Chapter 3: Configuring Geodetics & Units

WinFrog provides you with the ability to configure the **Working Geodetics** to suit survey requirements for almost any location worldwide. The configuration of the **Working Geodetics** involves selecting which mathematical model (**ellipsoid**) will be used to estimate the shape of the earth, and which **Map Projection** will be used to convert the Latitude and Longitude values to **Grid** (Northing/Easting) coordinates. These configuration options can be chosen from several standard geodetic configurations or can be customized to suit a specific unique requirement.

The **Units** that WinFrog uses is user-definable so that WinFrog displays coordinates, distances, and speed in the desired formats. In addition, you can select how **Geodetic Coordinates** (degrees of Latitude and Longitude) are displayed in WinFrog.

Geodetics

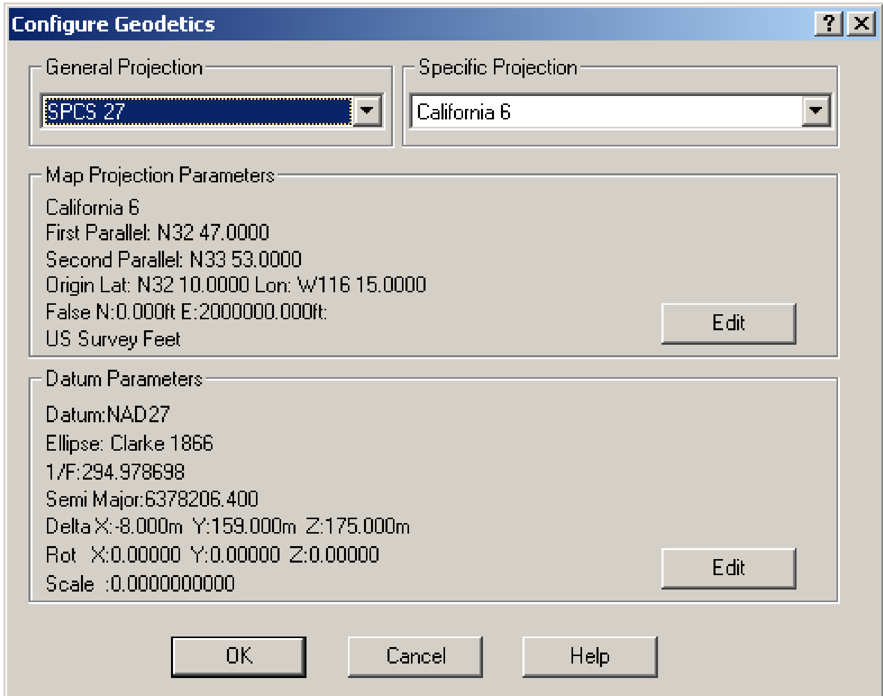
The configuration of **Geodetics** is one of the most important and powerful options in WinFrog. It allows you to modify the geodetic constants on which WinFrog bases its coordinate calculations. Errors made in specifying geodetic constants will be carried throughout an entire survey and may be very difficult, if not impossible, to correct. Therefore, it is imperative that you understand the implications of modifying the geodetic constants and ensure that all values are correctly set prior to entering coordinates or starting real-time operations.

Note: WinFrog uses WGS84 as a base reference datum/ellipsoid. Transformations are based on going between WGS84 and the selected working datum/ellipsoid. The datum/ellipsoids WGS84, ITRF00 and ITRF05 are considered to be the same for WinFrog applications. However, NAD83 is not considered to be the same as these with up to a 1.5m difference in position if the correct transformation is not applied.

Note: Most GPS receivers provide positions in WGS84 (ITRF00 or ITRF05) coordinates. However, there are exceptions to this, e.g. the default datum/ellipsoid for DGPS using corrections from USCG DGPS beacons is NAD83. It is crucial that you confirm the datum/ellipsoid the GPS receivers are providing positions for and configure them accordingly.

To Configure the Geodetic Parameters

1 Select the main menu item **Configure > Geodetics** to display the **Configure Geodetics** dialog box, as shown below.



2 Choose one of the **General Projection** options from the dropdown list. WinFrog lists some of the more commonly found **Ellipsoid** and **Map Projection** combinations **- ED50 UTM, NAD27 UTM, SPCS27, SPCS83**, and **WGS84 UTM**.

Choosing any one of these options will change the options that will appear in the **Specific Projection** dropdown list.

3 Once the **General Projection** has been chosen, you must further define the **Projection** by selecting one of the options in the **Specific Projection** dropdown list.

For example, when using one of the common **General Projection** combinations (to which a projection has already been matched), the **Specific Projection** dropdown list is used to select the projection **zone** in which you are working.

If you have chosen **User** or **NAD83**, you must now open the **Specific Projection** dropdown list to choose the **Projection** to be used. You must then **Edit** the **Map Projection Parameters** to suit the application.

For detailed information concerning choosing the **Specific Projection**, see the **Map Projections** section found later in this chapter.

4 The **Map Projection Parameters** area of the **Configure Geodetics** dialog box shows details concerning the current **General Projection** and **Specific Projection**. These are specific pre-defined details about the projection that typically do not require modification.

For detailed information concerning the editing of map projection parameters, see the **Map Projections** section found later in this chapter.

5 In the **Datum Parameters** area, click **Edit**. The resulting **Datum Parameters** dialog box displays the **Working Ellipsoid** parameters and the **Datum Shifts** that are used to relate the **Working Ellipsoid** to the **WGS 84** ellipsoid. This information is required if GPS (which is referenced to the WGS84 ellipsoid) is used to provide real-time positioning data to the vehicle.

Note: If the selected datum/ellipsoid has specific ellipsoid and transformation parameters, this dialog can be accessed to view the values, but the values cannot be edited.

For detailed information concerning changing the **Ellipsoid/Datum shift** parameters, see **Ellipsoidal Datum** in a later section in this chapter.

General Projection

The **General Projection** dropdown list provides you with the ability to choose one of several commonly used **Datum/Projection** combinations, or a **User** option that allows for full customization of the **Datum/Projection** parameter configuration. The choices offered are as follows:

ED50 UTM	Combines the **European Datum (1950)** and the **UTM** Projection.
NAD83	Allows you to define your own **Map Projection**.
NAD27 UTM	Combines the **North American Datum (1927)** and the **Universal Transverse Mercator** Projection.
SIRGAS2000	Combines the **Brazilian SIRGAS 2000 Datum** with **American Polyconic** Map Projection used in Brazil for a longitude of 54W and the **Universal Transverse Mercator** Projection for four zones 22S to 25S.
SPCS 27	Combines the **North American Datum (1927)** and American **State Plane Coordinate System** projections.
SPCS 83	Combines the **North American Datum (1983)** and American **State Plane Coordinate System** projections.
USER	Allows you to define your own **Ellipsoid** and **Map Projection**.
WGS84 UTM	Combines the **World Geodetic System (1984)** and the **Universal Transverse Mercator** Projection.

Note: The selection of a pre-configured **Datum/Projection** does not preclude the editing of the **Specific Projection**, **Map Projection**, and **Datum Parameter** configurations. The correct **Map Projection Zone** must be selected even if you decide not to configure any other items. The exception to this is the selection of those datums/ellipsoids whose ellipsoid and transformation parameters are very specific and must not be altered to ensure the correct application of the transformations to and from WGS84. This includes the following:

- NAD83
- SPCS83
- ED50(N Sea N62° South)

- ED50(N Sea N65° North)
- ED50(N Sea N62° to N65°

Note: If NAD83 or SPCS 83 datum/ellipsoid is selected, WinFrog calculates the transformation parameters for ITRF <-> NAD83 transformations. This determination of parameters is time dependent. The parameters are calculated when WinFrog launches and when it loads an ini or cfg file. They are updated at midnight after that.

Note: If SPCS 27 datum/ellipsoid with the shift method NADCON is selected, the transformation between NAD27 and WGS84 goes through NAD83, i.e. a NAD27 position is transformed to NAD83 using NADCON and then this NAD83 position is transformed to WGS84 using a Bursa-Wolfe transformation with the aforementioned calculated ITRF <-> NAD83 transformation parameters.

You should always confirm that the **Map Projection Parameters** (false northings, eastings, origin, and units) and the **Datum Parameters** (ellipse semi-major axis and flattening, and datum shift values) are correct for the current project. WinFrog does enter default configuration values for each of the above listed "common" projections, but these may not be the exact values required for the current project.

The following sections detail the configuration of **Map Projection** and **Datum Projection** parameters. This information is useful for both "common" and "User" **General Projection** selections.

Note: Unless configured for SPCS 27 datum/ellipsoid with the shift method NADCON, WinFrog uses a 7-parameter Bursa-Wolfe transformation. The transformation parameter sign convention is based upon going from the working ellipsoid to WGS84. It should be noted that the Bursa-Wolfe process varies from that of the US DOD in that the shift and scalar parameters are the same, but the sign convention for the rotations is the opposite.

Map Projections

WinFrog allows you to choose (or custom configure) basically any **Map Projection** that is found in use anywhere in the world.

There are three basic categories of **Map Projections** found in WinFrog:

Universal Transverse Mercator (UTM): A very common projection system. UTM is used worldwide and also in various State Plane Coordinate Systems.

Lambert: Most often used in US State Plane Coordinate Systems.

User: Various customizable projections, most commonly used for Local Coordinate Systems and for configuring an Oblique Mercator projection.

For more information on (and diagrams of) **Map Projections** refer to **Appendix A: Useful Geodetic Data** at the end of this manual.

The more common pre-configured general projections typically utilize the **UTM** or **Lambert** projection, requiring only that you select the particular **zone** to be used from the **Specific Projection** dropdown list (as well as confirming the **Datum Parameters,** as detailed later in this section).

Once you have selected the **General Projection > User** option, use the **Specific Projection** dropdown list to choose the **Projection** to be used. You have the following choices:

- Lambert
- Local
- Mercator (Clarke 1866)
- Mercator (WGS84)
- Oblique Mercator
- Oblique Mercator (RSO)
- Oblique Mercator (RSO) N Borneo
- Oblique Mercator (RSO) NW Borneo
- Plant Grid
- Polar Stereographic
- Polyconic
- StaOff (Station/Offset)
- Transverse Mercator

Each of these choices is covered in the following sections.

UTM and SPCS Projection Configuration

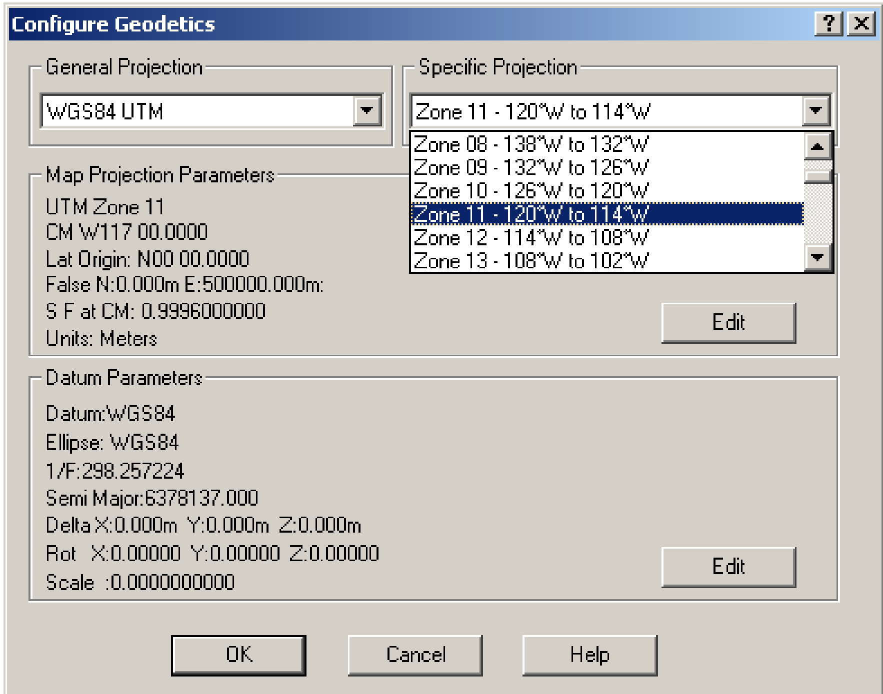
Typically, when you have chosen one of the more common general projections (which automatically combine certain ellipsoids and projections), the **UTM** or **SPCS Map Projection** parameters are fixed (except for choosing the appropriate zone) and should not be altered by the user. Generally, the only exception to this is when you are using the **UTM** projection while working South of the Equator. In this case you would have to **Edit** the **Map Projection Parameters** to change the **False Northing** to **10,000,000.00** meters.

If your specified **Map Projection Parameters** require further modifications, you should choose the **General Projection** option **User**, then select and configure the appropriate **Specific Projectio**n parameters.

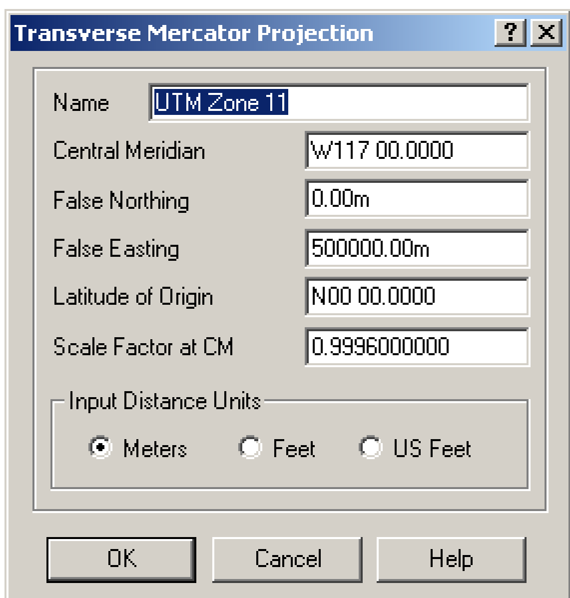
To Configure a UTM Projection

1 In the **Configure Geodetics** dialog box, **General Projection** dropdown list, select a **UTM** projection**.** (**WGS84 UTM** was selected for this example.)

2 In the **Specific Projection** area of the **Configure Geodetics** dialog box, use the dropdown list to select the appropriate zone. (For this example, **Zone 11** is selected to reflect the longitude of San Diego, CA - 117 West.)



3 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button.



The **Transverse Mercator Projection** dialog box allows for the configuration of the following parameters:

Name	Name of the Specific Projection
Central Meridian	Longitude of Central Meridian
False Northing	False Northing to be added to Northings
False Easting	False Easting to be added to Eastings
Latitude of Origin	Latitude of the Projection's Origin

Scale Factor at CM	Scale Factor at the Central Meridian
Units	Units of measure can be set to Meters, Feet, or US Survey Feet using the radio buttons. Typically, meters are used with UTM projections.

To Configure a State Plan Coordinate System (SPCS) Projection

The configuration for a **SPCS 27** or a **SPCS83 General Projection** is very similar to the procedures listed above for **UTM General Projections**.

1 Select either **SPCS27** or **SPCS83** from the **General Projection** dropdown list.

2 Select the appropriate state and zone from the **Specific Projection** dropdown list.

Some **SPCS'**s use the **Transverse Mercator** projection (which is configured the same way as shown above), while others use a **Lambert** projection. See below for more information on **Lambert** projection parameters.

User Specific Projection Configuration

As an alternative to the more common pre-configured map projection options provided, you can choose to use the **User** map projection. (Select the **User** option under **General Projection**).

The parameters that can be configured for the **User Projection** depend upon which specific projection option is chosen. This section examines the configurable parameters for each projection option listed, in the order found in the **Specific Projection** dropdown list.

Note: It is important to remember to configure the **Datum Parameters AFTER** the **Specific Projection** parameters have been configured.

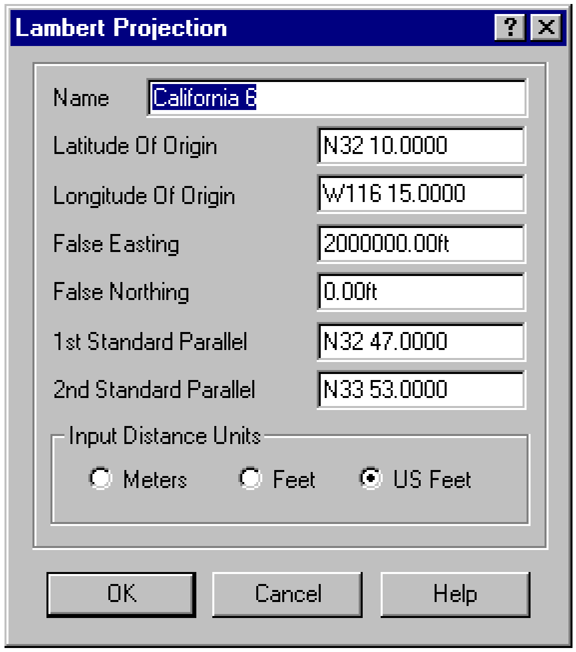
Lambert

The **Lambert Projection** is a conic conformal projection in which parallels are unequally spaced arcs of concentric circles and meridians are equally spaced radii of the same circles.

To Configure a Lambert Projection

1 In the **Configure Geodetics** dialog box, make sure **USER** is chosen in the **General Projection** dropdown list and **Lambert** is chosen in the **Specific Projection** dropdown list.

2 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button.



The **Lambert Projection** dialog box allows for the configuration of the following parameters:

Name	Name of the Specific Projection
Latitude of Origin	Latitude of the Projection's Origin
Longitude of Origin	Longitude of the Projection's Origin
False Easting	False Easting to be added to Eastings
False Northing	False Northing to be added to Northings
First Standard Parallel	Latitude of First Standard Parallel
Second Standard Parallel	Latitude of Second Standard Parallel
Units	Units of measure can be set to Meters, Feet, or US Survey Feet using the radio buttons

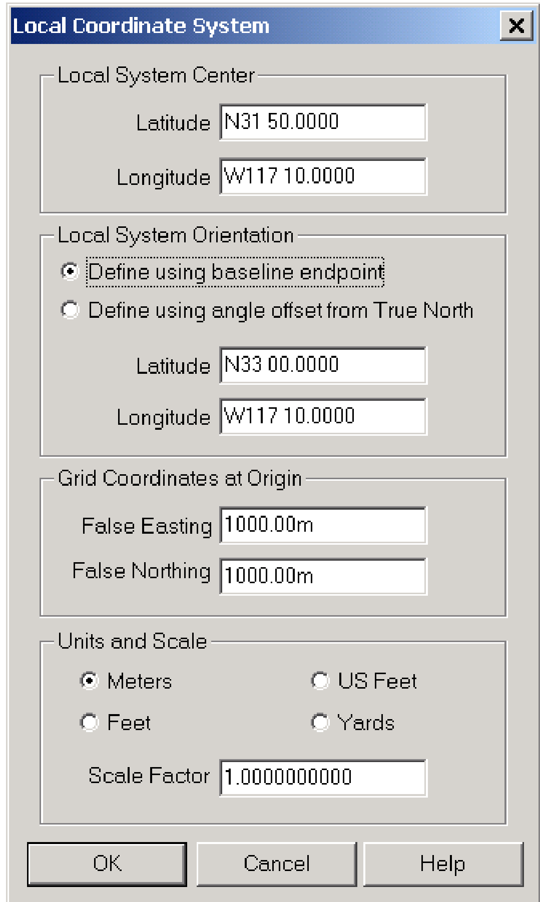
Local

The **Local Coordinate System** is a simple projection that uses one center point as its origin and one base line or angle offset as its north axis. Northings and Eastings are calculated simply in terms of distance North/South and East/West from the center point of the local north coordinate system. Because of this, it should only be used in a limited area from the center point to prevent excessive distortion.

To Configure the Local Coordinate System Projection

1. In the **Configure Geodetics** dialog box, make sure **USER** is chosen from the **General Projection** dropdown and **Local** displays in the **Specific Projection** dropdown.

2. In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button. The **Local Coordinate System** dialog box will appear.



The **Local Coordinate System** dialog box allows for the configuration of the following parameters:

Local System Center	Origin of Local Coordinate System. If the baseline option is used for orientation of the system, it is also the start position of the baseline.
Latitude	Latitude of Origin / Baseline start
Longitude	Longitude of Origin / Baseline start
Local System Orientation	Select the method of determining the orientation of the local system.
Using Baseline Endpoint	The geodetic azimuth between the start and end points of this baseline will be the local grid north.
Angle from True North	An angle can be manually entered for the difference between True and grid north.
Local System Base Line End	End position of the base line for defining the North axis of the Local Coordinate system.
Latitude	Latitude of baseline end
Longitude	Longitude of baseline end
Grid Coordinates at Origin	
False Easting	Easting value of local system center
False Northing	Northing value of local system center

Units	Units of measure can be set to Meters, Feet, US Survey Feet or Yards using the radio buttons
Scale	If there is a scale difference between distances on the ground and distances in the local system, enter it here.

Note: The base line or angle offset defines the north axis of the local coordinate system.

Mercator (Clark 1866 and WGS84)

The **Mercator Projection** is a cylindrical conformal map projection that is used extensively throughout the world, most commonly as the **Universal Transverse Mercator (UTM)** projection.

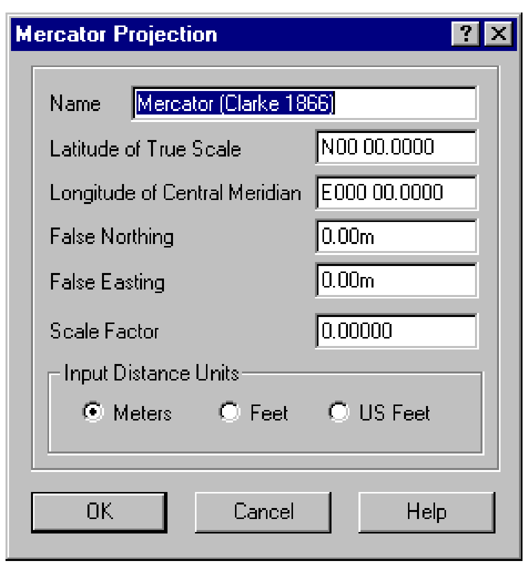
Note: This projection is often used when large areas are involved on a single project, e.g. trans-oceanic cable lay projects. An advantage of this projection for this type of work is that straight lines on the map represent Rhumb lines. WinFrog determines vehicle speed relative to the Working Map Projection and uses this speed for display and output. In most cases any variance between this and true geographic speed is so small as to be negligible. However, when using the Mercator map projection and operating a great distance from the **Latitude of True Scale**, the variance between Map Projection speed and true geographic speed can be of the magnitude of 20%. This must be considered when selecting and configuring the Working Map Projection for operations that are dependent on vehicle speed, such as cable lay operations.

The user-defined options allow you to define a **Mercator** projection with custom Origin, False Easting/Northing, and scale factor values.

To Configure the Mercator (Clarke 1866 or WGS 84) Projection

1 In the **Configure Geodetics** dialog box, make sure **USER** displays in the **General Projection** dropdown list and **Mercator (Clarke 1866** or **WGS 84)** in the **Specific Projection** dropdown list. Both options require the same configuration, differing only in the defaults that are presented in the **Datum Parameters** window.

2 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button to see the following dialog box.

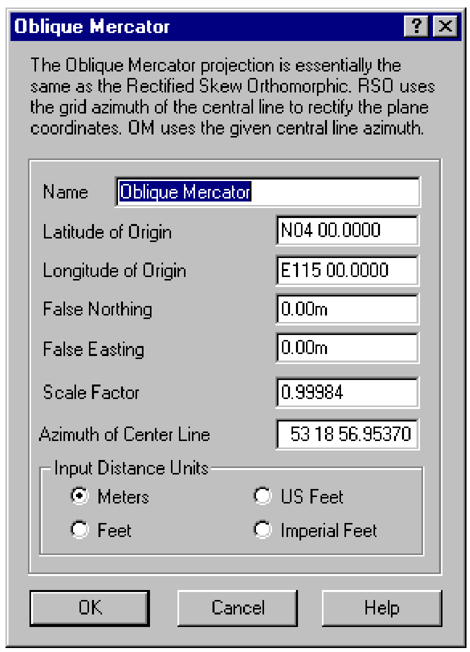


The **Mercator Projection** dialog box allows for the configuration of the following parameters:

Name	Name of the Specific Projection
Lat of True Scale	Latitude at which the map scale factor equals 1.000
Long of Central Meridian	Longitude of Central Meridian
False Northing	False Northing value to be added to Northings
False Easting	False Easting value to be added to Eastings
Scale Factor	Scale Factor at the Central Meridian
Units	Units of measure can be set to Meters, Feet, or US Survey Feet using the radio buttons.

Oblique Mercator/Oblique Mercator (RSO)

The **Oblique Mercator Projection** is a cylindrical conformal map projection that is used in various locations throughout the world. The two projections are essentially the same, as explained in the dialog box.



To Configure an Oblique Mercator Projection

1 In the **Configure Geodetics** dialog box, make sure **USER** displays in the **General Projection** dropdown and **Oblique Mercator** in the **Specific Projection** dropdown.

2 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button.

The **Oblique Mercator** dialog box allows for the configuration of the following parameters:

Name	Name of the Specific Projection
Lat of Origin	Latitude of the map origin
Long of Origin	Longitude of Central Meridian

False Northing	False Northing value to be added to Northings
False Easting	False Easting value to be added to Eastings
Scale Factor	Scale Factor at the Central Line
Azimuth of Center Line	Allows you to define a rotated Central Meridan as opposed to Mercator or Transverse Mercator projections.
Units	Units of measure can be set to Meters, Feet, or US Survey Feet using the radio buttons.

Plant Grid

The **Plant Grid Coordinate System** is based on a transformation between a **Lambert** map projection plane coordinate system and a locally derived coordinate system. As a result, part of the configuration of this coordinate system involves the configuration of **Lambert** projection parameters.

The transformation between the map projection plan and the local coordinate system is based on the following equations:

Projection → Local Northing $L_N = (C_{SN1} * S_N) + (C_{SE1} * S_E) - X_1$

Projection → Local Easting $L_E = (C_{SN2} * S_N) + (C_{SE2} * S_E) - X_2$

Local → Projection Northing $S_N = (C_{LN1} * L_N) + (C_{LE1} * L_E) + X_3$

Local → Projection Easting $S_E = (C_{LN2} * L_N) + (C_{LE2} * L_E) + X_4$

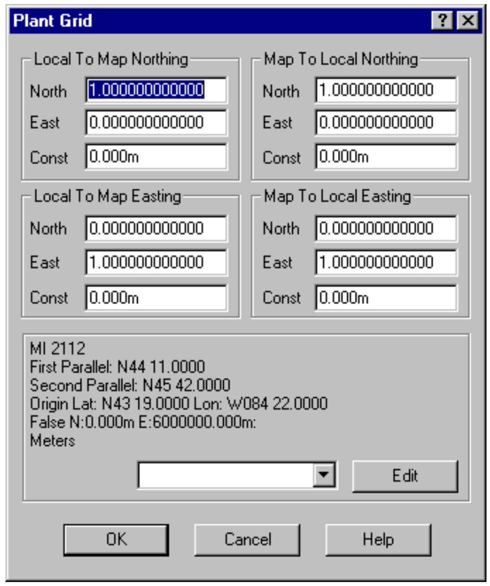
where:

L_N Local Northing
L_E Local Easting
S_N Map Projection Plane Northing
S_E Map Projection Plane Easting
C_{SN1} Map Projection Northing Coefficient to transform to Local Northing
C_{SE1} Map Projection Easting Coefficient to transform to Local Northing
X_1 Constant for transformation to Local Northing
C_{SN2} Map Projection Northing Coefficient to transform to Local Easting
C_{SE2} Map Projection Easting Coefficient to transform to Local Easting
X_2 Constant for transformation to Local Easting
C_{LN1} Local Northing Coefficient to transform to Map Projection Northing
C_{LE1} Local Easting Coefficient to transform to Map Projection Northing
X_3 Constant for transformation to Map Projection Northing
C_{LN2} Local Northing Coefficient to transform to Map Projection Easting
C_{LE2} Local Easting Coefficient to transform to Map Projection Easting
X_4 Constant for transformation to Map Projection Easting

To Configure a Plant Grid Coordinate System Projection

1 In the **Configure Geodetics** dialog box, make sure **USER** is chosen from the **General Projection** dropdown list and **Plant Grid** is chosen from the **Specific Projection** dropdown list.

2 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button.



The following parameters are configurable from the **Local Coordinate System** dialog box:

Local To Map Northing

North Local Northing Coefficient to transform to Map Projection Northing (C LN1)
East Local Easting Coefficient to transform to Map Projection Northing (C LE1)
Const Constant for transformation to Map Projection Northing (X3)

Local To Map Easting

North Local Northing Coefficient to transform to Map Projection Easting (C LN2)
East Local Easting Coefficient to transform to Map Projection Easting (C LE2)
Const Constant for transformation to Map Projection Easting (X4)

Map To Local Northing

North Map Projection Northing Coefficient to transform to Local Northing (C SN1)
East Map Projection Easting Coefficient to transform to Local Northing (C SE1)
Const Constant for transformation to Local Northing (X1)

Map To Local Easting

North Map Projection Northing Coefficient to transform to Local Easting (C SN2)
East Map Projection Easting Coefficient to transform to Local Easting (C SE2)
Const Constant for transformation to Local Easting (X2)

In addition to the above parameters, you must configure a **Lambert** Projection for the Local Coordinate System.

To Configure the Lambert Projection for a Local Coordinate System

1 Click the **Edit** button at the bottom of the **Local Coordinate System** dialog box to customize the **Lambert** projection associated with the plant grid.

This **Edit** button produces the same dialog box as when a Lambert projection is chosen under **Specific Projections.** (See the section above for details on the various entry windows.)

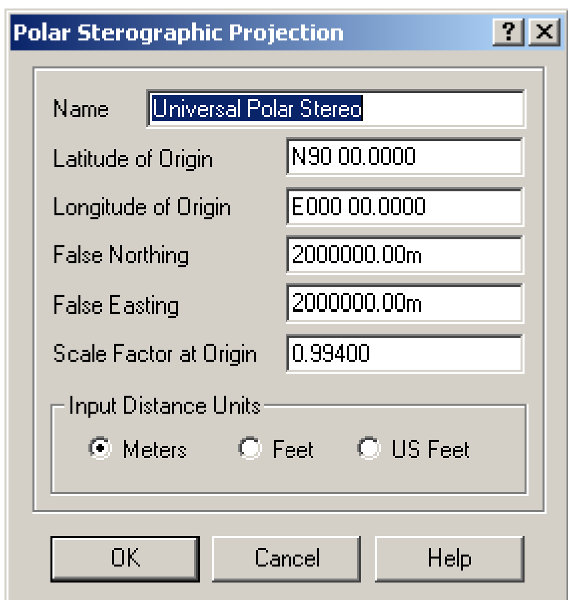
Polar Stereographic

The **Polar Stereographic Projection** is an azimuthal conformal map projection. This projection is often used to map the polar regions.

To Configure the Polar Stereographic Projection

1 In the **Configure Geodetics** dialog box, select **USER** from the **General Projection** dropdown list and **Polar Stereographic** from the **Specific Projection** dropdown list.

2 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button.



The **Polar Stereographic** dialog box allows for the configuration of the following parameters:

Name	Name of the Specific Projection
Lat of Origin	Latitude of the Projection's Origin
Long Of Origin	Longitude of the Projection's Origin
False Northing	False Northing to be added to Northings
False Easting	False Easting to be added to Eastings

Scale Factor at Orig	Scale Factor at the Origin
Units	Units of measure can be set to Meters, Feet or US Survey Feet using the radio buttons

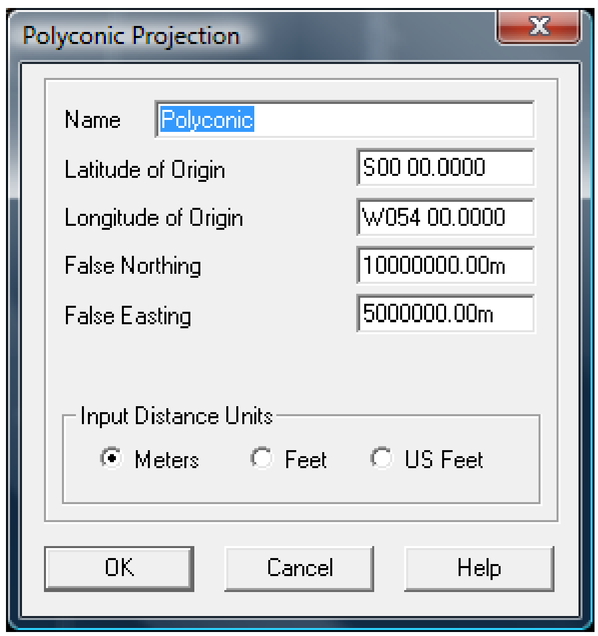
Polyconic

The **American Polyconic Projection** is neither conformal nor equal-area. This projection is used by Brazil.

To Configure the Polyconic Projection

1 This projection can be accessed from the **Configure Geodetics** dialog box and either by first selecting the **SIRGAS General Projection** and then **Polyconic Specific Projection** or select **USER** from the **General Projection** dropdown list then **Polyconic** from the **Specific Projection** dropdown list.

2 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button.

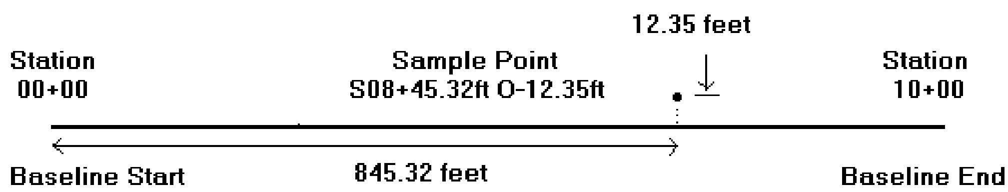


The **Polyconic** dialog box allows for the configuration of the following parameters:

Name	Name of the Specific Projection
Latitude of Origin	Latitude of the Projection's Origin
Longitude Of Origin	Longitude of the Projection's Origin
False Northing	False Northing to be added to Northings
False Easting	False Easting to be added to Eastings
Units	Units of measure can be set to Meters, Feet or US Survey Feet using the radio buttons

StaOff (Station/Offset)

The **StaOff** (Station/Offset) coordinate system is often used in linear construction projects. It is a local coordinate system that is defined by a baseline. The baseline defines the origin and orientation of the coordinate system as shown in the diagram below.



When **StaOff** is used as the map projection, coordinates previously displayed in Northings and Eastings are now displayed as **Station** and **Offset** values.

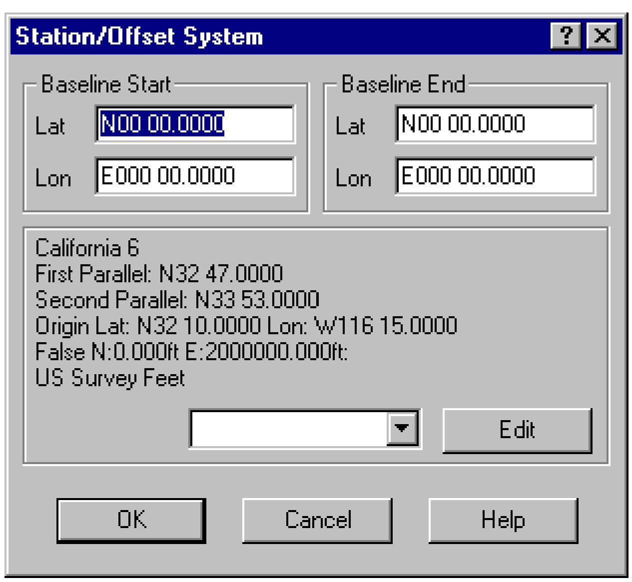
For example, an **Alongline (Sta)** distance of 845.32 ft and an **Offset** distance of **-**12.35 would be displayed as **S08+45.32ft O-12.35ft**.

Note: the coordinates are calculated using a **Lambert** projection.

To Configure a Station/Offset Coordinate System

1 In the **Configure Geodetics** dialog box, select **USER** from the **General Projection** dropdown list and **StaOff** from the **Specific Projection** dropdown.

2 In the **Map Projection Parameters** area of the **Configure Geodetics** dialog box, click the **Edit** button.



The following parameters are configurable from the **Station/Offset System** dialog box:

Baseline Start

Lat	Latitude of the baseline start point
Lon	Longitude of the baseline start point

Baseline End

Lat	Latitude of the baseline end point
Lon	Longitude of the baseline end point
Edit button	Opens the **Lambert Projection** dialog box. Its parameters are configured in the same way as described above.

To Configure a Transverse Mercator Projection

The **Transverse Mercator** projection is mathematically the same as the **UTM** projections defined above. However, this particular option allows you to define the parameters for a totally custom configuration.

The **Transverse Mercator** dialog box allows for the configuration of the following parameters:

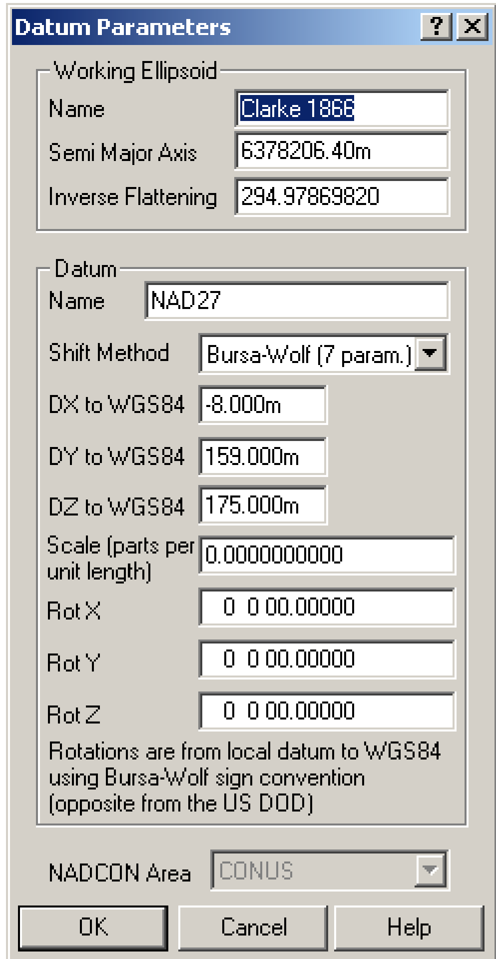
Name	Name of the Specific Projection
Central Meridian	Longitude of Central Meridian
False Northing	False Northing to be added to Northings
False Easting	False Easting to be added to Eastings
Lat of Origin	Latitude of the Projection’s Origin
Scale Factor at CM	Scale Factor at the Central Meridian
Units	Units of measure can be set to Meters, Feet, or US Survey Feet using the radio buttons.

Ellipsoidal Datum Parameters

As mentioned previously, you must always confirm that the datum parameters of the working ellipsoid have been configured correctly, including its relationship to the **WGS 84** ellipsoid.

To Edit the Ellipsoidal Datum Parameters

- In the **Datum Parameters** area of the **Configure Geodetics** dialog box, click **Edit**. In the example below, the **NAD27 SPCS General Projection** was selected.



The following parameters are configurable from this dialog box:

Working Ellipsoid

Name	Reference Ellipsoid name (*e. g*. Clarke 1866)
Semi Major Axis	Ellipsoid's Semi Major Axis (in meters, regardless of the setting in the **Data Units** dialog box)
Inverse Flattening	Ellipsoid's Inverse Flattening (1/f)

Datum

Name	Datum name (e.g. NAD 27)
Shift Method	Choose **Bursa Wolf** or **NADCON**.
dx	X coordinate datum shift parameter (WGS 84-Local)
dy	Y coordinate datum shift parameter (WGS 84-Local)
dz	Z coordinate datum shift parameter (WGS 84-Local)
Scale	In parts per million

Rot X	X axis rotation with respect to WGS 84 (d-m-s.sssss)
Rot Y	Y axis rotation with respect to WGS 84 (d-m-s.sssss)
Rot Z	Z axis rotation with respect to WGS 84 (d-m-s.sssss)
NADCON Area	used if **NADCON** is the chosen Shift Method - specify the general area where the project is to take place from the dropdown window options.

Note: WinFrog utilizes the multiple regression formula provided by NIMA for the NADCON datum shifts. These formulae must be downloaded from NIMA's internet site ftp://ftp.ngs.noaa.gov/pub/pcsoft/nadcon/. Once the site is open, double-click the .LAS and .LOS files of the desired zone, saving them (one at a time) to your hard disk in the same directory as the currently used winfrog.exe file. For example, if you are working in the Continental U.S., select the conus.las and conus.los files and save them to the C:\Program files\Fugro Pelagos\WinFrog\ (or to the correct location and name, as required). If WinFrog can not find these files or the files are misnamed an error message displays, "Unable to Initialize the Nadcon" when you try to configure.

Note: Datum transformation calculations, from WGS84 to the Working Ellipsoid and from the Working Ellipsoid to WGS 84, are monitored. Where applicable, when a problem is encountered executing the transformation, a pop-up message will appear providing details. For example, if the Geodetics are configured to use NADCON for transformations between the WGS84 and the Working Ellipsoid and the position being transformed does not lie within the configured area, the transformation will fail and a pop-message appears stating "Datum Shift Error: Input outside NADCON zone". This monitoring and reporting is performed for the POSITION and PSEUDORANGE data items, those devices that involve transformation of the input in order for it to be used and the respective Utilities. In the case of the data items and devices, when a problem is detected, the data is not used.

For more information concerning ellipsoidal datum parameters for a specific geodetic datum, refer to **Appendix A: Useful Geodetic Data**.

Units

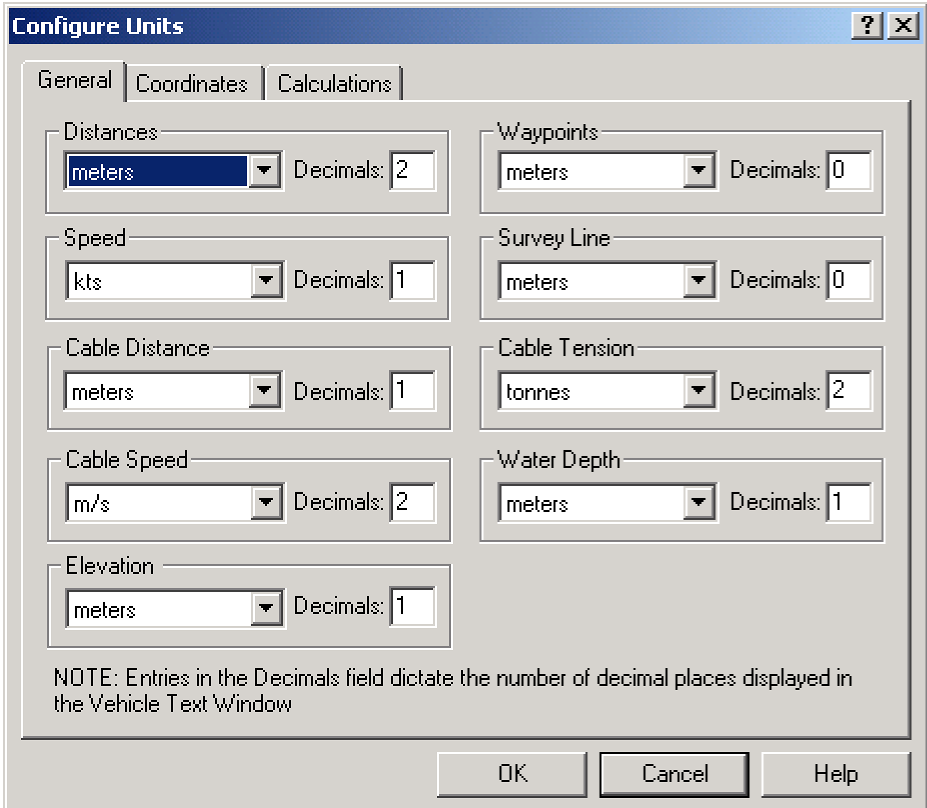
WinFrog allows you to configure the units of measurement and the types of coordinates that will appear in WinFrog's entry boxes. With these default formats pre-configured, the units will not have to be specified each time a value is entered in dialog box. These selections also affect the way these values will be seen throughout WinFrog.

Eleven different units of measure are available in WinFrog:

- meters
- feet
- US survey feet
- kilometers
- nautical miles
- fathoms
- imperial feet
- centimeters
- inches
- yards
- decimeters

To Configure Units

- From the **Configure** menu, choose **Units**.



The following parameters are configurable using this dialog box:

General Tab

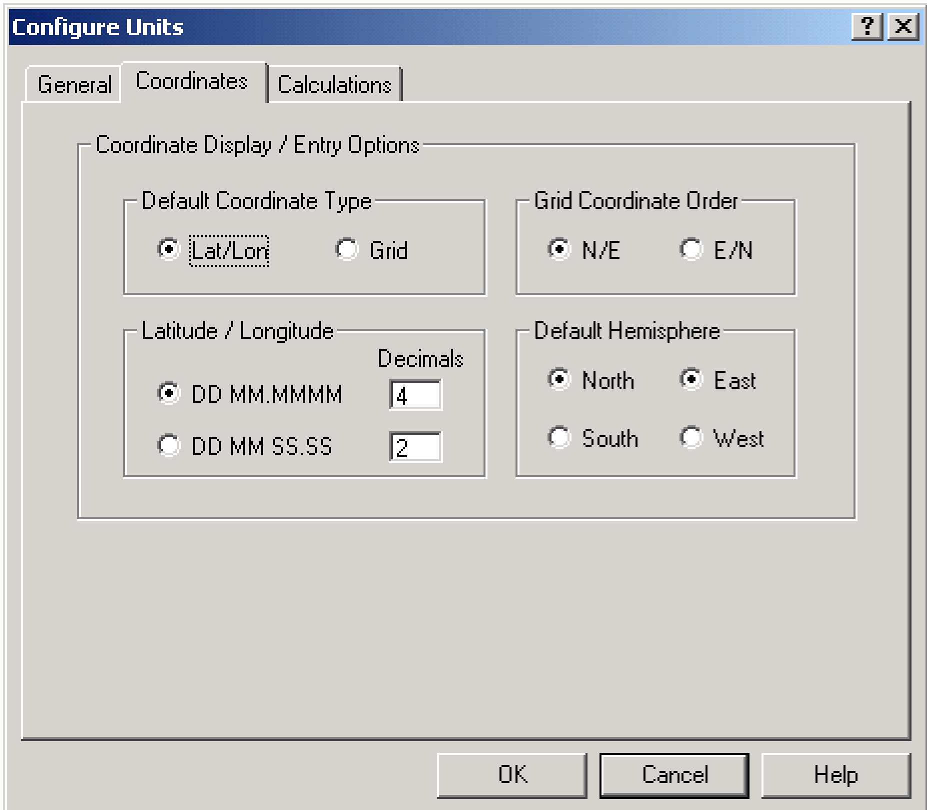
Distances	Units to be used for various forms of distances (ship offsets and dimensions, distance offline, etc.).
Waypoints	Units to be used when tracking Waypoints.
Speed	Units to be used to display Speed.
Survey Line	Units to be used when tracking Survey Lines.
Cable Distance	Units to be used to display laid Cable Distances.
Cable Tension	Units to be used to display Lay Cable Tensions.
Cable Speed	Units to be used to display LayCable Speed.
Water Depth	Units to be used to display Water Depth.
Elevation	Units to be used to display Elevation.

NOTE: When entering a distance you do not have to include the units if the number you are entering is in the same units as selected in the drop down, e.g. if the selected units are meters you can enter 3.7 or 3.7m. If the number you are entering is not in the same units as the selected units, you can enter the units as a one or two character suffix with no space after the number and have WinFrog make the conversion. Below is the list of abbreviations, either upper or lower case can be used:

Abbreviation	**Interpretation**
M	Meters
KM	Kilometers
CM	Centimeters
DM	Decimeters
FT	If the selected units are US Feet then this is considered US Feet. If the selected units are Feet (i.e. International feet) then this is considered International Feet. If the selected units are Imperial Feet then this is considered Imperial Feet. If the selected units are anything else then this is considered International Feet. You can override this interpretation using the abbreviations below.
US	US survey Feet, 1200/3937m
IF	International Feet, .3048m
IM	Imperial Feet, .3047994718m
YD	International Yards, 3 International feet
IN	Inches, 1/12 International foot
FM	International Fathoms, 6 International feet
NM	Nautical Miles, 1852m

Coordinates Tab

Select the **Coordinates** tab to configure the default format for coordinate display and entry.

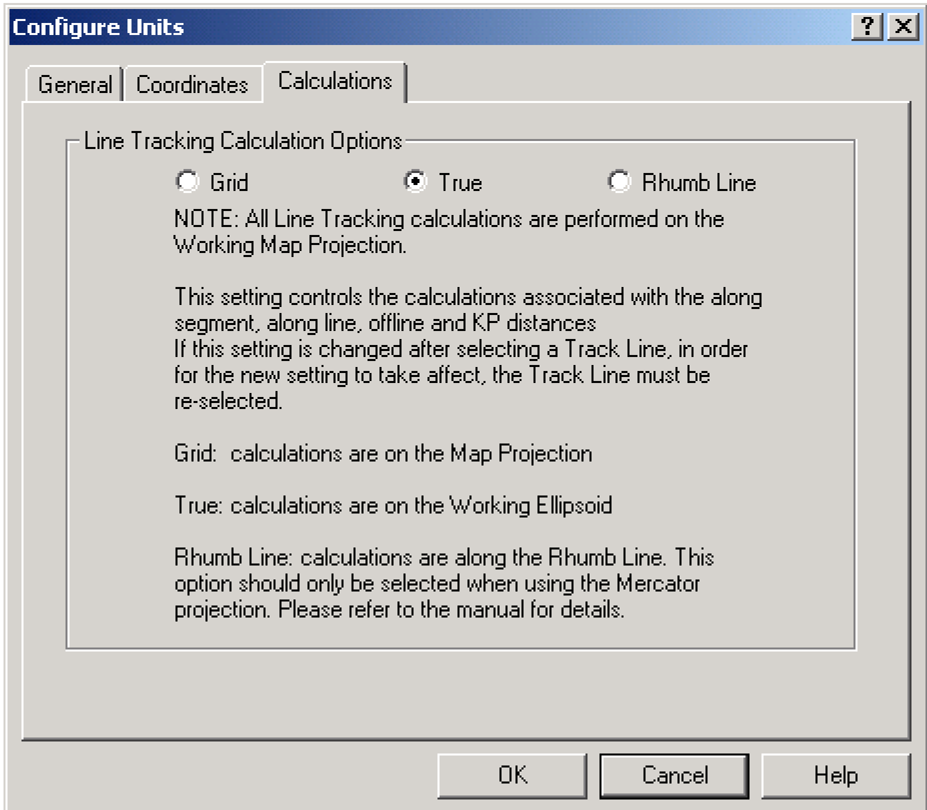


The following options are presented:

Default Coordinate Type Area Lat/Lon or Grid	Select the appropriate option to have coordinates displayed/entered as Geographic latitude/longitude or as Grid Northings/Eastings.
Grid Coordinate Order N/E or E/N	Select the appropriate option to present Grid coordinates as Northing/Easting (N,E or Y,X), or as Easting/ Northing (E,N or X,Y).
Latitude/ Longitude	Select the appropriate option to present geographical coordinates as degrees, minutes, and decimal minutes (DD MM.MMM) or degrees, minutes, seconds, and decimal seconds (DD MM SS.S). Enter the desired value to define the number of decimals for display.
Default Hemisphere	Default format for entering geographic coordinates. Both Latitude (North or South) and Longitude (East or West) can be configured.

Calculations Tab

Select the **Calculations** tab to select the type of calculations that will be undertaken to derive **Line Tracking** values.



WinFrog Line Tracking Process

When utilizing the Line Tracking feature in WinFrog, it is critical that the methodology applied by WinFrog is understood. This is especially true when the lines involved are very long, such as transoceanic RPLs.

The Relationship of the Vessel to the Line

The most important point to remember about line tracking is that the relationship of the vessel with the line being tracked is determined on the Working Map Projection Grid, not the Working Ellipsoid, i.e. WinFrog compares a vehicle position to the line on the map. This involves determining the intersection point of a line passing through the vessel's tracking point and perpendicular to the respective segment of the tracked line. This intersection point is determined using plane geometry based on the Working Map Projection. Essentially there are then three points to consider: 1) the reference point on the vehicle, 2) the point on the segment perpendicular to the reference point and 3) the coordinate of the start of the segment.

Representation of the Line Tracking Information

Once the intersection point is determined, the line tracking information must be calculated and presented. It is at this stage that the selection of the **Calculations** options, from the **Configure Units** dialog affects the line tracking calculations. The calculations involve the calculating of the cumulative along line distance, the along segment distance, the offline distance and the KP, as well as other less used values. These calculations involve the use of inverse algorithms between the three points plus the length of all the segments up to the segment in question.

When **Grid** is selected, the inverse calculations used apply plane geometry on the Map Projection to determine Map Projection grid distances. The above intersection point was determined on the Map Projection and is therefore left in that coordinate system.

When **True** is selected, the inverse calculations used are geodetic on the Working Ellipsoid. The three points are converted to geodetic coordinates then the geodetic inverses, on the working ellipsoid, are computed. The along segment distance is added to the sum of the geodetic distances along all the preceding segments.

When **Rhumb Line** is selected, the inverse calculations used are Rhumb Line using Working Ellipsoid geographic coordinates. The three points are converted to geodetic coordinates then the rhumb line distances, computed on the working ellipsoid, are calculated. The along segment distance is added to the sum of the rhumb line distances along all the preceding segments.

Associated Issues

The following are general and specific points that are important in understanding the WinFrog Line Tracking.

Geodetic Issues

- Technically speaking, the shortest distance between any two points on any particular surface is called a geodesic. On a sphere this line is usually called a great circle and on a plane it's always referred to as a straight line. On a reference ellipsoid it usually referred to as a geodesic.

- Except for special cases, a Great Circle and a geodesic cut meridians of longitude at constantly changing angles.
- A Rhumb Line (or loxodrome) may be considerably longer than either a Great Circle or geodesic and is affected by its location with respect to the equator and the separation of the end points.
- A Rhumb Line cuts all meridians of longitude at the same angle.

WinFrog Specific Issues

- WinFrog's geographic inverse and direct calculations utilize Puissant's short line formula for distances under 40km, and Sodano's for distances over 40km.
- The geographic inverse calculated with WinFrog over a sample 4000km line on WGS84 compares to GeoCalc (Blue Marble Geographics) to the hundredths of seconds in azimuth and to 15cm in distance.
- The setting of **Grid**, **True** or **Rhumb Line** affects the line tracking data displayed and the eventing, if based upon along line distance traveled.
- In the line dialog, the button **Insert POL's** allows you to have WinFrog calculate additional points on line at a specified interval using either Map Projection, geographic or Rhumb Line inverse and direct algorithms. For long lines this allows WinFrog to approximate a geodesic for geographic line tracking. Even though WinFrog is in fact still performing the line tracking calculations on the map projection, because several more points were added this new "path" better approximates the geodesic. The accuracy of the approximation of the geodesic depends upon the interval used to add the new nodes - the more points the better the approximation.

Map Projections

- When using the Mercator Projection, a straight line on the map is a Rhumb Line. Since WinFrog performs the line tracking calculations on the map projection, when using the Mercator Projection, WinFrog is performing Rhumb Line tracking. Combining this with the setting of Line Calculations to **Rhumb Line** results in Rhumb Line navigation with the graphical and alphanumerical data agreeing. If Rhumb Line tracking is desired then the map projection selected should be the Mercator.
- On all of the other WinFrog projections, except in special cases, a straight line on the map is neither a Rhumb Line nor a geodesic. Essentially a straight line on one of these projections is the chord of the geodesic between the same two points on the ellipsoid. A geodesic projected onto a map will appear as a section of an ellipse, circle or hyperbola depending upon the map projection.

Usage

- If the planned route was created on a Mercator projection and the desire is to track these same straight lines, then the Mercator projection must be selected with the same projection parameters as the map used for the design. Select the Rhumb Line calculation in the **Configure Units** dialog.

- If Rhumb Line tracking is desired then a Mercator projection is required with the Rhumb Line calculation selected in the **Configure Units** dialog.
- If the desire is to track a geodesic, then the length of the line segments need to be made short in order to approximate the geodesic on the map. To determine how short is required:
  1. Setup a line in WinFrog
  2. Find the center point coordinates
  3. Using the POL, divide the line exactly in half
  4. Compare the mid point in 3 with the point in 2
- Then select the calculation to either Grid or True in the **Configure Units** dialog. The choice here usually depends upon the KP values from the plan. If these were grid distance KP's then select Grid in the **Configure Units** dialog. If the plan KP's were true then select True in the **Configure Units** dialog.

For information on configuring a vehicle to track a survey line, see the Setup Line Tracking section in Chapter 6: Vehicles.