# HIGH ACCURACY REFERENCE NETWORK FOR SOUTH DAKOTA

**David R. Doyle**
**Senior Geodesist**
**National Geodetic Survey**

The National Geodetic Survey (NGS) has recently completed the final adjustment of the Federal and Cooperative Base Networks (FBN/CBN), and Area Navigation Approach (ANA) airport surveys for South Dakota. Consisting of 328 stations, 192 new and 136 existing National Spatial Reference System (NSRS) control stations spaced at approximately 40 kilometer (25 mile) intervals, the network was observed to A and B-Order accuracy standards (5 mm + 1:10,000,000 and 8 mm + 1:1,000,000) as defined by the Federal Geodetic Control Subcommittee. This network is often referred to as the High Accuracy Reference Network (HARN). Project implementation and coordination were directed by NGS, in coordination with the South Dakota Department of Transportation, Sioux Falls South Dakota Engineering Office, U.S. Forest Service, Montana Department of Transportation, and the Nebraska Department of Roads. Field operations were conducted between May and October, 1996, using Trimble 4000SSE, 4000SSI, and 4000SST dual-frequency Global Positioning System (GPS) receivers. Most observations far exceeded the 1:1,000,000 proportional accuracy required for the B-Order adjustment.

Adjustment of the GPS data was constrained to existing FBN stations in Minnesota, Montana, Nebraska, and Wyoming. In addition, all existing lower-order horizontal control in the State will be readjusted to provide consistency between the HARN and the existing horizontal network. The readjustment will extend into the bordering states to the extent necessary to maintain consistency of the NSRS. Until the completion of the state-wide readjustment, HARN stations will be designated as "SPECIAL STATUS" on NGS data sheets to indicate their positional differences with the existing lower order NSRS stations. Given the current back log of other HARN state-wide readjustments, the South Dakota readjustment could require as much as 2 years to complete. The new coordinate values are referred to as North American Datum of 1983 (NAD 83), Adjustment of 1996, and are designated NAD 83 (1996). This designation is necessary to distinguish between the original NAD 83 Adjustment of 1986, or NAD 83 (1986), and should be applied to the coordinate values of all surveys connected to the HARN or ANA control stations. Positional changes due to the network improvement vary across the State, but are generally less than 0.6 meter (2.0 feet). Positions and velocities relative to the International Earth Rotation Service (IERS) Terrestrial Reference Frame (ITRF) will also be published for all HARN stations.

Orthometric heights for the HARN were determined by occupying 96 stations with previously determined heights by leveling or GPS, and referenced to the North American Vertical Datum of 1988 (NAVD 88). NAD 83 ellipsoidal heights were determined by holding the values published for 37 existing NSRS stations in and around the State. Accuracies of ellipsoidal and orthometric heights determined by these observations vary, but are generally better than 5 cm.

All GPS surveys performed prior to the HARN, and not submitted to NGS ("Blue Booked") for inclusion in NSRS, should be readjusted from original observations to maintain consistency with NSRS. Lower order coordinate information (e.g. cadastral survey, photogrammetry,) can be transformed from NAD 83 (1986) to NAD 83 (1996) using version 2.10 of the NADCON software supplied by NGS, with special transformation grids for the South Dakota adjustment (SDHPGN.LAS and SDHPGN.LOS). The transformation grids will be developed by NGS following the state-wide readjustment, and should provide transformation values accurate to an average of 0.06 meter +/- 0.02 meter (0.20 +/- 0.06 feet) across the State. Updated coordinate information, and the NADCON software can be obtained from the NGS Information Services Section at (301) 713-3242 and the NGS Internet Home Page at http://www.ngs.noaa.gov.

Questions concerning the HARN and state-wide readjustment or coordinate transformations should be directed to Dave Doyle, NGS Observation and Analysis Division, telephone (301) 713-3178, or E-mail daved@ngs.noaa.gov.