

Chapter 5 - Survey Data

The survey data is at the center of the Horizontal XSection Log software, and understanding how it is employed by the program will make your use of this software easier and more productive. This chapter goes into detail about the how to enter, edit, import and export survey data, and the importance of the survey data to the program.

Glossary of Terms and abbreviations:

MD - Measured Depth.

INC - Inclination of the survey tool where 0° is vertical and 90° is horizontal.

AZ - Azimuth of the survey tool corrected for magnetic declination (0° - 360°).

TVD (KBTVD) - True Vertical Depth is the vertical distance from the KB to the survey tool – also known as KBTVD.

VS - Vertical Section is the horizontal distance from the well location to the survey tool projected to a vertical plane that is the azimuth from the well location to the "planned" final target location.

NS - North/South, also known as Northings, is the map-view north/south coordinate for the survey tool. Positive numbers denote a coordinate north of the well location while negative numbers denote a southern location.

EW - East/West, also known as Eastings, this is the map-view East/West coordinate for the survey tool. Positive numbers denotes a coordinate east of the well position, while negative numbers denote a western location.

DLS - Doglegs is the degree of curvature measured in degrees per 100'

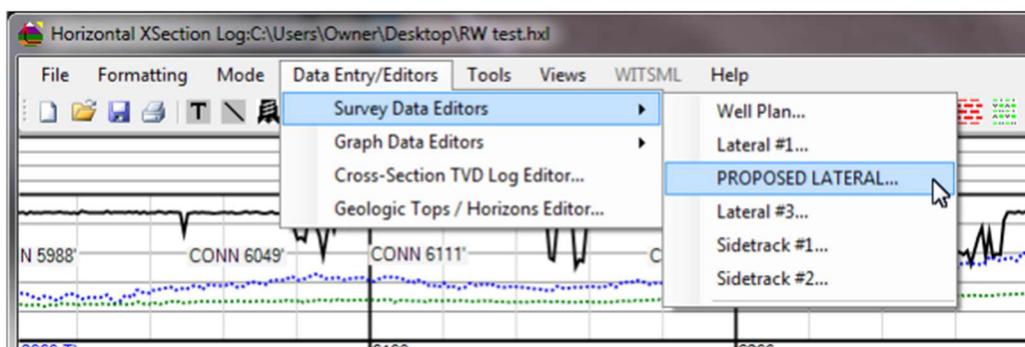
MD, INC and AZ, are measured by the down-hole survey tools (by the MWD personnel) and conveyed to the Directional Driller. TVD, VS, NS, EW and DLS are derived survey values. The dominate method of calculating the derived survey values is the Minimum Curvature method, and is the algorithm used by this software.

The Tie-In Value

The tie-in value is the start point for any curve that will be represented in the Horizontal XSection software, and is the survey from which all subsequent surveys are derived from. The tie-in value can be any survey, but must include the MD, INC, AZ, TVD, VS, NS, EW, DLS, as well as the azimuth from the well location to the final target location. This value is often known as the "Direction" or the "Vertical Section along azimuth" value. Without a correct "Direction", the software will not be able to accurately calculate the Vertical Section.

Note: that the tie-in value need not be the same tie-in value that the directional driller (DD) employs. Since, often time the Geologist will not be concerned with the up-hole portion of the well, any survey can be used as a starting point.

To enter the tie-in value click on the menu item Data Entry/Editors->Survey Data Editors-> and the survey lateral to edit.



Lateral #1 Survey Data Sheet

Tie-In Data

MD	INC	AZ	TVD	VS	NS	EW	DLS
0	0	0	0	0	0	0	0

Edit/Add Tie-In Survey Direction (vertical section along azimuth): 254.03

MD	INC	AZ	TVD	VS	NS	EW	Dogleg / 100'
6450	91.89	252.65	3026.10	3779.5	-1026.47	-3637.50	1.15
6511	92.33	252.4	3023.85	3840.5	-1044.77	-3695.65	0.83
6572	92.51	252.52	3021.27	3901.4	-1063.14	-3753.76	0.35
6638	92.33	252.81	3018.49	3967.3	-1082.79	-3816.71	0.52
6699	92.68	253.83	3015.82	4028.3	-1100.28	-3875.08	1.77
6760	91.45	253.36	3013.62	4089.2	-1117.49	-3933.56	2.16
6821	90.31	253.38	3012.69	4150.2	-1134.95	-3992.00	1.87
6883	90.75	253.49	3012.11	4212.2	-1152.62	-4051.42	0.73
6944	90.84	253.61	3011.27	4273.2	-1169.90	-4109.92	0.25
7005	91.71	253.59	3009.91	4334.2	-1187.12	-4168.42	1.43
7066	91.1	253.61	3008.41	4395.1	-1204.33	-4226.92	1.00
7127	90.04	253.04	3007.81	4456.1	-1221.84	-4285.36	1.97
7188	91.28	252.67	3007.10	4517.1	-1239.82	-4343.64	2.12
7249	90.92	252.7	3005.93	4578.1	-1257.97	-4401.86	0.59
7310	90.66	253.21	3005.09	4639.1	-1275.85	-4460.18	0.94
7371	90.57	253.59	3004.44	4700.1	-1293.27	-4518.63	0.64
7432	90.66	253.35	3003.78	4761.1	-1310.63	-4577.11	0.42
7494	91.19	253.19	3002.78	4823.0	-1328.47	-4636.48	0.89
7555	90.31	253.62	3001.98	4884.0	-1345.89	-4694.93	1.61
7616	91.71	253.41	3000.91	4945.0	-1363.20	-4753.41	2.32
7680	91.28	252.66	2999.24	5009.0	-1381.87	-4814.61	1.35
7743	90.75	253.38	2998.12	5072.0	-1400.26	-4874.85	1.42
7755	90.84	253.5	2997.96	5084.0	-1403.68	-4886.35	1.25
7833	90.84	253.5	2996.81	5162.0	-1425.83	-4961.13	0.00

Edit Survey Add Survey Import Surveys (*.csv) Done

Delete Survey Export Surveys (*.csv)

Slide Report

Add Slide Interval Slide From: Slide To: Tool Face (optional):

Delete Slide

Start	End	Tool Face
2488	2580	25L
2587	2610	HS
2618	2640	HS
2648	2669	HS
2677	2699	HS
2741	2761	10R
2771	2791	HS
2801	2821	HS
2837	2852	HS
2866	2884	HS
2894	2913	10R
2930	2948	HS
2958	2980	10L
2988	3012	5L
3022	3043	10LL
3055	3075	10L
3089	3107	HS
3121	3139	HS
3193	3203	5R
3213	3234	5R
3252	3266	5R

Import Slides (*.csv) Export Slides (*.csv)

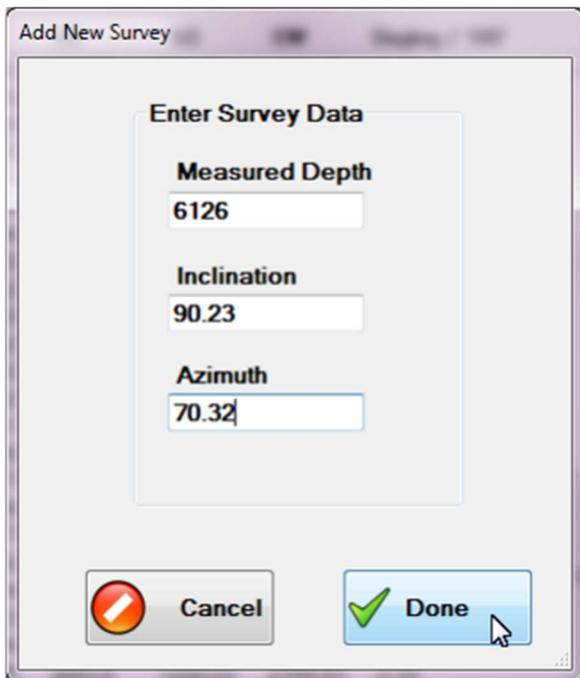
This will open the "Survey Data Sheet" window for the particular lateral chosen. Click on the "Edit / Add Tie-In Survey" button to open the "Add/Edit Tie-In" editor. Enter your tie-in survey data, as shown below.

Add/Edit Tie-In

MD	INC	AZ	TVD	VS	NS(Northings)	EW(Eastings)	Dogleg	Direction (degrees)
<input type="text" value="2564"/>	<input type="text" value="24.76"/>	<input type="text" value="188"/>	<input type="text" value="2554.29"/>	<input type="text" value="70"/>	<input type="text" value="-70.01"/>	<input type="text" value="-4.07"/>	<input type="text" value="7.81"/>	<input type="text" value="180"/>

Adding, Editing and Deleting Survey Data

Once the tie-in survey is entered, new surveys are entered through the "Add New Survey" window(see below). Click the "Add Survey" button to open the "Add New Survey" window. Note that the "Add New Survey" window only asks for the Measured Depth, Inclination and Azimuth data. The program will compute the derived survey values(TVD, VS, NS, EW and DLS) and add the new data to the "Survey Data Sheet" window.



To edit or delete a survey, just select the particular survey and click either the "Delete" or the "Edit" buttons. Slide data is entered on the right side of the Survey Data Sheet and is self-explanatory.

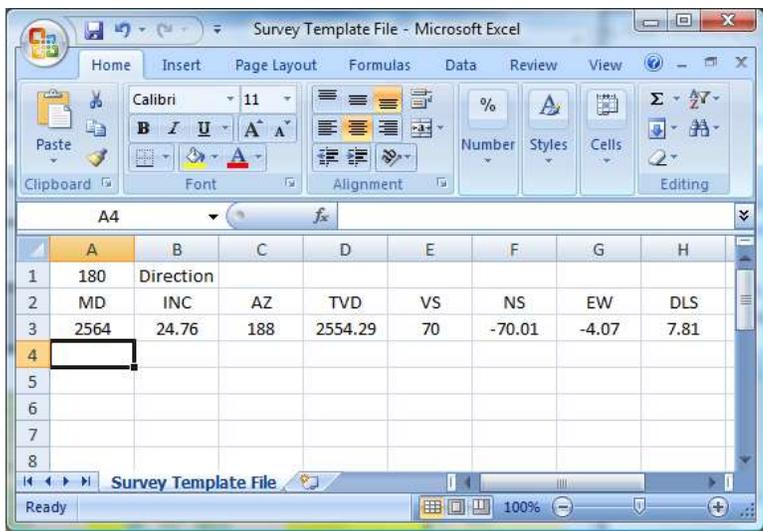
To quickly enter survey data using the above displayed "Add New Survey" dialog window, use the "Tab" key to quickly move from field to field and press the "Enter" key (same as clicking the "Done" button) to enter and close the window; click the "Enter" key again to open the "Add New Survey" window for the next survey entry.

Importing and Exporting Survey Data

Because it is often easier and faster to enter data in an Excel spreadsheet and then import the data into the Survey Data Sheets, the Horizontal XSection Log allows survey data to be imported and exported.

Use the "Import Survey Data (*.csv)" and the "Export Survey Data (*.csv)" buttons to import and export survey data, respectively.

However, the data must be formatted in a particular manner, and saved as a comma separated values file, also known as comma delimited text files (*.csv), in order for the program to be able to load the file. The simplest manner in which to create a template is to use the "Export Survey Data" button to create a CSV file. This file can then be opened by Microsoft Excel, edited, saved, and then imported back into the Survey Data Sheet of the particular lateral in question. To create a template, choose one of the empty laterals and open the "Survey Data Sheet" as shown above. Enter a tie-in value and click on the "Export Survey Data" button to create a CSV (*.csv) file. This file can then be opened in excel as shown below. If you double click a *.csv file, excel should automatically open. From within Microsoft Excel choose "Text Files" to display files of type comma delimited (*.csv).



The format of a template CSV file is simple:

CELL A1 has the direction data, ROW TWO is used as a header for the survey columns, ROW THREE holds the tie-in value and, ROWS FOUR onward are used for the survey parameter MD, INC and AZ.

The below example shows an Excel file that is ready to be imported with some survey data added in rows 4 - 7. Make sure you choose CSV(Comma Delimited) when saving the file, and make sure you close the file before trying to import it into the Horizontal XSection

software. Then simply open the Survey Data Sheet window for the appropriate lateral and import the file. The other survey fields (COLUMNS D - H) in rows 4+ are ignored when imported into the Survey Data Sheet window. Horizontal XSection will recalculate these values when the surveys are imported.

Note, when surveys are imported into a Survey Data Sheet, all preexisting surveys, including the tie-in value, will be deleted. However, previously entered slide data is not be altered.

	A	B	C	D	E	F	G	H
1	180	Direction						
2	MD	INC	AZ	TVD	VS	NS	EW	DLS
3	2564	24.76	188	2554.29	70	-70.01	-4.07	7.81
4	2609	28.44	187.57					
5	2654	32.79	185.3					
6	2698	37.29	184.17					
7	2743	41.43	184.59					
8								

As noted above, survey data is exported as a comma delimited text file (*.csv). The exported data includes all the derived survey values (TVD, VS, NS, EW, and DLS).

Matching the Directional Drillers Values

Though there are other methods for computation of the derived survey values, the most common method on horizontal wells is the minimum curvature methodⁱ. As long as the directional company is using this method, the values derived from the Horizontal XSection software will match the values from the directional driller. At times

rounding differences will result in values that differ by a few hundredths. If values differ by more than a few hundredths, examine your MD, INC, and AZ as well as the tie-in survey for date entry errors. Also remember that sometimes DD and MWD hands make mistakes too (though they may deny it)ⁱⁱ.

ⁱ I (Peter Falk) have personally worked as the well-site geologist on dozens of horizontal wells using four different directional companies and never seen another method employed.

ⁱⁱ It is a good idea to check your numbers with the Directional Driller numbers every few surveys to make positive your numbers match. Nine times out of ten any discrepancies will be a simple typographical data entry error. It is usually easy to find the error by working backwards to where the derived survey values go from not matching to matching.