy requirements set forth by the SPS specification.

Table 5-1 Horizontal & Vertical Accuracy Statistics for the Quarter

Site	95% Horizontal (Meters)	95% Vertical (Meters)	99.99% Horizontal (Meters)	99.99% Vertical (Meters)
Albuquerque	1.994	3.438	4.667	8.122
Anchorage	1.734	3.515	3.685	9.154
Atlanta	2.008	3.939	5.440	8.750
Barrow	1.473	4.061	3.333	11.217
Bethel	1.814	3.550	4.048	10.181
Billings	2.048	3.516	5.664	6.785
Boston	2.005	3.946	4.680	9.785
Cleveland	2.089	4.022	5.682	9.305
Cold Bay	2.082	3.532	4.628	8.648
Fairbanks	1.629	3.743	4.018	10.197
Gander	1.958	3.455	4.720	11.628
Honolulu	2.693	4.101	4.437	9.297
Houston	1.958	3.688	4.942	7.372
Iqaluit	1.630	3.632	6.359	20.159
Juneau	1.873	3.380	4.141	7.922
Kansas City	2.061	3.746	6.324	7.896
Kotzebue	1.562	3.788	3.610	10.954
Los Angeles	2.019	3.979	4.675	8.000
Merida	2.214	3.834	5.418	9.477
Miami	2.061	4.007	4.985	8.459
Minneapolis	2.013	3.716	5.841	7.840
Oakland	2.061	4.093	5.090	8.483
Salt Lake City	2.057	3.577	4.308	6.813
San Jose Del Cabo	2.202	3.552	5.063	6.987
San Juan	2.008	4.114	4.308	7.838
Seattle	2.106	3.545	4.730	7.335
Tapachula	2.469	3.775	5.833	7.955
Washington, DC	2.012	4.025	5.321	9.345

Figures 5-1 and 5-2 are the combined histograms of the vertical and horizontal errors for all twenty-eight WAAS sites from 1 July to 30 September 2008.

Figure 5-1 Global Vertical Error Histogram

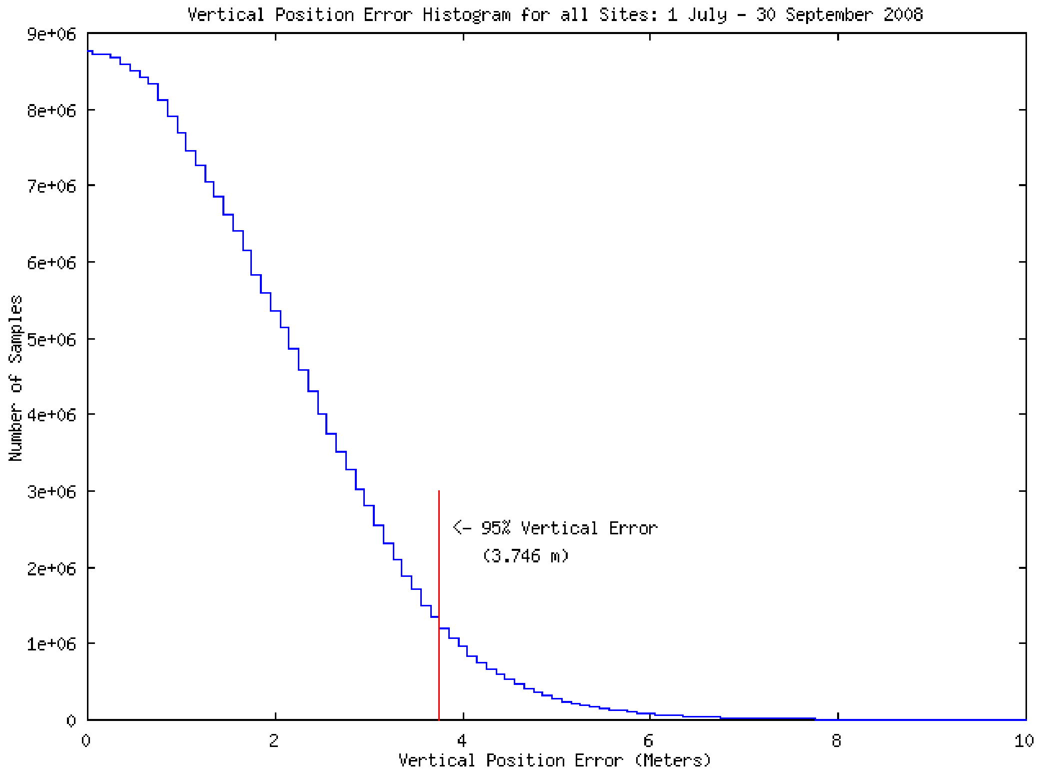
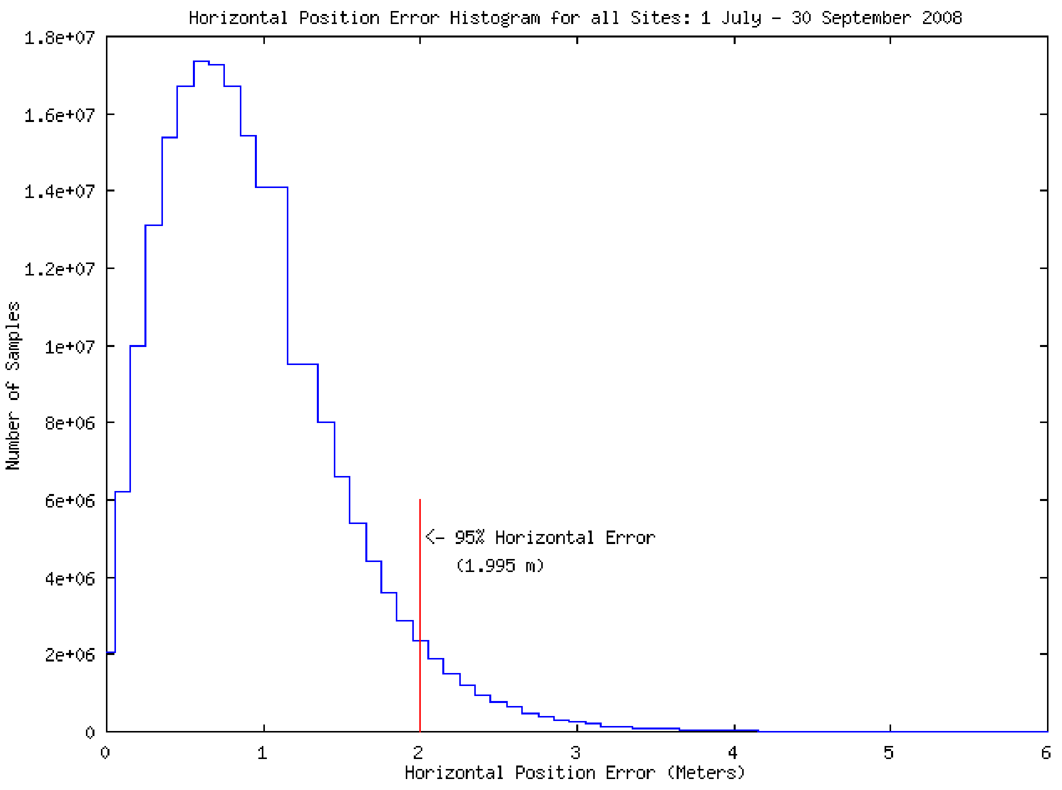


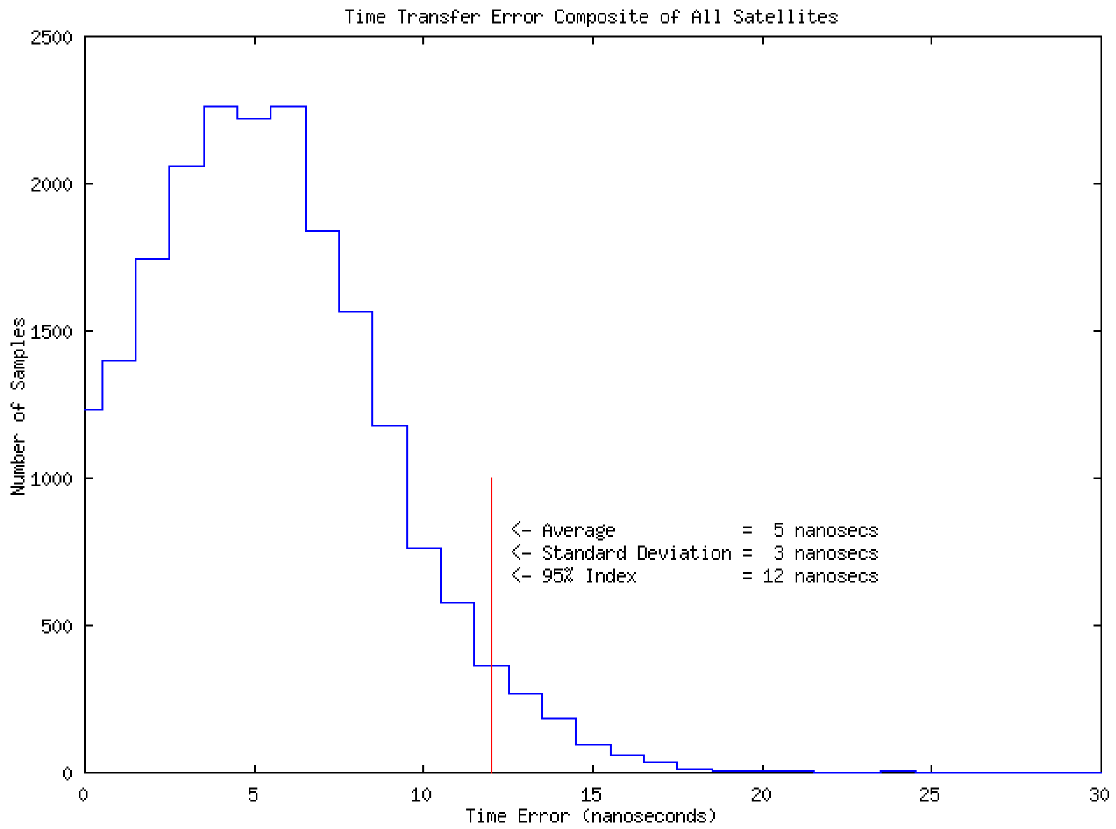
Figure 5-2 Global Horizontal Error Histogram



5.2 Time Transfer Accuracy

The GPS time error data between 1 July and 30 September 2008 was down loaded from USNO Internet site. The USNO data file contains the time difference between the USNO master clock and GPS system time for each GPS satellites during the time period. Over 10,000 samples of GPS time error are contained in the USNO data file. In order to evaluate the GPS time transfer error, the data file was used to create a histogram (Fig 5-3) to represent the distribution of GPS time error. The histogram was created by taking the absolute value of time difference between the USNO master clock and GPS system time, then creating data bins with one nanosecond precision. The number of samples in each bin was then plotted to form the histogram in Fig 5-3. The mean, standard deviation, and 95% index are within the requirements of GPS SPS time error.

Figure 5-3 Time Transfer Errors



5.3 Range Domain Accuracy

Tables 5-3 through 5-5 provide the statistical data for the range error, range rate error and the range acceleration error for each satellite. This data was collected between 1 July and 30 September 2008. The WAAS receiver at Houston was used to collect range measurement.

A weighted average filter was used for the calculation of the range rate error and the range acceleration error. All Range Domain SPS specifications were met.

Table 5-2 Range Error Statistics (meters)

PRN	RMS Range Error (≤ 6 m)	Range Error Mean	1σ	95% Range Error	Max Range Error (SPS Spec. ≤ 30 m)	Samples
2	1.5956	0.9180	1.1708	2.8555	6.639	14125934
3	1.6524	0.6143	1.1326	2.8587	6.649	12284121
4	1.4336	0.4966	1.1030	2.6513	7.481	13860724
5	1.4123	0.0238	1.1622	2.6085	7.885	5417762
6	1.4231	0.5114	1.0363	2.4920	6.000	13030971
7	1.3426	-0.2441	1.1054	2.4692	6.259	12053663
8	1.7341	0.3960	1.3610	3.2140	7.741	12913986
9	1.6082	0.5987	1.2567	2.9340	7.741	12950622
10	1.9481	1.2833	1.2270	3.3718	8.573	13570960
11	1.5287	0.6904	1.1284	2.7004	6.645	12396965
12	1.2589	0.3568	1.0815	2.3829	7.534	14335654
13	1.1867	0.1574	1.0574	2.2401	6.527	13962397
14	1.3609	0.8069	0.9691	2.4387	7.190	14114969
15	1.2627	0.3431	1.0269	2.3833	5.898	12664659
16	1.2756	0.6266	0.9603	2.2565	5.568	12883124
17	1.4425	0.0953	1.2183	2.7553	8.022	14111674
18	1.6555	1.1978	1.0493	2.8345	7.791	13109095
19	1.6051	1.0216	1.0643	2.7641	6.659	12541549
20	1.5012	0.9780	1.0220	2.6945	6.857	14190889
21	1.6734	1.1978	1.0541	2.7933	6.096	12110063
22	1.6444	1.0705	0.9900	2.7947	7.900	12438597
23	1.2235	0.4292	1.0041	2.2145	6.029	12822930
24	1.6785	0.8821	1.1344	2.9283	6.778	12405251
25	1.7139	-0.0452	1.2631	3.0937	7.374	9684496
26	1.3236	0.4708	1.0685	2.4889	6.272	12304975
27	1.8024	0.3690	1.3866	3.3164	16.243	12710914
28	1.7846	0.5158	1.3100	3.2664	9.117	12529449
29	1.4364	0.2585	1.0956	2.6318	11.797	13533907
30	1.6050	0.1219	1.2821	2.9585	7.607	13161156
31	1.1986	0.0954	1.0164	2.2642	11.377	13940056
32	1.5044	0.9285	0.9993	2.6734	6.703	14148115

Table 5-3 Range Rate Error Statistics (meters/second)

PRN	Range Rate Error RMS	Range Rate Error Mean	Range Rate Error 1σ	95% Range Rate Error	Max Range Rate Error	Samples
2	0.00133	-0.00004	0.00133	0.00252	0.08553	14125934
3	0.00166	-0.00005	0.00166	0.00275	0.15229	12284121
4	0.00134	-0.00006	0.00133	0.00241	0.09957	13860724
5	0.00206	-0.00004	0.00206	0.00231	0.14753	5417762
6	0.00119	-0.00002	0.00119	0.00228	0.12596	13030971
7	0.00128	-0.00001	0.00128	0.00244	0.07241	12053663
8	0.00185	-0.00004	0.00184	0.00278	0.15347	12913986
9	0.00183	0.00005	0.00183	0.00280	0.15575	12950622
10	0.00168	0.00002	0.00168	0.00285	0.15331	13570960
11	0.00137	-0.00001	0.00137	0.00255	0.10428	12396965
12	0.00132	-0.00001	0.00132	0.00257	0.03656	14335654
13	0.00129	0.00003	0.00128	0.00246	0.07214	13962397
14	0.00131	0.00000	0.00131	0.00248	0.08082	14114969
15	0.00129	-0.00001	0.00129	0.00250	0.03955	12664659
16	0.00126	-0.00001	0.00126	0.00243	0.04072	12883124
17	0.00141	-0.00003	0.00140	0.00259	0.12697	14111674
18	0.00130	-0.00004	0.00129	0.00250	0.05422	13109095
19	0.00127	-0.00002	0.00126	0.00244	0.06067	12541549
20	0.00128	0.00001	0.00128	0.00246	0.11884	14190889
21	0.00134	-0.00003	0.00133	0.00257	0.08636	12110063
22	0.00148	-0.00002	0.00148	0.00249	0.13769	12438597
23	0.00124	0.00001	0.00124	0.00236	0.10834	12822930
24	0.00157	-0.00005	0.00157	0.00259	0.14461	12405251
25	0.00178	-0.00002	0.00178	0.00219	0.17329	9684496
26	0.00134	0.00003	0.00133	0.00237	0.10363	12304975
27	0.00173	0.00004	0.00173	0.00262	0.17485	12710914
28	0.00146	0.00000	0.00145	0.00255	0.13215	12529449
29	0.00142	-0.00002	0.00142	0.00246	0.14057	13533907
30	0.00183	-0.00003	0.00183	0.00278	0.17085	13161156
31	0.00141	0.00003	0.00140	0.00237	0.23829	13940056
32	0.00121	0.00002	0.00121	0.00225	0.10489	14148115

Table 5-4 Range Acceleration Error Statistics (meters/second^2)

PRN	Range Acceleration Error RMS	Range Acceleration Error Mean	Range Acceleration 1σ	Max Range Acceleration Error	Samples
2	1.0162E-05	0	1.0162E-05	0.00084	14125934
3	1.2853E-05	0	1.2853E-05	0.00151	12284121
4	1.0664E-05	0	1.0664E-05	0.00100	13860724
5	1.8152E-05	0	1.8152E-05	0.00147	5417762
6	1.0241E-05	0	1.0241E-05	0.00125	13030971
7	1.0144E-05	0	1.0144E-05	0.00072	12053663
8	1.4589E-05	0	1.4589E-05	0.00153	12913986
9	1.4156E-05	0	1.4156E-05	0.00158	12950622
10	1.2719E-05	0	1.2719E-05	0.00154	13570960
11	1.0389E-05	0	1.0389E-05	0.00105	12396965
12	1.0014E-05	0	1.0014E-05	0.00036	14335654
13	1.0142E-05	0	1.0142E-05	0.00072	13962397
14	1.0410E-05	0	1.0410E-05	0.00075	14114969
15	1.0042E-05	0	1.0042E-05	0.00039	12664659
16	1.0015E-05	0	1.0015E-05	0.00040	12883124
17	1.0820E-05	0	1.0820E-05	0.00126	14111674
18	1.0077E-05	0	1.0077E-05	0.00055	13109095
19	1.0051E-05	0	1.0051E-05	0.00060	12541549
20	1.0114E-05	0	1.0114E-05	0.00119	14190889
21	1.0089E-05	0	1.0089E-05	0.00086	12110063
22	1.1976E-05	0	1.1976E-05	0.00137	12438597
23	1.0151E-05	0	1.0151E-05	0.00108	12822930
24	1.2227E-05	0	1.2227E-05	0.00144	12405251
25	1.5916E-05	0	1.5916E-05	0.00174	9684496
26	1.0619E-05	0	1.0619E-05	0.00102	12304975
27	1.3900E-05	0	1.3900E-05	0.00174	12710914
28	1.1668E-05	0	1.1668E-05	0.00132	12529449
29	1.1432E-05	0	1.1432E-05	0.00140	13533907
30	1.4551E-05	0	1.4551E-05	0.00171	13161156
31	1.1668E-05	0	1.1668E-05	0.00240	13940056
32	1.0310E-05	0	1.0310E-05	0.00105	14148115

Figures 5-4, 5-5 and 5-6 are graphical representations of the distributions of the maximum range error, range rate error and range acceleration error for all satellites. The highest maximum range error occurred on satellite 27 with an error of 16.243 meters. Satellite 16 had the lowest maximum range error of 5.568 meters.

Figure 5-4 Distribution of Daily Max Range Errors

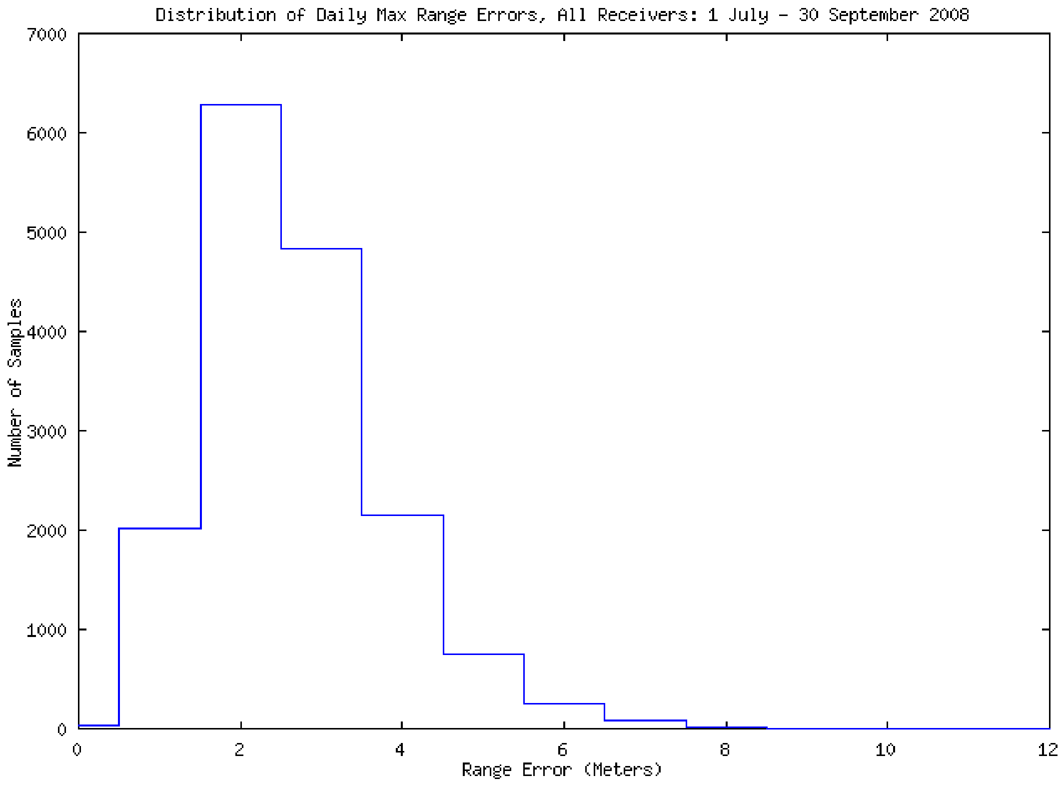


Figure 5-5: Distribution of Daily Max Range Rate Errors

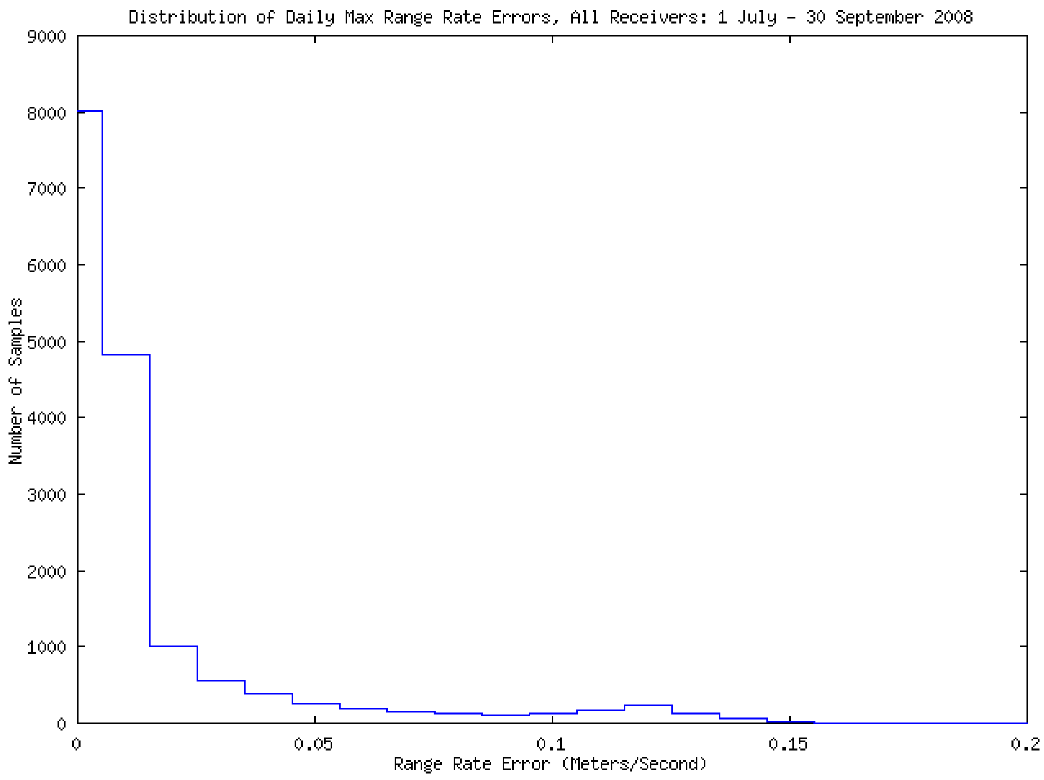


Figure 5-6: Distribution of Daily Max Acceleration Rate Errors

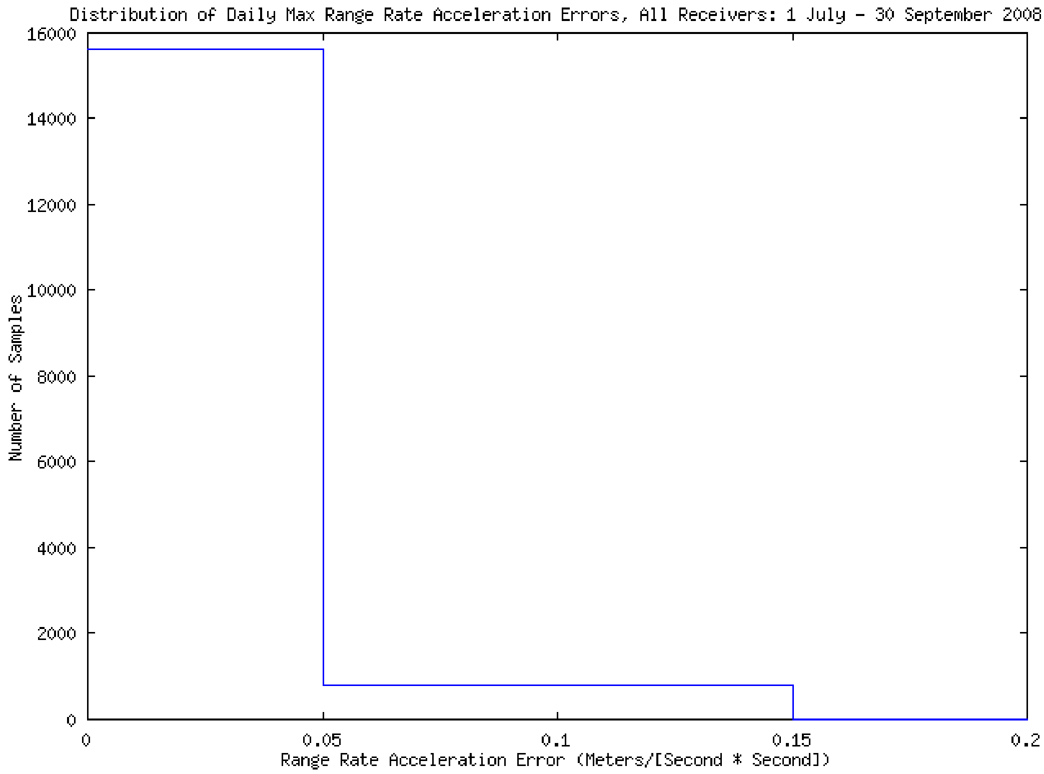
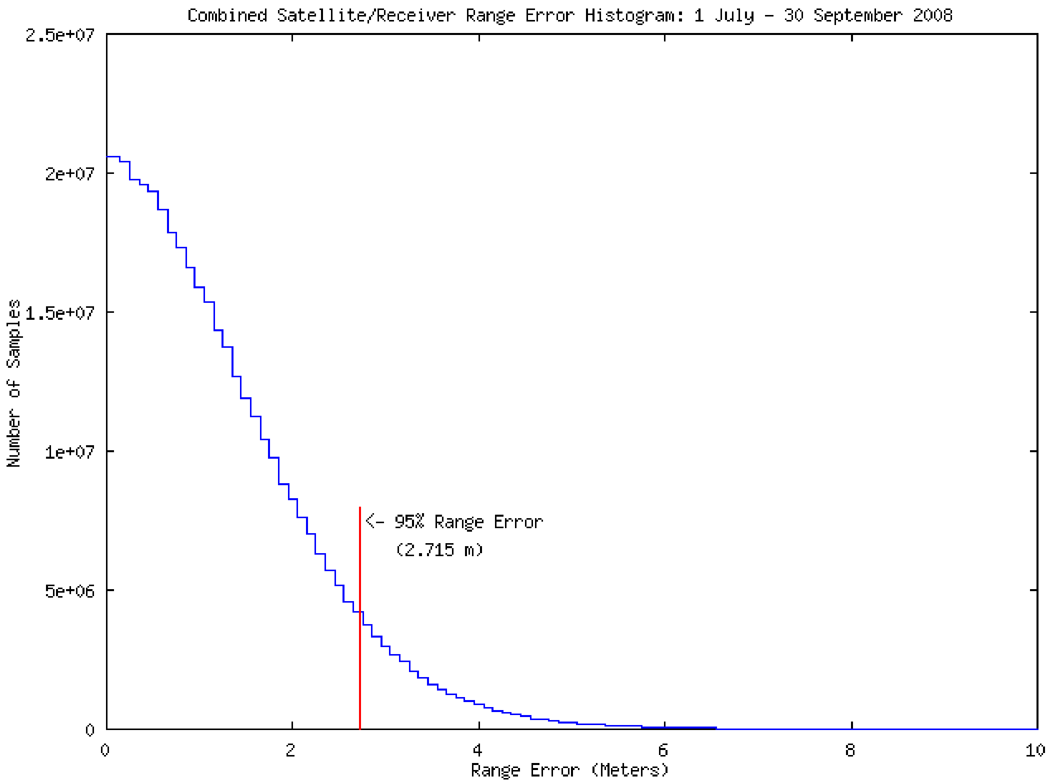


Figure 5-7: Range Error Histogram



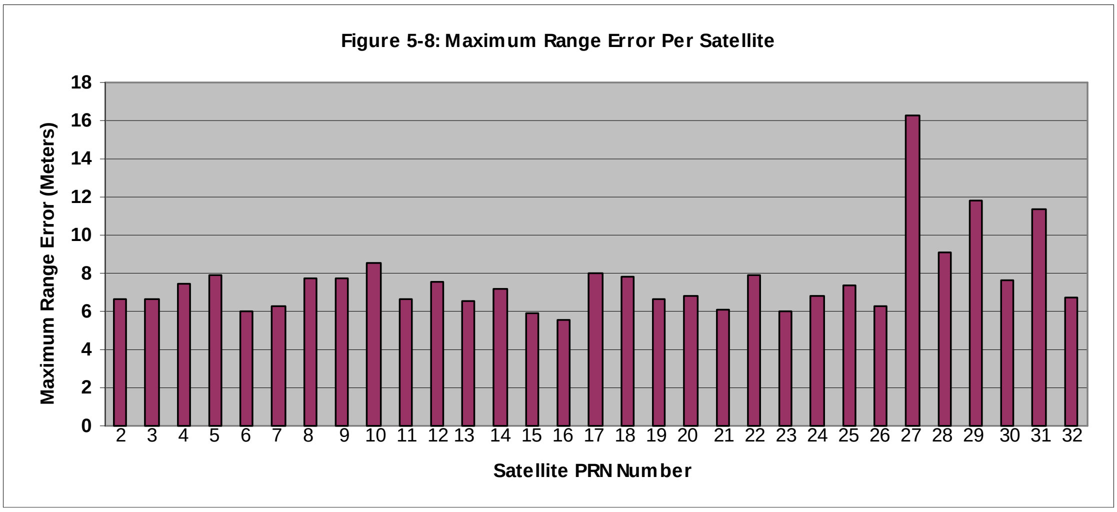


Figure 5-8: Maximum Range Error Per Satellite
Maximum Range Error (Meters)
0
2
4
6
8
10
12
14
16
18
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Satellite PRN Number

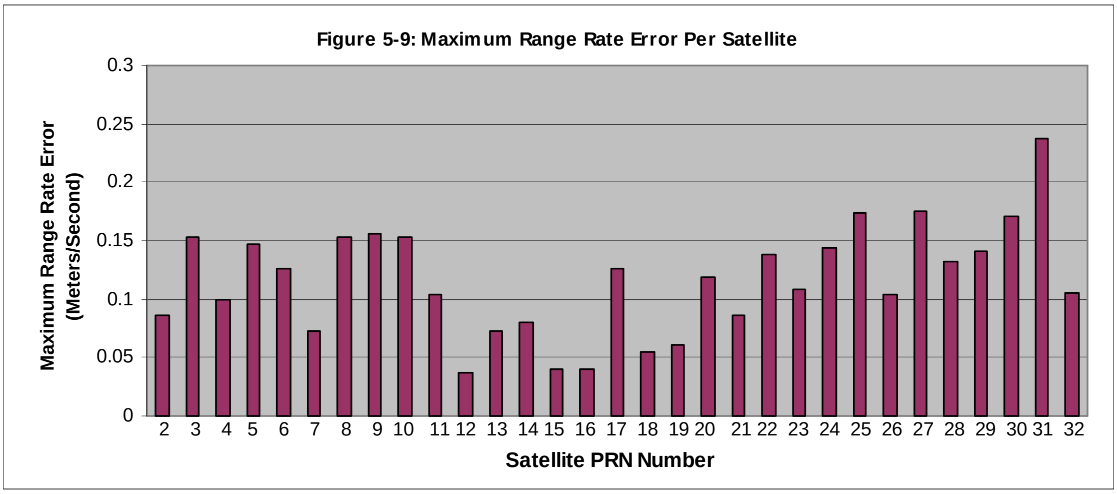


Figure 5-9: Maximum Range Rate Error Per Satellite
Maximum Range Rate Error
(Meters/Second)
0
0.05
0.1
0.15
0.2
0.25
0.3
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Satellite PRN Number

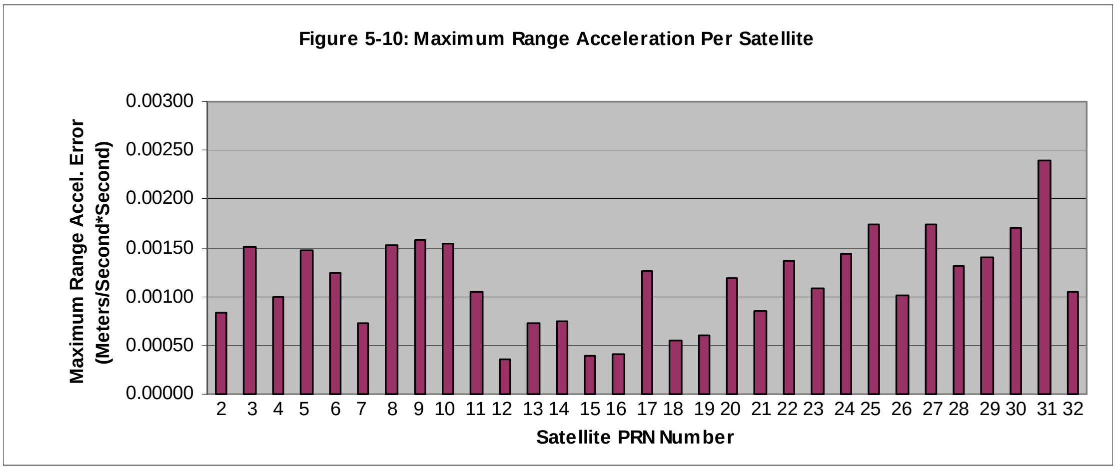


Figure 5-10: Maximum Range Acceleration Per Satellite
Maximum Range Accel. Error
(Meters/Second*Second)
0.00000
0.00050
0.00100
0.00150
0.00200
0.00250
0.00300
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Satellite PRN Number

6.0 Solar Storms

Solar storm activity is being monitored in order to assess the possible impact on GPS SPS performance. Solar activity is reported by the Space Environment Center (SEC) , a division of the National Oceanic and Atmospheric Administration (NOAA). When storm activity is indicated, ionospheric delays of the GPS signal, satellite outages, position accuracy and availability will be analyzed.

The following article was taken from the SEC web site http://sec.noaa.gov. It briefly explains some of the ideas behind the association of the aurora with geomagnetic activity and a bit about how the ‘K-index’ or ‘K-factor’ works.

The aurora is caused by the interaction of high-energy particles (usually electrons) with neutral atoms in the earth's upper atmosphere. These high-energy particles can ‘excite’ (by collisions) valence electrons that are bound to the neutral atom. The ‘excited’ electron can then ‘de-excite’ and return back to its initial, lower energy state, but in the process it releases a photon (a light particle). The combined effect of many photons being released from many atoms results in the aurora display that you see.

The details of how high energy particles are generated during geomagnetic storms constitute an entire discipline of space science in its own right. The basic idea, however, is that the Earth’s magnetic field (let us say the ‘geomagnetic field’) is responding to an outwardly propagating disturbance from the Sun. As the geomagnetic field adjusts to this disturbance, various components of the Earth’s field change form, releasing magnetic energy and thereby accelerating charged particles to high energies. These particles, being charged, are forced to stream along the geomagnetic field lines. Some end up in the upper part of the earth’s neutral atmosphere and the auroral mechanism begins.

An instrument called a magnetometer may also measure the disturbance of the geomagnetic field. At NOAA’s operations center magnetometer data is received from dozens of observatories in one-minute intervals. The data is received at or near to ‘real-time’ and allows NOAA to keep track of the current state of the geomagnetic conditions. In order to reduce the amount of data NOAA converts the magnetometer data into three-hourly indices, which give a quantitative, but less detailed measure of the level of geomagnetic activity. The K-index scale has a range from 0 to 9 and is directly related to the maximum amount of fluctuation (relative to a quiet day) in the geomagnetic field over a three-hour interval.

The K-index is therefore updated every three hours. The K-index is also necessarily tied to a specific geomagnetic observatory. For locations where there are no observatories, one can only estimate what the local K-index would be by looking at data from the nearest observatory, but this would be subject to some errors from time to time because geomagnetic activity is not always spatially homogenous.

Another item of interest is that the location of the aurora usually changes geomagnetic latitude as the intensity of the geomagnetic storm changes. The location of the aurora often takes on an ‘oval-like’ shape and is appropriately called the auroral oval.

Figures 6-1 through 6-3 show the K-index for three time periods with significant solar activity. Although there were other days with increased solar activity, these time periods were selected as examples. (See Appendix B for the actual geomagnetic data for this reporting period.)

Figure 6-1 K-Index for 3-5 September 2008

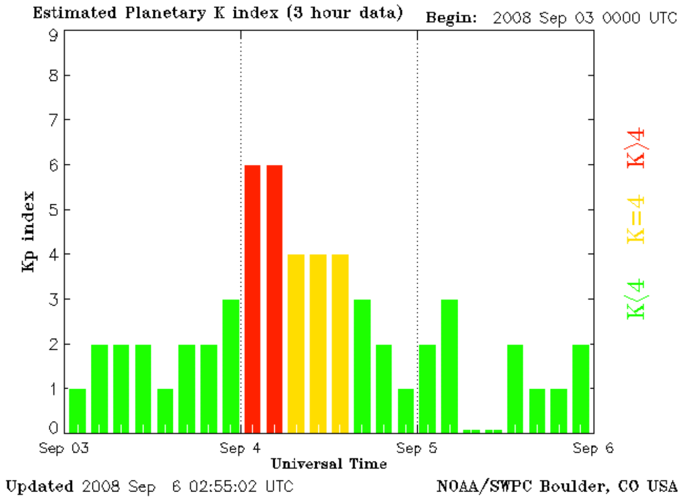


Figure 6-2 K-Index for 11-13 July 2008

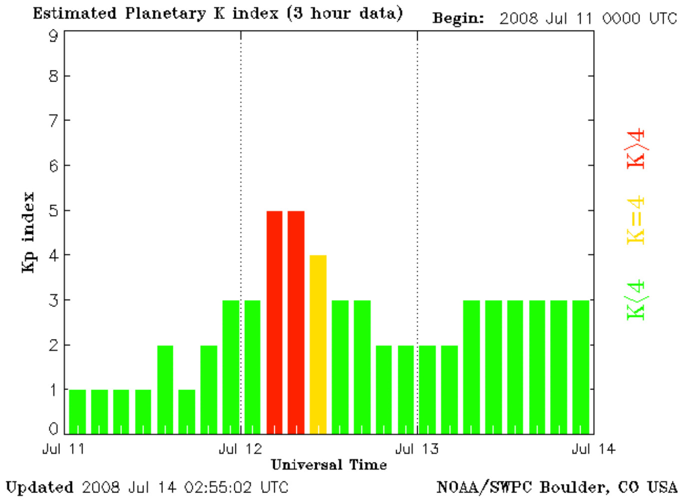


Figure 6-3 K-Index for 9-11 August 2008

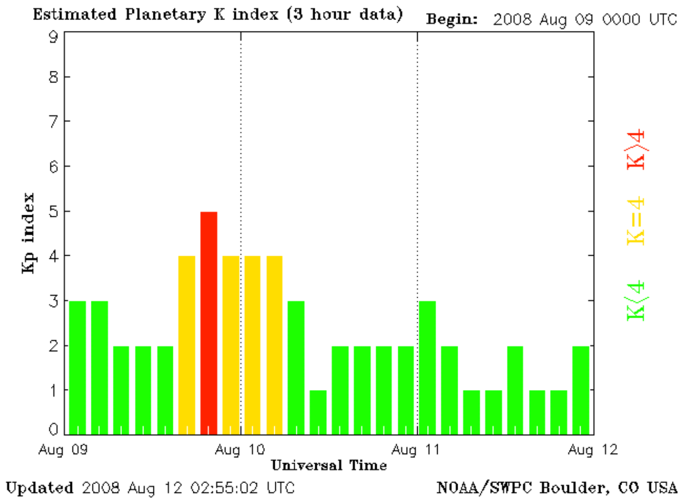


Table 6-1 shows the position accuracy information for the day corresponding to Figure 6-1. The GPS SPS performance met all requirements during all storms that occurred during this quarter.

Table 6-1 Horizontal & Vertical Accuracy Statistics for 4 September 2008

Site	95% Horizontal (Meters)	95% Vertical (Meters)	99.99% Horizontal (Meters)	99.99% Vertical (Meters)
Albuquerque	1.296	3.128	1.878	4.629
Anchorage	1.320	2.498	1.892	3.332
Atlanta	1.731	3.615	2.645	4.625
Barrow	1.299	3.042	1.767	4.104
Bethel	1.619	2.426	1.975	2.964
Billings	1.220	3.218	2.100	4.259
Boston	1.326	2.959	2.260	3.830
Cleveland	1.552	3.235	2.553	4.757
Cold Bay	1.871	2.796	2.400	3.375
Fairbanks	1.211	2.744	1.752	4.647
Gander	1.360	2.990	2.825	4.066
Honolulu	2.200	2.886	3.208	3.642
Houston	1.638	2.571	2.333	3.147
Iqaluit	1.136	2.568	5.736	18.826
Juneau	1.055	1.981	1.302	2.382
Kansas City	1.431	2.886	2.404	3.669
Kotzebue	1.312	2.961	1.725	3.619
Los Angeles	1.212	3.756	1.691	6.438
Merida	1.631	2.997	2.673	3.545
Miami	1.764	3.714	2.191	5.014
Minneapolis	1.429	3.373	2.153	4.438
Oakland	1.251	4.063	3.502	5.884
Salt Lake City	1.214	4.087	1.859	4.891
San Jose Del Cabo	1.653	3.196	2.119	4.980
San Juan	1.800	2.863	2.230	4.545
Seattle	1.477	2.954	2.157	4.374
Tapachula	2.320	3.748	2.768	7.375
Washington, DC	1.674	3.152	2.376	4.836

7.0 IGS Analysis

GPS SPS accuracy performance was evaluated at a selection of high rate IGS stations [1]. The IGS is a voluntary federation of many worldwide agencies that pool resources and permanent GNSS station data to generate precise GNSS products.

High data rate (1 Hz) sites that had high availability in 2006, were outside of the WAAS service area, and provided a good geographic distribution were selected. To facilitate differentiating between GPS accuracy issues and receiver tracking problem, an automatic data screening function excluded errors greater than 500 meters and or times when VDOP or HDOP were greater than 10. The remaining receiver tracking issues are still included in the statistics and are forced into the 50.1-meter histogram bin and are believed to influence the outliers in the 99.99% statistics. In addition Julian day 244 (August 31, 2008) has been temporarily excluded from the data set pending the resolution of an anomaly suspected to be an error in the IGS recorded broadcast ephemeris data. Once the anomaly has been resolved this PAN report will be revised.

Table 7.1 and Figure 7.1 show the IGS site information and locations. Table 7.2 shows the GPS SPS Accuracy Performance observed at a selection of High Rate IGS sites. Figure 7.2 shows the 95% horizontal accuracy at these sites. Figure 7.3 shows the 95% vertical accuracy at these sites.

During the evaluation period, the maximum 95% horizontal and vertical SPS errors are 2.62 meters at Maspalomas and 6.08 meters at New Norcia, respectively. The minimum 95% horizontal and vertical SPS errors are 1.61 meters and 3.91 meters at Norilsk. The maximum 99.99% horizontal and vertical SPS errors are 46.33 meters and >50.0 m, both at Maspalomas. A suspected receiver issue on day 189 contributes to Maspalomas being an accuracy outlier. The minimum 99.99% horizontal and vertical SPS errors are 5.09 meters at Santiago and 8.8 meters at Bangalore, respectively. GLPS was not evaluated this period due to no data being available.

(1) J.M. Dow, R.E. Neilan, G. Gendt, "The International GPS Service (IGS): Celebrating the 10th Anniversary and Looking to the Next Decade," Adv. Space Res. 36 vol. 36, no. 3, pp. 320-326, 2005.
Doi: 10.1016/j.asr.2005.05.125

Table 7-1 Selected IGS Site Information

ID	City	Country
GLPS	Puerto Ayora	Ecuador
GUAM	Dededo	Guam
IISC	Bangalore	India
KIRU	Kiruna	Sweden
KOUR	Kourou	French Guyana
MADR	Robledo	Spain
MALI	Malindi	Kenya
MAS1	Maspalomas	Spain
MOBN	Obninsk	Russian Federation
NNOR	New Norcia	Australia
NRIL	Norilsk	Russian Federation
PETS	Petropavlovsk-Kamchatka	Russian Federation
POL2	Bishkek	Kyrghyzstan
SANT	Santiago	Chile
SUTM	Sutherland	South Africa
TIDB	Tidbinbilla	Australia
USUD	Usuda	Japan

Figure 7-1 Selected IGS Site Locations

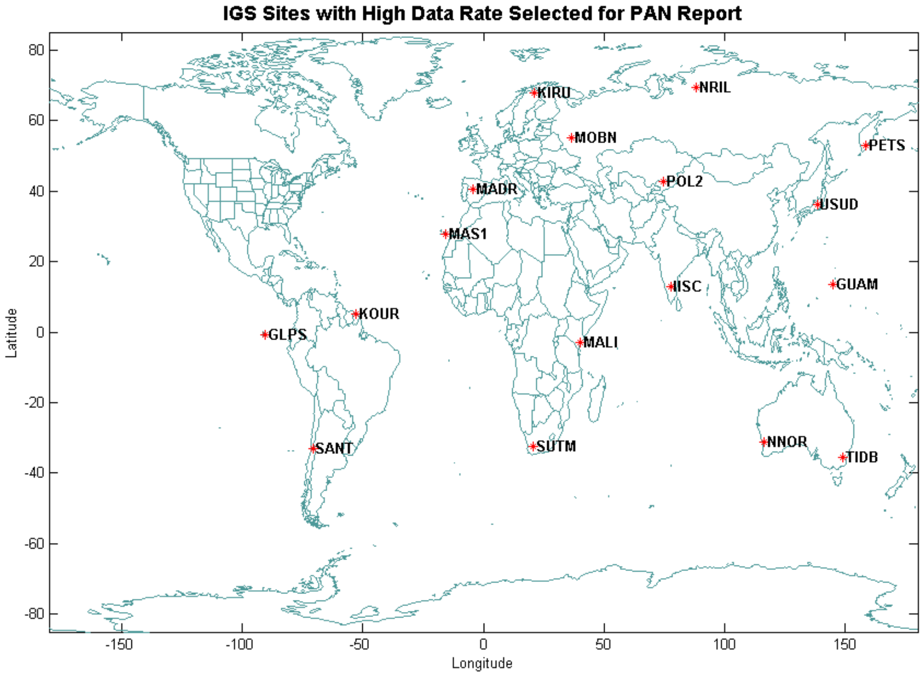


Table 7-2 GPS SPS Performance at a Selection of High Rate IGS Sites

site	95% Horizontal Error (m)	95% Vertical Error (m)	99.99% Horizontal Error (m)	99.99% Vertical Error (m)	Total 1 Hz Samples	Percent Data Available
GUAM	2.19	4.46	5.49	16.23	7857633	99.94%
IISC	1.86	4.11	5.33	8.8	6571904	83.59%
KIRU	1.91	4.27	8.44	29.14	7765148	98.76%
KOUR	1.97	4.3	10.86	23.67	7695005	97.87%
MADR	2.05	4.14	6.94	11.13	7504671	95.45%
MALI	2.01	4.48	15.09	15.73	6062636	77.11%
MAS1	2.62	4.36	46.33	>50.0	7562639	96.19%
MATE	2.06	4.08	7.9	12.27	7740443	98.45%
MOBN	2.44	4.3	13.9	18.77	7745575	98.51%
NNOR	2.39	5.09	6.08	16.52	7775017	98.89%
NRIL	1.61	3.91	5.88	12.7	7542919	95.94%
PETS	2.48	4.52	7.38	14.05	7371874	93.76%
POL2	2.25	4.05	5.6	11.49	7532370	95.80%
SANT	2.37	4.4	5.09	11.32	7774563	98.88%
SUTM	1.98	4.07	6.14	11.5	4491014	57.12%
TIDB	2.52	4.35	8.54	27.03	7536210	95.85%
USUD	2.51	4.94	6.31	13.16	7770401	98.83%

Figure 7-2 GPS SPS 95% Horizontal Accuracy Trends at Selected IGS Sites

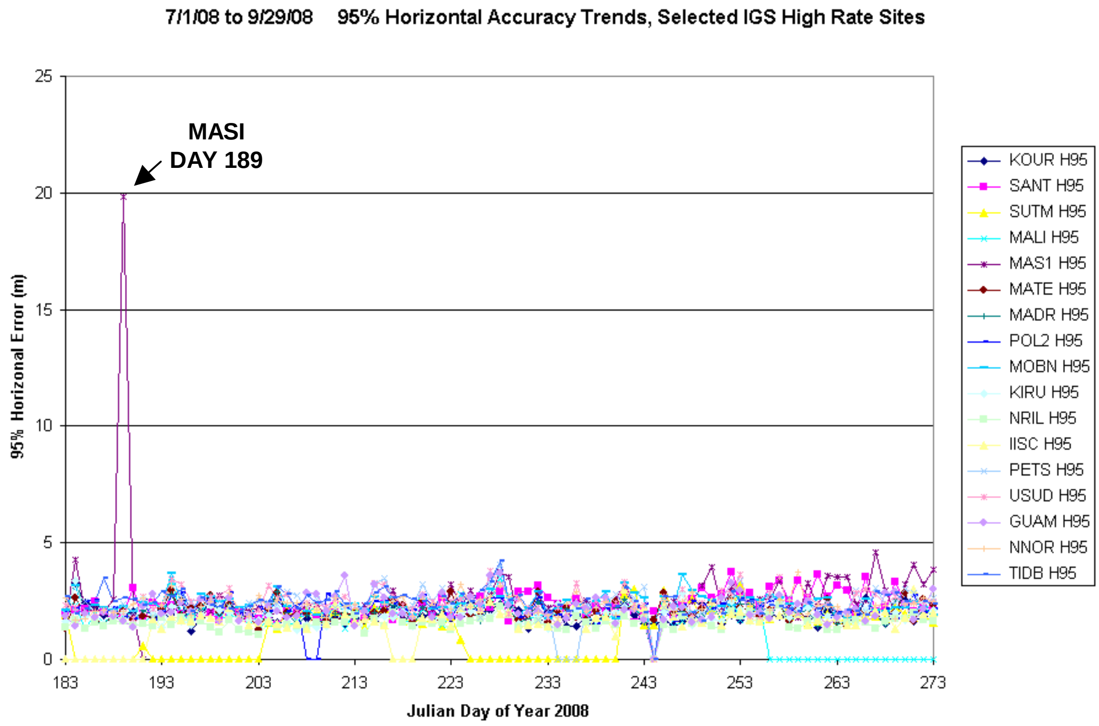
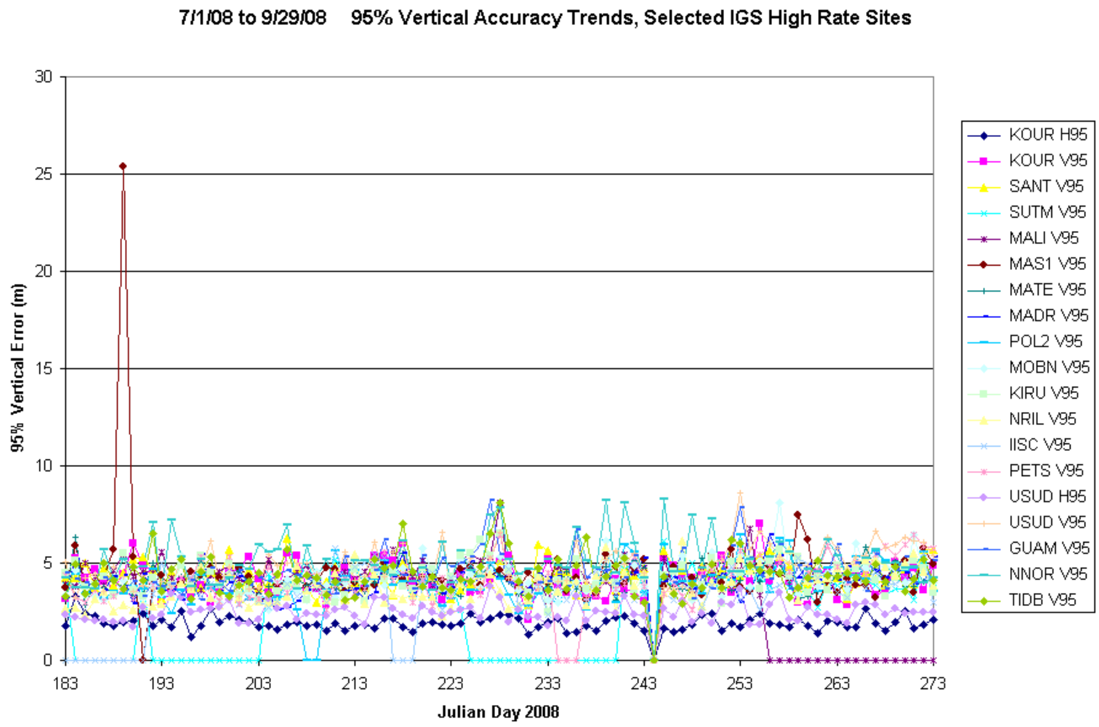


Figure 7-3 GPS SPS 95% Vertical Accuracy Trends at Selected IGS Sites



APPENDICES A – D

Conditions and Constraints	*PDOP Availability Standard*	*Measured Performance*
• Defined for position solution meeting the representative user conditions and operating within the service volume over any 24-hour interval. • Based on using only satellites transmitting standard code and indicating "health" in the broadcast navigation message (sub-frame 1).	≥ 98% global Position Dilution of Precision (PDOP) of 6 or less ≥ 88% worst site PDOP of 6 or less	≥ 99.987% ≥ 99.167%
Conditions and Constraints	***Service Availability Standard***	***Measured Performance***
• 36 meter horizontal (SIS only) 95% threshold. • 77 meter vertical (SIS only) 95% threshold. • Defined for position solution meeting the representative user conditions and operating within the service volume over any 24-hour interval.	≥ 99% Horizontal Service Availability average location ≥ 99% Vertical Service Availability average location	100%
• Based on using only satellites transmitting standard code and indicating "healthy" in the broadcast navigation message (sub-frame 1).	≥ 95.87% global average on worst-case day	100%
Conditions and Constraints	***Service Reliability Standard***	***Measured Performance***
• 30-meter Not-to-Exceed (NTE) SPS SIS URE. • Standard based on a measurement interval of one year; average of daily values within the service volume. • Standard based on 3 service failures per year, lasting no more than 6 hours each.	≥ 99.94% global average	100%
• 30-meter Not-to-Exceed (NTE) SPS SIS URE. • Standard based on a measurement interval of one year; average of daily values from the worst-case point within the service volume. • Standard based on 3 service failures per year, lasting no more than 6 hours each.	≥ 99.79% single point average	100%

Conditions and Constraints	***Accuracy Standard***	***Measured Performance***
• Defined for position solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours averaged over all points within the service volume.	Global Average Positioning Domain Accuracy • ≤ 13 meters 95% All-in-View horizontal error (SIS only) • ≤ 22 meters 95% All-in-View vertical error (SIS only)	1.995 m 3.746 m
• Defined for position solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours for any point within the service volume.	Worst Site Positioning Domain Accuracy • ≤ 36 meters 95% All-in-View Horiz Error (SIS only) • ≤ 77 meters 95% All-in-View Vertical Error (SIS only)	2.693 m 4.114 m
• Defined for time transfer solution meeting the representative user conditions. • Standard based on a measurement interval of 24 hours averaged over all points within the service volume.	Time Transfer Accuracy • ≤ 40 nanoseconds time transfer error 95% of time (SIS only)	12 nanoseconds 95%
• Average of the constellation's individual satellite SPS SIS RMS URE values over any 24-hours interval, for any point in the service volume.	≤ 6 meters RMS SIS SPS URE across the entire constellation	1.851 meters

```
#  Prepared by the U.S. Dept. of Commerce, NOAA, Space Environment Center.
#  Please send comment and suggestions to SEC.Webmaster@noaa.gov
#
#             Current Quarter Daily Geomagnetic Data
#
```

	Middle Latitude - Fredericksburg -		High Latitude ---- College ----		Estimated --- Planetary ---	
Date	A	K-indices	A	K-indices	A	K-indices
2008 07 01	4	2 1 2 1 2 0 0 1	7	2 1 2 2 4 1 0 0	5	2 2 2 1 2 1 0 2
2008 07 02	1	1 1 0 0 0 0 0 0	1	1 1 0 0 0 0 1 0	3	2 1 0 0 1 0 1 1
2008 07 03	3	1 1 0 0 1 2 1 1	1	1 1 0 0 0 0 0 0	4	1 1 0 0 1 2 1 1
2008 07 04	3	0 1 0 0 1 2 2 1	2	0 1 0 0 1 2 1 1	4	1 1 0 1 2 2 1 2
2008 07 05	7	2 1 0 2 3 2 2 2	14	2 2 0 5 4 2 2 1	7	2 1 0 2 2 2 2 2
2008 07 06	5	2 2 2 0 1 1 2 1	3	2 1 2 0 1 0 1 0	4	2 1 2 0 1 1 1 1
2008 07 07	2	1 1 0 0 1 1 0 0	1	0 1 1 0 0 0 0 0	3	1 1 0 0 1 0 0 2
2008 07 08	1	0 0 0 0 0 1 1 1	1	0 0 0 0 0 0 1 1	2	1 0 0 0 0 1 1 2
2008 07 09	3	0 1 0 1 1 1 2 1	2	1 1 0 1 1 0 1 1	4	1 1 0 1 1 0 1 2
2008 07 10	2	1 0 0 1 1 1 0 1	2	1 0 0 2 2 0 0 0	4	1 0 0 1 1 2 1 2
2008 07 11	6	1 0 2 1 2 2 2 3	9	1 1 1 4 3 1 2 2	7	1 1 1 1 2 1 2 3
2008 07 12	16	3 4 3 4 3 2 3 2	29	3 3 6 5 5 3 1 2	21	3 5 5 4 3 3 2 2
2008 07 13	10	2 2 3 2 2 1 3 3	-1	3-1 5 6 5 3 3 2	14	2 2 3 3 3 3 3 3
2008 07 14	9	2 2 3 2 2 2 2 3	-1	2 2 5 5 3 4-1-1	10	2 2 3 3 2 3 2 3
2008 07 15	7	3 1 2 1 1 1 2 2	8	3 2 2 3 2 1 1 2	7	3 2 2 2 1 2 2 2
2008 07 16	4	1 2 1 1 1 1 1 1	5	2 2 2 1 1 1 1 0	7	2 3 2 1 2 2 2 2
2008 07 17	3	2 1 1 0 0 1 1 0	-1	-1-1 1 1 1 1 2 0	5	2 2 1 1 1 1 2 1
2008 07 18	5	0 2 2 1 1 2 1 0	5	1 1 2 2 3 0 0 0	5	2 2 2 1 2 1 1 1
2008 07 19	1	0 0 0 0 1 1 0 1	0	0 0 0 0 0 0 0 0	3	1 0 0 0 1 2 1 2
2008 07 20	2	1 0 0 0 1 0 1 1	1	1 1 0 0 0 0 1 0	3	1 0 0 0 0 1 1 1
2008 07 21	5	0 1 2 2 2 1 2 1	13	1 2 4 5 3 1 1 1	6	1 1 2 2 2 1 2 2
2008 07 22	9	1 1 2 2 3 2 3 3	10	1 1 2 4 3 2 2 2	11	1 1 2 2 3 2 3 4
2008 07 23	12	3 3 3 2 3 2 3 2	29	3 4 4 5 6 4 2 1	16	3 4 3 2 3 3 3 3
2008 07 24	7	3 3 2 1 1 0 1 2	20	5 2 5 4 4 1 1 0	11	4 3 3 2 2 1 2 2
2008 07 25	2	0 1 0 1 0 1 0 1	4	1 2 1 3 0 0 0 0	3	1 2 0 2 0 0 0 1
2008 07 26	4	1 1 0 1 2 2 1 1	4	1 2 0 3 1 1 0 0	5	2 1 1 1 1 1 2 2
2008 07 27	4	0 0 0 2 1 1 2 3	4	1 0 0 3 2 0 1 2	7	0 0 0 2 1 2 2 4
2008 07 28	6	3 3 2 1 1 1 0 1	9	2 3 3 3 2 2 1 1	7	3 3 3 1 1 1 0 1
2008 07 29	2	0 0 0 1 1 1 1 1	2	0 0 0 1 1 1 1 1	3	0 1 0 1 0 1 1 1
2008 07 30	4	1 3 1 1 0 0 1 1	2	1 2 1 0 0 0 1 0	5	1 3 1 1 1 0 1 2
2008 07 31	4	0 1 1 1 1 1 3 1	3	0 1 1 3 0 0 1 0	4	1 1 0 2 1 1 1 1
2008 08 01	2	1 0 0 0 1 1 2 1	1	0 1 0 0 0 1 0 0	3	1 0 0 0 1 2 1 2
2008 08 02	2	1 0 0 1 0 0 1 2	1	0 0 0 0 0 0 1 1	3	1 0 0 0 1 1 1 2
2008 08 03	3	1 0 0 1 1 1 2 2	2	1 1 0 0 0 1 2 0	4	1 0 0 0 1 1 1 2
2008 08 04	3	1 1 0 1 1 1 1 1	1	1 1 0 1 0 0 0 1	4	1 0 0 1 1 2 1 1
2008 08 05	3	1 1 1 2 1 0 1 1	3	0 1 1 2 2 0 0 0	3	1 1 1 2 1 0 0 1
2008 08 06	5	1 1 1 1 2 1 2 2	2	0 1 1 2 0 0 1 1	4	1 1 1 1 1 1 1 2
2008 08 07	3	0 1 0 0 1 0 2 2	2	1 0 0 0 0 1 1 1	4	1 1 0 0 1 1 1 2
2008 08 08	3	0 0 0 0 1 1 1 3	1	0 1 0 0 0 0 0 1	4	1 1 0 0 0 2 1 3
2008 08 09	16	2 3 3 1 2 3 3 5	18	1 3 2 3 4 5 3 3	18	3 3 2 2 2 4 5 4
2008 08 10	9	3 3 2 2 1 2 2 2	19	4 5 2 3 3 4 2 2	13	4 4 3 1 2 2 2 2
2008 08 11	6	3 2 1 1 2 1 1 2	7	2 2 1 2 4 1 1 0	7	3 2 1 1 2 1 1 2
2008 08 12	6	2 2 2 1 1 3 1 1	7	2 2 2 2 3 2 1 0	6	3 2 2 1 1 1 1 1
2008 08 13	3	2 1 0 1 1 0 1 1	2	1 1 0 1 1 0 0 1	5	2 2 1 1 1 0 1 2
2008 08 14	4	2 3 1 1 1 0 1 0	6	2 4 0 0 1 1 1 1	5	2 3 1 0 1 1 1 1
2008 08 15	3	2 2 0 0 1 1 0 1	2	2 1 1 0 0 0 0 0	4	2 2 0 0 1 1 1 1
2008 08 16	4	0 1 1 1 0 1 2 3	2	1 0 2 0 0 0 0 1	5	1 0 1 1 1 1 1 3
2008 08 17	5	3 1 1 2 1 1 0 1	10	3 1 2 4 4 1 0 0	7	3 2 1 2 2 2 2 2
2008 08 18	15	2 3 3 3 4 2 3 3	40	2 3 4 6 7 4 3 2	23	3 4 3 4 5 4 3 3
2008 08 19	7	2 2 3 2 2 1 1 2	20	3 2 4 6 3 2 1 1	8	3 3 2 2 2 1 2 2
2008 08 20	5	3 1 2 1 1 1 1 1	4	2 2 1 1 2 1 0 1	6	3 3 2 1 1 1 0 1
2008 08 21	4	0 0 1 3 1 0 1 2	4	0 0 1 4 1 0 0 0	4	0 0 1 3 1 1 1 2
2008 08 22	2	1 1 2 1 0 0 0 0	4	1 0 2 3 1 0 0 0	4	1 1 1 1 1 1 1 2
2008 08 23	2	1 1 0 0 1 0 0 1	0	0 0 0 0 1 0 0 0	2	1 1 0 0 1 0 0 1
2008 08 24	2	0 0 1 0 1 0 1 1	1	0 0 2 1 0 0 0 0	4	0 1 1 0 1 0 1 1
2008 08 25	1	0 0 0 0 1 1 0 0	0	0 0 0 0 0 0 0 0	2	0 0 0 0 1 0 0 1
2008 08 26	1	0 0 0 0 1 1 0 0	0	0 0 0 0 0 0 1 0	3	1 0 0 0 2 1 1 2
2008 08 27	2	1 2 0 1 1 0 1 0	1	1 1 0 0 0 0 0 0	3	1 2 0 0 1 1 0 1

2008 08 28	2	0	1	0	0	1	0	1	1	1	1	1	0	0	0	0	0	0	2	1	1	0	0	0	1	1	1
2008 08 29	2	0	1	1	1	1	1	0	1	2	1	0	0	0	0	1	1	1	3	1	1	0	0	1	1	1	1
2008 08 30	2	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	3	1	0	0	1	1	1	1	2
2008 08 31	2	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	3	1	0	0	0	1	2	1	2
2008 09 01	2	1	1	0	0	1	0	1	0	2	1	2	0	0	0	0	1	0	4	1	1	0	0	1	2	2	2
2008 09 02	2	1	0	1	1	1	0	1	1	4	0	0	1	3	2	0	0	1	3	1	0	0	1	1	0	1	1
2008 09 03	7	0	2	3	2	2	2	2	2	5	0	1	2	3	0	2	1	1	7	1	2	2	2	1	2	2	3
2008 09 04	17	4	5	3	3	3	2	2	1	50	5	5	6	6	6	5	2	2	33	6	6	4	4	4	3	2	1
2008 09 05	7	2	3	1	2	2	1	1	2	9	2	3	1	2	4	1	1	1	7	2	3	0	0	2	1	1	2
2008 09 06	7	3	1	1	2	2	1	2	2	9	2	2	0	3	4	2	1	1	7	3	1	0	1	3	2	2	2
2008 09 07	7	3	2	1	0	2	2	3	1	7	2	1	0	2	4	1	2	1	8	3	2	0	0	2	1	3	1
2008 09 08	9	2	3	3	2	2	2	2	1	15	2	2	4	5	3	2	2	1	8	1	3	2	2	2	2	2	2
2008 09 09	4	1	2	2	1	1	0	1	2	3	1	2	2	1	0	0	0	1	6	1	2	2	1	0	1	1	3
2008 09 10	2	1	1	1	0	0	1	1	0	2	1	1	1	1	0	1	0	0	4	1	1	0	1	1	1	1	1
2008 09 11	1	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	2	0	1	0	0	0	0	1	2
2008 09 12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	1
2008 09 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008 09 14	4	0	0	2	1	0	0	2	3	3	0	0	1	1	0	0	2	2	6	0	0	1	0	1	1	3	4
2008 09 15	11	2	2	3	4	2	2	2	2	29	3	3	6	5	5	3	2	1	15	2	3	3	4	4	3	3	2
2008 09 16	7	0	3	3	2	1	1	2	1	15	1	2	5	5	2	1	1	1	9	1	4	3	2	1	1	1	2
2008 09 17	3	2	3	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	3	2	3	0	0	0	0	0	1
2008 09 18	5	2	2	2	2	2	1	0	0	21	1	2	6	5	4	1	0	0	9	1	2	3	3	3	1	0	1
2008 09 19	3	0	2	2	2	0	1	1	0	8	0	1	3	4	3	1	1	0	5	0	1	2	2	2	1	1	2
2008 09 20	1	2	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	3	2	2	0	0	0	1	0	0
2008 09 21	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	1	0	2	1	0	0	0	1	1	0	2
2008 09 22	2	2	2	0	0	0	0	0	1	1	2	1	0	0	0	0	0	0	4	3	3	0	0	0	1	0	1
2008 09 23	2	0	0	2	1	1	0	0	0	1	0	0	1	1	1	0	0	0	3	0	0	1	1	1	1	1	1
2008 09 24	1	0	1	0	1	0	0	0	1	2	0	0	1	2	2	0	0	0	4	1	1	0	1	2	1	1	2
2008 09 25	1	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	1	1	4	0	0	0	0	1	1	3	3
2008 09 26	2	2	1	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	4	2	1	0	0	1	1	1	1
2008 09 27	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	2	0	0	0	0	1	1	2	1
2008 09 28	2	0	1	1	0	2	1	0	0	3	0	0	0	2	3	0	0	0	3	0	1	1	1	2	1	0	1
2008 09 29	2	0	1	1	1	1	0	0	0	3	0	0	2	3	1	0	0	0	2	0	0	2	1	1	0	0	1
2008 09 30	3	0	0	0	0	2	1	2	2	1	0	0	0	0	0	1	1	1	4	0	0	0	0	1	2	1	3

Background:

In 1993, the FAA began monitoring and analyzing Global Positioning System (GPS) Standard Positioning Service (SPS) performance data. At present, the FAA has approved GPS for IFR and is developing WAAS and LAAS, both of which are GPS augmentation systems. In order to ensure the safe and effective use of GPS and its augmentation systems within the NAS, it is critical that characteristics of GPS performance as well as specific causes for service outages be monitored and understood. To accomplish this objective, GPS SPS performance data is documented in a quarterly GPS Performance Analysis (PAN) report. The PAN report contains data collected at various National Satellite Test Bed (NSTB) and Wide Area Augmentation System (WAAS) reference station locations. This PAN Problem Report will be issued only when the performance data fails to meet the GPS Standard Positioning Service (SPS) Signal Specification.

Problem Description:

There were no problems to report for the quarter.

The terms and definitions discussed below are taken from the Standard Positioning Service Performance Specification (October 2001). An understanding of these terms and definitions is a necessary prerequisite to full understanding of the Signal Specification.

General Terms and Definitions

Almanac Longitude of the Ascending Node (.o): Equatorial angle from the Prime Meridian (Greenwich) at the weekly epoch to the ascending node at the ephemeris reference epoch.

Coarse/Acquisition (C/A) Code: A PRN code sequence used to modulate the GPS L1 carrier.

Corrected Longitude of Ascending Node (Ωk) and Geographic Longitude of the Ascending Node (GLAN): Equatorial angle from the Prime Meridian (Greenwich) to the ascending node, both at arbitrary time T_k.

Dilution of Precision (DOP): The magnifying effect on GPS position error induced by mapping GPS ranging errors into position within the specified coordinate system through the geometry of the position solution. The DOP varies as a function of satellite positions relative to user position. The DOP may be represented in any user local coordinate desired. Examples are HDOP for local horizontal, VDOP for local vertical, PDOP for all three coordinates, and TDOP for time.

Equatorial Angle: An angle along the equator in the direction of Earth rotation.

Geometric Range: The difference between the estimated locations of a GPS satellite and an SPS receiver.

Ground track Equatorial Crossing (GEC, λ, 2 SOPS GLAN): Equatorial angle from the Prime Meridian (Greenwich) to the location a ground track intersects the equator when crossing from the Southern to the Northern hemisphere. GEC is equal to Ωk when the argument of latitude (Φ) is zero.

Instantaneous User Range Error (URE): The difference between the pseudo range measured at a given location and the expected pseudo range, as derived from the navigation message and the true user position, neglecting the bias in receiver clock relative to GPS time. A signal-in-space (SIS) URE includes residual orbit, satellite clock, and group delay errors. A system URE (sometimes known as a User Equivalent Range Error, or UERE) contains all line-of-sight error sources, to include SIS, single-frequency ionosphere model error, troposphere model error, multipath and receiver noise.

Longitude of Ascending Node (LAN): A general term for the location of the ascending node – the point that an orbit intersects the equator when crossing from the Southern to the Northern hemisphere.

Longitude of the Ground track Equatorial Crossing (GEC, λ, 2 SOPS GLAN): Equatorial angle from the Prime Meridian (Greenwich) to the location a ground track intersects the equator when crossing from the Southern to the Northern hemisphere. GEC is equal to Ωk when the argument of latitude (Φ) is zero.

Mean Down Time (MDT): A measure of time required to restore function after any downing event.

Mean Time Between Downing Events (MTBDE): A measure of time between any downing events.

Mean Time Between Failures (MTBF): A measure of time between unscheduled downing events.

Mean Time to Restore (MTTR): A measure of time required to restore function after an unscheduled downing event.

Navigation Message: Data contained in each satellite's ranging signal and consisting of the ranging signal time-of-transmission, the transmitting satellite's orbital elements, an almanac containing abbreviated orbital element information to support satellite selection, ranging measurement correction information, and status flags. The message structure is described in Section 2.1.2 of the SPS Performance Standard.

Operational Satellite: A GPS satellite which is capable of, but is not necessarily transmitting a usable ranging signal.

PDOP Availability: Defined to be the percentage of time over any 24-hour interval that the PDOP value is less than or equal to its threshold for any point within the service volume.

Positioning Accuracy: Defined to be the statistical difference, at a 95% probability, between position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.

- **Horizontal Positioning Accuracy:** Defined to be the statistical difference, at a 95% probability, between horizontal position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.
- **Vertical Positioning Accuracy:** Defined to be the statistical difference, at a 95% probability, between vertical position measurements and a surveyed benchmark for any point within the service volume over any 24-hour interval.

Position Solution: An estimate of a user’s location derived from ranging signal measurements and navigation data from GPS.

Position Solution Geometry: The set of direction cosines that define the instantaneous relationship of each satellite's ranging signal vector to each of the position solution coordinate axes.

Pseudo Random Noise (PRN): A binary sequence that appears to be random over a specified time interval unless the shift register configuration and initial conditions for generating the sequence are known. Each satellite generates a unique PRN sequence that is effectively uncorrelated (orthogonal) to any other satellite’s code over the integration time constant of a receiver’s code tracking loop.

Representative SPS Receiver: The minimum signal reception and processing assumptions employed by the U.S. Government to characterize SPS performance in accordance with performance standards defined in Section 3 of the SPS Performance Standard. Representative SPS receiver capability assumptions are identified in Section 2.2 of the SPS Performance Standard.

Right Ascension of Ascending Node (RAAN): Equatorial angle from the celestial principal direction to the ascending node.

Root Mean Square (RMS) SIS URE: A statistic that represents instantaneous SIS URE performance in an RMS sense over some sample interval. The statistic can be for an individual satellite or for the entire constellation. The sample interval for URE assessment used in the SPS Performance Standard is 24 hours.

Selective Availability: Protection technique formerly employed to deny full system accuracy to unauthorized users. SA was discontinued effective midnight May 1, 2000.

Service Availability: Defined to be the percentage of time over any 24-hour interval that the predicted 95% positioning error is less than its threshold for any given point within the service volume.

- **Horizontal Service Availability:** Defined to be the percentage of time over any 24-hour interval that the predicted 95% horizontal error is less than its threshold for any point within the service volume.
- **Vertical Service Availability:** Defined to be the percentage of time over any 24-hour interval that the predicted 95% vertical error is less than its threshold for any point within the service volume.

Service Degradation: A condition over a time interval during which one or more SPS performance standards are not supported.

Service Failure: A condition over a time interval during which a healthy GPS satellite's ranging signal exceeds the Not-to-Exceed (NTE) SPS SIS URE tolerance.

Service Reliability: The percentage of time over a specified time interval that the instantaneous SIS SPS URE is maintained within a specified reliability threshold at any given point within the service volume, for all healthy GPS satellites.

Service Volume: The spatial volume supported by SPS performance standards. Specifically, the SPS Performance Standard supports the terrestrial service volume. The terrestrial service volume covers from the surface of the Earth up to an altitude of 3,000 kilometers.

SPS Performance Envelope: The range of nominal variation in specified aspects of SPS performance.

SPS Performance Standard: A quantifiable minimum level for a specified aspect of GPS SPS performance. SPS performance standards are defined in Section 3.0.

SPS Ranging Signal: An electromagnetic signal originating from an operational satellite. The SPS ranging signal consists of a Pseudo Random Noise (PRN) C/A code, a timing reference and sufficient data to support the position solution generation process. A description of the GPS SPS signal is provided in Section 2. The formal definition of the SPS ranging signal is provided in ICDGPS-200C.

SPS Ranging Signal Measurement: The difference between the ranging signal time of reception (as determined by the receiver's clock) and the time of transmission derived from the navigation signal (as defined by the satellite's clock) multiplied by the speed of light. Also known as the *pseudo range*.

SPS SIS User Range Error (URE) Statistic:

- A satellite SPS SIS URE statistic is defined to be the Root Mean Square (RMS) difference between SPS ranging signal measurements (neglecting user clock bias and errors due to propagation environment and receiver), and "true" ranges between the satellite and an SPS user at any point within the service volume over a specified time interval.
- A constellation SPS SIS URE statistic is defined to be the average of all satellite SPS SIS URE statistics over a specified time interval.

Time Transfer Accuracy Relative to UTC (USNO): The difference at a 95% probability between user UTC time estimates and UTC (USNO) at any point within the service volume over any 24-hour interval.

Transient Behavior: Short-term behavior not consistent with steady-state expectations.

Usable SPS Ranging Signal: An SPS ranging signal that can be received, processed, and used in a position solution by a receiver with representative SPS receiver capabilities.

User Navigation Error (UNE): Given a sufficiently stationary and ergodic satellite constellation ranging error behavior over a minimum sample interval, multiplication of the DOP and a constellation ranging error standard deviation value will yield an approximation of the RMS position error. This RMS approximation is known as the UNE (UHNE for horizontal, UVNE for vertical, and so on). The user is cautioned that any divergence away from the stationary and ergodic assumptions will cause the UNE to diverge from a RMS value based on actual measurements.

User Range Accuracy (URA): A conservative representation of each satellite's expected (1ó) SIS URE performance (excluding residual group delay) based on historical data. A URA value is provided that is representative over the curve fit interval of the navigation data from which the URA is read. The URA is a coarse representation of the URE statistic in that it is quantized to levels represented in ICDGPS200C.