ECD in Riserless operations Methodology in SCA

There are two methods to calculate ECD in riser less drilling, giving two different results. These methods are client specific so we need to check what the client actually wants. This document describes two methods of calculating ECD when no riser is present. It also descirbes how to set up Maxwell software to calculate each method.

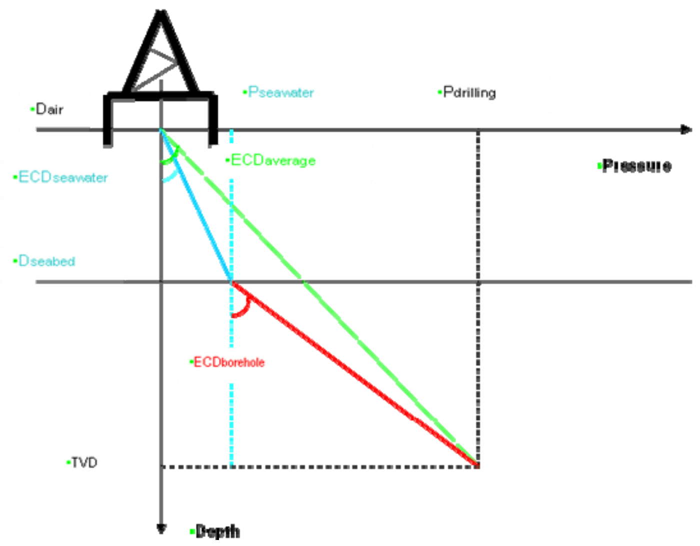


Figure 1. ECD methods in riserless drilling

Method 1: ECD average(See fig 1.)

$$ECD_{average} = \frac{P_{drilling}}{(TVD - D_{air}) * G}$$

Average Seawater pressure(seawater is constant)

$P_{drilling}$ = Annular pressure at sensor

TVD = True vertical depth

D_{air} =Air gap between Rig floor and mean sea level

G =Constant(0.052 change psi to ppg)

This is the preferred method when Client wants ECD in riserless borehole to relate closely to fracture gradient. This method will give lower relative values of ECD which are less sensitive to changes in borehole but it will fit their model.

Method 1 *is the preferred option of Statoil Exploration and Det Norske.*

When any client is undertaking exploration it is important to determine which method is preferred

Generally speaking method 1 will compare more closely to client derived fracture gradient of the well.

Before going ahead with riserless drilling where ECD/ESD measurements are required the client must be consulted as to what they would prefer.

Method 2 *has been the preferred option of Shell in Norway but again this has to be double checked*

Method 2: ECD borehole(See fig 1.)

$$\mathbf{ECD_{borehole}} = \frac{\mathbf{P_{drilling} - P_{seawater}}}{\mathbf{(TVD - D_{seabed} - D_{air})*G}}$$

Seawater pressure derived from depth and constant

$P_{drilling}$ = Annular pressure at sensor

$P_{seawater}$ = approx 0.44 psi per foot(derived from density of seawater and temperature gradient from surface).

TVD = True vertical depth

D_{seabed} = Water depth

D_{air} = Air gap between Rig floor and mean sea level

G = Constant(0.052 change psi to ppg)

This method gives more accurate readings of what is going on at the borehole. As it uses the TVD beginning depth from the seabed it will give higher readings than method one. This method is particularly useful for shallow water flow.

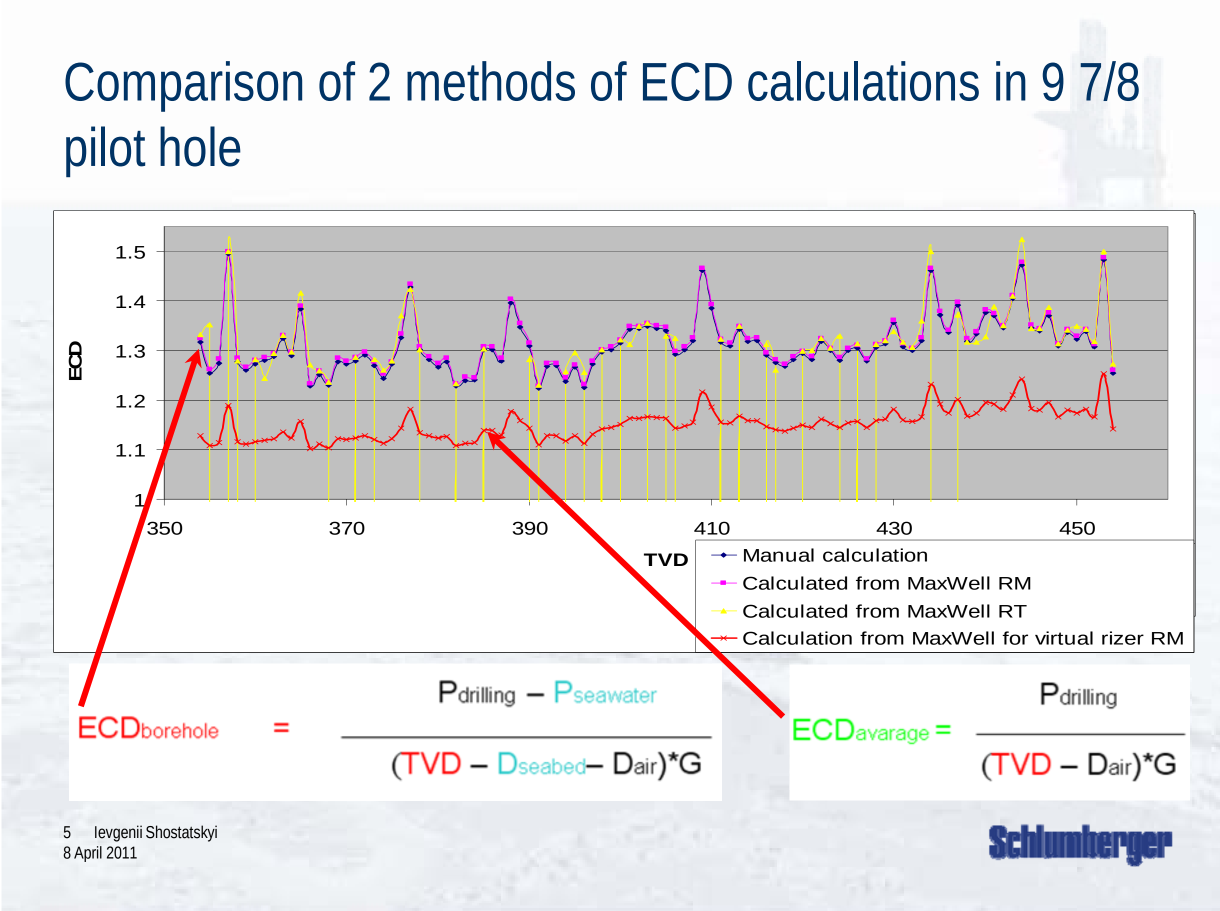


Fig3. Comparison of data from pilot hole ECD calculated with both methods

Comparison of actual data from a rig using both methods shows that ECD calculated with returns to seafloor(top curve fig3) shows that this value is higher and also more sensitive to changes in borehole. The lower curve on figure 3 shows the “average” ECD calculation where seawater pressure is taken to be constant(averaged). These values are lower and less sensitive. These values sit more in line with calculated fracture gradients.

Set up in Maxwell

Method 1: To be used on Statoil Exploration jobs in SCA

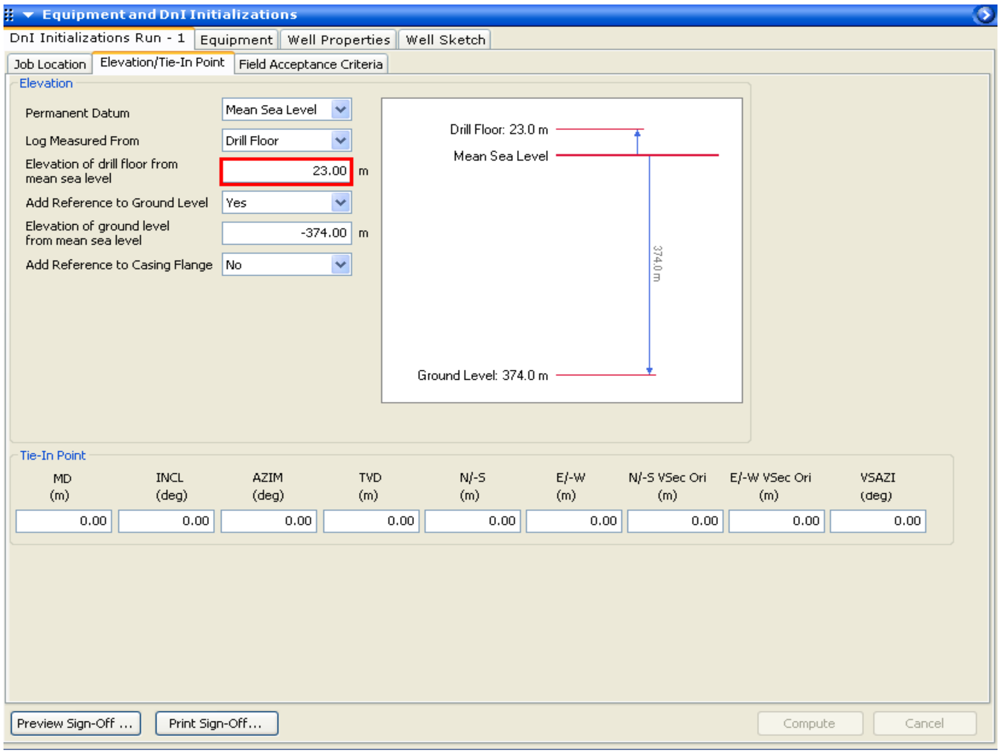


Figure 2. DnI inits page

Maxwell setup is similar to a normal set up with riser in place.

The DnI initialisations must remain the same as normal

Parameters

BHA01

Code	Value	Unit	Source	ZoneSet
BARI	**Yes**		Borehole	M1_TIME
BHK	0.00	%	Borehole	M1_TIME
BHT	**14.00**	degC	Borehole	
BSAL	33588.15	ppm	Borehole	M1_TIME
CDTS	100.00	us/ft	Borehole	F4
DFD	**1.03**	g/cm	Borehole	DFD_TIME
DFT	Water		Borehole	DFT_TIME
DFT_WATER	**Sea Water**		Borehole	
DTF	189.00	us/ft	Borehole	F3
DTM	56.00	us/ft	Borehole	F4
DTMD	**203.00**	us/ft	Borehole	M3_TIME
FD	**1.03**	g/cm	Borehole	F3
FLEV	**23.00**	m	Borehole	
GCSE_RM	BS ...		Borehole	GCSE
GCSE_RT	BS ...		Borehole	GCSE
GGRD	18.23	degC/	Borehole	GGRD
GRSE_RM	REMS ...		Borehole	
GRSE_RT	REMS ...		Borehole	
GTSE_RM	**DHAT** ...		Borehole	
GTSE_RT	**DHAT** ...		Borehole	
HEMA	No		Borehole	M1_TIME
MATR	LIMESTONE		Borehole	F5
MDEN	2.71	g/cm	Borehole	F5
MFST	**23.89**	degC	Borehole	M2_TIME
MRT	14.00	degC	Borehole	
MRT1	**14.00**	degC	Borehole	
MST	23.89	degC	Borehole	M2_TIME
RHO_SEAWATER	**1.03**	g/cm	Borehole	
RMCS		ohm.	Borehole	M2_TIME
RMFB	**0.24**	ohm.	Borehole	
RMFS	**0.19**	ohm.	Borehole	M2_TIME
RMS	**0.19**	ohm.	Borehole	M2_TIME
SF_FLAG	No		Borehole	
FLEV	**23.00**	m	Borehole	
SHT	**7.00**	degC	Borehole	
SPFS	Raymer-Hunt		Borehole	F4
TD	**955.00**	m	Borehole	
WPPV	100.00	%	Borehole	
WPSL	0.00	ppm	Borehole	

Parameters..

Important things here highlighted are

***DFD**: Density of seawater=1.03sg*

***DFT**:water*

***DFT_WATER**:Sea water*

***FLEV**: Elevation of Hydraulic Head. This should input the same as the airgap on rig(ADP).*

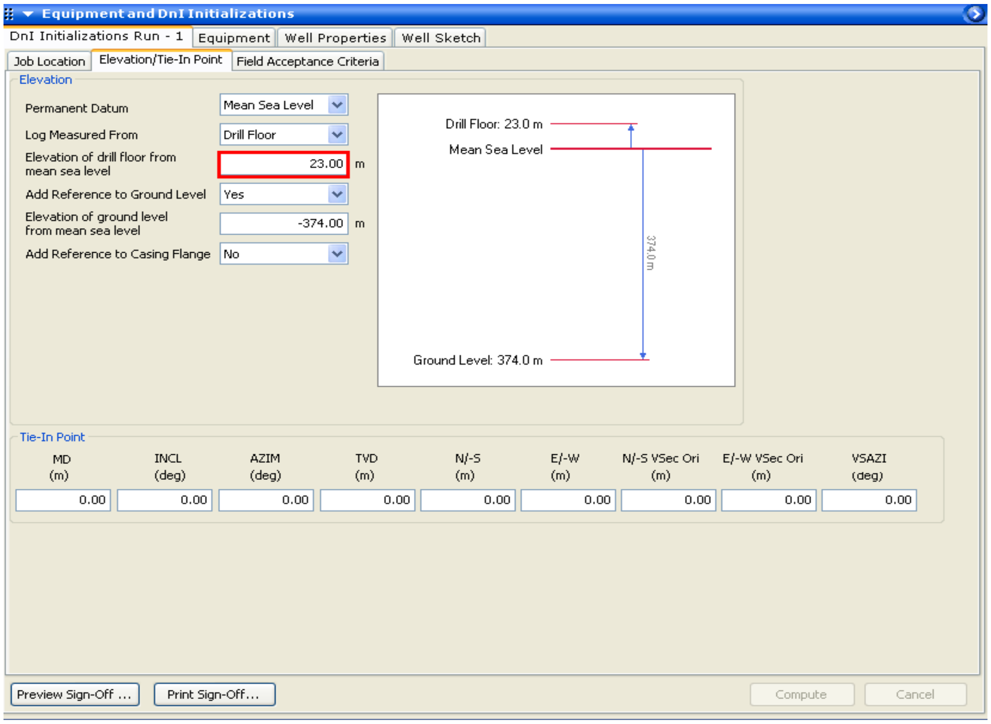
***SF_FLAG**: Returns to seabed flag should be set to **NO**. This is the difference from the way this has been done before but this fits in with this ECD average model.*

FLEV: FLEV** under the **SF_FLAG** should be set the same as **ADP

Essentially Maxwell system thinks that a riser is present and this creates a constant average across seawater which is what we want

Set up in Maxwell

Method 2

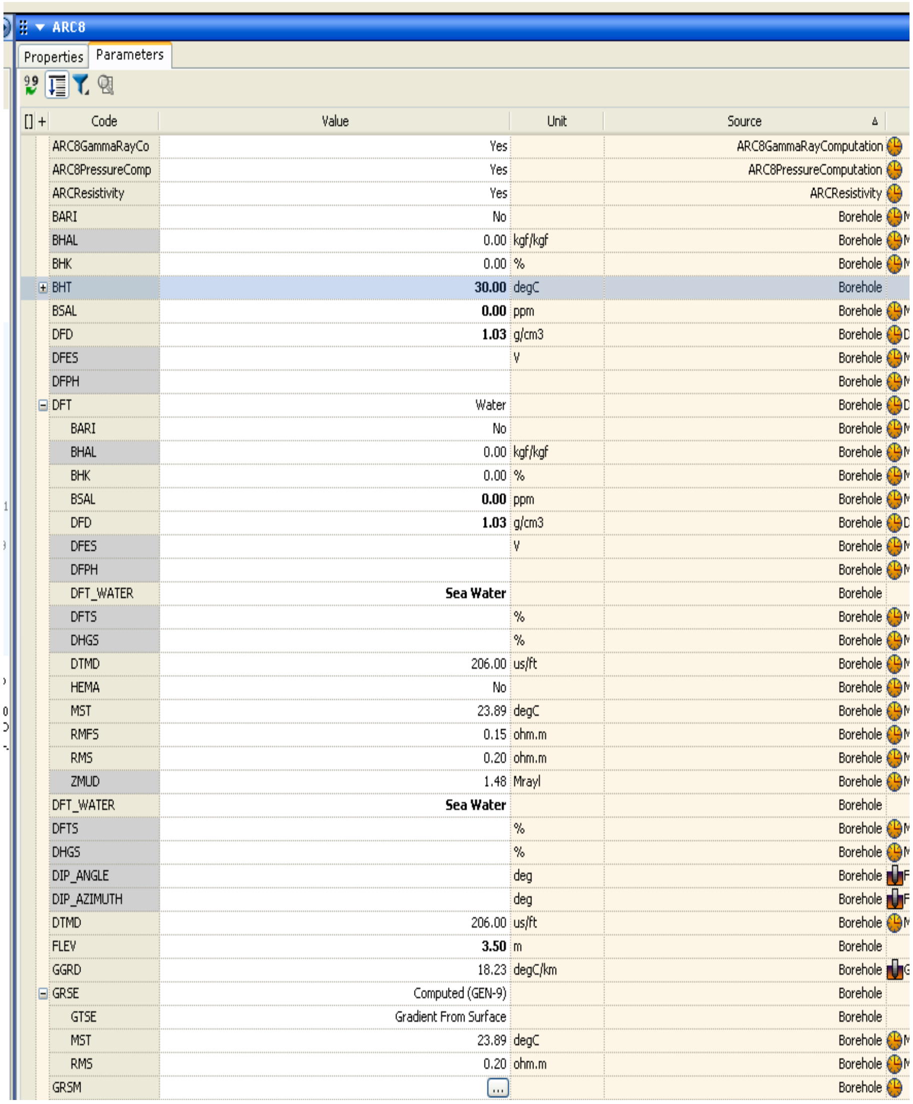


Air GAP(ADP)

This is used in equation in Maxwell to calculate the overburden of seawater

Elevation of ground level(water depth)

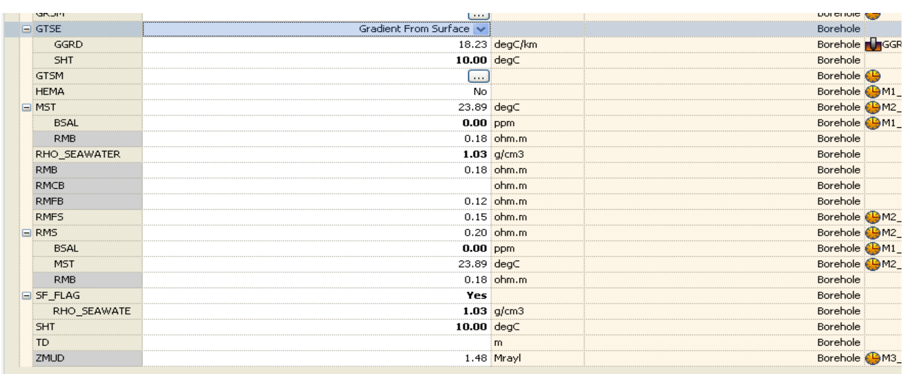
This is used in equation to calculate the pressure of sea water at sea bed



ARC8

Properties | Parameters

Code	Value	Unit	Source
ARC8GammaRayCo	Yes		ARC8GammaRayComputation
ARC8PressureComp	Yes		ARC8PressureComputation
ARCResistivity	Yes		ARCResistivity
BARI	No		Borehole
BHAL	0.00	kgf/kgf	Borehole
BHK	0.00	%	Borehole
BHT	**30.00**	degC	Borehole
BSAL	**0.00**	ppm	Borehole
DFD	**1.03**	g/cm3	Borehole
DFES		V	Borehole
DFPH			Borehole
DFT	Water		Borehole
BARI	No		Borehole
BHAL	0.00	kgf/kgf	Borehole
BHK	0.00	%	Borehole
BSAL	**0.00**	ppm	Borehole
DFD	**1.03**	g/cm3	Borehole
DFES		V	Borehole
DFPH			Borehole
DFT_WATER	**Sea Water**		Borehole
DFTS		%	Borehole
DHGS		%	Borehole
DTMD	206.00	us/ft	Borehole
HEMA	No		Borehole
MST	23.89	degC	Borehole
RMFS	0.15	ohm.m	Borehole
RMS	0.20	ohm.m	Borehole
ZMUD	1.48	Mrayl	Borehole
DFT_WATER	**Sea Water**		Borehole
DFTS		%	Borehole
DHGS		%	Borehole
DIP_ANGLE		deg	Borehole
DIP_AZIMUTH		deg	Borehole
DTMD	206.00	us/ft	Borehole
FLEV	**3.50**	m	Borehole
GGRD	18.23	degC/km	Borehole
GRSE	Computed (GEN-9)		Borehole
GTSE	Gradient From Surface		Borehole
MST	23.89	degC	Borehole
RMS	0.20	ohm.m	Borehole
GRSM	...		Borehole



Code	Value	Unit	Source
GTSE	Gradient From Surface		Borehole
GGRD	18.23	degC/km	Borehole GGR
SHT	**10.00**	degC	Borehole
GTSM	...		Borehole
HEMA	No		Borehole M1_
MST	23.89	degC	Borehole M2_
BSAL	**0.00**	ppm	Borehole M1_
RMB	0.18	ohm.m	Borehole
RHO_SEAWATER	**1.03**	g/cm3	Borehole
RMB	0.18	ohm.m	Borehole
RMCB		ohm.m	Borehole
RMFB	0.12	ohm.m	Borehole
RMFS	0.15	ohm.m	Borehole M2_
RMS	0.20	ohm.m	Borehole M2_
BSAL	**0.00**	ppm	Borehole M1_
MST	23.89	degC	Borehole M2_
RMB	0.18	ohm.m	Borehole
SF_FLAG	**Yes**		Borehole
RHO_SEAWATE	**1.03**	g/cm3	Borehole
SHT	**10.00**	degC	Borehole
TD		m	Borehole
ZMUD	1.48	Mrayl	Borehole M3_

Parameters..

BHT*(bottom hole temperature)*

Make sure this is reasonably accurate – not as important in real time as temperature gradient will be used

DFT*(Mud type)*

Should be water

DFT_WATER*(WBM type)*

Should be seawater

GGRD*(Geothermal Gradient)*

This should be accurate and can be obtained from Drilling program (note units here are degC per 1000m)

GTSE*(Generalized temperature selection)*

This is your temperature reference and should be set to gradient from surface

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Note: FLEV is not taken into consideration in this operation – FLEV is distance between drillfloor and return flowline, when conductor/riser is present

SHT*(surface hole temperature)*

This is the reference start point for temperature gradient. Make sure this is correct – temperature at seabed

RHO_SEAWATER*(density of seawater)*

This should come from mud report. If no mud report is available then you can use figure of 1.03g/cm3

SF_FLAG*(mud return to seafloor)*

This should be set to ***Yes***