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# SurvUtil

## OPERATION MANUAL



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Support for licensed users on any topics covered in this manual and for the use of the software described herein may be obtained from:

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## **1 OVERVIEW**

SurvUtil is a Microsoft Windows software program enabling geodetic and surveying computations based on the European Petroleum Survey Group (EPSG) data model.

The underlying database is derived directly from the EPSG MS Access database, and the user may browse all the associated tables. Additional data records for certain tables may be created and edited by the user. Original EPSG data cannot be edited or deleted.

Functionality is provided for:

- Datum transformations
- Geographic to geocentric computations
- Geographic to grid computations
- Geocentric to geographic computations
- Geocentric to grid computations
- Grid to geographic computations
- Grid to geocentric computations
- Ellipsoidal forward and inverse computations
- Grid forward and inverse computations
- Import and export of coordinates (stations)
- Batch (file) coordinate conversions
- A single network adjustment by weighted least squares method, including data snooping

The installation and licensing of this program is documented separately from this manual.

---



## 2 MAIN MENU

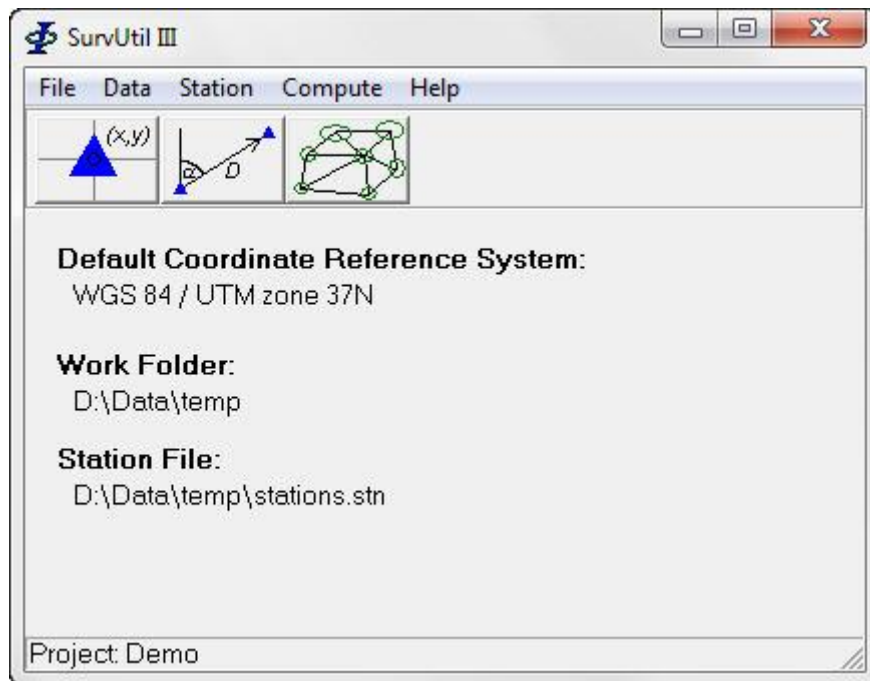


Figure 2.1

### 2.1 File

- New Project:** Invoke the Project Dialog to set up a new project.
- Open Project:** Open an existing project. Current project parameters are automatically saved.
- Save Project As:** Save the current project under a new name.
- Edit Project:** Invoke the Project Dialog to make changes to the project parameters.
- Open Station File:** Open a previously saved Station File. This also sets the Default Station File which will be loaded each time the program starts.
- Save Station File As:** Save the current Station table to a new file. This file becomes the default station file for the project.
-



*Printer Setup:* Brings up standard Windows Printer Setup dialogue.  
*Exit:* Exit the program.

## **2.2 Data**

*Database:* Provides access to all EPSG data tables.  
*Coordinate Ref System:* Displays the table of Coordinate Reference Systems (CRS).  
*Datum Transformation:* Displays the table of Datum Transformations – a subset of the Coordinate Operation table.  
*Projection:* Displays the table of Projections – a subset of the Coordinate Operation table.  
*Concatenated Op:* Displays the table of Concatenated Operations – a subset of the Coordinate Operation table.  
*Datum:* Displays the table of Datums.  
*Ellipsoid:* Displays the table of Ellipsoids.  
*Station:* Displays the table of Stations found in the current *Station File*.

## **2.3 Station**

*Import:* Enables import of geographic or grid coordinates on a specified coordinate reference system (CRS), to a specified CRS, effectively allowing batch datum transformations and/or projections.  
*Export:* Enables export of selected station geographic or grid coordinates.  
*File Conversion:* Enables conversion of coordinates from file to file. UKOOA P1/90, SPS and user defined formats are supported.

## **2.4 Compute**

*Geodetic For/Inv:* Invokes the Geodetic Forward and Inverse computation dialog.  
*Grid For/Inv:* Invokes the Grid Forward and Inverse computation dialog.  
*Network Adjustment:* Invokes the Network Adjustment computation dialog.

---



## **2.5 Help**

*Manual:* Displays this manual. An Acrobat reader must be installed.

*About:* Displays the software version, licence number and support contacts.



### **3 DATABASE**

The database tables fall into three categories

- Tables which contain EPSG data and in which the user can add, edit and delete records.
- Tables which contain only original EPSG data which cannot be altered in any way.
- The station table which contains no EPSG data and will be empty until the user adds records.

#### **3.1 User Tables**

Tables in which the user can add, edit and delete records are:

*Coordinate Reference System:* Abbreviated to CRS throughout this document. A CRS is a set of attributes, some of which are related to other tables in the database, which form the immediate frame of reference for any coordinated point (station) to be uniquely spatially defined.

Throughout this document Geographic CRS will be abbreviated to Geog CRS, and Projected, or Grid, CRS to Grid CRS.

**Note:** at present only Geographic and Grid CRS are implemented in the software.

*Datum Transformation:* This is a sub-set of the EPSG Coordinate Operation table. A datum transformation is a set of attributes and parameters, some of which are related to other tables, which are to be used in transforming a station's coordinates from one Geographic CRS to another Geographic CRS.

*Projection:* This is a sub-set of the EPSG Coordinate Operation table. A Projection is a set of attributes and parameters, some of which are related to other tables, which are to be used in

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converting a station's coordinates between its Geographic CRS and a Projected (Grid) CRS.

*Concatenated Operation:* This is a sub-set of the EPSG Coordinate Operation table and is a coordinate operation involving more than one step, for example two datum transformations, or a datum transformation and a projection.

*Datum:* A datum is a instance of an ellipsoid together with a prime meridian which bears a unique spatial relation to the earth and is used to relate a Geographic CRS to the earth.

*Ellipsoid:* An ellipsoid is a mathematical model approximating the shape of the earth, defined by any two of semi-major axis, semi-minor axis and flattening.

*Station:* A station is a set of Geographical coordinates referenced to a Geographic CRS. A station may also have a set of Grid coordinates relating it to a Grid (Projected) CRS.  
Any number of Station tables can be created although only one can be in use at any time.

These tables are accessed from the main menu under *Data*.

**Note:** Some attributes are not used by this program and are not displayed.

### **3.2 EPSG Tables**

The EPSG tables are accessible from the main menu by selecting *Data | Database*. The user is referred to the EPSG documentation for a detailed description of these tables.

Although most of these tables are used within the program It is unlikely that the user will need to interact with them.

**Note:** Some attributes are not used by the software and are not displayed.

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### 3.3 Codes

Code numbers 0 to 32767 are reserved for EPSG assigned codes. User created records will be automatically assigned a unique code higher than 32767.

### 3.4 Table Interface


The database tables are accessible from the *Data* menu. An example is shown below in Figure 3.1.


	COORD_REF_SYS_CODE	COORD_REF_SYS_NAME	AREA_OF_USE	COORD_REF_SYS
0	4143	Abidjan 1987	Cote d'Ivoire (Ivory Coast)	geographic 2D
1	2165	Abidjan 1987 / TM 5 NW	Cote d'Ivoire (Ivory Coast)	projected
2	2043	Abidjan 1987 / UTM zone 29N	Cote d'Ivoire (Ivory Coast)	projected
3	2041	Abidjan 1987 / UTM zone 30N	Cote d'Ivoire (Ivory Coast)	projected
4	4168	Accra	Ghana	geographic 2D
5	2136	Accra / Ghana National Grid	Ghana	projected
6	2137	Accra / TM 1 NW	Ghana - offshore	projected
7	4201	Adindan	Africa - Ethiopia and Sudar	geographic 2D
8	20137	Adindan / UTM zone 37N	Africa - Ethiopia and Sudar	projected
9	20138	Adindan / UTM zone 38N	Africa - Ethiopia and Sudar	projected
10	4205	Afgooye	Somalia	geographic 2D
11	20538	Afgooye / UTM zone 38N	Somalia - W of 48 deg E	projected
12	20539	Afgooye / UTM zone 39N	Somalia - E of 48 deg E	projected
13	4206	Agadez	Niger	geographic 2D
14	4202	AGD66	Australasia - Australia and F	geographic 2D

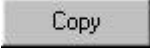
Figure 3.1


No data can be edited from within the table. Editing can be performed only from within the detail form.



To display the form for a record double click on the record, press the <Enter> key with the record highlighted, or click the  button.

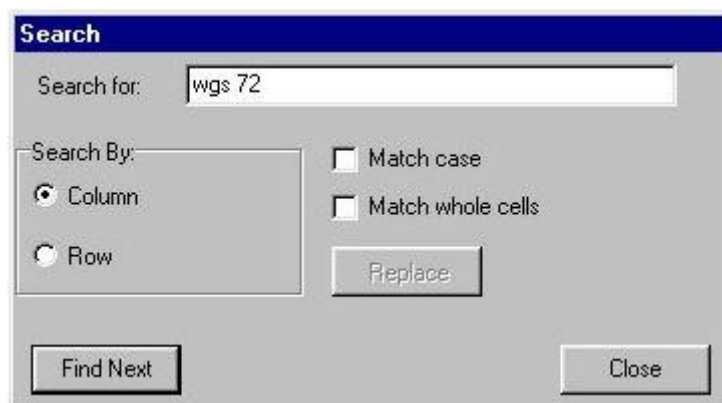
To create a new record click the  button. A new record will be created and saved, and appear at the bottom of the table. A unique code will be assigned to it. In the case of a station the default Geog CRS and Grid CRS will be assigned. The record form will be displayed.

To create a copy of an existing record highlight that record and click the  button. A new record will be created and saved, and appear at the bottom of the table. All attributes will be copied except for the code which will be uniquely assigned. The record form will be displayed.

To delete records highlight them then click the  button. Only user created records i.e. ones with codes greater than 32767, can be deleted.


### 3.4.1 Searching

From the menu select *Search | Find* to invoke the search dialog as shown in Figure 3.2.



**Figure 3.2**

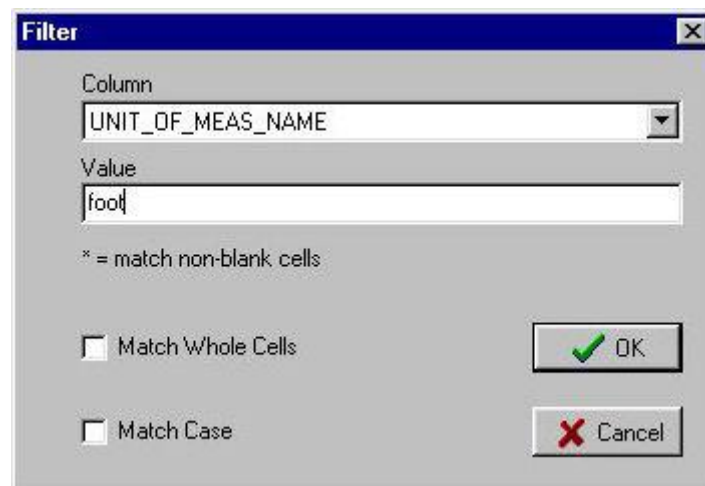


Enter the search string and click  button.

The replace function is disabled.

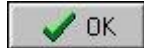
### 3.4.2 Filtering

To filter data records from the menu select *Filter | Filter* to invoke the filter dialog as shown in Figure 3.3.



**Figure 3.3**

In the *Column* dropdown list select the column in which the filter value is to be searched.

Enter the filter criteria in the *Value* field and click the  button. Only records which contain the filter criteria in the selected column will be displayed.

To apply a second filter on the filtered records repeat the process.

Entering an asterisk in the *Value* field will include all non-blank cells.

To remove all filtering select *Filter | Remove Filter* from the menu.


---



### 3.4.3 *Multiple Tables*

To display simultaneously more than one table select the table from *Data* in the main program menu. To replace the current table select the table from the *Data* in the current table menu .

### 3.5 **Form Interface**

To display the form for a record double click on the record, press the <Enter> key with the record highlighted, or click the  button.



**Ellipsoid: Airy 1830**

Code: 7001      Deprecated: No

Name: Airy 1830

Semi-major Axis: 6377563.396

Inv. Flattening: 299.3249646

Semi-minor Axis: 6356256.90923729 \*  
\* computed

Unit of Measure: metre

Remarks: Original definition is a=20923713 and b=20853810 feet of 1796. For the 1936 retriangulation OSGB defines the relationship of feet of 1796 to the International metre through  $\log(1.48401603)$  exactly [=0.3048007491...]. 1/f is given to 7 decimal places.

Information Source: Ordnance Survey of Great Britain.


Data Source: EPSG


Revision Date: 02/06/1995

Change ID: 98.321 98.34

New Copy Save Delete Close < >


Figure 3.4

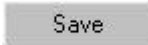
Beside any fields which relate to a record in another table clicking the  button will display the form for that record.

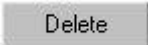
To create a new record click the  button. A new record will be created and saved. A unique code will be assigned to it. In the case of a station the default Geog CRS and Grid CRS will be assigned. The record form will be displayed.

---



To create a copy click the  button. A new record will be created and saved. All attributes will be copied except for the code which will be uniquely assigned. The record form will be displayed.

To save changes click the  button.

To delete click the  button. Only user created records i.e. ones with codes greater than 32767, can be deleted.

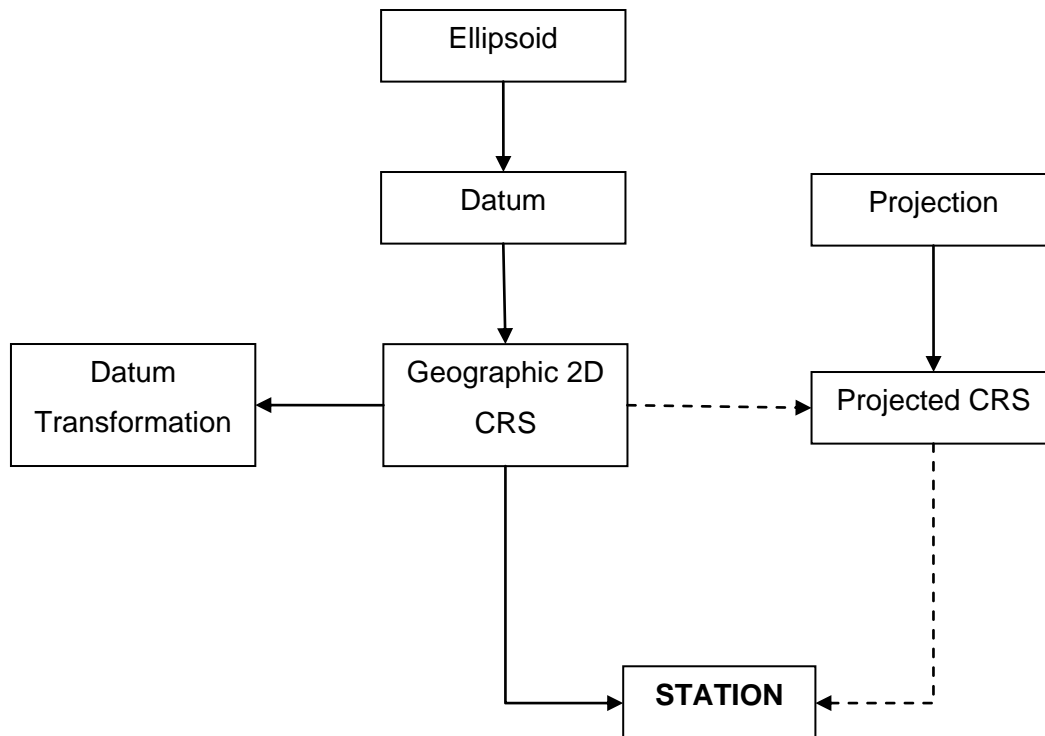
To view the previous or next record click the  or  button respectively.

When the form is closed or scrolled to the previous or next record the user will be prompted to save any unsaved data.

---



## 4 RELATIONS AND DEPENDENCIES



The above chart shows the relations between the fundamental data tables. The more trivial ones such as units of measure have been omitted for clarification.

### 4.1 Creating new Entities

New entities can be created by:

- Clicking the **New** or **Copy** button in the table toolbar
- Clicking the **New** or **Copy** button on a form
- Additionally, in the case of a station by clicking the **Save New** button on the form



The following are the **mandatory** attributes which must be set when creating new entities:

#### *4.1.1 Station*

When creating a new station its CRS must be selected from the dropdown list. This may optionally be a Projected CRS in which case that CRS's source CRS will be the Geographic CRS.

#### *4.1.2 Geographic CRS*

When creating a new Geographic CRS the following must be selected from dropdown lists:

- Type – normally geographic 2D
- Coordinate System – normally Ellipsoidal 2D, with axes in degrees, minutes, seconds and hemisphere
- Datum

A datum transformation may then optionally be created to relate this CRS to another Geographic CRS.

#### *4.1.3 Projected CRS*

When creating a new Projected CRS the following must be selected from dropdown lists:

- Type – normally projected
- Coordinate System – normally Cartesian 2D, with axes of eastings and northings in metres
- Source CRS
- Projection

#### *4.1.4 Datum*

When creating a new Datum the following must be selected from dropdown lists:

- Type – normally geodetic
  - Ellipsoid
-



- Prime Meridian – normally Greenwich

#### *4.1.5 Ellipsoid*

When creating a new Ellipsoid the following must be selected from dropdown lists:

- Type – normally geodetic

#### *4.1.6 Datum Transformation*

When creating a new Datum Transformation the following must be selected from dropdown lists:

- Source CRS
- Target CRS
- Method – this defines the operation to transform station coordinates from the Source CRS to the Target CRS. The parameters should then be entered.

#### *4.1.7 Projection*

When creating a new Projection the following must be selected from dropdown lists:

- Method – this defines the operation to transform station coordinates from the station's Geographic CRS to its Projected CRS. The parameters should then be entered.

#### *4.1.8 Concatenated Coordinate Operation*

When creating a new Concatenated Coordinate Operation the following must be selected from dropdown lists:

- Source CRS
  - Target CRS
  - Method – this defines the operation to transform station coordinates from the Source CRS to the Target CRS. The parameters should then be entered.
-



## 5 STATION DATA

Station data refers to a table of stations with associated coordinates and other attributes, related where applicable to the EPSG database, e.g. Geographic Coordinate Reference System.

	STATION_CODE	STATION_NAME	GEOG_CRIS	LAT	LON
0	34001	Test Bursa Wolf	WGS 84	1.23449999999694	2.34559999999418
1	34003	Test Lambert 2	RGF93	47 30 0.00000 N	004 00 0.00002 E
2	34005	Test Hotine OM	NAD27	57 00 0.00000 N	133 40 0.00000 W
3	34007	Test Reversible Poly 4th order - ED50-ED87(1)	ED50	52 30 30.00000 N	002 00 0.00000 E
4	34009	Test Bursa Wolf	WGS 84	1.23449999999694	2.34559999999418
5	34011	Test Bursa Wolf	WGS 84	1.23449999999694	2.34559999999418
6	34012	Test Transverse Mercator South Orientated	Hartebeesthoek94	00 00 1.00000 N	015 00 1.00000 E
7	34013	Test Transverse Mercator South Orientated comp	Hartebeesthoek94	00 00 1.00000 S	015 00 1.00001 E
8	34000	Test Bursa Wolf	WGS 84	1.23449999999694	2.34559999999418
9	34002	Test lambda rotation	Batavia	0	106.807719444179
10	34004	Test oblique stereographic	Amersfoort	50 22 37.80178 N	005 00 0.00121 E
11	34006	Test oblique stereographic	Amersfoort	53 00 0.00000 N	006 00 0.00000 E

Figure 5.1

When the program is used for the first time the Station table will be empty.

The Station table may be invoked from the main menu by selecting *Data / Station*, or by

clicking the  button in the main toolbar.



## 5.1 Attributes

The attributes for each station (with maximum field lengths in square brackets where applicable) are:

STATION_CODE	Automatically assigned and cannot be edited.
STATION_NAME[80]	Station name.
CRS	The Coordinate Reference System, relates to the Coordinate Reference System table.*
LAT	Geographic Latitude.
LON	Geographic Longitude.
GEOG_UOM	The Unit of Measure for LAT and LON, relates to the Unit of Measure table.*
HEIGHT	Ellipsoidal height.
HEIGHT_UOM	The Unit of Measure for HEIGHT, relates to the Unit of Measure table.*
X	Geocentric X.
Y	Geocentric Y.
Z	Geocentric Z.
GEOCENTRIC_UOM	The Unit of Measure for X, Y and Z, relates to the Unit of Measure table.*
E	Grid easting or westing.
N	Grid northing or southing.
GRID_UOM	The Unit of Measure for E and N, relates to the Unit of Measure table.*
ELEVATION	Station elevation.
ELEVATION_UOM	The Unit of Measure for ELEVATION, relates to the Unit of Measure table.*

---



CONVERGENCE	Grid convergence.
SCALE_FACTOR	Grid scale factor.
REMARKS[255]	Arbitrary information.
INFORMATION_SOURCE[254]	Arbitrary information.
DATA_SOURCE[40]	Always set to "USER" and cannot be edited.
REVISION_DATE[10]	Date in format <i>dd/mm/yy</i> .
DEPRECATED	"Yes" or "No".*


\* selected from dropdown list.

---



## 5.2 Editing Data

Data editing cannot be done directly within the table but is performed using the *Details* form.

The *Station Details* form, as shown in Figure 5.2 below, may be displayed by double clicking on the record in the table or clicking the  button in the table toolbar.

The screenshot shows a software window titled "Station: TEST". It contains several input fields and buttons. At the top, there is a "Code" field with the value "34000" and a "Deprecated" dropdown menu set to "No". Below this is a "Name" field containing "TEST". The "Coord Ref Sys" is set to "Abidjan 1987 / TM 5 NW" with a "Change" button. The "Latitude" field is "11 18 36.93159 N", "Longitude" is "001 00 50.98594 E" with a "Units" dropdown set to "degree minute second hemisphere", and "Height" is "-99.223" with a "Units" dropdown set to "metre". There are "Compute Geocentric and Grid Coordinates" and "Compute Geographic and Geocentric Coordinates" buttons. Below these are tabs for "Previous Geographic", "Geocentric", "Grid", and "General". The "General" tab is active, showing "Projection" as "TM 5 NW", "Easting" as "1157449.326", "Northing" as "1256958.23" with "Units" set to "metre", "Elevation" as "0.000" with "Units" set to "metre", "Convergence" as "001 11 1.53338 W", and "Scale Factor" as "1.004954416". At the bottom, there is a toolbar with buttons for "New", "Copy", "Save", "Save New", "Delete", "Close", and navigation arrows.

Figure 5.2



### 5.2.1 Coordinate Reference System

A station must be referenced to a *Coordinate Reference System* (CRS).

#### 5.2.1.1 Changing the CRS

To change the CRS click on the **Change** button to invoke the CRS selection dialog as shown in Figure 5.3 below.

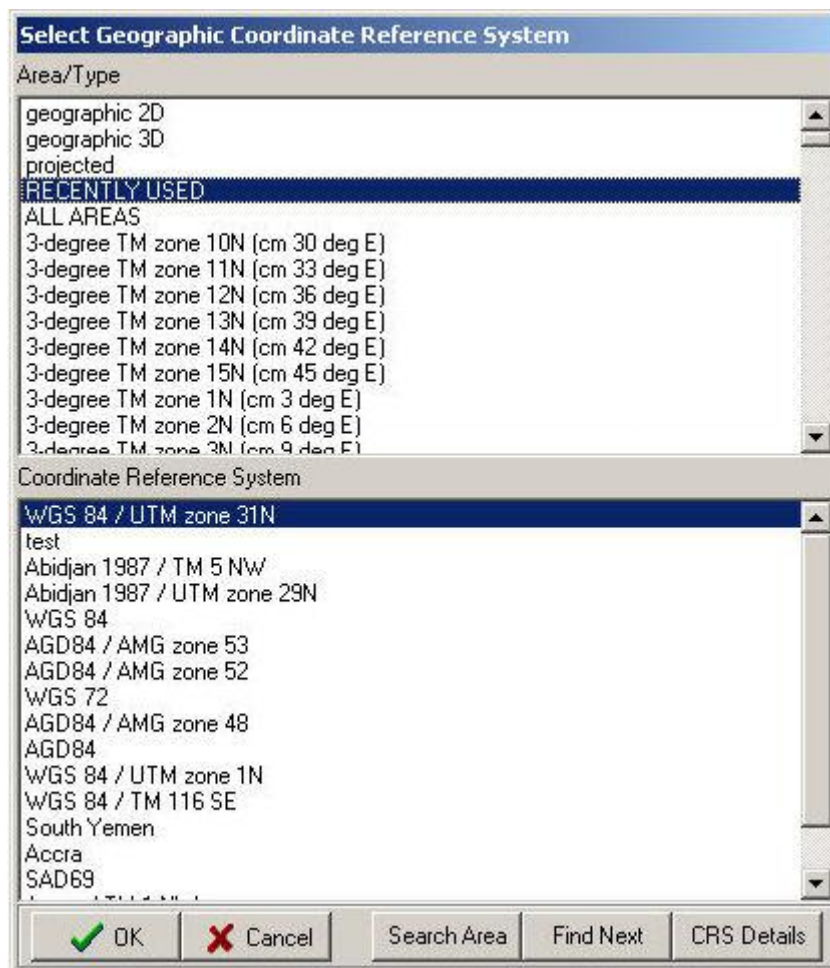

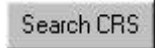



Figure 5.3

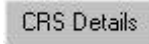
The list of CRS is displayed in the lower, *CRS*, panel and is dependent on the item selected in the top, *Area/Type*, panel. Only Geographic and Projected CRS are shown. The default



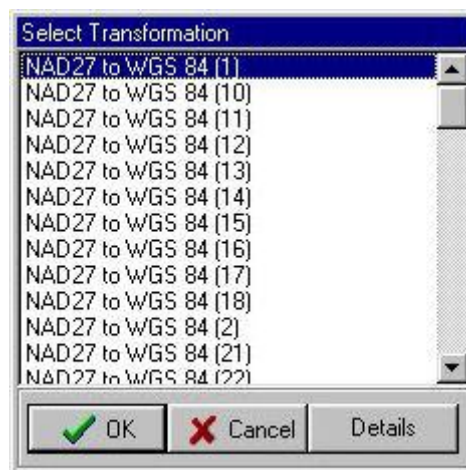
selection is RECENTLY USED which shows the last 100 selections which have been made. This list will therefore initially be empty.

When the lower panel is clicked the  button changes to .

To search the respective lists click on the *Search* button and type in the search string in the dialog box. To search for subsequent occurrences of the same search string click on the  button.

To display the *CRS Details* form click on the  button.

The required CRS is selected by clicking the  button or double clicking on the CRS in the list.




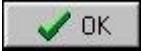
**Figure 5.4**

Once the selection is made a list of all the datum transformations defined for transforming the coordinates into the new Geog CRS is displayed, as show in Figure 5.4.

---



To display the *Datum Transformation Details* form double click on the item in the list or click on the  button.


Click the  button to select the transformation required.

Once the transformation is selected the following will occur:

- The name of the CRS changes to the selection.
- The geographic coordinates referenced to the new Geog CRS are computed and displayed.
- The previous Geog CRS and associated coordinates are displayed in the *Previous Geographic* page.
- The Geocentric coordinates referenced to the new Geog CRS are computed and displayed in the *Geocentric* page.
- If the CRS is a projection then the Grid coordinates are computed and displayed.

#### 5.2.1.2 Editing the Geographic Coordinates

Type in the new coordinate values or edit the existing ones.

**Note:** The entry must conform to the specified Units. The *Unit of Measure* details form may be displayed by clicking on the respective  button.



**Figure 5.5**

When the coordinates are edited the Geocentric and Grid coordinates will be invalid, their


---



respective fields will change from green to red, and the *Compute* button (Figure 5.5) will be enabled. Click on this button to compute the new Geocentric and Grid coordinates. Grid coordinates will only be computed if a Grid CRS is specified.

### 5.2.1.3 Editing the Grid Coordinates

Type in the new coordinate values or edit the existing ones.

**Note:** The entry must conform to the specified Units. The *Unit of Measure* details form may be displayed by clicking on the respective  button.



**Figure 5.6**

When the coordinates are edited the Geographic and Geocentric coordinates will be invalid, their respective fields will change from green to red, and the *Compute* button (Figure 5.6) will be enabled. Click on this button to compute the new Geographic and Geocentric coordinates.

### 5.2.2 Geocentric Coordinates

The Geocentric coordinates displayed in the *Geocentric* page are referenced to the Earth Centred Earth Fixed (ECEF) 3 dimensional right-handed cartesian reference frame with the X-axis always positive in the direction of where the Greenwich meridian intersects the equator, regardless of the prime meridian to which the Geog CRS datum is referenced.

---



**Figure 5.7**

The Geocentric coordinates may be edited and the resultant Geographic and Grid coordinates computed by clicking on the *compute* button (Figure 5.7).




### 5.3 Computing a Datum Transformation

The computation of a datum transformation is achieved by creating a station referred to an existing Coordinate Reference System (CRS), then changing this CRS to another CRS which is related to the first CRS by an existing Datum Transformation.

If they do not already exist in the EPSG database the “from” and “to” CRS’s and the datum transformation should be created before creating the station. Refer to the section Creating new Entities for information on this.

To compute a datum transformation on a station:

1. Ensure that the “from” and “to” CRS’s, and the datum transformation relating them, exist.
2. Create the station using the “from” CRS, then enter its name and coordinates.
3. Optionally save this station if a permanent record is required.
4. Select the “To” CRS, specifying the datum transformation to use. The new coordinates on the “to” CRS are automatically computed.
5. To save this station as a new station optionally enter a new name then click on the  button.

### 5.4 Geographic <> Grid <> ECEF Cartesian Conversions


To compute coordinate conversions between Geographic, Grid and Earth Centred Earth Fixed (ECEF) Cartesian coordinates first create a station using the required CRS. If a grid coordinate conversion is required then the CRS should be a projected CRS. If the CRS does not already exist in the EPSG database then a new one should be created. Refer to the section Creating new Entities for information on this.

To compute the conversion simply edit the coordinates in one of the three systems then click the *Compute* button which automatically becomes enabled when the edit is made. The new coordinates appear.

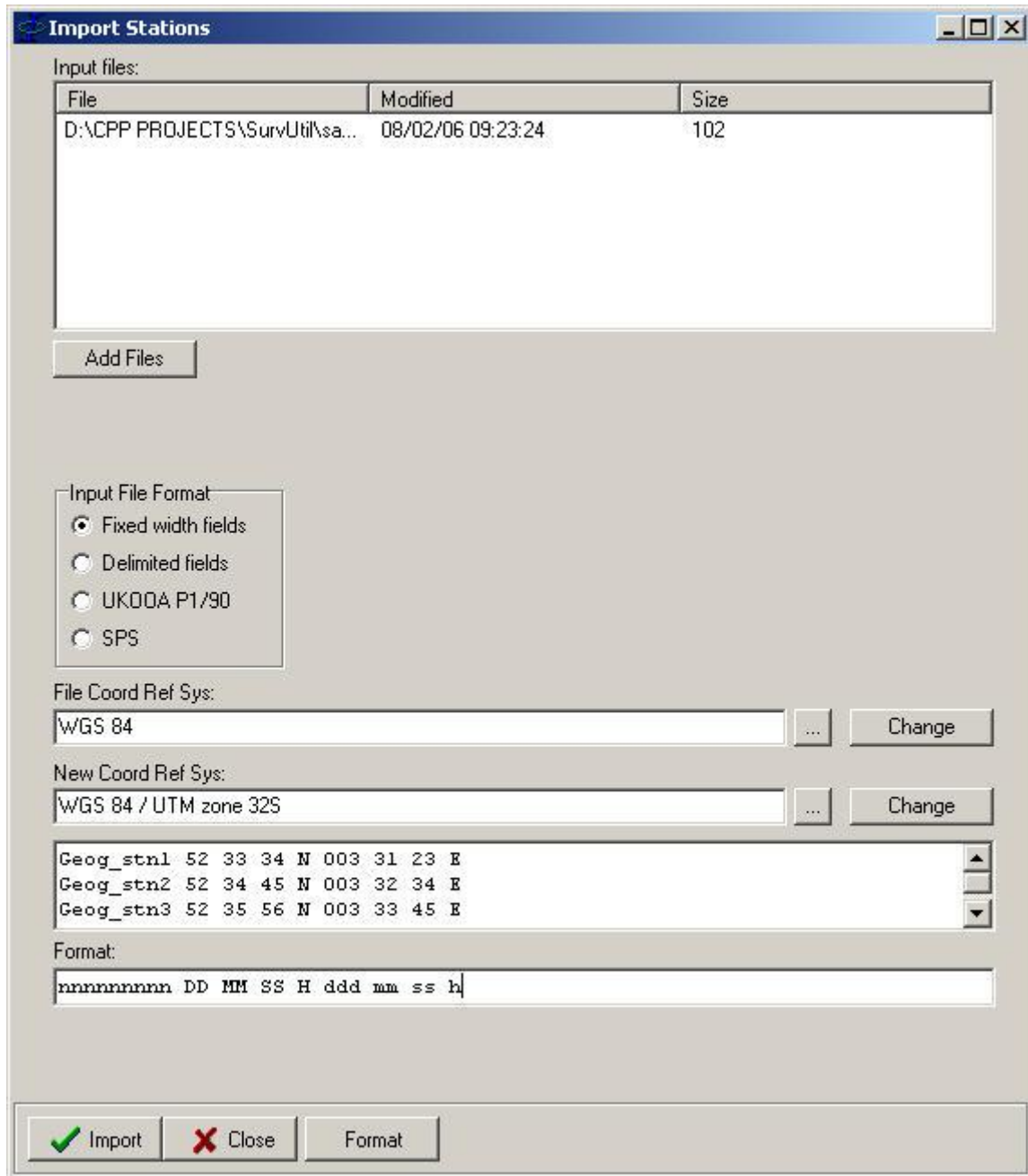
---



## 5.5 Importing Station Coordinates from File

From the main menu select *Station | Import* to invoke the dialog shown in Figure 5.8 below, and select the file containing the Station coordinate data. After setting the required options described below click on the  button to import the data. When the Stations have been imported they will appear in the Station table.

---



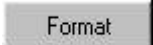
**Figure 5.8**



#### 5.5.1.1 Input File Format

The following formats are supported:

- UKOOA P1/90
- Shell Processing Support (SPS)
- User defined – the user must choose between Fixed and delimited field formats. The format specification descriptions for these may be displayed by clicking the

 button.

#### 5.5.1.2 File Coordinate Reference System

This is the CRS to which the coordinates in the file are referenced, and must be specified.

#### 5.5.1.3 New Coordinate Reference System

This is the CRS to which the imported stations will be referenced.

If this is the same as the File CRS then no coordinate computations will be carried out, and the station coordinates in the database will be the same as those in the file.

If this is different to the File CRS then the required datum transformation and/or projection computation will be carried out. If the File and New Geographic CRS are different and no datum transformation exists to convert between them then an error message will be displayed and the stations will not be imported.

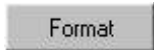
If the new CRS is a Grid CRS referenced to the same Geographic CRS as the File CRS, as shown in Figure 5.8, then the Geographic coordinates will remain unchanged and only the Grid coordinates will be computed.

#### 5.5.1.4 Format

If a user defined format is to be specified then this must be entered in the Format field, and

---



the delimiter specified if required. The format specifiers are described as follows, and may also be displayed by clicking the  button:

n = station name

**GEOGRAPHIC:**

D = degrees latitude	M = minutes latitude	S = seconds latitude	H
= hemisphere latitude			
d = degrees longitude	m = minutes longitude	s = seconds longitude	h
= hemisphere longitude			
Z = height above spheroid			

**OR GRID:**

E = easting	N = northing
z = elevation	

any other character = do not import field

File records beginning with a forward slash (/) will not be imported

File records must be terminated with cr/lf

**FIXED WIDTH:**

format characters must match exact file positions

**Examples:**

```
data: station1 45 00 00.000 N 001 00 00.00 E 10.0
format: nnnnnnnn DD MM SSSSSS H ddd mm sssss h ZZZZ
```

```
data: 0010000.00e 450000.000n 10.0 station1
format: dddmmsssssh DDMMSSSSSSH ZZZZ nnnnnnnn
```

```
data: station1 45.00000N 001.00000E 10.0
format: nnnnnnnn DDDDDDDH ddddddddh ZZZZ
```

```
data: station1 -45.00000 -001.00000 10.0
format: nnnnnnnn DDDDDDDDD dddddddddd ZZZZ
```

```
data: station1 123456.7 23456789.0 10.0
format: nnnnnnnn EEEEEEEE NNNNNNNNNN zzzz
```

**OR DELIMITED:**

only one character is used to represent a field, field delimiter character(s) must be provided

**Examples:**

```
data: station1,45,00,00.000,n,001,00,00.000,e,10.00
format: nDMSHdmshZ
field delimiter: ,
```

```
data: station1##1234567.8##23456789.0##10.00
format: nENz
field delimiter: ##
```

## 5.6 Exporting Station Coordinates to File

From the main menu select *Export | Geographic Coordinates* to invoke the dialog shown in



Figure 5.9 below.

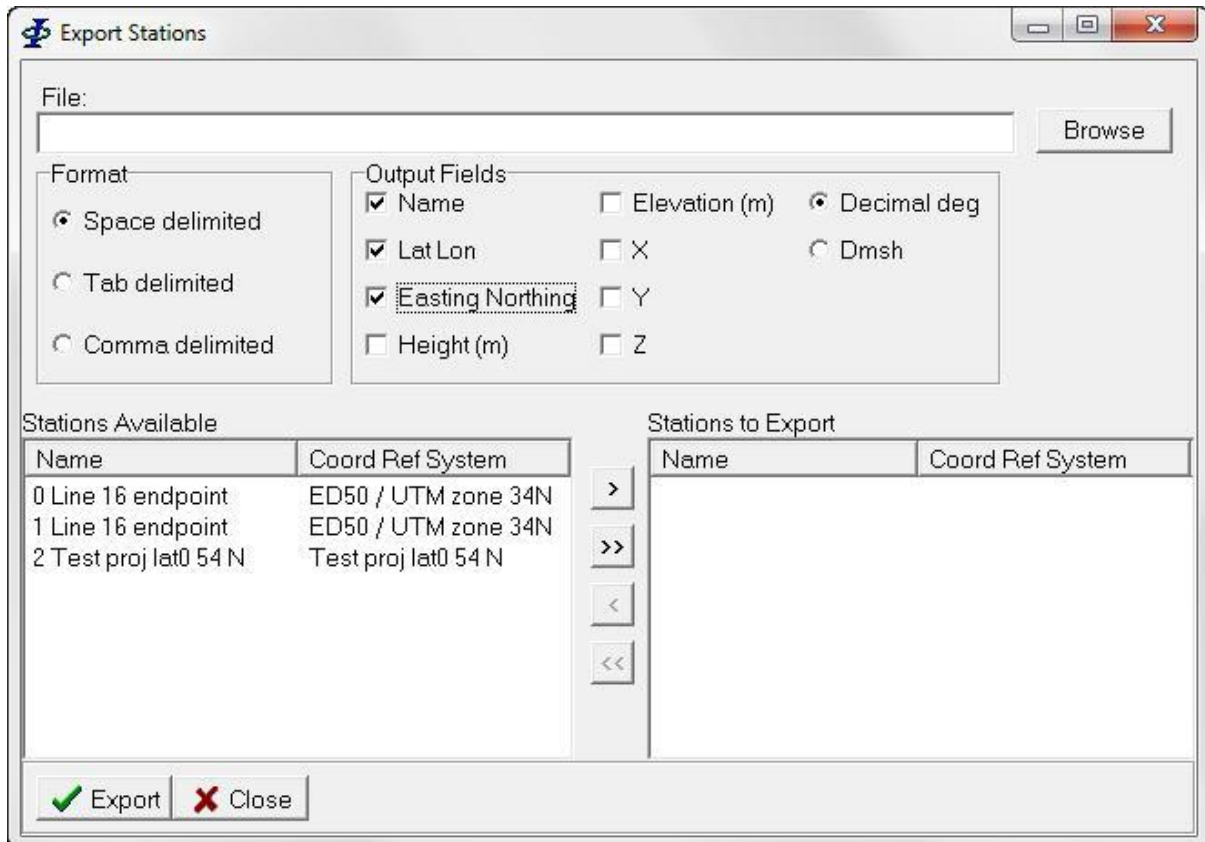

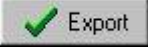


Figure 5.9

1. Enter the name of the file to be written, or select from the *File Save* dialog using the  button.
2. Select the file format. The default is for space delimited fields. The file format will change to the file type specified in the *File Save* dialog.  
**Note:** the filename extension will be “txt” for space and tab delimited files, and “csv” for comma delimited files.
3. Select which attributes are to be output. If *Lat Lon* is specified then a further choice of decimal degrees or degrees, minutes, seconds and hemisphere (Dmsh) can be specified.



4. Select the stations to be exported by clicking on the appropriate arrow buttons.
5. Click on the  button to export the stations.



## 6 FILE CONVERSIONS

This module enables the conversion of file coordinates referenced to one CRS into the corresponding coordinates referenced to a different CRS. Both CRS's must exist before the conversion can be carried out. To perform file to file coordinate conversions select from the main menu *Station | File Conversion*. The dialog as appears in Figure 6.1 appears.

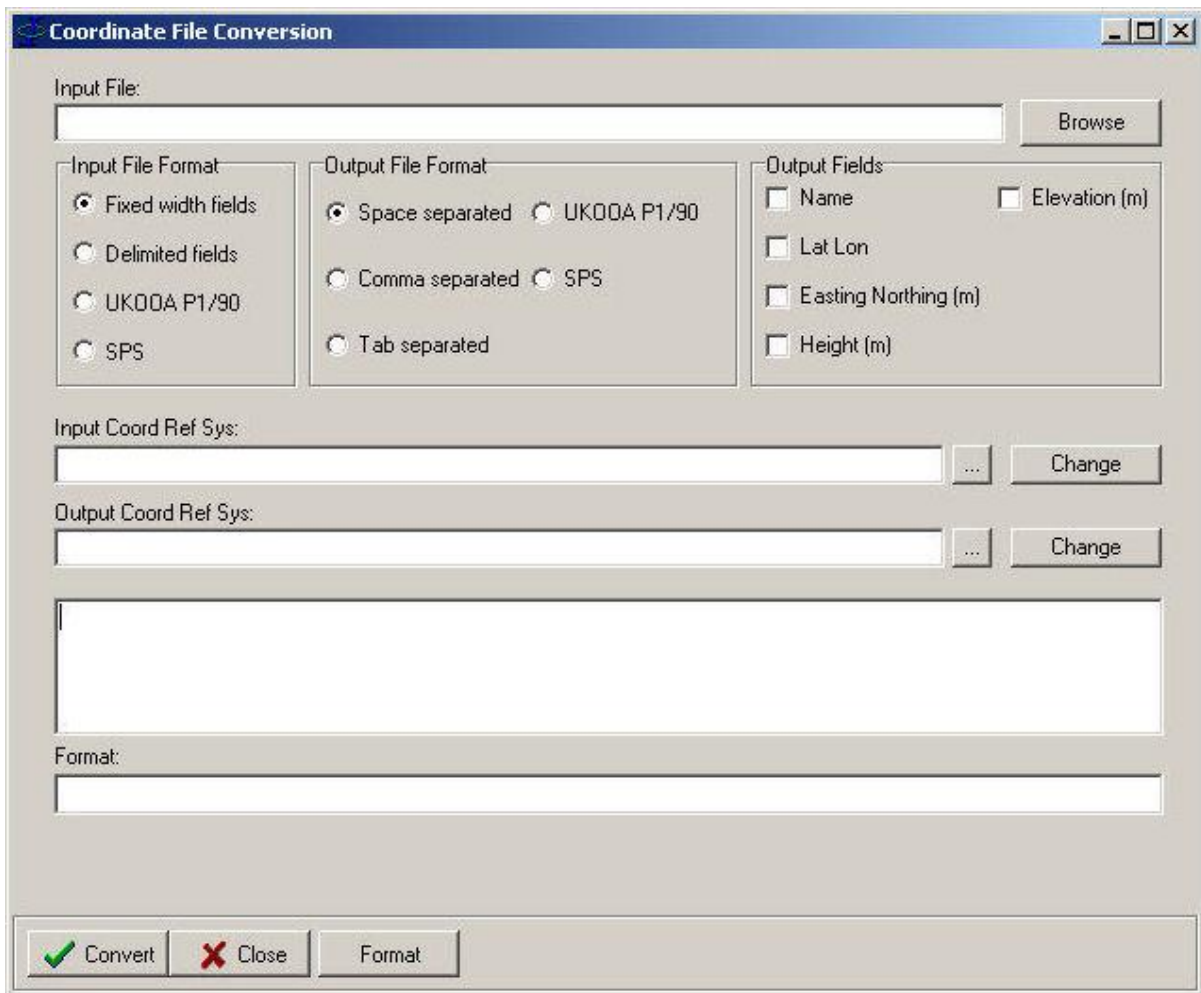


Figure 6.1



## 6.1 File Formats

### 6.1.1 Input

The following input file formats are supported:

*Fixed width fields:* A user defined format where each field within a record is of a known, fixed, width and each record is terminated by a Carriage Return/Line Feed (CRLF). Every record in the file must be of the same format.

*Delimited fields:* A user defined format where each field within a record, except the last, is separated from the next field by a constant field delimiter of between 1 and 255 characters. Each record is terminated by a CRLF. Every record in the file must be of the same format

*UKOOA P1/90:* The file conforms to the UKOOA P1/90 format.

*SPS:* The file conforms to the Shell Processing Support format.

#### 6.1.1.1 User Defined Format

To convert a file in the fixed or delimited user defined format the format description must be provided by entering the appropriate format specifiers in the *Format* field. Clicking the

Format

button displays a description of the format specifiers and the options available,

shown below:

n = station name

GEOGRAPHIC:

D = degrees latitude M = minutes latitude S = seconds latitude H = hemisphere  
latitude

d = degrees longitude m = minutes longitude s = seconds longitude h = hemisphere  
longitude

Z = height above spheroid

OR GRID:

E = easting N = northing

z = elevation

any other character = do not import field

---



File records beginning with a forward slash (/) will not be imported

File records must be terminated with cr/lf

**FIXED WIDTH:**

format characters must match exact file positions

**Examples:**

```
data: station1 45 00 00.000 N 001 00 00.00 E 10.0
format: nnnnnnnn DD MM SSSSSS H ddd mm sssss h ZZZZ
```

```
data: 0010000.00e 450000.000n 10.0 station1
format: dddmmsssssh DDMSSSSSSH ZZZZ nnnnnnnn
```

```
data: station1 45.00000N 001.00000E 10.0
format: nnnnnnnn DDDDDDDDH ddddddddh ZZZZ
```

```
data: station1 -45.00000 -001.00000 10.0
format: nnnnnnnn DDDDDDDDD dddddddddd ZZZZ
```

```
data: station1 123456.7 23456789.0 10.0
format: nnnnnnnn EEEEEEEE NNNNNNNNNN zzzz
```

**OR DELIMITED:**

only one character is used to represent a field,  
field delimiter character(s) must be provided

**Examples:**

```
data: station1,45,00,00.000,n,001,00,00.000,e,10.00
format: nDMSHdmshZ
field delimiter: ,
```

```
data: station1##1234567.8##23456789.0##10.00
format: nENZ
field delimiter: ##
```

### 6.1.2 Output

The following output formats are supported:

**Space separated:** Each output field is separated by a space, and each record by a CRLF.

**Comma separated:** Each output field is separated by a comma, and each record by a CRLF.

**Tab separated:** Each output field is separated by a tab, and each record by a CRLF.

**UKOOA P1/90:** The input format must be UKOOA P1/90

**SPS:** The input format must be SPS.

For each of the three field delimited formats the output fields must be specified by checking

---



the appropriate checkboxes.


## 6.2 Coordinate Reference Systems

The input and output CRS's must be specified. These can be any combination of Geographic and Projected CRS's. The possible output result will depend on the combination of specified CRS's, and the coordinate type in the file, as described in the following table:

<b>Specified input CRS</b>	<b>Specified output CRS</b>	<b>File coords</b>	<b>Output Coords</b>
Geographical	Geographical	Geog	Geog only
Geographical	Geographical	Grid	No output
Geographical	Projected	Geog	Geog and/or Grid
Geographical	Projected	Grid	No output
Projected	Geographical	Geog	Geog only
Projected	Geographical	Grid	Geog only
Projected	Projected	Geog	Geog and/or Grid
Projected	Projected	Grid	Geog and/or Grid

Note: Projected CRS includes the source geographical CRS

## 6.3 Execution

Once all of the parameters have been specified click the  button to process the file. The output file name will be the same as the input file name with the suffix ".OUT" appended.



## 7 GEODETIC FORWARD/INVERSE

From the main menu select *Compute | Geodetic Forward/Inverse* or click the



button to invoke the dialog shown in Figure 7.1 below.

**Geodetic Forward/Inverse**

**1**

Station: Test Bursa Wolf

Latitude: 70 43 53.90400 N Units: degree minute second hemisphere

Longitude: 134 23 34.72800 E Ellipsoid: WGS 84

Compute Coords 1

Save

**1 to 2**

Distance: 1852 Units: metre

Azimuth: 45 Units: degree minute second

Back Azimuth: 225 02 0.86131

Compute 1 to 2

Compute 2 to 1

**2**

Station:

Latitude: 70 44 36.14645 N Units: degree minute second hemisphere

Longitude: 134 25 42.75673 E Ellipsoid: WGS 84

Compute Coords 2

Save

Close

Figure 7.1


In the instructions which follow, panels **1** and **2** are identical and interchangeable.

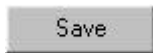
All fields will turn green after a computation has been made, and unaltered fields will turn red after changes are made, indicating that the values displayed are no longer valid.



## 7.1 Forward

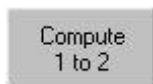
To compute new coordinates from given coordinates and an *ellipsoidal* distance and *geodetic* azimuth:

2. Select the station from the drop-down list, or manually enter the coordinates in panel 1 or 2. If selecting a station the ellipsoid and units will change to those to which the station is referenced. If no station is selected the ellipsoid will default to that to which the *Default Geog CRS* is referenced, and the units to degree, minute, second and hemisphere.
3. Enter the ellipsoidal distance and azimuth. The units will default to metres and degrees, minutes and seconds respectively.
4. Click the *Compute Coords* button in the opposite panel to which the coordinates have been entered i.e. if coordinates have been entered, or a station selected, in panel 1 then click the  button.

5. The target coordinates and back azimuth will be computed.
6. Optionally click the  button to save the computed point as a new station. The Geog and Grid CRS of the new station will be the same as those of the station from which the computation was made.

## 7.2 Inverse

To compute the *ellipsoidal* distance and *geodetic* azimuth and back azimuth between the two points:

1. For each of panels 1 and 2 select the station from the drop-down list, or manually enter the coordinates and select the ellipsoid.
2. Click the  button to compute the distance and azimuth from points 1 to 2, and vice versa.

**Note:** If the ellipsoids for the two points differ a warning will be displayed and the option

---



given to compute on the “from” ellipsoid, or to cancel the computation. I.e. if computing 1 to 2 the option will be given to compute on ellipsoid 1.



## 8 GRID FORWARD/INVERSE

From the main menu select *Compute | Grid Forward/Inverse* to invoke the dialog shown in Figure 8.1 below.

The dialog box 'Grid Forward/Inverse' is shown with the following data:

Section	Field	Value	Units
1	Station	Test Bursa Wolf	
	Easting	427196.861	metre
	Northing	136458.511	
1 to 2	Distance	1852	metre
	Azimuth	45	degree minute second
2	Station		
	Easting	428506.422758755	metre
	Northing	137768.07275876	

Figure 8.1

In the instructions which follow, panels **1** and **2** are identical and interchangeable.

All fields will turn green after a computation has been made, and unaltered fields will turn red after changes are made, indicating that the values displayed are no longer valid.



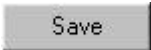
## 8.1 Forward

To compute new coordinates from given coordinates and a *grid* distance and azimuth:

1. Select the station from the drop-down list, or manually enter the coordinates in panel 1 or 2. If selecting a station the units will change to those with which the station is defined. If no station is selected the units will default to metres.
2. Enter the grid distance and azimuth. The units will default to metres and degrees, minutes and seconds respectively.
3. Click the *Compute Coords* button in the opposite panel to which the coordinates have been entered i.e. if coordinates have been entered, or a station selected, in panel 1 then click the




button.

4. The target coordinates will be computed.
  5. Optionally click the
- 
- button to save the computed point as a new station. The Geog and Grid CRS of the new station will be the same as those of the station from which the computation was made.


## 8.2 Inverse

To compute the *grid* distance and azimuth between the two points:

1. For each of panels 1 and 2 select the station from the drop-down list, or manually enter the coordinates.
  2. Click the
- 
- button to compute the distance and azimuth from points 1 to 2, and vice versa.



## 9 NETWORK ADJUSTMENT

From the main menu select *Compute / Network Adjustment*, or click the  button to invoke the Network Adjustment control panel (Figure 9.1).

The Network Adjustment is a single weighted least squares adjustment of up to 100 nodes and 1000 observations. Delft method data snooping is included for data rejection or re-weighting. All conventional statistics are computed.

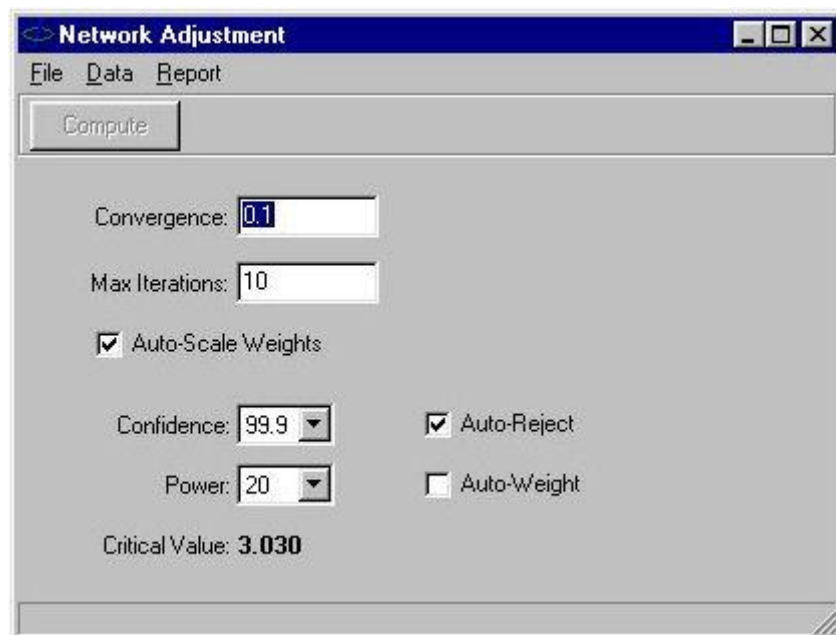


Figure 9.1



## 9.1 Input Data

The node and observation data are read from file. At present only a proprietary file format is supported. From the menu select *Data | Import from File* to invoke the import dialog as shown in Figure 9.2 below.

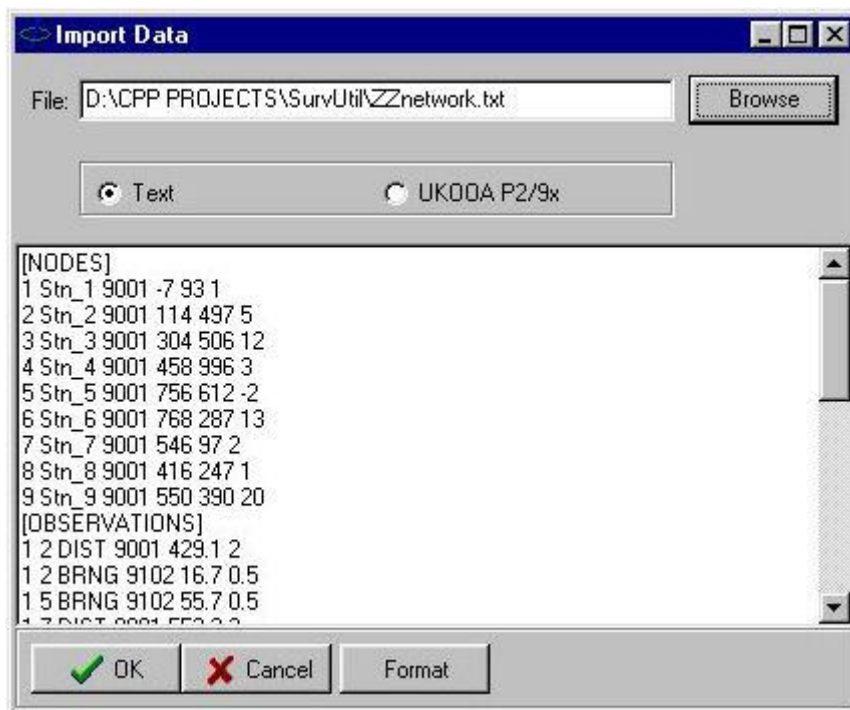
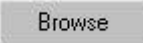
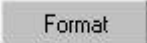


Figure 9.2

Enter the file name or select using the  button.

### 9.1.1 File Format

At present only a proprietary file format is supported. The format description may be displayed by clicking the  button.

The format consists of two types of records, Nodes and observations. Each record type must

---



be in a contiguous block preceded by either [NODES] or [OBSERVATIONS].

After selecting the file and clicking the  button the network will be graphically displayed according to the initial estimate positions of the nodes.

The format description is as follows:

[NODES]

ID, NAME, UNITCODE, EASTING, NORTHING, HEIGHT

Where:

ID = integer, unique identifier.  
NAME = string, max 20 characters and must not contain any field delimiter characters  
UNITCODE = integer, unit of measure EPSG code (m = 9001)  
EASTING = floating point, initial position estimate in units of UNITCODE  
NORTHING = floating point, initial position estimate in units of UNITCODE  
HEIGHT = floating point, height in units of UNITCODE

[OBSERVATIONS]

AT, TO, TYPE, UNITCODE, VALUE, SD

Where:

AT = integer, NODE ID  
TO = integer, NODE ID, if observation TYPE is EASTING or NORTHING then should be same as AT  
TYPE = string, following types supported:  
DIST = distance  
BRNG = bearing  
EAST = easting  
NORTH = northing  
UNITCODE = integer, unit of measure EPSG code (m = 9001, deg = 9102)  
VALUE = float point, in units of UNITCODE  
SD = floating point, a priori standard deviation in units of UNITCODE

Up to 100 nodes and 1000 observations may be defined  
Recognised field delimiters are: space (" "), comma (","), tab (" ")  
Comment records should start with forward slash ("/")

EXAMPLE:

[NODES]

```
1 Stn_1 9001 -7 93 1
2 Stn_2 9001 114 497 5
3 Stn_3 9001 304 506 12
```

[OBSERVATIONS]



```
1 1 EAST 9001 -7 2
1 1 NORTH 9001 93 2
1 2 DIST 9001 429.1 2
1 2 BRNG 9102 16.7 0.5
1 3 DIST 9001 517.1 2
2 3 DIST 9001 189.5 2
/ This is a comment and will not be read
```

## 9.2 Nodes

### 9.2.1 Identification

The node ID in field 1 for each node must be a unique integer. These are used by the observations to specify the node(s) to which the observations relate.

### 9.2.2 Initial Estimate Position

The initial estimate positions must be sufficiently accurate to maintain the network topology otherwise the solution will diverge.

The units of measure for the initial positions are defined by the UNITCODE.

### 9.2.3 Height

The values given for node heights are used to reduce the distance observations to horizontal. If the distance observations are horizontal distances, then they should be entered as zero.

The units of measure for the height are defined by the UNITCODE.

### 9.2.4 Units of Measure

The node position and height units of measure must be defined using the EPSG codes. These can be found by selecting from the main menu *Data | Database | Unit of Measure*. The most commonly used code will be:

9001 metre

---



When the data is imported all node eastings, northings and heights are converted to metres using the defined unit codes.

### **9.3 Observations**

#### *9.3.1 Types*

Four types of observations are supported:

- Easting
- Northing
- Slope Distance
- Bearing

#### *9.3.2 Constraints*

The network requires at least one easting and northing pair, and one bearing.

If no easting or northing observation is present in the data file then an easting and northing pair, in metres, will be automatically created for the first node found, taking on the metre equivalent values of that node's initial estimate position, and assigned a standard deviation of 0.1m. This is necessary to constrain the network. In this case the absolute position of the solved network will only be as accurate as the first node's initial estimate position.

If no bearing observation is present in the data file then a bearing, in radians, will be created between the first two nodes found, based upon those nodes initial estimate positions, and assigned a standard deviation of 0.001 radian (0.057°). This is necessary to provide orientation for the network. In this case the accuracy of the orientation of the network will be a function of the accuracy of the relative initial estimate positions of the first two nodes.

In all cases, the relative computed node positions, assuming convergence, will be the Best Linear Unbiased Estimate (BLUE).

---



### 9.3.3 Units of Measure

The units of measure for observations and a priori standard deviations must be defined using the EPSG codes. These can be found by selecting from the main menu *Data | Database | Unit of Measure*. The most commonly used codes will be:

9101	metre
9102	degree

When the data is imported all observations are converted to metres or radians using the defined unit codes.

## 9.4 Options

The adjustment options available are:


- Convergence:** The maximum node easting or northing correction between iterations before the solution is considered to have converged. The default value is 0.1.
- Max Iterations:** The maximum number of iterations allowed. The default value is 10.
- Auto-Scale Weights:** If checked the observation a priori SDs will be adjusted to force the unit variance to be one. The default is off.
- Confidence:**  $100 - \alpha$  where  $\alpha$  is the percentage probability of rejecting a good observation. The default value is 99.9.
- Power:** The percentage probability that errors the size of the reported marginally detectable errors will be accepted. The default value is 20.
- Critical Value:** A function of confidence, the normalised residual above which an observation will be rejected or down weighted if auto-rejection or auto-weighting is implemented.
- Auto-Reject:** If checked, the observation with the highest residual exceeding the critical value will be rejected and the solution re-iterated without incrementing the iteration count. The default is on.
-



*Auto-Weight:* If checked, the observation with the highest residual exceeding the critical value will be down weighted by a function of its normalised residual and the solution re-iterated without incrementing the iteration count. The default is off.

**Note:** Auto-rejection and auto-weighting are mutually exclusive.

### **9.5 Computing the adjustment**

To compute the adjustment click the  button. Once the network is computed, whether solved or not, the graphical display will be updated and the report file displayed.

Once the solution has converged, or the number of iterations reaches the maximum specified, a report will be displayed and the graphical display updated.

**Note:** the units of measure used for the adjustment are metres and radians. All angular quantities are reported in degrees.

---



## 9.6 Graphical Display

A sample display is shown below in Figure 9.3.

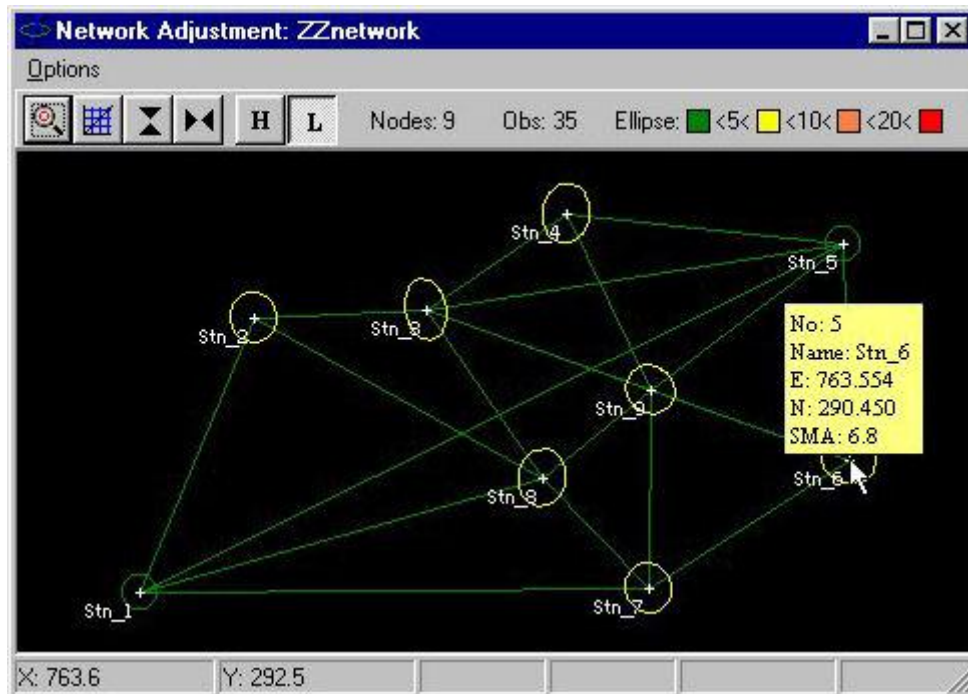


Figure 9.3

### 9.6.1 Display Information

The display will initially show the horizontal view of the network. By clicking the **H** button the elevation view of the network is displayed. The position of the mouse cursor in the units of the node coordinates (see 9.2.2 Initial Estimate Position) is shown below the display.

Measurements can be made by drawing a line using the right mouse button. The radial and orthogonal lengths in the units of the node coordinates, and the bearing in degrees of the line is shown below the display.

By holding the left mouse button down on a node the following information is displayed:

---



No. The node number as listed in the adjustment report (not the node ID).

Name

Easting

Northing

Semi-major axis (95%) if computed


Node label display can be toggled by clicking the  button.

The number of *visible* nodes and observations is shown above the display. These will change when the display is zoomed.

### 9.6.2 Error Ellipses

Once the network has been solved the 95% probability error ellipses will be displayed for each node. These ellipses are drawn with true orientation but not scale. The size of the ellipses can be estimated by using the colour key above the display.


### 9.6.3 Scale

The display is initially scaled so as to occupy the whole window. True scale can be shown by clicking the  button.

### 9.6.4 Zooming

To zoom in on a part of the display draw a rectangle using the left mouse button. All nodes falling outside the rectangle will not be displayed.

To zoom out vertically click repeatedly on the  button.

To zoom out horizontally click repeatedly on the  button.

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To zoom out so that the whole network is visible click on the  button.

## 9.7 Report

The report automatically appears on completion of the adjustment. If close it can be displayed by selecting *Report | View Adjustment Log* from the menu.

Each time an adjustment is computed on the same network file a new report is produced with an incremental naming convention, named after the data file.

For each iteration the following is reported:

- For each node
  - number
  - name
  - easting (m)
  - northing (m)
- Maximum node movement
- For each observation
  - number
  - name
  - value (m or deg)
  - SD (m or deg)
  - weight
  - residual (m or deg)
  - W-statistic (normalized residual)
  - marginally detectable error (MDE) (m or deg)
- Variance factor
- Degrees of freedom

On completion of the adjustment the following is reported:

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- Observations auto-rejected or auto-weighted
  - For each node:
    - number
    - name
    - easting (m)
    - northing (m)
    - 95% error ellipse semi-major axis (m)
    - 95% error ellipse semi-minor axis (m)
    - error ellipse orientation (deg)
    - external reliability (m)
    - observation number to which the external reliability value is attributable
-