

Verification of Oliasoft WellDesign

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1. Executive Summary

WE, Well Expertise AS, has carried out a methodology to verify all modules in the software from Oliasoft, namely WellDesign, which is a software tool used to optimise and digitalize well planning and enabling a more efficient structure and flow through the whole well planning process.

In the following, a practical Verification & Validation (V&V) is proposed for the calculation engine behind the Oliasoft WellDesign well engineering software. This project has had a span over several weeks, with help from drilling engineers at WE and professors at the University of Stavanger.

Since the Landmark software Compass, StressCheck, WellCat and Wellplan is a well-known product within the drilling environment world-wide and recognized as a compliant industry and regulatory tool for designing safe and efficient wells, those software has been used as a comparison in order to have a safe and professional transition towards the digital drilling software Oliasoft WellDesign.

The results from this report is summarised below.

ID	Clarification Request	Summary of Methodology and Method	Validation Conclusion
1	Trajectory Design	One trajectory is built using the Optimum Align-option in both software.	Approved and fully functional
2	Casing Loads	Replication of initial conditions, well design and casing loads for both software.	Approved and fully functional
3	Temperature Analysis	Replication of drilling and production scenarios for both software.	Tested but with some degree of deviation

In the following modules for the Oliasoft WellDesign software it was similar and accurate results, and it is therefore concluded that both software delivers a very precise result that is satisfactory with the industry standard and theory.

2. Verification

The exact same pore pressures (PP) and fracture gradients (FG) have been used in addition to duplication of all inputs in order to compare the results in a best possible way.

2.1. Project Settings

Well Configuration:	Offshore.
Drilling Unit:	Semi-submersible.
Air Gap (RKB/RT):	35 m.
Water Depth:	350 m.
Wellhead Depth:	385 m.
Drill floor Temperature:	3.43°C.
Seabed Temperature:	4.44°C.
Geothermal Gradient:	3.75 °C/100 m.

The PPFG-values and graph used for both software can be seen in appendix A.

2.2. Trajectory Design

The following coordinate system and main drilling site is defined as:

- Geodetic Datum: World Geodetic System 1984 (WGS84)
- Coordinate System: Universal Transverse Mercator (UTM)
- North Reference: Grid North (GN)
- Location UTM:
 - o Zone: 31
 - o Easting: 460,000 m
 - o Northing: 6,800,000 m
- Geomagnetic Model: IGRF, 16/07/2020

One well trajectory is duplicated using the same procedure in both software:

1. A Line TVD from seabed to 800 m.

2. Build to Target is used with Optimum Align-option and DLS1 DLS2. The parameters DLS1 (3°/30 m), DLS2 (3°/30 m) Inclination (90°), Azimuth (120°) and no Align on Target. Target is set as custom to reach 3500mTVD at 1200 m N/S and 450 m E/W.
3. Last, a Dogleg Toolface with Inclination (90°), Azimuth (120°) and Measured Depth of 7500 m to obtain a long horizontal section.

Both Landmark Compass and Oliasoft WellDesign produced the exact same well trajectory. The produced trajectory for both Compass and WellDesign can be found in appendix B.

2.3. Casing Loads

A well schematic is defined in both software with the same casing size, depths and grades, and is summarized below.

- Riser:
 - OD: 21"
 - ID: 19"
 - Length: 385 m
- 36" Hole and 30" Conductor casing:
 - Hole size: 36"
 - Top of casing: 385 m MD/TVD
 - Bottom of casing: 490 m MD/TVD
 - Top of cement: 385 m MD/TVD
 - Mud Weight at Shoe: 1.031 sg
 - Mud Type: SW
 - Cement Volume (only Oliasoft WellDesign calculates this): 21.1 m³
 - Float Depth: 490 m MD/TVD
 - Hole Depth: 490 m MD/TVD
 - Displacement Fluid: 1.20 sg
 - Lead Slurry Density: 1.87 sg
 - Tail Slurry Length: 0 m
 - Tail Slurry Density: N/A
 - Cement Type: Default Cement
 - Temperature Profile: Geothermal
 - String Details:
 - OD: 30"
 - Weight: 309.7 ppf
 - Grade: X-56
 - Connection: SL-60
 - Design Factors: NORSOK D-010

- 26" Hole and 20" Surface casing:
 - Hole size: 26"
 - Top of casing: 385 m MD/TVD
 - Bottom of casing: 765 m MD/TVD
 - Top of cement: 385 m MD/TVD
 - Mud Weight at Shoe: 1.20 sg
 - Mud Type: Default WBM
 - Cement Volume: 60.4 m³
 - Float Depth: 765 m MD/TVD
 - Hole Depth: 765 m MD/TVD
 - Displacement Fluid: 1.10 sg
 - Lead Slurry Density: 1.87 sg
 - Tail Slurry Length: 0 m
 - Tail Slurry Density: N/A
 - Cement Type: Default Cement
 - Temperature Profile: Geothermal
 - String Details:
 - OD: 20"
 - Weight: 133 ppf
 - Grade: X-56
 - Connection: Tenaris ER casing
 - Design Factors: NORSOK D-010
- 17 1/2" Hole and 13 3/8" Intermediate casing:
 - Hole size: 17 1/2"
 - Top of casing: 385 m MD/TVD
 - Bottom of casing: 3760/3322 m MD/TVD
 - Top of cement: 2500/2264 m MD/TVD
 - Mud Weight at Shoe: 1.20 sg
 - Mud Type: Default WBM
 - Cement Volume: 81.3 m³
 - Float Depth: 3760/3322 m MD/TVD
 - Hole Depth: 3760/3322 m MD/TVD
 - Displacement Fluid: 1.35 sg
 - Lead Slurry Density: 1.87 sg
 - Tail Slurry Length: 300 m
 - Tail Slurry Density: 1.90 sg
 - Cement Type: Default Cement
 - Temperature Profile: Geothermal
 - String Details:
 - OD: 13 3/8"
 - Weight: 72 ppf
 - Grade: P-110
 - Connection: VAM TOP
 - Design Factors: NORSOK D-010

- 12 ¼" Hole and 9 5/8" Production casing:
 - Hole size: 12 ¼"
 - Top of casing: 385 m MD/TVD
 - Bottom of casing: 5500/3500 m MD/TVD
 - Top of cement: 3500/3119 m MD/TVD
 - Mud Weight at Shoe: 1.40 sg
 - Mud Type: Default WBM
 - Cement Volume: 58.5 m³
 - Float Depth: 5500/3500 m MD/TVD
 - Hole Depth: 5500/3500 m MD/TVD
 - Displacement Fluid: 1.40 sg
 - Lead Slurry Density: 1.87 sg
 - Tail Slurry Length: 200 m
 - Tail Slurry Density: 1.90 sg
 - Cement Type: Default Cement
 - Temperature Profile: Geothermal
 - String Details:
 - OD: 9 5/8"
 - Weight: 53.5 ppf
 - Grade: 385-3500 m MD Q-125, 3500-5500 m MD L-80
 - Connection: VAM TOP
 - Design Factors: NORSOK D-010
- 8 ½" Hole and 7" Production liner:
 - Hole size: 8 ½"
 - Top of liner: 385 m MD/TVD
 - Bottom of liner: 7500/3500 m MD/TVD
 - Top of cement: 5350/3500 m MD/TVD
 - Mud Weight at Shoe: 1.20 sg
 - Mud Type: Default WBM
 - Cement Volume: 25.4 m³
 - Float Depth: 7500/3500 m MD/TVD
 - Hole Depth: 7500/3500 m MD/TVD
 - Displacement Fluid: 1.20 sg
 - Lead Slurry Density: 1.87 sg
 - Tail Slurry Length: 200 m
 - Tail Slurry Density: 1.90 sg
 - Cement Type: Default Cement
 - Temperature Profile: Geothermal
 - String Details:
 - OD: 7"
 - Weight: 32 ppf
 - Grade: P-110
 - Connection: VAM TOP
 - Design Factors: NORSOK D-010

- 5" Production tubing:
 - Top of tubing: 0 meters
 - Bottom of tubing: 7500/3500 m MD/TVD
 - Mud Type: Default WBM
 - Completion Fluid: 1.10 sg
 - Packer Depth: 5500/3500 m MD/TVD
 - Plug Depth: 7500/3500 m MD/TVD
 - String Details:
 - OD: 5"
 - Weight: 23.2 ppf
 - Grade: Q-125
 - Connection: VAM TOP
 - Design Factors: NORSOK D-010

A sub-chapter for each specific casing/liner/tubing section will be presented below. There will be a description of each load and its inputs and results in both StressCheck and WellDesign.

2.3.1. 30" Conductor Casing Loads

Burst Load (30" Conductor Casing):

The Drill Ahead Burst inputs for the 30" casing is:

Drill Ahead (Burst Load):	
- Internal Profile:	
o MW next section:	1.10 sg
o ECD:	0.036 sg
- External Profile:	
o Fluid Gradients w/ PP (Burst)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.00 sg
- Temperature Profile:	
o Geothermal Temperature	

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

There is seen zero error in the outputs at top of the string, but a small error in the output at TD for the different software.

StressCheck - Burst differential pressure		Oliasoft - Burst differential pressure			
Depth (mMD)	Drill Ahead (bar)	Depth (mMD)	Depth (mTVD)	Drill Ahead (bar)	error
385	7.55	385	385	7.55	0.0%
490	7.31	490	490	7.73	5.8%

Collapse Loads (30" Conductor Casing):

The Drill Ahead Collapse inputs for the 30" casing is:

Drill Ahead (Collapse Load):	
- Internal Profile:	
o MW next section:	1.10 sg
o ECD:	0.036 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.20 sg
- Temperature Profile:	
o Geothermal Temperature	

The Casing Evacuation Collapse inputs for the 30" casing is:

Casing Evacuation (Collapse Load):	
- Internal Profile:	
o Percent evacuation:	100%
o Mud level:	490 m
o Mud weight:	1.10 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.00 sg
- Temperature Profile:	
o Geothermal Temperature	

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

The results given from both software yields correct answers, except for the Drill Ahead case with a small error.

StressCheck - Collapse differential pressure			Oliasoft - Collapse differential pressure					
Depth (mMD)	Full/Partial Evacuation	Drill Ahead (bar)	Depth (mMD)	Depth (mTVD)	Casing Evacuation (bar)	error	Drill Ahead (bar)	error
385	45.3	2.42	385	385	-45.3	0.1%	-2.42	0.1%
385	35.3	-7.55	385	385	-35.3	0.2%	7.55	0.0%
490	47.2	-7.31	490	490	-46.9	0.8%	7.73	5.8%

Installation Loads (30" Conductor Casing):

The Running in Hole Installation inputs for the 30" casing is:

Running in Hole (Installation Load):	
- Internal Profile:	
o Running speed:	1.00 m/s
- Temperature Profile:	
o Bottom hole Circulating Temperature	

The Overpull Installation inputs for the 30" casing is:

Overpull (Installation Load):	
- Internal Profile:	
o Overpull force:	50 MT
o Mud level:	0.00 sg
o Mud weight:	1.10 sg
- Temperature Profile:	
o Geothermal Temperature	

Inputs from the two above installation tables are used to make an axial profile through the depth of the casing and is summarised in the table below.

There is seen a larger error in the software outputs regarding the installation loads. This is reported to both WE and Oliasoft personnel and will further be compiled.

StressCheck - Axial/Installation loads					
Depth (mMD)	Running in Hole (tonne)			Overpull Force (tonne)	
	Apparent (w/Bending)	Actual (w/o Bending)		Apparent (w/Bending)	Actual (w/o Bending)
385	408		408	92	92
490	366		366	50	50

Oliasoft - Axial/Installation loads									
Depth (mMD)	Depth (mTVD)	Running in Hole (tonne)				Overpull Force (tonne)			
		Apparent (w/Bending)	error	Actual (w/o Bending)	error	Apparent (w/Bending)	error	Actual (w/o Bending)	error
385	385	404	1.0%	404	1.0%	92	0.0%	92	0.0%
490	490	362	1.1%	362	1.1%	50	0.0%	50	0.0%

2.3.2. 20" Surface Casing Loads

Burst Load (20" Conductor casing):

The Lost Returns w/ Water Burst inputs for the 20" casing is:

Lost Returns w/ Water (Burst Load):	
- Internal Profile:	
○ Mud/Water interface:	756 m
○ Frac. Margin of err.:	0.00
○ MW in hole:	1.35 sg
- External Profile:	
○ Fluid Gradients w/ PP (Burst)	
○ FG above TOC:	1.10 sg
○ FG below TOC:	1.00 sg
- Temperature Profile:	
○ Geothermal Temperature	

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, the burst loads in both software coincides well.

StressCheck - Burst differential pressure		Oliasoft - Burst differential pressure			
Depth (mMD)	Lost Returns (bar)	Depth (mMD)	Depth (mTVD)	Lost Returns w/Water (bar)	error
385	47.4	385	385	47.4	0.0%
490	51.9	490	490	52.3	0.8%
600	50.2	600	600	50.2	0.0%
685	52.7	685	685	52.6	0.0%
700	48.7	700	700	48.7	0.0%
765	48.5	765	765	48.5	0.0%

Collapse Loads (20" Conductor Casing):

The Cementing Collapse inputs for the 20" casing is:

Cementing (Collapse Load):	
- Internal Profile:	
o Mud weight:	1.20 sg
- External Profile:	
o Mud and Cement Slurry	
- Temperature Profile:	
o Geothermal Temperature	

The Drill Ahead Collapse inputs for the 20" casing is:

Drill Ahead (Collapse Load):	
- Internal Profile:	
o MW next section:	1.35 sg
o ECD:	0.036 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.20 sg
- Temperature Profile:	
o Geothermal Temperature	

The Casing Evacuation inputs for the 20" casing is:

Casing Evacuation (Collapse Load):	
- Internal Profile:	
o Percent evacuation:	-
o Mud level:	765 m
o Mud weight:	1.20 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.20 sg
- Temperature Profile:	
o Geothermal Temperature	

The inputs above yield an internal and external pressure profile, resulting in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, the collapse loads in both software coincides well.

StressCheck - Collapse differential pressure							
Depth (mMD)	Full/Partial Evacuation (bar)		Cementing (bar)		Drill Ahead (bar)		
385	45.3		3.8		-7.0		
490	57.6		11.7		-8.9		
490	47.2		11.7		-19.3		
600	59.7		20.0		-21.8		
685	65.5		26.4		-27.5		
700	71.0		27.6		-24.1		
765	77.5		32.5		-26.4		

Oliasoft - Collapse differential pressure							
Depth (mMD)	Depth (mTVD)	Casing Evacuation (bar)	error	Cementing (bar)	error	Drill Ahead (bar)	error
385	385	-45.3	0.1%	-3.8	0.0%	7.0	0.0%
490	490	-57.7	0.1%	-11.7	0.0%	8.9	0.0%
490	490	-46.9	0.8%	-11.7	0.0%	19.7	2.2%
600	600	-59.8	0.1%	-20.0	0.0%	21.8	0.0%
685	685	-65.6	0.1%	-26.4	0.0%	27.5	0.0%
700	700	-71.0	0.1%	-27.6	0.0%	24.1	0.0%
765	765	-77.6	0.1%	-32.5	0.0%	26.4	0.0%

Installation Loads (20" Conductor Casing):

The Overpull Installation inputs for the 20" casing is:

Overpull (Installation Load):	
- Internal Profile:	
o Overpull force:	24 MT
- Temperature Profile:	
o Geothermal Temperature	

The Running in Hole Installation inputs for the 20" casing is:

Running in Hole (Installation Load):	
- Internal Profile:	
o Running speed:	1.00 m/s
- Temperature Profile:	
o Bottomhole Circulating Temperature	

Inputs from the two above installation tables are used to make an axial profile through the depth of the casing and is summarised in the tables below.

There is seen a larger error in the software outputs regarding the installation loads. This is reported to both WE and Oliasoft personnel and will further be compiled.

StressCheck - Axial/Installation loads				
Depth (mMD)	Running in Hole (tonne)		Overpull Force (tonne)	
	Apparent (w/Bending)	Actual (w/o Bending)	Apparent (w/Bending)	Actual (w/o Bending)
385	219	219	88	88
490	201	201	70	70
600	183	183	52	52
685	169	169	37	37
700	166	166	35	35
765	155	155	24	24

Oliasoft - Axial/Installation loads									
Depth (mMD)	Depth (mTVD)	Running in Hole (tonne)				Overpull Force (tonne)			
		Apparent (w/Bending)	error	Actual (w/o Bending)	error	Apparent (w/Bending)	error	Actual (w/o Bending)	error
385	385	219	0.1%	219	0.1%	89	1.0%	89	1.0%
490	490	202	0.1%	202	0.1%	71	1.2%	71	1.2%
600	600	183	0.1%	183	0.1%	52	0.0%	52	0.0%
685	685	169	0.1%	169	0.1%	37	0.0%	37	0.0%
700	700	166	0.1%	166	0.1%	35	0.0%	35	0.0%
765	765	155	0.1%	155	0.1%	24	0.0%	24	0.0%

2.3.3. 13 3/8" Intermediate Casing Loads

Burst Loads (13 3/8" Intermediate Casing):

The Displacement to Gas Burst inputs for the 13 3/8" casing is:

Displacement to Gas (Burst Load):	
- Internal Profile:	
○ Influx depth:	5500 m
○ Mud/gas interface:	0 m
○ Mud weight:	1.40 sg
○ Gas gradient:	0.230666
○ Limit frac @ shoe:	No
○ Frac. Margin of err.:	0.00 sg
- External Profile:	
○ Fluid Gradients w/ PP (Burst)	
○ FG above TOC:	1.35 sg
○ FG below TOC:	1.00 sg
- Temperature Profile:	
○ Geothermal Temperature	

The Drill Ahead Burst load inputs for the 13 3/8" casing is:

Drill Ahead (Burst Load):	
- Internal Profile:	
○ MW next section:	1.40 sg
○ ECD:	0.036 sg
- External Profile:	
○ Fluid Gradients w/ PP (Burst)	
○ FG above TOC:	1.35 sg
○ FG below TOC:	1.00 sg
- Temperature Profile:	
○ Geothermal Temperature	

The Frac @ Shoe /GG Above Burst inputs for the 13 3/8" casing is:

Frac @ Shoe /GG Above (Burst Load):	
- Internal Profile:	
○ Gas Gradient Above:	0.230666 sg
○ Frac. Margin of err.:	0.00 sg

- External Profile:
o Fluid Gradients w/ PP (Burst)
o FG above TOC: 1.35 sg
o FG below TOC: 1.00 sg
- Temperature Profile:
o Geothermal Temperature

The Gas Over Mud Ratio Burst inputs for the 13 3/8" casing is:

Gas Over Mud Ratio (Burst Load):
- Internal Profile:
o Influx depth: 5500 m
o Gas gradient: 0.2307 sg
o Frac. Margin of err.: 0.00 sg
o Mud @ Shoe Next: 1.40 sg
o Gas percent: 50%
o Depth reference 385 m
o MASP/MAWP to frac @ shoe: No
o Limit to frac @ shoe: No
- External Profile:
o Fluid Gradients w/ PP (Burst)
o FG above TOC: 1.35 sg
o FG below TOC: 1.00 sg
- Temperature Profile:
o Geothermal Temperature

The Lost Returns w/ Water Burst inputs for the 13 3/8" casing is:

Lost Returns w/ Water (Burst Load):
- Internal Profile:
o Mud/Water interface: 3760 m
o Frac. Margin of err.: 0.00
o MW in hole: 1.40 sg
- External Profile:
o Fluid Gradients w/ PP (Burst)
o FG above TOC: 1.35 sg
o FG below TOC: 1.00 sg

- Temperature Profile:
o Geothermal Temperature

The Pressure Test Burst inputs for the 13 3/8" casing is:

Pressure Test (Burst Load):	
- Internal Profile:	
o Test Pressure:	300 bar
o Fluid density:	1.35 sg
- External Profile:	
o Fluid Gradients w/ PP (Burst)	
o FG above TOC:	1.35 sg
o FG below TOC:	1.00 sg
- Temperature Profile:	
o Geothermal Temperature	

The Gas Kick Profile Burst inputs for the 13 3/8" casing is:

Gas Kick Profile (Burst Load):	
- Internal Profile:	
o Influx depth:	5500 m
o Kick volume:	5 m ³
o Kick intensity:	0.06 sg
o Max mud weight:	1.30 sg
o Kick gas density:	0.7
o Fracture MoE:	385 m
o DP OD:	5.5"
o DC OD:	6.5"
o DC length:	150 m
o Limit frac. @ shoe:	No
- External Profile:	
o Fluid Gradients w/ PP (Burst)	
o FG above TOC:	1.35 sg
o FG below TOC:	1.00 sg
- Temperature Profile:	
o Geothermal Temperature	

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, the burst loads in both software coincides well.

StressCheck - Burst differential pressure															
Depth (mMD)	Displacement To Gas (bar)		Lost Returns (bar)		Gas Kick (bar)		Pressure Test (bar)		Fracture @ Shoe w/ Gas Gradient Above (bar)		Drill Ahead (bar)		Gas over Mud Ratio (bar)		
385	321		262		40		300		483		3		121		
765	280		249		32		300		441		6		79		
800	276		248		31		300		438		7		75		
900	265		244		29		300		427		8		64		
1004	254		241		27		300		416		8		53		
1116	243		237		26		300		405		9		42		
1235	232		234		25		300		394		10		31		
1354	221		230		25		300		383		11		20		
1472	210		227		24		300		372		12		9		
1591	199		224		23		300		361		13		-2		
1710	188		220		23		300		350		13		-13		
1889	171		215		22		300		333		15		-29		
1948	166		213		21		300		328		15		-29		
2067	155		210		21		300		317		16		-28		
2186	144		206		20		300		306		17		-28		
2500	115		197		18		300		277		19		-27		
2543	120		205		27		309		282		28		-17		
2662	100		192		17		300		262		20		-26		
2781	92		191		19		302		253		24		-23		
2900	63		170		1		285		225		7		-40		
3018	49		164		-3		281		210		4		-43		
3137	34		157		-7		278		196		2		-46		
3254	37		167		6		291		199		16		-32		
3360	34		172		13		300		196		25		-24		
3479	35		180		25		312		197		38		-10		
3510	32		179		24		311		194		38		-11		
3570	25		176		22		310		187		37		-12		
3720	12		171		20		310		173		37		-12		
3750	11		173		22		312		173		40		-10		
3760	12		173		22		313		173		41		-9		
Oliasoft - Burst differential pressure															
Depth (mMD)	Depth (mTVD)	Displacement To Gas (bar)		Lost Returns w/Water (bar)		Gas Kick Profile (bar)		Pressure Test (bar)		Frac@Shoe/GG Above (bar)		Drill Ahead (bar)		Gas Over Mud Ratio (bar)	
385	385	321	0.0%	262	0.0%	40	0.7%	300	0.0%	483	0.0%	3	0.1%	143	18.3%
765	765	280	0.0%	249	0.0%	31	1.1%	300	0.0%	441	0.0%	6	0.1%	101	28.0%
800	800	276	0.0%	248	0.0%	31	0.5%	300	0.0%	438	0.0%	7	0.1%	97	29.4%
901	900	265	0.0%	244	0.0%	29	0.7%	300	0.0%	427	0.0%	8	0.1%	86	34.3%
1004	1000	254	0.0%	241	0.0%	27	0.8%	300	0.0%	416	0.0%	8	0.1%	75	41.5%
1116	1100	243	0.0%	237	0.0%	25	3.2%	300	0.0%	405	0.0%	9	0.1%	64	52.3%
1233	1199	232	0.1%	234	0.1%	24	4.3%	300	0.0%	394	0.0%	10	0.0%	53	71.2%
1352	1299	221	0.0%	231	0.0%	24	5.1%	300	0.0%	383	0.0%	11	0.0%	42	109.6%
1472	1399	210	0.0%	227	0.0%	23	5.7%	300	0.0%	372	0.0%	12	0.0%	31	239.5%
1591	1500	199	0.0%	224	0.0%	22	6.1%	300	0.0%	361	0.0%	13	0.0%	20	1075.7%
1710	1600	188	0.0%	220	0.0%	21	6.4%	300	0.0%	350	0.0%	13	0.1%	9	26.3%
1828	1699	177	3.3%	217	0.9%	21	5.1%	300	0.0%	339	1.7%	14	2.9%	-1	94.9%
1947	1799	166	0.1%	213	0.0%	20	6.7%	300	0.0%	328	0.0%	15	0.0%	-13	56.8%
2066	1899	155	0.0%	210	0.0%	19	6.7%	300	0.0%	317	0.0%	16	0.0%	-24	17.3%
2186	2000	144	0.0%	206	0.0%	19	6.6%	300	0.0%	306	0.0%	17	0.0%	-28	0.0%
2500	2264	115	0.0%	197	0.0%	17	6.1%	300	0.0%	277	0.0%	19	0.1%	-27	0.0%
2542	2299	120	0.1%	205	0.0%	26	4.0%	309	0.0%	282	0.0%	28	0.0%	-17	0.0%
2661	2400	100	0.1%	193	0.1%	16	5.4%	300	0.0%	262	0.1%	20	0.2%	-26	0.1%
2780	2500	92	0.0%	192	0.0%	18	4.5%	302	0.0%	253	0.0%	24	0.0%	-23	0.0%
2898	2599	63	0.5%	171	0.2%	0	80.6%	285	0.1%	225	0.2%	7	3.2%	-40	0.5%
3017	2699	49	0.3%	164	0.1%	-4	18.2%	281	0.0%	211	0.1%	4	0.8%	-43	0.1%
3137	2799	34	0.3%	157	0.1%	-8	5.0%	278	0.0%	196	0.1%	2	1.8%	-46	0.0%
3254	2900	37	0.0%	167	0.0%	5	1.2%	291	0.0%	199	0.0%	16	0.1%	-32	0.0%
3366	3000	34	0.4%	172	0.2%	13	2.8%	300	0.1%	196	0.0%	25	2.0%	-23	2.0%
3479	3100	35	0.0%	181	0.0%	25	0.0%	312	0.0%	197	0.0%	38	0.0%	-10	0.0%
3500	3119	33	3.7%	179	0.3%	24	1.4%	312	0.1%	195	0.6%	38	0.5%	-11	1.9%
3597	3200	22	12.2%	174	0.7%	21	4.1%	309	0.2%	184	1.6%	36	1.1%	-13	4.1%
3728	3300	11	4.9%	171	0.1%	18	8.6%	310	0.0%	173	0.3%	38	0.2%	-12	0.4%
3760	3323	12	1.0%	173	0.4%	20	9.2%	313	0.3%	173	0.1%	41	2.3%	-9	9.3%
3760	3323	12	0.6%	173	0.0%	20	12.5%	313	0.0%	173	0.0%	41	0.1%	-9	0.8%

Collapse Loads (13 3/8" Intermediate Casing):

The Casing Evacuation Collapse inputs for the 13 3/8" casing is:

Casing Evacuation (Collapse Load):	
- Internal Profile:	
o Percent evacuation:	-
o Mud level:	3760 m
o Mud weight:	1.40 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.35 sg
o FG below TOC:	1.35 sg
- Temperature Profile:	
o Geothermal Temperature	

The Cementing Collapse inputs for the 13 3/8" casing is:

Cementing (Collapse Load):	
- Internal Profile:	
o Mud weight:	1.20 sg
- External Profile:	
o Mud and Cement Slurry	
- Temperature Profile:	
o Geothermal Temperature	

The Lost Return w/ Mud Drop Collapse inputs for the 13 3/8" casing is:

Lost Returns w/ Mud Drop (Collapse Load):	
- Internal Profile:	
o Lost return depth:	5500 m
o Pore pressure override:	-
o MW in hole:	1.35 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.30 sg
o FG below TOC:	1.30 sg
- Temperature Profile:	
o Geothermal Temperature	

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

The results given from both software yields correct answers, except for the Lost Returns with Mud Drop case with a small error. This can be explained with the dissimilar depth values corresponding to the pressure values. Especially, for Lost Returns-case the values are sensitive due to the low differential pressure and large changes in them for depth-to-depth. For the depth-values that is similar, it is seen the exact same differential pressure, ref. depths from 385 meters to 2,500 meters.

StressCheck - Collapse differential pressure			
Depth (MD) (m)	Full/Partial Evacuation (bar)	Cementing (bar)	Lost Returns (bar)
385	51	-6	22
765	101	-11	20
800	106	-12	20
900	119	-13	20
1020	134	-15	19
1128	147	-16	19
2500	299	-33	13
3180	392	-4	38
3240	392	-1	31
3360	397	4	21
3460	398	8	10
3510	402	11	9
3570	410	14	11
3720	426	20	11
3760	427	21	8

Oliasoft - Collapse differential pressure							
Depth (mMD)	Depth (mTVD)	Casing Evacuation (bar)	error	Cementing (bar)	error	Lost Returns With Mud Drop (bar)	error
385	385	-51	0.0%	6	0.0%	-18	20.0%
765	765	-101	0.1%	11	0.0%	-16	21.9%
800	800	-106	0.1%	12	0.0%	-16	22.1%
901	900	-119	0.1%	13	0.1%	-15	22.6%
1004	1000	-132	1.4%	15	1.4%	-15	22.9%
1128	1110	-147	0.1%	16	0.0%	-14	23.9%
2500	2264	-300	0.1%	33	0.0%	-11	17.1%
3152	2812	-393	0.1%	5	29.1%	-40	5.9%
3254	2900	-392	0.1%	1	41.1%	-28	8.5%
3366	3000	-397	0.2%	-4	6.7%	-20	6.9%
3479	3100	-398	0.1%	-9	10.4%	-7	28.8%
3500	3119	-401	0.2%	-10	4.3%	-8	13.8%
3597	3200	-414	1.0%	-15	8.7%	-10	3.9%
3728	3300	-427	0.3%	-20	1.5%	-10	9.4%
3760	3323	-427	0.1%	-21	0.0%	-7	12.1%

Installation Loads (13 3/8" Intermediate Casing):

The Overpull Installation inputs for the 13 3/8" casing is:

Overpull (Installation Load):	
- Internal Profile:	
o Overpull force:	109 MT
- Temperature Profile:	
o Geothermal Temperature	

The Running in Hole Installation inputs for the 13 3/8" casing is:

Running in Hole (Installation Load):	
- Internal Profile:	
o Running speed:	1.00 m/s
- Temperature Profile:	
o Bottomhole Circulating Temperature	

Inputs from the two above installation tables are used to make an axial profile through the depth of the casing and is summarised in the tables below.

There is seen a minor error in the software outputs regarding the installation loads.

StressCheck - Axial/Installation load					
Depth (MD) (m)	Running in Hole (tonne)		Overpull Force (tonne)		
	Apparent (w/Bending)	Actual (w/o Bending)	Apparent (w/Bending)	Actual (w/o Bending)	
385	351	351	377	377	
765	322	322	348	348	
800	377	320	403	345	
900	371	312	396	338	
1020	362	303	388	329	
1128	354	295	379	321	
2118	279	221	304	246	
2500	250	192	276	218	
3180	199	135	225	161	
3240	195	130	220	155	
3360	186	119	211	145	
3450	179	111	205	137	
3510	174	106	200	131	
3570	169	100	195	126	
3720	156	87	182	113	
3760	153	83	178	109	

Oliasoft - Axial/Installation load									
Depth (mMD)	Depth (mTVD)	Running in Hole (tonne)				Overpull Force (tonne)			
		Apparent (w/Bending)	error	Actual (w/o Bending)	error	Apparent (w/Bending)	error	Actual (w/o Bending)	error
385	385	357	1.7%	357	1.7%	383	1.6%	383	1.6%
765	765	329	2.1%	329	2.1%	355	2.0%	355	2.0%
800	800	384	1.8%	326	2.0%	410	1.7%	352	1.9%
901	900	377	1.7%	317	1.6%	403	1.6%	343	1.5%
1004	1000	370	2.0%	309	2.0%	395	1.9%	335	1.9%
1128	1110	359	1.4%	299	1.3%	385	1.3%	324	1.2%
2186	2000	278	0.3%	217	1.9%	303	0.3%	242	1.6%
2500	2264	254	1.4%	193	0.2%	279	1.3%	218	0.2%
3152	2812	203	1.8%	139	3.2%	228	1.7%	165	2.7%
3254	2900	194	0.3%	129	0.6%	220	0.2%	155	0.4%
3366	3000	186	0.1%	119	0.2%	211	0.0%	145	0.2%
3479	3100	179	0.1%	109	1.9%	204	0.1%	135	1.5%
3500	3119	177	1.6%	107	1.2%	203	1.4%	133	1.1%
3597	3200	169	0.3%	98	2.1%	194	0.2%	124	1.6%
3728	3300	157	0.6%	86	0.8%	183	0.5%	112	0.5%
3760	3323	154	1.0%	83	0.1%	179	0.6%	109	0.0%

2.3.4. 9 5/8" Production Casing Loads

Burst Loads (9 5/8" Production Casing):

The Displacement to Gas Burst inputs for the 9 5/8" casing is:

Displacement to Gas (Burst Load):	
- Internal Profile:	
○ Influx depth:	5500 m
○ Mud/gas interface:	0 m
○ Mud weight:	1.30 sg
○ Gas gradient:	0.2307
○ Limit frac @ shoe:	No
○ Frac. Margin of err.:	0.00 sg
- External Profile:	
○ Fluid Gradients w/ PP (Burst)	
○ FG above TOC:	1.40 sg
○ FG below TOC:	1.00 sg
- Temperature Profile:	
○ Geothermal Temperature	

The Pressure Test Burst inputs for the 9 5/8" casing is:

Pressure Test (Burst Load):	
- Internal Profile:	
○ Test Pressure:	300 bar
○ Fluid density:	1.40 sg
- External Profile:	
○ Fluid Gradients w/ PP (Burst)	
○ FG above TOC:	1.40 sg
○ FG below TOC:	1.00 sg
- Temperature Profile:	
○ Geothermal Temperature	

The Tubing Leak Burst inputs for the 9 5/8" casing is:

Tubing Leak (Burst Load):	
- Internal Profile:	
○ Perforation Depth:	7500 m
○ Packer Depth:	5500 m

○ Packer fluid:	1.031 sg
○ Gas gravity:	0.7
- External Profile:	
○ Fluid Gradients w/ PP (Burst)	
○ FG above TOC:	1.40 sg
○ FG below TOC:	1.00 sg
- Temperature Profile:	
○ Production temp.:	121.25°C

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, the burst loads in both software coincides well. The only deviation seen is when the corresponding depths and differential pressures does not match perfectly, resulting in a higher/lower pressure.

StressCheck - Burst differential pressure			
Depth (mMD)	Displacement To Gas (bar)	Pressure Test (bar)	Tubing Leak (bar)
385	319	300	303
800	272	300	288
900	260	300	284
1020	247	300	280
1128	236	300	277
3180	38	300	214
3240	32	300	212
3360	20	300	208
3450	11	300	206
3500	6	300	204
3570	2	302	204
3720	-7	307	204
3760	-9	308	205
3888	14	340	234
4251	0	338	228
5500	0	338	228

Oliasoft - Burst differential pressure							
Depth (mMD)	Depth (mTVD)	Displacement To Gas (bar)	error	Pressure Test (bar)	error	Tubing Leak (bar)	error
385	385	319	0.0%	300	0.0%	315	4.1%
600	600	295	8.4%	300	0.0%	308	6.8%
901	900	260	0.0%	300	0.0%	297	4.4%
1004	1000	249	0.7%	300	0.0%	293	4.6%
1116	1100	237	0.5%	300	0.0%	290	4.6%
3152	2812	41	7.0%	300	0.0%	228	6.2%
3254	2900	31	4.2%	300	0.0%	224	5.7%
3366	3000	20	3.0%	300	0.0%	221	5.9%
3479	3100	8	26.2%	300	0.0%	217	5.7%
3500	3119	6	0.1%	300	0.0%	216	6.1%
3597	3200	0	89.3%	303	0.3%	217	6.2%
3728	3300	-8	5.5%	307	0.1%	217	6.1%
3760	3323	12	23.3%	308	0.0%	217	6.1%
3888	3400	14	0.0%	311	8.5%	217	7.0%
4252	3500	0	0.0%	315	6.7%	218	4.5%
5500	3500	0	0.0%	315	6.7%	218	4.5%

Collapse Loads (9 5/8" Production Casing):

The Above/Below Packer Collapse inputs for the 9 5/8" casing is:

Above/Below Packer (Collapse Load):	
- Internal Profile:	
o Perforation Depth:	7500 m
o Packer Depth:	5500 m
o Density above packer:	1.031 sg
o Density below packer:	0.00 sg
o Fluid drop above packer:	No
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.40 sg
o FG below TOC:	1.40 sg
- Temperature Profile:	
o Production Temperature:	121.25°C

The Casing Evacuation Collapse inputs for the 9 5/8" casing is:

Casing Evacuation (Collapse Load):	
- Internal Profile:	
o Percent evacuation:	-
o Mud level:	5500 m
o Mud weight:	1.20 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.40 sg
o FG below TOC:	1.40 sg
- Temperature Profile:	
o Geothermal Temperature	

The Lost Returns w/ Mud Drop Collapse inputs for the 9 5/8" casing is:

Lost Returns w/ Mud Drop (Collapse Load):	
- Internal Profile:	
o Lost return depth:	5500 m
o Pore pressure override:	1.29 sg
o MW in hole:	1.20 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.35 sg

○ FG below TOC:	1.35 sg
- Temperature Profile:	
○ Geothermal Temperature	

The Gas Migration Collapse inputs for the 9 5/8" casing is:

Gas Migration (Collapse Load):	
- Internal Profile:	
○ Packer fluid:	1.031 sg
- External Profile:	
○ Gas Migration External Gradient	
○ Fluid density:	1.40 sg
○ Limit to frac @ shoe:	Yes
- Temperature Profile:	
○ Production Temperature:	121.25°C

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, the burst loads in both software coincides well.

StressCheck - Collapse differential pressure				
Depth (MD) (m)	Full/Partial Evacuation (bar)	Lost Returns (bar)	Above/Below Packer (bar)	Gas Migration (bar)
385	53	-23	14	158
800	110	-15	29	173
900	123	-13	33	177
1020	139	-11	37	181
1128	152	-9	40	185
3180	389	25	103	247
3240	396	26	105	249
3360	411	28	108	253
3450	422	29	111	256
3500	428	30	113	257
3570	436	31	115	260
3720	452	34	119	264
3760	427	5	91	265
3888	426	-4	83	268
4251	442	0	89	271
5500	442	0	89	271

Oliasoft - Collapse differential pressure									
Depth (mMD)	Depth (mTVD)	Casing Evacuation (bar)	error	Lost Returns With Mud Drop (bar)	error	Above/Below Packer (bar)	error	Gas Migration (bar)	error
385	385	-53	0.1%	22	6.6%	-14	0.0%	-158	0.0%
800	800	-110	0.1%	16	3.2%	-29	0.1%	-173	0.0%
901	900	-124	0.2%	14	7.3%	-33	0.0%	-177	0.0%
1004	1000	-137	1.3%	13	16.0%	-36	1.5%	-181	0.3%
1128	1110	-152	0.1%	11	22.0%	-40	0.1%	-185	0.0%
3152	2812	-386	0.7%	-14	43.8%	-102	0.9%	-246	0.4%
3254	2900	-398	0.5%	-15	41.0%	-105	0.3%	-249	0.1%
3366	3000	-412	0.3%	-17	40.2%	-109	0.1%	-253	0.0%
3479	3100	-426	0.9%	-18	38.4%	-112	0.7%	-257	0.3%
3500	3119	-428	0.1%	-18	39.2%	-113	0.1%	-257	0.0%
3597	3200	-439	0.8%	-20	37.7%	-116	0.6%	-260	0.3%
3728	3300	-453	0.3%	-21	37.5%	-119	0.0%	-264	0.0%
3760	3323	-427	0.1%	-9	66.9%	-91	0.1%	-265	0.0%
3888	3400	-427	0.1%	1	81.0%	-83	0.2%	-267	0.0%
4252	3500	-443	0.1%	-3	0.0%	-89	0.2%	-271	0.0%
5500	3500	-443	0.1%	-3	0.0%	-89	0.2%	-271	0.0%

Installation Loads (9 5/8" Production Casing):

The Overpull Installation inputs for the 9 5/8" casing is:

Overpull (Installation Load):	
- Internal Profile:	
○ Overpull force:	158 MT
- Temperature Profile:	
○ Geothermal Temperature	

The Running in Hole Installation inputs for the 9 5/8" casing is:

Running in Hole (Installation Load):	
- Internal Profile:	
○ Running speed:	1.00 m/s
- Temperature Profile:	
○ Bottom hole Circulating Temperature	

Inputs from the two above installation tables are used to make an axial profile through the depth of the casing and is summarised in the tables below.

There is seen a minor error in the software outputs regarding the installation loads.

StressCheck - Axial/Installation load				
Depth (MD) (m)	Running in Hole (tonne)		Overpull Force (tonne)	
	Apparent (w/Bending)	Actual (w/o Bending)	Apparent (w/Bending)	Actual (w/o Bending)
385	292	292	388	388
800	292	292	388	388
900	292	292	388	388
1020	292	292	388	388
1128	292	292	388	388
3180	227	201	322	297
3240	223	198	319	293
3360	217	191	312	287
3450	212	186	307	282
3500	209	183	304	279
3570	205	180	301	275
3720	197	171	292	267
3760	195	169	290	265
3900	187	161	282	257
4260	167	141	263	237
5500	96	62	192	158

Oliasoft - Axial/Installation load									
Depth (mMD)	Depth (mTVD)	Running in Hole (tonne)				Overpull Force (tonne)			
		Apparent (w/Bending)	error	Actual (w/o Bending)	error	Apparent (w/Bending)	error	Actual (w/o Bending)	error
385	385	292	0.1%	292	0.1%	388	0.0%	388	0.0%
800	800	292	0.1%	292	0.1%	388	0.0%	388	0.0%
901	900	292	0.1%	292	0.1%	388	0.0%	388	0.0%
1004	1000	292	0.1%	292	0.1%	388	0.0%	388	0.0%
1128	1110	292	0.1%	292	0.1%	388	0.0%	388	0.0%
3152	2812	228	0.7%	202	0.3%	324	0.6%	298	0.5%
3254	2900	222	0.5%	195	1.2%	318	0.3%	291	0.7%
3366	3000	216	0.3%	189	1.0%	312	0.1%	285	0.6%
3479	3100	210	0.9%	183	1.8%	306	0.5%	279	1.1%
3500	3119	208	0.2%	182	0.9%	304	0.0%	278	0.5%
3597	3200	203	0.9%	176	1.8%	299	0.5%	272	1.0%
3728	3300	196	0.4%	169	1.2%	292	0.2%	265	0.7%
3760	3323	194	0.2%	167	1.0%	290	0.0%	263	0.5%
3888	3400	187	0.1%	160	0.6%	283	0.2%	256	0.3%
4252	3500	167	0.1%	140	1.0%	262	0.1%	236	0.5%
5500	3500	96	0.3%	62	0.5%	192	0.0%	158	0.0%

2.3.5. 7" Production Liner Loads

Burst Loads (7" Production Liner):

The Tubing Leak Burst inputs for the 7" liner is:

Tubing Leak (Burst Load):	
- Internal Profile:	
o Perforation Depth:	7500 m
o Packer Depth:	5500 m
o Packer fluid:	1.031 sg
o Gas gravity:	0.7
- External Profile:	
o Fluid Gradients w/ PP (Burst)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.00 sg
- Temperature Profile:	
o Production temp.:	121.25°C

The Green Cement Pressure Test Burst inputs for the 7" liner is:

Green Cement Pressure Test (Burst Load):	
- Internal Profile:	
o Test Pressure:	300 bar
o Fluid density:	1.40 sg
- External Profile:	
o Mud and Cement Slurry	
- Temperature Profile:	
o Geothermal Temperature	

The Cementing Collapse inputs for the 7" liner is:

Cementing (Collapse Load):	
- Internal Profile:	
o Mud weight:	1.20 sg
- External Profile:	
o Mud and Cement Slurry	
- Temperature Profile:	
o Geothermal Temperature	

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, the Green Cement Pressure Test burst load coincides well. For the Tubing Leak load, it is seen a large error. The root of the problem will be discussed with Oliasoft.

StressCheck - Burst differential pressure					
Depth (mMD)	Tubing Leak (bar)		Green Cement Pres. Test (bar)		
5350	273		350		
5500	273		350		
5500	0		350		
7500	0		350		

Oliasoft - Burst differential pressure					
Depth (mMD)	Depth (mTVD)	Tubing Leak (bar)	error	Green Cement Pressure Test (bar)	error
5350	3500	31	88.7%	350	0.0%
5500	3500	31	88.7%	350	0.0%
5500	3500	0	0.0%	350	0.0%
7500	3500	0	0.0%	350	0.0%

Collapse Loads (7" Production Liner):

The Casing Evacuation Collapse inputs for the 7" liner is:

Casing Evacuation (Collapse Load):	
- Internal Profile:	
o Percent evacuation:	100%
o Mud level:	-
o Mud weight:	1.20 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.20 sg
- Temperature Profile:	
o Geothermal Temperature	

The Above/Below Packer Collapse inputs for the 7" liner is:

Above/Below Packer (Collapse Load):	
- Internal Profile:	
o Perforation Depth:	7500 m
o Packer Depth:	5500 m
o Density above packer:	1.031 sg
o Density below packer:	0.00 sg
o Fluid drop above packer:	Yes
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.20 sg
o FG below TOC:	1.20 sg
- Temperature Profile:	
o Production Temperature:	121.25°C

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, all the collapse loads in both software coincides well.

StressCheck - Collapse differential pressure							
Depth (mMD)		Cementing (bar)		Full Evacuation (bar)		Above/Below Packer (bar)	
5350		0		412		-31	
5500		0		412		-31	
5500		0		442		443	
7500		0		442		443	

Oliasoft - Collapse differential pressure							
Depth (mMD)	Depth (mTVD)	Cementing (bar)	error	Casing Evacuation (bar)	error	Above/Below Packer (bar)	error
5350	3500	0	0.0%	-412	0.1%	31	0.0%
5500	3500	0	0.0%	-412	0.1%	31	0.0%
5500	3500	0	0.0%	-443	0.1%	-443	0.0%
7500	3500	0	0.0%	-443	0.1%	-443	0.0%

Installation Loads (7" Production Liner):

The Overpull Installation inputs for the 7" liner is:

Overpull (Installation Load):	
- Internal Profile:	
o Overpull force:	215 MT
- Temperature Profile:	
o Geothermal Temperature	

The Running in Hole Installation inputs for the 7" liner is:

Running in Hole (Installation Load):	
- Internal Profile:	
o Running speed:	1.00 m/s
- Temperature Profile:	
o Bottom hole Circulating Temperature	

Inputs from the two above installation tables are used to make an axial profile through the depth of the casing and is summarised in the tables below.

There is seen a minor error in the software outputs regarding the installation loads.

StressCheck - Axial/Installation load									
Depth (mMD)	Running in Hole (tonne)				Overpull Force (tonne)				
	Apparent (w/Bending)		Actual (w/o Bending)		Apparent (w/Bending)		Actual (w/o Bending)		
5350	126		117		303		295		
5500	121		112		298		289		
7500	51		37		229		215		

Oliasoft - Axial/Installation load											
Depth (mMD)	Depth (mTVD)	Running in Hole (tonne)				Overpull Force (tonne)					
		Apparent (w/Bending)		error		Actual (w/o Bending)		error		Apparent (w/Bending)	
5350	3500	125	0.8%			110	5.8%			303	0.2%
5500	3500	120	0.8%			105	6.1%			297	0.2%
7500	3500	51	0.4%			34	8.0%			229	0.0%
										288	2.2%
										283	2.3%
										212	1.3%

2.3.6. 5" Production Tubing Loads

Burst Load (5" Production Tubing):

The Pressure Test Burst inputs for the 5" tubing is:

Pressure Test (Burst Load):	
- Internal Profile:	
o Test Pressure:	345 bar
o Fluid density:	1.031 sg
- External Profile:	
o Fluid Gradients w/ PP (Burst)	
o FG above TOC:	-
o FG below TOC:	1.00 sg
- Temperature Profile:	
o Geothermal Temperature	

...

StressCheck - Burst differential pressure		Oliasoft - Burst differential pressure			
Depth (mMD)	Pressure Test (bar)	Depth (mMD)	Depth (mTVD)	Pressure Test (bar)	error
0	345	0	0	345	0.0%
385	345	385	385	346	0.3%
800	345	800	800	347	0.7%
900	345	901	900	348	0.8%
1020	345	1004	1000	348	0.9%
1128	345	1116	1100	348	1.0%
3180	345	3152	2812	354	2.4%
3240	345	3254	2900	354	2.5%
3360	345	3366	3000	354	2.6%
3570	345	3597	3200	355	2.8%
3720	345	3728	3300	355	2.9%
3870	345	3888	3400	355	2.9%
4200	345	4252	3500	356	3.0%
5500	345	5500	3500	356	3.0%
5500	0	7500	3500	356	0.0%
7500	0	7500	3500	256	0.0%

Collapse Load (5" Production Tubing):

The Casing Evacuation Collapse inputs for the 5" tubing is:

Casing Evacuation (Collapse Load):	
- Internal Profile:	
o Percent evacuation:	100%
o Mud level:	-
o Mud weight:	1.031 sg
- External Profile:	
o Fluid Gradients w/ PP (Collapse)	
o FG above TOC:	1.031 sg
o FG below TOC:	1.031 sg
- Temperature Profile:	
o Geothermal Temperature	

The inputs above yield an internal and external pressure profile, capitulating in the differential pressure results from StressCheck and WellDesign, which is summarised in the tables below.

As seen from the table below, the Collapse load coincides well with both software. The small amount of error from the table is due to comparing depths with minor increments between the points.

StressCheck - Collapse differential pressure		Oliasoft - Collapse differential pressure			
Depth (mMD)	Full/Partial Evacuation (bar)	Depth (mMD)	Depth (mTVD)	Casing Evacuation (bar)	error
0	0	0	0	0	0.0%
385	39	385	385	-39	0.2%
800	81	800	800	-81	0.2%
900	91	901	900	-91	0.2%
1020	102	1004	1000	-101	1.3%
1128	112	1116	1100	-111	0.7%
3180	286	3152	2812	-284	0.7%
3240	291	3254	2900	-293	0.6%
3360	302	3366	3000	-303	0.4%
3570	321	3597	3200	-324	0.9%
3720	333	3728	3300	-334	0.3%
3870	342	3888	3400	-344	0.5%
4200	353	4252	3500	-354	0.2%
5500	353	5500	3500	-354	0.2%
5500	0	7500	3500	-354	0.0%
7500	0	7500	3500	-443	0.0%

Installation Loads (5" Production Tubing):

The Overpull Installation inputs for the 5" tubing is:

Overpull (Installation Load):	
- Internal Profile:	
○ Overpull force:	100 MT
- Temperature Profile:	
○ Geothermal Temperature	

The Running in Hole Installation inputs for the 5" tubing is:

Running in Hole (Installation Load):	
- Internal Profile:	
○ Running speed:	1.00 m/s
- Temperature Profile:	
○ Bottom hole Circulating Temperature	

Inputs from the two above installation tables are used to make an axial profile through the depth of the casing and is summarised in the tables below.

There is seen a minor error in the software outputs regarding the installation loads.

StressCheck - Collapse differential pressure									
Depth (mMD)	Running in Hole (tonne)				Overpull Force (tonne)				
	Apparent (w/Bending)		Actual (w/o Bending)		Apparent (w/Bending)		Actual (w/o Bending)		
35	131		131		204		204		
385	131		131		204		204		
800	131		131		204		204		
1128	131		131		204		204		
3360	131		131		204		204		
3510	130		130		202		202		
3570	129		129		202		202		
3720	126		126		199		199		
3780	125		125		198		198		
3870	123		123		196		196		
4200	115		115		187		187		
5500	85		82		157		155		
7500	34		27		106		100		

Oliasoft - Axial/Installation load									
Depth (mMD)	Depth (mTVD)	Running in Hole (tonne)				Overpull Force (tonne)			
		Apparent (w/Bending)	error	Actual (w/o Bending)	error	Apparent (w/Bending)	error	Actual (w/o Bending)	error
0	0	147	12.0%	147	12.0%	221	8.3%	221	8.3%
385	385	147	12.0%	147	12.0%	221	8.3%	221	8.3%
800	800	147	12.0%	147	12.0%	221	8.3%	221	8.3%
1128	1110	147	12.0%	147	12.0%	221	8.3%	221	8.3%
3366	3000	146	11.5%	146	11.5%	220	8.1%	220	8.1%
3500	3119	145	11.8%	145	11.8%	219	8.0%	219	8.0%
3597	3200	144	11.7%	144	11.7%	217	7.6%	217	7.6%
3728	3300	141	11.6%	141	11.6%	214	7.6%	214	7.6%
3760	3323	140	11.9%	140	11.9%	213	7.8%	213	7.8%
3888	3400	136	10.4%	136	10.4%	210	7.2%	210	7.2%
4252	3500	128	11.6%	125	9.0%	202	7.8%	199	5.9%
5500	3500	96	13.4%	89	8.5%	169	7.4%	163	5.1%
7500	3500	37	10.8%	27	0.2%	110	3.8%	100	0.2%

2.4. Temperature Analysis

Six well operational procedures have been chosen as comparison; one drilling and five production scenarios. The first drilling scenario is drilling into the reservoir, i.e. the last hole to be drilling. While the other loads are more towards production, whereas first is to displace the well to the completion fluid followed by a test-scenario with three days of production and shut-in the well for a short period of 24 hours, then a steady-state production scenario for 10 years and finally a late stage production where the reservoir is depleted, meaning low flow rates. Each scenario will be described in more detail and the data output will be presented to compare below.

2.4.1. Drilling of the reservoir section

Drilling the last section, a 2000 m 8 1/2" open hole, from a depth of 5500/3500 m MD/TVD to 7500/3500 m MD/TVD. This section only consists of horizontal drilling, meaning a 90° inclination.

Initial conditions: Geothermal temperature

Section: 8 1/2" OH

Drillpipe/BHA: 5 1/2"

Depth: 7500 m

Drilling mud: Default WBM (1.20 sg)

Circulation rate: 4000 L/min

Pump pressure: 25 bar

Volume: 20 m³

Ambient temperature: 3.43°C

ROP: 40 m/h

Drill power: 4590 kW

These settings will yield the following temperature behaviour in WellCat and Oliasoft.

WellCat - Drill reservoir section									
MD (m)	Drill String Fluid (°C)	Drill String (°C)	Drill String Annulus (°C)	9 5/8" csg (°C)	13 3/8" csg (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)	
385	6.1	7.2	23.5	6.0	4.4	4.4	4.4	4.4	
386	6.1	14.6	23.6	23.4	18.7	13.0	8.5	4.5	
387	6.2	14.6	23.6	23.4	18.9	13.4	8.9	4.5	
388	6.2	14.6	23.6	23.5	18.9	13.5	9.0	4.6	
490	8.1	16.5	25.4	25.3	21.3	16.4	12.4	8.4	
610	10.9	18.7	27.1	27.0	23.6	19.4		12.9	
765	13.3	21.6	30.3	30.3	27.5	24.2		18.7	
1219	23.0	30.3	38.2	38.2	37.6			34.5	
1829	34.0	40.8	48.0	48.1	50.1			53.7	
2438	44.2	51.1	58.4	58.5	63.0			73.0	
2500	45.2	52.7	60.6	60.7	64.8			74.9	
3048	56.0	62.4	69.1	69.3	75.5			92.2	
3353	61.9	68.3	75.0	75.2	82.4			102.1	
3500	64.3	71.1	78.2	78.4	86.5			106.9	
3760	69.5	76.0	82.9	83.1	92.0			114.6	
3962	73.5	79.8	86.4	86.7				118.9	
4267	80.3	85.8	91.6	91.8				121.3	
4877	90.2	94.9	99.9	100.1				121.3	
5350	96.7	102.0	107.5	107.6				121.3	
5500	99.2	104.4	109.8					121.3	
6096	112.0	117.1	119.7					121.4	
6706	123.5	128.2	130.6					121.4	
7200	133.1	138.1	140.8					121.4	
7315	135.4	139.7	142.1					121.5	
7437	137.0	141.8	144.3					121.5	
7500	146.9	146.9	146.9					121.5	

Oliasoft - Drill reservoir section											
MD (m)	Tubing fluid (°C)	Drillpipe (°C)	A Annulus (°C)	9 5/8 csg (°C)	B Annulus (°C)	13 3/8 csg (°C)	C Annulus (°C)	20 csg (°C)	D Annulus (°C)	30 csg (°C)	Undisturbed (°C)
385	11.6	16.9	41.0	41.2	33.7	31.0	20.8	11.6	5.7	4.2	4.4
386	11.6	20.2	41.0	41.2	33.7	31.2	23.7	18.4	15.1	11.6	4.5
387	11.6	20.2	41.1	41.2	33.9	31.5	24.3	19.2	16.0	12.6	4.5
388	11.7	20.2	41.1	41.2	34.0	31.6	24.4	19.3	16.1	12.7	4.6
490	14.1	22.6	43.3	43.5	36.4	34.1	27.0	22.1	19.4	15.8	8.4
628	18.1	26.1	45.6	45.7	39.1	37.0	30.4	25.8	23.7		13.5
765	20.6	28.9	49.3	49.4	42.8	40.7	35.1	30.2	28.3		18.7
1264	32.8	40.3	58.7	58.9	53.7	52.0	48.3				35.9
1846	45.6	52.7	70.3	70.5	66.7	65.4	62.8				54.3
2420	57.6	64.4	81.1	81.3	79.0	78.3	76.7				72.4
2500	58.5	65.7	83.3	83.5	81.2	80.4	79.2				74.9
3013	69.5	75.9	91.7	91.9	91.3	91.1	91.0				91.1
3334	75.7	81.9	97.1	97.4	97.8	98.1	98.4				101.4
3500	78.1	84.6	100.5	100.8	101.5	101.8	102.4				106.9
3760	83.0	89.3	104.7	105.0	105.9	106.5	107.4				114.6
3927	86.6	92.4	106.6	106.9	107.9						118.3
4262	92.5	98.0	111.7	111.9	112.6						121.3
4848	102.2	107.3	120.0	120.2	119.9						121.3
5350	109.5	114.6	127.2	127.3	126.2						121.3
5500	111.8	116.8	129.2	129.3	127.9						121.3
6083	120.8	125.1	135.8								121.3
6750	129.8	133.7	143.5								121.3
7250	136.1	139.8	148.8								121.3
7333	137.1	140.7	149.7								121.3
7417	138.5	141.4	150.3								121.3
7500	146.9										121.3

2.4.2. Displacing the well to completion fluid

After completion of the drilling, the well will be displaced to the completion fluid. A 1.20 sg WBM mud is used as the completion fluid in this case. The following values was used.

Operation type: Circulate
 Initial conditions: Geothermal temperature
 Section: 8 ½" OH
 Sequence: Before/while casing installation
 Drillpipe/BHA: 5 ½"
 Depth: 7500 m
 Circulation fluid: Default WBM (1.20 sg)
 Circulation rate: 2500 L/min
 Volume: 250 m³
 Ambient temperature: 3.43°C
 Simulation time: 24 hours

These settings will yield the following results in a table.

WellCat - Displace well to completion fluid								
MD (m)	Workstring Fluid (°C)	Workstring (°C)	Annulus Fluid (°C)	9 5/8 csg (°C)	13 3/8 csg (°C)	20 csg (°C)	30 csg (°C)	Undisturbed (°C)
385	5.3	11.0	28.0	25.5	13.4	5.7	4.5	4.5
390	5.4	11.2	28.1	26.2	15.3	6.4	4.7	4.6
496	7.1	13.0	30.0	28.4	18.5	10.2		8.6
765	11.6	17.5	34.9	33.8	26.4	20.0		18.7
914	14.4	20.2	37.2	36.3	30.4			24.3
1219	20.8	26.5	43.0	42.6	38.9			34.5
1829	32.4	38.2	53.7	53.9	54.7			53.7
2500	45.3	51.8	67.4	68.1	72.7			74.9
3048	58.0	63.6	76.3	77.4	85.7			92.2
3353	65.0	70.5	82.4	83.6	93.6			102.1
3500	67.8	73.5	85.5	86.5	97.1			106.9
3658	71.7	77.1	88.1	89.1	100.7			111.8
3760	73.9	79.2	90.1	91.1	103.1			114.6
3810	75.3	80.4	90.7	91.8				115.8
3962	78.5	83.4	93.3	94.4				118.9
4267	85.8	89.8	97.7	98.6				121.3
4877	95.3	98.2	103.7	104.4				121.3
5350	100.7	103.3	108.1	108.7				121.3
5500	103.9	108.6	110.6	110.7				121.3
6096	113.5	115.7	116.6	116.7				121.4
6706	118.9	120.0	120.5	120.6				121.4
7315	121.3	121.7	121.8	121.8				121.5
7500	121.5	121.5	121.5	121.6				121.5

Oliasoft - Displace well to completion fluid										
MD (m)	Tubing fluid (°C)	A Annulus (°C)	9 5/8 csg (°C)	B Annulus (°C)	13 3/8 csg (°C)	C Annulus (°C)	20 csg (°C)	D Annulus (°C)	30 csg (°C)	Undisturbed (°C)
385	5.4	13.7	13.8	11.6	10.9	8.4	6.2	4.9	4.5	4.4
388	5.5	13.8	13.9	11.2	10.2	7.4	5.3	4.8	4.6	4.6
490	8.6	17.0	17.1	14.6	13.7	11.0	9.1	8.7	8.4	8.4
765	16.6	25.1	25.2	23.4	22.8	21.5	19.3	19.0		18.7
931	22.4	28.5	28.6	27.8	27.5	26.8				24.9
1264	31.6	37.7	37.8	37.5	37.4	37.0				35.9
1846	47.5	53.5	53.6	54.0	54.1	54.3				54.3
2500	63.9	71.8	71.9	73.7	74.2	74.7				74.9
3013	78.4	83.9	84.0	88.2	89.6	90.4				91.1
3334	86.2	91.4	91.5	97.4	99.3	100.4				101.4
3500	89.1	96.0	96.3	102.3	103.6	105.5				106.9
3630	92.9	97.9	98.2	105.0	106.5	109.0				111.0
3760	95.0	100.9	101.1	105.6	109.7	112.2				114.6
3844	97.4	101.5	101.8	106.2						116.6
3927	98.9	102.8	103.1	107.6						118.3
4262	104.1	107.2	107.4	111.6						121.3
4848	110.5	112.4	112.6	115.6						121.3
5350	113.6	115.1	115.2	117.5						121.3
5500	114.4	115.6	115.7	117.7						121.3
6088	116.5	117.1								121.3
6748	118.0	118.3								121.3
7325	118.5	118.6								121.3
7500	121.3									121.3

2.4.3. Producing for three days

This production behaviour is a short temperature build up for three days. The production rate is set to 15,000 barrels per day.

Operation type: Production

Initial conditions: Geothermal temperature

Production flow path: Inside tubing

Wellhead pressure: 50 bar

Inflow depth: 7500 m

Inlet temperature: 121°C

Production fluid: Oil 24 API

PVT model: Peng Robinson

Multiphase model: Zhang

Production rate: 15,000 bpd

Water cut: 0%

Flow behaviour: Transient

WellCat - Production for 3 days								
MD (m)	Workstring Fluid (°C)	Workstring (°C)	Annulus Fluid (°C)	9 5/8" csg & 7" Lnr (°C)	13 3/8" csg (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	114.8	27.0	4.4	4.4	4.4	4.4	4.4	4.4
386	114.9	113.1	92.7	80.8	67.4	51.3	36.5	4.5
387	114.9	113.7	100.3	92.5	83.3	71.7	58.4	4.5
388	114.9	113.8	101.6	94.5	86.1	75.5	63.1	4.6
490	115.3	114.5	105.1	99.5	93.1	85.1	75.3	8.4
610	115.7	114.9	105.7	100.3	94.0	86.2		12.9
762	116.4	115.6	106.8	101.7	95.8	88.4		18.6
1219	117.9	117.2	109.6	105.2	100.1			34.5
1829	119.7	119.0	113.2	109.7	105.7			53.7
2438	121.1	120.6	116.4	113.9	111.0			73.0
2500	121.3	120.8	116.8	114.4	111.7			74.9
3048	122.2	121.9	119.3	117.7	116.0			92.2
3353	122.6	122.4	120.6	119.6	118.4			102.1
3500	122.8	122.6	121.2	120.4	119.3			106.9
3760	123.0	122.9	122.2	121.7	121.2			114.6
3962	123.0	123.0	122.6	122.4				118.9
4267	123.0	122.9	122.8	122.7				121.3
4877	122.7	122.7	122.6	122.5				121.3
5350	122.4	122.4	122.3	122.3				121.3
5500	122.4	122.3	122.3	122.3				121.3
6096	122.1	122.1	122.0	122.0				121.4
6706	121.7	121.7	121.7	121.7				121.4
7010	121.6	121.6	121.6	121.6				121.4
7315	121.4	121.4	121.4	121.4				121.5
7494	121.3	121.3	121.3	121.3				121.5
7500	121.3	121.3	121.3	121.3				121.5

Oliasoft - Production for 3 days												
MD (m)	Tubing fluid	Tubing (°C)	A Annulus (°C)	7" Liner (°C)	B Annulus (°C)	9 5/8" csg (°C)	C Annulus (°C)	13 3/8" csg (°C)	D Annulus (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	100.8	99.7	79.4			59.9	40.5	34.0	22.3	13.8	7.3	4.4
386	100.8	100.1	83.9			68.2	54.2	49.5	42.8	37.9	29.3	4.5
387	100.8	100.2	85.5			71.3	58.6	54.3	48.1	43.6	35.1	4.5
388	100.8	100.2	85.8			71.9	59.4	55.2	49.1	44.7	36.2	4.6
490	101.6	101.0	87.1			73.7	61.6	57.6	51.6	47.3	39.1	8.4
628	102.3	101.7	88.4			75.5	63.9	60.0	54.3	50.1		13.5
765	103.4	102.9	90.4			78.3	67.6	64.0	59.3	53.3		18.7
1264	107.7	106.8	104.2			101.7	100.2	99.7	98.9			35.9
1846	112.9	112.2	110.0			107.8	106.7	106.3	105.6			54.3
2420	117.0	116.5	114.7			113.0	112.1	111.8	111.3			72.4
2500	117.7	117.2	115.5			113.9	113.2	112.9	110.6			74.9
3092	120.2	120.0	118.8			117.7	117.2	117.0	115.3			93.6
3334	121.0	120.8	119.9			118.9	118.5	118.3	117.1			101.4
3500	121.5	121.4	120.8			120.2	119.4	119.1	118.2			106.9
3760	121.9	121.9	121.6			121.4	121.0	120.5	120.1			114.6
3927	122.0	122.0	121.9			121.8	121.6					118.3
4262	122.1	122.1	122.0			122.0	121.9					121.3
4848	122.0	121.9	121.9			121.9	121.8					121.3
5350	121.9	121.8	121.8	121.8	121.8	121.8	121.7					121.3
5500	121.8	121.8	121.8	121.8	121.8	121.7	121.7					121.3
6090	121.7	121.7	121.7	121.6	121.6							121.3
6754	121.5	121.5	121.5	121.5	121.5							121.3
7002	121.4	121.4	121.4	121.4	121.4							121.3
7334	121.3	121.3	121.3	121.3	121.3							121.3
7417	121.3	121.3	121.3	121.3	121.3							121.3
7500	121.2	121.2	121.2	121.2	121.2							121.3

2.4.4. Shut-in well short for 24 hours

In this temperature model, the well is shut-in for a short time right after having produced for three days. Following inputs are used.

Operation type: Shut-in

Initial conditions: Production for 3 days

Simulation time: 24 hours

WellCat - Shut-in for 24 hours								
MD (m)	Tubing Fluid (°C)	Tubing (°C)	Annulus Fluid (°C)	9 5/8" csg (°C)	13 3/8" csg (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	4.7	4.5	4.4	4.4	4.4	4.4	4.4	4.4
386	43.3	41.2	41.1	40.3	39.2	36.0	30.9	4.5
387	67.9	66.1	65.9	65.1	63.7	60.2	53.6	4.5
388	72.2	70.6	70.3	69.6	68.3	65.0	58.7	4.6
490	82.5	81.2	81.0	80.5	79.4	76.9	71.8	8.4
610	83.8	82.6	82.4	81.9	80.9	78.5		12.9
762	86.1	84.9	84.7	84.2	83.3	81.1		18.6
1219	91.9	91.0	90.8	90.4	89.7			34.5
1829	99.3	98.5	98.4	98.1	97.5			53.7
2438	106.3	105.8	105.7	105.5	105.0			73.0
2500	106.6	106.0	105.9	105.7	105.3			74.9
3048	112.8	112.4	112.3	112.2	111.9			92.2
3353	116.3	116.0	115.9	115.8	115.7			102.1
3500	117.6	117.4	117.4	117.3	117.2			106.9
3760	120.4	120.3	120.3	120.2	120.2			114.6
3962	121.9	121.9	121.9	121.8				118.9
4267	122.7	122.6	122.6	122.6				121.3
4877	122.5	122.4	122.4	122.4				121.3
5350	122.2	122.2	122.2	122.2				121.3
5500	122.2	122.2	122.2	122.2				121.3
6096	122.0	122.0	122.0	122.0				121.4
6706	121.7	121.7	121.7	121.7				121.4
7010	121.6	121.6	121.6	121.6				121.4
7315	121.4	121.4	121.4	121.4				121.5
7494	121.3	121.3	121.3	121.3				121.5
7500	121.3	121.3	121.3	121.3				121.5

Oliasoft - Shut-in short for 24 hrs												
MD (m)	Tubing fluid (°C)	Tubing (°C)	A Annulus (°C)	7" Liner (°C)	B Annulus (°C)	9 5/8" csg (°C)	C Annulus (°C)	13 3/8" csg (°C)	D Annulus (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	23.4	21.7	23.1			24.3	20.8	19.7	14.7	11	7	4.4
386	41.2	40.6	40.2			39.2	38	37.4	36.2	35.2	29.2	4.5
387	47.7	47.1	46.6			45.6	44.3	43.8	42.4	41.3	35.1	4.5
388	48.9	48.4	47.9			46.9	45.6	44.9	43.6	42.4	36.1	4.6
490	51.8	51.3	50.7			49.7	48.4	47.8	46.4	45.2	39.1	8.4
628	54.4	53.9	53.4			52.5	51.2	50.6	49.2	48.1		13.5
765	58.6	57.6	56.9			55.8	54.2	53.5	51.8	51		18.7
1264	81.3	80.7	80.7			80.5	80.4	80.3	80.2			35.9
1846	91.2	90.8	90.7			90.6	90.5	90.5	90.3			54.3
2420	100.4	100.1	100			99.9	99.9	99.8	99.7			72.4
2500	108.1	107.2	107.2			107.2	107.3	107.3	107.6			74.9
3013	113.8	113.7	113.7			113.7	113.7	113.7	113.3			91.1
3334	116.6	116.5	116.5			116.5	116.5	116.5	116.2			101.4
3500	118.6	118.4	118.5			118.5	118.4	118.3	117.9			106.9
3760	120.5	120.4	120.4			120.4	120.4	120.2	119.9			114.6
3927	121.2	121.2	121.2			121.2	121.2					118.3
4262	121.9	121.9	121.9			121.9	121.9					121.3
4848	121.8	121.8	121.8			121.8	121.8					121.3
5350	121.7	121.7	121.7	121.7	121.7	121.7	121.7					121.3
5500	121.7	121.7	121.7	121.7	121.7	121.7	121.7					121.3
6091	121.6	121.6	121.6	121.6	121.6							121.3
6671	121.4	121.4	121.4	121.4	121.4							121.3
7002	121.4	121.4	121.4	121.4	121.4							121.3
7334	121.3	121.3	121.3	121.3	121.3							121.3
7417	121.3	121.3	121.3	121.3	121.3							121.3
7500	121.2	121.2	121.2	121.2	121.2							121.3

2.4.5. Steady-state production for 10 years

After a transient flow, it is assumed a steady-state behaviour for 10 years and the fluid temperature analysis is done based on the following inputs.

Operation type: Production

Initial conditions: Shut-in well short for 24 hours

Production flow path: Inside tubing

Riser: Installed

Wellhead pressure: 20 bar

Inflow depth: 7500 m

Inlet temperature: 121°C

Production fluid: Oil 31 API

PVT model: Peng Robinson

Multiphase model: Beggs & Brill

Production rate: 15,000 bpd

Water cut: 0%

Flow behaviour: Steady-State

Simulation time: 10 years

WellCat - Production for 10 years								
MD (m)	Workstring Fluid (°C)	Workstring (°C)	Annulus Fluid (°C)	9 5/8" csg (°C)	13 3/8" csg (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	114.651	27.792	4.439	4.439	4.439	4.439	4.439	4.439
386	114.751	113.083	92.691	80.774	67.371	51.284	36.521	4.473
387	114.76	113.649	100.261	92.413	83.266	71.663	58.408	4.53
388	114.764	113.749	101.548	94.396	86.052	75.473	63.06	4.564
490	115.177	114.378	104.973	99.459	93.049	85.036	75.208	8.376
610	115.617	114.822	105.627	100.236	93.969	86.152		12.861
762	116.257	115.484	106.771	101.662	95.726	88.347		18.576
1219	117.793	117.077	109.577	105.179	100.074			34.517
1829	119.595	118.975	113.096	109.649	105.653			53.739
2438	121.046	120.547	116.292	113.797	110.909			72.962
2500	121.203	120.727	116.701	114.341	111.609			74.904
3048	122.127	121.789	119.201	117.684	115.931			92.184
3353	122.539	122.296	120.536	119.504	118.312			102.066
3500	122.7	122.508	121.159	120.369	119.266			106.949
3760	122.899	122.795	122.096	121.685	121.111			114.597
3962	122.967	122.913	122.561	122.354				118.854
4267	122.903	122.882	122.741	122.658				121.255
4877	122.634	122.617	122.502	122.435				121.295
5350	122.381	122.366	122.276	122.223				121.326
5500	122.306	122.293	122.259	122.231				121.336
6096	122.029	122.02	121.997	121.978				121.375
6706	121.711	121.707	121.696	121.688				121.414
7010	121.548	121.546	121.542	121.538				121.434
7315	121.381	121.382	121.385	121.387				121.454
7494	121.263	121.267	121.274	121.28				121.466
7500	121.252	121.256	121.265	121.272				121.467

Oliasoft - Production for 10 years												
MD (m)	Tubing fluid (°C)	5" Tubing (°C)	A Annulus (°C)	7" Liner (°C)	B Annulus (°C)	9 5/8" csg (°C)	C Annulus (°C)	13 3/8" csg (°C)	D Annulus (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	96.7	96	76.7			58.1	39.5	33.3	22	13.7	7.3	4.4
386	96.7	96.2	81			66.3	53.2	48.7	42.4	37.8	29.2	4.5
387	96.8	96.3	82.6			69.4	57.5	53.5	47.7	43.5	35.1	4.5
388	96.8	96.3	83			70	58.3	54.4	48.7	44.5	36.1	4.6
490	98.1	97.7	84.7			72.2	60.9	57.1	51.5	47.4	39.3	8.4
628	99.6	99.2	86.7			74.5	63.5	59.8	54.4	50.5		13.5
765	101.3	101	89.1			77.7	67.5	64	59.5	53.8		18.7
1264	107.1	106.6	104.1			101.7	100.3	99.8	99			35.9
1846	112.7	112.3	110.2			108.2	107	106.6	105.9			54.3
2420	116.8	116.5	114.8			113.2	112.3	112	111.5			72.4
2500	117.5	117.2	115.7			114.3	113.5	113.3	111.2			74.9
3013	119.8	119.6	118.5			117.5	117	116.8	115.1			91.1
3334	120.9	120.8	119.9			119.1	118.7	118.5	117.4			101.4
3500	121.4	121.3	120.8			120.3	119.5	119.3	118.5			106.9
3760	121.9	121.8	121.6			121.4	121.1	120.6	120.2			114.6
3927	122	122	121.9			121.8	121.6					118.3
4262	122.1	122.1	122			122	122					121.3
4848	121.9	121.9	121.9			121.9	121.9					121.3
5350	121.8	121.8	121.8	121.8	121.8	121.8	121.8					121.3
5500	121.8	121.8	121.8	121.8	121.8	121.7	121.7					121.3
6090	121.6	121.6	121.6	121.6	121.6							121.3
6671	121.5	121.5	121.5	121.5	121.5							121.3
7002	121.4	121.4	121.4	121.4	121.4							121.3
7334	121.3	121.3	121.3	121.3	121.3							121.3
7417	121.3	121.3	121.3	121.3	121.3							121.3
7500	121.2	121.2	121.2	121.2	121.2							121.3

2.4.6. Late stage production for one year

This production case simulates temperature behaviour for the last couple of years with a lower production rate and depleted reservoir. The following inputs are used.

Operation type: Production

Initial conditions: Production for 10 years

Production flow path: Inside tubing

Wellhead pressure: 850.89 bar

PVT model: Peng Robinson

Multiphase model: Beggs & Brill

Production rate: 3,000 bpd

Water cut: 0%

Flow behaviour: Pseudo Steady-State

Simulation time: 365 days

WellCat - Late stage production								
MD (m)	Workstring Fluid (°C)	Workstring (°C)	Annulus Fluid (°C)	9 5/8" csg (°C)	13 3/8" csg (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	92.7	14.0	4.4	4.4	4.4	4.4	4.4	4.4
386	92.9	89.6	73.6	64.3	53.9	41.6	30.2	4.5
387	93.0	90.8	80.3	74.1	67.0	58.0	47.8	4.5
388	93.0	91.0	81.4	75.8	69.3	61.1	51.6	4.6
490	94.4	92.8	85.5	81.3	76.3	70.2	62.7	8.4
610	95.8	94.2	87.1	82.9	78.1	72.0		12.9
762	98.0	96.5	89.7	85.7	81.2	75.5		18.6
1219	103.2	101.8	95.8	92.3	88.3			34.5
1829	109.6	108.3	103.5	100.7	97.5			53.7
2438	114.8	113.7	110.2	108.1	105.7			73.0
2500	115.4	114.5	111.1	109.1	106.8			74.9
3048	118.6	117.9	115.7	114.4	112.9			92.2
3353	119.9	119.4	117.9	117.1	116.1			102.1
3500	120.5	120.1	119.0	118.4	117.5			106.9
3760	121.1	120.9	120.4	120.1	119.7			114.6
3962	121.3	121.3	121.1	121.0				118.9
4267	121.4	121.4	121.4	121.4				121.3
4877	121.4	121.4	121.4	121.4				121.3
5350	121.4	121.4	121.4	121.4				121.3
5500	121.4	121.4	121.4	121.4				121.3
6096	121.3	121.3	121.3	121.3				121.4
6706	121.3	121.3	121.3	121.3				121.4
7010	121.3	121.3	121.3	121.3				121.4
7315	121.3	121.3	121.3	121.3				121.5
7494	121.3	121.3	121.3	121.3				121.5
7500	121.3	121.3	121.3	121.3				121.5

Oliasoft - Late stage production												
MD (m)	Tubing fluid (°C)	5" Tubing (°C)	A Annulus (°C)	7" Liner (°C)	B Annulus (°C)	9 5/8" csg (°C)	C Annulus (°C)	13 3/8" csg (°C)	D Annulus (°C)	20" csg (°C)	30" csg (°C)	Undisturbed (°C)
385	49.8	46.5	37.5			28.9	20.2	17.4	12	8.1	5.5	4.4
386	49.8	48	40.3			32.8	26.4	24.3	21.1	18.7	15.1	4.5
387	49.8	48.2	41.2			34.3	28.6	26.7	23.7	21.5	17.8	4.5
388	49.9	48.3	41.4			34.7	29	27.1	24.2	22	18.4	4.6
490	52.1	50.6	43.9			37.5	32.1	30.3	27.4	25.4	21.8	8.4
628	54.5	53.1	46.8			40.7	35.6	33.9	31.2	29.2		13.5
765	57.7	56.5	50.5			44.8	40.2	38.6	36.3	33.5		18.7
1264	70.1	68.2	66.9			65.6	65	64.8	64.4			35.9
1846	85.8	84.2	83			81.8	81.2	81	80.7			54.3
2420	99.7	98.4	97.3			96.3	95.8	95.6	95.3			72.4
2500	102.2	101	100			99	98.5	98.4	97.1			74.9
3013	110.9	110.1	109.4			108.6	108.3	108.2	107			91.1
3334	115.6	115	114.4			113.8	113.5	113.5	112.6			101.4
3500	117.8	117.4	117.1			116.7	116.1	115.9	115.4			106.9
3760	119.9	119.7	119.6			119.5	119.2	118.9	118.6			114.6
3927	120.6	120.6	120.5			120.4	120.3					118.3
4262	121.2	121.2	121.2			121.2	121.2					121.3
4848	121.3	121.3	121.3			121.3	121.3					121.3
5350	121.3	121.3	121.3	121.3	121.3	121.3	121.3					121.3
5500	121.3	121.3	121.3	121.3	121.3	121.3	121.3					121.3
6091	121.3	121.3	121.3	121.3	121.3							121.3
6671	121.3	121.3	121.3	121.3	121.3							121.3
7002	121.3	121.3	121.3	121.3	121.3							121.3
7334	121.3	121.3	121.3	121.3	121.3							121.3
7417	121.3	121.3	121.3	121.3	121.3							121.3
7500	121.3	121.3	121.3	121.3	121.3							121.3

Appendix A. Pore Pressure- & Fracture Gradient values

Depth (mTVD)	Pore Pressure (sg)	PP Pressure (bar)	Fracture Gradient (sg)	FG Pressure (bar)
385	0.94	35	1.64	62
600	1.02	60	1.65	97
685	0.98	66	1.62	109
700	1.04	71	1.68	115
800	1.03	81	1.68	132
900	1.06	93	1.72	152
1000	1.06	104	1.73	170
1100	1.08	116	1.66	179
1200	1.21	142	1.80	212
1300	1.22	156	1.82	232
1400	1.23	169	1.84	253
1500	1.22	179	1.84	271
1600	1.18	185	1.81	284
1700	1.18	197	1.82	303
1800	1.19	210	1.71	302
1900	1.21	225	1.72	320
2000	1.31	257	1.84	361
2100	1.30	268	1.84	379
2200	1.31	283	1.86	401
2300	1.31	295	1.87	422
2400	1.35	318	1.92	452
2500	1.34	329	1.92	471
2600	1.41	360	1.87	477
2700	1.42	376	1.89	500
2800	1.43	393	1.91	524
2900	1.38	392	1.87	532
3000	1.35	397	1.85	544
3100	1.31	398	1.82	553
3200	1.32	414	1.84	577
3300	1.32	427	1.85	599
3400	1.28	427	1.82	607
3500	1.29	443	1.84	632
3600	1.37	484	1.83	646
3700	1.40	508	1.87	679
3800	1.42	529	1.89	704
3900	1.41	539	1.91	731
4000	1.40	549	1.98	777

Appendix B. Trajectory output

Compass Trajectory					Oliasoft Trajectory			
Data-Entry Mode	MD (m)	INC (°)	AZ (°)	TVD (m)	MD (m)	Inc (°)	Azi (°)	TVD (m)
MD-INC-AZ	0	0	0	0	0	0	0	0
MD-INC-AZ	30	0	0	30	30	0	0	30
MD-INC-AZ	60	0	0	60	60	0	0	60
MD-INC-AZ	90	0	0	90	90	0	0	90
MD-INC-AZ	120	0	0	120	120	0	0	120
MD-INC-AZ	150	0	0	150	150	0	0	150
MD-INC-AZ	180	0	0	180	180	0	0	180
MD-INC-AZ	210	0	0	210	210	0	0	210
MD-INC-AZ	240	0	0	240	240	0	0	240
MD-INC-AZ	270	0	0	270	270	0	0	270
MD-INC-AZ	300	0	0	300	300	0	0	300
MD-INC-AZ	330	0	0	330	330	0	0	330
MD-INC-AZ	360	0	0	360	360	0	0	360
MD-INC-AZ	390	0	0	390	390	0	0	390
MD-INC-AZ	420	0	0	420	420	0	0	420
MD-INC-AZ	450	0	0	450	450	0	0	450
MD-INC-AZ	480	0	0	480	480	0	0	480
MD-INC-AZ	510	0	0	510	510	0	0	510
MD-INC-AZ	540	0	0	540	540	0	0	540
MD-INC-AZ	570	0	0	570	570	0	0	570
MD-INC-AZ	600	0	0	600	600	0	0	600
MD-INC-AZ	630	0	0	630	630	0	0	630
MD-INC-AZ	660	0	0	660	660	0	0	660
MD-INC-AZ	690	0	0	690	690	0	0	690
MD-INC-AZ	720	0	0	720	720	0	0	720
MD-INC-AZ	750	0	0	750	750	0	0	750
MD-INC-AZ	780	0	0	780	780	0	0	780
MD-INC-AZ	800	0	0	800	800	0	0	800
MD-INC-AZ	810	1	350.88	810	810	1	-9.1174	810
MD-INC-AZ	840	4	350.88	840	840	4	-9.1174	840
MD-INC-AZ	870	7	350.88	870	870	7	-9.1174	870
MD-INC-AZ	900	10	350.88	899	900	10	-9.1174	899
MD-INC-AZ	930	13	350.88	929	930	13	-9.1174	929
MD-INC-AZ	960	16	350.88	958	960	16	-9.1174	958
MD-INC-AZ	990	19	350.88	987	990	19	-9.1174	987
MD-INC-AZ	1020	22	350.88	1015	1020	22	-9.1174	1015
MD-INC-AZ	1050	25	350.88	1042	1050	25	-9.1174	1042
MD-INC-AZ	1080	28	350.88	1069	1080	28	-9.1174	1069
MD-INC-AZ	1110	31	350.88	1095	1110	31	-9.1174	1095
MD-INC-AZ	1127.68	32.77	350.88	1110	1127.68	32.768	-9.1174	1110

MD-INC-AZ	1140	32.77	350.88	1120	1140	32.768	-9.1174	1120
MD-INC-AZ	1170	32.77	350.88	1146	1170	32.768	-9.1174	1146
MD-INC-AZ	1200	32.77	350.88	1171	1200	32.768	-9.1174	1171
MD-INC-AZ	1230	32.77	350.88	1196	1230	32.768	-9.1174	1196
MD-INC-AZ	1260	32.77	350.88	1221	1260	32.768	-9.1174	1221
MD-INC-AZ	1290	32.77	350.88	1247	1290	32.768	-9.1174	1247
MD-INC-AZ	1320	32.77	350.88	1272	1320	32.768	-9.1174	1272
MD-INC-AZ	1350	32.77	350.88	1297	1350	32.768	-9.1174	1297
MD-INC-AZ	1380	32.77	350.88	1322	1380	32.768	-9.1174	1322
MD-INC-AZ	1410	32.77	350.88	1348	1410	32.768	-9.1174	1348
MD-INC-AZ	1440	32.77	350.88	1373	1440	32.768	-9.1174	1373
MD-INC-AZ	1470	32.77	350.88	1398	1470	32.768	-9.1174	1398
MD-INC-AZ	1500	32.77	350.88	1423	1500	32.768	-9.1174	1423
MD-INC-AZ	1530	32.77	350.88	1448	1530	32.768	-9.1174	1448
MD-INC-AZ	1560	32.77	350.88	1474	1560	32.768	-9.1174	1474
MD-INC-AZ	1590	32.77	350.88	1499	1590	32.768	-9.1174	1499
MD-INC-AZ	1620	32.77	350.88	1524	1620	32.768	-9.1174	1524
MD-INC-AZ	1650	32.77	350.88	1549	1650	32.768	-9.1174	1549
MD-INC-AZ	1680	32.77	350.88	1575	1680	32.768	-9.1174	1575
MD-INC-AZ	1710	32.77	350.88	1600	1710	32.768	-9.1174	1600
MD-INC-AZ	1740	32.77	350.88	1625	1740	32.768	-9.1174	1625
MD-INC-AZ	1770	32.77	350.88	1650	1770	32.768	-9.1174	1650
MD-INC-AZ	1800	32.77	350.88	1675	1800	32.768	-9.1174	1675
MD-INC-AZ	1830	32.77	350.88	1701	1830	32.768	-9.1174	1701
MD-INC-AZ	1860	32.77	350.88	1726	1860	32.768	-9.1174	1726
MD-INC-AZ	1890	32.77	350.88	1751	1890	32.768	-9.1174	1751
MD-INC-AZ	1920	32.77	350.88	1776	1920	32.768	-9.1174	1776
MD-INC-AZ	1950	32.77	350.88	1802	1950	32.768	-9.1174	1802
MD-INC-AZ	1980	32.77	350.88	1827	1980	32.768	-9.1174	1827
MD-INC-AZ	2010	32.77	350.88	1852	2010	32.768	-9.1174	1852
MD-INC-AZ	2040	32.77	350.88	1877	2040	32.768	-9.1174	1877
MD-INC-AZ	2070	32.77	350.88	1902	2070	32.768	-9.1174	1902
MD-INC-AZ	2100	32.77	350.88	1928	2100	32.768	-9.1174	1928
MD-INC-AZ	2130	32.77	350.88	1953	2130	32.768	-9.1174	1953
MD-INC-AZ	2160	32.77	350.88	1978	2160	32.768	-9.1174	1978
MD-INC-AZ	2190	32.77	350.88	2003	2190	32.768	-9.1174	2003
MD-INC-AZ	2220	32.77	350.88	2029	2220	32.768	-9.1174	2029
MD-INC-AZ	2250	32.77	350.88	2054	2250	32.768	-9.1174	2054
MD-INC-AZ	2280	32.77	350.88	2079	2280	32.768	-9.1174	2079
MD-INC-AZ	2310	32.77	350.88	2104	2310	32.768	-9.1174	2104
MD-INC-AZ	2340	32.77	350.88	2130	2340	32.768	-9.1174	2130
MD-INC-AZ	2370	32.77	350.88	2155	2370	32.768	-9.1174	2155
MD-INC-AZ	2400	32.77	350.88	2180	2400	32.768	-9.1174	2180
MD-INC-AZ	2430	32.77	350.88	2205	2430	32.768	-9.1174	2205
MD-INC-AZ	2460	32.77	350.88	2230	2460	32.768	-9.1174	2230
MD-INC-AZ	2490	32.77	350.88	2256	2490	32.768	-9.1174	2256
MD-INC-AZ	2520	32.77	350.88	2281	2520	32.768	-9.1174	2281

MD-INC-AZ	2550	32.77	350.88	2306	2550	32.768	-9.1174	2306
MD-INC-AZ	2580	32.77	350.88	2331	2580	32.768	-9.1174	2331
MD-INC-AZ	2610	32.77	350.88	2357	2610	32.768	-9.1174	2357
MD-INC-AZ	2640	32.77	350.88	2382	2640	32.768	-9.1174	2382
MD-INC-AZ	2670	32.77	350.88	2407	2670	32.768	-9.1174	2407
MD-INC-AZ	2700	32.77	350.88	2432	2700	32.768	-9.1174	2432
MD-INC-AZ	2730	32.77	350.88	2457	2730	32.768	-9.1174	2457
MD-INC-AZ	2760	32.77	350.88	2483	2760	32.768	-9.1174	2483
MD-INC-AZ	2790	32.77	350.88	2508	2790	32.768	-9.1174	2508
MD-INC-AZ	2820	32.77	350.88	2533	2820	32.768	-9.1174	2533
MD-INC-AZ	2850	32.77	350.88	2558	2850	32.768	-9.1174	2558
MD-INC-AZ	2880	32.77	350.88	2584	2880	32.768	-9.1174	2584
MD-INC-AZ	2910	32.77	350.88	2609	2910	32.768	-9.1174	2609
MD-INC-AZ	2940	32.77	350.88	2634	2940	32.768	-9.1174	2634
MD-INC-AZ	2970	32.77	350.88	2659	2970	32.768	-9.1174	2659
MD-INC-AZ	3000	32.77	350.88	2684	3000	32.768	-9.1174	2684
MD-INC-AZ	3030	32.77	350.88	2710	3030	32.768	-9.1174	2710
MD-INC-AZ	3060	32.77	350.88	2735	3060	32.768	-9.1174	2735
MD-INC-AZ	3090	32.77	350.88	2760	3090	32.768	-9.1174	2760
MD-INC-AZ	3120	32.77	350.88	2785	3120	32.768	-9.1174	2785
MD-INC-AZ	3152.09	32.77	350.88	2812	3152.088	32.768	-9.1174	2812
MD-INC-AZ	3180	31.27	355.32	2836	3180	31.2681	-4.6757	2836
MD-INC-AZ	3210	29.84	0.52	2862	3210	29.8417	0.5185	2862
MD-INC-AZ	3240	28.64	6.15	2888	3240	28.6361	6.1454	2888
MD-INC-AZ	3270	27.68	12.17	2915	3270	27.6804	12.1743	2915
MD-INC-AZ	3300	27	18.54	2941	3300	27.0011	18.5397	2941
MD-INC-AZ	3330	26.62	25.14	2968	3330	26.6197	25.1401	2968
MD-INC-AZ	3360	26.55	31.84	2995	3360	26.549	31.8449	2995
MD-INC-AZ	3390	26.79	38.51	3022	3390	26.7915	38.5098	3022
MD-INC-AZ	3420	27.34	45	3048	3420	27.3388	44.9956	3048
MD-INC-AZ	3450	28.17	51.19	3075	3450	28.1731	51.1863	3075
MD-INC-AZ	3480	29.27	57	3101	3480	29.2697	57	3101
MD-INC-AZ	3510	30.6	62.39	3127	3510	30.6003	62.3908	3127
MD-INC-AZ	3540	32.14	67.34	3153	3540	32.1356	67.3447	3153
MD-INC-AZ	3570	33.85	71.87	3178	3570	33.8475	71.8713	3178
MD-INC-AZ	3600	35.71	76	3203	3600	35.7104	75.9958	3203
MD-INC-AZ	3630	37.7	79.75	3227	3630	37.7015	79.7517	3227
MD-INC-AZ	3660	39.8	83.18	3250	3660	39.8014	83.176	3250
MD-INC-AZ	3690	41.99	86.31	3273	3690	41.9933	86.3058	3273
MD-INC-AZ	3720	44.26	89.18	3295	3720	44.2632	89.176	3295
MD-INC-AZ	3750	46.6	91.82	3316	3750	46.5993	91.8188	3316
MD-INC-AZ	3780	48.99	94.26	3336	3780	48.9918	94.263	3336
MD-INC-AZ	3810	51.43	96.53	3355	3810	51.4322	96.5343	3355
MD-INC-AZ	3840	53.91	98.66	3373	3840	53.9136	98.6551	3373
MD-INC-AZ	3870	56.43	100.65	3390	3870	56.43	100.6451	3390
MD-INC-AZ	3900	58.98	102.52	3406	3900	58.9765	102.5218	3406
MD-INC-AZ	3930	61.55	104.3	3421	3930	61.5487	104.3002	3421

MD-INC-AZ	3960	64.14	105.99	3435	3960	64.143	105.9937	3435
MD-INC-AZ	3990	66.76	107.61	3447	3990	66.756	107.6142	3447
MD-INC-AZ	4020	69.38	109.17	3459	4020	69.385	109.1722	3459
MD-INC-AZ	4050	72.03	110.68	3469	4050	72.0275	110.6772	3469
MD-INC-AZ	4080	74.68	112.14	3477	4080	74.6813	112.1377	3477
MD-INC-AZ	4110	77.34	113.56	3484	4110	77.3443	113.5615	3484
MD-INC-AZ	4140	80.01	114.96	3490	4140	80.0147	114.9558	3490
MD-INC-AZ	4170	82.69	116.33	3495	4170	82.6908	116.3274	3495
MD-INC-AZ	4200	85.37	117.68	3498	4200	85.371	117.6827	3498
MD-INC-AZ	4230	88.05	119.03	3500	4230	88.0538	119.0277	3500
MD-INC-AZ	4251.7	90	120	3500	4251.7	90	120	3500
MD-INC-AZ	4260	90	120	3500	4260	90	120	3500
MD-INC-AZ	4290	90	120	3500	4290	90	120	3500
MD-INC-AZ	4320	90	120	3500	4320	90	120	3500
MD-INC-AZ	4350	90	120	3500	4350	90	120	3500
MD-INC-AZ	4380	90	120	3500	4380	90	120	3500
MD-INC-AZ	4410	90	120	3500	4410	90	120	3500
MD-INC-AZ	4440	90	120	3500	4440	90	120	3500
MD-INC-AZ	4470	90	120	3500	4470	90	120	3500
MD-INC-AZ	4500	90	120	3500	4500	90	120	3500
MD-INC-AZ	4530	90	120	3500	4530	90	120	3500
MD-INC-AZ	4560	90	120	3500	4560	90	120	3500
MD-INC-AZ	4590	90	120	3500	4590	90	120	3500
MD-INC-AZ	4620	90	120	3500	4620	90	120	3500
MD-INC-AZ	4650	90	120	3500	4650	90	120	3500
MD-INC-AZ	4680	90	120	3500	4680	90	120	3500
MD-INC-AZ	4710	90	120	3500	4710	90	120	3500
MD-INC-AZ	4740	90	120	3500	4740	90	120	3500
MD-INC-AZ	4770	90	120	3500	4770	90	120	3500
MD-INC-AZ	4800	90	120	3500	4800	90	120	3500
MD-INC-AZ	4830	90	120	3500	4830	90	120	3500
MD-INC-AZ	4860	90	120	3500	4860	90	120	3500
MD-INC-AZ	4890	90	120	3500	4890	90	120	3500
MD-INC-AZ	4920	90	120	3500	4920	90	120	3500
MD-INC-AZ	4950	90	120	3500	4950	90	120	3500
MD-INC-AZ	4980	90	120	3500	4980	90	120	3500
MD-INC-AZ	5010	90	120	3500	5010	90	120	3500
MD-INC-AZ	5040	90	120	3500	5040	90	120	3500
MD-INC-AZ	5070	90	120	3500	5070	90	120	3500
MD-INC-AZ	5100	90	120	3500	5100	90	120	3500
MD-INC-AZ	5130	90	120	3500	5130	90	120	3500
MD-INC-AZ	5160	90	120	3500	5160	90	120	3500
MD-INC-AZ	5190	90	120	3500	5190	90	120	3500
MD-INC-AZ	5220	90	120	3500	5220	90	120	3500
MD-INC-AZ	5250	90	120	3500	5250	90	120	3500
MD-INC-AZ	5280	90	120	3500	5280	90	120	3500
MD-INC-AZ	5310	90	120	3500	5310	90	120	3500

MD-INC-AZ	5340	90	120	3500	5340	90	120	3500
MD-INC-AZ	5370	90	120	3500	5370	90	120	3500
MD-INC-AZ	5400	90	120	3500	5400	90	120	3500
MD-INC-AZ	5430	90	120	3500	5430	90	120	3500
MD-INC-AZ	5460	90	120	3500	5460	90	120	3500
MD-INC-AZ	5490	90	120	3500	5490	90	120	3500
MD-INC-AZ	5520	90	120	3500	5520	90	120	3500
MD-INC-AZ	5550	90	120	3500	5550	90	120	3500
MD-INC-AZ	5580	90	120	3500	5580	90	120	3500
MD-INC-AZ	5610	90	120	3500	5610	90	120	3500
MD-INC-AZ	5640	90	120	3500	5640	90	120	3500
MD-INC-AZ	5670	90	120	3500	5670	90	120	3500
MD-INC-AZ	5700	90	120	3500	5700	90	120	3500
MD-INC-AZ	5730	90	120	3500	5730	90	120	3500
MD-INC-AZ	5760	90	120	3500	5760	90	120	3500
MD-INC-AZ	5790	90	120	3500	5790	90	120	3500
MD-INC-AZ	5820	90	120	3500	5820	90	120	3500
MD-INC-AZ	5850	90	120	3500	5850	90	120	3500
MD-INC-AZ	5880	90	120	3500	5880	90	120	3500
MD-INC-AZ	5910	90	120	3500	5910	90	120	3500
MD-INC-AZ	5940	90	120	3500	5940	90	120	3500
MD-INC-AZ	5970	90	120	3500	5970	90	120	3500
MD-INC-AZ	6000	90	120	3500	6000	90	120	3500
MD-INC-AZ	6030	90	120	3500	6030	90	120	3500
MD-INC-AZ	6060	90	120	3500	6060	90	120	3500
MD-INC-AZ	6090	90	120	3500	6090	90	120	3500
MD-INC-AZ	6120	90	120	3500	6120	90	120	3500
MD-INC-AZ	6150	90	120	3500	6150	90	120	3500
MD-INC-AZ	6180	90	120	3500	6180	90	120	3500
MD-INC-AZ	6210	90	120	3500	6210	90	120	3500
MD-INC-AZ	6240	90	120	3500	6240	90	120	3500
MD-INC-AZ	6270	90	120	3500	6270	90	120	3500
MD-INC-AZ	6300	90	120	3500	6300	90	120	3500
MD-INC-AZ	6330	90	120	3500	6330	90	120	3500
MD-INC-AZ	6360	90	120	3500	6360	90	120	3500
MD-INC-AZ	6390	90	120	3500	6390	90	120	3500
MD-INC-AZ	6420	90	120	3500	6420	90	120	3500
MD-INC-AZ	6450	90	120	3500	6450	90	120	3500
MD-INC-AZ	6480	90	120	3500	6480	90	120	3500
MD-INC-AZ	6510	90	120	3500	6510	90	120	3500
MD-INC-AZ	6540	90	120	3500	6540	90	120	3500
MD-INC-AZ	6570	90	120	3500	6570	90	120	3500
MD-INC-AZ	6600	90	120	3500	6600	90	120	3500
MD-INC-AZ	6630	90	120	3500	6630	90	120	3500
MD-INC-AZ	6660	90	120	3500	6660	90	120	3500
MD-INC-AZ	6690	90	120	3500	6690	90	120	3500
MD-INC-AZ	6720	90	120	3500	6720	90	120	3500

MD-INC-AZ	6750	90	120	3500	6750	90	120	3500
MD-INC-AZ	6780	90	120	3500	6780	90	120	3500
MD-INC-AZ	6810	90	120	3500	6810	90	120	3500
MD-INC-AZ	6840	90	120	3500	6840	90	120	3500
MD-INC-AZ	6870	90	120	3500	6870	90	120	3500
MD-INC-AZ	6900	90	120	3500	6900	90	120	3500
MD-INC-AZ	6930	90	120	3500	6930	90	120	3500
MD-INC-AZ	6960	90	120	3500	6960	90	120	3500
MD-INC-AZ	6990	90	120	3500	6990	90	120	3500
MD-INC-AZ	7020	90	120	3500	7020	90	120	3500
MD-INC-AZ	7050	90	120	3500	7050	90	120	3500
MD-INC-AZ	7080	90	120	3500	7080	90	120	3500
MD-INC-AZ	7110	90	120	3500	7110	90	120	3500
MD-INC-AZ	7140	90	120	3500	7140	90	120	3500
MD-INC-AZ	7170	90	120	3500	7170	90	120	3500
MD-INC-AZ	7200	90	120	3500	7200	90	120	3500
MD-INC-AZ	7230	90	120	3500	7230	90	120	3500
MD-INC-AZ	7260	90	120	3500	7260	90	120	3500
MD-INC-AZ	7290	90	120	3500	7290	90	120	3500
MD-INC-AZ	7320	90	120	3500	7320	90	120	3500
MD-INC-AZ	7350	90	120	3500	7350	90	120	3500
MD-INC-AZ	7380	90	120	3500	7380	90	120	3500
MD-INC-AZ	7410	90	120	3500	7410	90	120	3500
MD-INC-AZ	7440	90	120	3500	7440	90	120	3500
MD-INC-AZ	7470	90	120	3500	7470	90	120	3500
MD-INC-AZ	7500	90	120	3500	7500	90	120	3500