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## Where Freedom Stands

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Millions of Americans watched as the Statue of Freedom was gently lifted from its perch atop the Capitol in Washington D.C. on Mother's Day, May 9, 1993. After 130 years, this great symbol of America was in desperate need of cleaning and repair. Identified in the National Geodetic Survey (NGS) data base as CAPITOL HEAD OF FREEDOM, she also represented an important part of the horizontal portion of the National Geodetic Reference System (NGRS).

The first determination of an accurate position was performed by the United States Coast and Geodetic Survey (now NGS) between October and November 1880, as part of a triangulation of the Washington D. C. area under the direction of Subassistant C. H. Sinclair. This historic landmark has participated in all major national horizontal reference systems including the New England Datum (1880), United States Standard Datum (1901), North American Datum (1913), North American Datum of 1927 (NAD 27), the North American Datum of 1983 (NAD 83) and finally the Maryland High Accuracy Reference Network (NAD 83/91). Removal of the statue provided a unique opportunity to obtain an improved position of the center of probably the most famous building on the planet.

In an effort to maximize the opportunity provided, NGS decided to attempt to position the center of the dome where the statue is bolted. The concept was to directly occupy the dome with dual-frequency Global Positioning System (GPS) equipment and observe direct connections to nearby stations of the National Geodetic Reference System. Using GPS would provide a highly accurate three dimensional positional connection to the NGRS. This survey would be a 90's version of a similar operation conducted by the U.S. Coast and Geodetic Survey in 1937 when the Washington Monument was occupied during cleaning and repair operations by the U.S. Park Service.

Permission to proceed with this one-in-a-lifetime survey was obtained from the Architect of the Capitol, George White in late May. James Cieutat, Superintendent of Construction was assigned as the point of contact for survey activities. Unlike most job sites, operations on the Capitol grounds require very strict security arrangements. Officers of the Capitol Police Force are required to review all incoming traffic and personnel, which sometimes included a K-9 search, even for official government vehicles.

Once arrangements had been made to proceed for the survey, an on-site investigation of the dome was conducted by Dave Doyle, Horizontal Network Branch, and Roy Anderson, Space and Physical Geodesy Branch, NGS. As with any project, proper reconnaissance proved invaluable. The initial visit indicated that access to the dome area is very complicated. Entrance to the Capitol is through the public access areas which requires a through inspection of all personnel and equipment by the Capitol Police. The building is a maze of small corridors and hallways that lead to elevators that were definitely an after thought in their design and placement. What passes for elevators are very narrow, cramped lifts that were fit into old air shafts. Due to the restricted space, several trips were required to transport equipment and people to the third story of the building. From this level the trip to the dome area is a HIKE. The walk to the top is very deceiving to the casual observer. Stairs extending from the third floor are often steep and narrow leading to the walkways in the upper levels of the Rotunda then to the base of the pedestal supporting the statue. During the reconnaissance we were treated to a first hand view of the murals painted on the Rotunda. Paintings that appear life size from the floor are gigantic up close. George Washington's thumb is as large as an adults forearm!

Under the base of the pedestal is an exit to the exterior of the dome and the scaffolding erected by the ironworkers engaged in the restoration efforts. This area is covered with the names of visitors, including maintenance workers, House and Senate staff and famous (and not so famous) politicians dating back over 100 years. A very steep and narrow stairway leads up into the center of the pedestal to the area beneath the base of Freedom. From the pedestal area we climbed the scaffolding approximately 40 feet to the walkways constructed around the top of the pedestal. This area provides a panorama view of the District of Columbia, Virginia and Maryland that few will ever experience.

Dimensions of the pedestal base were taken, from which a tripod mounting board was designed by the NGS Instrumentation and Equipment Section in Corbin, Virginia under the direction of Charlie Glover. Charlie's mounting board supported a 2-meter fixed height tripod that when installed would be forced centered on the base of the pedestal.

Scheduling of GPS operations on the Capitol were coordinated with the conclusion of the Virginia High Accuracy Reference Network (HARN). The Virginia HARN will provide easily available control points spaced approximately 30 kilometers apart positioned to A and B-Order accuracies (1:10,000,000 and 1:1,000,000 respectively). Specifications for the Capitol survey called for two sessions of 6 hours each. In addition to the GPS receiver on the dome, operations also included two previously positioned GPS control points on the east lawn of the Capitol grounds, the 1890 Meridian Stone in Presidents Park just south of the White House, and the Jefferson Pier on the west slope of the Washington Monument grounds, and a new monument dedicated to Ferdinand Hassler, the father of American geodesy, on the grounds of the new home of NGS at the National Oceanic and Atmospheric Administration (NOAA) complex in Silver Spring, Maryland. Each of these monuments is important in its own right.

The Jefferson Pier marks the first meridian of the United States and was originally established in 1793 on a line due south through the center of the White House at the intersection of a line west from the center of the Capitol. The original point was marked by a wooden stake and replaced by a stone pier in 1804. The monument was removed and replaced several times until finally being restored in 1889 under the direction of Colonel O. H. Ernst, Officer in Charge of Public Buildings and Grounds. The pier, a 2 foot square granite monument extending 2 feet above the ground remains today a point of curiosity with tourists who seldom understand its significance. The meridian of the United States was changed to the center of the dome old Naval Observatory in 1850, and finally replaced legally by the adoption the Greenwich (England) Meridian for both boundaries and navigation in 1912.

Subsequent to the reestablishment of the Jefferson Pier in 1889, the Office of Public Building and Grounds set a new monument, the Meridian Stone of 1890 in the center of Presidents Park approximately 459 meters north of and in the same meridian as the Jefferson Pier, but in a more protected area. This monument is marked by an 18 inch square granite post set flush with the ground.

Both monuments were positioned by the U. S. Coast and Geodetic Survey (now NGS) in a triangulation scheme of the District of Columbia in 1890 (also under the direction of C. H. Sinclair). While their positions were published on the NAD 27, the data for the 1890 survey was later determined to be of less than third-order quality and was not republished on the NAD 83. GPS Connections of these two monuments would once again would make them part of the NGRS.

Station HASSLER 1993 was established at the NOAA complex to honor the first Superintendent of the Survey of the Coast (now NGS) Ferdinand Hassler, a Swiss immigrant, geodesist and mathematician. Hassler's name is not well know to the

majority of surveyors, however, his vision, intellect and tenacity helped to establish the first scientific agency of the United States Government, develop the system of triangulation which has become the NGRS, establish a federal bureau of weights and measures which has become the National Institute for Standards and Technology and began the systematic charting of United States coastal areas to a level unequaled in the world.

Control points located on the east lawn of the Capitol grounds designated US CAPITOL 1 and US CAPITOL 2 were established in the summer of 1992 to support survey operations to assist the Architect of the Capitol (AOC) to locate and document the cornerstone of the Capitol, which unfortunately still remains missing. These stations will provide AOC with highly accurate starting points for any surveys that must be conducted on Capitol Hill, and assist in incorporating AOC activities into a future Federal Capitol Mall Geographic Information System. All stations in the Capitol survey program were occupied for two 6 hours sessions. The intent is for all stations to be classified at least first-order (1:100,000) horizontal control points.

GPS sessions were observed from approximately 6 am until noon on two days in early September with support from NGS office personnel (Dave Doyle, Roy Anderson, Madeline White, Janet Jean, Dennis Hoar, Mat Wingate and Frank Maida) assistance from the Washington Suburban Sanitary Commissions Survey Section (Alan Drago and Larry Trainum) and technical support provided by representatives from Trimble Navigation (George Ott and Hugh Johnson). Sessions were planned to precede the dreaded D.C. Rush Hour, maintain an optimum satellite constellation (4 or more), and minimize the interference to reconstruction operations on the dome area.

All observers were on station at the appropriate time and all instruments worked perfectly for both days. The data from this survey will provide high precision connections to both the Virginia and Maryland HARNs for one of the most important sites in the United States, if not the world. Coordinate values for all stations will be adjusted by NGS and published by early Spring, 1994.