



NOAA Technical Memorandum NOS NGS-70

NADCON Version 2.10

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PROGRAM DESCRIPTION

NADCON transforms latitude and longitude coordinate values between the North American Datum of 1927 (NAD 27) and the North American Datum of 1983 (NAD 83). NADCON is the Federal standard for NAD 27 to NAD 83 datum transformations (as was articulated in the Federal Register, Volume 55, Number 155 dated August 10, 1990). NADCON also transforms data originally expressed in old island datums that exist in Alaska, Hawaii, Puerto Rico, American Samoa, and Virgin Islands into data referenced to NAD 83. However all datums, including these, are referred to within the program as NAD 27. NADCON automatically chooses the proper transformation; the user does not need to know the specific name of the old island datum.

NADCON conversions between datums are approximate values based on models of real data. NADCON should be used only when data does not exist in the data base (NGSIDB) for one of the datums required. The accuracy of the transformations should be viewed with some caution. At the 67 percent confidence level, this method introduces approximately 0.15 meter uncertainty within the conterminous United States, 0.50 meter uncertainty within Alaska, 0.20 meter uncertainty within Hawaii, and 0.05 meter uncertainty within Puerto Rico and the Virgin Islands. In areas of sparse geodetic data coverage NADCON may yield less accurate results, but seldom in excess of 1.0 meter. Transformations between NAD 83 and States/Regions with High Accuracy Reference Networks (HARNS) introduce approximately 0.05 meter uncertainty. Transformations between old datums (NAD 27, Old Hawaiian, Puerto Rico etc.) and HARN could combine uncertainties (e.g. NAD 27 to HARN equals 0.15 meter + 0.05 meter = 0.20 meter). In near offshore regions, results will be less accurate but seldom in excess of 5.0 meters. Farther offshore NAD 27 was undefined. Therefore, the NADCON computed transformations are extrapolations and no accuracy can be stated.

NADCON cannot improve the accuracy of data. Stations that are originally third-order will not become first-order stations. NADCON is merely a tool for transforming coordinate values between

datums. Remember, this program is based exclusively upon data within the official National Spatial Reference System (NSRS). Data originating from stations not part of this official reference may not be compatible. Be sure that the data to be transformed is actually referenced to the NSRS. While NADCON will print out latitudes and longitudes to 0.00001 seconds of arc, the results in the fourth or fifth place may change depending on the platform used. However, all results will be limited to, and within, the accuracy stated above. This is true even though additional precision may be implied by the results.

This additional precision is included for internal computation. Users should not infer that the accuracy is better than it really is. The following areas are available for transformations between NAD 27 and NAD 83: (Each area consists of a pair of files, one ending in .LAS (Latitude Seconds), the other .LOS (Longitude Seconds)).

Area	Name	Description
CONUS	CONTERMINOUS U S (lower 48 states)	CONUS
Alaska Islands	ALASKA	Alaska, incl. Aleutian
St. Lawrence Is., AK Alaska	STLRNC	Old Island Datum within
St. George Is., AK Alaska	STGEORGE	Old Island Datum within
St. Paul Is., AK Alaska	STPAUL	Old Island Datum within
Puerto Rico and V.I.	Puerto Rico and the Virgin Islands	PRVI
Hawaii Islands	HAWAII	Hawaiian

St. George I. and St. Paul I. are part of a region known as the Pribilof Islands. There were two separate datums, one for each island, before NAD 83. The old island datums differ significantly from NAD 27. Data input into NADCON must be consistent with the identified transformation data sets. The transformation of misidentified data can result in very large errors (as much as hundreds of meters).

The CONUS grids cover an area from 20 to 50 degrees north latitude and from 63 to 131 degrees west longitude. The Alaskan grids cover an area from 46 to 77 degrees north latitude and from 128 to 194 degrees west longitude. The CONUS and Alaskan grids overlap between 46 to 50 degrees north latitude and 128 to 131 degrees west longitude. In this area, the CONUS and Alaskan grids agree within 2 centimeters. For those cases requiring precision greater than this, the CONUS grids are to be considered correct. Remember, NADCON should be used only within the U.S. territorial limits.

HIGH ACCURACY REFERENCE NETWORK PROJECTS:

In 1992, NADCON capability was expanded to include transformations of latitude and longitude coordinate values between NAD 83 (1986) (includes post NAD 83 adjustments) and state readjustments to HARN projects. Latitude and longitude conversions from NAD 83 (1986) to HARN and from HARN to NAD 83 (1986) are computed in the same manner as those conversions between NAD 27 and NAD 83 (1986), but access HPGN (HARN) prepared files instead of the original Conus, Alaska, etc. grid files. Prior to 1992 HARNs were referred to as High Precision GPS Networks (HPGN) and that acronym is used in NADCON. Pairs of grid files are available for the following states:

Area/State Execution	File Name	Name For NADCON
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Alabama	ALHPGN	AL
Arkansas	ARHPGN	AR
Arizona	AZHPGN	AZ
California (Above 37 degrees latitude)	*CNHPGN	CN
California (Below 37 degrees latitude)	*CSHPGN	CS
Colorado	COHPGN	CO
Florida	FLHPGN	FL
Georgia	GAHPGN	GA
Guam	GUHPGN	GU
Hawaii	HIHPGN	HI

Idaho-Montana (East of 113 degrees longitude)	EMHPGN	EM
Idaho-Montana (West of 113 degrees longitude)	WMHPGN	WM
Iowa	IAHPGN	IA
Illinois	ILHPGN	IL
Indiana	INHPGN	IN
Kansas	KSHPGN	KS
Kentucky	KYHPGN	KY
Louisiana	LAHPGN	LA
Maryland - Delaware	MDHPGN	MD
Maine	MEHPGN	ME
Michigan	**MIHPGN	MI
Minnesota	MNHPGN	MN
Mississippi	MSHPGN	MS
Missouri	MOHPGN	MO
Nebraska	NBHPGN	NB
Nevada	NVHPGN	NV
New England (CT,MA,NH,RI,VT)	NEHPGN	NE
New Jersey	NJHPGN	NJ
New Mexico	NMHPGN	NM
New York	NYHPGN	NY
North Carolina	NCHPGN	NC
North Dakota	NDHPGN	ND
Ohio	OHHPGN	OH
Oklahoma	OKHPGN	OK
Pennsylvania	PAHPGN	PA
Puerto Rico-Virgin Is	PVHPGN	PV
Samoa	***ESHPGN	ES

Samoa (Western Islands)	***WSHPGN	WS
South Carolina SC	SCHPGN	
South Dakota	SDHPGN	SD
Tennessee	TNHPGN	TN
Texas (East of 100 degrees longitude)	ETHPGN	ET
Texas (West of 100 degrees longitude)	WTHPGN	WT
Utah	UTHPGN	UT
Virginia	VAHPGN	VA
Washington-Oregon	WOHPGN	WO
West Virginia	WVHPGN	WV
Wisconsin	WIHPGN	WI
Wyoming	WYHPGN	WY

** During the analysis of the transformation grids for Michigan, a serious inconsistency was found in the positional shifts for the control on Isle Royale when compared with the mainland portion of the state. Investigation revealed that this was due to the fact that no HARN stations had been observed on the island, and that the existing horizontal control had poor geometric ties to the networks in Michigan and Minnesota. The island is classified as a wilderness area by the National Park Service and will see little if any development. Therefore, the data for this area was omitted in the development of the transformation grids.

*** The positional data for American Samoa is distributed over two clusters of islands separated by many miles of ocean. The lack of control on which to base grids which this separation represents creates distortions unless the grids are split into two separate grid pairs. WSHPGN covers the Islands of Tutuila and Aunu'u. ESHPGN covers Ofu, Olosega, and Ta'u Islands.

Guam and American Samoa never went through the intermediate step of island datum to NAD83. Those islands were adjusted directly from their old island datums (Guam 1963 and American Samoa 1962) to HPGN. Consequently, positions computed on the island datums are considered to be NAD83 for the input/output purposes.

INSTALLATION

The disks in the NADCON package contain the NADCON program executable file, pairs of grid files ending in .LAS and .LOS, a README.210 file, other readme files for advanced use, four sample data sets, a utility program, NADGRD, and, in a separate directory, program source codes. The NADCON executable on this disk is for an IBM compatible microcomputer with either a hard disk or a 1.2 Mbyte floppy. A floating point coprocessor (e.g. a 8087 or 80287) is not necessary. You do not need to store the data files for areas other than the ones of interest. For example, if you are only concerned with data from Alaska, you do not need to obtain the data for Hawaii and the lower 48 States. The data files for each region are labeled with ".LAS" and ".LOS" extensions. Be sure to include both files in the directory that contains the "NADCON.EXE" file. Before using the program, copy NADCON210.EXE file and any pairs of .LAS and .LOS files you will use.

Remember, all the files MUST be in the same directory as the .EXE file for the program to work properly.

DATA INPUT/OUTPUT

As of 10/15/2001, NADCON has been modified to allow either east or west longitudes. However, NADCON still will only allow north latitudes. In areas of south latitude where grids exist, the latitude must be entered as positive. This will not affect the shifts - they will still be correct.

Data may be entered either interactively or via a file. The interactive use is preferable when only a few points are desired. Three file formats are available. These are the standard NGS Horizontal Blue Book and two very general (or free format) file structures. In the two free format input file formats, the exact column position of the latitude and longitude is not important as long as they fall within the appropriate range (columns 41-80 for free format type 1 and columns 1-40 for free format type 2). The latitude and longitude in the two general file formats may be expressed as integer degrees, integer minutes, and decimal seconds; as integer degrees and decimal minutes; or as decimal degrees. The free

format files also differ in the structure of their output file. Further information is available in the "help" feature within the program.

Sample files, TYPE1.DAT and TYPE2.DAT, are provided to give you a start with the free format file structures and with batch processing. Please note that in these input files, various data formats have been used for examples. Most users will probably use a consistent data format within an input file.

Also included in the package is a sample file of NAD 27 position data for 221 stations, and the corresponding file of NAD 83 positions output by NADCON-computed transformations. Stations were selected from each of the seven grid areas. The input file, NAD 27.DAT, and the output file, NADCON.OUT, are both in the format for *80* records described in "Input Formats and Specifications of the National Geodetic Survey Data Base, Volume I. Horizontal Control Data". The station positions in these files are useful for tests of mathematical consistency when transporting NADCON to other computers.

INPUT/OUTPUT WITH UTM OR STATE PLANE COORDINATES

Output printed to the screen and in the output file contain the latitude and longitude shifts in meters. This shift is a ground shift. It cannot be applied directly to projected coordinates such as the Universal Transverse Mercator (UTM) coordinates or State Plane coordinates. To transform UTM X-Y coordinates from NAD 27 to NAD 83, for example, is a three step procedure. First, the NAD 27 UTM coordinates must be converted to NAD 27 geographic (latitude and longitude) coordinates. Next, the NAD 27 geographic coordinates are transformed with NADCON to NAD 83 geographic coordinates. Last, the transformed geographic coordinates are converted to NAD 83 UTM coordinates. State Plane coordinate transformations are done similarly. If the state/area has a HARN, then a fourth step must be added to transform the NAD 83 geographic coordinates to "HPGN" prior to their conversion into either UTM or State Plane Coordinates. Questions concerning this procedure or software needed to convert to and from geographic coordinates, please call the NGS Information Services Branch (see below).

PROGRAM EXECUTION

Get into the directory containing NDCON210.EXE and the grid files.

Type NDCON210.

If transformation between NAD 27 and NAD 83 is selected, all grid files pertaining to NAD 27-NAD 83 shifts within the directory will be opened. If transformation between NAD 83 and HARN is selected, the user will be prompted for the two-letter area/state code. The state/area codes are listed in the available state HARN areas above. NDCON210 will permit three sets of HARN files to be open at a time. DO NOT USE THIS OPTION. Complete all the conversions for one area (state) before continuing to another area. A menu at the beginning of the program permits the user to select only one datum pair at a time for latitude, longitude conversions: NAD 27-NAD 83 or NAD 83-HPGN. If both types of conversions are needed, compute all the transformations for one datum shift first. NDCON210 will then return to the menu and conversions for the second datum shift can then be computed.

PROBLEMS

Most problems are concentrated on opening the grid files.

- Check that the file names have not been changed
- Are the grid files in the same directory as the executable?
- Do both the *.LAS and *.LOS files exist for the same area?
- Do you have NADCON, Version 2.10?

Some computers can not open all seven pairs of NAD 83-NAD 27 grid files at one time. Version 2.10 has been compiled with an option to correct this.

- Are both the *.LAS and *.LOS grid files for an area from the same source? NADCON will open a pair of grid files only if their headings are the same.

UTILITY PROGRAM, NADGRD

Included with NADCON is a utility that allows users to manipulate the gridded data sets (as described below).

This utility, NADGRD, allows users to:

- (1) reformat the binary data sets into ASCII for transfer to other computers;
- (2) reformat those data sets back into binary for use with NADCON; and

(3) reformat data into an ASCII format compatible with SURFER, a product of Golden Software, Inc., Golden, CO.

Files in this last format can be displayed as contour maps and 3-D wire-frame figures using SURFER.

In addition, the NADGRD utility can extract data sets covering a smaller area from data sets covering larger ones. These smaller, gridded areas can be used either directly with NADCON or can be reformatted themselves with NADGRD. The extraction is based on user specified minimum and maximum latitudes and longitudes for the rectangular area defining a region.

Transformations calculated with the extracted data sets will be identical to ones computed using the larger grids; there is no loss of accuracy. The README.GRD file provides additional information about NADGRD. Extracting a smaller area can be particularly important if you are only interested in a specific region, such as a state, county, or municipality. This will greatly reduce the amount of space necessary on the hard or floppy disk.

This utility will also be important to those with computer limitations, especially field parties with lap-top systems.

Note that this version is an official DISTRIBUTION version.

Comments, questions, and concerns can be addressed to:

Mr. David Doyle or Ms. Cindy Craig
Telephone: (301) 713-3178 Telephone: (301) 713-3194
email: Dave.Doyle@noaa.gov email: Cindy.Craig@noaa.gov

Additional copies of this program can be obtained from:

National Geodetic Survey
Information Services Branch
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282
Telephone: (301) 713-3242

World Wide Web Home Page: <http://www.ngs.noaa.gov>