




THE SPECTRA LINE MANAGEMENT NODE

This PDF document has been produced from the Online Help for the LMN.

There are a variety of ways you can use it:

Use the **Hypertext Bookmarks** in the left-hand pane of your Acrobat Reader as a table of contents and to move around the material.

Your Acrobat Reader also has a **Search** facility you can use to pinpoint relevant material. In addition, each topic in this document contains **hyperlinks (shown in Blue)**. Click on a link to jump to another topic. Click on this icon  to open notes.

The SPECTRA Line Management Node (LMN) is used to:

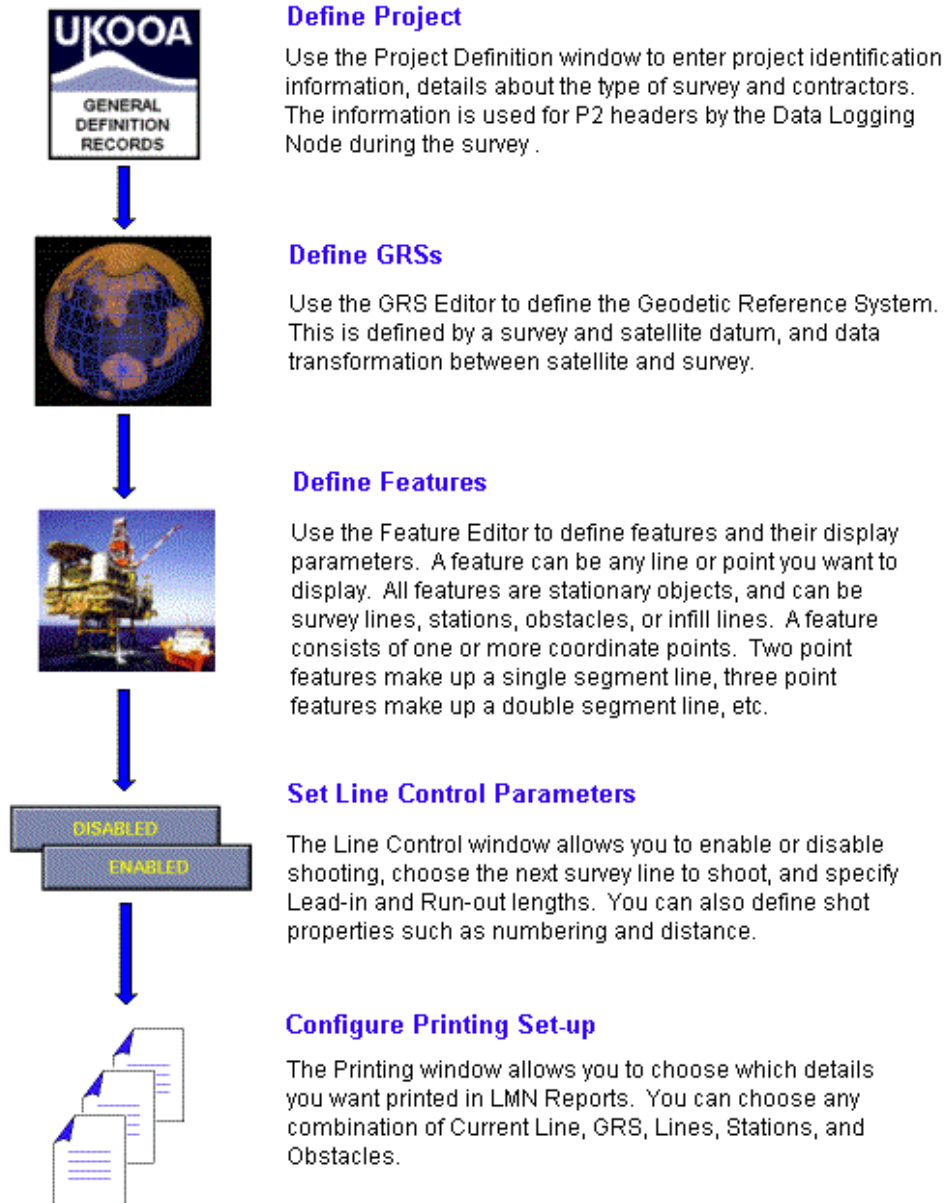
- ◆ Specify the parameters for the survey, the survey lines and enable shooting.
- ◆ Define survey specific details such as the GRS, stations and obstacles

Since much of the information about line positioning may be supplied before actually starting the survey, you can use the LMN while disconnected from the Data Server to set up survey data before the survey starts. This information can be stored in a configuration file and passed to the Data Server at a later date.

For an overview of the Line Management Node's operation, refer to the [TYPICAL OPERATIONAL FLOW OF THE LMN](#). For help on a particular task, refer to the [LMN TASK LIST](#).

TYPICAL OPERATIONAL FLOW OF THE LMN

The diagram below represents the typical operational flow of the LMN. Click on the graphics at the left to go to more information about a particular topic.



Related Information

- ◆ [LMN TASK LIST](#)

LMN TASK LIST

The following tasks are performed within the LMN. Click on a link to go to a topic with more detail about the task.

- ◆ [DEFINING THE PROJECT](#)
- ◆ [DEFINING AND EDITING THE GRS](#)
- ◆ [DEFINING A NEW GRS](#)
- ◆ [ADDING COMMENTS TO THE GRS](#)
- ◆ [SPECIFYING THE PROJECTION](#)
- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
 - ◆ [DEFINING FEATURE ATTRIBUTES](#)
 - ◆ [GROUPING FEATURES](#)
 - ◆ [REPEATING FEATURES](#)
 - ◆ [USING THE DYNAMIC FEATURE EDITOR](#)
 - ◆ [DEFINING POINTS AND SEGMENTS](#)
 - ◆ [COPYING AND PASTING FIELDS, POINTS, AND FEATURES](#)
- ◆ [DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW](#)
 - ◆ [SETTING LINE ATTRIBUTES](#)
 - ◆ [SETTING AN AIM POINT](#)
 - ◆ [SETTING APPROACH AND RUN-OUT LENGTHS](#)
 - ◆ [CONTROLLING SHOOTING](#)
 - ◆ [SPECIFYING SHOT NUMBERING](#)
 - ◆ [SPECIFYING SHOT SPACING](#)
- ◆ [CONFIGURING THE PRINTING SET-UP](#)

Related Information

- ◆ [TYPICAL OPERATIONAL FLOW OF THE LMN](#)

DEFINING THE PROJECT

From the main window of the LMN, select *Project Definition* from the **Options menu** to bring up the Project Definition window. The information you enter here is used by the Data Logging Node during the survey for P2/91 and P2/94 headers. Fill in the fields as follows:

- ◆ **Project Identifier** - this can be any combination of alpha-numeric characters but should be something that uniquely identifies this particular project.
- ◆ **Project Name** - again, this should be a name which uniquely identifies this particular project.
- ◆ **Project Start** and **End Dates** - Enter these dates in the form YYYY MM DD. The **End Date field** can be left blank if not yet known and filled in later.
- ◆ **Survey Type** and **Location** - type of survey e.g. 'multi-vessel' and general location e.g. 'North sea'.
- ◆ **Prepared By** - For the logging tape being used, who it was prepared by (the media label is automatically created by the Data Logging Node)
- ◆ **Client**
- ◆ **Geophysical contractor**
- ◆ **Positioning contractor**
- ◆ **Processing contractor**

Related Information

- ◆ [TYPICAL OPERATIONAL FLOW OF THE LMN](#)
- ◆ [LMN TASK LIST](#)

DEFINING AND EDITING THE GRS

The Geodetic Reference System (GRS) comprises a survey and satellite datum, and datum transformations between satellite and survey. The satellite datum is provided to allow externally computed positions (e.g. satellite latitude and longitude) to be converted to the survey datum for use within Spectra. You also need to specify the projection for converting latitude/longitude coordinates to Easting/Northing. (Please refer to [SPECIFYING THE PROJECTION](#))

*If you want to learn more about Geodesy and GRSs, use the bookmarks on the left of your Acrobat Reader to select a topic from the **Background Information** folder.*

Note that unless you are opening an existing GRS, and do not wish to make any changes, you must use the -G option when starting the Line Management Node in order to be able to access the GRS.

1. From the main window of the LMN, select *GRS Editor* from the **Options menu** to bring up the GRS window.
2. To configure the GRS setup, either:
Open an existing GRS file (via *File/Open*), or
Define a new GRS setup from scratch (refer to [DEFINING A NEW GRS](#))
3. Opening an existing GRS file is the usual mode of operation. The environment variable PN_GRS must have been set to the directory in which the default GRS files are stored.
4. In both cases you then need to specify the projection required.

Related Information


- ◆ [DEFINING A NEW GRS](#)
- ◆ [SPECIFYING THE PROJECTION](#)
- ◆ [ADDING COMMENTS TO THE GRS](#)

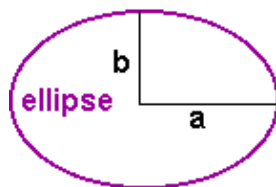
DEFINING A NEW GRS

If there is an existing GRS file, it cannot be overwritten. The recommended method of operation is to open an existing GRS as detailed in [DEFINING AND EDITING THE GRS](#). However, you can define a completely new GRS from scratch if required. You have to define both datums (satellite and survey) and the datum shift before specifying the projection.

1. From the main window of the LMN, select *GRS Editor* from the **Options menu** to bring up the GRS window. Usually, the information to be entered into the fields in this window is supplied by the exploration company's head office.

*If you want to learn more about Geodesy and GRSs, use the bookmarks on the left of your Acrobat Reader to select a topic from the **Background Information** folder.*

2. Enter names for the datum definition and spheroid definition in the **Datum Name** and **Spheroid Name fields** respectively. Note that if you enter the name 'ED50' as the survey datum name, this triggers the polynomial datum shift. 
3. Enter the length of the spheroid **Semi-major Axis** in metres.
4. Enter the **Inverse Flattening** of the spheroid, see diagram below.



$$\text{flattening} = \frac{a - b}{a}$$

$$\text{inverse flattening} = \frac{a}{a - b}$$

a = semi-major axis
(the distance of any point on the equator from the centre of the earth)

b = semi-minor axis
(the distance of either of the poles from the centre of the earth)

5. Now you need to define the datum shifts used. Enter the X, Y, and Z offsets in the appropriate fields. These are the distances the satellite datum is offset from the survey datum in each plane, expressed in the current units of length.
6. Enter the X, Y, and Z rotations in the appropriate fields. These are the amounts the satellite datum is offset rotationally from the survey datum, expressed in the current rotational units. There is a separate value for each plane.

Two rotation conventions are commonly in use, the Bursa-Wolf model (used in Europe) and the coordinate frame rotation (used in the USA). They differ in the sign used for all the rotations. Spectra uses the Bursa-Wolf model throughout.

7. Enter the difference in scale between the satellite datum and the survey datum (in parts per million) in the **Scale Difference field**.
8. The Comments field at the foot of the GRS Editor can be used to enter further information that may be relevant to the GRS set-up. Alternatively, this field may be automatically populated if you are using a polynomial datum shift as the survey datum.

More information may be added to the GRS set-up by selecting *Options/View Parameters* to display the GRS View window. See [ADDING COMMENTS TO THE GRS](#) for further information.


Related Information

- ◆ [DEFINING AND EDITING THE GRS](#)
- ◆ [SPECIFYING THE PROJECTION](#)
- ◆ [ADDING COMMENTS TO THE GRS](#)

ADDING COMMENTS TO THE GRS

You can add comments and/or further information to the GRS that may be relevant to the set up.

1. From the main window of the LMN, select *GRS Editor* from the **Options menu** to bring up the GRS window.
2. Choose *View Parameters* from the **Options menu** of that window to bring up the GRS View window.
3. Enter or edit comments in the main field of this window and click **OK** when you are finished.

Note that this window is automatically filled if you have chosen to use a polynomial datum shift and this information will overwrite  any other comments you may enter.

Related Information

- ◆ [DEFINING AND EDITING THE GRS](#)
- ◆ [DEFINING A NEW GRS](#)
- ◆ [SPECIFYING THE PROJECTION](#)

SPECIFYING THE PROJECTION

This should be done AFTER you have defined the GRS. (Please consult [DEFINING AND EDITING THE GRS](#)) The Projection is used to convert latitude/longitude coordinates to the grid Easting/Northing coordinates. This information is **not** held in the GRS file.

If you want to learn more about Geodesy and different types of Projections, consult the [BACKGROUND INFORMATION: MAP PROJECTIONS](#) topic.

1. From the main window of the LMN, select *GRS Editor* from the **Options menu** to bring up the GRS window.
2. From the GRS window, select *Projection* from the **Options menu** to bring up the LMN Projection window.
3. Select a projection type, using the pop-up menu at the top of the window. Choose from:
Transverse Mercator
Mercator
Stereographic
New Zealand Grid
Lambert 1
Lambert 2
RSO
UTM
4. Depending on your selection, different fields are enabled in the LMN Projection window.

For *U.T.M.* projections select the required hemisphere (*North* or *South*) using the **Hemisphere pop-up menu** and enter the zone number in the **UTM Zone field**. (UTM Zone numbers are listed by the United States Geological Survey. Southern Hemisphere zone numbers are negative.)

For other projections enter the *Latitude* and *Longitude* of the

projection's origin. Alternatively, enter the *Northing* and *Easting* of the projection's origin (in current length units). Enter the *Scale Factor* for the projection.

For *Lambert 1 and 2* projections enter the *1st parallel* in degrees. For Lambert 2 projections only, also enter the *2nd parallel* in degrees.

For *RSO* projections enter the *Initial bearing* and the *Skew angle* in degrees.

5. Provided you started the LMN with the -U option, you can use the **Grid Units pop-up menu** to set the grid units to *Metres*, *Feet*, *US Feet*, or *Custom* units. The appropriate column headings in the Display Node display which units are active. If you did not use the -U option, the grid units are set to metres and the Grid Unit setting controls do not appear in this window. Refer to the *Spectra Software Installation and Set Up* manual for full details of all command line arguments.

Related Information

- ◆ BACKGROUND INFORMATION: MAP PROJECTIONS
- ◆ DEFINING AND EDITING THE GRS
- ◆ LMN TASK LIST
- ◆ TYPICAL OPERATIONAL FLOW OF THE LMN

DEFINING AND EDITING FEATURES: THE FEATURE EDITOR

A feature consists of either a point (such as a rig, base station, etc.), or a series of two or more points which together define a line. Two point features make up a single-segment line, three point features make up a double-segment line, etc. Each segment of a line connects two points.

You can import feature definitions from another LMN file by appending it to the end of the one you are currently working on. See [APPENDING ANOTHER LMN FILE](#) for details.

All features are stationary objects, and can be categorised as:

Survey Lines	These are line to be shot during the survey, and make up the prospect.
Stations	These are radionav stations and are single point features. The coordinates of these features are used to construct observations (within the Spectra Configuration Node).
Obstacles	These single or multi-point features are primarily used by the Display Node. They can be any fixed object.

To bring up the Feature Editor window, select *Feature Editor* from the **Options menu** of the main window of the LMN.

The Feature Editor is divided into three main sections: the main control area (at the top of the window) where you define feature attributes, the point definition area (in the middle), and the segment definition area (at the bottom). Generally, you would start by [DEFINING FEATURE ATTRIBUTES](#). Alternatively, select a specific task from the main [LMN TASK LIST](#).

Related Information

- ◆ [DEFINING FEATURE ATTRIBUTES](#)
- ◆ [APPENDING ANOTHER LMN FILE](#)

- ◆ GROUPING FEATURES
- ◆ REPEATING FEATURES
- ◆ DEFINING POINTS AND SEGMENTS

APPENDING ANOTHER LMN FILE

You can append features from another LMN file to the one you are currently working on.

1. From the main window of the LMN, select *Feature Editor* from the **Options menu** to bring up the Feature Editor.
2. From the **File menu** of the Feature Editor, select *Append* to bring up a standard File Select window.
3. Select the LMN file containing the features you wish to append to the end of your existing file. Features can only be appended from another LMN file.

Note that if any feature names are duplicated between your existing file and the file to be appended then those features are not appended.

4. If required you can now edit these features as described in [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#).

Related Information

- ◆ [TYPICAL OPERATIONAL FLOW OF THE LMN](#)
- ◆ [LMN TASK LIST](#)
- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [DEFINING FEATURE ATTRIBUTES](#)

DEFINING FEATURE ATTRIBUTES

In the main control area of the Feature Editor (*Options/Feature Editor* from the main window) you can define new features or edit existing ones.

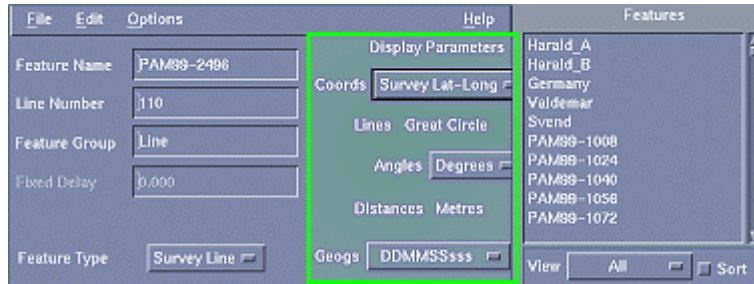


A list containing all of the current features is displayed to the right in the **Features list box**. Use the scroll bar to view the whole list. Enable the **Sort button** to rearrange the list into alphabetical and numerical order. Use the pop-up **View menu** to specify the sort of features you want to see listed to make the list more manageable. The default type is *All*.

1. To define a new feature select *Feature/New* from the **Edit menu** of the Feature Editor. Enter a new name in the **Feature Name field** and select a **Feature Type** from the pop-up menu. The default type is *Survey Line*. For survey lines, the **Line Number field** displays the line number, otherwise the field is inactive.

To edit an existing feature, double-click on its name in the **Features list box**, or enter the name in the **Feature Name field**, to display its attributes in the other fields.

2. Define the coordinate system and units of measurement in which the feature data items are displayed by using the pop-up menus in the **Display Parameters** section:



First, select the coordinate system using the **Coords pop-up menu**. This determines the coordinates in which the features are displayed. Your choice is reflected in the coordinates used in the point definition area. Select *Survey Lat-Long* to use the survey latitude/longitude coordinate datum. Select *East-North* to use Northing and Easting values for the coordinates rather than latitude and longitude. The default is *Survey Lat-Long*. If you started the LMN with the -G parameter, you also have the option of *Sat Lat-Long* which activates the satellite latitude/longitude coordinate datum.

3. The navigation mode is shown on the **Lines label**. It can be *Great Circle*, *Grid*, *Grid True*, or *Rhumb* mode and reflects whichever choice you applied when **SPECIFYING SHOT SPACING** in the Line Control window.
4. Select the units in which angles are displayed using the **Angles pop-up menu**. Choose between *Degrees* and *Radians*. The default is *Degrees*.
5. Whatever you specified for *Grid Units* in the Projection window is reflected here by the **Distances label**. (The Projection window is accessed via the **Options menu** of the GRS window.)
6. Select the format in which geographical coordinates are to be entered and displayed. Use the **Geogs pop-up menu** to choose between:

DDMMSSsss for degrees, minutes, seconds and decimal seconds.

DDMMmmmmm for degrees, minutes and decimal minutes

DDdddddd for degrees and decimal degrees
The default is *DDMMSSsss*.

7. For a radionav station, specify any delay associated with the feature. Enter a value in the ***Fixed Delay field***, in station pattern units. This information is used when defining observations (in the Spectra Configuration Node).

Related Information

- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [GROUPING FEATURES](#)
- ◆ [REPEATING FEATURES](#)
- ◆ [DEFINING POINTS AND SEGMENTS](#)

GROUPING FEATURES

Within the LMN's Feature Editor you have the option to assign features to different logical groups, for example 'rigs', 'lines', etc. This is of use primarily in the Display Node where you can apply display configuration properties to these groups of features instead of individually.

1. From the main window of the LMN, select *Feature Editor* from the **Options menu** to bring up the Feature Editor.
2. From the **Feature list**, select the feature you want to be part of a group.
3. Specify an existing feature group by selecting *Options/Select Group* to bring up a list of defined groups. If no groups have yet been defined, this window is empty and you must define a new group (see step 4).
4. To use a group, select it from the list and *Apply* (or *OK*). Alternatively, enter the group name directly into the **Feature Group field**.
5. To define a new group and assign the feature to it, select the feature and enter the new group's name in the **Feature Group field**. Whatever groups you define are then added as options to the Group Select window.

Related Information

- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [DEFINING FEATURE ATTRIBUTES](#)
- ◆ [REPEATING FEATURES](#)
- ◆ [APPENDING ANOTHER LMN FILE](#)
- ◆ [DEFINING POINTS AND SEGMENTS](#)

DEFINING POINTS AND SEGMENTS

Each feature defined in the LMN consists of at least a single point (such as a rig, base station, etc.), or a series of two or more points which together define a feature in terms of line segments connecting the points.

Use the point and segment definition areas (the central and lower portions of the Feature Editor) to define either the coordinates of a single point feature, or individual points on a line plus the line segments which connect them. These areas are divided into subsections, showing three points at a time, plus the (two) line segments connecting them.

The screenshot displays the Feature Editor interface with the following fields and values:

Point Number	1	2		Point Number
Latitude	055°55'47.560"N	058°08'05.350"N		Latitude
Longitude	003°58'05.720"E	004°41'23.310"E		Longitude
Height (Metres)	0.00	0.00		Height (Metres)
Locked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Locked

Locked	<input type="checkbox"/>	Locked	<input type="checkbox"/>
Length	50440.91 Metres	Length	Metres
Bearing	82.80334 Degrees	Bearing	Degrees

Use the horizontal scroll bar to move forwards and backwards through the points and line segments, always showing three points and their two connecting line segments at a time.

The points and segments areas behave interactively. When entering the point coordinates, the line segment's data is calculated and shown in their respective fields. Editing a point's coordinates causes the rest of the points to be recalculated accordingly.

1. Define the individual points on the line. You may create as many points as required for the feature (using *Edit|Point|New*), and delete any unwanted points (using *Edit|Point|Delete*).

You can view and edit three points at a time using the fields in the point definition area. Remember that if segments have already been defined, there may be data already in the point

coordinate fields - if this data is changed the segment data is recalculated and updated accordingly.

Points are defined via the following fields:

Point Number This identifies which point you are editing. This field is purely for information and is not editable.

Latitude This is the latitude or Northing (depending on the coordinate system selected in the main control area) of the point you are editing. To move the point, type a new coordinate in this field. A Northing is expressed as a decimal number. A latitude is expressed in the format selected from the **Geogs pop-up menu**.

Longitude This is the longitude or Easting (see above, substituting longitude for latitude and Easting for Northing).

Height This is the height of the current point above geoid (expressed using the length unit selected in the main control area). To change the height, enter a new value in this field.

Locked This switch determines whether the point can be changed automatically in response to changes in other parts of the line. If it is left disabled (the default) for a point, a change made to another point causes this point to be updated accordingly. If it is enabled, the point is not updated automatically when other points are changed. It is not possible to lock more than one point or segment for any one feature.

To save time: You can save a lot of repetitive work by using the Feature Editor's **Edit menu** options to add new points and copy and paste point definitions. Please refer to [COPYING AND PASTING FIELDS, POINTS, AND FEATURES](#) for details.

To delete an unwanted point, select one of that point's fields, then select *Edit|Point|Delete*. If you do not select a point's field before using *Edit|Point|Delete*, the point with the highest Point Number is deleted.

2. Define the line segments which connect individual points on a line, using the segment definition area. The segments shown are those connecting the points shown in the point definition area. Remember that if the point coordinates have already been defined, there may be data already in the segment fields - if this data is changed the point coordinate data is recalculated and updated accordingly.

Segments are defined by the following fields:

Length This is the length of the segment (in the distance units selected in the main control area).

Locked This switch determines whether the segment can be changed automatically in response to changes in other parts of the line. If it is enabled (i.e. locked), the segment cannot be changed automatically. If you leave it disabled (the default) it means that changing one end point of the segment automatically changes the other end point so that the length and direction of the segment remain the same. It is not possible to lock more than one point or segment for any feature.

Bearing This is the direction of a straight line segment.

Related Information

- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [DEFINING FEATURE ATTRIBUTES](#)
- ◆ [GROUPING FEATURES](#)
- ◆ [REPEATING FEATURES](#)
- ◆ [COPYING AND PASTING FIELDS, POINTS, AND FEATURES](#)
- ◆ [APPENDING ANOTHER LMN FILE](#)

COPYING AND PASTING FIELDS, POINTS, AND FEATURES

Defining every feature, point, and segment in the survey individually from scratch in the Feature Editor would involve a lot of repetitive work - avoid this by using the various copy and paste options contained in the **Edit menu**. Also see [REPEATING FEATURES](#).

Copying and Pasting a point

To copy data from one point into another point:

1. From the **Features list**, select the feature **from** which you wish to copy a point and select the point by placing the cursor in a field of the point's definition area. Select *Edit|Point|Copy* to copy the contents of the point to memory.
2. Select the feature to copy the point **to** (using the **Features list**). If you are copying to another point within the same feature, omit this step.
3. Place the cursor in a field of the required point in the point's definition area. Select *Edit|Point|Paste*. This pastes the copied data from memory into the selected point.

Replacing a feature/Editing an existing feature

1. Select the feature to edit or replace in the **Features list**. Either edit the fields/menus as desired or, to replace the feature, select *Edit|Feature|New*.
2. If you have made changes to the current feature before attempting to replace it, without applying the changes, a message is displayed warning you that *'Current feature has been changed since saved. All changes will be lost unless saved.'* There is a choice of three responses to this - *Apply*, *Discard*, or *Cancel*. Either *Apply* the changes to the current feature before replacing it with a new one, *Discard* the changes and replace the

feature with a new one, or *Cancel* the command to replace the current feature.

3. Feature Names must be unique. If you change the name of the current feature to a duplicate of a defined feature, when you apply the changes a warning message is displayed warning you that the '*Given feature name is already in use*'. You should enter a new, unique name for the feature in the **Feature Name field** to correct the problem.

Copying a feature

To make the current feature a copy of an existing feature:

1. Select the feature to copy in the **Features list**. Select *Edit|Feature|Copy*. The current feature is now a copy of the selected feature, with only the Feature Name field left blank.
2. Enter a new name for the feature in the **Feature Name field** before clicking *Apply*.

Related Information

- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [GROUPING FEATURES](#)
- ◆ [REPEATING FEATURES](#)
- ◆ [DEFINING POINTS AND SEGMENTS](#)
- ◆ [APPENDING ANOTHER LMN FILE](#)

REPEATING FEATURES

This primarily used for specifying survey lines but can be used to repeat any feature.

To make a specified number of repetitions of an existing feature:

1. From the main window of the LMN, select *Feature Editor* from the **Options menu** to bring up the Feature Editor.
2. Select the feature to repeat in the **Features list**. Select *Edit|Feature|Repeat* to display the Feature Repeat window.

Alternatively, call up the Feature Repeat window first by selecting *Edit|Feature|Repeat*. Then type the name of the feature to be repeated in the **Feature Name field**.

3. Enter the basis for the name of the repeated feature in the **Repeat Name field**. For example, if you enter EastCoast then repetitions of the feature will be named EastCoast00001, EastCoast00002, etc, up to EastCoast0000 n , where n is the value you enter for *Repeat Count* (see below).
4. Specify the number of times to repeat the feature in the **Repeat Count field**. The default value is 1. You can enter any positive integer value.
5. Indicate whether or not the repeated feature is to constitute parallel lines, using the **Parallel Lines button**. If the button is on (highlighted), the *Offset Range* defines the separation between the parallel lines. If you select *Parallel Lines*, the *Offset Bearing* is inapplicable and the field is greyed out.
6. Enter the range offset to be successively applied for each repetition, in the **Offset Range field**.

7. Enter the bearing offset to be successively applied for each repetition, in the **Offset Bearing field**. Note that if you turn on the *Parallel Lines* option, this option is inapplicable and the field is greyed out.
8. *Apply* the repeated feature definition.

You can repeat this process for any other features you wish to repeat before closing the Feature Repeat window.

Related Information

- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [GROUPING FEATURES](#)
- ◆ [DEFINING POINTS AND SEGMENTS](#)
- ◆ [COPYING AND PASTING FIELDS, POINTS, AND FEATURES](#)
- ◆ [APPENDING ANOTHER LMN FILE](#)

USING THE DYNAMIC FEATURE EDITOR

The Dynamic Feature Editor is used to enter details of obstacles encountered during the course of the survey. It supplies the current vessel position and allows you to enter feature details relative to that position. The feature can have only one point since it must be a stationary obstacle.

However, another use for the Dynamic Feature Editor is creating a test line. You may want to do this if, for example, you are on a line change and do not want to alter the vessel's course but want to test the systems in a real shooting situation. Please refer to the second section in this topic for details of how to create a test line.

Defining a Stationary Obstacle:

1. From the main window of the LMN, select *Feature Editor* from the **Options menu** to bring up the Feature Editor.
2. Select *Dynamic* from the **Options menu** of the Feature Editor to show the Dynamic Feature Editor window.

The current vessel position is shown in the **Current Latitude and Current Longitude fields**. These fields read *No solution data* if the LMN is not receiving data from the NCN and nothing you enter in any of the fields will be applied in that case.

Provided the position fields are populated, the position is updated dynamically until you fill in the other fields, at which point it stops updating.

3. Enter the range and bearing of the obstacle from the current vessel position in the **Range Offset and Bearing Offset fields**. Enter a name for the feature in the **Feature Name field**.
4. Click **OK** and the feature is added to the **Feature list** on the Feature Editor.

Creating a Test Line

(Points 1 and 2 as above.)

3. Enter **0** in both the **Range Offset** and **Bearing Offset** fields and enter a name for your test line in the **Feature Name** field. The **Current Latitude** and **Current Longitude** fields should reflect the vessel's current position.
4. Click **OK** to return to the Feature Editor.
5. Change the selection in the **Feature Type** menu from *Obstacle* to *Survey Line*.
6. Lock the first point by enabling the **Locked** checkbox underneath the point definition for Point Number 1.
7. Enter the desired length of the test line in the **Length** field.
8. Enter the CMG (the direction in which the vessel is travelling) in the **Bearing** field. (You can ascertain the CMG from the Vessels Display of the Display Node.)
9. **Apply** the feature definition. This creates the second point for you automatically.
10. Click **OK** then, from the main, window **Submit**.

The newly created test line can now be selected and controlled from the Line Control window as the line the vessel is currently travelling along.

Related Information

- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [TYPICAL OPERATIONAL FLOW OF THE LMN](#)

DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW

Access the Line Control window by selecting *Line Control* from the **Options menu** of the LMN's main window.

This displays the line attributes for the currently selected line, as well as general information relating to the line. Use it to set up current line information, define and start the current line, put in a long shot interval if required, and control shooting.

The Line Control window comprises six separate areas. Click on one of the links below to go to help for each area.

- ◆ [SETTING LINE ATTRIBUTES](#)
- ◆ [SETTING AN AIM POINT](#)
- ◆ [SETTING APPROACH AND RUN-OUT LENGTHS](#)
- ◆ [CONTROLLING SHOOTING](#)
- ◆ [SPECIFYING SHOT NUMBERING](#)
- ◆ [SPECIFYING SHOT SPACING](#)

Note that whenever you apply changes from here all the details on the Line Control window are saved to a `.CLF` file in the data directory. When you use the `filename.LMN` configuration file, the line name stored in the associated `filename.CLF` is used.

WARNING: When the LMN is closed down, or in the event of a crash, the line control parameters as defined via the Line Control window are saved to file, even if they have not been saved properly via *File/Save*. On restarting, these parameters are loaded back into the LMN. Thus, if shooting was enabled at the time of shutdown it will be enabled at start-up, and vice versa.

Related Information

- ◆ [TYPICAL OPERATIONAL FLOW OF THE LMN](#)

SETTING LINE ATTRIBUTES

The **Line Attributes panel** (top left of the Line Control window) displays the current line and its bearing (or azimuth).

1. From the main window of the LMN, select *Line Control* from the **Options menu** to bring up the Line Control window.
2. To change the name of the line, as set up in the Feature Editor, enter a new name in the **Name field**. The number in the small field to the right of the **Name field** contains the sequence number associated with that line as set up in the P2 file.
3. To change the current line, right-click in the **Name field** or choose *Select* from the **Options menu** to display the Line Selection window. The **Items panel** lists all currently defined lines. Use the scroll bar to see the complete list. When on line, the current line is highlighted on the list, and shown in the **Selection field**. Select the line required by either double-clicking on its name, selecting the name and clicking **OK**, or entering its name in the **Selection field** and clicking **OK**.
4. To reverse the current line select *Reverse/Current Line* from the **Options menu**. This causes the lead-in and run-out sections to be switched to the opposite ends of the line. You can only use this option before reaching the lead-in stage.
5. Select *Reverse/Aimpoint* to reverse the line associated with the aimpoint. Refer to [SETTING AN AIM POINT](#) for more details about aim points.
6. The **Start and End fields** display the start and end points of the currently selected line, in whatever coordinate system is specified in the Feature Editor. These details cannot be edited from this window.

7. The ***Bearing or Azimuth*** field displays the current line bearing. This value changes according to which section of the line is current (e.g. for dog-legs etc). It cannot be edited here, but is set when you define the survey line using the Feature Editor. The label changes between *bearing* and *azimuth* depending on the method of shot spacing specified. It reads *azimuth* if *Great Circle* or *Rhumb* are selected and *bearing* if *Grid* or *Grid True* are selected.

Related Information

- ◆ [SETTING AN AIM POINT](#)
- ◆ [SPECIFYING SHOT SPACING](#)
- ◆ [DEFINING AND EDITING FEATURES: THE FEATURE EDITOR](#)
- ◆ [DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW](#)

CHANGING THE CURRENT LINE

By default, when you enter the Line Control window, the current line details are shown if you are on line.

To change the line shown:

1. Right-click in the **Name field** or choose *Select* from the **Options menu** to display the Line Selection window. The **Items panel** lists all currently defined lines. Use the scroll bar to see the complete list. The current line is highlighted on the list, and shown in the **Selection field**.
2. Select the line required by either double-clicking on its name, selecting the name and clicking **OK**, or entering its name in the **Selection field** and clicking **OK**.

Related Information

- ◆ [SETTING LINE ATTRIBUTES](#)
- ◆ [DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW](#)

SETTING AN AIM POINT

If you wish, you can specify an aim point.

1. From the main window of the LMN, select *Line Control* from the **Options menu** to bring up the Line Control window.
2. Right click in the **Feature to use field** to bring up the Target Select window where you can choose from a list of defined features. Use the scroll bar to view the whole list and select a feature by either double-clicking on its name or selecting it and clicking **OK**.

If the line you select as the *Feature to use* is the current line, when a new current line is selected, the *Feature to use* field changes to match it. This does not happen if any other feature is selected as the *Feature to use*.

3. Use the **Mode pop-up menu** to select the coordinate mode in which to display the separation of the point from the vessel, choosing between *Polar* and *Rectangular* coordinates. Also, use the **Relative to pop-up menu** to specify whether the separation coordinates are to be shown relative to *North* or relative to the *Line Bearing* (the default).

The *X* ordinate (or *Range*) and *Y* ordinate (or *Bearing*) of the selected point from the vessel's reference point are displayed in the last two fields in this section of the window. An alphanumeric display of range and bearing to aim point can be shown using the Display Node.

Related Information

- ◆ [DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW](#)
- ◆ [SETTING LINE ATTRIBUTES](#)

SETTING APPROACH AND RUN-OUT LENGTHS

Approach and run-out lengths refer to distances directly at the start and end of the line. On approach, the guns start firing test shots before the line proper to allow an opportunity to check everything is functioning properly. At the end of the line, the guns continue firing for the number of shots specified as the run-out, usually until the first half of the streamers has passed over the end of the line. Approach and run-out lengths are always on the same bearing as the line itself.



1. From the main window of the LMN, select *Line Control* from the **Options menu** to bring up the Line Control window.
2. The Approach and Run-out section is situated in the lower left portion of the window.

Enter the *Approach* and *Run-out* lengths as numbers of shots. You can alter the run-out length any time before the end of the line is reached. Enter a zero in the **Run-out field** if no run-out is required.

Related Information

- ◆ [DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW](#)
- ◆ [SETTING LINE ATTRIBUTES](#)
- ◆ [LMN TASK LIST](#)

CONTROLLING SHOOTING

Shooting is enabled and disabled from the Line Control window.

1. From the main window of the LMN, select *Line Control* from the **Options menu** to bring up the Line Control window.

The Shot Control section is situated in the top right portion of the window.

2. Select a shot control method from the **Mode pop-up menu**.

Choose *On Line* to shoot when on line, but not during approach. This means that during approach, shot closures are not issued from the RTNU, and automatic shots are generated internally by the RTNU, to stop guns firing. Shooting starts automatically when the vessel is on line, providing the **Shot Control button** is *ENABLED*.

Choose *On Line & Approach* to shoot when on line *and* during approach: shooting commences automatically when the vessel reaches the approach area, providing the **Shot Control button** is *ENABLED*. If you wish to inhibit individual triggers on approach when in this mode, enable the **Online Only checkbox** for those triggers in the RTCN's O/P Trigger Editor.

3. The **Shot Control button**, when depressed, enables shooting and displays *ENABLED*. When released, the button disables shooting and displays *DISABLED*.

When you press the **Shot Control button**, you are asked to confirm if you really want to enable/disable shooting and this confirmation acts as a submit. Remember to apply the line control definition before enabling shooting.

Related Information

- ◆ [DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW](#)

SPECIFYING SHOT NUMBERING

1. From the main window of the LMN, select *Line Control* from the **Options menu** to bring up the Line Control window.

The Shot Numbering section is situated in the middle right portion of the window.

2. Enter the number of the first shot at the start of the line in the **Line start field**. The *Line start* can be any valid shot number.

In the **Step field**, to the right of the **Line start field**, enter a number to define the shot increment. If, for example, you entered a *Step* of 3 and a *Line start* of 1, then the shot numbering would be 1, 4, 7, 10, etc. Note that you can enter a negative shot increment for count-down shot numbering.

3. The first shot number at the start of approach (*Approach start*) is calculated automatically (from the *Line start* and *Approach length* values specified - see above and [SETTING APPROACH AND RUN-OUT LENGTHS](#)).

Alternatively, to specify this manually, enable the check box next to the **Approach start field** to enable the field, then enter the required shot number. This can be any valid shot number.

4. The shot number at which automatic shooting starts (*Actual shot start*) is calculated automatically (from the *Line start* and *Approach length* values specified, and the shot control *Mode* selected - see above, [SETTING APPROACH AND RUN-OUT LENGTHS](#), and [CONTROLLING SHOOTING](#)).

Alternatively, to specify this manually, enable the check box next to the **Actual shot start field** to enable the field, then enter the required shot number. This can be different from the *Line start* shot number if, for example, you previously shot part of a line and now wish to resume shooting where you left off.

5. The **Line end shot** field displays the shot number of the end of the line. If you enable the check box to the right of the field, the label changes to **Actual end shot** and the field becomes active. This is used if you only want to shoot part of a line.
6. You can move the shooting reference point back or forth by entering an adjustment value in the **Shot Layback** field. For example, a value of 20 moves the reference point 20 metres forward; a value of -20 moves the reference point 20 metres backward.

Related Information

- ◆ [DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW](#)
- ◆ [SETTING APPROACH AND RUN-OUT LENGTHS](#)
- ◆ [CONTROLLING SHOOTING](#)

SPECIFYING SHOT SPACING

1. From the main window of the LMN, select *Line Control* from the **Options menu** to bring up the Line Control window.

The Shot Spacing section is situated in the lower right portion of the window.

2. Specify the Shot Spacing mode by choosing an option from the left-hand pop-up menu. Select either *Grid*, *Great Circle*, *Grid True*, or *Rhumb* calculation mode.

The shot spacing mode controls the way line calculations are performed. In both *Grid* and *Grid True* modes, the line is a straight line in the projection, i.e. what you see if you draw a straight line between the points on a chart. In *Great Circle* mode the line is the curve on the spheroid of shortest length between the points. *Rhumb* uses the path between the points which crosses each meridian at the same angle.

Grid and *Grid True* modes differ in the way preplots are computed and in the meaning of *Dalong* and *Doff* coordinates. In *Grid* mode, the preplot shot points are a constant grid distance apart (i.e. on a chart they appear a constant distance apart). Similarly, in *Grid* mode, *Dalong* and *Doff* are in grid metres, while in *Grid True* mode they are in true metres. In *Great Circle* and *Rhumb* mode the preplots are a constant true distance apart, and *Dalong* and *Doff* are also in true metres.

The choice you make here is reflected in the Feature Editor Display Parameters section (see [DEFINING FEATURE ATTRIBUTES](#)), on the **Lines label**.

3. Specify the approach and line shot spacing by selecting *DAlong Track*, *Cycle Test*, *Time*, or *Time Dual* from the pop-up menu on the right and entering a shot spacing or time value.

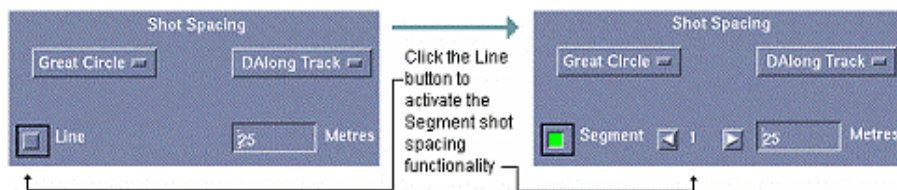
Note: Both the *Approach and Run-out* and *Shot Numbering*

sections are updated as the shot spacing mode is changed.

DAlong Track

For this method of shot spacing, enter a shot spacing value, x (in metres), in the **Metres field**. This causes a shot to be fired every x metres along the lead-in and line, irrespective of the distance the vessel actually travels if it is not tracking true to line. For example, if the vessel is following a zig-zag course back and forth across the lead-in or line, and you enter a value of 25 metres, shots are fired every 25 metres along the lead-in or line, and not every 25 metres the vessel travels.

There is also a facility which allows you to specify shot intervals per segment when on a multi-segment line in *DAlong Track* mode. If these conditions are met, extra fields appear.



The current segment number is displayed and the value in the **Metres field** applies to the shot spacing for that segment. The arrows can be used to increase and decrease the segment number.

Cycle Test

For this method of shot spacing, enter a shot spacing value, x (in seconds), in the **Seconds field**. This causes a shot to be fired every x seconds along the lead-in and line, irrespective of the distance the vessel has actually travelled.

Time

For this method of shot spacing, the value entered in the **Metres field** controls the shot spacing for lead-in while the value entered in the **Seconds field** controls the shot spacing for line.

Enter a shot spacing value, x (in metres), in the **Metres field**. This causes a shot to be fired every x metres the vessel travels

irrespective of the distance actually made good along the lead-in. For example, if the vessel is following a zig-zag course back and forth along the lead-in, and you enter a value of 25 metres in the **Metres field**, shots are fired every 25 metres the vessel travels and not every 25 metres along the lead-in.

Enter a shot spacing value, x (in seconds), in the **Seconds field**. This causes a shot to be fired every x seconds the vessel travels along the line, irrespective of the distance the vessel actually travels.

Next Shot Offset

This option is available in *Time* mode only. This feature enables you to put in a long shot interval during a line. You may want to do this if, for example, another survey vessel is shooting close enough to clash with your vessel's own shots. Enter a value in seconds in the **Next Shot Offset field** and click *Submit*. The NCN reads this value and uses it to delay the time of the next shot prediction (not the one it is currently predicting). The offset is used for one shot only and resets to zero once it has been submitted.

Time Dual

This method of shot spacing is intended to provide a method of synchronising shooting between master and slave vessels when there is no radio link between them.

When you select the *Time Dual* method of shot spacing, the **SOL field** displays the predicted time of the first shot on line and updates it on Approach. The predicted time becomes more accurate the closer you are to the start of line.

On the master vessel, monitor the SOL prediction and, at the desired time, enable the check box to the right of the field. You can now edit the contents of the field if you wish. Submit the LMN configuration to the Data Server and telephone the slave vessels to tell them the fixed time of the SOL. They should then also enable the same checkbox on their systems and enter the same fixed time. This ensures that all vessels in the survey have

the same predicted time for SOL. All vessels should now fire their first, and subsequent shots at the same time (+/- 50ms).

Related Information

- ◆ **DEFINING LINE CONTROL PARAMETERS: THE LINE CONTROL WINDOW**
- ◆ **SETTING LINE ATTRIBUTES**
- ◆ **SPECIFYING SHOT NUMBERING**
- ◆ **SETTING APPROACH AND RUN-OUT LENGTHS**

CONFIGURING THE PRINTING SET-UP

If required, configure the Node's printing set-up. If you do not perform any configuration, the LMN prints full details of: The Current Line, GRS, Lines, Stations, and Obstacles, along with a cover sheet giving the Project name, ID, Client and Contractor.

1. From the main window of the LMN, select *Options/Printing/Configuration* to bring up the Printing window.
2. Enable printing of details by enabling/disabling the appropriate buttons. Choose any combination of *Current Line*, *GRS*, *Lines*, *Stations*, and *Obstacles*.

You can initiate printing according to this set-up at any time by selecting *Options/Printing/Start Printing* from the main window of the LMN. This sends a Postscript file to the laser printer.

Related Information

- ◆ [TYPICAL OPERATIONAL FLOW OF THE LMN](#)
- ◆ [LMN TASK LIST](#)

LMN FILE FORMAT

The .LMN configuration file contains descriptions of all the features defined using the LMN. LMN files are ASCII files with fields separated by TABs and CRLF characters used to terminate sections within the file. In the lists below, each field is followed by a TAB unless otherwise indicated.

In this file format, GRSs are referred to as PSDs, the survey datum is called the standard datum and the satellite datum is called the alternate datum.

The main sections of the file define:

- ◆ Default values
- ◆ PSD information for the standard PSD
- ◆ PSD information for the alternate PSD
- ◆ Shot conventions
- ◆ Feature definitions
- ◆ Project information
- ◆ Current line information
- ◆ Aim point information
- ◆ Run-in information
- ◆ GRS file name
- ◆ Printing setup information

These sections appear in the file in the above order, and their field descriptions and types are as listed in the following sections.

Defaults

CRLF

"defaults"


Angle units

STRING

STRING

default is "degrees"




Scale factor	NUMBER	
Latitude	NUMBER	
Longitude	NUMBER	
Easting	NUMBER	
Northing	NUMBER	
Projection type	STRING	
<i>plus, for Lambert 1 & 2 projections:</i>		
First parallel	NUMBER	degrees
<i>and, for Lambert 2 projections:</i>		
Second parallel	NUMBER	degrees
<i>plus, for RSO projections:</i>		
Initial bearing	NUMBER	degrees
Skew angle	NUMBER	degrees
followed by:		
CRLF		

PSD information (alternate PSD)

"alt_psd" STRING
followed by the same fields as for the standard PSD.

Shot conventions

"shot_conv"	STRING	
Lead-in start	NUMBER	
Lead-in change	NUMBER	
Line start	NUMBER	
Line change	NUMBER	
Number to add for reshoot	NUMBER	
Partial or full line indicator	STRING	(not followed by TAB) 
CRLF		

Feature definitions

Repeated for each defined feature.

Polyline definition:

"polyline"	STRING
Feature name	STRING
Feature representation	NUMBER

then, for each point in the feature:

Latitude	NUMBER
Longitude	NUMBER

Height NUMBER

followed by:

CRLF

Attributes list

"attributes" STRING

Line number NUMBER

Feature group name STRING

Feature naming convention name STRING

Feature correction NUMBER

Feature type STRING

and, for line or infill features:

Shot numbering convention name STRING

plus, for default shot spacing type:

Default string STRING

and, for infill features:

Associated line name STRING (not followed by TAB)

followed by:

CRLF

Project information

"project" STRING

Project ID STRING

Project name STRING

Project start date STRING

Project end date STRING

Survey contractor STRING

Media label STRING

Media prepared STRING

Date of issue STRING

Client STRING

Geophysical contractor STRING

Positioning contractor STRING

Processing contractor STRING

CRLF STRING

Current line information

If current line assigned.

"current" STRING

Current line name STRING

CRLF

Aim point information

"aimpoint"	STRING
Aim point name	STRING
Range (to aim point)	NUMBER
Bearing (to aim point)	NUMBER
Aim point type	NUMBER
CRLF	

Run-in information

"runin"	STRING
Shotpoint units	NUMBER
Default run-in length	NUMBER
Lead-in start flag	NUMBER
Actual start flag	NUMBER
CRLF	

GRS file name

"grs"	STRING
File name	STRING
CRLF	

Printing set-up information

"printing"	STRING
Current line printed	NUMBER
GRS printed	NUMBER
Lines printed	NUMBER
Stations printed	NUMBER
Obstacles printed	NUMBER
CRLF	

Related Information

- ◆ TYPICAL OPERATIONAL FLOW OF THE LMN
- ◆ LMN TASK LIST

BACKGROUND INFORMATION: HISTORICAL GEODESY

The requirement to map the information obtained during a particular survey, and allow return to that same location means that position is a very important factor in seismic surveying. Measurements are taken at or near the surface of the earth and therefore an adequate definition of this body is required.

History

Spherical Earth Models

The first methodical measurement of the size of the earth was undertaken by Eratosthenes (276-195BC), an Alexandrian scientist who concluded a value of 6267km for the radius of a spherical earth based on the shadow cast by a staff at two locations on the same meridian (line of constant longitude). This differs by only about 2% from the current accepted radius for a mean spherical earth, a result which may be attributed more to luck than good judgement since a number of false assumptions were made in the calculations.

Ellipsoidal Earth Models

Isaac Newton (1643-1727) and Christian Huygens (1629-1695) developed earth models flattened at the poles after an increase in gravity nearer with increasing latitude had been inferred from the variation of the oscillations of a pendulum.

Thus the earth was now considered to have the properties of an oblate spheroid, the solid shape described on rotating an ellipse around its minor axis.

The Geoid

Amongst others, Laplace, Gauss, and Bessel recognised in the early nineteenth century that even an ellipsoidal earth model produces contradictions to physical measurements of the local plumb line (a measure of the local direction of gravity) when compared to the ellipsoidal normal. This deflection of the vertical was initially treated as a random observational error in adjustments of arc measurements. F.R. Helmert (1843-1917) was the first to directly utilise these

deflections as observations to be taken into account in the determination of the shape and size of the geoid.

Related Information

- ◆ BACKGROUND INFORMATION: THE SHAPE OF THE EARTH
- ◆ BACKGROUND INFORMATION: GEODETIC DATUMS AND COORDINATE SYSTEMS
- ◆ BACKGROUND INFORMATION: TIME
- ◆ BACKGROUND INFORMATION: MAP PROJECTIONS
- ◆ BACKGROUND INFORMATION: BIBLIOGRAPHY AND OTHER RESOURCES

BACKGROUND INFORMATION: THE SHAPE OF THE EARTH

Definition of the shape of the earth is an important task for the placing of spatial observations.

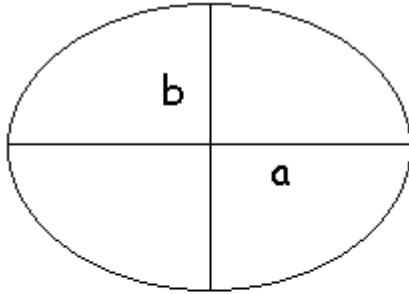
Geoid

If the waters of the ocean are considered a free-moving, homogeneous body, then at a state of equilibrium, and subject only to the gravity field of the earth, such a body assumes a particular level surface of that gravity field. If this *equipotential* surface is imagined extended under the continents, then we have defined the *geoid*. A simple interpretation of this is that the geoid is that equipotential surface which coincides, on average, with mean sea level.

Since the shape and size of this body is a function of the earth's gravity field, then variations in this field lead to discontinuities in the curvature of the geoid itself. Thus, this body is not a suitable reference surface for position determination. Nonetheless, it is a physically measurable surface, and useful particularly in the deduction of height of a point.

Spheroid

The earth itself may be thought of as an oblate spheroid (i.e. flattened at the poles). The size and shape of this spheroid are then important parameters in the definition of the reference surface. The size and shape of an ellipsoid are usually defined through the semi-major axis (a) and the inverse flattening ($1/f$) respectively.



a = semi major axis

b = semi minor axis

$$f = (a-b)/a$$

Typical values for these parameters are:

a = 6378137m, and

1/f = 298.257223563

(values are for the WGS-84 ellipsoid, a part of the WGS-84 datum)

One other important spheroid parameter is the eccentricity, which may be obtained from the quoted values of *a* and *f* and the calculated value of *b*. The (first) eccentricity of a spheroid is obtained from the values of the semi-major and semi-minor axes:

$$e = \frac{\sqrt{a^2 - b^2}}{a}$$

A related value, known as the second eccentricity, is found from:

$$e = \frac{\sqrt{a^2 - b^2}}{b}$$

Whilst at first glance it might appear most obvious to describe a spheroid by its semi-major and semi-minor axes values, the format is generally not used since the values are very susceptible to interchange, being so alike. For similar reasons, the value of e^2 , which is useful in many calculations, is left for computation by the user since its value (approximately 0.0067) is again easily wrongly

transcribed. Conversely, the inverse flattening is close to 300 in magnitude, and false transcription is therefore readily spotted since it is of easily remembered magnitude. For this reason, the values quoted in the description of a spheroid are most usually a and f .

Many other spheroids have been computed, the parameters created such that a best fit is afforded for the area of interest. A list of these spheroids is available in the reference *Geodesy for the Layman* noted in the Bibliography.

Related Information

- ◆ [BACKGROUND INFORMATION: HISTORICAL GEODESY](#)
- ◆ [BACKGROUND INFORMATION: GEODETIC DATUMS AND COORDINATE SYSTEMS](#)
- ◆ [BACKGROUND INFORMATION: TIME](#)
- ◆ [BACKGROUND INFORMATION: MAP PROJECTIONS](#)
- ◆ [BACKGROUND INFORMATION: BIBLIOGRAPHY AND OTHER RESOURCES](#)

BACKGROUND INFORMATION: GEODETIC DATUMS AND COORDINATE SYSTEMS

In seismic navigation, our interest in geodesy lies in the ability to assign measurements (shot points etc) to a particular position. In order to do this, we must have some body to which measurements can be referred. This involves coordinate systems and the related subject of geodetic datums.

Datum

A geodetic datum defines the reference system that describes the shape and size of the earth. The coordinates of a particular position are related to a particular datum, be that a local flat plane, or a complex global system.

Any geodetic datum (other than a local flat plane) requires as part of its definition some reference ellipsoid which mathematically approximates the size and shape of the earth (see [BACKGROUND INFORMATION: THE SHAPE OF THE EARTH](#)). This is chosen so as to best approximate the surface of the earth in the area of interest, be that local, regional, or global.

A datum may be horizontal (defining horizontal position), vertical (a basis for the definition of height) or three-dimensional.

Transformation between different datums is often a task which must be undertaken when working in large areas (where the local datum may change), or when a client requires coordinate information referenced to a particular datum. If both datums involved are well known, then transformation parameters can be defined, usually by way of three translations (along the x, y, and z axes), three rotations (around each of these axes), and a scale change. Lists of the required parameters are also available for many common translations, particularly for the more commonly used datums (see the WGS-84 reference in the Bibliography).

A number of ad hoc conversion systems exist which are important in marine navigation. NADCON is a conversion routine specifically for

converting between the NAD27 and NAD83 horizontal datums used in the United States, and also to high precision state systems.

A second important datum transformation system that has been implemented in CSL software is the Statens Kartverk, the Norwegian national mapping agency. This allows transformation between various national realisations of the European Datum of 1950 (ED50) and WGS-84 and is optimised for use in the North Sea.

Coordinate Systems

Coordinate systems come in a number of different formats, the choice being dependent on the particular application at hand.

Cartesian Coordinates

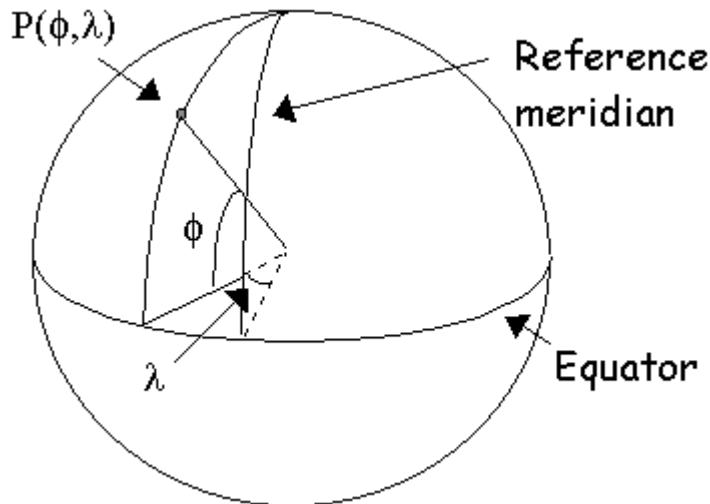
Familiar rectangular coordinates used in mathematics are also utilised in geodesy, particularly when describing satellite positions. A three-dimensional Cartesian (x, y, z) earth fixed system defines a fundamental terrestrial coordinate system. Origin is given as the centre of the earth's mass (the *geocentre*, a position which cannot be defined precisely and may be different for different datums, dependant on it's empirical definition), and the z-axis is defined to coincide with the mean rotational axis² of the earth. The xy plane is described by the mean equatorial plane perpendicular to the z-axis, and the direction of x passes through the mean meridian plane at Greenwich. The y-axis is directed so as to form a right handed system, i.e. it is located 90 degrees east of Greenwich. This coordinate system is known as the Conventional Terrestrial System (CTS).

Although it is easy to compute distances between pairs of Cartesian coordinates, their usefulness diminishes when navigating a course over the surface of the earth - a 'straight' line from Edinburgh to New York would, because of the curvature of the Earth, pass under the floor of the Atlantic, reaching a maximum depth of 1200km, and would be 500km shorter than the shortest route on the surface.

Geographic Coordinates

The most usual system for describing vessel position is that of latitude, longitude, and height. It is most usual for geographic

(geodetic) latitude and longitude to be referred to the equator and Greenwich meridian as their respective origins. The illustration below describes the relationship of these parameters.



Latitude (ϕ) is therefore the angle between the equatorial plane and the line describing the normal to the ellipsoid at point P. Longitude (λ) is the angle between some reference meridian (usually that through Greenwich, although others such as those through Paris and Jakarta have been used in the past) and the meridian passing through P. Longitude is usually defined positive east of Greenwich, and negative to the west, although not exclusively. Similarly, positive latitude usually signifies a position to the north of the equator, negative to the south.

The third coordinate in this system is height. Height must be referenced with relation to some vertical datum, often taken as mean sea level. Such heights are referred to as *orthometric heights*. It is also common to be faced with spheroidal heights, where the locally used spheroid parameters define a zero height. Orthometric and spheroidal heights are very rarely the same, and often vary by tens of metres (this difference is known as the geoid-spheroid separation). It is therefore important to know what type of height is given or required.

Related Information

◆ [BACKGROUND INFORMATION: HISTORICAL GEODESY](#)

- ◆ BACKGROUND INFORMATION: THE SHAPE OF THE EARTH
- ◆ BACKGROUND INFORMATION: TIME
- ◆ BACKGROUND INFORMATION: MAP PROJECTIONS
- ◆ BACKGROUND INFORMATION: BIBLIOGRAPHY AND OTHER RESOURCES

BACKGROUND INFORMATION: TIME

Time is an important concept in positioning and its definition is closely related to the science of geodesy. A number of different time systems may be encountered - the following gives an introduction to the most important.

International Atomic Time (TAI) is that kept by a series of atomic clocks spread around the globe. It was defined to be equal to Universal Time at midnight, January 1st, 1958, and is a continuous time scale (i.e. with no jumps).

Prior to the advent of atomic clocks, the rotation rate of the earth had been used as timekeeper. *Sidereal time* is based on the apparent motion of the stars (or a particular point on the *celestial sphere* at least) due to the rotation of the earth. *Greenwich Apparent Sidereal Time* (GAST) is a particular realisation of sidereal time, based on observations at the meridian running through Greenwich.

Universal Time (UT0 - be careful not to confuse with UTC, they are not the same!) is based on the apparent motion of a mean sun (the true motion of the sun is non-uniform) around the equator. On correction for *polar motion* this time scale is known as UT1. UT1 is therefore the time scale associated with the CTS (the z-axis of this system is defined to be the *mean* rotational axis). Variations in the position of the rotational axis of the earth were touched upon in the previous section. As well as this polar motion there is also a definite variation in the *speed* of this rotation; a general statement being that the rate of earth spin is slowing over time due to the braking effect of the tides. A deviation between UT1 and TAI is observable due to this slowing and it is for this reason that *leap seconds* are introduced periodically to *Coordinated Universal Time* (known by its French acronym of UTC). UTC is a civil time scale, defined such that its rate is equal to that of TAI, but kept roughly in line with the motion of the sun by the application of these leap seconds.

Since the time system used in the Global Positioning System (GPS Time) must be continuous for signal tracking reasons, there exists an offset of an integer number of seconds between UTC and GPS time

(currently July 1997), GPS time is ahead of UTC by 12 seconds. A summary of the relationships between the various time scales is given by the US Naval Observatory:

"As of 1 July 1997,

TAI is ahead of UTC by 31 seconds.

TAI is ahead of GPS by 19 seconds.

GPS is ahead of UTC by 12 seconds."

Related Information

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- ◆ [BACKGROUND INFORMATION: MAP PROJECTIONS](#)
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BACKGROUND INFORMATION: MAP PROJECTIONS

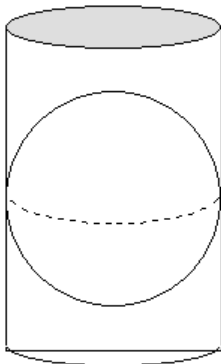
The earth is a three-dimensional, approximately spheroidal shape upon which measurements (including those for seismic navigation) are made. A piece of paper or a computer screen upon which we wish to represent this spatial data is flat and two-dimensional. Therefore, in order to resolve the above two statements, some method of transforming the real world data to a format that may be plotted or displayed is required.

Transforming from the three-dimensional world to a two-dimensional chart is going to result in some distortion. The level of distortion is a measure of the suitability of a particular map projection for the charting process in hand, taking into account the area of coverage and the purpose for which the map or chart is to be used. It must be appreciated that no projection is completely free of distortion - it is the cartographer's task to choose a projection which exhibits those properties considered advantageous for that particular application.

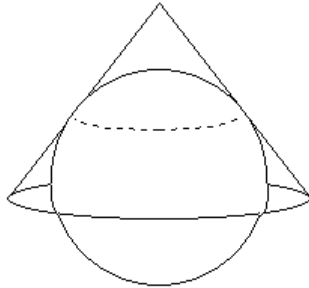
Classification of Map Projections

Map projections are often classified according to the method by which they are obtained or the properties they are designed to maintain. Classification according to the geometrical figure used as the projection surface provides the following general categories.

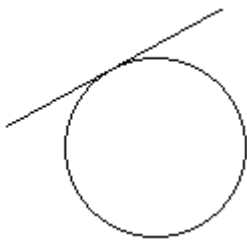
Cylindrical - If the map sheet is imagined rolled into a cylinder, and wrapped around the globe, then projection of the earth's surface to the map sheet will result in a cylindrical projection.



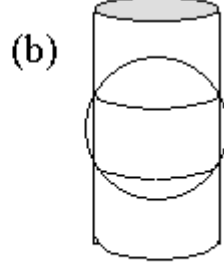
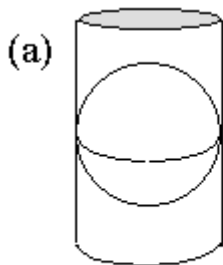
Conical - In this case, the map sheet is a cone, and the earth surface projected to this figure.



Azimuthal - The mapping sheet is a flat plane.



In each of the above scenarios, the projection figure (cylinder, cone, plane) may touch the globe at a point or along a single line (the projection is known as *tangential*), and distortion will increase away from this line or point. Alternatively, the figure may 'cut' through the globe, and touch its surface along a pair of lines (a single circle or ellipse in the case of an azimuthal projection), in which case we have what is known as a *secant* projection.



(a) Tangential and (b) Secant projections

Since the area of minimum distortion is that closest to the intersection of the globe and projection figure, then a secant projection will provide a comparatively larger area of such minimum distortion. The choice depends on the size of area to be mapped - secant projections are often used to map continental areas.

The particular properties of a projection are also a function of the location of the imaginary light source used to 'project' the earth surface to the map sheet.

Another variant in the definition of map projections is the orientation of the projection figure itself. Besides the usual orientation of the cylinder, the cylinder may be made transverse (at 90 degrees to its present position) or oblique (any angle between). The same generally applies to the conic and azimuthal projections - the cone or plane can be located at any location on the globe. The purpose of these shifts in aspect is to orient the zone of minimum distortion such that it coincides with the area of interest.

Properties of Map Projections

Every projection maintains a different set of properties of the area to be mapped. The following is an outline of the desirable characteristics to be preserved (remember that no map can exhibit *all* of these - the perfect map projection is impossible).

Area - a map projection in which the area of a particular region is conserved is known as *equal area*. This is advantageous for mapping of relative properties of areas (e.g. population density).

Distance - A projection in which the distance between any pair of points is conserved is known as *equidistant*. This is a highly desirable property in applications such as route planning in aerial navigation. Indeed, most aeronautical charts are equidistant.

Angle - If the azimuths measured on the map are equal to those which would be measured in the real world, then directions may be said to be preserved.

Conformality - If the scale in any direction from any point on a map is constant then the projection used is known as *conformal* (or sometimes *orthomorphic*). A conformal projection also has the property of conserving shapes over small areas. The most famous example of a conformal projection is the Mercator projection, often used in marine navigation since a straight line on the map equates to a line of constant bearing (loxodrome) in the real world. The disadvantages of the Mercator projection are highlighted in the Mercator World Map, where the extreme northern and southern latitudes are greatly expanded, leading to a false impression of the size of areas such as northern Canada and Greenland.

Map Lines, Great Circles and Loxodromes

If a ship's captain requires to sail from point A to point B, the map projection which has been used to produce the chart is an important consideration. A line of constant bearing will not necessarily plot as a straight line on the chart.

A *Great Circle* is a line describing the shortest distance between two points on the surface of a sphere. Since the shortest route is (often) the most efficient, aircraft tend to follow great circle routes. This is the reason that an aircraft flying from Europe to North America will often fly over Iceland and Greenland, and a flight from Europe to Japan will fly over the North Pole - these are the shortest routes, even though they may not look the most intuitive from simple inspection of a map. If, however, you were to inspect a globe, or a map produced with a *gnomic* projection (one in which great circles are straight lines) then the route taken would appear more obvious.

We have therefore come across one of the aspects of map making and map use which must be considered for navigation. What does a straight line drawn on a map (a map-line) mean in the real world? And conversely, how is a constant course followed on the surface of the earth represented in a particular map projection? Different projections will cause different types of distortion to the course navigated. By choosing a projection in which great circle distances are straight lines, we preclude the map's ability to represent lines of constant bearing as straight lines also. You should therefore be

aware that a straight line drawn on one map projection is probably not a straight line on another.

Examples of Map Projections

The following is a list of some of the more commonly used map projections, together with an outline of their properties, and typical usage.

Mercator

The Mercator projection is conformal and has the property of retaining straight lines of constant compass bearing. Parallels and meridians (lines of constant latitude and longitude respectively) cross at right angles. Scale is true along the Equator, or along any two parallels equidistant from the Equator.

A variant of this projection, the *Universal Transverse Mercator* (UTM) is used widely for mapping at medium scales on a national level. The UTM minimises distortion by splitting the globe into bands of 6 degrees of longitude and defining a transversely located cylinder for the projection at the centre of each band.

Albers

Albers is an equal area conic projection and as such preserves the proportion of any area mapped in relation to its real world basis. This projection is widely used for mapping in large countries with a larger east west than north south extent (e.g. United States).

Stereographic

Used for navigation in polar areas since directions are true from its centre point. This is an azimuthal projection in which scale increases away from the centre, as does distortion in area and shape. The Universal Polar Stereographic (UPS) projection is often used for high latitude mapping (above 84 degrees north and 80 degrees south).

Lamberts Conformal Conic

As its name suggests, this projection is conformal, and is based on a conical projection figure. This projection exists in tangential and secant form, i.e. with either one or two standard parallels. Since the zone of minimum distortion surrounds the standard parallel, then area

and shape are distorted away from the standard parallel(s) but directions are true for limited areas.

Parallels are unequally spaced arcs of concentric circles, more closely spaced near the centre of the map. Meridians are equally spaced radii of the same circles, thereby cutting parallels at right angles. Scale is true along the standard parallel(s). The pole in the same hemisphere as the standard parallels is a point, while the other pole is at infinity. Used for maps of countries and regions with predominant east-west expanse.

Polyconic

This is a projection widely used in the past for USGS mapping (United States Geological Survey - essentially the national mapping agency in the United States until recently). Based on an infinite number of cones tangent to an infinite number of parallels, scale is true along each parallel and the central meridian. The central meridian is straight, all others are complex curves. This projection is rarely used today.

Rectified Skew Orthomorphic

Belonging to the conformal family of projections, the *Rectified Skew Orthomorphic* displays the property of constant scale in any direction from any point. This is the general projection of which the Mercator and Transverse Mercator are special cases. Any great circle may be used as the transverse equator, and for this reason the projection is often used for countries with an oblique long axis.

Cassini

Devised by C.F. Cassini de Thury in 1745 for the survey of France, and modified by Soldner in 1810 (sometimes called the *Cassini-Soldner* projection for this reason), this is a cylindrical projection which is neither equal-area or conformal. The central meridian, each meridian 90 degrees from that central meridian, and the Equator are straight lines. All other meridians and parallels are complex curves. Scale is true along the central meridian, and along lines perpendicular to central meridian. Scale is constant but not true along lines parallel to central meridian on spherical form, nearly so for ellipsoid. This projection was used for mapping the UK in the past, and is still used in some areas of the world.

Kavraisky

A conical projection with minimum linear distortion. This projection is constructed using two true-scale parallels, and is primarily used in the mapping of moderate to high latitude areas.

New Zealand Map Grid

The *New Zealand Map Grid* (NZMG) is a projection used to convert latitudes and longitudes on the New Zealand Geodetic Datum 1949 (NZGD49) to eastings and northings used for the mapping of New Zealand. The purpose of this projection system is to minimise scale error over New Zealand specifically, and therefore cannot be sensibly used elsewhere.

Project Definition

In order for a particular projection to be adequately defined mathematically, a number of parameters must be provided. Typically this involves the definition of the standard parallel or meridian, the latitude and longitude of the projection origin, and the scale factor at that origin. Other parameters may be required for some projections, dependant on the complexity of that projection. Some, like the New Zealand Map Grid, are defined using specific polynomials.

Map Grids and Graticules

Printed onto many maps and charts are tick lines or a grid. The coordinates of a particular location can be simply read off the map by use of these markings.

A *graticule* is the projection of the three-dimensional lines of latitude and longitude onto the flat surface of the map. Therefore, the graticule is often not a pattern of perpendicular lines (dependant on the projection).

A *grid*, however, is some arbitrary rectangular system overlaid onto the map projection to provide a suitable coordinate reference system. A prime example of this is the UK National Grid, defined so that Ordnance Survey maps can easily be used to define a unique position of any point in the British Isles. The origin of the National Grid is located to the west of the Scilly Isles such that grid

coordinates are always positive, and the coordinates thus defined are known as *Eastings* and *Northings*.

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BACKGROUND INFORMATION: BIBLIOGRAPHY AND OTHER RESOURCES

Internet Resources

Further information on **map projections** can be found at the following URLs:

<http://www.utexas.edu/depts/grg/gcraft/notes/mapproj/mapproj.html>

or

<http://www.uncc.edu/~lagaro/cwg/mapproj/index.html>

or

<http://www.uidaho.edu/~huber921/map/>

Information on **coordinate systems**:

<http://www.utexas.edu/depts/grg/gcraft/notes/coordsys/coordsys.html>

Information on **geodetic datums**:

<http://www.utexas.edu/depts/grg/gcraft/notes/datum/datum.html>

Information on **time**, specifically as it regards **GPS**:

<http://tycho.usno.navy.mil/time.html>

The **US National Imagery and Mapping Agency** (an umbrella organisation, bringing together, amongst others, the Defence Mapping Agency (DMA) and the US Geological Service (USGS) Mapping Division:

<http://www.nima.mil/>

The **Marine Navigation** Home Page:

<http://164.214.2.59/Navigation/index-frs.html>

Geodesy for the Layman, a Department of Defence publication, now available at:

<http://164.214.2.59/geospatial/products/GandG/geolay/toc.html>

Publications

Torge, Wolfgang (1991). *Geodesy*, 2nd Ed., De Gruyter.

A rather complex and mathematical approach to the definition of geodesy and the geoid.

Vanicek, Petr and Edward Krakiwsky. *Geodesy: The Concepts*
Regarded by many as the 'bible' of geodesy, written by two of the most respected in the field.

Snyder, John P. (1987). *Map Projections - A Working Manual*, US Geological Survey.

A definitive work, covering the concepts, principles and modern techniques.

Defence Mapping Agency (1991) *World Geodetic System 1984: Its Definition and Relationships with Local Geodetic Systems*, TR8350.2, DMA.

The US DoD Mapping Agency report on WGS84, the global datum used for computations in the GPS system.

Bock, Yehuda (1995). "Reference Systems" In *GPS for Geodesy*, Eds. Alferd Kleusberg and Peter Teunissen, Netherlands Geodetic Commission.

One chapter of a good technical reference for (mainly) static geodetic techniques. Still, it has much of interest to the wider GPS community.

Parkinson, Bradford and J.J. Spilker Jr. (1996) *Global Positioning System: Theory and Applications*

A comprehensive guide to GPS, from its initial design and implementation to the latest techniques and applications. Contains some information on reference systems and time as they are applied to GPS.

Statens Karverk (1990) *The Transformation between ED50 and WGS84 for Exploration Purposes in the North Sea*.

A short paper on the datum transformation system agreed on between Denmark, Germany, the UK, the Netherlands and Norway.

Featherstone, Will and R.B. Langley (1997) *Coordinates and Datums and Maps! Oh My!* Innovations column, *GPS World*, January 1997.

An accessible summary of the problems associated with the various maps and datums used in GPS.