ADRILLTECH
ADVANCED DRILLING TECHNOLOGIES

# GEOTHERMAL 2023

## REALISING THE AMBITION

# *MULTIPHASE DRILLING FLUID UTILIZING CCS ON GEOTHERMAL OPERATIONS*

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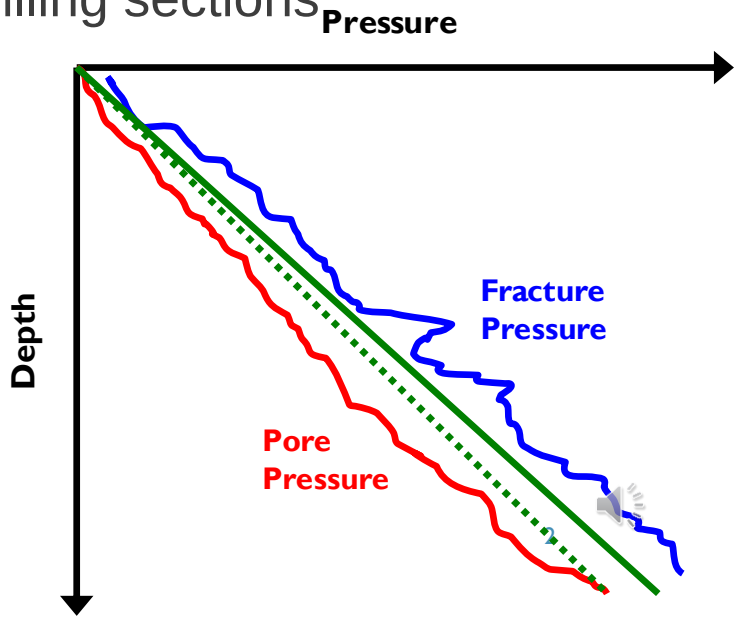
# CCS- GEOTHERMAL DRILLING APPLICATIONS

**Geothermal Drilling with Constant Circulating System (CCS) in Conjunction with Multiphase Fluids**

Enables the reduction of NPT in  Geothermal Drilling:

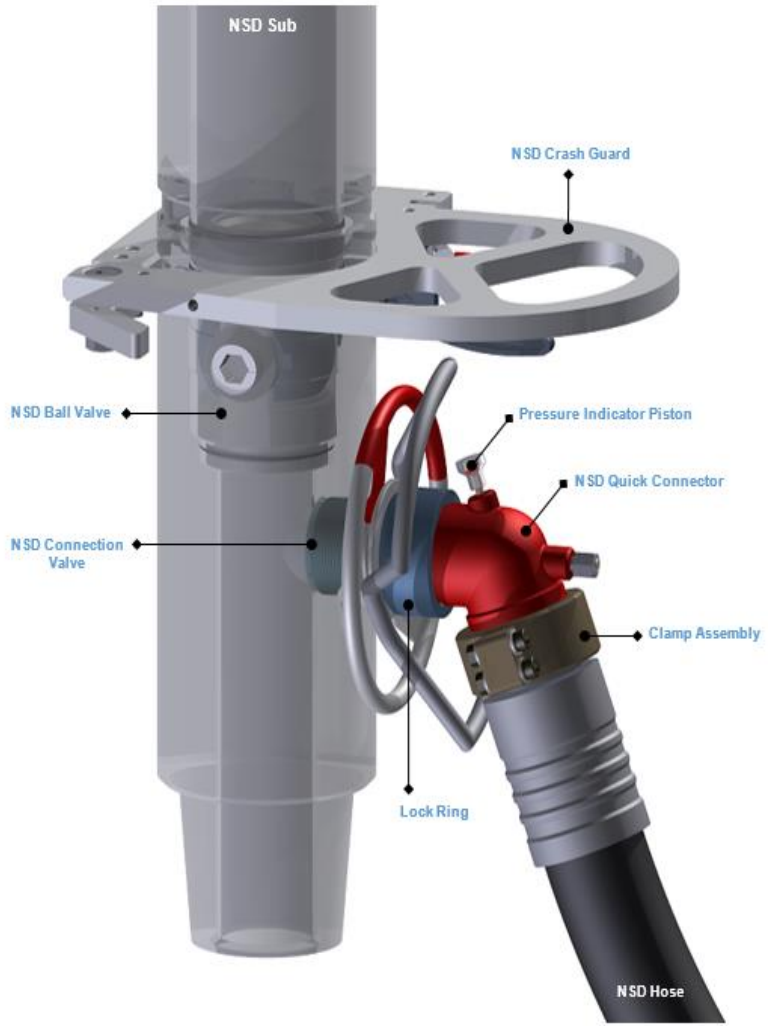
- Combined systems have been used in Volcanic Ash/Tuff drilling sections
- Mitigate Total losses in fractured formations
- Mitigates Stuck Pipe/Lost BHA's from hole collapse
- Reducing Connection Times with Multiphase flow
- Good ECD control
- Allows for improved BHA Temperature Control



# MULTIPHASE
# DRILLING FLUID FOR GEOTHERMAL OPERATIONS

| Drilling Fluid | Description | Application | Remarks |
|---|---|---|---|
| Air | • Air is the continuous phase | • Extremely low formation pressure<br>• Non water-bearing formations | • May require large air equipment spread<br>• Higher annular velocities can be expected |
| Foam/Stiff Foam | • A mixture of water or polymer slurry with foaming agents is added to compressed air stream | • Large annular spaces (washouts, vugular formations)<br>• Macro fractured formations<br>• Water-bearing formations | • Less volumes of water required than single phase fluids<br>• Mist pump required to achieve stiff foam<br>• Improved well bore stability<br>• Improved cuttings carrying capacity |
| Aerated Mud | • Liquid based Drilling fluid is the continuous phase<br>• Air is added to reduce the hydrostatic pressure | • Weak Formations<br>• Unstable formations with subnormal pressure (6 to 8 ppg (0.72-0.96 sg) EMW | • Maintain Higher density Fluids<br>• No Mist pump required |

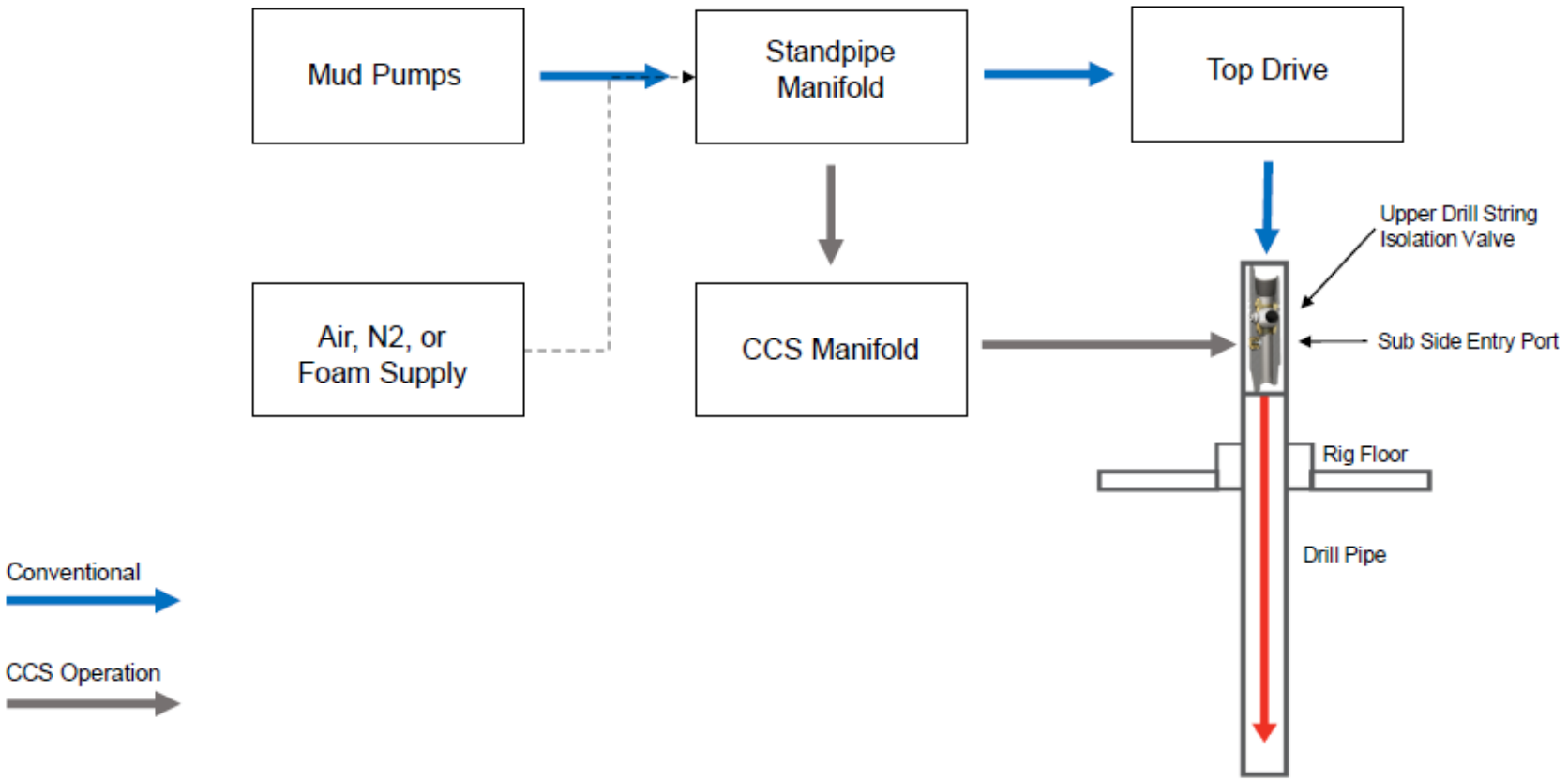
# CCS SYSTEM OVERVIEW

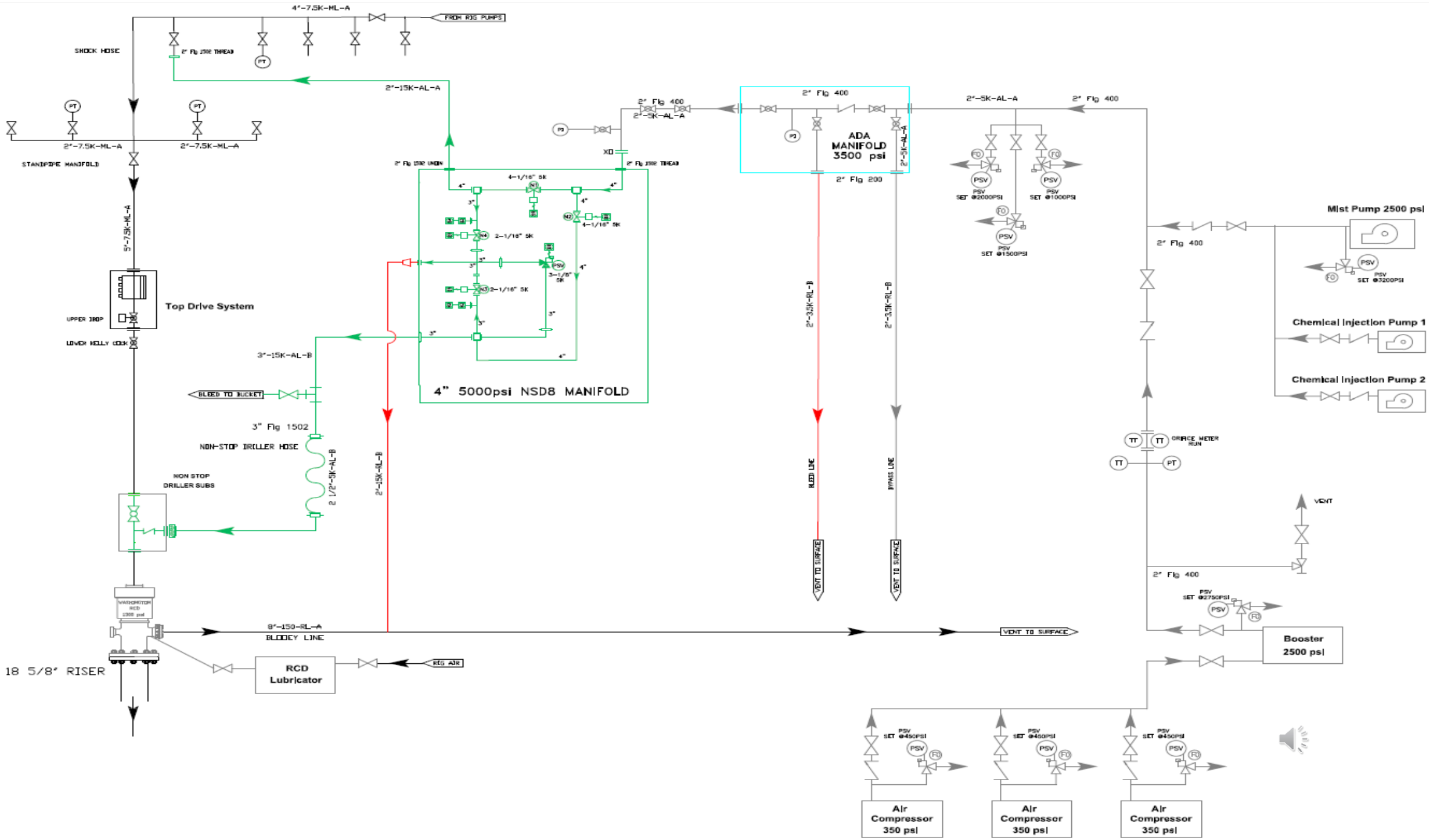


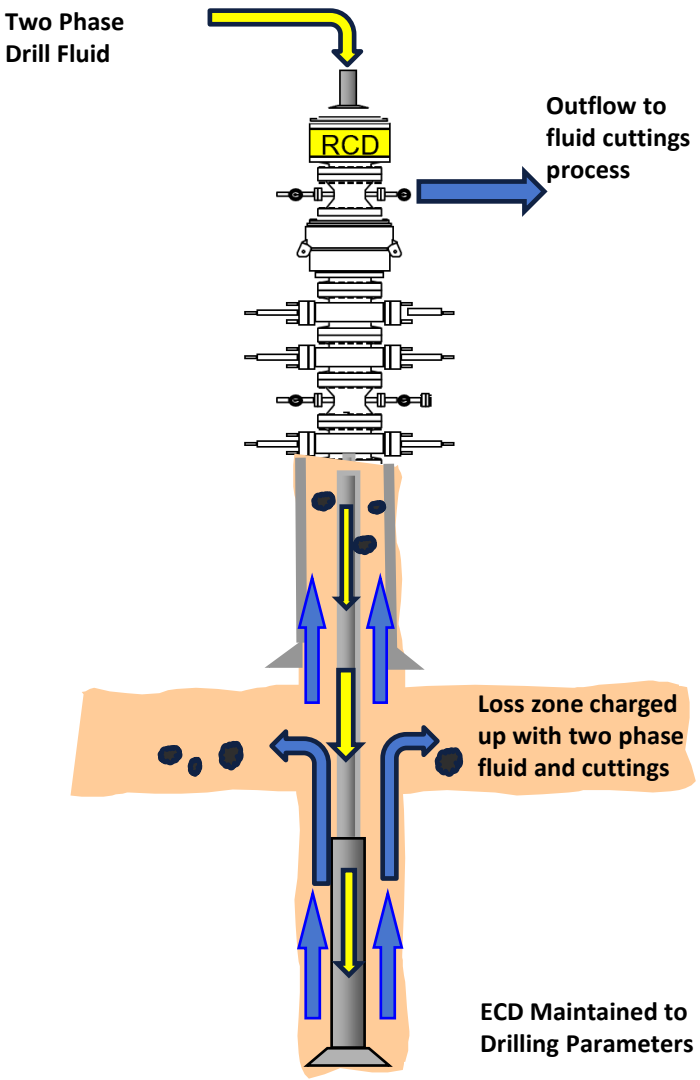

- The CCS system is a DNV certified process that allows the pressure isolation of the rigs top drive via diverting flow through a manifold to a drill pipe sub that has an internal ball valve and side entry port . Thus, enabling the continued circulation of drill pipe whilst making a drill pipe connection.
- Subs are made up to the top of each drill pipe stand that is required to drill a predetermined well section, .
- Subs can be manufactured to fit desired drill pipe tool joint from 4” to 6 5/8” .

# MULTI PHASE FUID WITH CONTINUOUS CIRCULATION

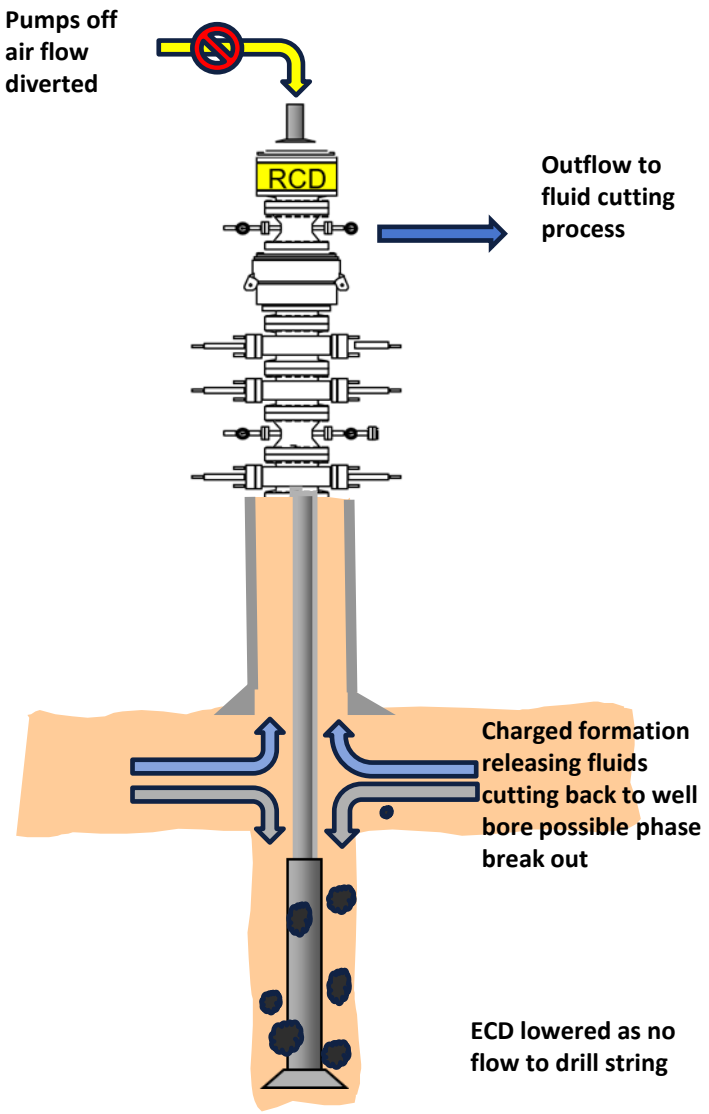
## CCS - Flow Schematic & System Overview



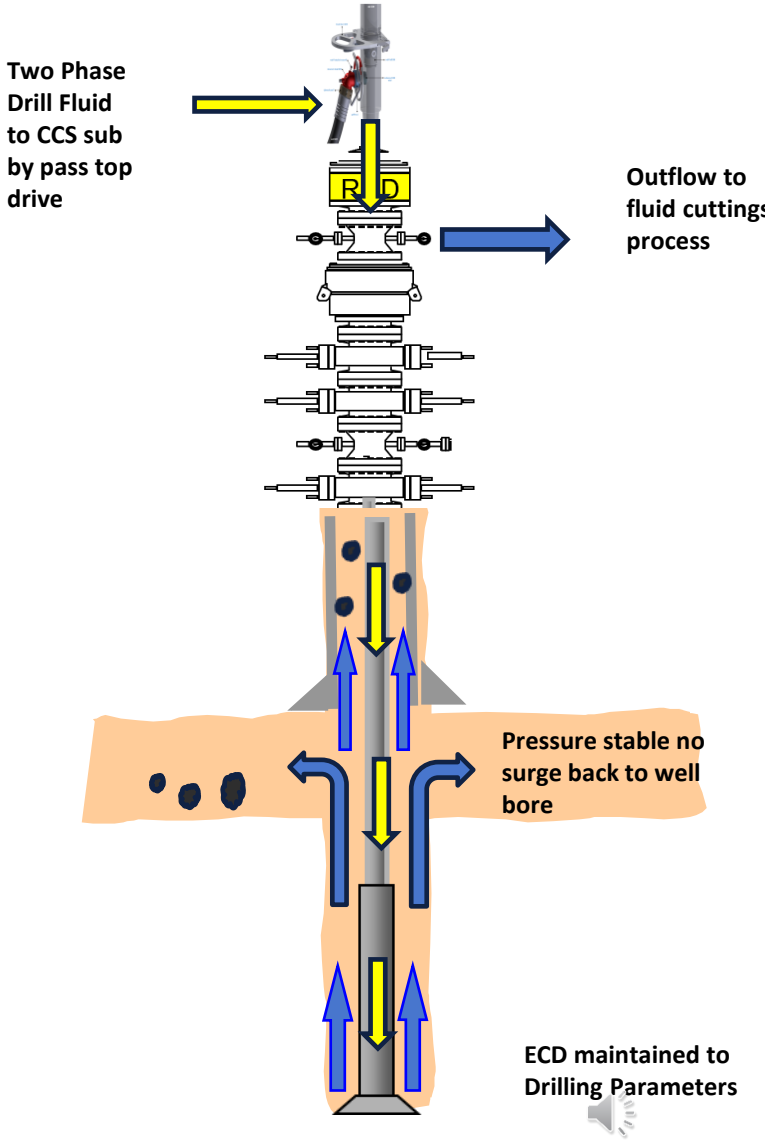

4"-7.5K-ML-A
FROM RIG PUMPS
SHOCK HOSE
2" Fig 1502 THREAD
PT
2"-15K-AL-A
2" Fig 400
2"-5K-AL-A
2"-7.5K-ML-A
2"-7.5K-ML-A
STANDPIPE MANIFOLD
5"-7.5K-ML-A
Top Drive System
UPPER IBOP
LOWER KELLY COCK
3"-15K-AL-B
BLEED TO BUCKET
3" Fig 1502
NON-STOP DRILLER HOSE
2 1/2"-5K-AL-B
NON STOP DRILLER SUBS
2"-15K-RL-B
4" 5000psi NSD8 MANIFOLD
4-1/16" 5K
2-1/16" 5K
3-1/8" 5K
2" Fig 1502 UNION
2" Fig 1502 THREAD
XO
ADA MANIFOLD 3500 psi
2" Fig 200
2"-5K-AL-A
2"-3.5K-RL-B
BLEED LINE
BYPASS LINE
VENT TO SURFACE
VENT TO SURFACE
PSV SET @2000PSI
PSV SET @1000PSI
PSV SET @1500PSI
Mist Pump 2500 psi
PSV SET @3200PSI
Chemical Injection Pump 1
Chemical Injection Pump 2
TT
TT
ORIFICE METER RUN
TT
PT
VENT
PSV SET @2750PSI
Booster 2500 psi
8"-150-RL-A
BLOOEY LINE
VENT TO SURFACE
18 5/8" RISER
RCD Lubricator
REG AIR
PSV SET @450PSI
PSV SET @450PSI
PSV SET @450PSI
Air Compressor 350 psi
Air Compressor 350 psi
Air Compressor 350 psi




Normal Drilling Operation

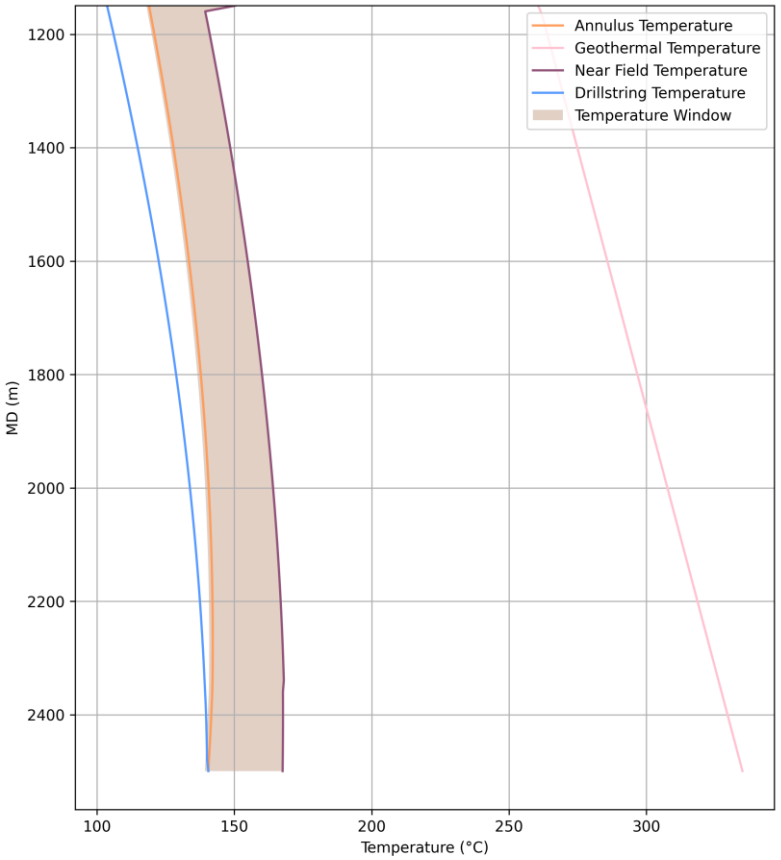



Normal Connection

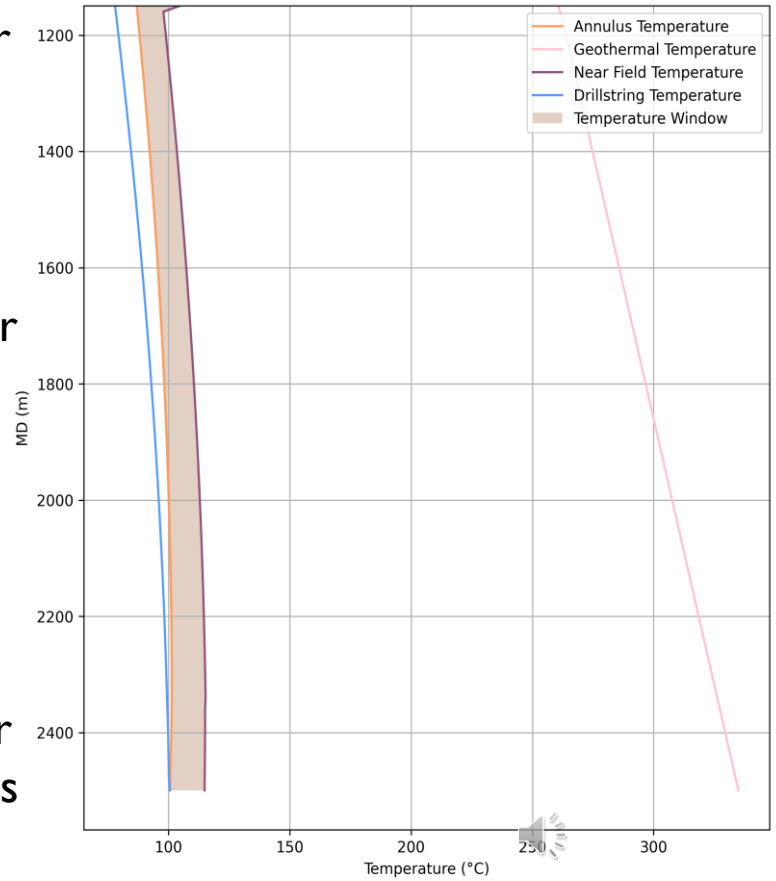



CCS Connection

# GEOTHERMAL SIMULATED NEAR BORE TEMPERATURE REDUCTION




- Left diagram drilling volcanics 3m/hr 8.5” reservoir section with water utilizing normal drilling connection procedures
- Right diagram drilling volcanic 3m/hr 8.5” reservoir section with water utilizing CCS on connections
- Results show that by using CCS a 35 to 40 deg C decrease in near well bore temperature.
  The reduced temp allows for longer use of mud motors and MWD tools limiting high temp degradation to down hole tools



# NON STOP DRILLER© - SUCCESSFUL OPERATIONS
# HIGH PRESSURE/HIGH TEMPERATURE MWD TOOLS SAVED

Assessed Hydrothermal Influx **350degC** at 60mbsf

Pumping

8-1/2"hole:

Influx Flow-in: 350degC x 200gpm at 60mbsf

38-114degC @ 600gpm

21-95degC @ 800gpm

Annular BP: 40psi @800gpm x 100mbsf

12-1/4"hole:

Influx Flow-in: 350deg C x 200gpm at 60mbsf

26-74degC @1200gpm

Annular BP: 20psi@1200gpmx100mbsf

Pumps Off

8-1/2"hole:

Influx Flow-in: 350deg C x 400gpm at 60mbsf

Max 182degC @ 2min

Max 212degC @ 3min

12-1/4"hole:

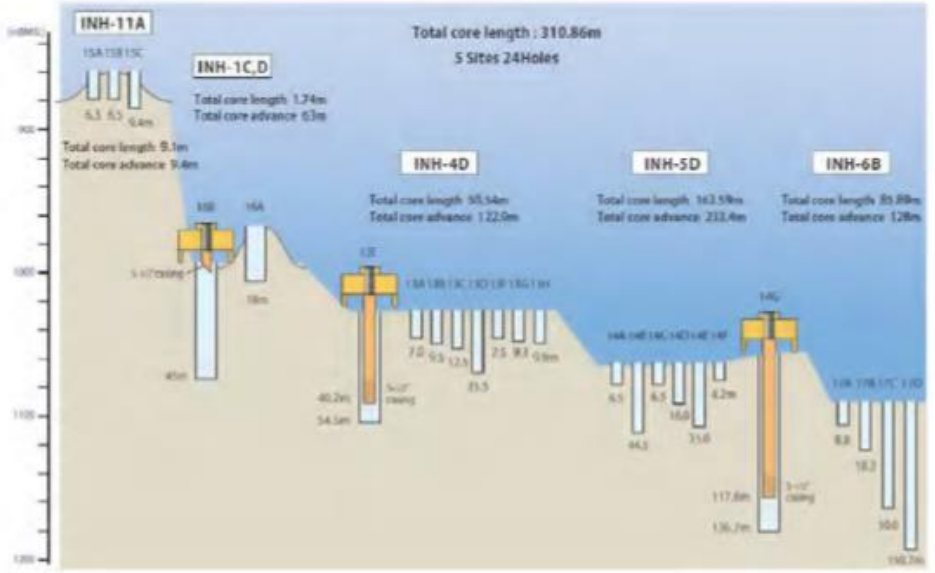
Influx Flow-in: 350deg C x 400gpm at 60mbsf

Max 128degC @2min

Max 168degC @3min

Max 196degC @4min

IODP EXP 331 Deep Hot Biosphere wells




- LWD Specification for 8 ½"hole size BHA temperature rating = **175degC**
- Worst conditions encountered during "no pumping" events while the hydrothermal fluid influx occurred upwards of 400degC

# STAR ENERGY / SCHLUMBERGER IPM; MBC-1 INDONESIA 2017

Star Energy / Schlumberger IPM first well NSD MBC-1 in Indonesia, 2017

- Drilled 3 sections, 17-1/2”, 12-1/4” and 8-1/2” section.
- WBM used for the 17-1/2” section with 2-phase drilling in 12-1/14” and 8-1/2” section
- A total of 1500m of open hole drilled with continuous circulation.
- No stuck pipe events.

# STAR ENERGY / SCHLUMBERGER IPM; WWA-7 INDONESIA 2017

Star Energy / Schlumberger IPM Second well with NSD WWA-7 in Indonesia, 2017

- Drilled 3 sections, 17-1/2”, 12-1/4” and 8-1/2” section.
- Single phase used for the 17-1/2” section with 2-phase drilling in 12-1/4” and 8-1/2” section
- A total of 2015m of open hole drilled with continuous circulation.
- No stuck pipe events.
- 7th Well on PAD, Deepest and fastest well drilled on pad by over 3 days and 500m deeper than previously been able to achieve.

# STAR ENERGY / SCHLUMBERGER IPM; MBC-1 / WWA-7 INDONESIA 2017

Utilizing CCS allowed STAR ENERGY to accomplish the following:

- Drilling with stands, compared to drilling in doubles conventionally due to need to make connections one single off bottom to allow drill string movement.
- Reduced the overall connection time from 35-45 mins to10 mins, by eliminating need to excessively back ream prior to connection and reduce the time it takes to regain stable 2 phase drilling ratios.
- Substantial risk reduction of stuck pipe during connections, due to drilled solids drop out, or formation collapse due to cyclic pressure variations in the wellbore.
- No stuck pipe incidents.
- Allowed section to be drilled to planned TD. Previous well abandon with BHA lost in hole due to sever well bore instability.

# SAE/ HALLIBURTON IPM; SMT-H2 INDONESIA

SAE/ Halliburton IPM first well NSD SMT-H2 in Indonesia, 2018

- Drilled 26” hole section with 2-phase drilling medium.
- Maintained constant circulation over whole section
- A total of 298m of open hole drilled with continuous circulation.
- No stuck pipe events.

# SAE/ HALLIBURTON IPM; SMT-H2 INDONESIA

SAE/ Halliburton IPM Second well NSD SMT-F1 in Indonesia

- Drilled 2 sections 17-1/2” and 12-1/4” side.
- A combination of single phase and 2-phase fluids used in loss zones.
- A total of 1688m of open hole drilled with continuous circulation.

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*Thank You!*

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