Innova Engineering - BHA Analysis & SAG Example

This tutorial will demonstrate the steps required to perform BHA Analysis and SAG Correction.

This example project guide comes as part of the standard install and can be found in the following location: **C:\Program Files (x86)\Innova Drilling and Intervention\Innova Engineering\Manuals**

If you have already completed and saved the project for the **Survey Import Example**, open your saved file in Innova Engineering and progress to Page 2. Alternatively you can open **Survey Import – Example Project** located in **C:\Program Files (x86)\Innova Drilling & Intervention\Innova Engineering\Example Projects.** If you would like to follow the example by initially learning how to import surveys in to Innova Engineering, then proceed as guided below.

Create a new blank project. The units required are the default unit sets.

- Lengths are in Feet
- Weight units are in Imperial
- Mud units are PPG.

Click on the Surveys tab and follow the steps detailed in the **Survey Import Example,** located in **C:\Program Files (x86)\Innova Drilling and Intervention\Innova Engineering\Manuals**.

Import both the Raw Survey file and the MD INC AZI file. Both of these files are located in **C:\Program Files (x86)\Innova Drilling & Intervention\Innova Engineering\Example Projects\Example Surveys**

Enter the following BHA in to the Drill String table.

NB, once one row of the Drill String is completed, click the 'Insert After' radio button to add an additional row.

Description	OD	ID	Type	Length
Bit	12.250	2.000	Bit	0.5
Collar	8.000	2.813	Drill Collar	4
Stab	8.000	2.813	Stab	5
Collar	8.000	2.813	Drill Collar	58
Stab	8.000	2.813	Stab	5
Collar	8.000	2.813	Drill Collar	28
Stab	8.000	2.813	Stab	5
Collar	8.000	2.813	Drill Collar	44

For the purposes of BHA Analysis and SAG correction the BHA should be entered up to the component above the last stabiliser. No additional components need to be entered to perform the calculation. Once the BHA is entered the drill string grid should look like the screenshot below.

	Description	OD (in)	ID (in)	TJ OD (in)	TJ ID (in)	Weight (lb/ft)	Component	Length (ft)	Total Length (ft)	Non-Magnetic
1	Bit	12.250	2.000			389.77	Bit	0.500	0.50	☐
2	Collar	8.000	2.813			149.67	Drill Collar	4.000	4.50	☐
3	Stab	8.000	2.813			149.67	Stabilizer	5.000	9.50	☐
4	Collar	8.000	2.813			149.67	Drill Collar	58.000	67.50	☐
5	Stab	8.000	2.813			149.67	Stabilizer	5.000	72.50	☐
6	Collar	8.000	2.813			149.67	Drill Collar	28.000	100.50	☐
7	Stab	8.000	2.813			149.67	Stabilizer	5.000	105.50	☐
8	Collar	8.000	2.813			149.67	Drill Collar	44.000	149.50	☐

The stabiliser details now need to be entered. Click on the first stabiliser and go to the Component Details grid which is located below the Drill String grid and enter the following properties.

Stab OD = 12.25 in

Stab Blade Length = 12 in

Stab Dist From Bottom= 2 ft

The Stab Blade Length is the total length of the stabiliser blades in inches. The Stab Dist From Bottom is the distance from the start of the stabiliser blade to the bottom connection face, this distance is in the project units set.

If a motor or an MWD tool with a stabiliser on it was being used, the properties to be set would be exactly the same as the above. The Stab Dist From Bottom property is always the distance from the bottom of the stabiliser blades to the bottom of the tool.

The properties grid should look like the screenshot below

SN	
Stab OD (in)	12.250
Stab Blade Length (in)	12.000
Stab Dist From Bottom (ft)	2.000
Connection Top	
Connection Bottom	
Stab Blade Width (in)	
No. Stab Blades	

Click on each stabiliser and edit the Component Details to be the same as the above.

Set up the Well Geometry grid to have an open hole section of 1000ft long with an ID of 12.25"

Well Geometry

	Type	MD (ft)	TVD (ft)	ID (in)	OD (in)
1	Open Hole	1000.00		12.250	12.25
2					

Enter the Mud Weight as 8.4ppg

Fluid properties

Mud Weight (ppg)	8.4
PV	
YP	

Add Fluid

Fluid Library
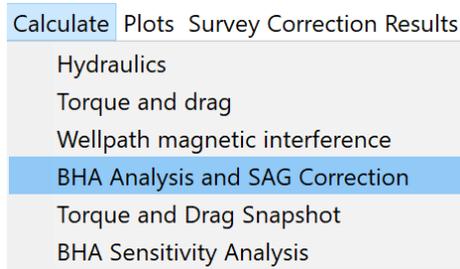
In the Survey corrections frame set the sensor offset to 13, DLS 0, Inc 60, TF 0, SAG Calc Type to single
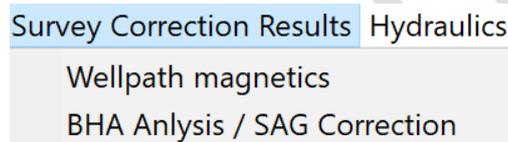
Survey Corrections

Survey Offset (ft)	Inc Start	Inc Stop	Inc Step	Calc Type
13	0.0	0.0	0.0	Single

DLS	Inc	TF
0.0	60	0.0

From the calculate menu click on the "BHA Analysis and SAG correction" option or the Calculate BHA Analysis and SAG button on the toolbar.

Calculate Plots Survey Correction Results
        Hydraulics
        Torque and drag
        Wellpath magnetic interference
        BHA Analysis and SAG Correction
        Torque and Drag Snapshot
        BHA Sensitivity Analysis

or

The calculations will now run, and the results will automatically appear in a new window. If you close this window, the results can be viewed again either by clicking on the Survey correction Results-> BHA Analysis and SAG Correction results menu or by clicking the BHA Analysis and SAG results button on the toolbar.

Survey Correction Results Hydraulics
        Wellpath magnetics
        BHA Anlysis / SAG Correction

The results will be displayed in the grid and the deflected shape of the BHA can be seen in the upper graph and the SAG correction along the BHA length in the lower graph.

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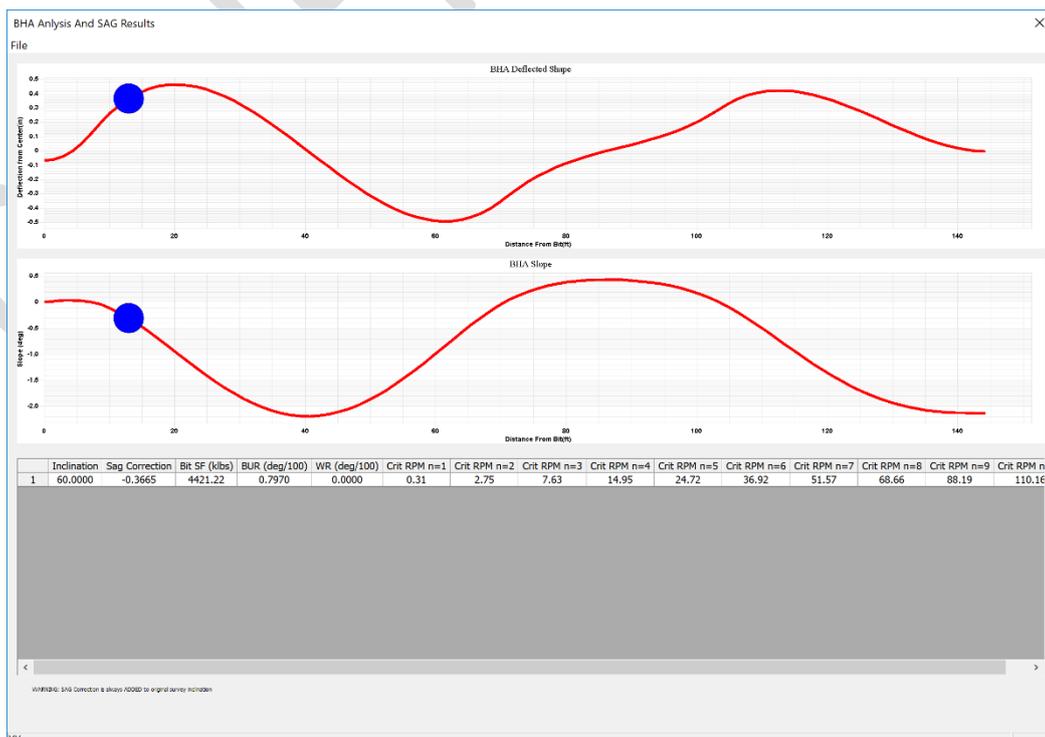
Note the SAG correction value should always be ADDED to the original survey inclination

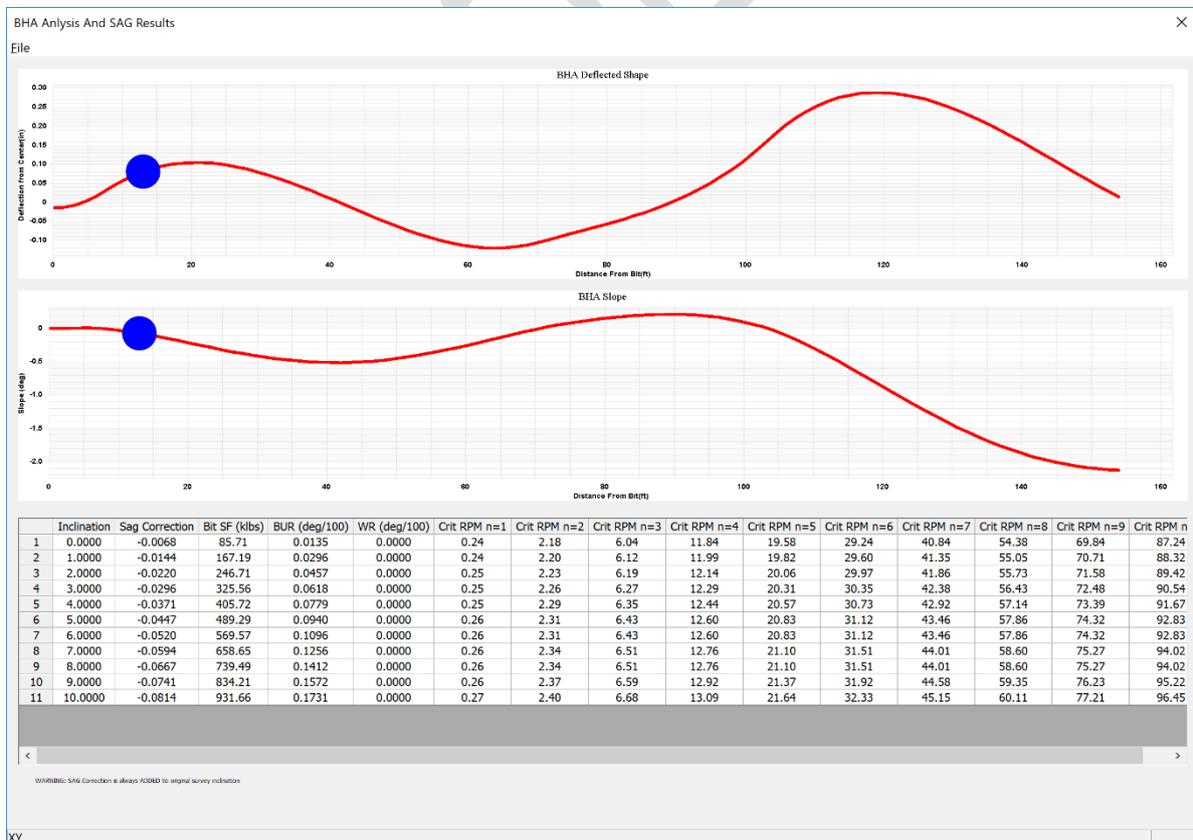The predicted BHA build and walk rates are also displayed. The BHA walk rate is dependent on the bit index which can be changed from the bit properties. For a tricone bit typical values range between 0.1 and 0.21 and for a PDC 0.15 to 0.35 depending on aggressiveness.

If a motor or RSS is included the motor bend and RSS deflection entered in the Drill String Component Details section will be taken in to account. The option to include or exclude the motor bend in the calculation is available via 'Options > Include Motor Bend in BHA Analysis'.

If you wish to run the SAG calculation for a range of inclinations go back to the Survey corrections frame and select "Inclination Range" from the BHA Analysis Calc Type drop down. Set the start inc to 0 and the stop inc to 10 and the step to 1.

Survey Corrections

Survey Offset (ft)	Inc Start	Inc Stop	Inc Step	Calc Type
13	0.0	10	1	Inc Range

DLS	Inc	TF
0.0	60	0.0

Run the calculation again and view the results

BHA Anlysis And SAG Results

File

BHA Deflected Shape

BHA Slope

	Inclination	Sag Correction	Bit SF (klbs)	BUR (deg/100)	WR (deg/100)	Crit RPM n=1	Crit RPM n=2	Crit RPM n=3	Crit RPM n=4	Crit RPM n=5	Crit RPM n=6	Crit RPM n=7	Crit RPM n=8	Crit RPM n=9	Crit RPM n
1	0.0000	-0.0068	85.71	0.0135	0.0000	0.24	2.18	6.04	11.84	19.58	29.24	40.84	54.38	69.84	87.24
2	1.0000	-0.0144	167.19	0.0296	0.0000	0.24	2.20	6.12	11.99	19.82	29.60	41.35	55.05	70.71	88.32
3	2.0000	-0.0220	246.71	0.0457	0.0000	0.25	2.23	6.19	12.14	20.06	29.97	41.86	55.73	71.58	89.42
4	3.0000	-0.0296	325.56	0.0618	0.0000	0.25	2.26	6.27	12.29	20.31	30.35	42.38	56.43	72.48	90.54
5	4.0000	-0.0371	405.72	0.0779	0.0000	0.25	2.29	6.35	12.44	20.57	30.73	42.92	57.14	73.39	91.67
6	5.0000	-0.0447	489.29	0.0940	0.0000	0.26	2.31	6.43	12.60	20.83	31.12	43.46	57.86	74.32	92.83
7	6.0000	-0.0520	569.57	0.1096	0.0000	0.26	2.31	6.43	12.60	20.83	31.12	43.46	57.86	74.32	92.83
8	7.0000	-0.0594	658.65	0.1256	0.0000	0.26	2.34	6.51	12.76	21.10	31.51	44.01	58.60	75.27	94.02
9	8.0000	-0.0667	739.49	0.1412	0.0000	0.26	2.34	6.51	12.76	21.10	31.51	44.01	58.60	75.27	94.02
10	9.0000	-0.0741	834.21	0.1572	0.0000	0.26	2.37	6.59	12.92	21.37	31.92	44.58	59.35	76.23	95.22
11	10.0000	-0.0814	931.66	0.1731	0.0000	0.27	2.40	6.68	13.09	21.64	32.33	45.15	60.11	77.21	96.45

WARNING: SAG Correction is always ADDED to original survey inclination

XY

The graphs displayed are for the final inclination calculated, if a DLS was selected it would be applied to all the inclinations which the calculation was run for.

If you wish to calculate the SAG correction for a specific survey, then select "Surveys" from the Calc Type drop down.
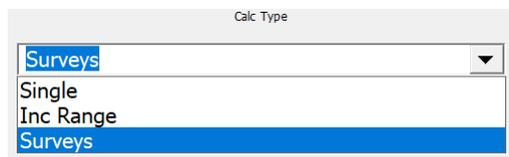
If this option is selected, then the DLS option is disabled and the curvature is calculated between survey stations. The calculation will then be run against whatever you have selected in the "Survey Selection" drop down.
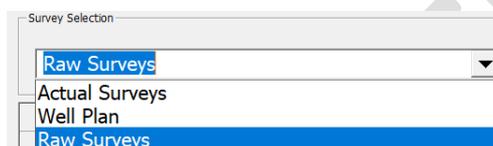
If the RAW survey grid is selected the SAG corrected inclinations will be displayed in the grid as well as the Delta Inc.

As a reference a completed Engineering Project file entitled **SAG - Example Project.ieng** can be found in the following location: **C:\Program Files (x86)\Innova Drilling and Intervention\Innova Engineering\Example Projects**.