



Annular Pressure Monitoring- How it is Improving the Industry





UNDERGROUND CONSTRUCTION TECHNOLOGY

THE UNDERGROUND UTILITIES EVENT | JANUARY 25-27, 2022 | FORT WORTH, TEXAS

Introductions

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- Overview
- What is Annular Pressure?
- What are the benefits of controlling Annular Pressure?
- What is an Inadvertent Return?
- What do we need in order to properly operate an Annular Pressure Tool?
- How do we control Annular Pressure?
- What are the pros and cons of Annular Pressure Tools?



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- Environmental
- HDD Industry.
- Prevention
- Solutions
- Constructability





What is Annular Pressure?

- Pressure it takes to pump the fluid through the hole caused by friction.
- Head pressure from the mud in the annulus of the hole.





What are the benefits of controlling Annular Pressure?

- Real time down hole annular pressure data.
- Cleaner and safer pilot hole.
- Help prevent inadvertent returns.





What is an Inadvertent Return?

Mud that returns to the surface.





What do we need in order to properly operate an Annular Pressure Tool?

- Geotechnical Report.
- Hydra Fracture Analysis.
- Max allowable pressure.
- Allowable pressure.
- Anticipated pressure.





Delft Equation

$$P'_{max} = [\sigma'_0(1 + \sin \varphi) + c \cos \varphi + c \cot \varphi] \left[\left(\frac{R_0}{R_{p,max}} \right)^2 + \frac{(\sigma'_0 \cdot \sin \varphi + c \cdot \cos \varphi)}{G} \right]^{\frac{-\sin \varphi}{(1 + \sin \varphi)}} - c \cot \varphi [1]$$

Where:

$\sigma'_0 =$

Effective Stress [kPa]

$\varphi =$

Effective Angle of Internal Friction [degrees]

$c =$

Cohesion [kPa]

$R_0 =$

Initial Hole Radius [m]

$R_g =$

Hole Radius [m]

$R_{p,max} =$

Maximum Plastic Radius [m]

$G =$

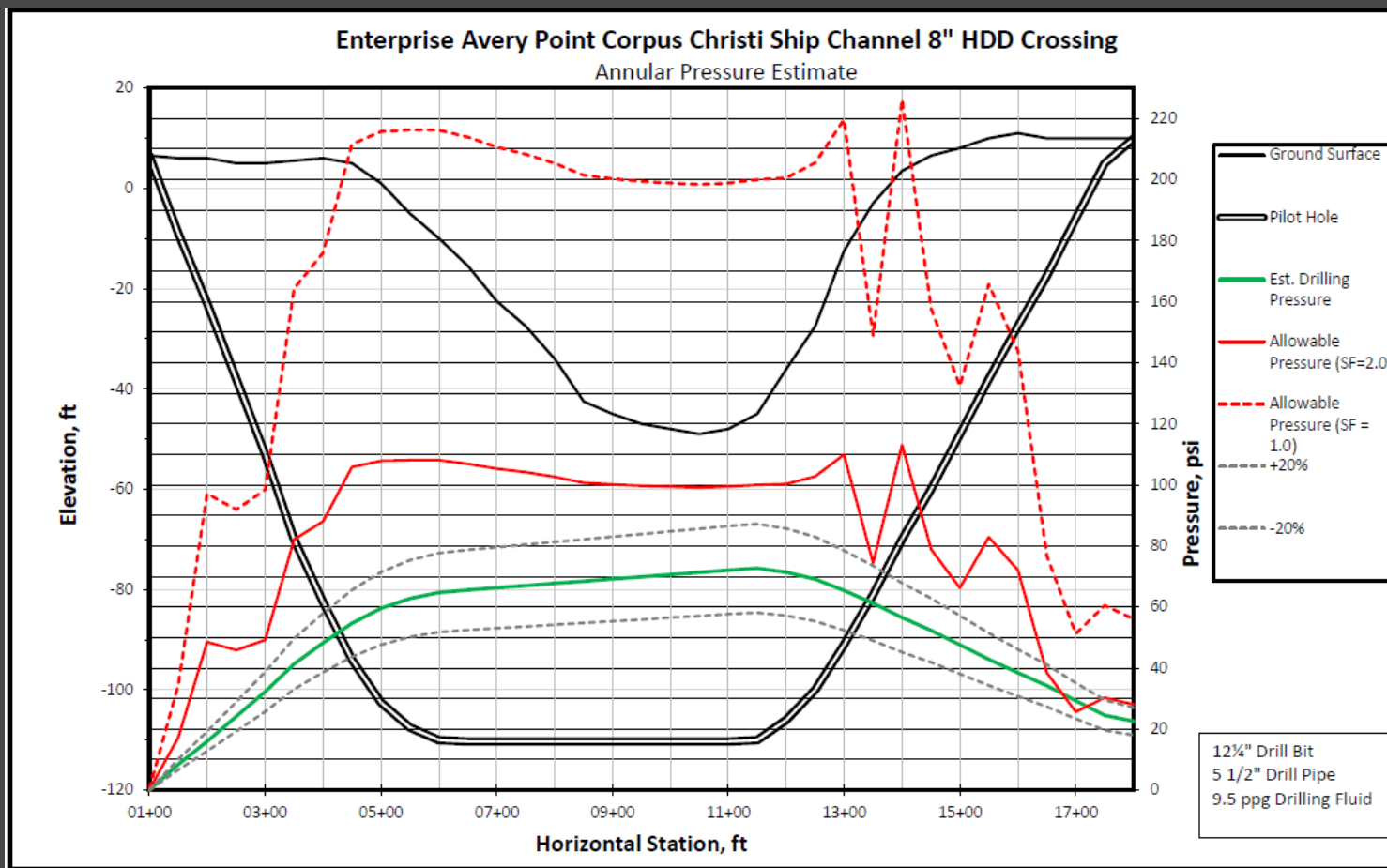
Shear Modulus [kPa]

$P'_{max} =$

Maximum Allowable Pressure [kPa]



Hydra Fracture Analysis





How do we control Annular Pressure?

- Select the correct soil layer.
- Install surface casing.
- Control the percent of solids in the drill mud.
- Control the GPM's pumped.
- Bottoms up (circulation of the hole).





Data from Annular Pressure Tool

Nr	X(ft)	Y(ft)	Z(ft)	Elevation (ft)	Inclination (°)	Azimuth (°)	Minimum Mud Pressure (psi)	Maximum Mud Pressure (psi)	Average Mud Pressure (psi)	Total Distance (ft)
0	0.00	0.00	0.00	6.15	-17.54	17.07	0.00	0.00	0.00	0.00
1	17.99	0.01	-5.71	0.44	-17.75	17.21	0.00	0.00	0.00	18.87
2	48.76	0.09	-15.39	-9.24	-16.92	17.22	0.00	0.00	0.36	51.13
3	79.19	0.14	-24.44	-18.29	-16.46	17.11	7.25	26.11	16.68	82.88
4	109.74	0.15	-33.46	-27.31	-17.08	17.31	18.85	29.01	22.84	114.73
5	140.59	0.13	-42.91	-36.76	-16.95	17.11	23.21	24.66	26.11	147.00
6	171.20	0.21	-52.28	-46.13	-17.30	17.28	55.11	71.07	51.85	179.01
7	201.87	0.35	-61.55	-55.4	-16.32	17.28	44.96	46.41	55.84	211.05
8	232.18	0.57	-70.56	-64.41	-17.43	16.89	47.86	98.63	83.03	242.68
9	262.83	0.45	-79.58	-73.43	-15.38	16.84	60.92	171.14	133.43	274.63
10	293.66	0.38	-87.98	-81.83	-13.43	17.33	91.37	116.03	96.45	306.59
11	324.60	0.65	-95.37	-89.22	-12.10	17.25	102.98	131.98	105.88	338.40
12	356.04	0.79	-101.55	-95.4	-9.89	17.36	97.18	126.18	99.35	370.44
13	387.79	0.98	-106.61	-100.46	-8.40	17.40	118.93	134.89	110.23	402.60
14	419.12	1.04	-110.89	-104.74	-6.69	17.10	105.88	111.68	102.25	434.22
15	450.89	1.17	-114.37	-108.22	-5.64	17.30	110.23	129.08	109.87	466.18
16	482.35	1.15	-116.81	-110.66	-3.22	16.83	107.33	114.58	102.98	497.74
17	514.35	1.24	-118.33	-112.18	-1.94	17.31	110.23	114.58	102.25	529.78
18	546.04	1.33	-119.04	-112.89	-0.37	17.25	105.88	121.83	104.06	561.48
19	578.13	1.37	-119.16	-113.01	0.11	17.21	94.27	113.13	101.16	593.57
20	610.01	1.38	-119.16	-113.01	0.57	16.93	95.72	116.03	98.62	625.45
21	642.26	1.32	-119.08	-112.93	0.31	16.92	105.88	116.03	100.80	657.70
22	674.43	1.28	-118.90	-112.75	0.08	16.75	87.02	92.82	101.89	689.87



What are the pros and cons of monitoring Annular Pressure?

- Pro's
 - Cleaner and safer hole
 - Helps prevent IR's
 - Real time annular pressure readings.
 - Better for the environment.
 - Improves HDD image as an industry.





What are the pros and cons of monitoring Annular Pressure?

- Con's
 - Decreases Rate of Penetration by half.
 - Must have Hydra fracture Analysis.
 - Requires additional mitigation procedures
 - Significant cost impacts





Summary

- Annular pressure monitoring is a very useful tool when utilized correctly.





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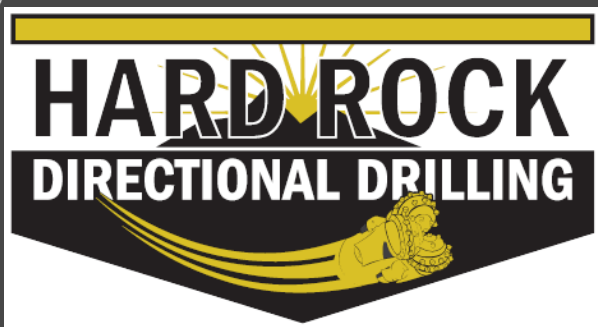
Questions and Answers





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Thank You