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WEM SIMULATION TUTORIAL

Well Evaluation Model for Perforating Design

Prepared by: Baby Cintami Massaugee Abdullah

Date: January 2020

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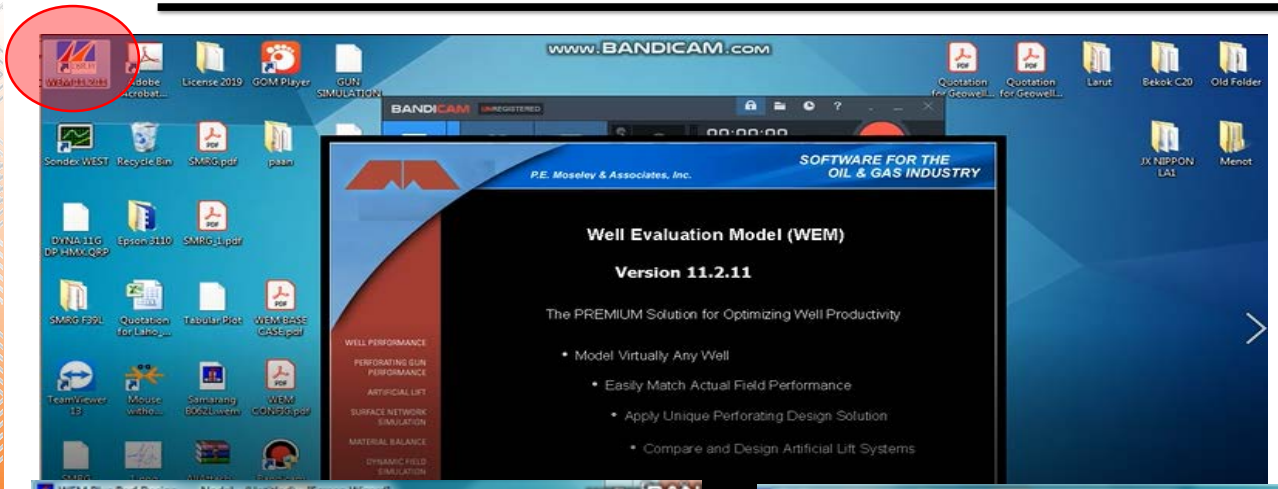
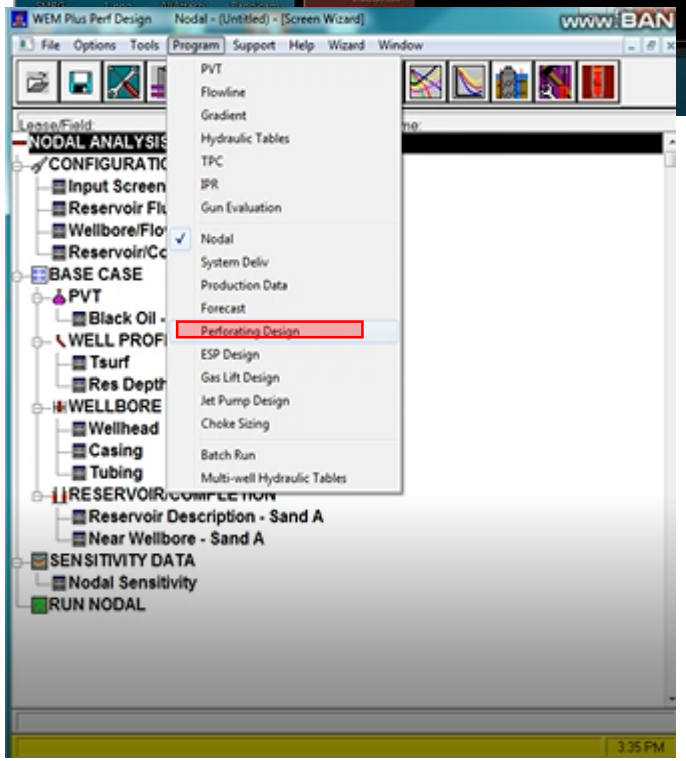
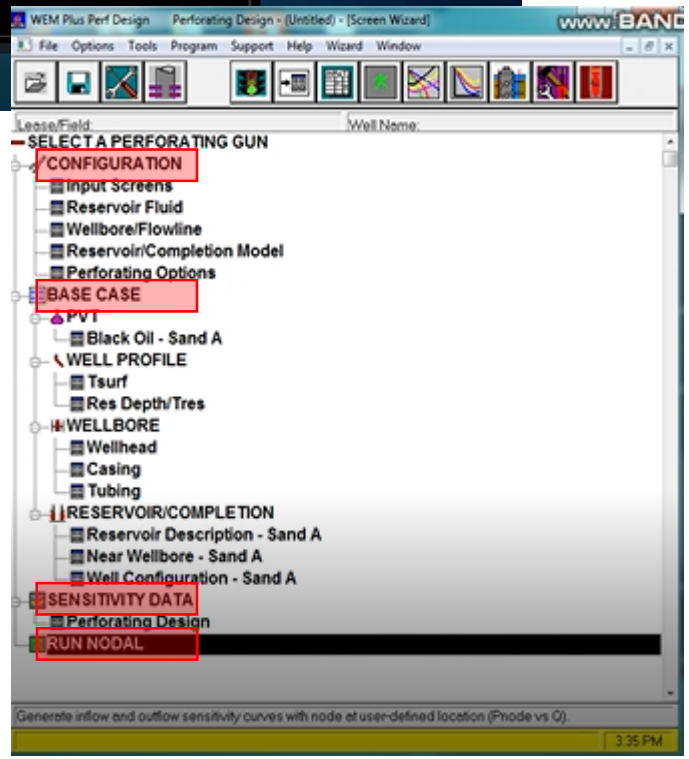
CONFIGURATIONS - SELECT WELL PROGRAM







1. Open WEM 11.2.11
2. Click **Screen Wizard** > OK

Note: Screen Wizard represents all input screens required to make a run.

3. Go to Program > Select **Perforating Design.**

Note: There are 3 Group of Program. In the middle section of the dropdown menu, there are 8 programs which consist the Perforating Design.

4. The selected program comprised 4 main branches: **CONFIGURATIONS, BASE CASE, SENSITIVITY DATA & RUN NODAL.**

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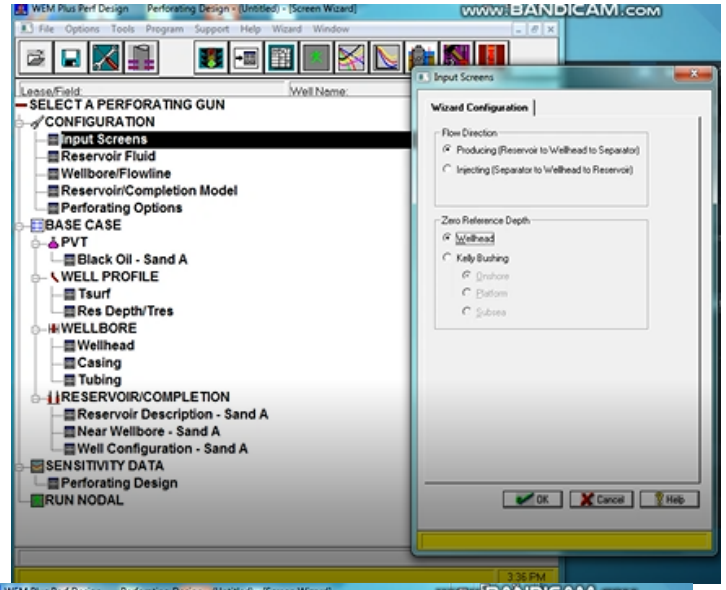
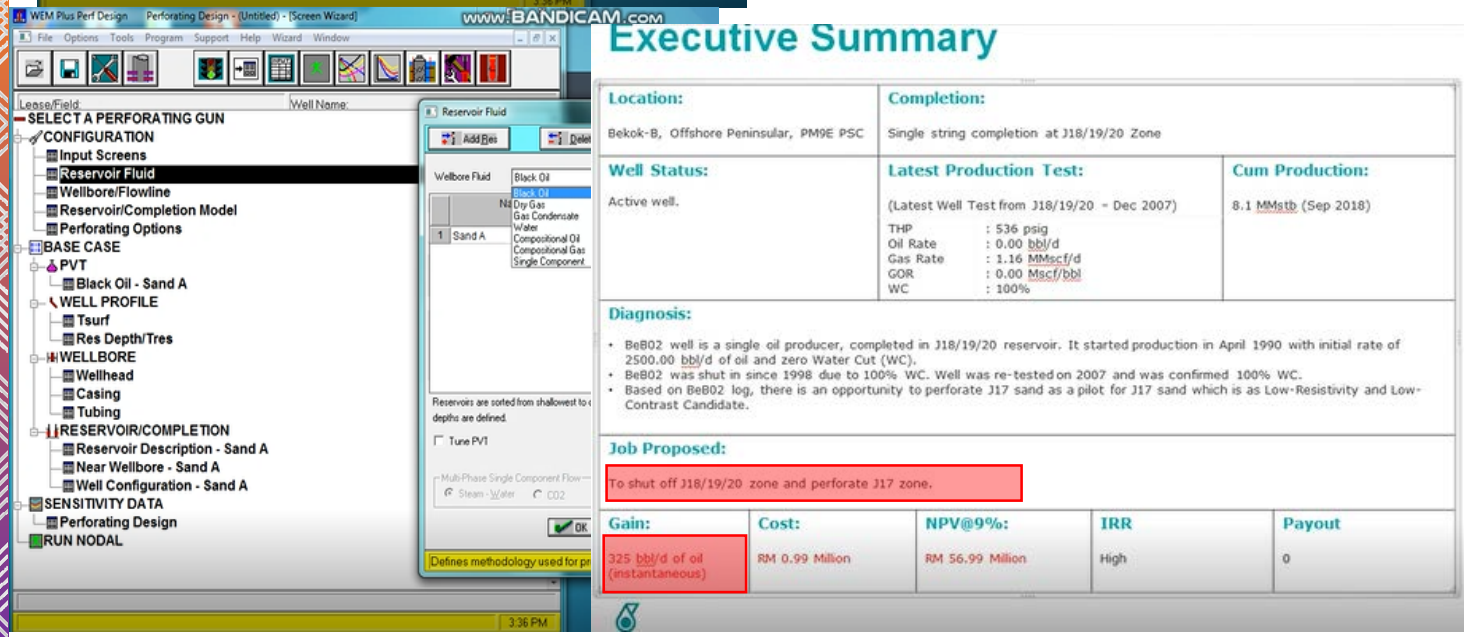
INPUT SCREEN / RES FLUID



1. Flow Direction > **Producing (Reservoir to Wellhead to Seperator)**
2. Zero reference depth > **Wellhead**

Note: reference datum as either the wellhead or the Kelly rig bushing. If Kelly bushing option is selected, all actual lengths in the well are corrected back to the wellhead for calculation purposes. The reference depth has no influence on the Flowline profile.



3. Choose Reservoir Fluid that is expected to be produced – this will define the PVT model used. You may refer to the job proposal.

4. Rename sand accordingly.

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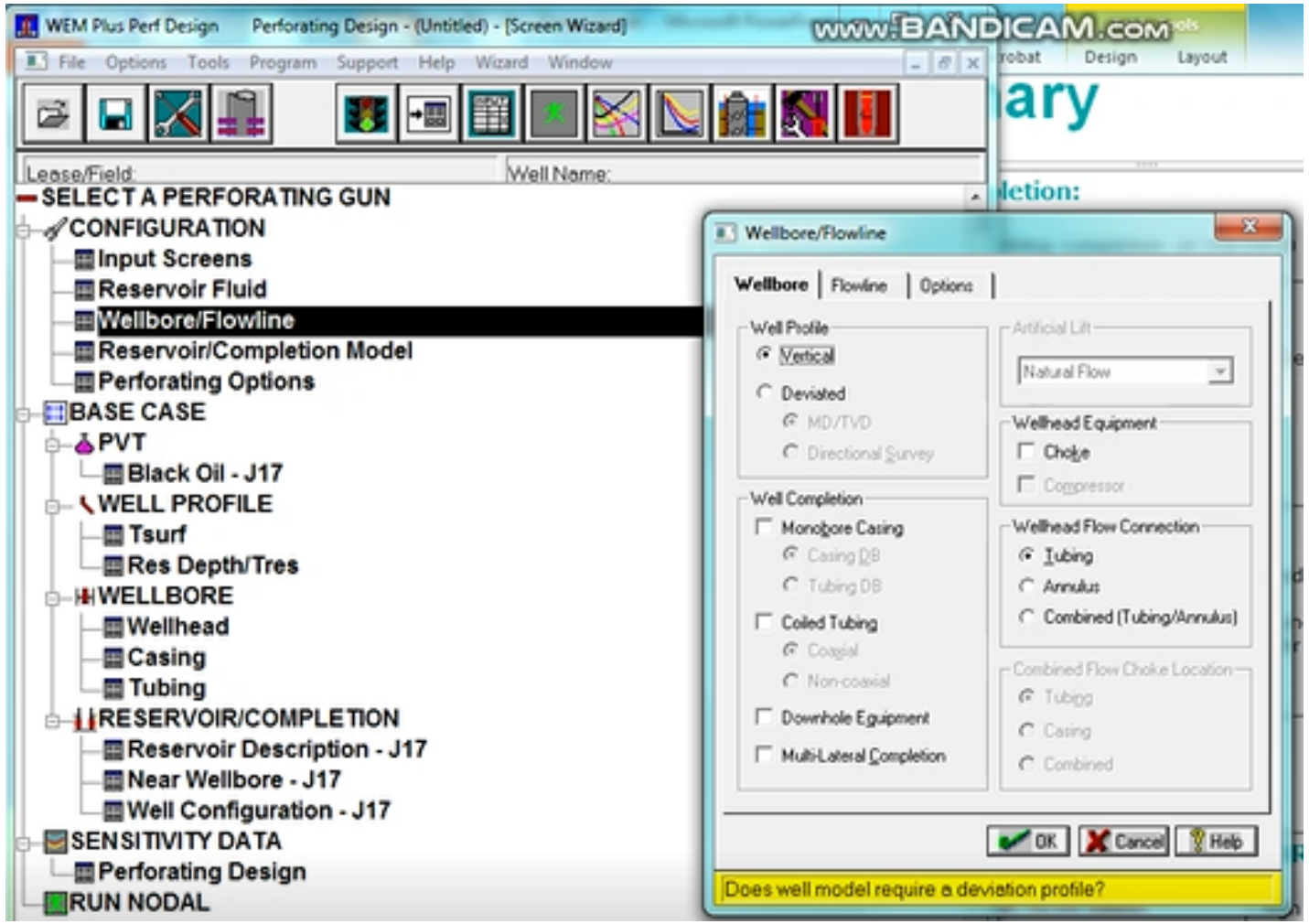
WELLBORE/FLOWLINE



1. Wellbore/flowline config screen provides choices for configuring the flow system that connects bottom hole to the end of flowline. For this simulation, choke size and flowline will be an option as it can be adjusted during sensitivity (if known or specific request by client). If choke or flowline been chosen, you need to input all the data for both (next tab).
2. **For this section, tick only well profile and wellhead flow connection.**

Note: Downhole equipment is generally for all accessories downhole installed such as SSD, TRSV etc. This will counted later on the pressure losses for Outflow Calculation.

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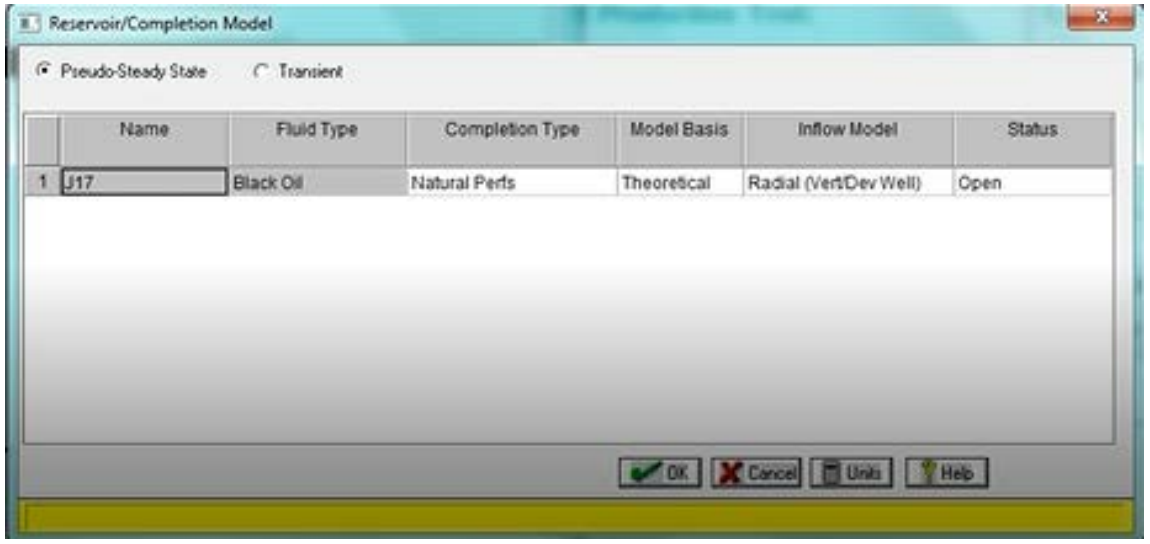
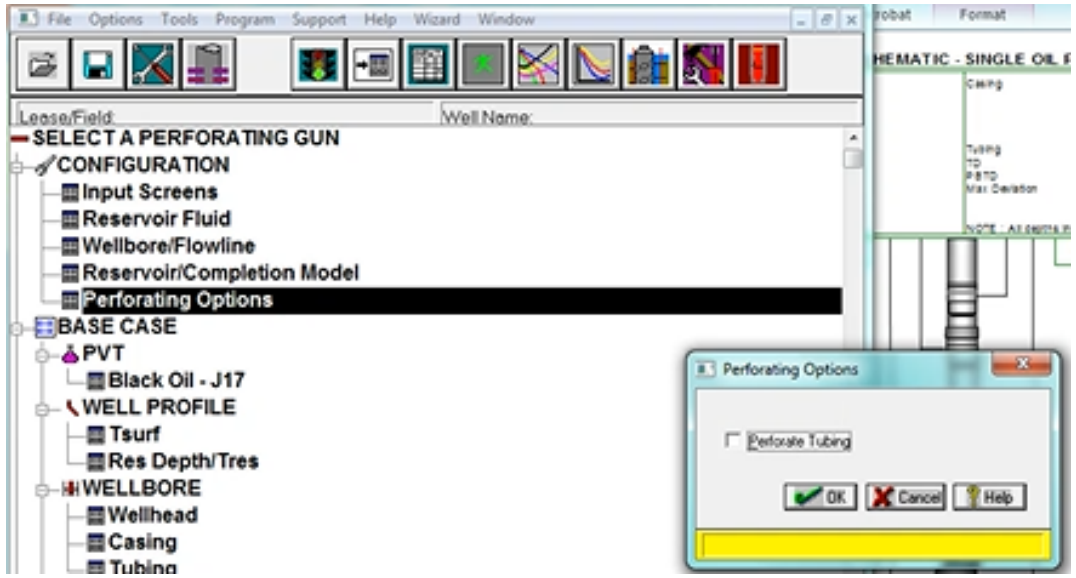
RES/COMPLETION MODEL





1. Completion type describes method used to establish flow communication between reservoir and wellbore.

2. Completion Type – **Natural Perfs.**

3. Model Basis – **Theoretical (distinguish between formation pressure drop and completion pressure drop with no welltest data available).**

4. Inflow Model – **Radial / Horizontal (based on well trajectory).**

5. Status – **Open *(must set 'Open' otherwise could not run the model).***

6. Perforating Options – tick if perforate through tubing. If perf directly to casing, leave the box unchecked.

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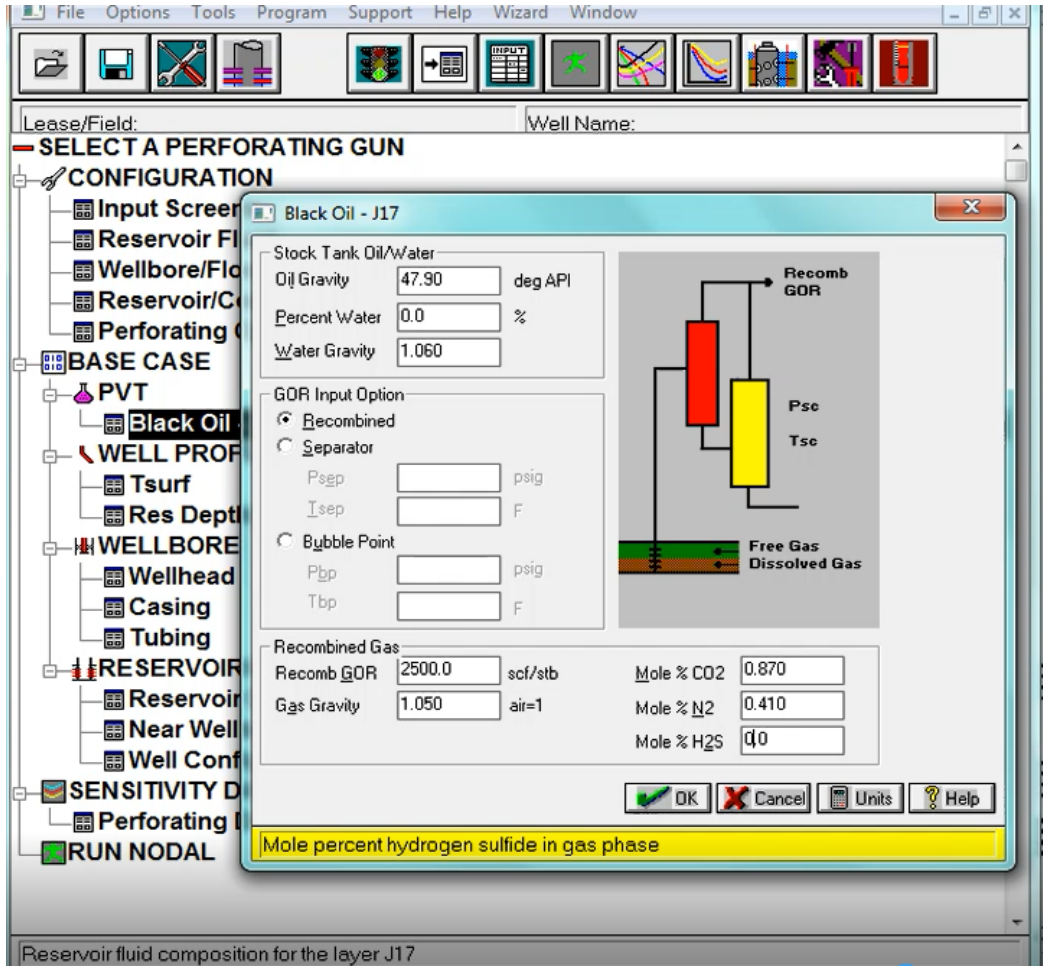
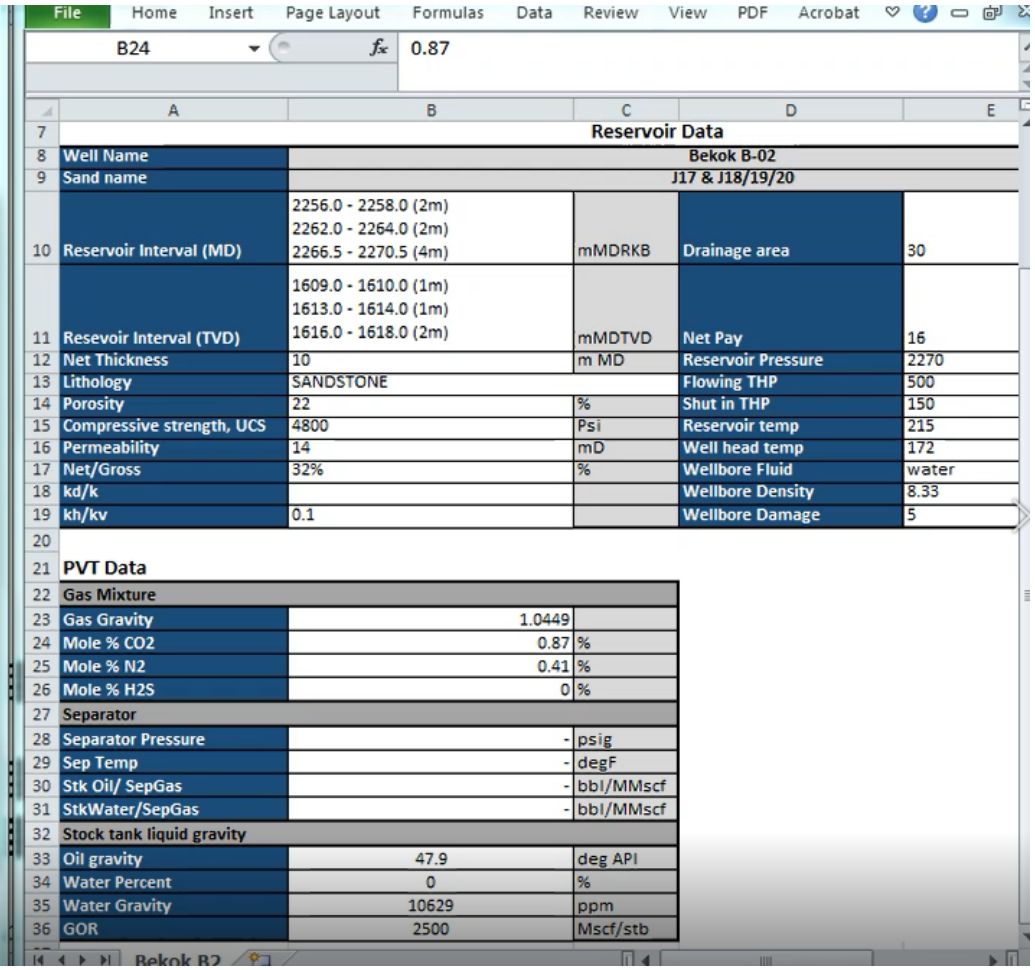
BASE CASE - PVT





B24 | 0.87

	A	B	C	D	E
7	Reservoir Data				
8	Well Name	Bekok B-02			
9	Sand name	J17 & J18/19/20			
10	Reservoir Interval (MD)	2256.0 - 2258.0 (2m) 2262.0 - 2264.0 (2m) 2266.5 - 2270.5 (4m)	mMDRKB	Drainage area	30
11	Resevoir Interval (TVD)	1609.0 - 1610.0 (1m) 1613.0 - 1614.0 (1m) 1616.0 - 1618.0 (2m)	mMDTVD	Net Pay	16
12	Net Thickness	10	m MD	Reservoir Pressure	2270
13	Lithology	SANDSTONE		Flowing THP	500
14	Porosity	22	%	Shut in THP	150
15	Compressive strength, UCS	4800	Psi	Reservoir temp	215
16	Permeability	14	mD	Well head temp	172
17	Net/Gross	32%	%	Wellbore Fluid	water
18	kd/k			Wellbore Density	8.33
19	kh/kv	0.1		Wellbore Damage	5
20					
21	PVT Data				
22	Gas Mixture				
23	Gas Gravity	1.0449			
24	Mole % CO2	0.87	%		
25	Mole % N2	0.41	%		
26	Mole % H2S	0	%		
27	Separator				
28	Separator Pressure	-	psig		
29	Sep Temp	-	degF		
30	Stk Oil/ SepGas	-	bbl/MMscf		
31	StkWater/SepGas	-	bbl/MMscf		
32	Stock tank liquid gravity				
33	Oil gravity	47.9	deg API		
34	Water Percent	0	%		
35	Water Gravity	10629	ppm		
36	GOR	2500	Mscf/stb		

Bekok B2

Refer to the data that filled by client on WEM Input Template and fill in the PVT accordingly.

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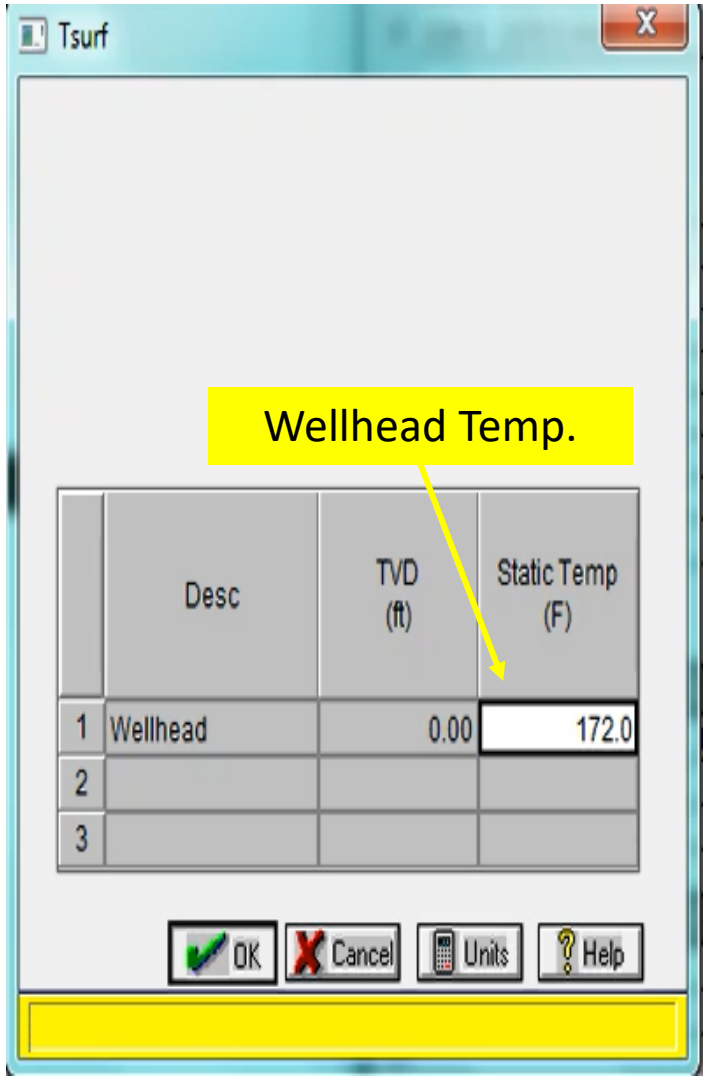
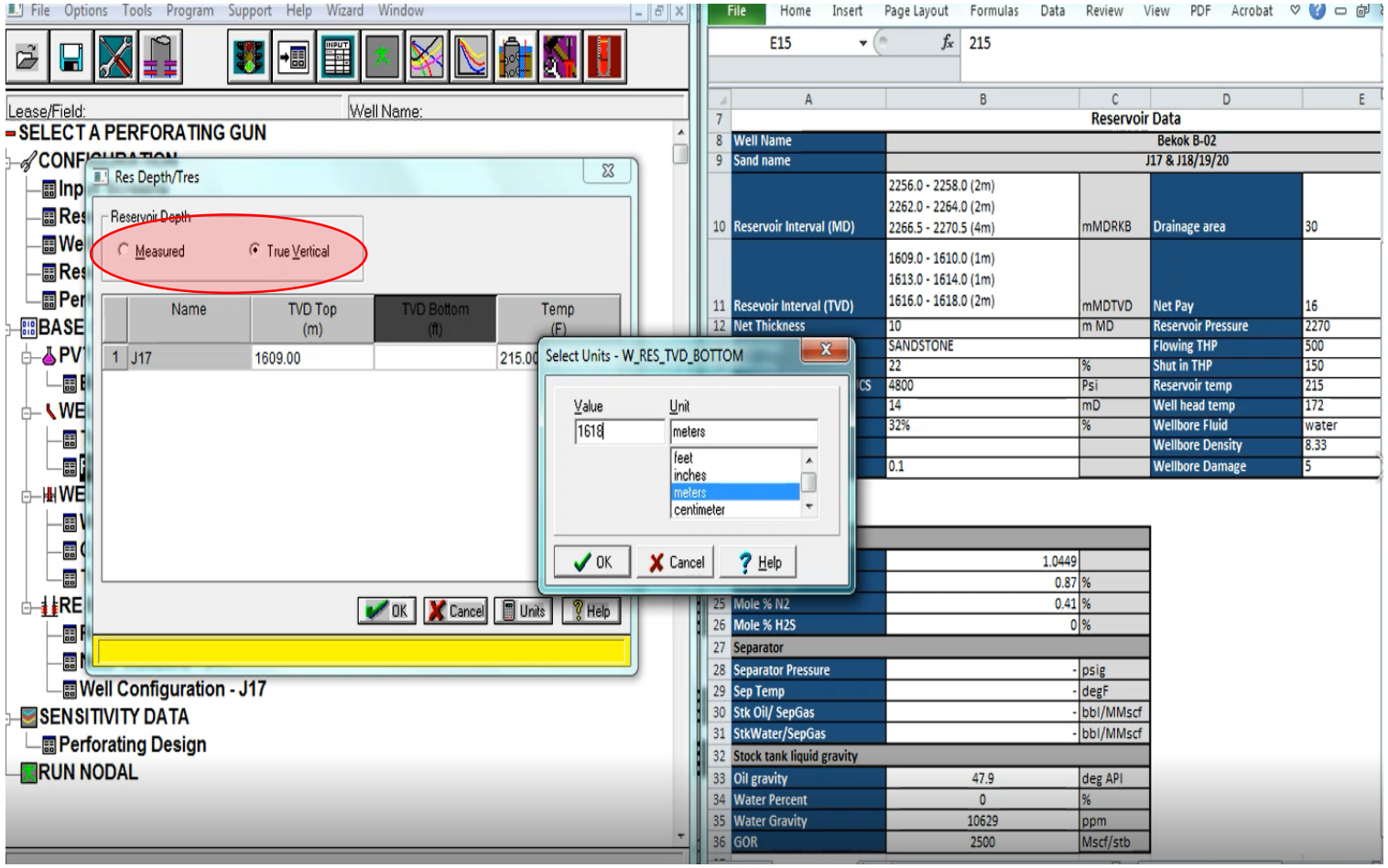
WELL PROFILE





Res Depth/Tres – Fill up both Perforation depth in ‘Measured’ & ‘TVD’.

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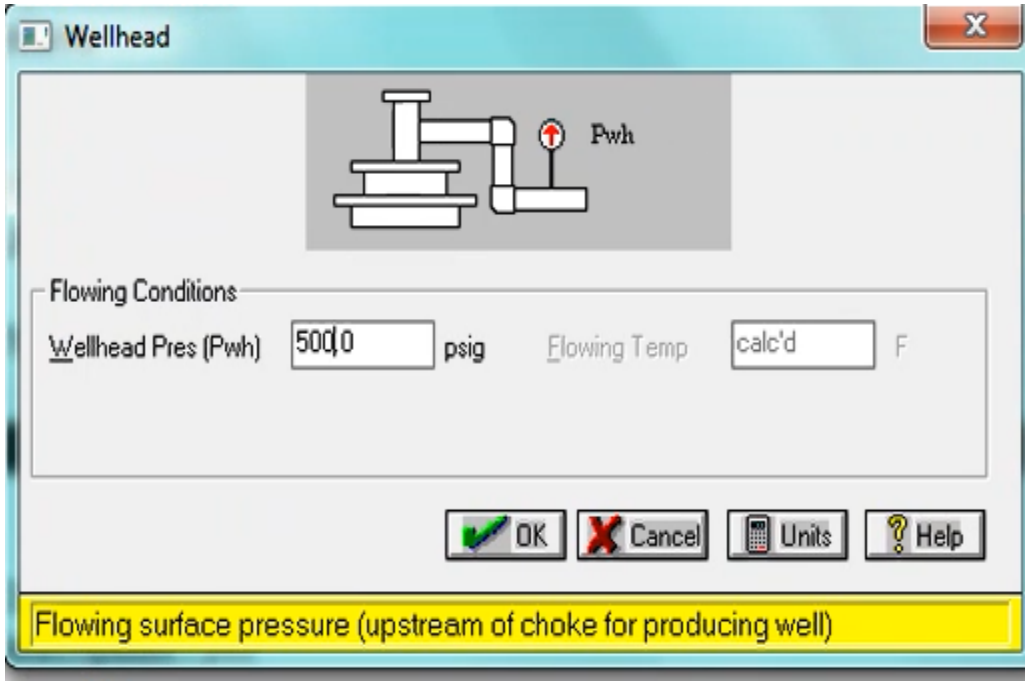
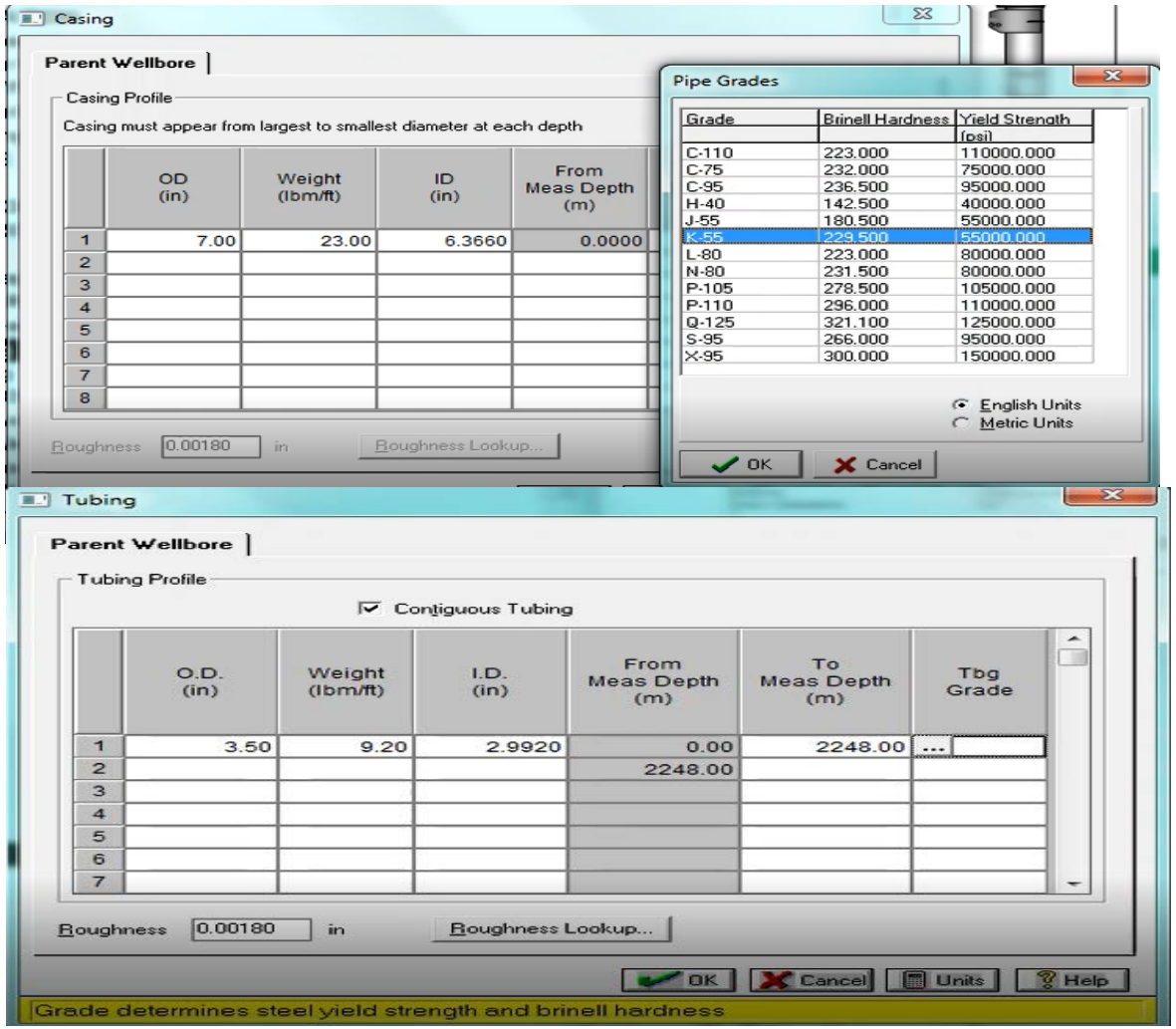
WELL PROFILE



Pwh – Flowing THP



Fill up the casing and tubing details as per well schematic provided

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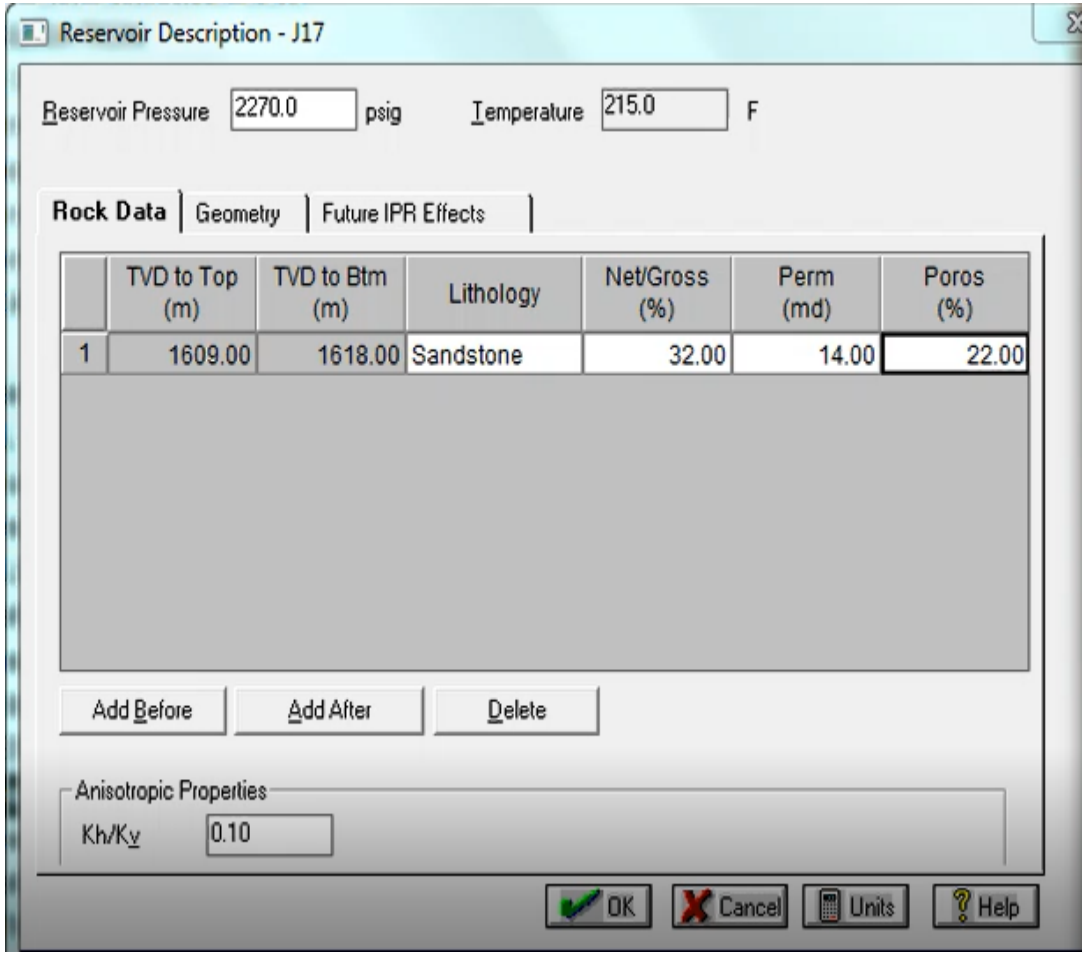
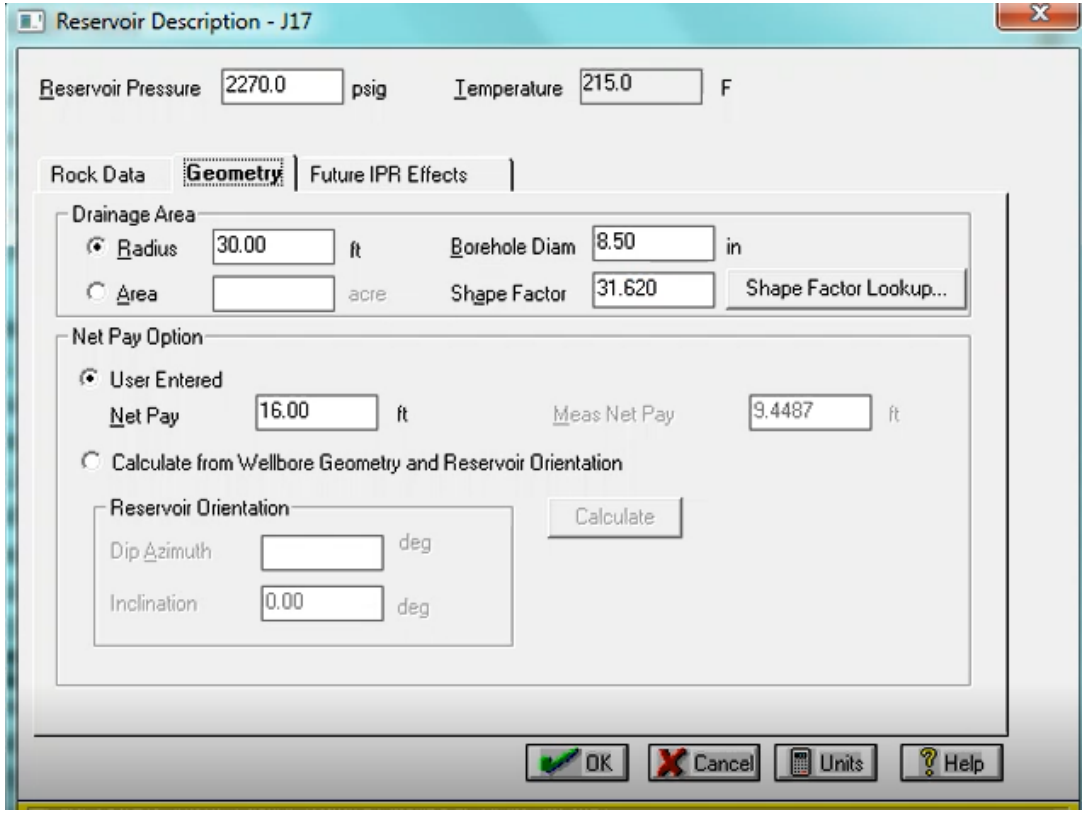
RESERVOIR DESCRIPTION





Fill up the reservoir details for rock data and geometry. You may refer to drill bit size chart for borehole diameter if no information provide by client.

Note: For radius of drainage area, minimum value is 150ft.

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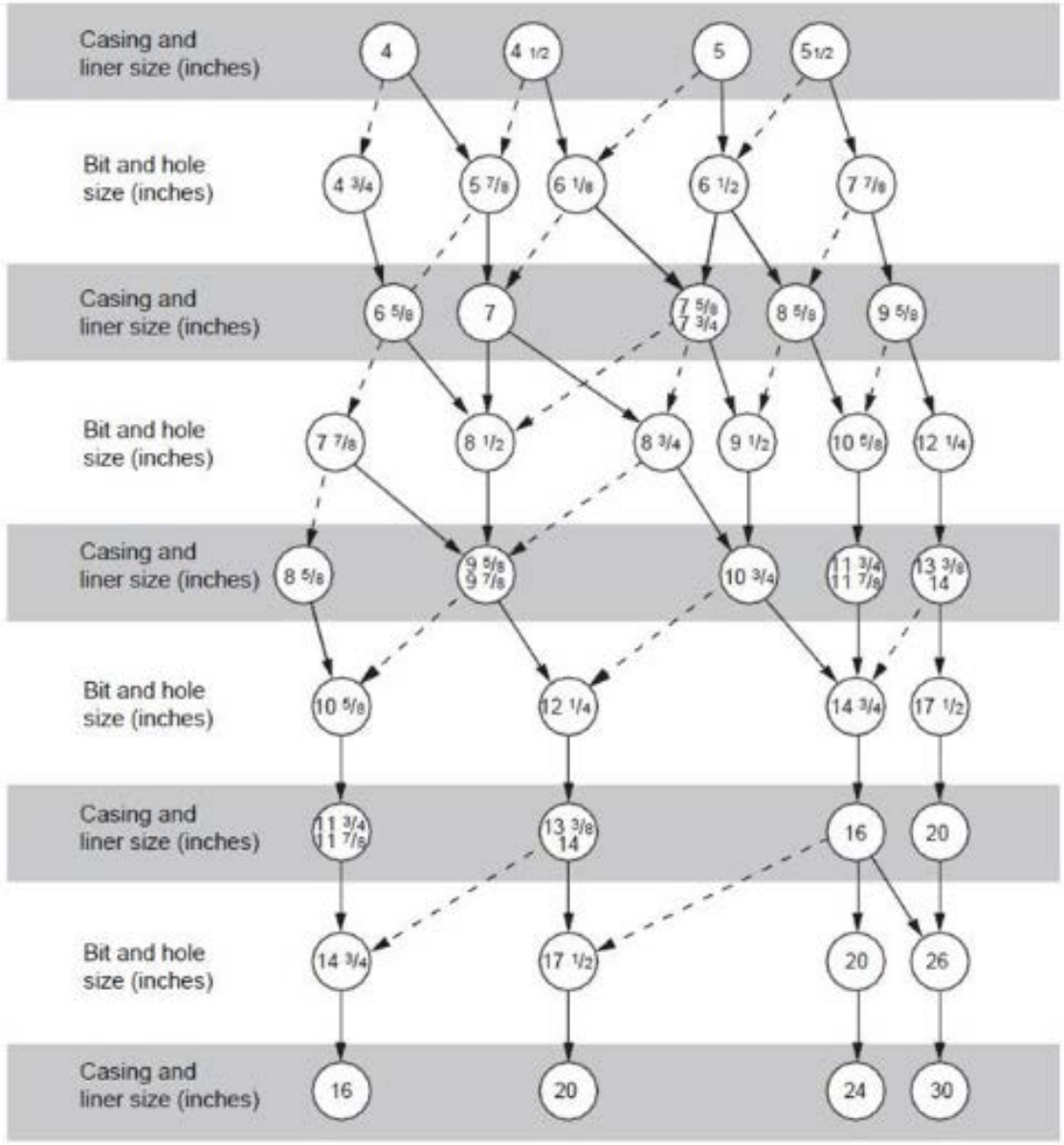
RESERVOIR DESCRIPTION



Use straight line as primary bit size and dotted line as secondary bit size.

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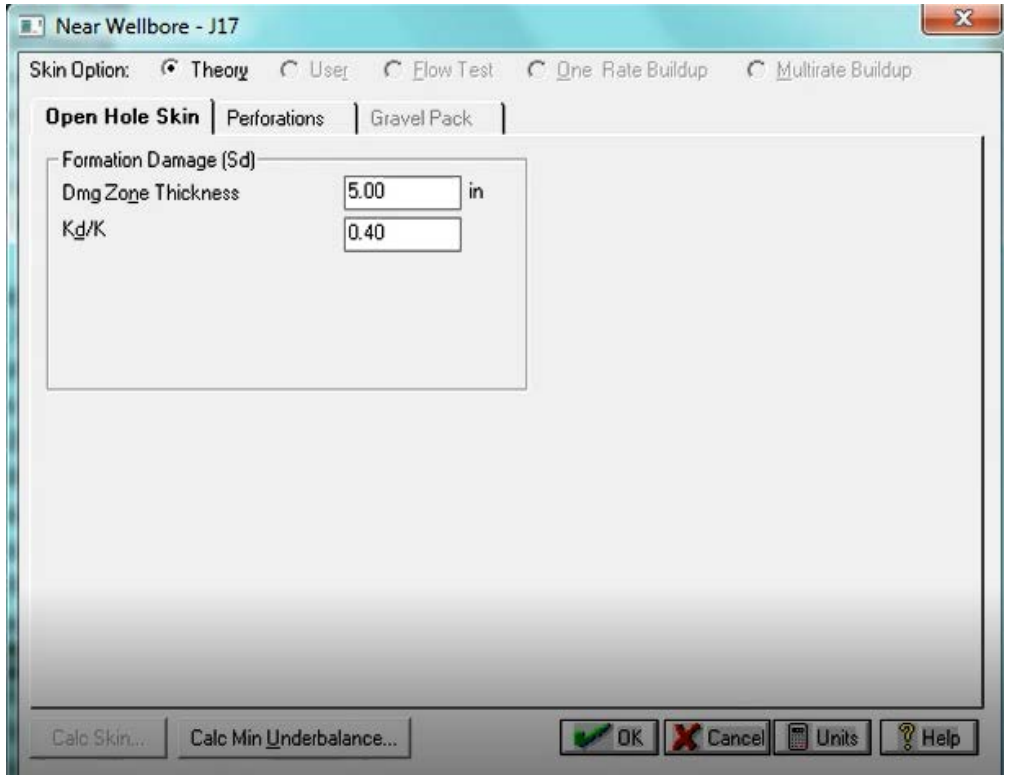
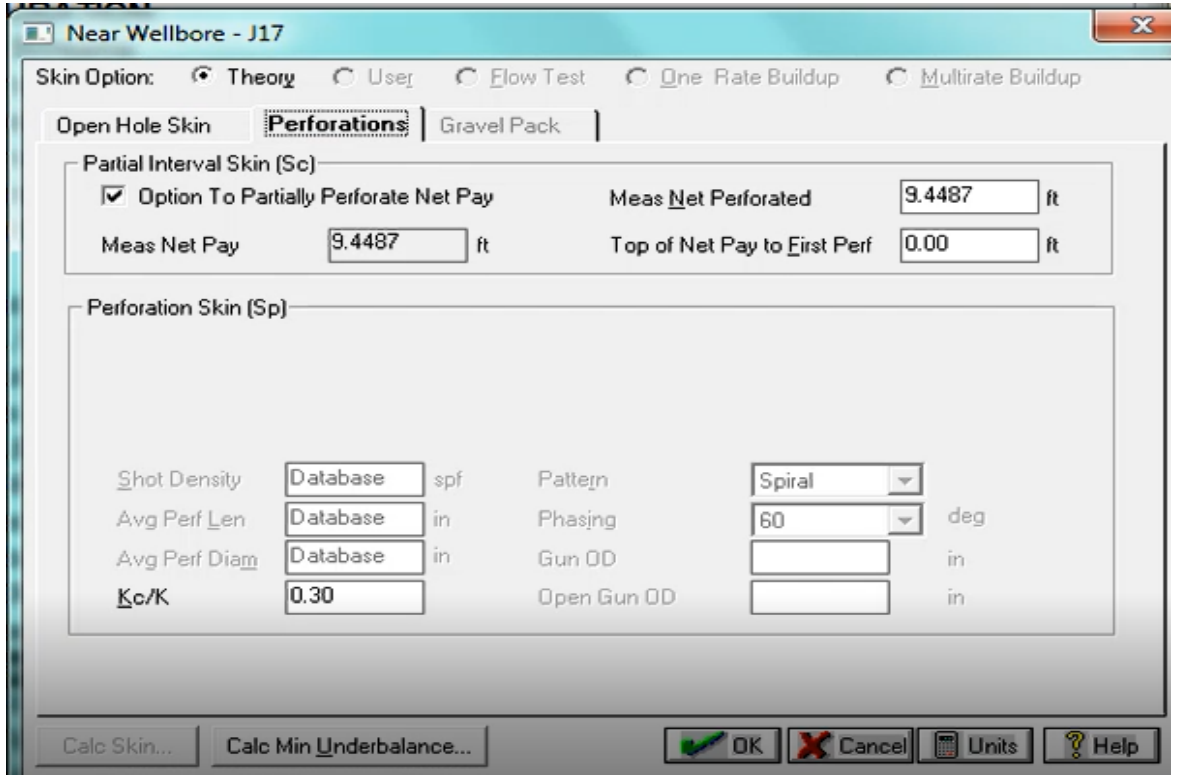
NEAR WELLBORE





Fill in formation damage zone thickness and Kd/K (ratio of permeability in damage zone to virgin zone). ***Note: Use default value of 6" for damage zone thickness and 0.40 for the ratio.***

Tick partial skin (Sc) if you're intended to partially perforated the zone. If no, leave the box unchecked.

Cut the video from 3:15mins to 7:31mins – not using

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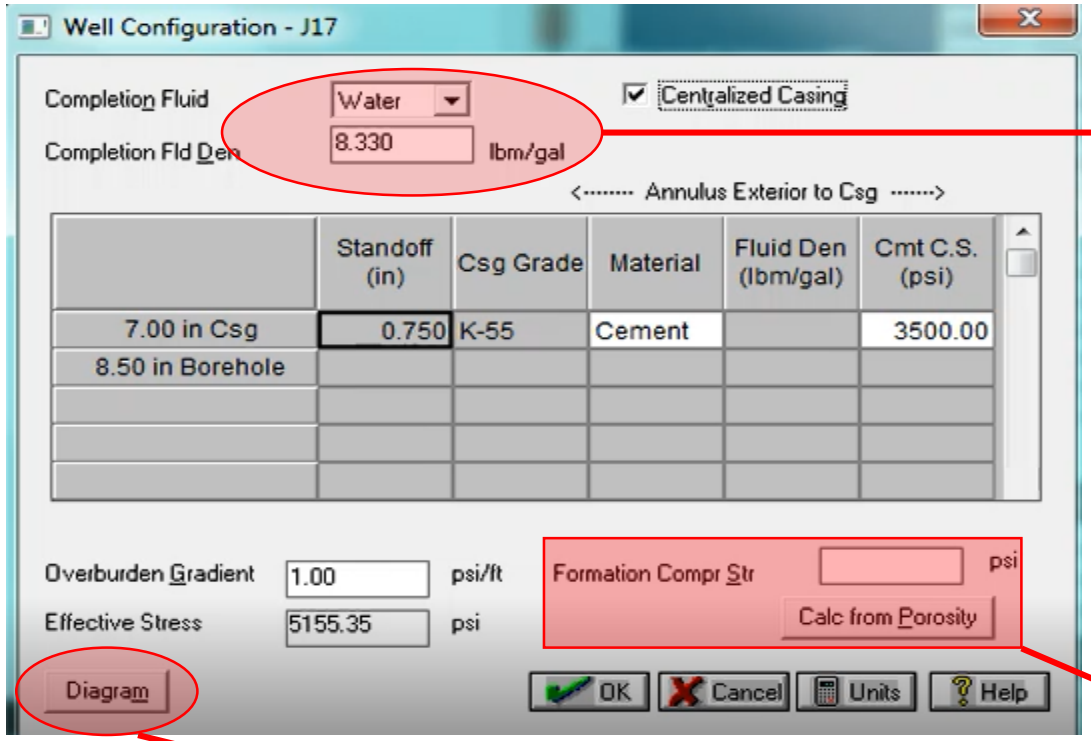
WELL CONFIGURATION



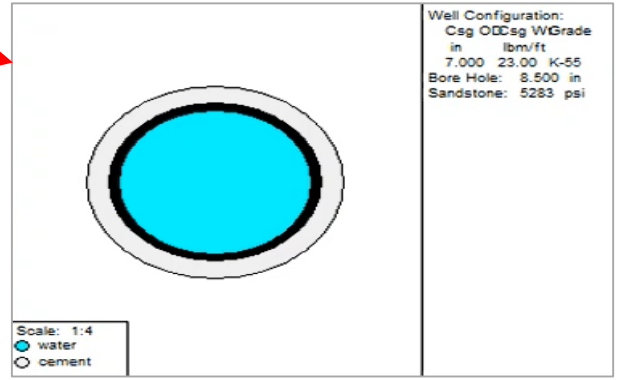
Current wellbore fluid and density (ppg) inside the tubing/casing during the perforation job –Water/diesel/mud/gas.

Input referring to tubular annulus (exterior to casing).
Eg. Behind 7" casing is cement thus cement compressive strength input is required. If you choose water, then the water density is required.

Note: If you are perforating through tubing, where you tick perforated tubing (in Perforating Options @ configuration setup branch), the tubing size will appear here. Therefore, you will need to define type of material for both tubing and casing.

Formation CS: use as per input from client; IF no info, it can be calculated from porosity.

Click on Diagram to check if your wellbore configuration setup is OK (without gun).



Blue: Water (completion fluid inside the wellbore where your gun is)
Black: Casing
Grey: Cement

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WELL CONFIGURATION

CemCRETE Type	Density		Vp (m/s)	acoustic impedance (MRayl)	Compressive Strength (psi)
	(kg/m3)	(ppg)			
LiteCRETE-2	1.20	10.0	2694	3.23	1500
LiteCRETE-3	1.40	11.8	2883	4.04	2100
LiteCRETE-4	1.46	12.2	2870	4.19	2100
LiteCRETE-5	1.54	12.8	2988	4.60	3500
SqueezeCRETE-1	1.68	14.0	2822	4.74	5500
SqueezeCRETE-2	1.68	14.0	2988	5.02	3700
SqueezeCRETE-3	1.68	14.0	2419	4.06	2000
LiteCRETE UL-1	1.03	8.6	2540	2.62	1400
LiteCRETE UL-2	1.03	8.6	2566	2.64	1420
LiteCRETE UL-3	1.04	8.7	2117	2.20	760
LiteCRETE UL-4	1.04	8.7	2490	2.59	1400
LiteCRETE UL-5	1.04	8.7	2674	2.78	1950
LiteCRETE UL-6	1.04	8.7	1954	2.03	320

CemCRETE Type	Density		Vp (m/s)	acoustic impedance (MRayl)	Compressive Strength (psi)
	(kg/m3)	(ppg)			
G + Silica-1	1.90	15.8	2822	5.36	3500
G + Silica-2	2.00	16.7	2988	5.98	4200
G Neat	1.90	15.8	2822	5.36	3000
CemCRETE-1	2.00	16.7	3256	6.51	5550
CemCRETE-2	2.00	16.7	3256	6.51	5000
CemCRETE-3	2.00	16.7	2988	5.98	3600
CemCRETE-4	2.00	16.7	2822	5.64	5200
CemCRETE-5	2.00	16.7	3098	6.20	3300
DensCRETE-1	2.30	19.2	3024	6.95	4500
DensCRETE-2	2.50	20.8	3387	8.47	6000
DensCRETE-3	2.50	20.8	3175	7.94	5000
DuraSTONE	2.08	17.4	3387	7.00	8000
FlexSTONE-1	2.00	16.7	3387	6.77	5000
FlexSTONE-2	2.00	16.7	2761	5.52	2750
FlexSTONE-3	2.00	16.7	2702	5.40	2000
LiteCRETE-1	1.20	10.0	2679	3.22	1400

Typical SLB cement properties – can be use as guideline as well. If there is no info from completion report, use G-cement properties with 15.8 ppg and cement CS 3500 psi.

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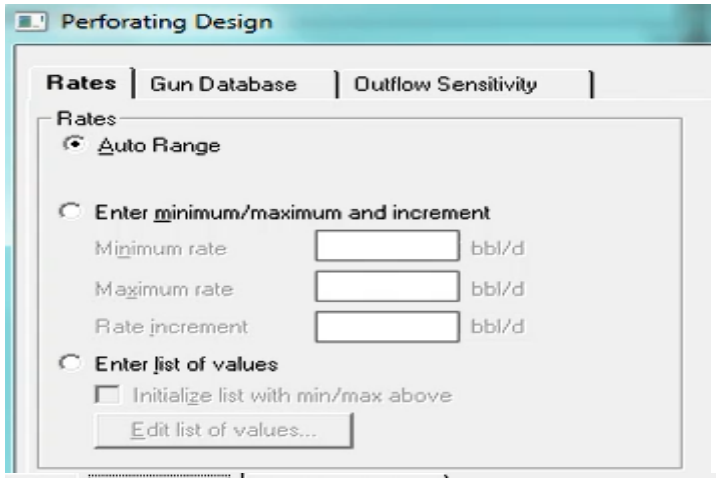
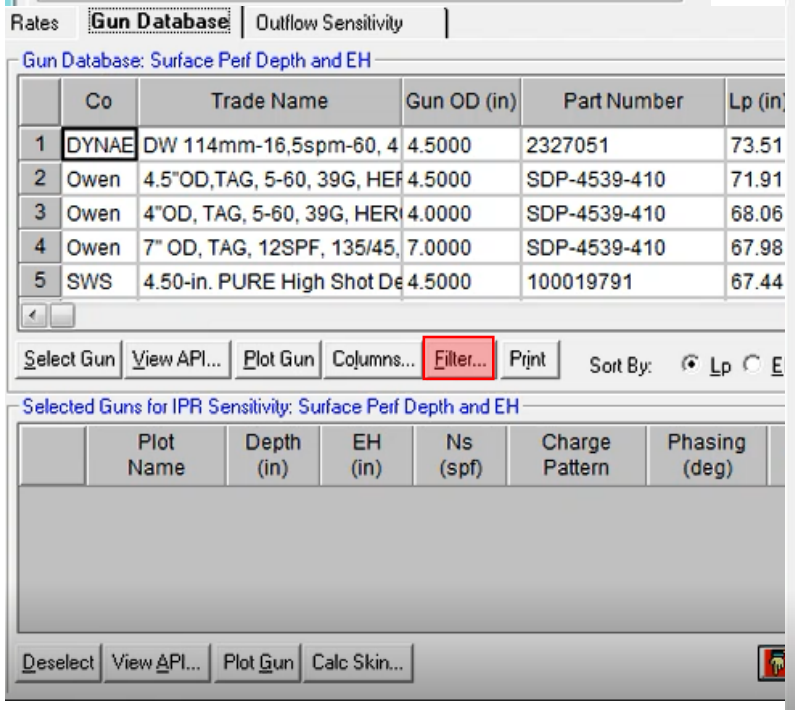
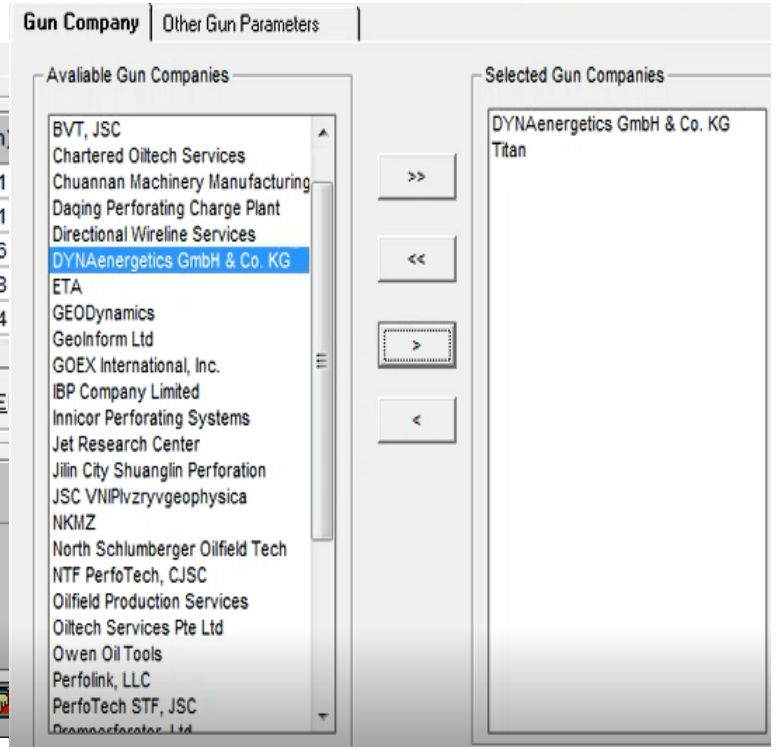
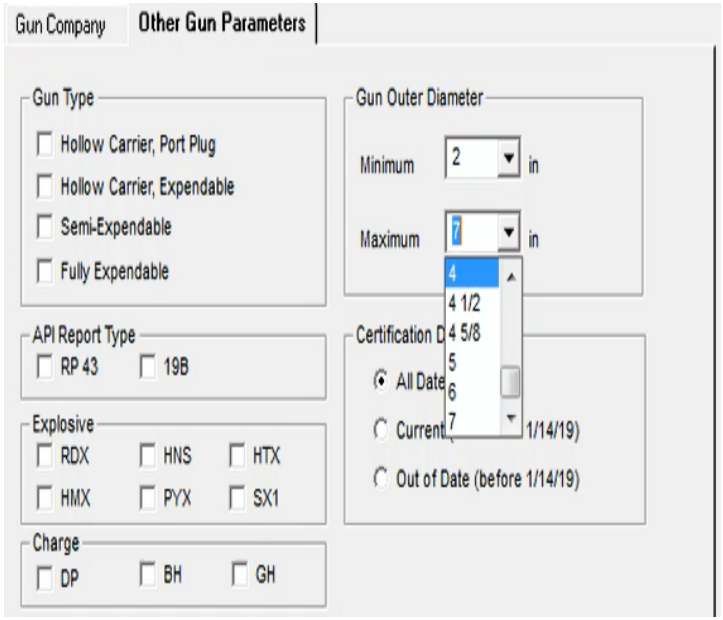
SENSITIVITY DATA









1. On the Rates tab – use **Auto Range**
2. Click Gun Database tab, click filter to choose gun manufacturer.
3. Click other gun parameters tab to filter gun size or shape charges type.

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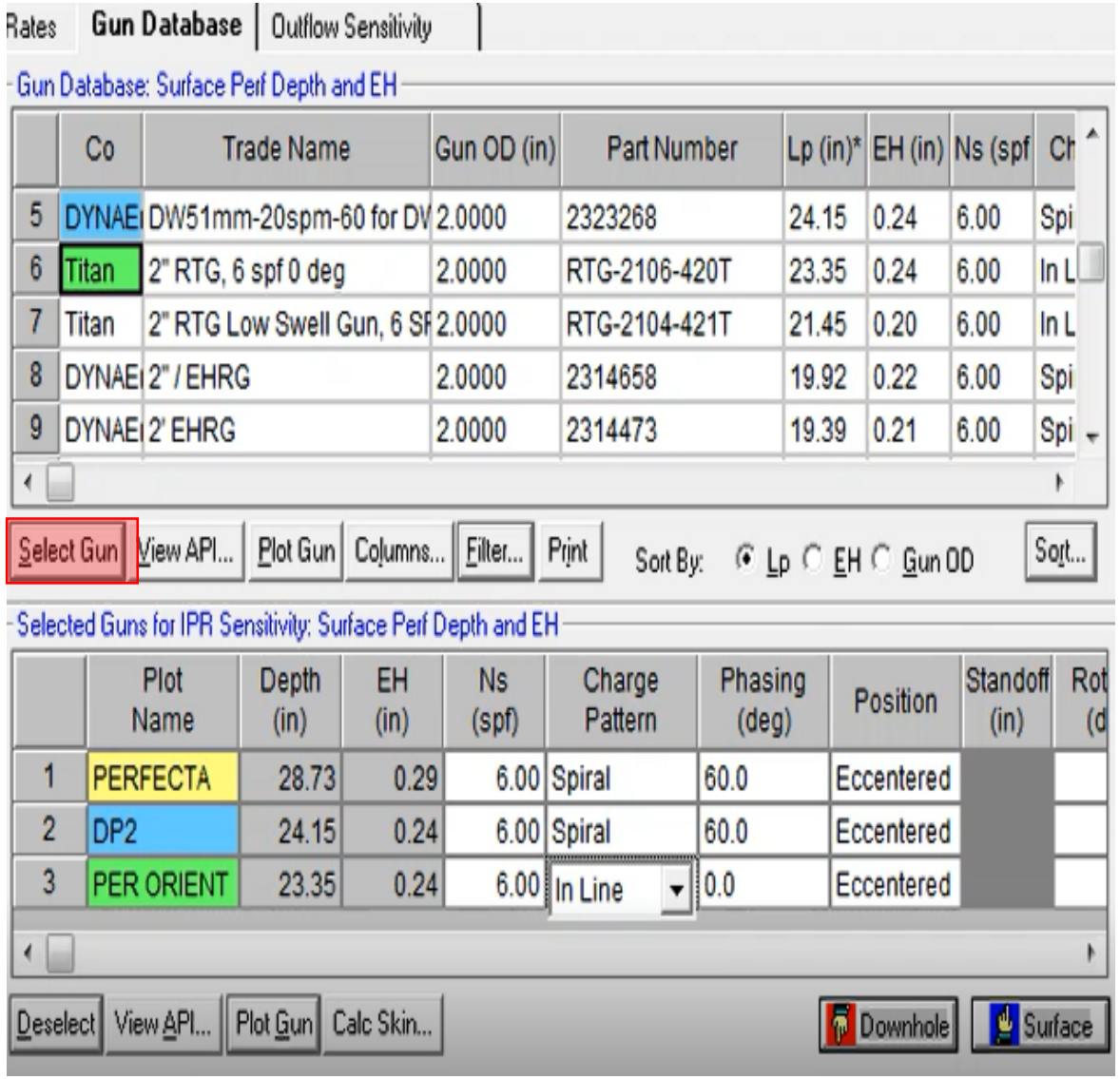
SENSITIVITY DATA



Click select gun for the gun chosen and name the shape charges (SC) accordingly.
For this simulation, the type of SC are as below:

1. 2” PERFECTA, 6 SPF, 60 DEG Phasing
2. 2” DP2, 6 SPF, 60 DEG Phasing
3. 2” PERFECTA, 6 SPF, 0 DEG Phasing (Oriented Perf)

Click **View API** – to view each SC Performance according to API19B

Click **Plot Gun** – to view simulated gun plot summary for each SC Penetration Length and Entrance Hole Diameter.

Click **Calc Skin** – to view skin value.

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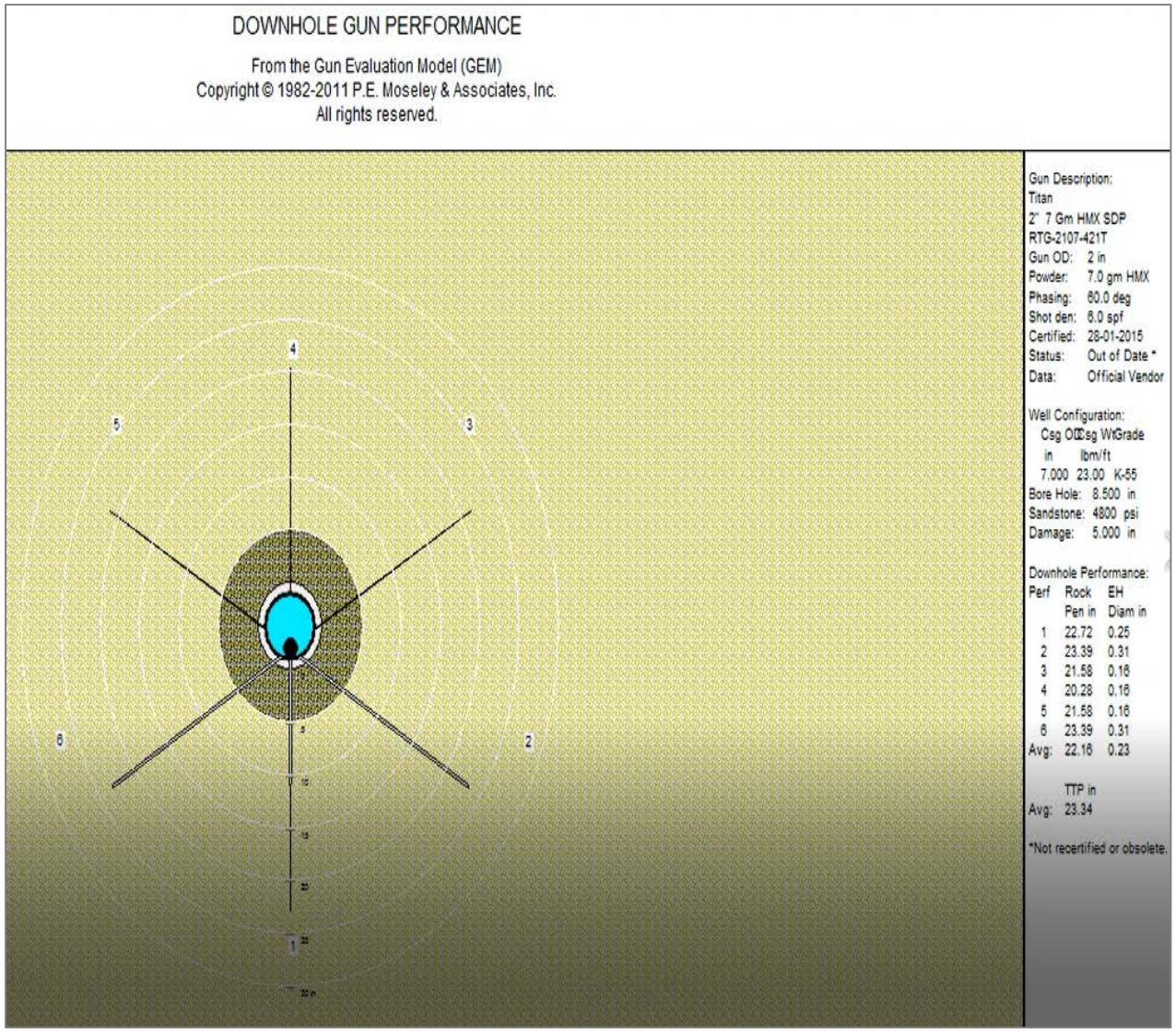
SENSITIVITY DATA



Gun Downhole Performance Plot can be view for 1 gun at a time. You may need to click at each selected gun to produce each report.

To save file: Go to Options and Print Auto Scale > PDF > Name the file *(Gun Performance Plot_PERFECTA_6SPF_60DEG)*

Go to Other Plots > Tabular Results to view detailed reports for the gun performance.

To save file: Go to Printer > PDF > Name the file *(PEM Tabular Report_PERFECTA_6SPF_60DEG)*

Note: Double check all the input in the summary prior to print the report(s).

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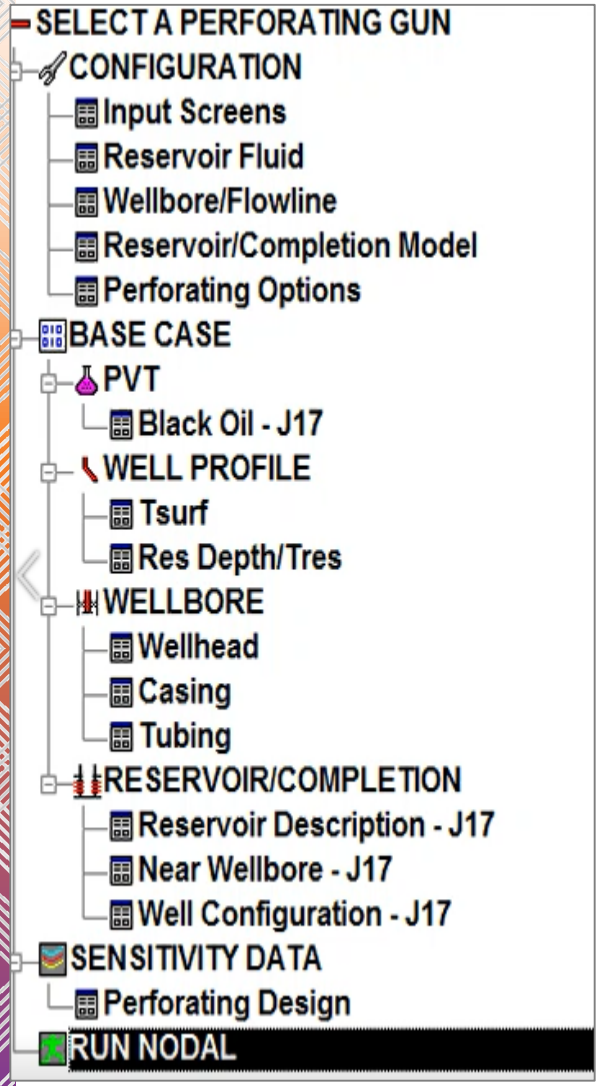
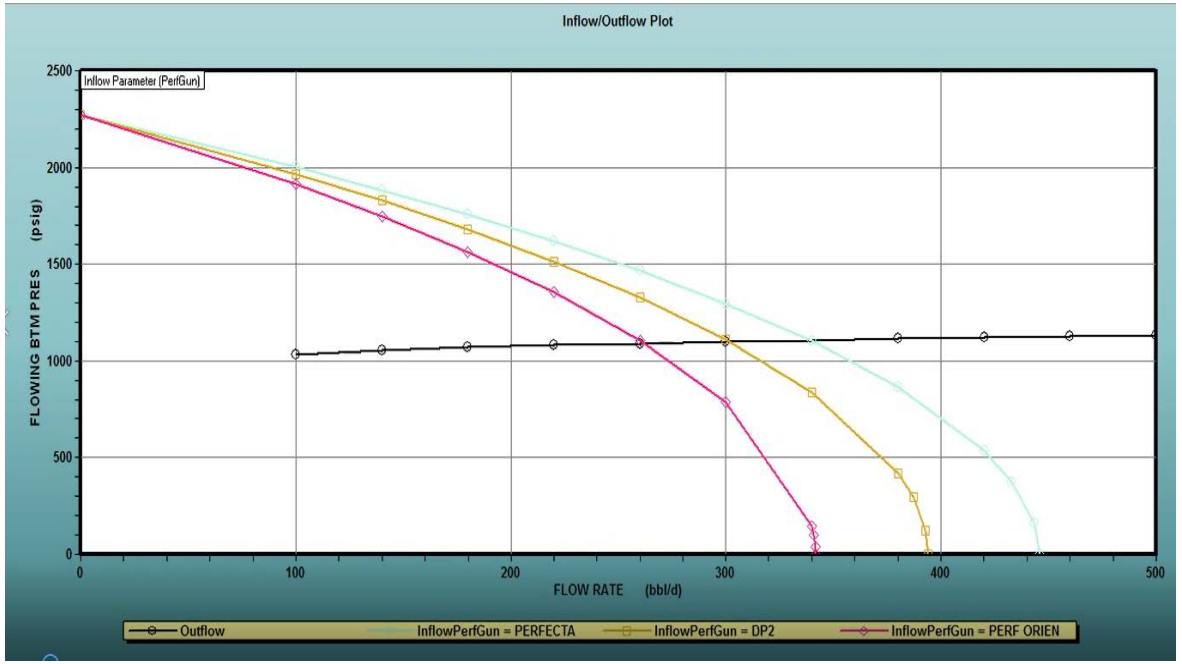
RUN NODAL



1. Click Run Nodal – nodal couldn't be run until all input is fixed.
2. Once OK, the software will plot Inflow/Outflow Curves (FBHP vs Q).



To save file: Go to File > Import > Name the file > change format type to .BMP *(Inflow_Outflow Plot)*

There are 3 input curves for selected SC and the intersection point of Inflow/Outflow curve is the estimated production rates (bbl/d) based on the base case you have input.

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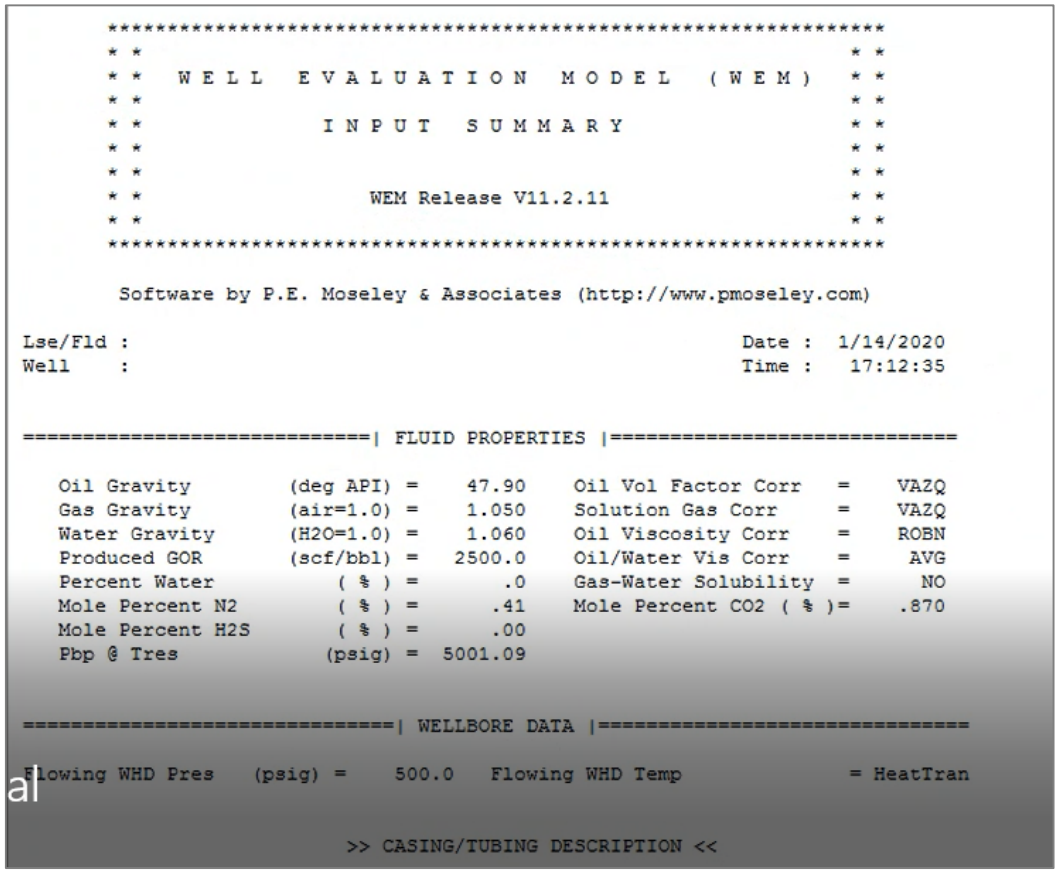
RUN NODAL

To view Nodal Report Summary, go to **View > View Tab Report > Detailed**



```
**************************************************************
* *                                                        * *
* *  W E L L   E V A L U A T I O N   M O D E L   ( W E M )  * *
* *                                                        * *
* *              I N P U T   S U M M A R Y                 * *
* *                                                        * *
* *                                                        * *
* *                   WEM Release V11.2.11                 * *
* *                                                        * *
**************************************************************

       Software by P.E. Moseley & Associates (http://www.pmoseley.com)

Lse/Fld :                                          Date :  1/14/2020
Well    :                                          Time :   17:12:35


============================| FLUID PROPERTIES |============================

   Oil Gravity        (deg API) =    47.90    Oil Vol Factor Corr   =    VAZQ
   Gas Gravity        (air=1.0) =    1.050    Solution Gas Corr     =    VAZQ
   Water Gravity      (H2O=1.0) =    1.060    Oil Viscosity Corr    =    ROBN
   Produced GOR       (scf/bbl) =   2500.0    Oil/Water Vis Corr    =     AVG
   Percent Water          ( % ) =      .0    Gas-Water Solubility  =      NO
   Mole Percent N2        ( % ) =      .41   Mole Percent CO2 ( % )=    .870
   Mole Percent H2S       ( % ) =      .00
   Pbp @ Tres            (psig) =  5001.09


============================| WELLBORE DATA |============================

 Flowing WHD Pres    (psig) =    500.0   Flowing WHD Temp             = HeatTran

                          >> CASING/TUBING DESCRIPTION <<
```

All parameters input were summarized in the report as follow:

1. Fluid Properties
2. Wellbore Data
3. Reservoir Description
4. Interval Profile
5. Near Wellbore Data
6. IPR/Tubing Performance Report for each inflow curve for perf gun.

To save file: Go to Printer > PDF > Name the file *(Inflow_Outflow Input Summary)*

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-END OF SLIDE-

THANK YOU