

**National  
Geodetic  
Survey**



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U.S. Department  
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Atmospheric Administration

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Ocean Service

# ***NADCON***

## ***User Manual***

*3 March 2013*



*This document has been prepared by Information Manufacturing Corporation, 310 State Route 956,  
Rocket Center, WV. 26726, under Contract Number EA133E-06-NC-0503.  
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## Section 1 – What Is NADCON Used for?

### 1.1 The Purpose of NADCON

*NADCON applies a standard method to calculate mathematical transformations between horizontal geodetic datums.*

In 1990, the Federal Geodetic Control Committee (FGCC) announced a decision to adopt a standard method for calculating mathematical transformations between two horizontal geodetic datums: the North American Datum of 1927 (NAD 27) and the North American Datum of 1983 (NAD 83(86)). To accomplish this task, the FGCC chose the North American Datum Conversion Utility (NADCON) software as the Federal standard for performing these datum transformations. This recommendation was made with the intent of maintaining consistency in the calculations and minimizing the potential for errors.

### 1.2 What Does NADCON Do?

*NADCON transforms latitude and longitude coordinate values between any two datums for which a conversion grid is available.*

NADCON transforms latitude and longitude coordinate values between two geodetic coordinate systems known as “datums.” To do so, NADCON uses a pair of conversion grids that essentially provide a transformation “bridge” between the two datums. NADCON can transform between any two datums for which grids are available. See [Available Datum Shifts](#).

To perform the conversions, the NADCON application reads input coordinate data and uses an algorithm developed by Warren T. Dewhurst, Ph.D., and described in [NOAA Technical Memorandum NOS NGS-50](#), dated January, 1990, to calculate new coordinate values and shift offsets. Results are displayed in seconds and meters and the new values are written and displayed. Each conversion requires the presence of conversion grids that are pairs of binary files (\*.las, \*.los) made up of a grid array of datum shift values plus spatial location and parameter information. Datum shifts for each input value are calculated based on an algorithm that interpolates the positional data using a minimum curvature function. NADCON reproduces the conversions exactly the same as the prior version of NADCON.

NADCON conversions between datums are approximate values based on models of real data. NADCON should be used only when data for the point(s) to be shifted does not exist in the NGS data base (NGSIDB). 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. Accordingly, NADCON results should not be used as a navigational aid.

Transformations between NAD 83(86) 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 combine uncertainties with the transformation uncertainties occurring in the intermediate step of transforming to NAD 83(86). For example, NAD 27 to HARN requires a transformation from NAD27 to NAD 83(86) first and so the uncertainty would be 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.



## SECTION 2 – NADCON Features

<p><b>2.1 Why Was a New NADCON Version Developed?</b></p>	<p>The new version of NADCON was developed to replace and/or improve functionality of the existing application, significantly improve the user interface, expand support parameters to encompass a broader spectrum of problem types, and provide platform and architectural improvements.</p>
<p><b>2.2 What's New - NADCON Key Features</b></p> <hr/> <p><i>NADCON maintains previous functionality and adds many new features.</i></p>	<p><b>2.2.1 The Basics</b></p> <ul style="list-style-type: none"> <li>• Provides a new interface.</li> <li>• Accepts three types of latitude/longitude coordinate input.</li> <li>• Accepts any valid geographic coordinate in any hemisphere.</li> <li>• Provides a programmable interface.</li> <li>• Is compliant with section 508 of the Rehabilitation Act of 1973.</li> <li>• Allows user control of conversion grid selection.</li> <li>• Provides datum conversions that are easily extensible.</li> <li>• Supports additional input and output data formats.</li> <li>• Maintains conversion integrity of previously available formats.</li> <li>• Maintains user flexibility.</li> </ul> <p>Maintains reporting.</p> <p><b>2.2.2 The Details</b></p> <p>NADCON will provide geographic conversion services similar to the previous NADCON application. The new NADCON application not only maintains existing key features, but also adds several new features and product improvements:</p> <ul style="list-style-type: none"> <li>• <u>Provides a new interface.</u> This version includes a “user-friendly” interface, making the application easier to use, more intuitive, and therefore less prone to error. The command line interface has been eliminated.</li> <li>• <u>Accepts any valid geographic coordinate as long as it falls within a conversion grid.</u> The new application accepts any valid geographic coordinate. Previous versions of NADCON would not accept coordinates with east longitude or south latitude; it was written for use only in the northern and western hemispheres. In the new NADCON, north latitude is positive and south latitude is negative. For longitude, east is positive and west is negative.</li> </ul>



*NADCON now uses negative symbols for south latitude and west longitude.*

- However, shift values will not follow this convention. A westward shift will be positive to be consistent with previous NADCON versions in which shifts are relative to the positive west value. Therefore, a shift from 80.0W to 81.0W would be considered a shift of +1 (even though those numbers could be displayed as -80 and -81.)

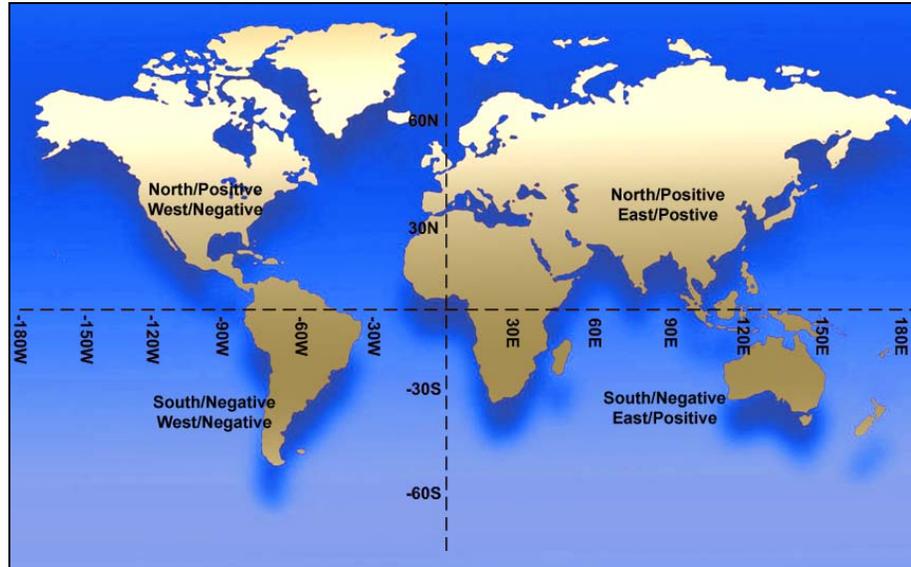


Figure 2-1: Graphic Representation of Latitude and Longitude

- Accepts three formats of coordinate data points: decimal degrees; degrees/decimal minutes; or degrees/minutes/decimal seconds.
- Provides a programmable interface: so that the library of conversion functions is callable from other computer programs.
- Is compliant with section 508 of the Rehabilitation Act of 1973: as amended (29 U.S.C. 794d) regarding accessibility and usability of software for individuals with disabilities.
- Includes all previously available grids. For a complete list, refer to [Available Datum Conversions](#).
- Allows user control of conversion grid selection. The new application performs conversions based on the conversion type selected by the user. The previous application automatically selected the first set of grids that covered an area that included the input point. Since some grids overlap, but have very different shifts (i.e. the Pribilof Islands and Alaska), this occasionally resulted in an incorrect conversion grid file selection.
- Provides datum conversions that are easily extensible: requiring only the addition of new grids.



	<ul style="list-style-type: none"><li>• <u>Supports additional input and output data formats.</u> “ESRI Shapefile” and “ESRI World File” have been added to the available formats.</li><li>• <u>Maintains conversion integrity of previously available formats.</u> The previous NADCON application accepted data input as geographic coordinate points in one of four formats. The new application numerically reproduces the conversions exactly the same except for the previously noted correction to the handling of the south latitude and west longitude. The four previously available formats are as follows:<ul style="list-style-type: none"><li>- Single geographic point stated as a latitude/longitude pair in traditional degrees, minutes and seconds.</li><li>- NGS Horizontal Bluebook format. See file <a href="#">bluebook.txt</a>.</li><li>- Data files in “Free format 1”. See file <a href="#">Free Format Type 1.doc</a>.</li><li>- Data files in “Free format 2”. See file <a href="#">Free Format Type 2.doc</a>.</li></ul></li><li>• <u>Maintains user flexibility:</u> can be downloaded and run on a stand-alone workstation or accessed via the web.</li><li>• <u>Maintains and improves reporting.</u> Consistent with the prior application, the new application produces summary reports for the conversion(s). The conversion summary report produced by NADCON adds paging, headers, and page numbers. It is important to note that if there’s only a single point to be converted the report will print the details of the conversion but not a summary page. This is because the mean and standard deviation are not meaningful when there is only one data point.</li></ul>
<p><b>2.3 Datums</b></p> <hr/> <p><i>Many Available Datum Shifts.</i></p>	<p><b>2.3.1 Available Datum Conversions</b></p> <p>The new application provides a large number of datum shifts. For a complete list, as well as pertinent notes, refer to <a href="#">Available Datum Conversions</a>.</p> <p><b>2.3.2 Additional Details About the Grid Files</b></p> <p>In 1992, NADCON capability was expanded to include transformations of latitude and longitude coordinate values between NAD 83 (86) and individual state readjustments for High Accuracy Reference Network (HARN) projects. Latitude and longitude conversions from NAD 83 (86) to HARN and from HARN to NAD 83 (86) are computed in the same manner as those conversions between NAD 27 and NAD 83 (86), but</p>



access different grid files. Prior to 1992 HARNs were referred to as High Precision Geodetic Networks (HPGN) and that acronym is used in the grid file designations; the Florida HARN grid files are, for instance, designated **flhpgn.las** and **flhpgn.los**.



## Section 3 – Using NADCON

### 3.1 Opening NADCON

Double-click the NADCON icon located on the desktop. If the icon has been removed from the desktop, go to **Start > Programs > NADCON**.

The following main screen is displayed when the program is launched from the locally-installed copy on the workstation:

Figure 3-1: NADCON Main Form

### 3.2 Converting Data Points – General Information

NADCON can convert either a single coordinate point or multiple geographic coordinates stored in one of the supported file formats.

Entering values in the Input **Latitude/Longitude** fields causes the program to perform a single point conversion. Refer to section 3.3, [“Converting a Single Data Point”](#).

Entering values in the **File Format, Input File, and Output File** fields causes the program to perform file based conversion. Refer to section 3.4, [“Converting Multiple Data Points”](#). The file formats are explained in detail, including instructions for converting multiple data points.



*New Graphic User Interface simplifies the conversion process.*

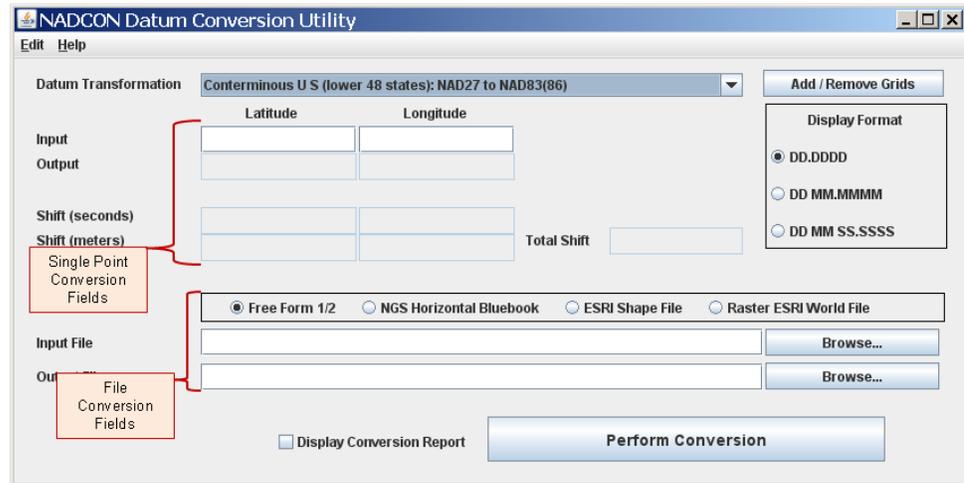


Figure 3-3: Main Form: Converting a Single Data Point versus Multiple Data Points

### 3.3 Converting a Single Data Point

*Multiple display formats are available.*

#### 3.3.1 Method

To convert a single geographic coordinate point, use the Input Latitude and Longitude fields.

1. Select the **Datum Transformation** from the pull-down menu.
2. Enter the coordinate values into the **Input Latitude** and **Longitude** fields. Coordinates can be in one of three formats:
  - Decimal Degrees (DD.DDDD)
  - Degrees and Decimal Minutes (DD MM.MMMM)
  - Degrees, Minutes, Seconds (DD MM SS.SSSSS)
  - Refer to [“Coordinate Formats”](#) for more information.

*Note: NADCON will recognize if the numbers/data entered do not meet required parameters. If a field turns yellow after the user tabs out of the field, this is an indication that the data does not fit the required format and must be revised. Holding the mouse pointer over the highlighted field (hovering) will display a brief description of the error. If the user still attempts to perform the conversion, NADCON will provide an error message.*

3. Choose the **Display Format** by clicking one of the radio buttons.

*Important Note: This choice determines the way that the*



*Coordinates MUST have a decimal point in both the Latitude and Longitude values.*

*output is displayed, regardless of the input format. This setting affects the on-screen display as well as the conversion summary report, but does not affect the values written to the supported file formats. For example, if a user enters a coordinate in DD MM SS format and the Display Format selected is DD.DDD, the NADCON program will accept the field input, validate it as a geographic value, and immediately reformat it in the decimal degrees format.*

4. Click **Display Conversion Report** if a report is desired. The report will be displayed on the screen after all conversions are complete. This file is in an ASCII text file format and can be saved, if desired, using the normal "File-Save" method for your text file viewing application. Refer to "[Conversion Detail Report](#)."
5. Click the **Perform Conversion** button. The results of the conversion will be displayed on the screen.

The output will contain the latitude and longitude of the converted coordinate point, as well as the latitude and longitude shifts in arc seconds and meters, and the total shift in meters.

### 3.3.2 Coordinate Formats

- General Information:
  - Three Formats may be used: decimal degrees; degrees and decimal minutes; and degrees, minutes, seconds.
  - *The decimal is important!* NADCON uses the location of the decimal to determine the format of the input. If no decimal is present, an error message will be displayed.
- Decimal Degrees:
  - This format treats the coordinate as a signed floating point value. Latitudes may be between -90.0000 and 90.0000. A positive value indicates north latitude. A negative value indicates south latitude. Longitudes may be between -360.00000 and 360.0000. Any number of decimal places may be specified. A positive value indicates an east longitude. A negative value indicates a west longitude. A longitude greater than 180 and less than 360 indicates that the program will treat it as "wrapping around" to the other hemisphere. Therefore longitude 185 west will be treated as 175 east.
  - Alternatively, the hemisphere may be indicated by an alphabetic indicator. Enter "E" for east or "W" for west longitude. Enter "N" for north, "S" for south latitude. The hemisphere indicator can be placed either before or after the numeric value. Following are examples of valid values in this format:



<b>Latitude</b>	<b>Longitude</b>
39.718	-78.234
39.718N	78.234W
S23.4055	165.3223-

- Degrees and Decimal Minutes:

- The latitude value is entered as an integer from -90 to 90 followed by one or more spaces. The longitude value is entered as an integer from -360 to 360 followed by one or more spaces. Following the space, the minutes value is entered as a floating point value ranging from 0.0000 to 60.0000, for both latitude and longitude. Any number of decimal places may be specified. A positive value indicates north latitude or an east longitude. A negative value indicates south latitude or a west longitude.
- Alternatively, the hemisphere may be indicated by an alphabetic indicator either before or after the numeric value. Enter "E" for east or "W" for west longitude. Enter "N" for north, "S" for south latitude. The hemisphere indicator can be placed either before or after the numeric value. Following are examples of valid values in this format:

<b>Latitude</b>	<b>Longitude</b>
39 23.718	-78 10.234
39 23.718N	78 10.234E
S23 39.4055	165 0.3223-

- Degrees, Minutes, Seconds:

- In this recognizable, classic format, the latitude value is entered as an integer from -90 to 90 followed by one or more spaces. The longitude value is entered as an integer from -360 to 360 followed by one or more spaces. Following the space, the minutes value is entered as an integer between 00 and 59, again followed by a space, and finally followed by a floating point seconds value ranging from 0.0000 to 60.0000. A positive value indicates north latitude or an east longitude. A negative value indicates south latitude or a west longitude.
- The rules for entering the hemisphere indicator are the same as for the other two formats above. Following are examples of valid values in this format:

<b>Latitude</b>	<b>Longitude</b>
39 23 10.	-78 10 45.234
39 23 10.000N	78 10 45.234E
S23 39 52.4055	165 0 0.-



### 3.3.3 Using the Clipboard

NADCON allows the user to copy a coordinate into and out of the NADCON Main Form. Several options are available from the “Edit” menu:

- Copy *Input Values* to Clipboard (Shortcut key Alt+C): Copies values from the input fields and places them onto the clipboard. Values may be pasted into another document by using the paste function within that document.
- Copy *Output Values* To Clipboard (Shortcut Key Alt+O): Copies output values from the output fields and places them onto the clipboard. Values may be pasted into another document by using the paste function within that document.
- Copy *Shift Values* To Clipboard (Shortcut Key Alt+S): Copies shift values from the output fields and places them onto the clipboard. Values may be pasted into another document by using the paste function within that document. When performing this function, NADCON will add abbreviated text to the information, thus enabling the user to easily identify the shift direction and values, as shown in the following:

```
lat-sec. 0.7178 lon-sec. 2.13052 lat-m. 22.12237  
lon-m. 53.62802 tot-m. 58.01176
```

- Paste *Input Values* From Clipboard (Shortcut Key Alt+V): Allows user to place values onto the clipboard from another document and then paste them into the correct input fields.

*Important Note: Pasting from the clipboard means pasting a latitude and longitude in a “freeform” format. When performing the paste operation, NADCON will interpret the values as if they were freeform text, will separate the latitude and longitude values, and will place them into the correct fields on the main form. However, the latitude and longitude values must still conform to the requirements for coordinate formats explained in [“Coordinate Formats”](#).*

- Clear all fields (Shortcut Key Alt+Z): Clears all information on the form.

*Important note regarding edit functions: The purpose of the edit function shortcuts is to make handling latitude/longitude pair values in text format a little quicker and easier. The standard system edit functions (i.e., “Paste” function, using the **ctrl-v** keyboard shortcut) still work as expected for all fields on the form.*



## 3.4 Converting Multiple Data Points

*Multiple data points can be converted by using files containing sets of coordinate points:*

- Free format 1
- Free format 2
- NGS  
Horizontal  
Bluebook
- ESRI  
Shapefile
- ESRI World  
File

### 3.4.1 Method

1. Select the **Datum Transformation** from the pull-down menu.
2. Select the **File Format** by choosing the appropriate radio button. For more information about file format, refer to ["File Format Descriptions"](#).
3. Select the input file for conversion by clicking the **Browse** button next to the **Input File** field. The program will display an **Open** dialog box, which allows the user to pick the file. If desired, the user may also type the full path to the data in this field.
4. Select the location (folder) to which the output file should be posted by clicking the **Browse** button next to the **Output File** field. Additionally, an output file name **MUST** be specified. If the Output File field and file name have not been chosen, NADCON will not attempt to perform the conversion.
5. If a report is desired, click **Display Conversion Report**. The report will be displayed on the screen only. If the file to be converted contains more than 1000 points, the conversion report will not be generated. Note: The displayed conversion report will be an ASCII file. If desired, it may be saved using the Notepad "File-Save" menu options.
6. After the file names have been entered, click the **Perform Conversion** button at the bottom of the form. NADCON will then execute the necessary actions to perform the interpolation function and will save the results in a file to the location specified.
7. The output can be viewed by navigating to the output file specified.

### 3.4.2 File Format Descriptions

There are five major types of file formats accepted by NADCON.

#### **NGS Horizontal Bluebook**

- Latitude and longitude in NGS Horizontal Blue Book \*80\* record format. Only the latitude and longitude in the record are modified, leaving the rest of the record unchanged.
- For more information refer to ["Input Formats and Specifications of the National Geodetic Survey Data Base"](#). The \*80\* format is described on pages 2-77 and 2-78 in Chapter 2: "Horizontal Observation Data".

#### **Free Format 1 and Free Format 2:**

- ASCII text files consisting of latitude and longitude point definitions.



- Latitude and Longitude:
  - Free Format 1 - latitude and longitude in columns 41-80
  - Free Format 2 - latitude and longitude in columns 1-40

In both of these formats, there will be 40 columns of unused space on one side or the other. If desired, the user can type a station name or other identifying information into the unused columns. NADCON will capture this information and print it out in the report.

- Both free format input types accept any supported coordinate formats, as specified in the "[Coordinate Formats](#)" section.
- 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 correct range of columns. However, the latitude and longitude columns **MUST** contain something even if only spaces. Commas are not allowed.
- The latitude and longitude numeric format in the two Free Format types may be expressed as:
  - Integer degrees, integer minutes, and decimal seconds.
  - Integer degrees and decimal minutes.
  - Decimal degrees.
- *The decimal is important!* NADCON uses the location of the decimal to determine the format of the input. If no decimal is present, an error message will be displayed.

### ***Raster/ESRI World File***

- A file format for associating geographical point data with bitmapped image files, allowing assignment of geo-coordinate information to a map or other image file.
- World files consist of sets of point data consisting of six lines each, denoting the following:
  - Line 1: (size in pixels in x direction)
  - Line 2: (rotation term for row)
  - Line 3: (rotation term for column)
  - Line 4: (size in pixels in y direction)
  - Line 5: (x coordinate of center of upper left pixel in map units)
  - Line 6: (y coordinate of center of upper left pixel in map units)
- The World file format is always associated with a bitmap or raster image file. There are many of these image formats and all will be supported by NADCON, since processing is identical for all. The image file itself is unchanged. The text file containing the geographic coordinate data is assigned a new file extension, depending on the original file type.



- The following table lists the image file types and extensions recognized by NADCON:

SHORT NAME	DESCRIPTIVE NAME	IMAGE FILE EXTENSIONS	WORLD FILE EXTENSIONS
ADRG	ARC Digitized Raster Graphics	*.img, *.ovr, *.l	
ASRP <sup>1</sup>	DIGEST ARC Standardized Raster Product	*.img, *.ovr, *.l	
BIL	Band Interleaved by Line	*.bil	*.blw
BIP	Band Interleaved by Pixel	*.bip	*.bpw
BMP	Windows Bitmap	*.bmp	*.bpw
BSQ	Band Sequential	*.bsq	*.bqw
CADRG	Compressed ARC Digitized Raster Graphics	*.* (no standard)	*.* (no standard)
CIB	Controlled Image Base	*.* (no standard)	
ERDAS	ERDAS <sup>®</sup> GIS or LAN	*.gis, *.lan	*.gsw, *.lnw
GeoTIFF	TIFF with Geo Header	*.tif	
GIF	Graphics Interchange Format	*.gif	*.gfw
GRID <sup>2</sup>	ArcGrid <sup>™</sup>	*.*(no standard)	
IMAGINE <sup>1</sup>	ERDAS IMAGINE <sup>™</sup>	*.img	
IMPELL	Impell Bitmap	*.rlc	*.rlw
JFIF, JPG	JPEG	*.jpg	*.jgw
MrSID	Multiresolution Seamless Image Database	*.sid	*.sdw
NITF	National Imagery Transfer Format	*.ntf	*.nfw
PNG	Portable Network Graphics	*.png	*.pgw
SUN	SunRaster <sup>™</sup> File	*.sun, *.ras	*.snw, *.rsw

### **ESRI Shapefile**

Geographical data file format supported by Environmental Systems Research Institute, Inc. (ESRI) software. ESRI shapefiles are composite data structures consisting of several independent data files. The two files that NADCON works with are:

- 1) The main file.
- 2) An index to the main file.



	<p><i>Note: NADCON will only create a conversion for the main file and the index file. If copies of the other files/file types are needed to complete the shapefile structure, the user will have to make copies of the exiting files and manually rename the files to match the newly converted main file and index file.</i></p> <p><i>Additional Note: NADCON will <b>not</b> convert a geographic data point if the coordinate is located in the database (.dbf) file.</i></p> <p>A full description of ESRI Shapefiles is available at <a href="http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf">http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf</a>.</p> <p><b>Important note pertaining to shapefiles and world files: NADCON only works for latitude and longitude formats. It cannot convert coordinate formats/projections such as State Plane Coordinates or Universal Transverse Mercator coordinates.</b></p>
<p><b>3.5</b> <b><i>Removing, Adding, and Maintaining Conversion Types</i></b></p> <hr/> <p><i>Conversion Types can be tailored to suit user preferences.</i></p>	<p><b>3.5.1 The Basics</b></p> <p>The purpose of removing, adding, and maintaining datum conversion types is to allow the user to:</p> <ul style="list-style-type: none"><li>• Add, remove, or re-order items in the Datum Transformations pull-down menu, and</li><li>• Tailor the way in which the items on the pull-down menu are displayed.</li></ul> <p><b><i>How is This Feature Used?</i></b></p> <p>The user may wish to remove conversion types not necessary for the current work at hand, thereby increasing the efficiency of the tool. If a conversion type is removed, the grid file is not physically deleted from the file system. It will still reside within the local installation folder. This allows the user to add conversion types back into the pull-down menu at a later time if desired.</p> <p><b><i>How to Get There</i></b></p> <p>To get to the Maintain Conversion Types Form, click the <b>Add/Remove Grids</b> button on the NADCON Datum Conversion Utility screen. The following screen will appear:</p>



Maintain Conversion Types

Conversion Type: 0 - Conterminous U S (lower 48 states): NAD27 to NAD83(86)

Conversion ID: 0 Shift Direction: Old datum to new datum

Description: Conterminous U S (lower 48 states): NAD27 to NAD83(86)

Grid File Path: grids\conus Browse...

New Remove Save

Cancel All Changes and Close Save Pending Changes and Close

Figure 3-4: Add/Remove Transformations Form

### 3.5.2 Adding a New Datum Transformation

1. Click the **New** button. This prepares the screen for addition of new datum transformation grids.

*Note: All fields are cleared except for the Conversion ID. The program defaults the ID to the next available integer. After saving this transformation type, the user may modify this ID to control the order in which the datum transformations are displayed. Refer to [“Conversion ID”](#) below for more information.*

2. Click the **Browse** button. A typical Windows dialog box will allow the user to navigate to the folder where the grids are located.
3. Navigate to the location of the grid files.

*Note: The grid files are in pairs that have extensions of “.las” and “.los”. Both files in a pair must be present in order to function. These files are located in the program installation directory in a folder called “grids”. Only the files having the “.los” extension will be visible.*

4. When the “.los” file of the grid pair is located, highlight the file and click **OK**. The program will automatically pull the file into the “Add/Remove Transformations” form. The .las and .los extensions will be stripped off in the display.
5. The other details – shift direction and description – can then be filled in. See [“Tailoring the Appearance or Order of a Conversion Type”](#).
6. Save the change:
  - Click **Save** to save the change and continue grid changes. Or,
  - Click **Save Pending Changes and Close** to save the changes and return to the main screen.



*Note: Clicking on the **Cancel All Changes and Close** button reverts the “in-memory model” so that it matches the last saved Datum Transformation file.*

### **3.5.3 Removing a Datum Transformation**

1. Select the **Datum Transformation** from the pull-down menu.
2. Click **Remove**.

*Note: The user will be required to validate the choice by responding to a “Please confirm this action” screen. Select **Yes** or **No** as needed.*

3. Save the change:

- Click **Save** to save the change and continue, or,
- Click **Save Pending Changes and Close** to save the changes and return to the main screen.

*Note: Clicking on the **Cancel All Changes and Close** button reverts the “in-memory model” so that it matches the last saved Datum Transformation file.*

### **3.5.4 Tailoring the Appearance or Order of a Datum Transformation**

The user may wish to change the way in which a conversion types appears on the pull down menu. To do so, refer to the following:

- The **Datum Transformation** dropdown displays the same list of supported conversions as on the main screen. The user may use it to select an existing conversion type that he or she wishes to modify or remove.
- The **Conversion ID** field displays and allows modification of the assigned integer ID. This allows the user to control the order in which the supported conversion is presented. If the user enters an ID already in use, the existing records are renumbered so that entries with a larger ID are “shifted down” in the display order.
- The **Shift Direction** field is a pull-down box which allows the user to select whether a conversion using this conversion grid is performed from an older datum to a newer one or from a newer to an older.
- The **Description** field allows the user to enter or modify descriptive information for a Datum Transformation field. This description is also used in the title of the Conversion Statistics Report.
- The **Grid File Path** displays and allows the user to enter or modify the file system path where the “.las” and “.los” files stored. The grid file path also contains the name of the file. The browse button presents a folder browse dialog box to allow the user to navigate to the file. The



“.las” and “.los” extensions are stripped from the display but both files are used by the program.

### 3.6 Viewing Conversion Reports

*Output information is available in summary form, which includes a graphic representation*

#### 3.6.1 Conversion Detail Report

For each conversion performed, the NADCON application will create a detail report displaying information for the conversion operation. If the button **Display Conversion Report** was chosen, the report can be viewed on-screen.

A sample of the report follows:

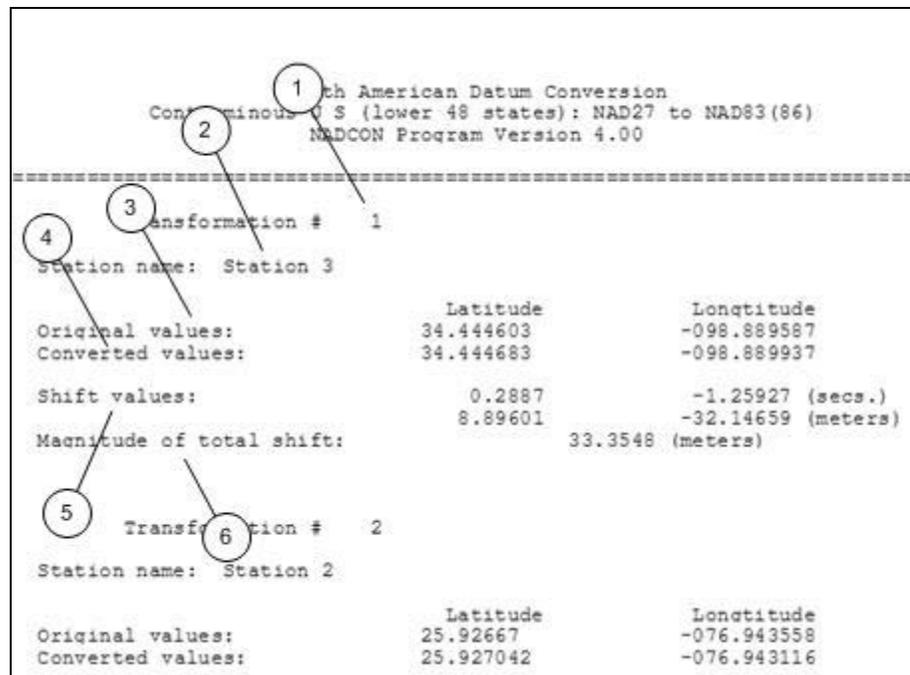


Figure 3-5: Conversion Detail Report

As illustrated above, the detail report will display - for each geographic point in the input file - a description of the conversion operation, including the following data items (refer to the numbered labels above):

1. Transformation #: A simple sequential count of transformations.
2. Station Name: The user-supplied identity of the geographic station name.
3. Original Values: The Latitude and Longitude of the input geographic point. Lat/Long point values are presented in the display format selected by the user on the NADCON main form.
4. Converted Values: The results of the NADCON conversion operation.



- 5. Shift Values: The distance of the NADCON conversion shift in both seconds and meters in both the east/west and north/south directions.
- 6. Magnitude of Total Shift: The total distance of the shift.

### 3.6.2 Conversion Summary Report

After all conversions are complete, the NADCON application will create a detail report displaying statistics for all conversions performed during a single operation.

*NOTE: The summary report will only be created if there is more than one point converted. Additionally, if there are more than 1000 points to be converted, this report will not be produced.*

A sample of the report follows:

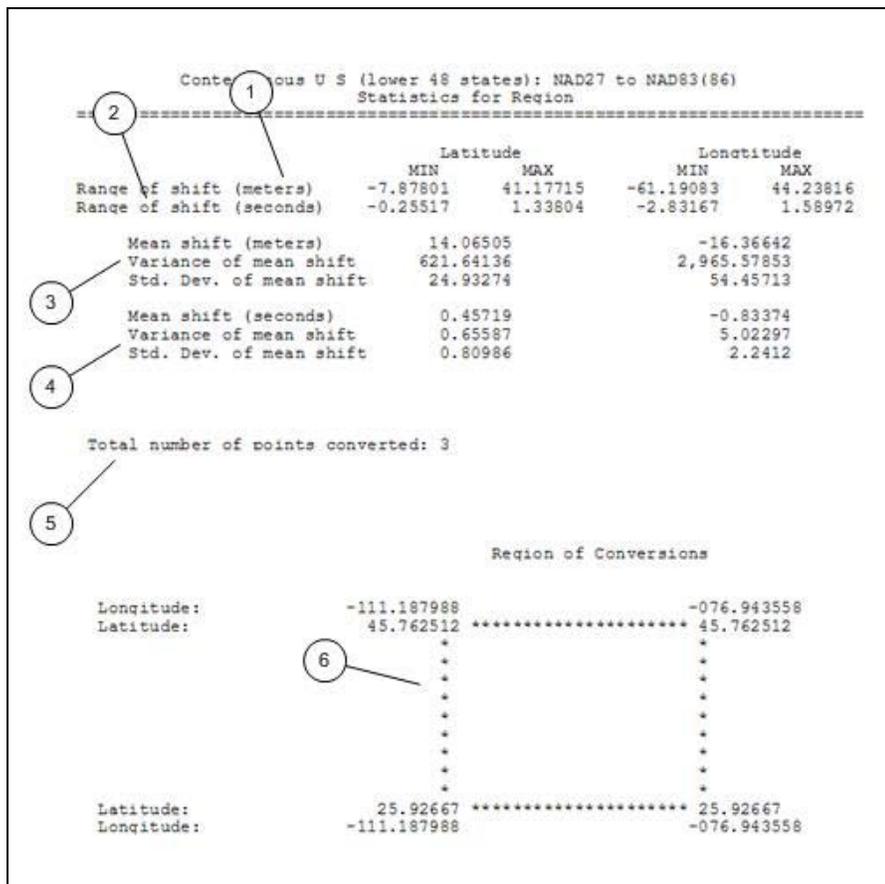


Figure 3-6: Conversion Summary Report

As illustrated above, the summary report will display, for the total of all points converted, the totals of all conversion operations, including the following data items (refer to the numbered labels above):



1. Range of shift (meters): For both latitude and longitude, the smallest and largest shift performed, in meters.
2. Range of shift (seconds): For both latitude and longitude, the smallest and largest shift performed, in arc seconds.
3. Summary for mean, variance, and standard deviation in meters: For both latitude and longitude, general statistics in meters.
4. Summary for mean, variance and standard deviation in seconds: For both latitude and longitude, general statistics in arc seconds.
5. Total number of conversions: Total count for all conversion operations.
6. Region of Conversions: A graphic representation/diagram illustrating the minimum and maximum latitude and longitude for all conversions in the group.

### ***3.6.3 Conversion Summary Error Reports***

There are two main types of conversion summary errors that can occur during the NADCON conversion.

- The first error type is one that occurs when input data does not pass validation rules. This applies to either the user entered parameters on any of the program forms, as well as data in input files.
- The second error type occurs when an environmental or program logic error occurs. In both cases, a form, report or message will be displayed containing some or all of the following information as appropriate (actual appearance may vary based on the run-time context).

*Note: Prior to pressing the Perform Conversion button, NADCON will recognize if the numbers/data entered do not meet required parameters. If a field turns yellow after the user 'tabs out' of the field, this is an indication that the data does not fit the required format and must be revised. Holding the mouse pointer over the highlighted field (hovering) will display a brief description of the error. If the user still attempts to perform the conversion, NADCON will provide an error message.*

- Following is a sample of a conversion summary error report:

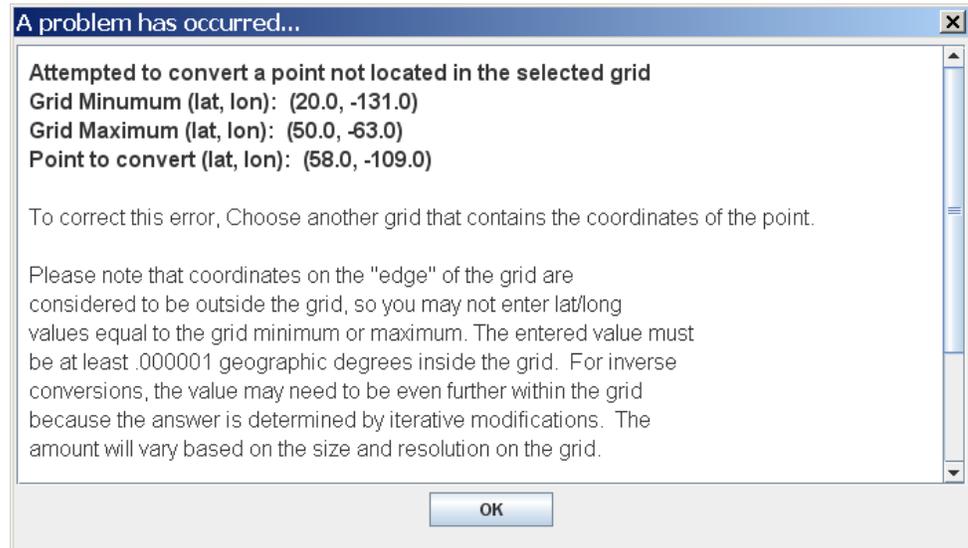


Figure 3-7: Conversion Summary Error Report

### 3.7 Help

Help for NADCON is available by using the **Help** menu at the top of the NADCON Main Form. The help menu topics correspond with this User Manual. The help menu also has short-cut keys:

- Alt+1: What Is NADCON
- Alt+2: NADCON Features
- Alt+3: Using NADCON
- Alt+4: Troubleshooting
- Alt+5: Technical Information
- Alt+6: Additional References

Context-specific help is also available by placing the cursor in a field (or using the tab key to move the focus to the screen control of interest) and pressing the **F2** key.



## SECTION 4 – Troubleshooting

### 4.1 General Troubleshooting Tips

#### **I added a conversion grid file but NADCON won't let me add it to the Conversion Type list.**

Conversion Grid files must consist of a matched pair of two files – one derived from latitude shifts (file extension .las) and the other from longitude shifts (file extension .los). The files must have identical file prefixes, i.e. “flhp gn”, but must also have the two different extensions. For example, in order to do a NAD 83(86) to HARN datum transformation in Florida, the files flhp gn.las and flhp gn.los must both be present.

#### **The output format for my single point conversion does not match the input format.**

Display format is chosen by selecting one of three radio buttons. Make sure to choose the selection that best matches the output format desired.

#### **I can't find my grid files.**

- The default (and recommended) installation path is C:\Program Files\NOAA-NGS\NADCON. All grids will be installed under a folder called “grids” in the NADCON directory.
- If the program files have been moved to a new location, perform a file search using a wild card and one of the grid file extensions (i.e. “\*.los”). The search will return a list of all the files with that extension and will display the folder in which they are located.

#### **When I try to run NADCON on my workstation, I get an error message: “ Windows cannot find ‘javaw’. Make sure you typed the name correctly, and then try again. To search for a file, click the Start button, and then click Search.”**

This message indicates one of two things:

- Java has not been installed on the local workstation. JRE version 1.4.0 or later must be installed for NADCON to work properly. To install Java, refer to “Installing the Java Runtime Environment,” below.

-Or-

- The java bin directory needs to be part of the workstation's “Path” environment variable. To do so, refer to “Ensure that the Java bin Directory is in the Path Environment Variable” in Section 5.



## 4.2 Error Messages

### Error

### Code Error Message

- AR001 Unable to initialize the Maintain Conversion Types dialog box.
- AR002 An error occurred attempting to browse for the Grid File.
- AR003 An error occurred while attempting to save Conversion Types.
- AR004 An error occurred while attempting to save Conversion Types.
- BL001 NADCON was unable to open a browser.
- CB001 An error occurred while attempting to work with your system clipboard.
- CB004 An error has occurred during the copy operation.
- CB005 An error has occurred during the copy operation.
- CB006 An error has occurred during the copy operation.
- CB007 An error has occurred during the paste operation.
- CB008 An error has occurred during the clear fields operation.
- CS001 Your data set is too large to report statistics.
- CS002 Could not generate the statistics report.
- CT001 An error has occurred trying to select a new Conversion Type.
- CT002 An error has occurred trying to display the Add/Remove Conversion Types dialog box.
- CV001 Maximum iterations exceeded while attempting reverse conversion.
- CV003 A problem has occurred while attempting to convert your file.
- CV005 An error has occurred performing the conversion function.
- CV006 An error has occurred performing the conversion function.
- CV010 An error has occurred displaying the main conversion form.
- DS001 Latitude field is missing or invalid. The data entered was "xxxxxxx"
- DS002 Longitude field is missing or invalid. The data entered was "xxxxxxx"
- E0001 A serious error has occurred trying to start this application.
- FF001 File Format does not fit definition.
- FP001 Problem processing data file.
- FP003 Given File is not Found.
- FP010 An error occurred while trying to load the Conversion Types File: "xxxxxxxx\xxxxx\xxxx"
- GR001 Latitude String does not conform to one of the supported patterns.
- GR002 Selected Grid File Do not Match.
- GR003 Coordinates of point are not in the grid.
- HP001 An error has occurred trying to access help.
- LL001 Latitude String does not conform to one of the supported patterns.



	<p>LL002 Longitude String does not conform to one of the supported patterns.</p> <p>SF001 Shape does not confirm to one of the supported shape patterns</p> <p>SF002 Shape file is invalid.</p> <p>UI001 An error has occurred processing data from the input field.</p> <p>UI002 An error has occurred processing data from the input field.</p> <p>UI003 An error has occurred processing data from the input field.</p> <p>UI004 An error has occurred processing data from the input field.</p> <p>UI005 An error has occurred processing data from the input field.</p> <p>UI006 An error has occurred processing data from the input field.</p> <p>UI007 An error has occurred processing data from the input field.</p> <p>UI008 An error has occurred processing data from the input field.</p> <p>UI010 An error has occurred performing the browse function.</p> <p>UI011 An error has occurred performing the browse function.</p> <p>UI020 NADCON was unable to open the file browse dialog.</p>
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## SECTION 5 - Technical Information About This Release

<h3>5.1 System and Operational Requirements</h3>	<h4>5.1.1 Requirements for a Locally-Installed Application</h4> <p>This application can be locally installed on an end-user workstation and operated without connection to a centralized database or file server. The application has been developed to operate on Intel x86 based PCs running Microsoft Windows 2000, Windows XP or later operating system. Additionally, installation of a Java run-time environment 1.4.0 or later will be required. To install NADCON on a stand-alone workstation, refer to <a href="#">"Installing NADCON"</a>.</p>
<h3>5.2 Installing NADCON</h3>	<p>Installing NADCON can be accomplished by users running a system with the minimum equipment listed in <a href="#">"Requirements for a Locally-Installed Application"</a>. To install NADCON:</p> <ol style="list-style-type: none"><li>1. Open the web browser and Navigate to: <a href="http://www.ngs.noaa.gov/PC_PROD/NADCON/">http://www.ngs.noaa.gov/PC_PROD/NADCON/</a></li></ol> <h3>NADCON Launch Page</h3>  <p><b>Installing NADCON</b></p> <ol style="list-style-type: none"><li>1. Click on Launch</li><li>2. If prompted, check "Always trust content from this publisher" - one time only</li><li>3. Click Run button</li></ol> <p><i>NOTE - NADCON shortcut is created on your desktop</i></p> <p><a href="#">User Manual</a></p> <p><i>Disclaimer: Use it at your own discretion</i></p> <ol style="list-style-type: none"><li>2. Click Launch button.</li></ol>



3. Check “Always trust content from this publisher” – one time only.
4. Click the Run button.

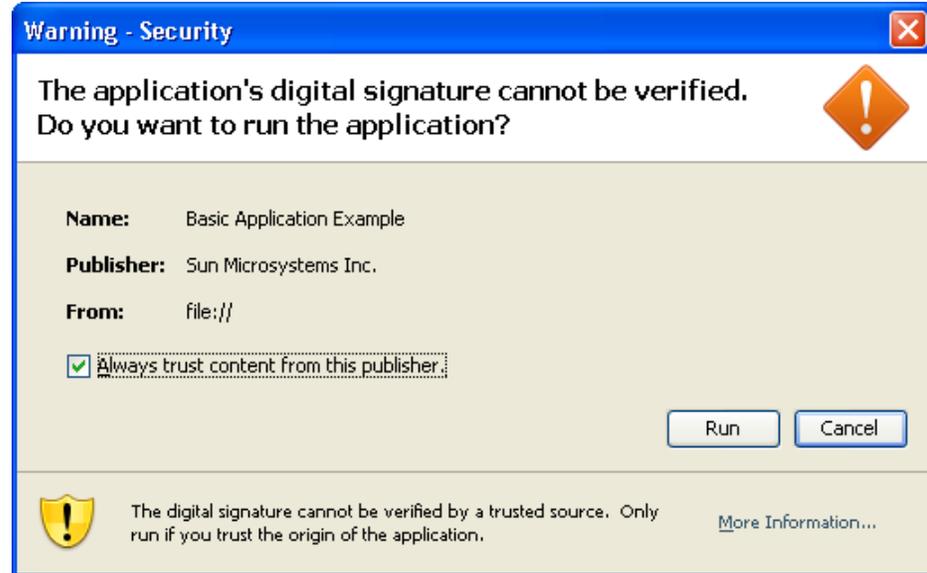


Figure 5-1: File Download screen

5. A NADCON shortcut will be created on the desktop. It can also be found under Start>Programs>NADCON.

## 5.3 Installing the Java Runtime Environment (JRE)

*A Java Runtime Environment MUST be installed on the local workstation.*

### 5.3.1 NADCON Requires a Java Runtime Environment (JRE).

Prior to installing NADCON v4.2, it is required that Java Runtime Environment (JRE), minimum version 1.4.0, is installed on the workstation. Before attempting a download of NADCON v4.2, users should check to determine whether or not a JRE is already resident.

Please note that the download/install instructions presented here are for workstations running a Windows XP operating system and using Microsoft Internet Explorer web browser. Users may encounter other download and installation scenarios, depending on the operating system and browser being used.

Additionally, these download and installation instructions refer to the Sun Microsystems™ website and are current as of 3 October 2006. Since NADCON has no control over the methods for installing a JRE, it will be important for users to



follow the instructions presented on that website, should they differ from those which are presented here.

### 5.3.2 *Checking for Existing JRE Software*

1. Go to the control panel: click **Start > Settings > Control Panel**.
2. If the control panel is displayed in “Category View,” switch to the “Classic” view by clicking the link at the top left portion of the page, under “Control Panel.”

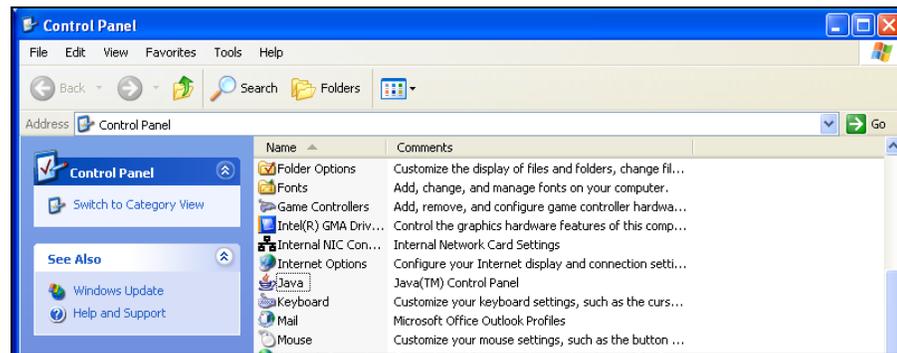


Figure 5-5: Control Panel screen

3. Scroll through the list of items and look for “Java.” If the Java icon (☞) does not exist, go to the next paragraph, entitled “[Locating Java using Add or Remove Programs](#),” below.
4. Double-click on the item to open the **Java Control Panel** screen.

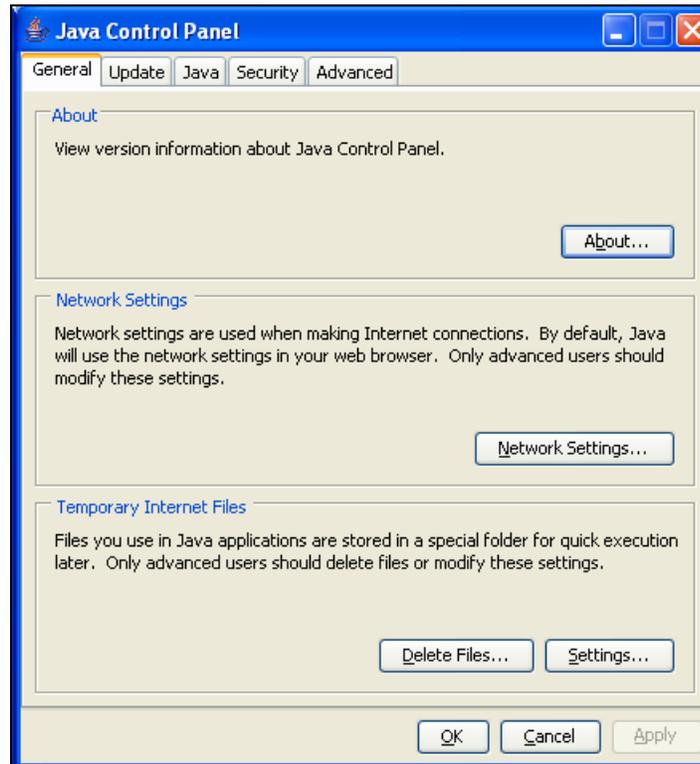


Figure 5-6: Java Control Panel screen

5. Click the **General** tab.
6. Click the **About** button.

A screen will appear showing the Version information for the currently-installed Java platform. At a minimum, the version must be at least version 1.4.0. If it is older than this, remove the JRE software and re-install a more recent version.

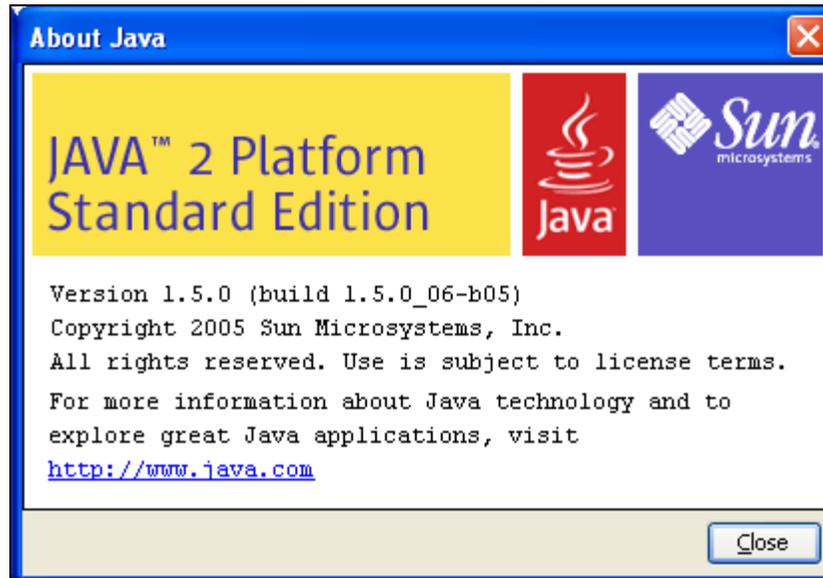


Figure 5-7: About Java (Java Version Information)

### 5.3.3 Locating Java using Add or Remove Programs

If a Java icon does not show up in the Control Panel screen, Java may still exist on the local workstation. Use the “Add/Remove Programs” feature to absolutely verify whether or not Java exists on the workstation.

1. Go to the control panel: click **Start > Settings > Control Panel**.
2. Locate “Add Remove Programs” and click the link. A list of currently-installed programs will appear.
3. Again, look for items entitled “Java” or “J2SE” or “J2SE Development Kit”, “Java Runtime Environment,” etc.

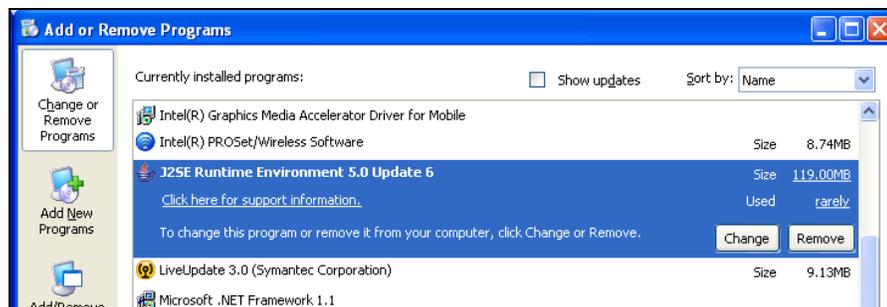


Figure 5-8: Add or Remove Programs screen

4. Once located, click on the item to highlight it. Then click the “Click here for support information” link. A message box will appear showing the version information of the Java Product.



Figure 5-9: Java Support Information screen

5. If none of the Java products are located, or if the version is older than 1.4.0, then an updated JRE must be installed on the workstation prior to installing NADCON.

### 5.3.4 Installing the Java Runtime Environment

1. Go to [www.sun.com](http://www.sun.com).
2. Click the “Run Desktop Apps Faster with Java” link, located at the bottom right portion of the screen. A **Free Download** screen will appear.
3. Click the **Download Now** button.



Figure 5-10: Java Free Download screen

4. A **Begin Download** screen will appear. Click the **Begin Download** button.



Figure 5-11: Java Begin Download screen

5. **Windows XP SP2 users:** Check the top of the browser to see if the following message appears: "This site might require the following ActiveX control: J2SE Runtime Environment 5.0 Update 7." If so, click on the information bar to enable ActiveX control and continue the Java software installation.



Figure 5-12: ActiveX Control message

6. A **Security Warning** screen will appear. Click **Install** to start the installation process.



Figure 5-13: Internet Explorer Installation Security Warning



7. The download process will start. During the download, a progress window lets users know the estimated time remaining for the download to finish. The download can take anywhere from a few seconds on a fast Internet connection to half an hour or more on a very slow connection. Once the download is over the installation process will start automatically.
8. The installer displays a setup-type screen that allows users to choose either a typical or custom setup. Java recommends the “Typical” option as the default selection except in the case of an advanced user who wants more control over the components that will be installed. After ensuring that the “Typical” setup is selected, click the **Accept** button to continue with the installation.

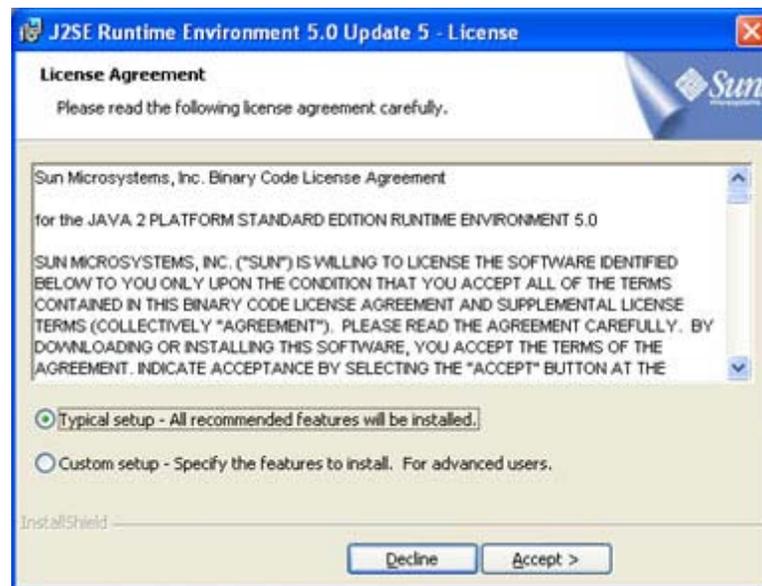


Figure 5-14: Java License Agreement

9. Once the installation is successfully completed, the “Verify Installation” page will appear, instructing users on how to verify the Java version installation. Close the browser then reopen it.
10. Go to <http://java.com/en/download/installed.jsp>. The **Verification** screen will reload.
11. Click the **Verify Installation** button. Make sure that the version installed is at least version 1.4.0 or later.

### 5.3.5 *Ensure that the Java bin Directory is in the Path Environment Variable*

*NOTE: This is a highly specialized activity that can result in system difficulties if performed incorrectly. If you are at all uncertain about proceeding, contact technical support for your workstation or Java*



products. Additionally, these instructions may vary based on your operational platform.

1. Go to the Control Panel: click **Start > Settings > Control Panel**.
2. If the control panel is displayed in “Category View,” switch to the “Classic” view by clicking the link at the top left portion of the page, under “Control Panel.”
3. Locate the “System” icon. Double click the icon to open the **System Properties** box.
4. Click on the **Advanced** tab.
5. Click on the **Environment Variables** button.

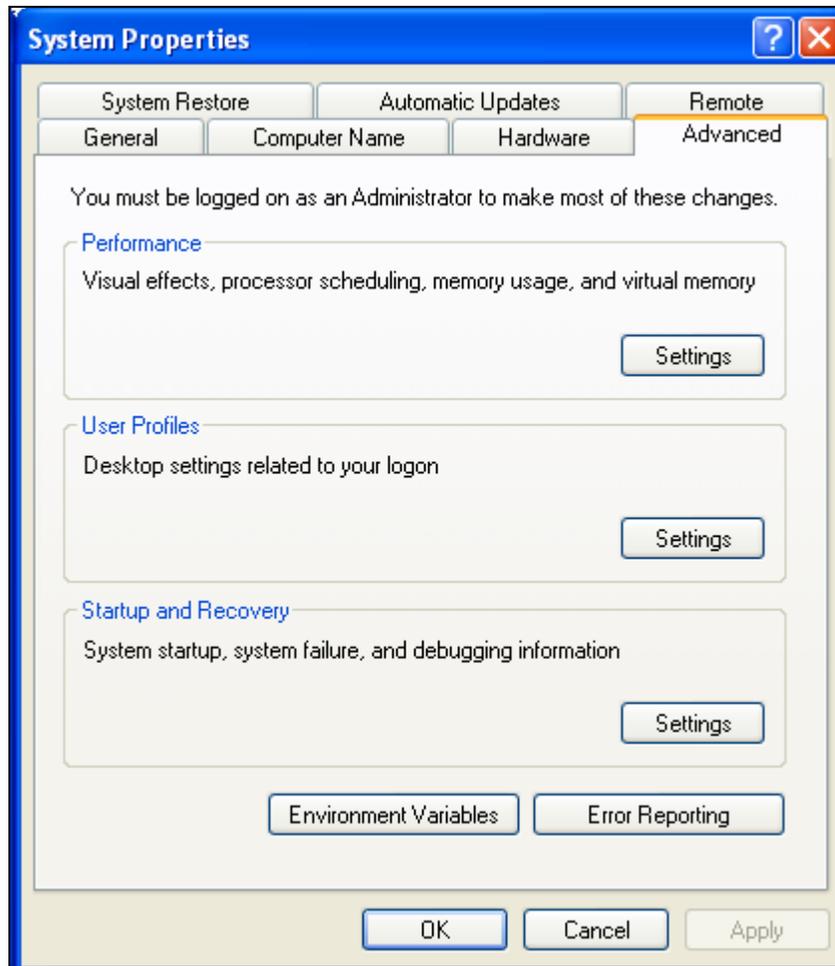


Figure 5-15: System Properties screen

6. On the bottom portion of the screen under **System variables**, locate the variable named “Path” by scrolling through the list.

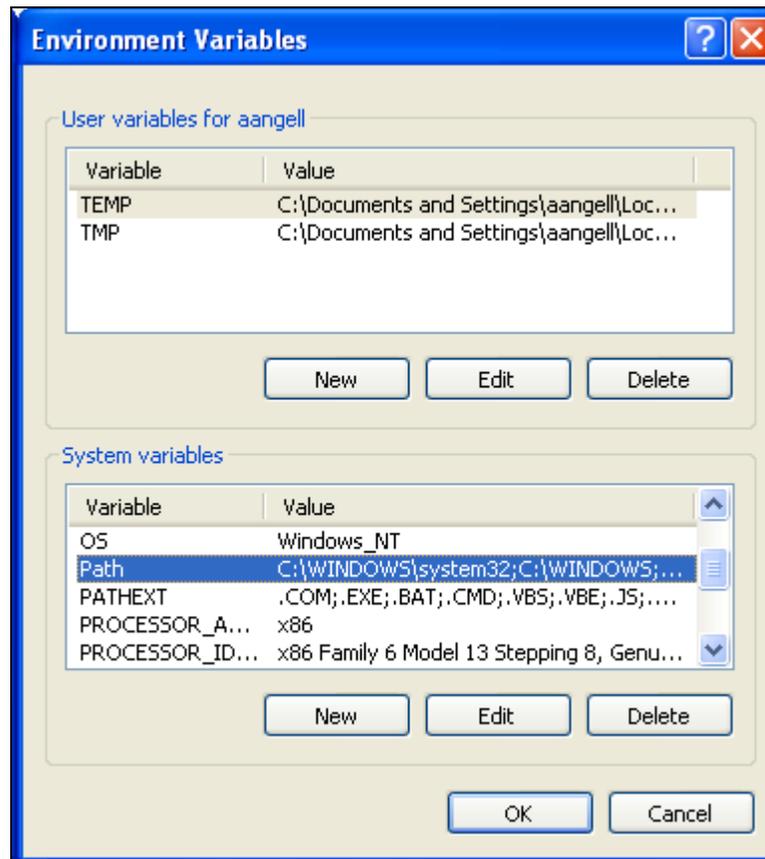


Figure 5-16: Environment Variables screen

7. Highlight that item and click the **Edit** button.
8. Examine that path string to determine if it 'points' to `c:\program files\java\jre1.5.0_06\bin` by moving the cursor back and forth through the string using the ← and → (arrow) keys. If this path is not in the string, it must be added to the end of the path string.
9. To do so, go to the end of the string, type a semi-colon (if one does not exist), then type this text string as shown below (or as necessary to correctly reference your java installation "bin" folder):  
`c:\program files\java\jre1.5.0_06\bin`
10. Click **OK** to save the change and continue to click the **OK** buttons until returned to the Control Panel.
11. Close the Control Panel.



## 5.4 Release Notes

### 5.4.1 New and/or Key Features

NADCON will provide geographic conversion services similar to the previous NADCON application. The new NADCON application not only maintains existing key features, but also adds several new features and product improvements:

- Provides a new interface. This version includes a “user-friendly” interface, making the application easier to use, more intuitive, and therefore less prone to error. (The command line interface has been eliminated.)
- Accepts any valid geographic coordinate as long as it falls within a conversion grid. The new application accepts any valid geographic coordinate. Previous versions of NADCON would not accept coordinates with east longitude or south latitude; it was written for use only in the northern and western hemispheres. In the new NADCON, north latitude is positive and south latitude is negative. For longitude, east is positive and west is negative. However, shift values will not follow this convention. A westward shift will be positive to be consistent with previous NADCON versions in which shifts are relative to the positive west value. Therefore, a shift from 80.0W to 81.0W would be considered a shift of +1 (even though those numbers could be displayed as -80 and -81).

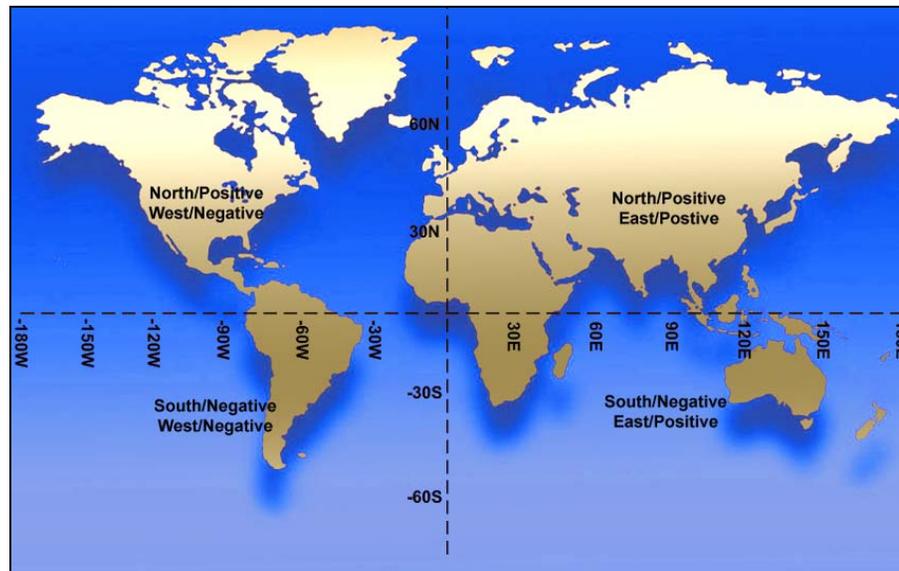


Figure 5-17: Graphic Representation of Latitude and Longitude

- Accepts three formats of coordinate data points: decimal degrees; degrees/decimal minutes; or degrees/minutes/decimal seconds.
- Provides a programmable interface: so that the library of conversion functions is callable from other computer programs.



- Is compliant with section 508 of the Rehabilitation Act of 1973: as amended (29 U.S.C. 794d) regarding accessibility and usability of software for individuals with disabilities.
- Provides support for several new datums. Refer to [Available Datum Conversions](#).
- Allows user control of conversion grid selection. The new application performs conversions based on the conversion type selected by the user. The previous application automatically selected the first set of grids that covered an area that included the input point. Since some grids overlap, but have very different shifts (i.e. the Pribilof Islands and Alaska), this occasionally resulted in an incorrect conversion grid file selection.
- Provides datum conversions that are easily extensible: requiring only the addition of new grids.
- Supports additional input and output data formats. “ESRI Shapefile” and “ESRI World File” have been added to the available formats.
- Maintains conversion integrity of previously available formats. The previous NADCON application accepted data input as geographic coordinate points in one of four formats. The new application numerically reproduces the conversions exactly the same except for the previously noted correction to the handling of the south latitude and west longitude. The four previously available formats are as follows:
  - Single geographic point stated as a latitude/longitude pair in traditional degrees, minutes and seconds.
  - [NGS Horizontal Bluebook format](#).
  - Data files in “[Free format 1](#)”.
  - Data files in “[Free format 2](#)”.
- Maintains user flexibility: can be downloaded and run on a stand-alone workstation or accessed via the web.
- Maintains and improves reporting. Consistent with the prior application, the new application produces summary reports for the conversion(s). Reports produced by NADCON will also have paging, complete with headers and page numbers. It is important to note that if there is only a single point to be converted the report will print the details of the conversion but not a summary page. This is because the mean and standard deviation are not necessary when there is only one data point.



## ***5.4.2 Brief Design Overview***

The new application has been developed as a collection of software components which interact to provide the required geographic data point conversions (see Attachment A for definition of terms). The components will be structured using the “Model, View, Controller” design architecture as described in “Design Patterns: Elements of Reusable Object Oriented Software”, 1995, by Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides.

The core component is a Java Language software library of functional routines which perform the actual computations. This library represents the “Model” component of the architecture. A related component implemented as a separate library but still part of the Model will be routines necessary to interact with the underlying operating system platform. The routines in this library are segregated so that any functions specific to a proprietary platform may be replaced easily in versions of the application deployed to other platforms. The Model components will be responsible for logical representations of the stored data, serialization to and from physical storage, and implementation of all conversion algorithms.

The “View” and “Controller” components have two distinct implementations.

Implementation 1 consists of routines to present the user interaction when the application is run as a disconnected, locally-installed program on the end user’s standalone workstation. In this instance, the application will consist of standard display forms, screens and documents to display information to the user and accept user input. Event handlers and links to the Model (the “Controller” component) will be deployed integrated with the forms components as a single software package.

Implementation 2 will consists of web browser displayable documents and forms as the user interface, and server hosted Java “servlet” and “jsp” components to provide event services and links to the model layer. This implementation will use stateless server components to reduce server component requirements. Conversation state will be stored in the browser page and message content.

## ***5.4.3 System Design Diagrams***

This diagram represents the overall architecture of the NADCON application:

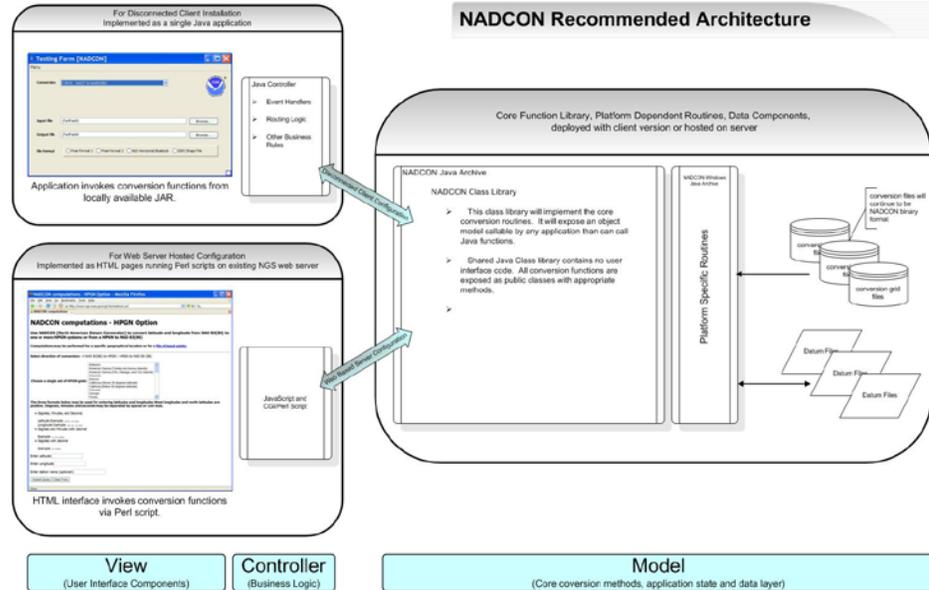


Figure 5-18: NADCON Architecture

The next diagram presents the major system classes of the core NADCON conversion library and their logical relationship to each other.

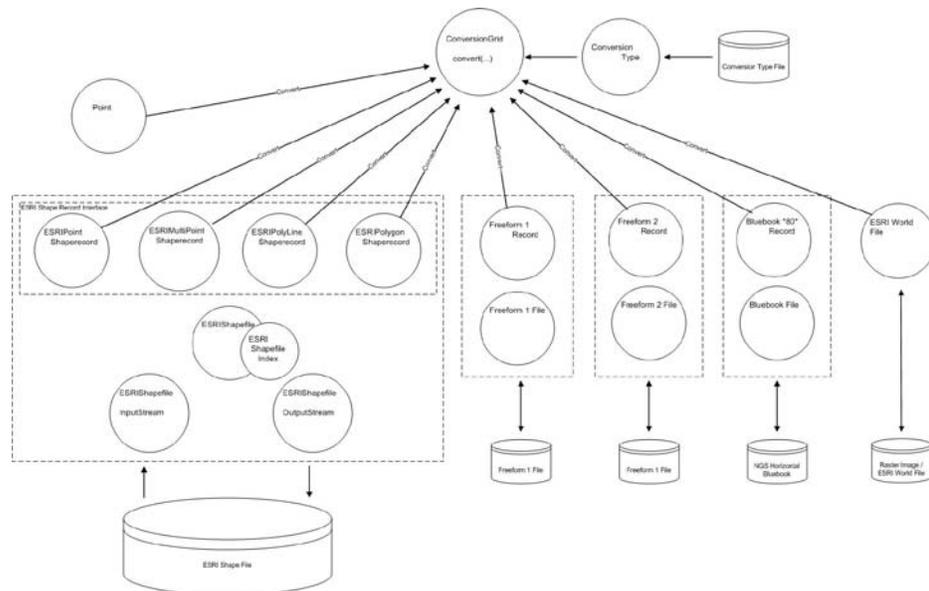


Figure 5-19: System Classes and Relationships

This last diagram presents the module and class structure for the interaction of the Web Based User Interface (UI) with the Library Classes.

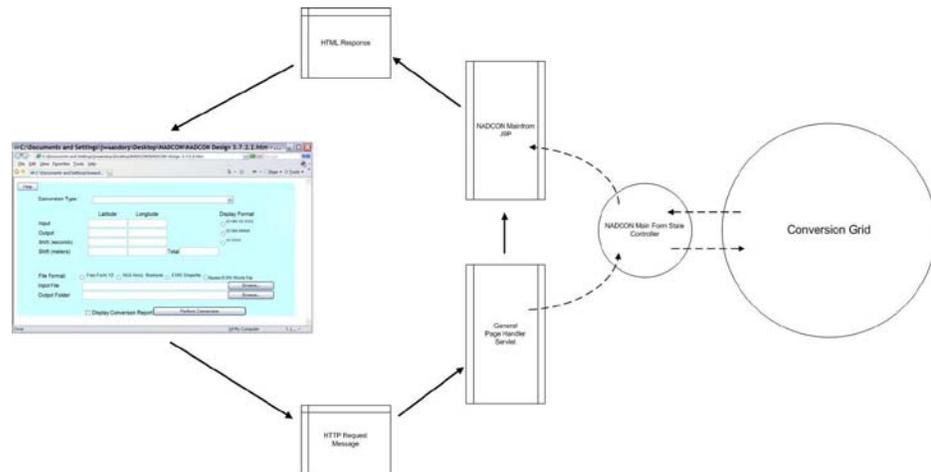


Figure 5-20: Module and Class Structure for Interaction of UI and Library Classes

#### 5.4.4 Software Description

The core conversion library components, the platform specific routines (as much as possible), and the locally-installed user interface/controller logic, have been developed using the Java programming language. Development and testing will be completed using Java 2 Platform Standard Edition Version 1.5.0.

The user interface of the server based version of the application has been implemented using standard Hypertext Markup Language (HTML). Development and testing has been completed using HTML version 4.01. Some limited browser page automations have been implemented using ECMA-262 (JavaScript) Edition 4. The business rules and event handling code for the server based version have been implemented as Java Servlets and JSPs using Sun J2EE version 1.4.0. The application has been using the Apache Tomcat Application Server version 5.5.7 and Sun Java System Application Server version 8.1.

#### 5.4.5 Data Flow Diagram



# NADCON

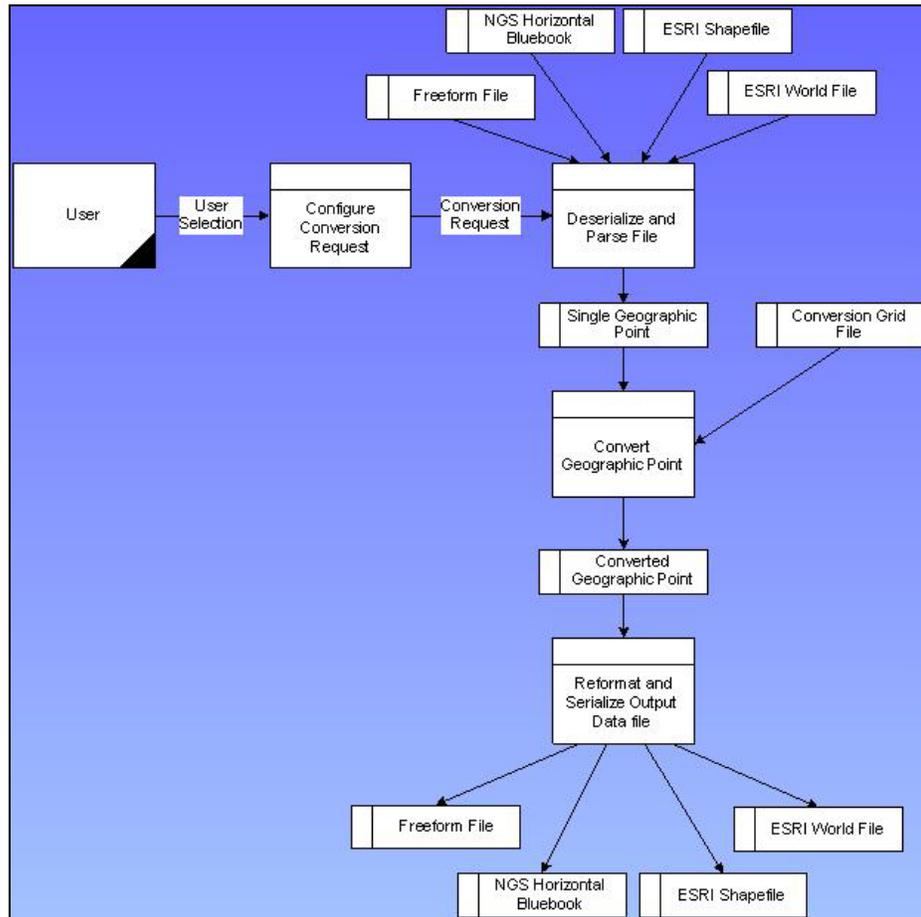


Figure 5-21: NADCON Data Flow Diagram



## SECTION 6.0 *Additional References*

<p><b>6.1</b> <b><i>Reference Documents and Web Sites</i></b></p>	<ul style="list-style-type: none"><li>• Application Programming Interface: Go to the NADCON API.zip file at <a href="http://www.ngs.noaa.gov/PC_PROD/NADCON/">http://www.ngs.noaa.gov/PC_PROD/NADCON/</a></li><li>• NGS Horizontal Bluebook: <a href="http://ftp.ngs.noaa.gov/FGCS/BlueBook/">http://ftp.ngs.noaa.gov/FGCS/BlueBook/</a></li><li>• ESRI Shapefiles: <a href="http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf">http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf</a></li><li>• Mathematical transformation method: Additional information about the mathematical transformation method and the way it is used in NADCON can be found on the NGS Web site in an excellent paper developed by William T. Dewhurst, PhD. and described in NOAA Technical Memorandum NOS NGS-50 dated January 1990). Go to <a href="http://www.ngs.noaa.gov/PUBS_LIB/NGS50.pdf">http://www.ngs.noaa.gov/PUBS_LIB/NGS50.pdf</a>.</li><li>• NOAA Notice announcing NADCON as the standard method for mathematical transformations: <a href="http://www.ngs.noaa.gov/PUBS_LIB/FedRegister/FRdoc90-18809.pdf">http://www.ngs.noaa.gov/PUBS_LIB/FedRegister/FRdoc90-18809.pdf</a></li><li>• Printer-friendly version of this user manual:</li></ul> 
<p><b>6.2</b> <b><i>Contact Information</i></b></p>	<p>For more information about the grids and datums, contact:</p> <p>Ms. Cindy Craig N/NGS21 Telephone: (301) 713-3194 Email: <a href="mailto:Cindy.Craig@noaa.gov">Cindy.Craig@noaa.gov</a></p>