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Geothermal well diagnostics with high temperature video technology



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Geothermal Challenges

Scale

Nature of geothermal fluid

Inevitable challenge

Impacts production

Well deformation

Geologically active areas

Main reason for early abandonment

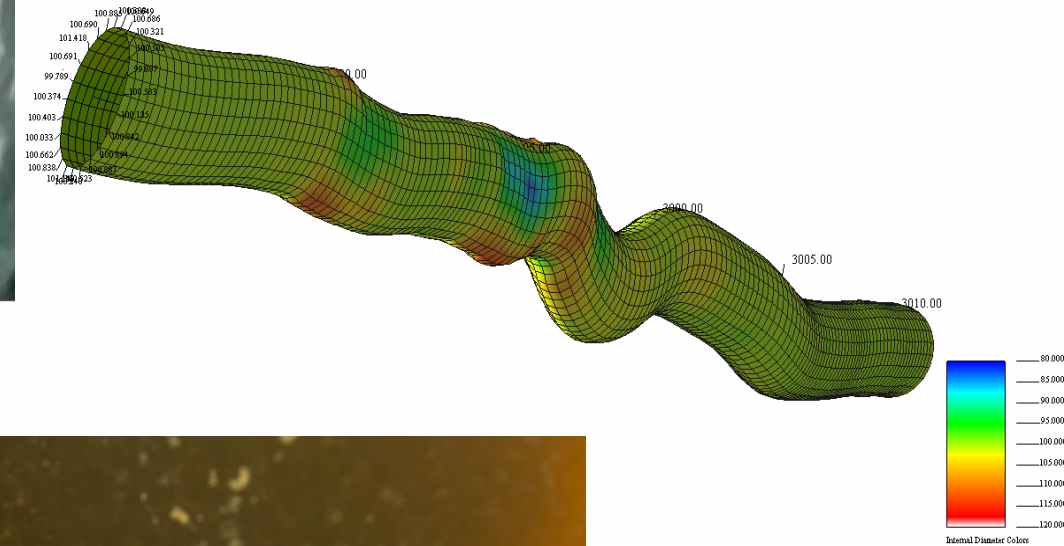
Corrosion

Corrosive composites in fluid

Production well → High H₂S and CO₂ content

Injection well → High O₂ content

Manageable challenge



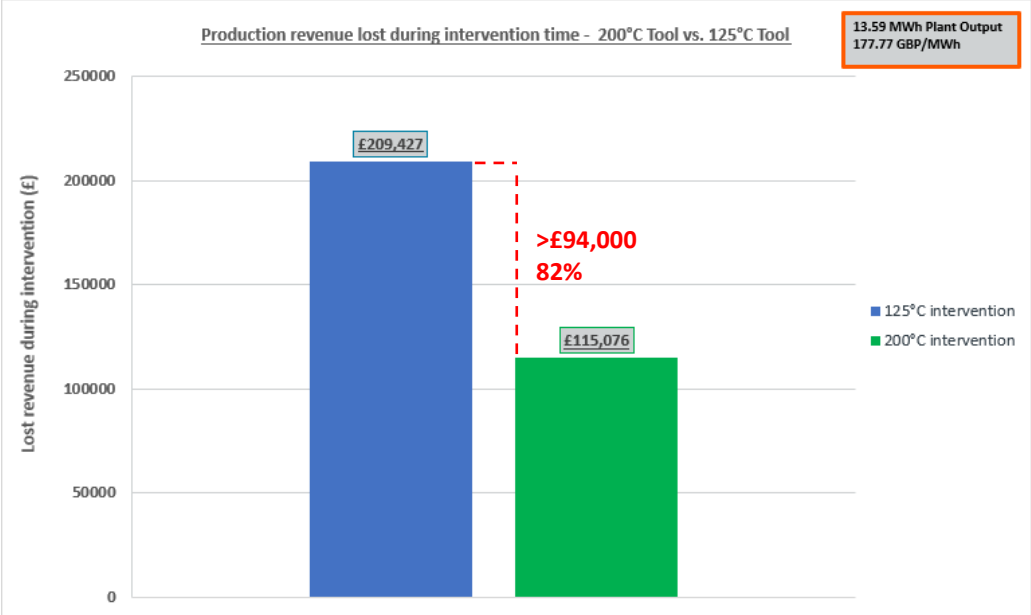
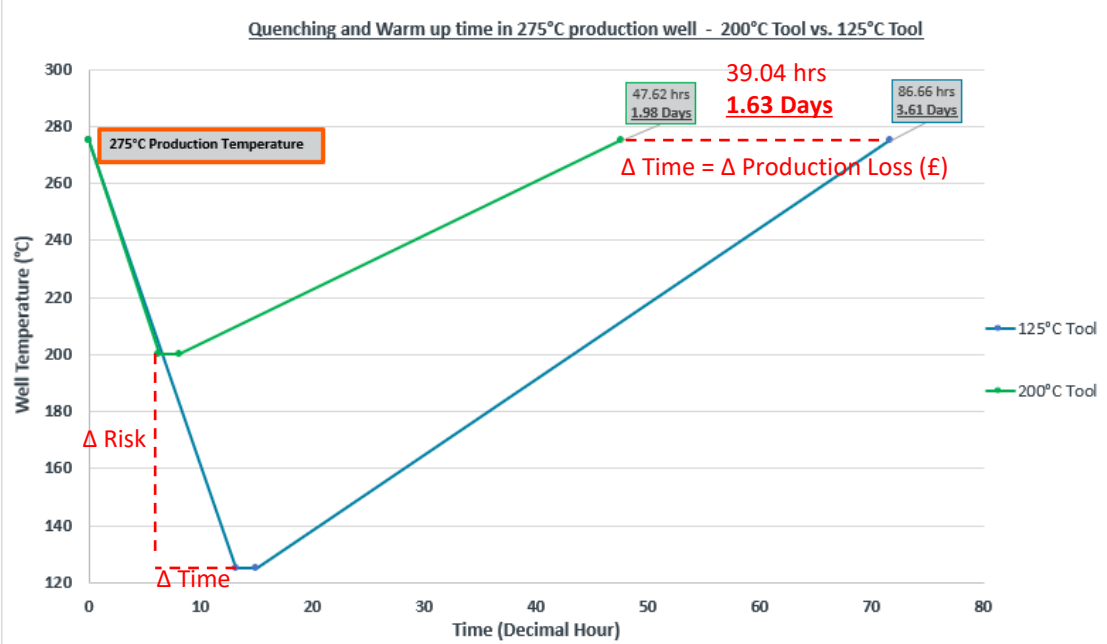
High Temperature Tools

Minimises the quenching requirements

Maximise accessibility to AOI

Maximise time efficiency

Minimises disruption in production



Inspection of Deformation in Monitor Well

Challenge

Understand shallow restriction

Objective

Inspect restriction

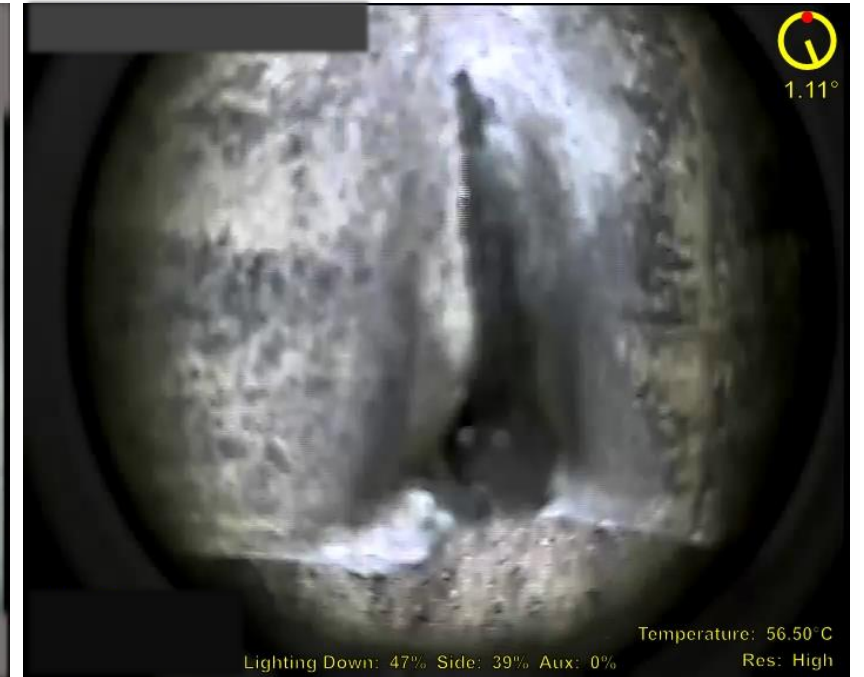
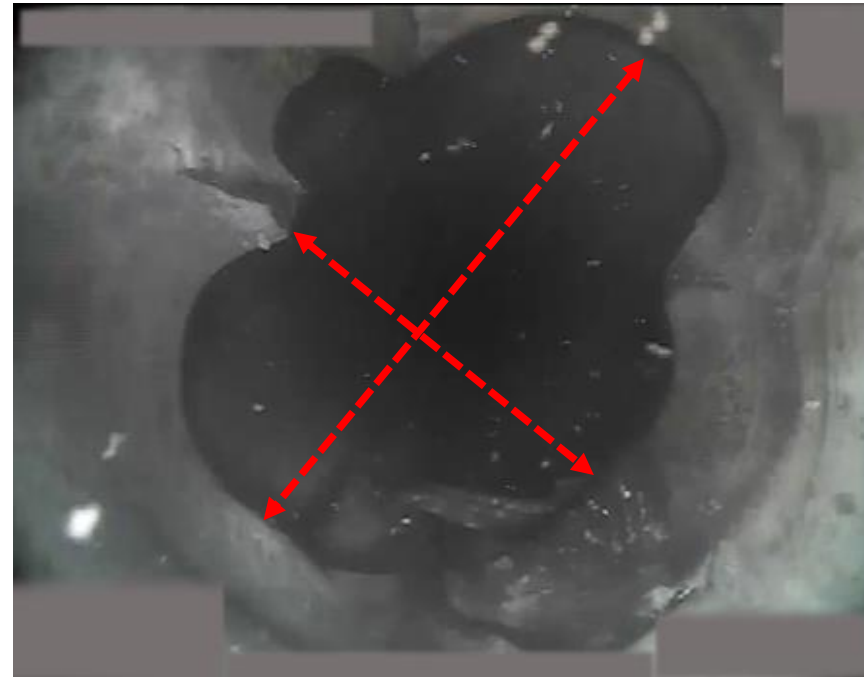
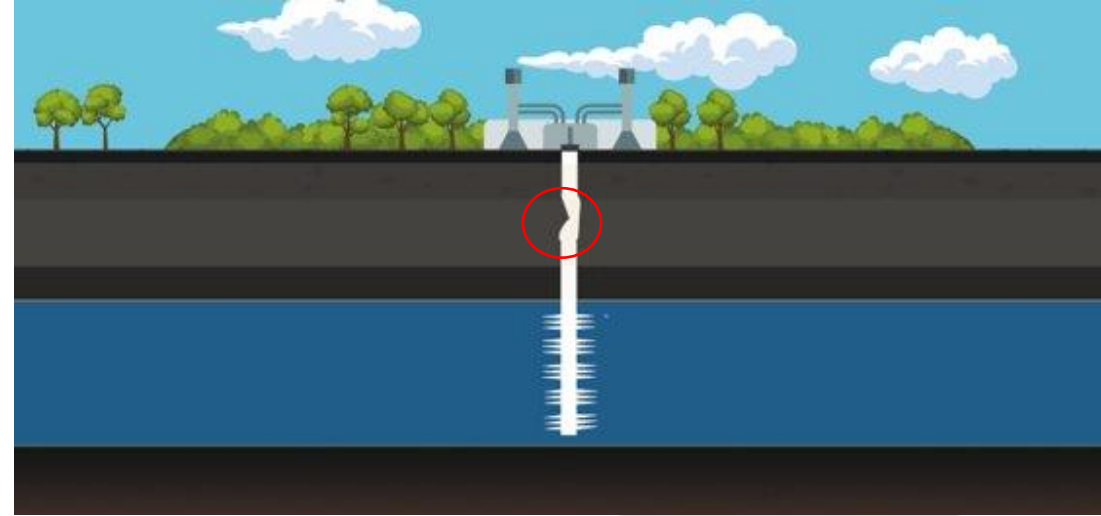
Results

Liner breach

Action

Mechanical Swaging

Successful abandonment



Remedial Aid in Injection Well

Challenge

Plan and perform remedial intervention
Restore injectivity

Objective

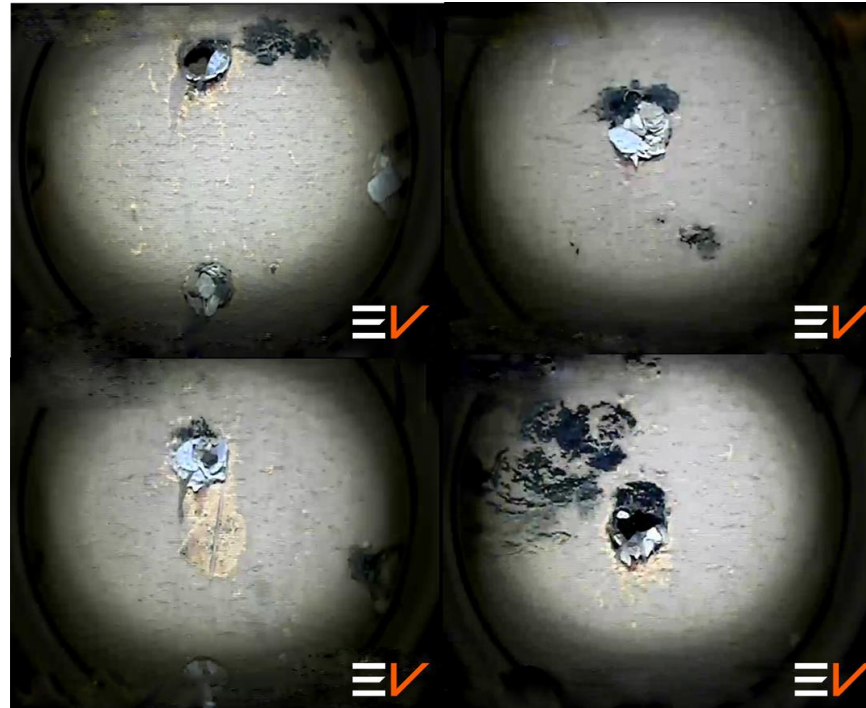
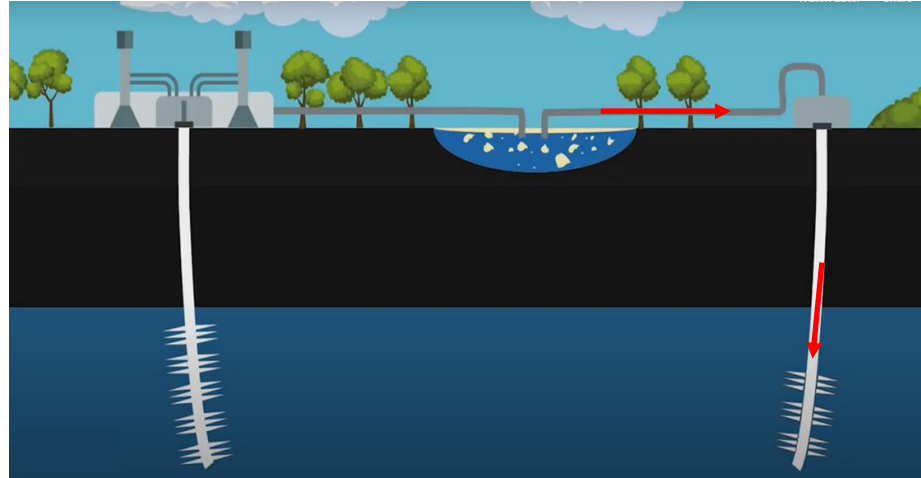
Aid remedial decision making
Inspect well integrity

Results

Scale fragments confirmed
No significant corrosion in well

Action

Scale clean up
Injectivity better than before



Exploration of Hold Up Depth in Monitor Well

Challenge

Understand anomalous hold up
Confirm milling job

Objective

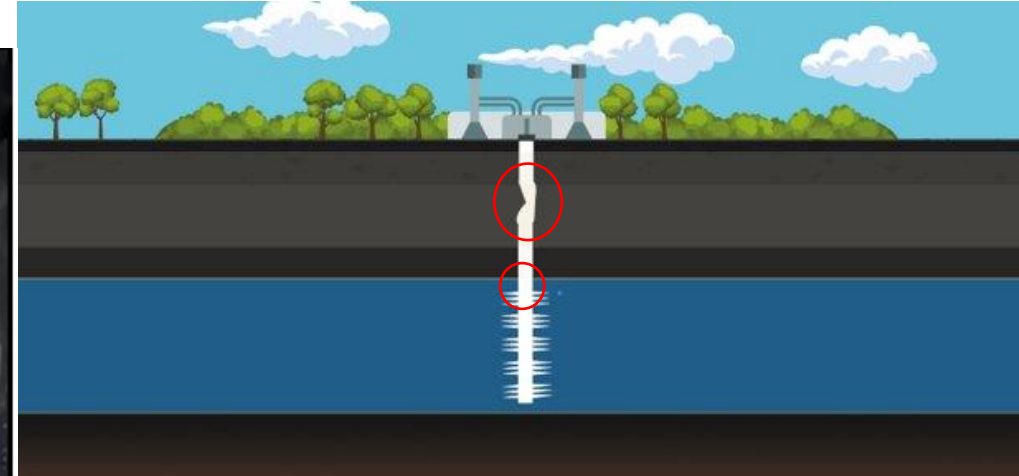
Identify the encountered obstruction
Assess milling job

Results

No new damage
Milling confirmed successful

Action

Place cement plug on top of liner
Successfully abandoned well



Fishing Operation in Production Well

Challenge

Recover anti-scale tubing
Recommence the production

Objective

Aid fishing operation
Explore for restrictions

Results

Discovery of unexpected scale
Real-time portrayal of fish

Action

Ramp up anti-scale program
Well back on production



Conclusions

High temperature cameras are an optimal diagnostic solution for geothermal wells.

Minimizing strain in well and on production.

High resolution data, minimising risk of missing small crucial details.

Proven geothermal track record.



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Thank you!



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Q&A Slides

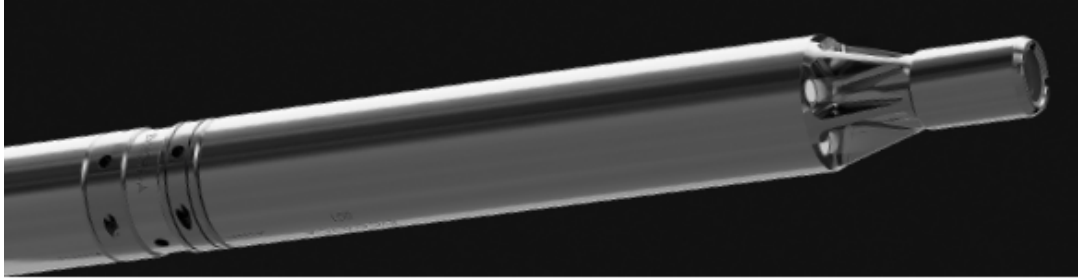


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EV High Temperature Cameras

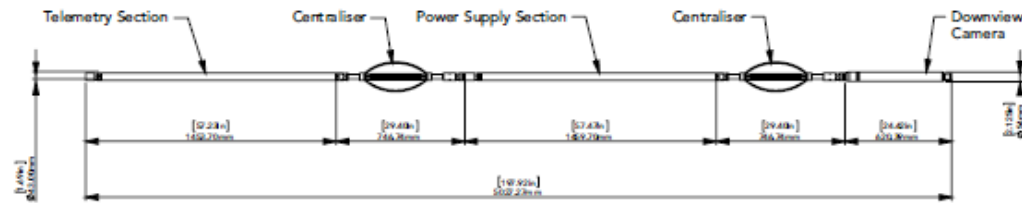
R200



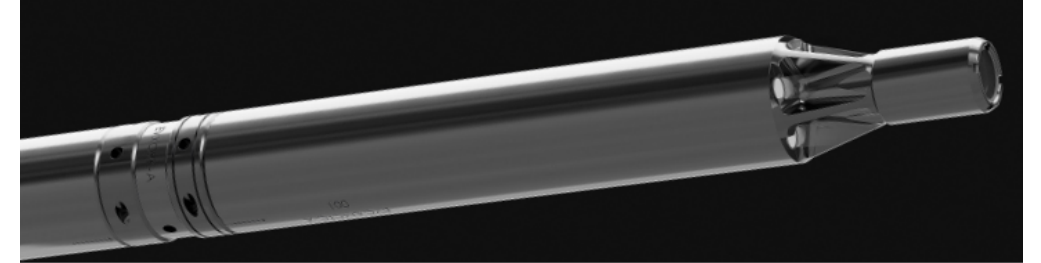
SPECIFICATIONS

Diameter	2.125 in	54.0 mm
Length*	197.92 in	5027.27 mm
Pressure rating	15,000 psi	1034 bar
Temperature rating	392 °F (4 hours)	200 °C (4 hours)
Camera Type	Downview (Monochrome)	
Video Frame Rate	Up to 4 fps	
Orientation Sensor	High-side relative bearing and deviation from vertical	
Field of View	112° (Water) / 135° (Gas)	
Recording Capacity	Continuous real-time transmission to surface with any mono-conductor and multi-conductor cable	
H2S / CO2	Compatible with corrosion resistant materials throughout	

*Example tool string



R150



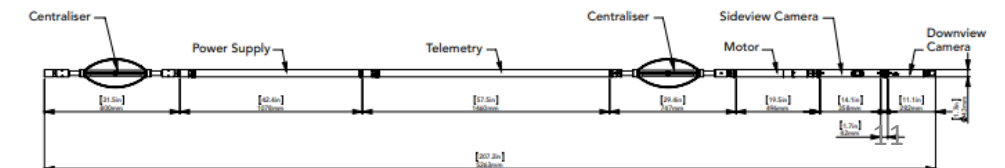
SPECIFICATIONS

Diameter	1.7 in	43.0 mm
Length*	207.2 in	5263.0 mm
Pressure rating	15,000 psi	1034 bar
Temperature rating	302 °F (6 hours/3 hours) ¹	150 °C (6 hours/3 hours) ¹
Camera Type	Downview (Monochrome) & 360° Motorised Sideview (Monochrome)	
Video Frame Rate	Up to 4 fps	
Orientation Sensor	High-side relative bearing and deviation from vertical	
Field of View	112° (Water) / 135° (Gas)	
Recording Capacity	Continuous real-time transmission to surface with any mono-conductor or multi-conductor cable	
H2S / CO2	Compatible with corrosion resistant materials throughout	

* Example tool string

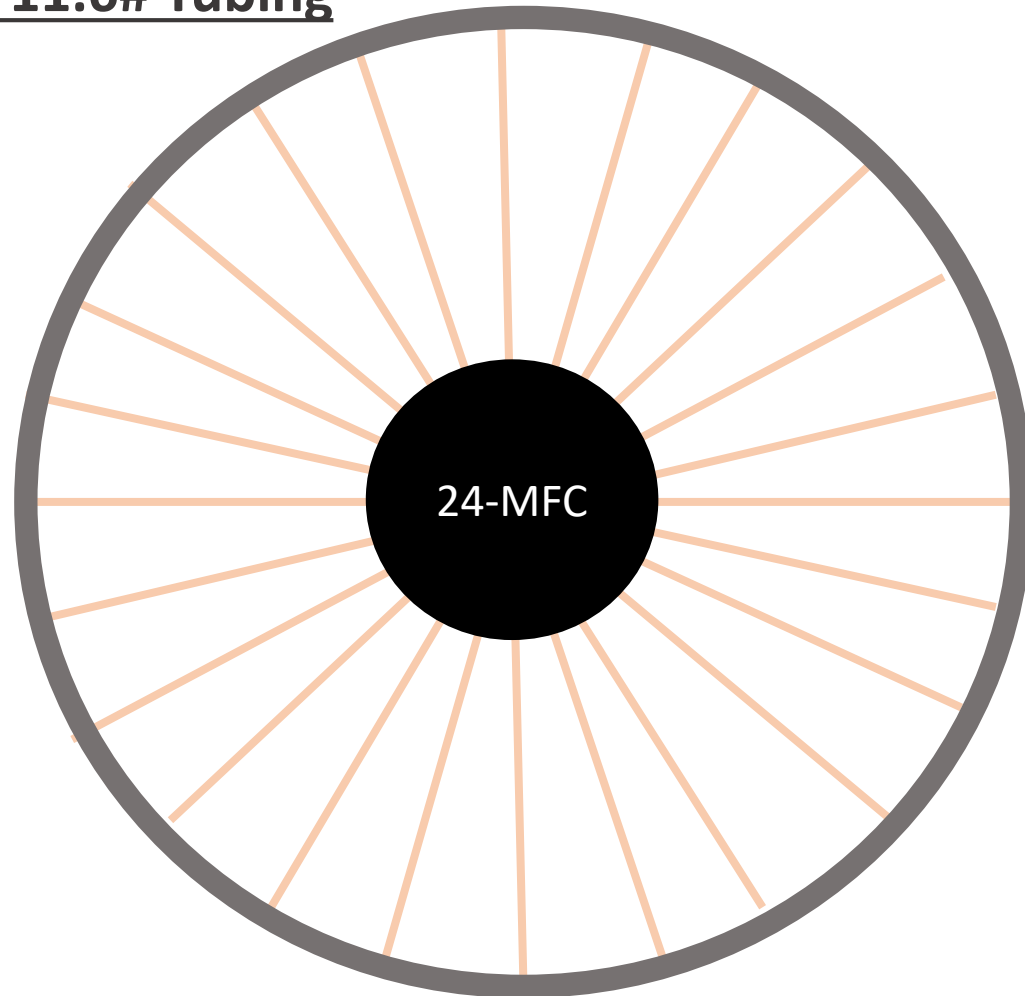
¹ Two flasked telemetry versions exist. Type 1 is rated to 150°C for up to 6 hours. Type 2 is rated to 150°C for up to 3 hours.

*Example tool string



Camera vs. Static diagnostic tool

4.5" 11.6# Tubing

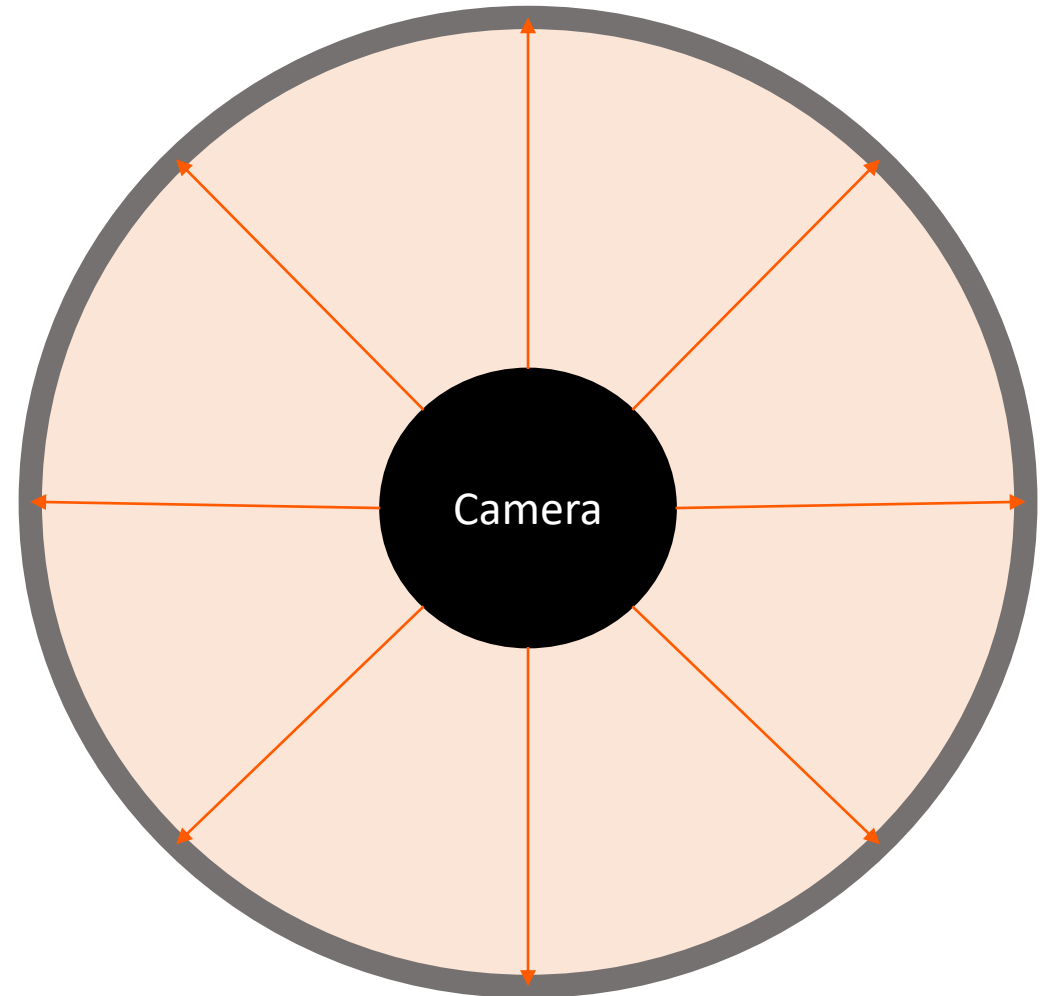


12% Pipe wall coverage

Number of fingers: 24

Finger contact: 1.5"

Pipe circumference: 12.6"



Full 360° visibility

Not Limited to pipe ID