

HIGH ACCURACY REFERENCE NETWORK FOR KANSAS

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) for Kansas. Consisting of 120 stations, 19 new and 101 existing National Spatial Reference System (NSRS) control stations spaced at approximately 70 kilometer (44 mile) intervals, the network was observed to A and B-Order accuracy standards ($5 \text{ mm} + 1:10,000,000$ and $8 \text{ mm} + 1:1,000,000$) as defined by the Federal Geodetic Control Subcommittee. This network is often referred to as the High Accuracy Reference Network (HARN). Field operations were conducted between April, and June 1997, under the direction of NGS in cooperation with the Kansas Department of Transportation (KSDOT), Kansas State University, Environmental Protection Agency, Garden City Engineering Office, CP Engineers, the Boeing Company, Colorado Department of Transportation, Nebraska Department of Roads and the Missouri Department of Natural Resources. Observations were made using Ashtech Z-XII, Sokkia GSR2200 and Trimble 4000SSE, 4000SSI, 4000SST, 4400, dual frequency Global Positioning System (GPS) receivers. Most observations far exceeded the $1:1,000,000$ proportional accuracy required for the B-Order adjustment.

In addition to adjusting the GPS data to fiducial stations of the International GPS and Geodynamics Service (IGS), and existing FBN stations in Colorado, Missouri, Nebraska, and Oklahoma all existing 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 Kansas 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 1997, and are designated NAD 83 (1997). This designation is necessary to distinguish between the original NAD 83 Adjustment of 1986, or NAD 83 (1986). Coordinate values, including State Plane Coordinates or Universal Transverse Mercator Grid should be properly labeled to eliminate confusion. Positional changes due to the network improvement vary across the State, but are generally less than 0.3 meter (1.0 foot). 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 62 bench marks and 6 stations with previously determined heights by GPS, referenced to the North American Vertical Datum of 1988 (NAVD 88). NAD 83 ellipsoidal heights were determined by holding the values published for 6 Continuously Operating Reference Stations (CORS) and 31 existing stations with published ellipsoidal heights in and around the State. The accuracy of ellipsoidal heights determined by these observations vary, and are sometimes less than third-order. Orthometric heights are generally considered to be equivalent to those obtained by conventional vertical angle observations (0.1 meter/0.3 feet).

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, GIS data) can be transformed from NAD 83 (1986) to NAD 83 (1997) using version 2.10 of the NADCON software supplied by NGS, with special transformation grids for the Kansas adjustment (KSHPGN.LAS and KSHPGN.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 Monroe Rivers, NGS Kansas Geodetic Advisor, telephone (913) 296-6835, E-mail mrivers@wizard.dot.state.ks.us, or Dave Doyle, NGS Observation and Analysis Division, telephone (301) 713-3178, or E-mail daved@ngs.noaa.gov.