

DIMENSION BID

BASIC DOWNHOLE TOOL

Module 04

SKG-25



Course Outline

1. CHS Downhole Tools
2. Introduction to Cable Head
3. Introduction to Deployment Tools in E-Line
4. Introduction to Perforating Tools
5. Introduction to Logging Tools
6. Introduction to Advance Logging Tools

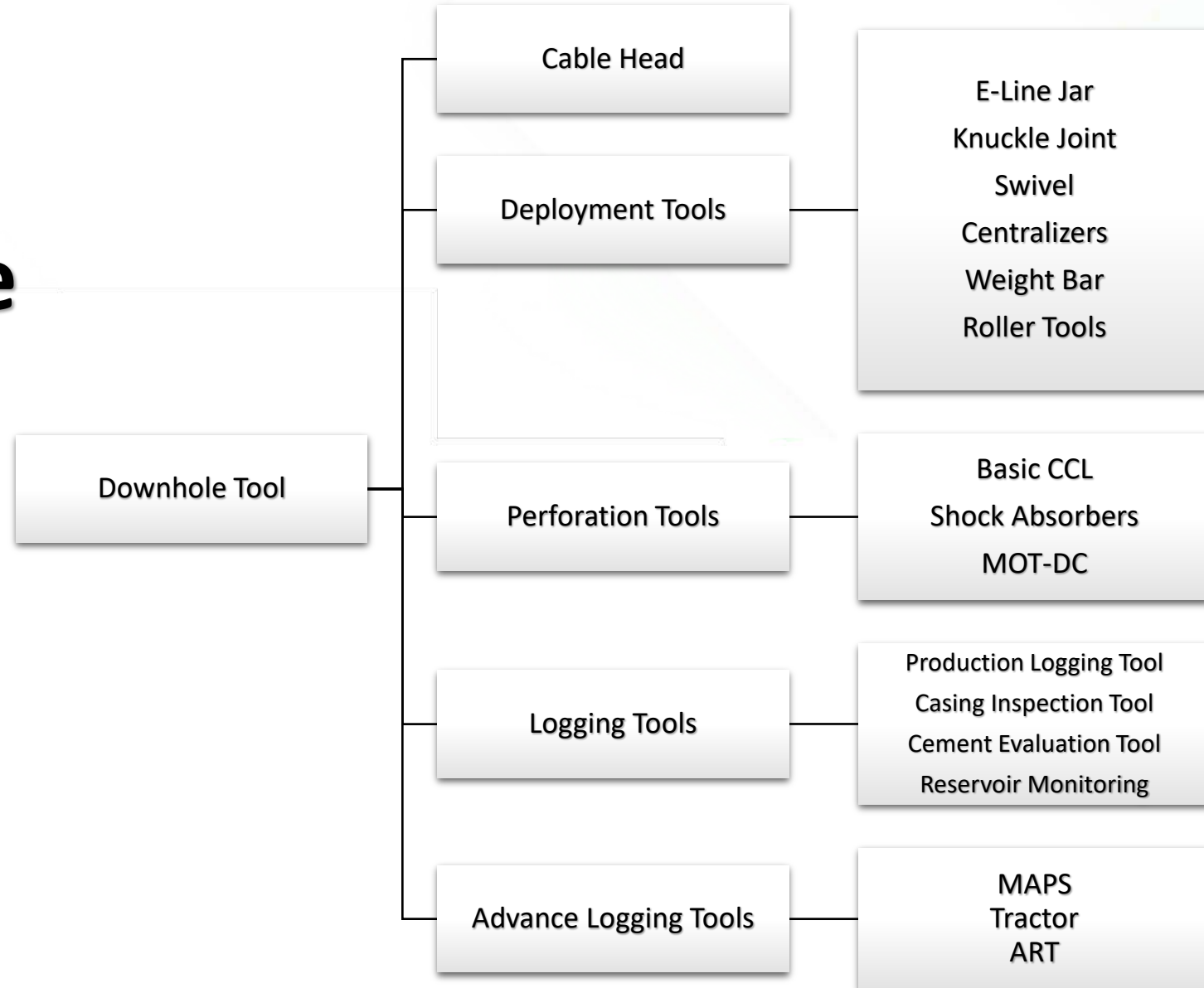
By the end of the course, participants should be able to:

1. Differentiate 5 general types of downhole tools.
2. Explain on the basic principle, function and application of the complete basic downhole tools.
3. Design the best tool that fits the **Job Objective** required accordingly.

CHS DOWNHOLE TOOLS

CHS Downhole Tools

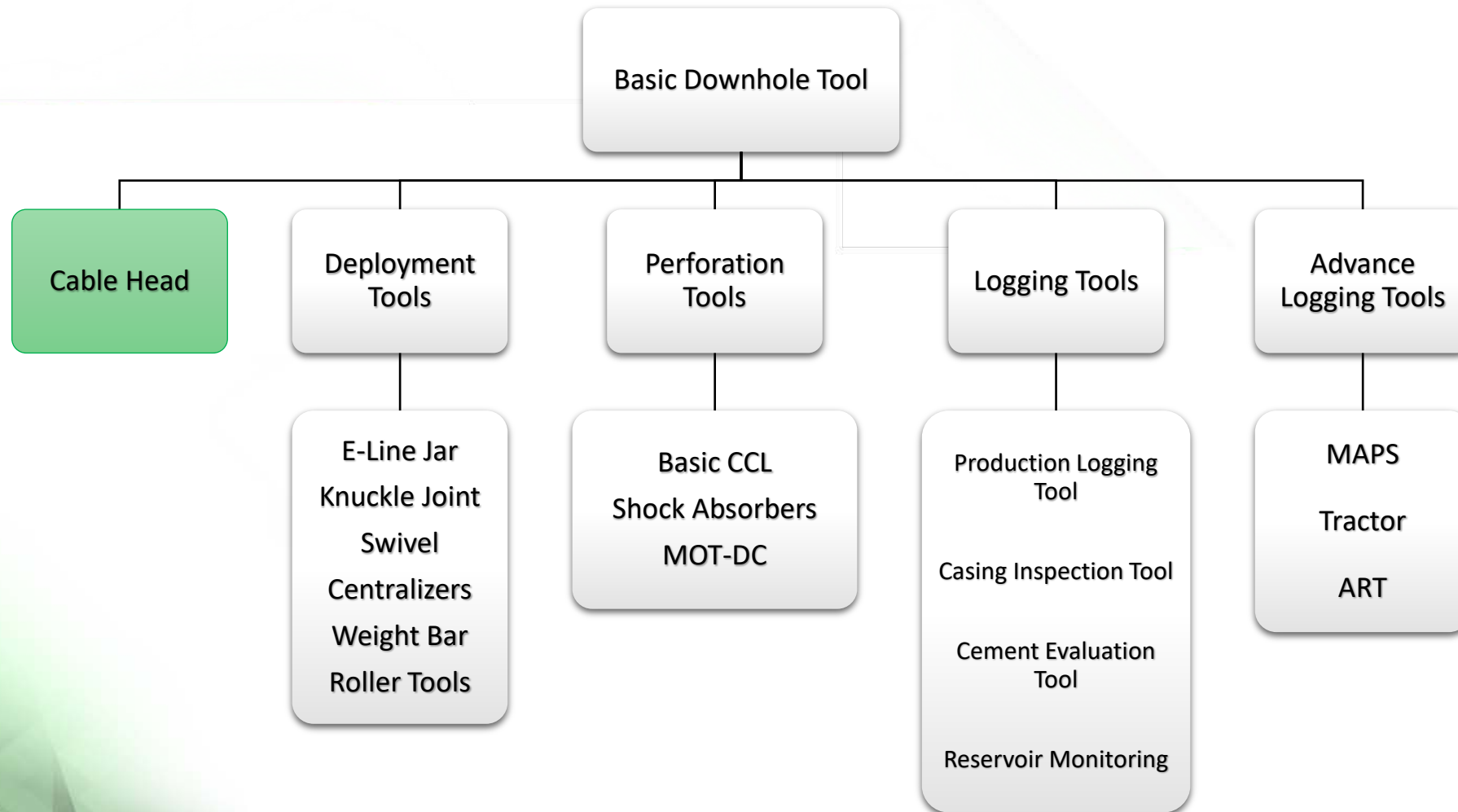
Dimension Bid offers a variety of services; from gathering production profile, reservoir monitoring, cement integrity and a wide range of explosive services coupled with years of experiences.



INTRODUCTION TO CABLE HEAD

Introduction to Cable Head

General types



Introduction to Cable Head

3D illustration



Robust electrical design;
foolproof from all types of
corrosive wellbore fluids

High Strength and Quality
Steel to survive in H₂S
environment

Convertible Weak Point
to adapt on various well
profiles

Introduction to Cable Head

Brief principle

- Cable heads provide **mechanical** and **electrical** connections between the wireline cable and tool string.
- Cable heads are constructed of high quality, high strength steel and H₂S resistant ensuring mechanical durability.
- Electric bulkhead protects the electrical connections from all types of corrosive wellbore fluids.
- A **weak point** inside the cable head bears the entire load of the tool string weight.
- Cable mechanical integrity is guaranteed by the high quality weak point incorporated inside the head ensuring clean release of a stuck tool string.



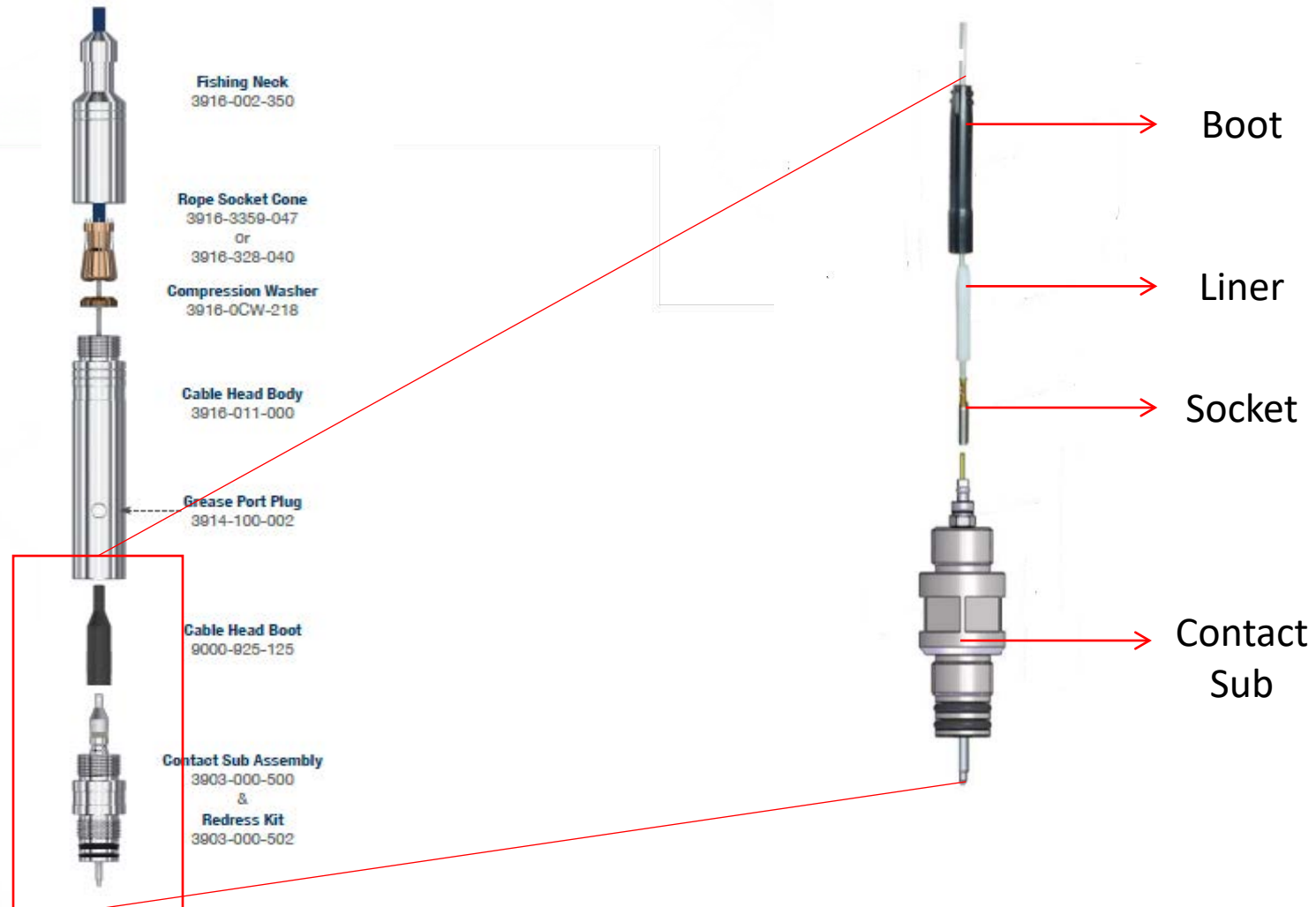
Introduction to Cable Head

Cable Head Applications and Features

- Cable head Application: ❖ Cased hole wireline support
 - ❖ Perforating
 - ❖ Production Logging
 - ❖ Wireline steering tool services
- Cable Head Features: ❖ Compatibility with all types of armored wireline cable
 - ❖ Built in weak point and standard slickline fishing head
 - ❖ High current tractor conversion kits available
- Benefits : ❖ Interchangeable parts allow multiple use with different types of cable
 - ❖ Reduce operating cause

Cable head contact sub

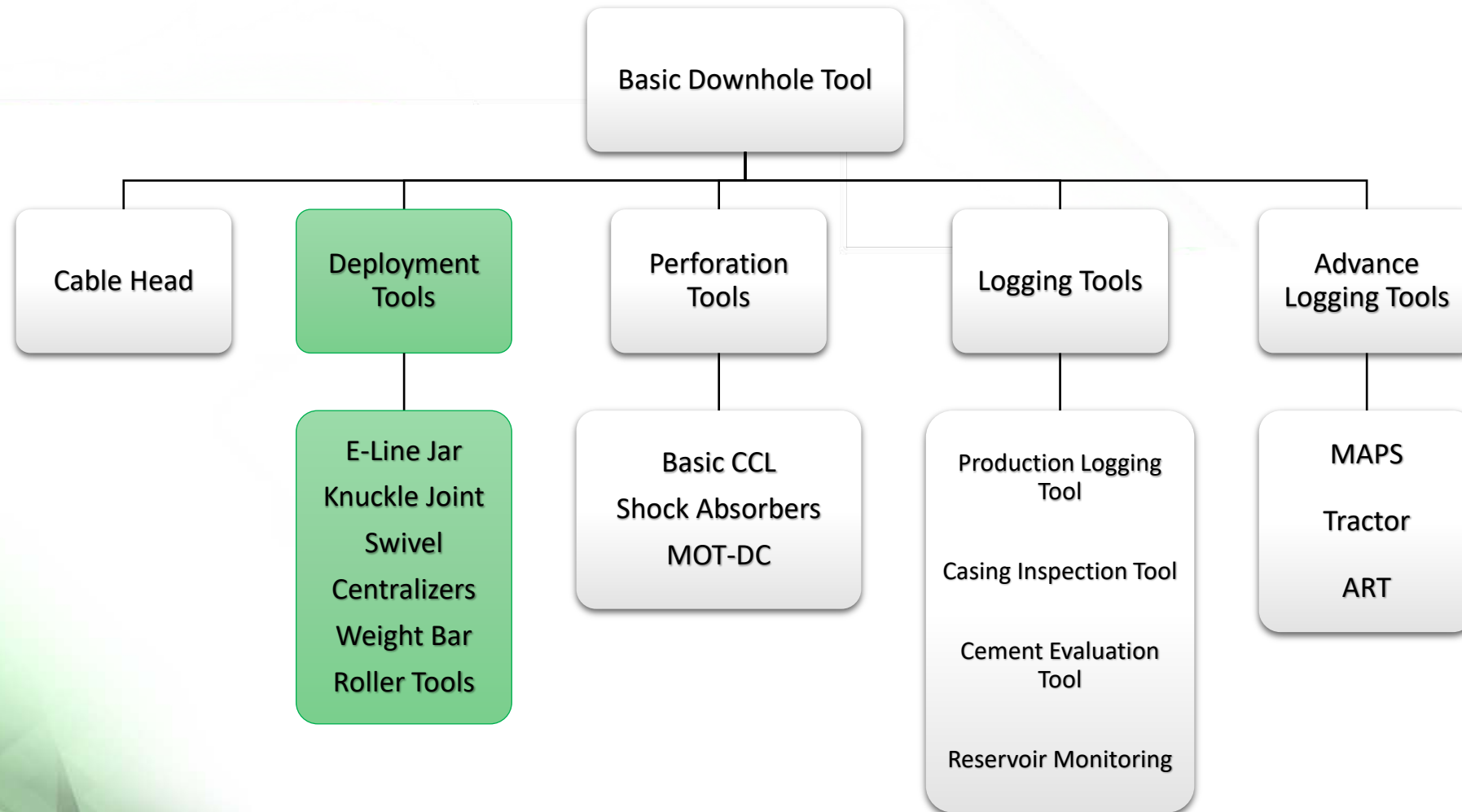
New revised design



INTRODUCTION TO DEPLOYMENT TOOLS

CHS Downhole Tools

General types



E-Line Jar

1. E-Line jars allow for more efficient and safer operations in even the harshest environments by virtually eliminating the risk of a stuck string and the staggering costs associated with stripovers, fishing, and rig downtime.
2. Factors to Consider:
 - Max safe pulling weight of the cable
 - Weight of the cable in the well-bore at target depth
 - Pull-out tension or “weak point” at the cable head
 - Remember that E-Line jars are typically run at the uppermost position with the bulk of the weight below the jar
3. [SKG\X-Calibur/Playback Video](#)



E-Line Jar Benefits

1. Facilitates logging, perforating, pipe recovery, and P&A operations under adverse wellbore conditions
2. Helps make wireline thru-tubing possible in lieu of rig workover
3. Offers a cost-effective alternative to coiled-tubing conveyance in many situations
4. Promotes reliable performance with an all-mechanical design protected from contaminants and unaffected by extreme pressures or temperatures
5. Ensures outstanding electrical integrity with fluid-to-air connectors tested at 550 mA and 500 V
6. Resets downhole in mere seconds, under its own weight, for unlimited activation cycles
7. Features a versatile, 1-9/16 inch diameter
8. Accommodates all e-line connections and slickline wire sizes
9. Reset and activate multiple time downhole.



Knuckle Joint

- 1. Knuckle Joint Function:** Compact universal ball joint with a limited degree of movement. It is used to add flexibility to the toolstring. The Knuckle Joint allows $\pm 10^\circ$ movement in both the X and Y-axis.
- 2. Application :**
 - ❖ Situations where flexible toolstrings are required.
 - ❖ To offset the CCL for improved collar logs.
 - ❖ To minimize the centralized weight in highly deviated or horizontal wells.
 - ❖ To separate tools that need to be centralized from tools that need to be positioned against the casing or tubing.
 - ❖ To reduce the maximum straight line length of a toolstring to help pass through completion items, negotiate doglegs or kick off points of short radius horizontal wells.



Swivel

1. **Swivel Function** : Allows free rotation between the upper and lower head while maintaining an electrical connection. The top and bottom sub assemblies are linked by a shaft, which is free to rotate on a set of ball bearings to support both lateral and vertical forces.
2. Application:
 - ❖ Perforating jobs.
 - ❖ Minimization of tool rotation due to wireline torque.
 - ❖ Multifinger imaging tool operations.
 - ❖ Heavy tool inside dry well
3. Electrical continuity of both conductor and armor is maintained by rotating low resistance contacts. A sliding sleeve relieves internal pressure changes caused by well pressure or expansion of the filling oil due to rising temperature. This prevents seal friction increases, minimizing rotational resistance.



Centralizers

1. **Centralizers Function** : This compact, 3 arm, inline, low friction roller centralizer is designed to center production logging tools accurately in vertical or deviated wells.
2. **Application** :
 - ❖ Centralization of logging tools in vertical, deviated or horizontal wells.
 - ❖ Centralization of slickline tools.
 - ❖ Minimization of toolstring drag and wear.
 - ❖ Can be used as a tubing end locator by observing line tension when pulling into the tubing.
3. Inside the central rod is a single feed through shaft. The electrical feedthrough enables the tool to be used at any point in the string. The monoconductor is passed from upper to lower connectors.



Sinker Bar / Weight Bar

1. Function: Help increase the weight of wireline equipment such that they can overcome friction in deviated wells.
2. Small perforating guns and production tools have low weights and are susceptible to being displaced out of hole in high flowing wells or high wellhead pressure. The addition of sinker bars can avoid such problems.
3. Sinker bars also act as a stand-off tool in order to avoid direct shock to the weakpoint during explosive or perforating process.

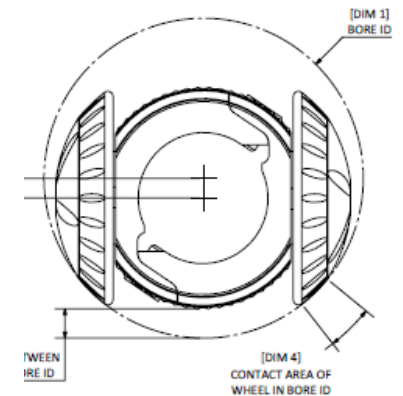
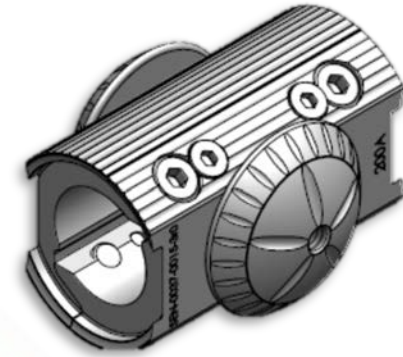


Sinker Bar Specification

SPECIFICATIONS	AS60002	AS60003
Tool diameter (O.D.)	1.687 in. (42.85 mm)	1.687 in. (42.85 mm)
Tool length	60 in. (1524 mm)	60 in. (1524 mm)
Tool weight	37 lb. (16.78 kg)	58 lb. (26.31 kg)
Shipping length	66 in. (1676.4 mm)	66 in. (1676.4 mm)
Temperature rating	500°F (260°C)	500°F (260°C)
Pressure rating	21000 psi (145 MPa)	21000 psi (145 MPa)
Top connection	Go TYPE Female (1 3/16" - 12 UN)	Go TYPE Female (1 3/16" - 12 UN)
Bottom connection	Go TYPE Male (1 3/16" - 12 UN)	Go TYPE Male (1 3/16" - 12 UN)

Roller Tools – IWheel

1. Function: Reduce tool friction with tubing wall thus helping conveyance through high deviation well. Has been tested in deviated wells up to 84degree and friction reduce by 80%
2. Application:
 - Logging operation
 - Perforation: rate for ballistic usage
 - Wheel size can be change depend on tubing ID or well restriction
 - Create standoff which significantly reduce abnormal contact friction
3. DB record history: MOT perforation using IWheel inside 2-7/8in tubing and 64degree deviation well.



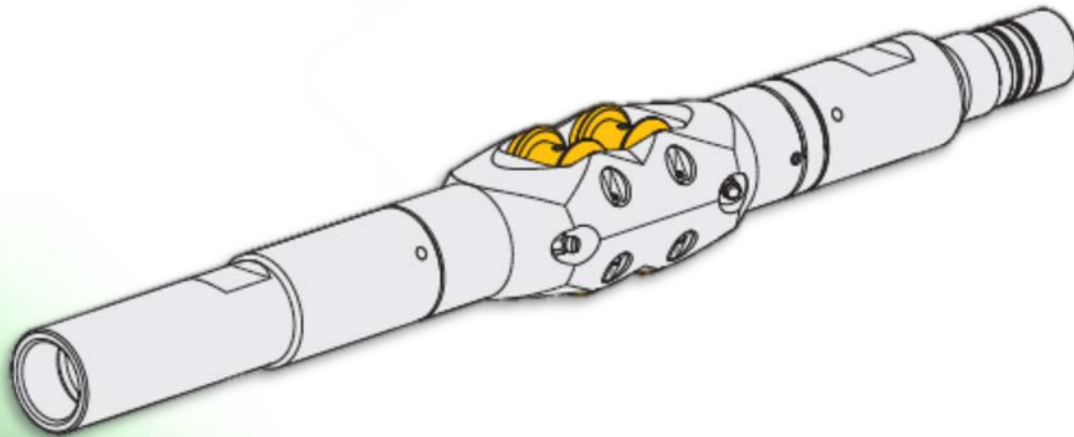
Environmental Specifications

Max Temperature (°F/°C)	450 / 232
Max Pressure (psi/MPa)	25000 / 172
Material Body/Wheels	17-4PH H1150 Stainless Steel

Mechanical Specifications						
I-Wheel Type	1.500"	1.688"	2.000"	2.875"	3.375" (XLT)	4.500"
Outer Diameter	1.70" - 1.83"	2.08" - 3.55"	2.55" - 3.32"	3.10" - 3.96"	3.70" - 5.00"	5.100"
Logging Tool	1.500"	1.688" / inline	inline	1.688" / inline	inline	2.875" / inline

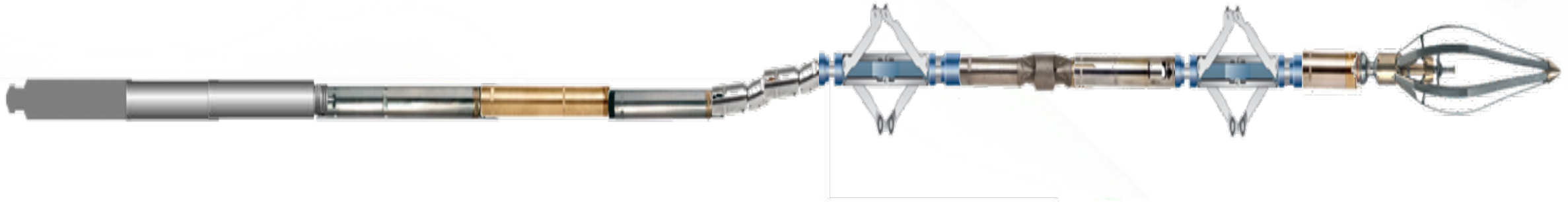
Roller Tools – Roller Bogie

1. Function: Lift and support the wireline toolstring off the low side of the well. It also enable access in deviated wells.
2. Same application as I-Wheel. Roller Bogie is also design for perforation job.
3. Has been tested from 35 deg – 87 deg inside 5.5” monobore completion/dry well.



Roller Bogie Size	Weight (lbs)	Length	Maximum Conveyable Toolstring
1.950"	11	18"	1.688"
2.125"	11	17"	1.750"
2.275"	11	17"	1.938"
2.400"	11	16"	2.000"
2.500"	11	17"	2.125"
2.600"	12	19"	2.250"
2.770"	12	18"	2.375"
3.000"	16	19"	2.500"
3.350"	30	20"	2.875"
3.600"	30	21"	3.125"
3.850"	42	21"	3.500"
4.100"	42	22"	3.625"
4.500"	46	24"	4.000"
4.900"	64	26"	4.375"
5.500"	84	26"	5.000"

Standard E-Line Cased Hole Toolstring Configuration (Basic Equipment)



Cable Head

- Provide **mechanical** and **electrical** connections between the wireline cable and tool string.

Weight Bars

- Increase the **weight** of wireline equipment such that they can overcome friction in deviated **wells**.

Knuckle Joint

- Enhance tool **flexibility** up to $\pm 10^\circ$ movement per tool.

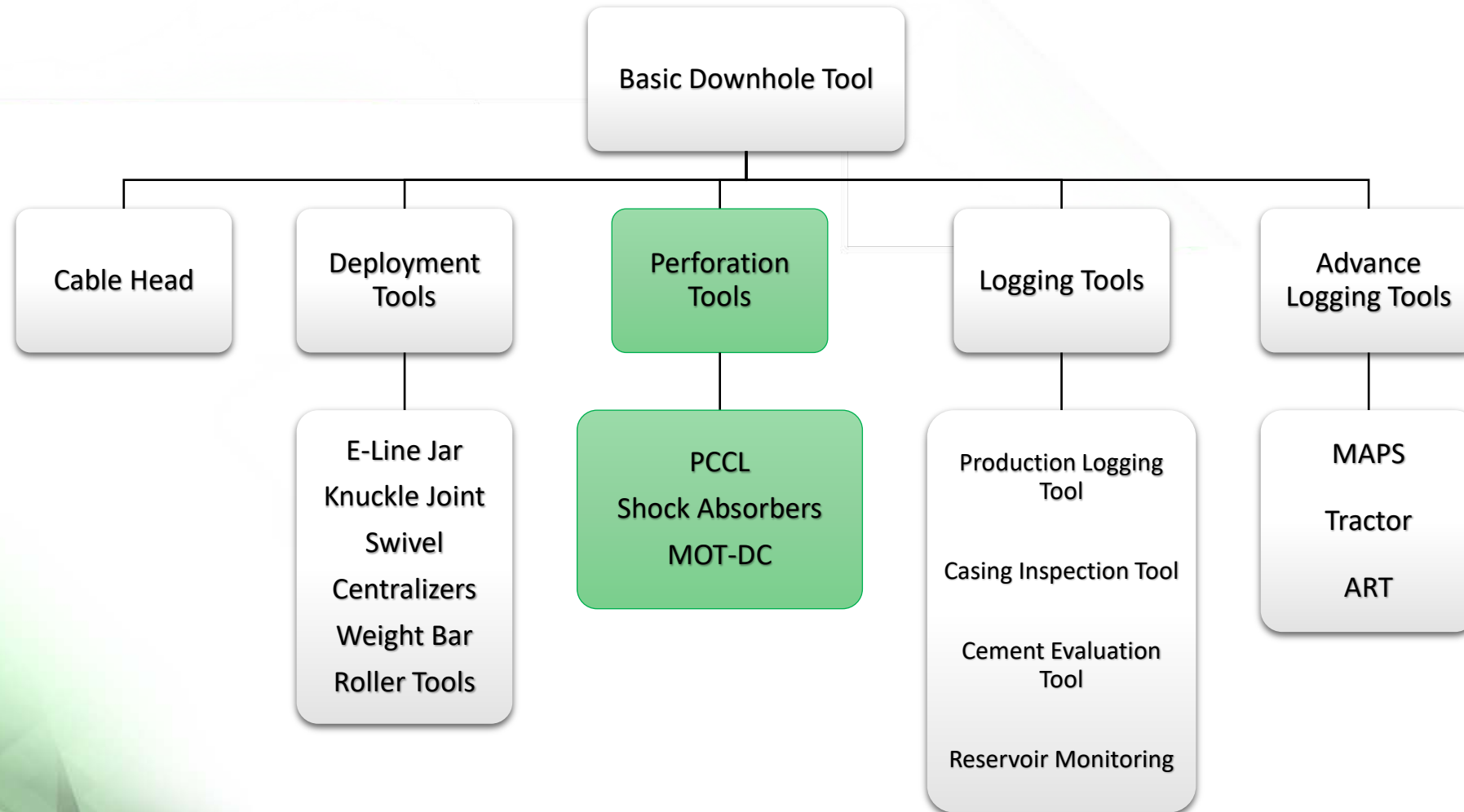
Centralizers

- **Center** production logging tools accurately in vertical or deviated **wells**.

INTRODUCTION TO PERFORATION TOOLS

CHS Downhole Tools

General types



Passive CCL, PCCL

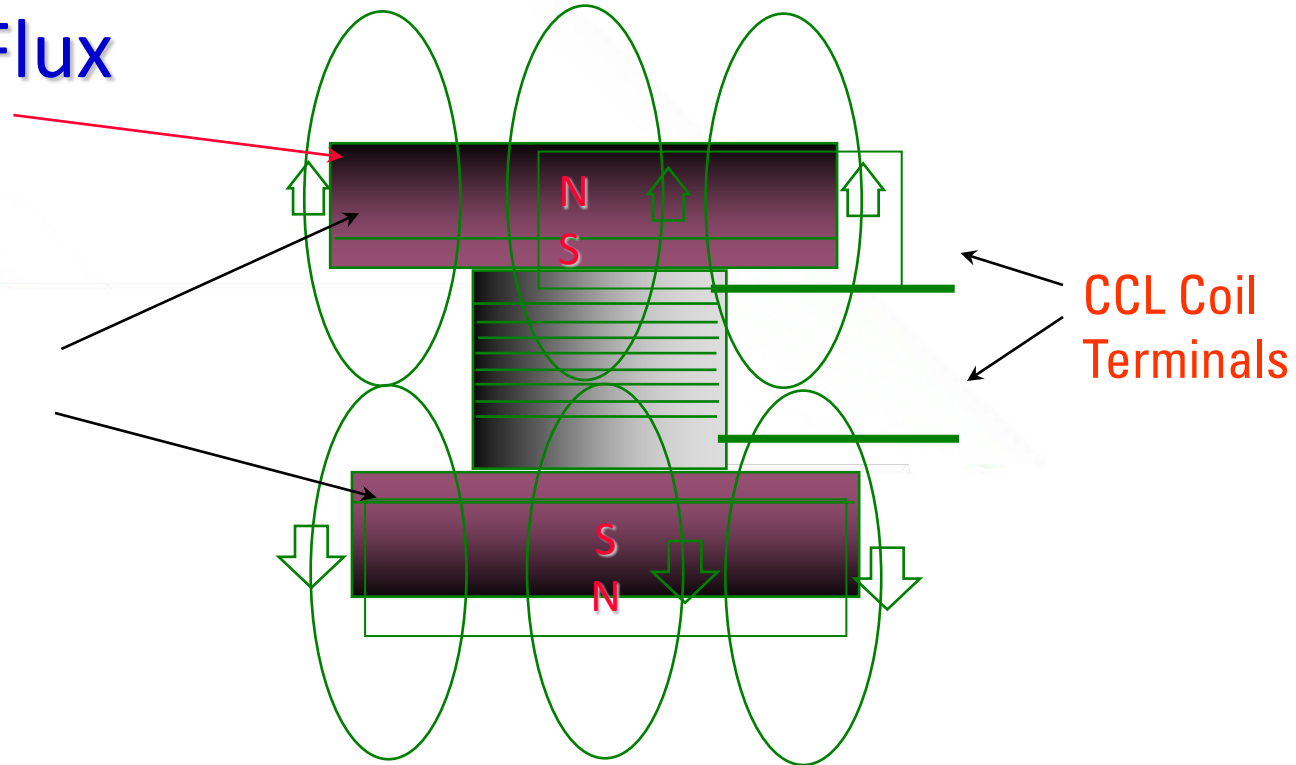
1. PCCL responds to changes in metal volume, like tubing collars and perforations.
2. As the tool passes a collar, or change in metal volume, lines of magnetic flux between two opposing permanent magnets are disturbed. This causes a low frequency voltage or Electro Magnetic Field (EMF) to be induced in a coil, mounted between the permanent magnets. Finally the signal is converted by a voltage-controlled oscillator for recording in the Memory section of the tool.
3. Application :
 - ❖ Depth control in casing or tubing.
 - ❖ Location of casing or tubing damage.
 - ❖ Confirmation of perforation depths or intervals.



PCCL - Theory of measurement

Magnetic Flux

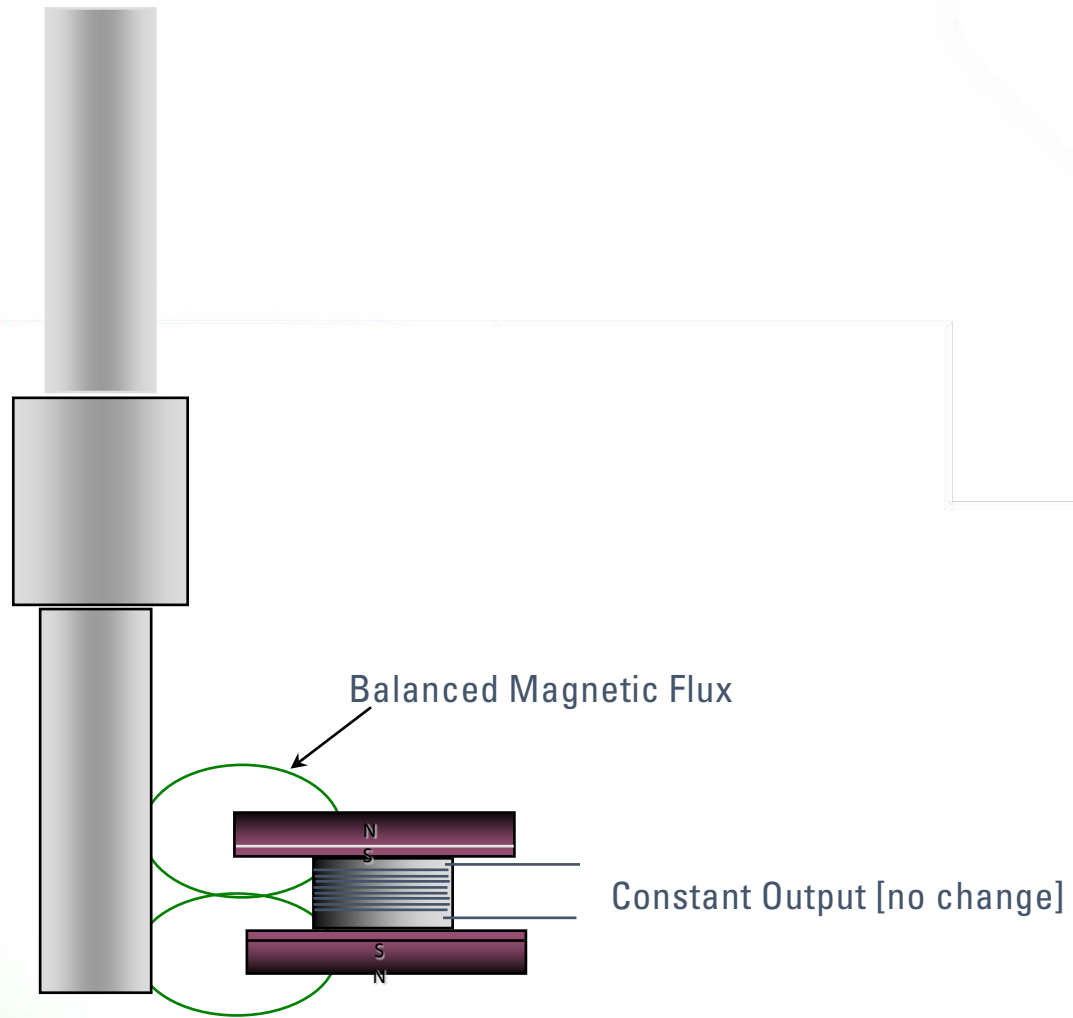
Powerful
Magnets



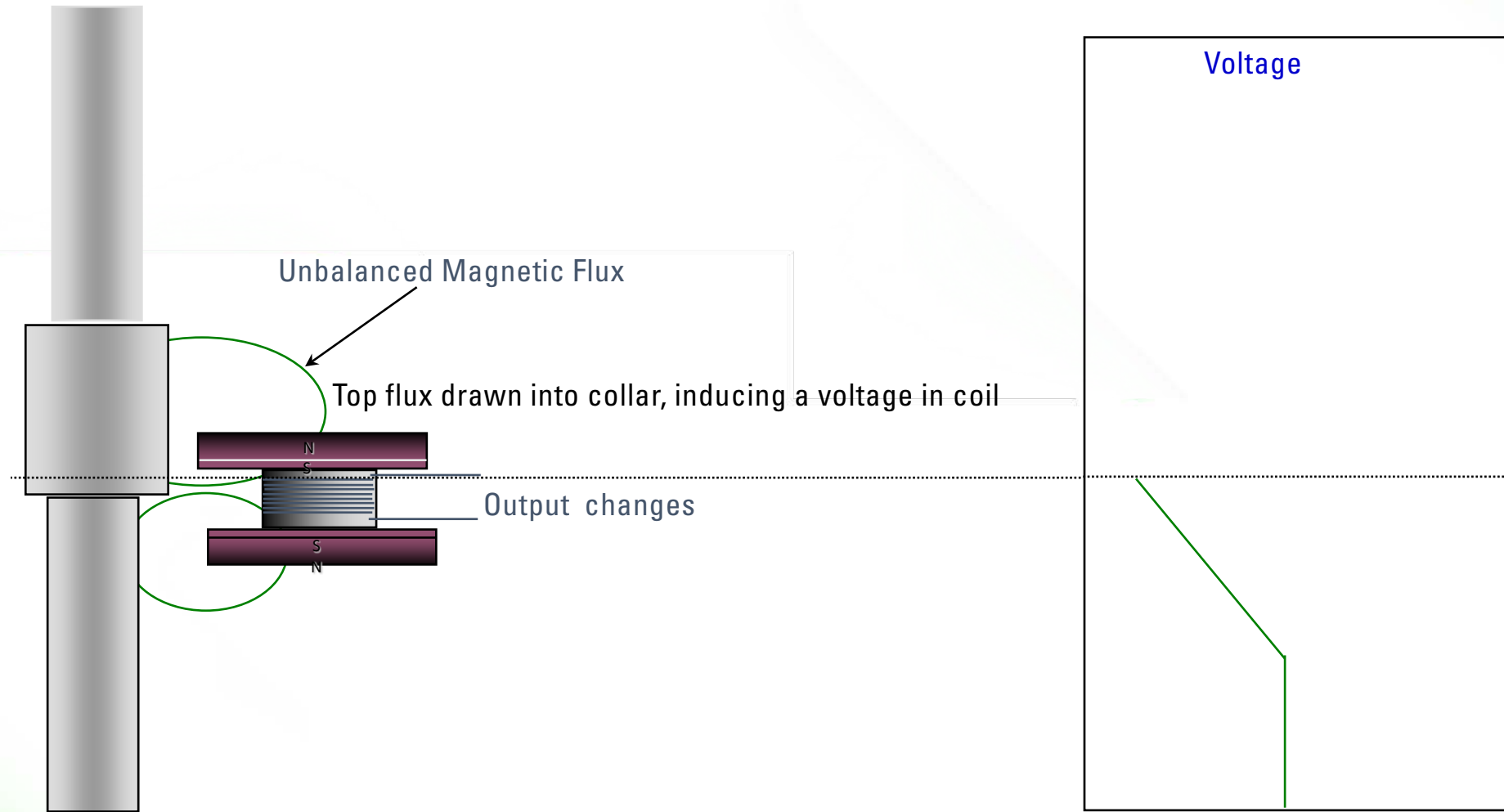
Any change in the Magnetic Flux will generate a Voltage Signal

$$\text{Emf} = - \frac{\Delta \phi}{\Delta t}$$

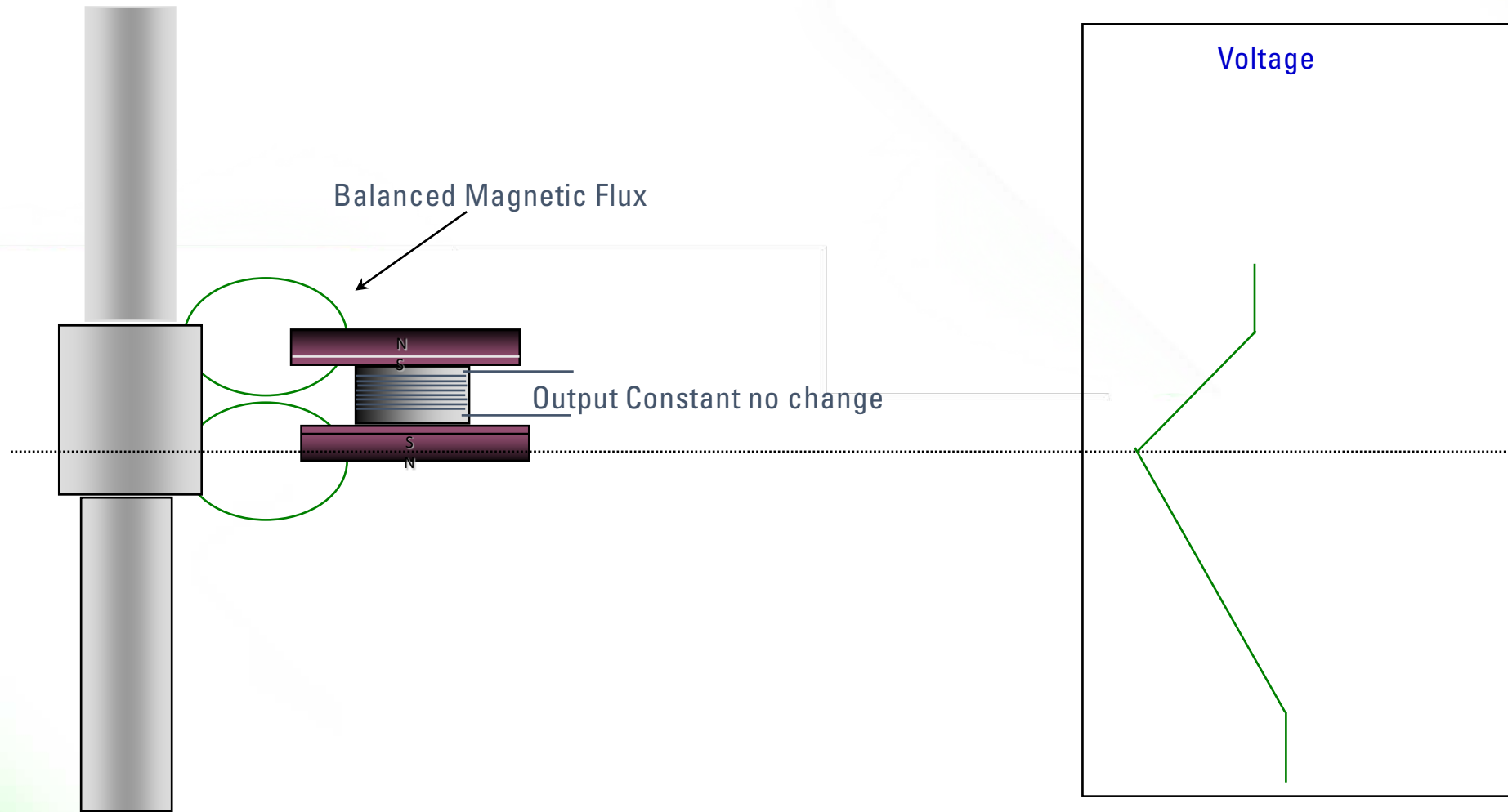
Collar Locator Principle



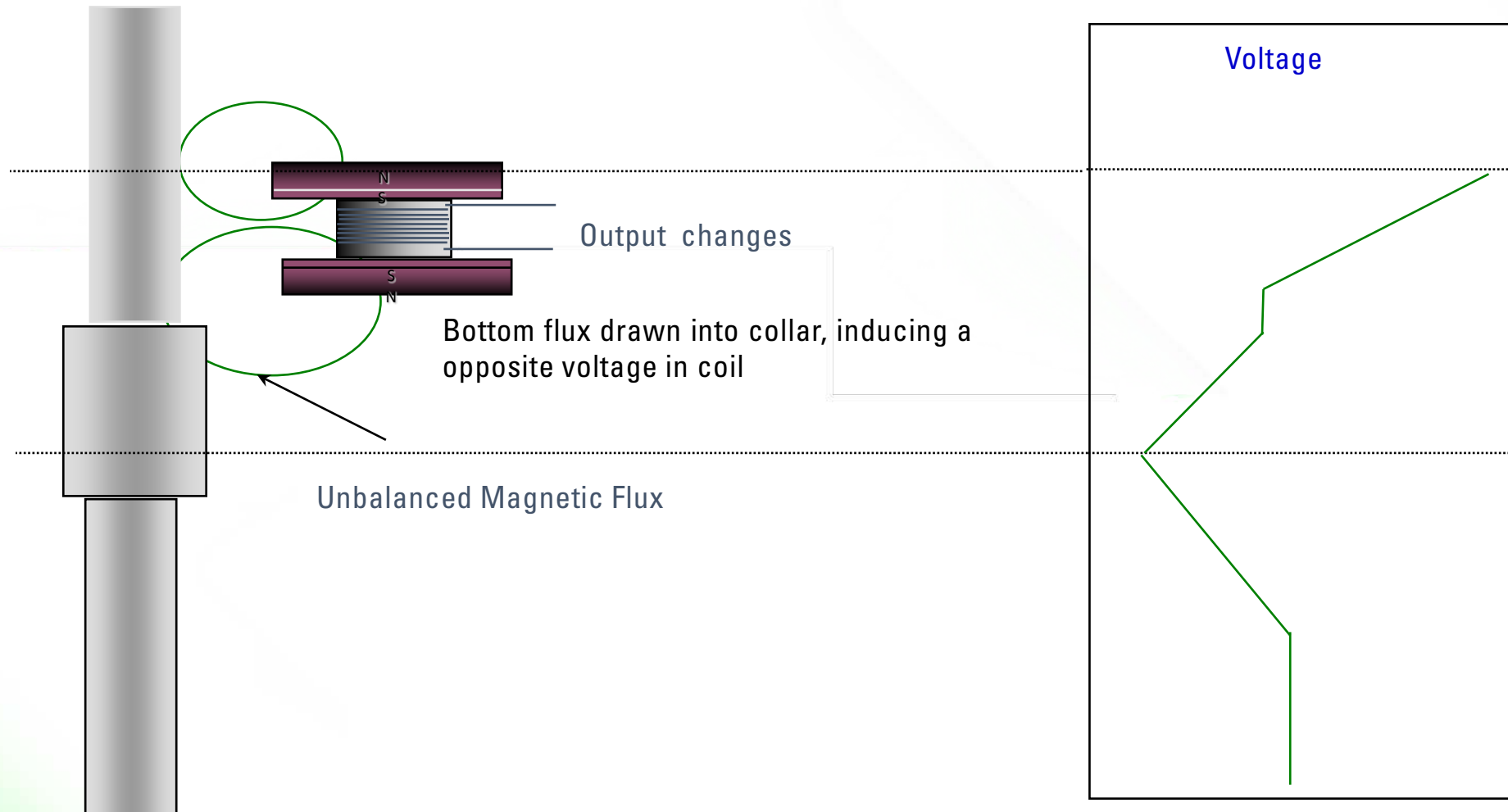
Collar Locator Principle



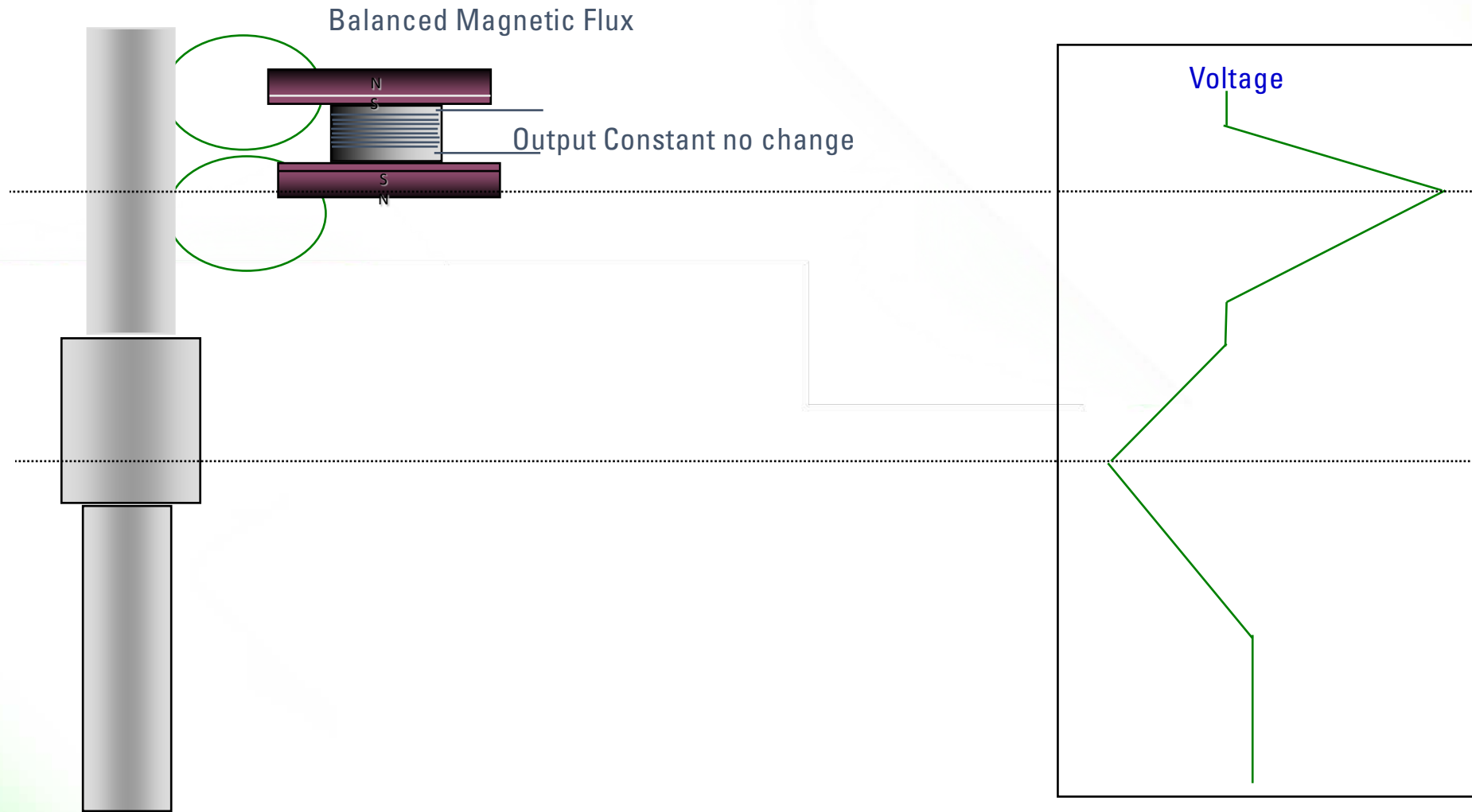
Collar Locator Principle



Collar Locator Principle



Collar Locator Principle



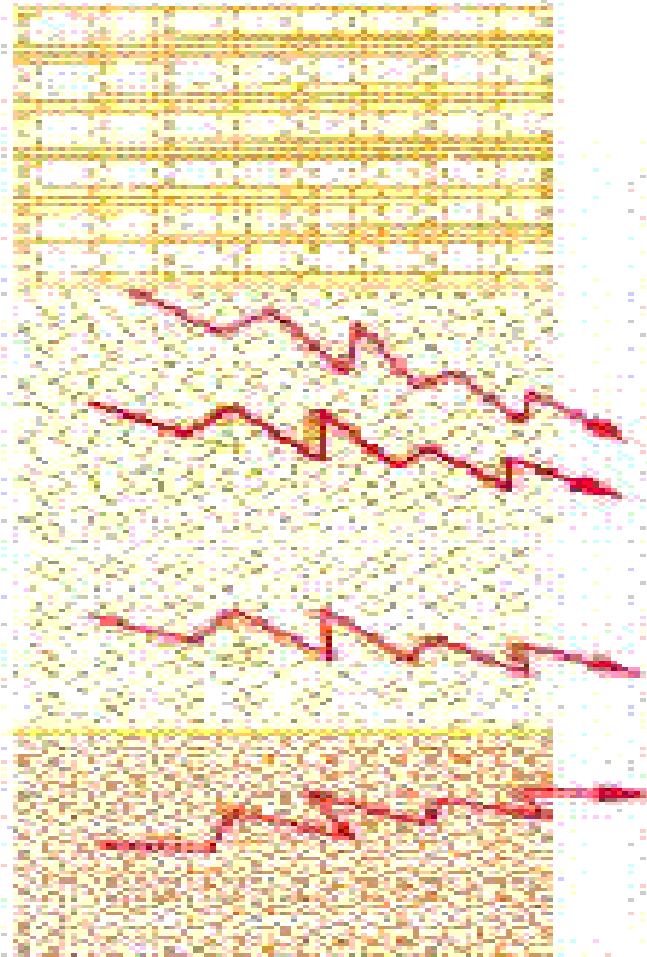
Shooting Gamma Ray

1. Compatible with all types of detonators, igniters and firing modules
2. Designed to operate at +50VDC
3. Shoot using -ve voltage
4. Size range from 1-11/16" to 3-1/8" size
5. New version of Shooting Gamma Ray
 - Build in with pressure and temperature sensors
 - Also build in with Perforation Shock Absorber
 - Eliminate requirement of running PLT before perforation run
 - Real time monitor performance of new perf zone

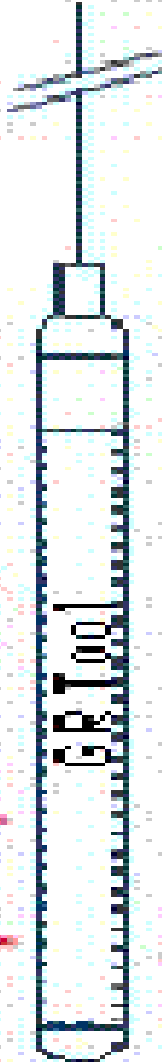
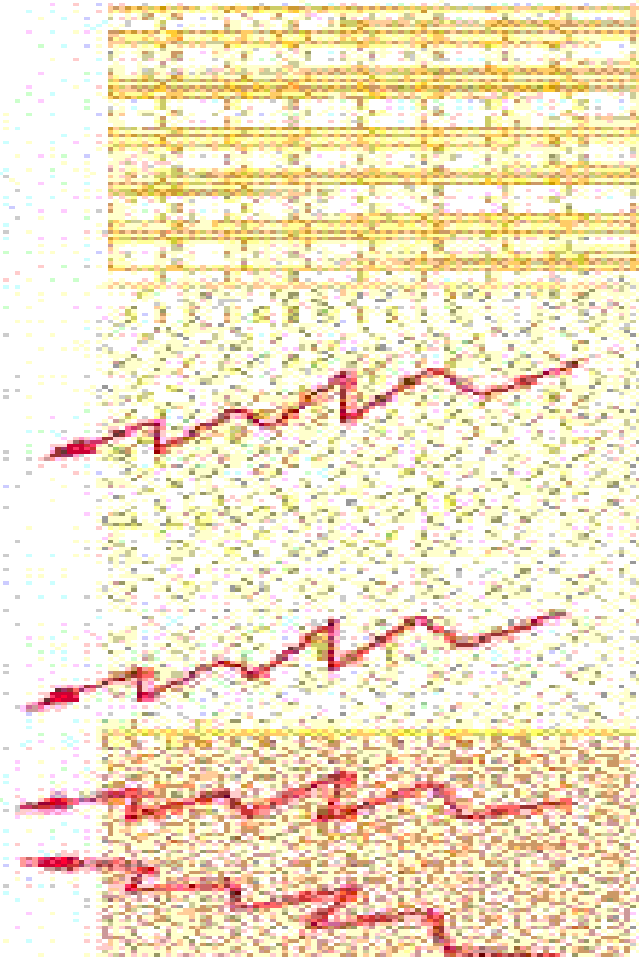


Naturally Occurring Gamma Rays

Rock formation

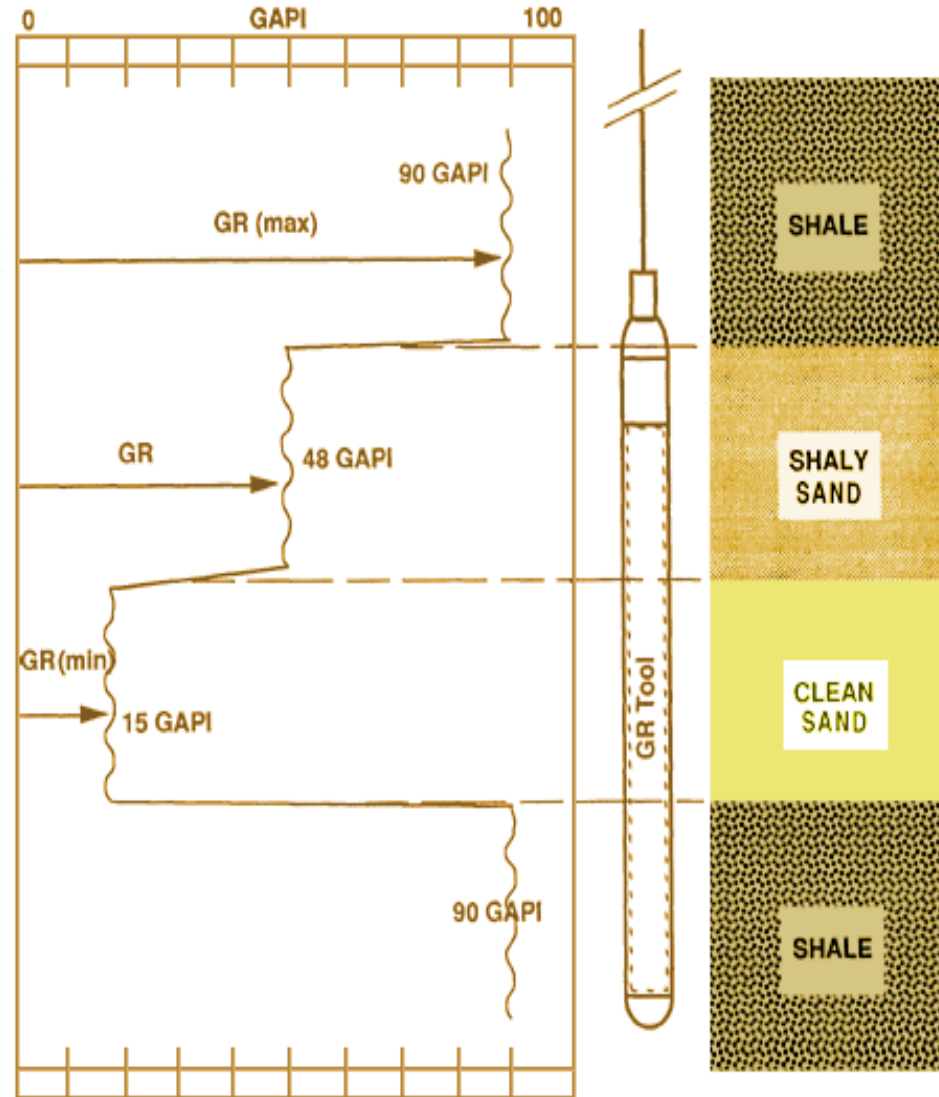


Rock formation



Typical GR Response

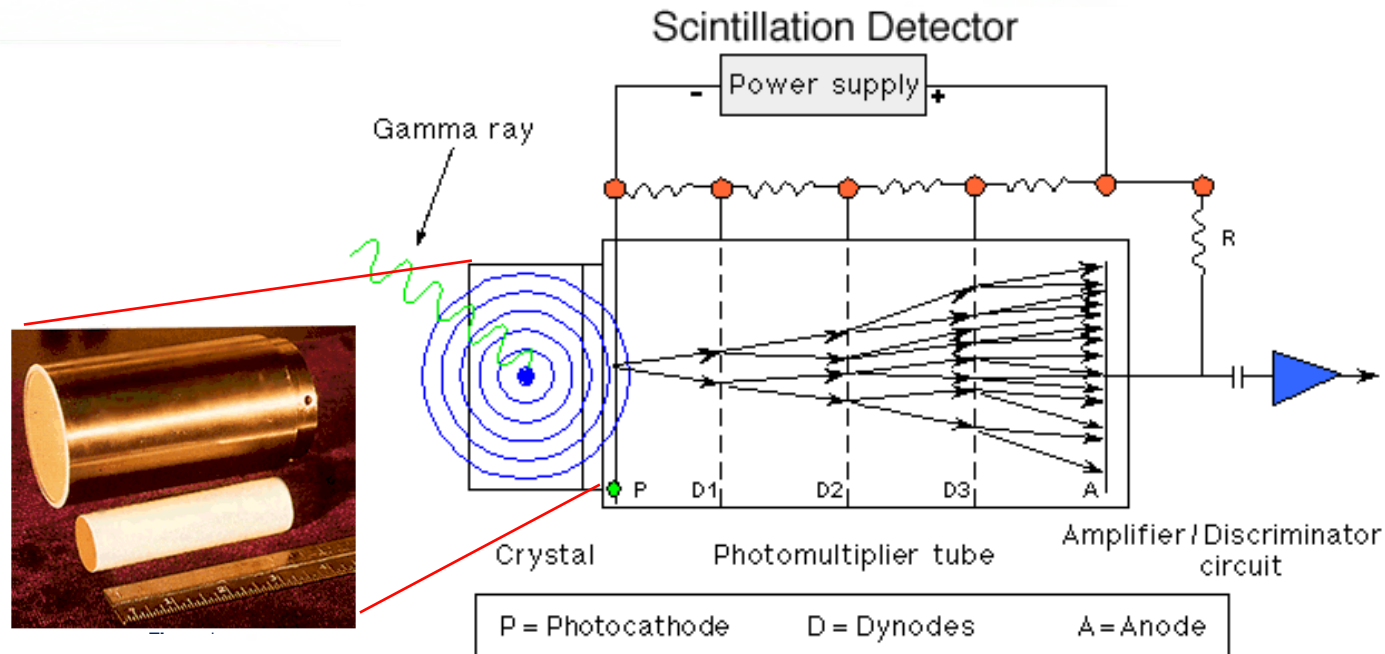
Typical Gamma Ray Responses



Scintillation Detectors

The scintillator counter is divided into three sections:

- the crystal scintillator
- Photomultiplier Tube (PM Tube) (amplifies by 10,000)
- the amplifier/discriminator circuit

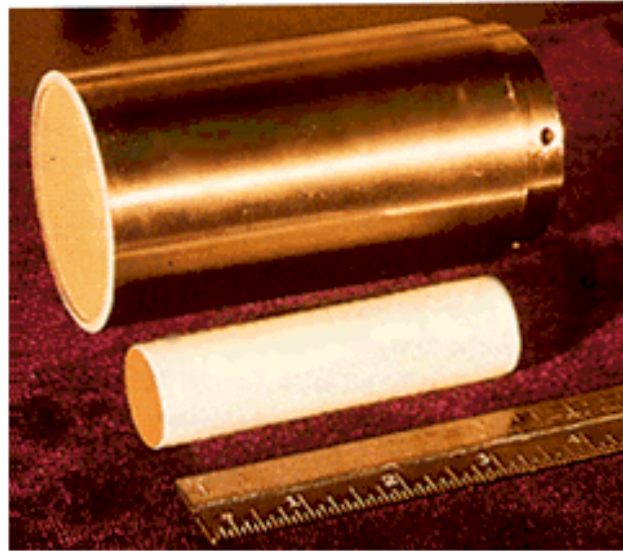


γ -ray radiation interacts in the crystal generating the flashes of light called **scintillations**

Scintillation Crystals

Scintillation Detectors are commonly made of:

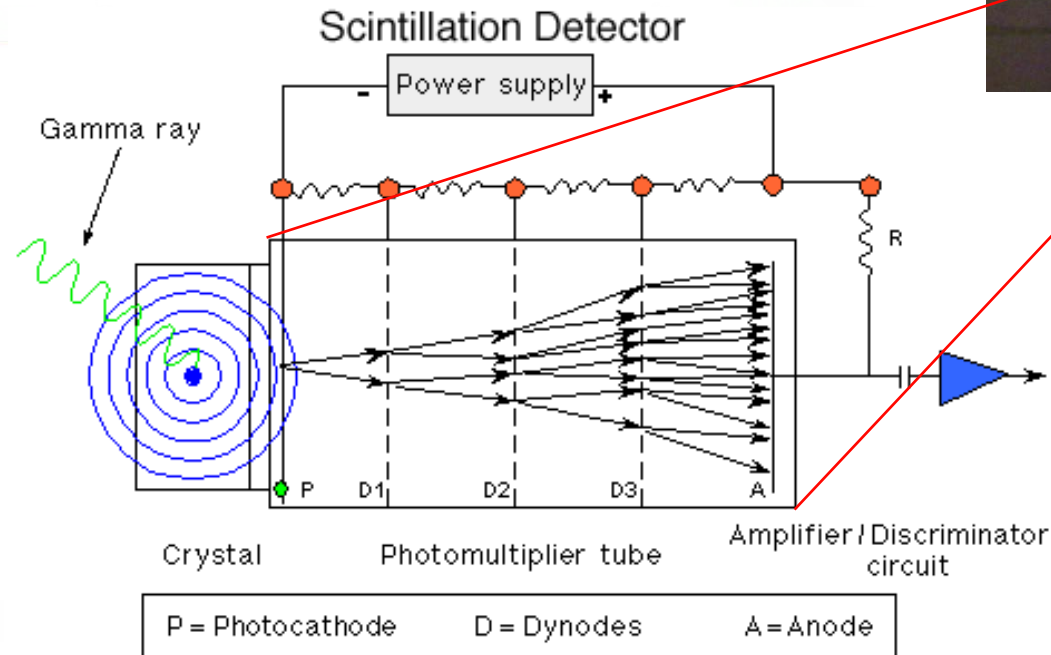
- **NaI: Sodium Iodide**
- Activated with **Tl (Thallium)** in crystal form
- Wavelength of emitted photons is in the UV Region



Photomultiplier (PM Tube)

The scintillator counter is divided into three sections:

- the crystal scintillator
- Photomultiplier Tube (PM Tube)
- the amplifier/discriminator circuit



The photons emitted by the scintillator are converted to an electrical signal on the Photomultiplier

Gamma Ray and CCL Log Applications

1. CORRELATION

- Depth matching between different logging runs
- Correlation from well to well
- Depth determination
- Provide depth control needed for cased hole perforation
- Positioning of perforating guns [e.g. TCP or Wireline Guns using PGGT]

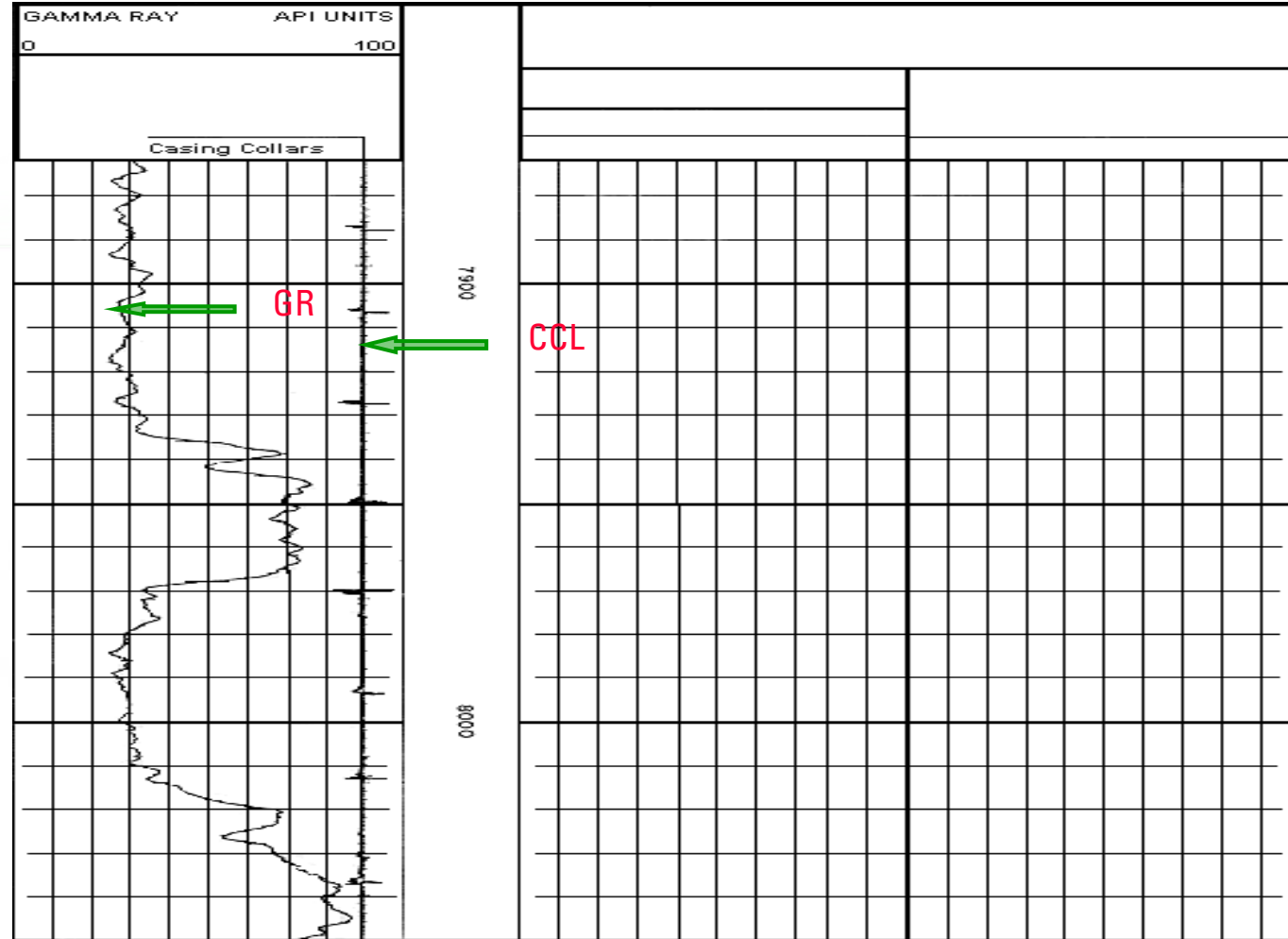
2. LITHOLOGY INDICATOR

- Indication of shaliness in other formations
- Find radioactive mineral deposits
- Calculate Shaliness (volume of shale) in formations - Quantitative
- Water production in old wells
- Workover problems (Radioactive Tracer Surveys)

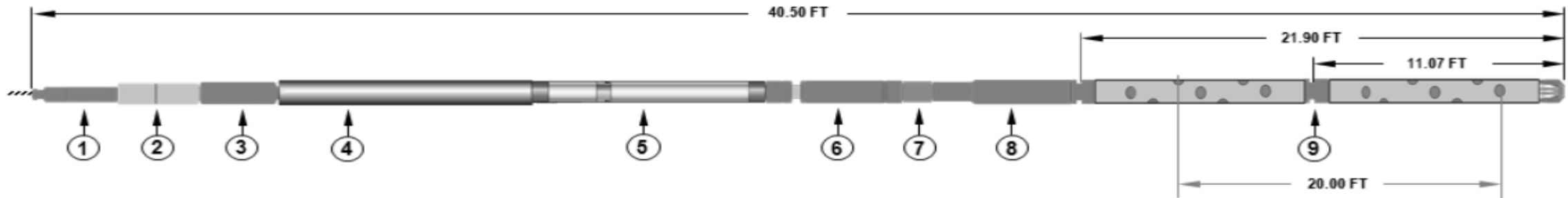
3. OTHERS

- Scale build-up monitoring, clay typing, etc

GR-CCL Log



Standard E-Line Perforation Toolstring Configuration

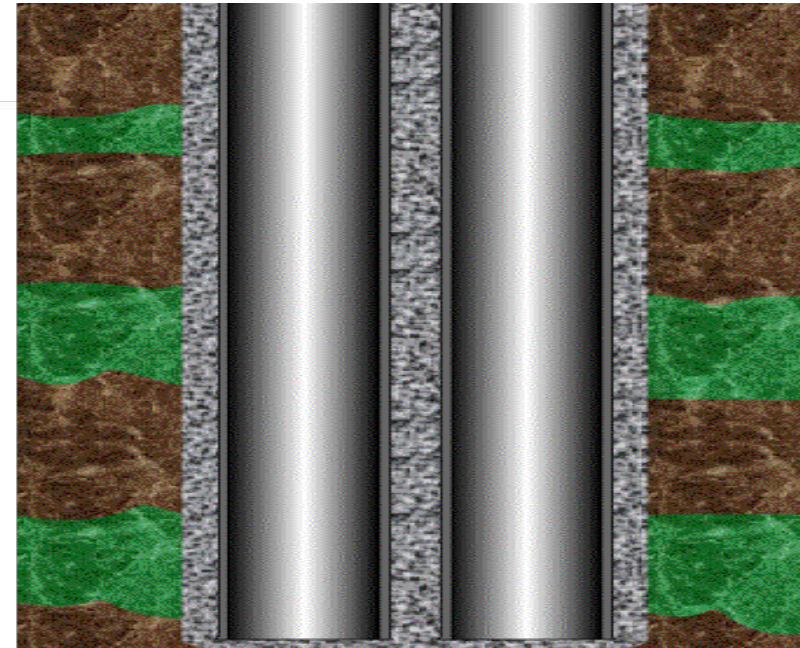


ITEM	TOOL	TOP CONN	BOTTOM CONN	MUL (FT)	MAX OD (in)	WEIGHT (IBS)
1	1 ¹ / ₁₆ " CABLE HEAD		1 ³ / ₁₆ " GO STD P	1.10	1.69	5.50
2	2 ¹ / ₈ " ADDRESSABLE RELEASE TOOL, ART-H	1 ³ / ₁₆ " GO STD B	1 ³ / ₁₆ " GO STD P	2.30	2.13	19.0
3	2 ¹ / ₈ " VOLTAGE SENSING SWITCH, VSS-Y	1 ³ / ₁₆ " GO STD B	1 ³ / ₁₆ " GO STD P	0.92	2.13	7.30
4	2.00" STEEL SINKER BAR	1 ³ / ₁₆ " GO STD B	1 ³ / ₁₆ " GO STD P	5.00	2.00	50.0
5	1 ¹ / ₁₆ " SHOOTING GR-COL TOOL	1 ³ / ₁₆ " GO STD B	1 ³ / ₁₆ " GO STD B	6.32	1.69	28.0
6	1 ¹ / ₁₆ " PERFORATING SHOCK ABSORBER	1 ³ / ₁₆ " GO STD P	1 ³ / ₁₆ " GO STD B	1.70	1.69	12.0
7	1 ¹ / ₁₆ " DOUBLE PIN ADAPTER	1 ³ / ₁₆ " GO STD P	1 ³ / ₁₆ " GO STD P	0.16	1.69	2.64
8	2.00" FIRING HEAD ASSEMBLY	1 ³ / ₁₆ " GO STD B	1 ¹ / ₁₆ " SA B	1.08	2.00	7.70
9	2.00" HSC GUN CARRIER – LOADED 3M X 3M	1 ¹ / ₁₆ " SA P		21.9	2.00	120
TOTAL LENGTH : 40.50 FT / 12.30 MTR				TOTAL WEIGHT, IBS : 252.00		
MAX RUNNING OD, in : 2.13				MAX POOH OD, in : 2.19		

How to perforate well in dual tubing completion?

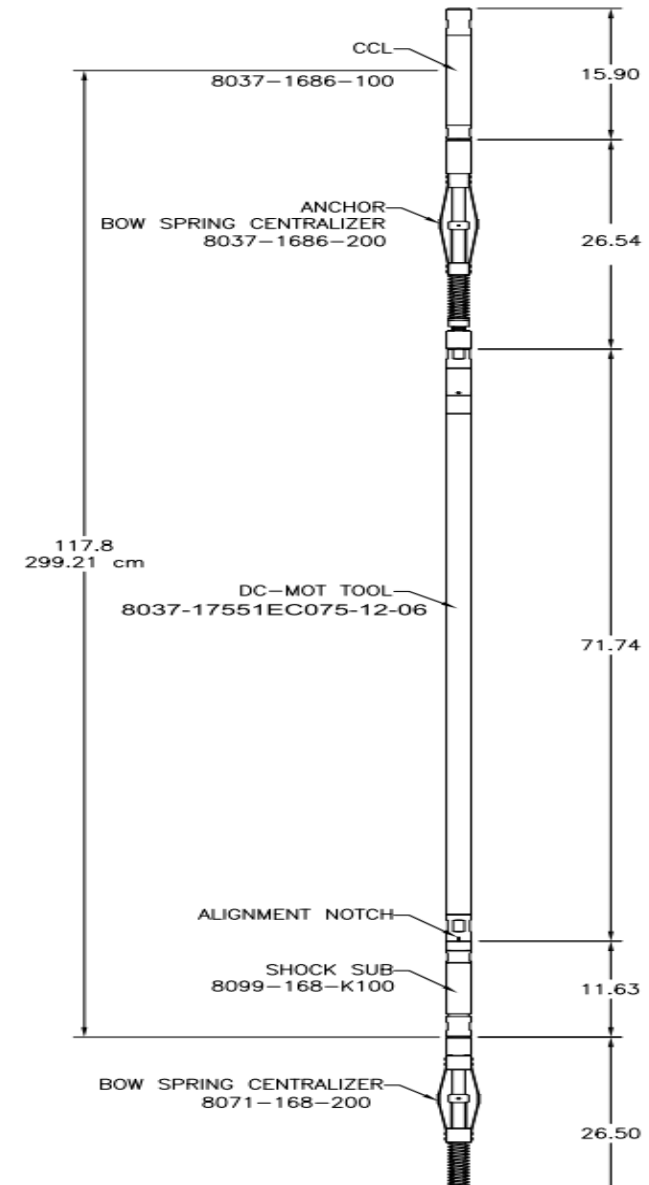
Perforate away from completion components

- Avoid perforating long string (dual string)
- Avoid perforating cables, control lines, sensors

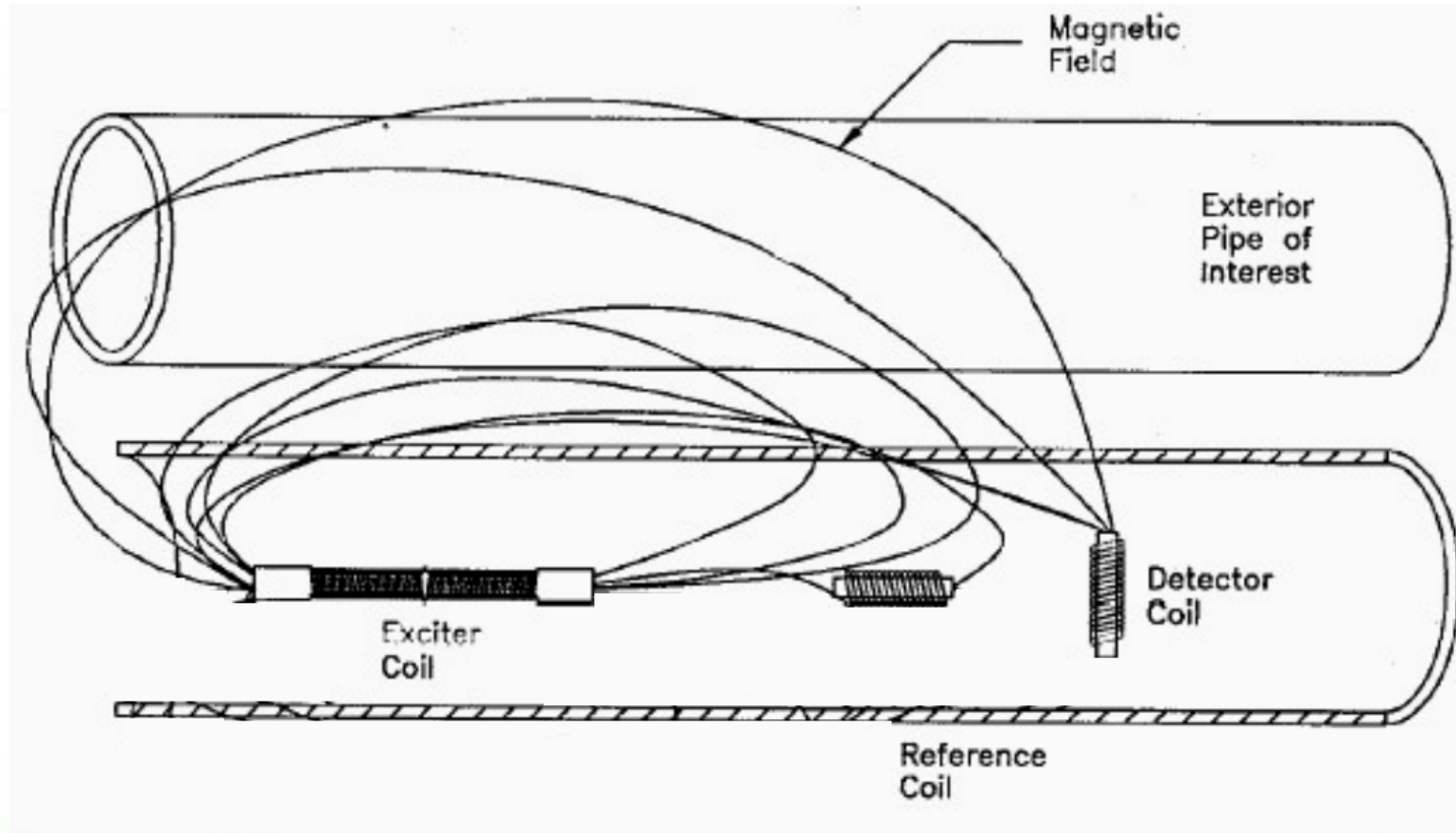


Multi Orientation Perforation Tool – MOT-DC

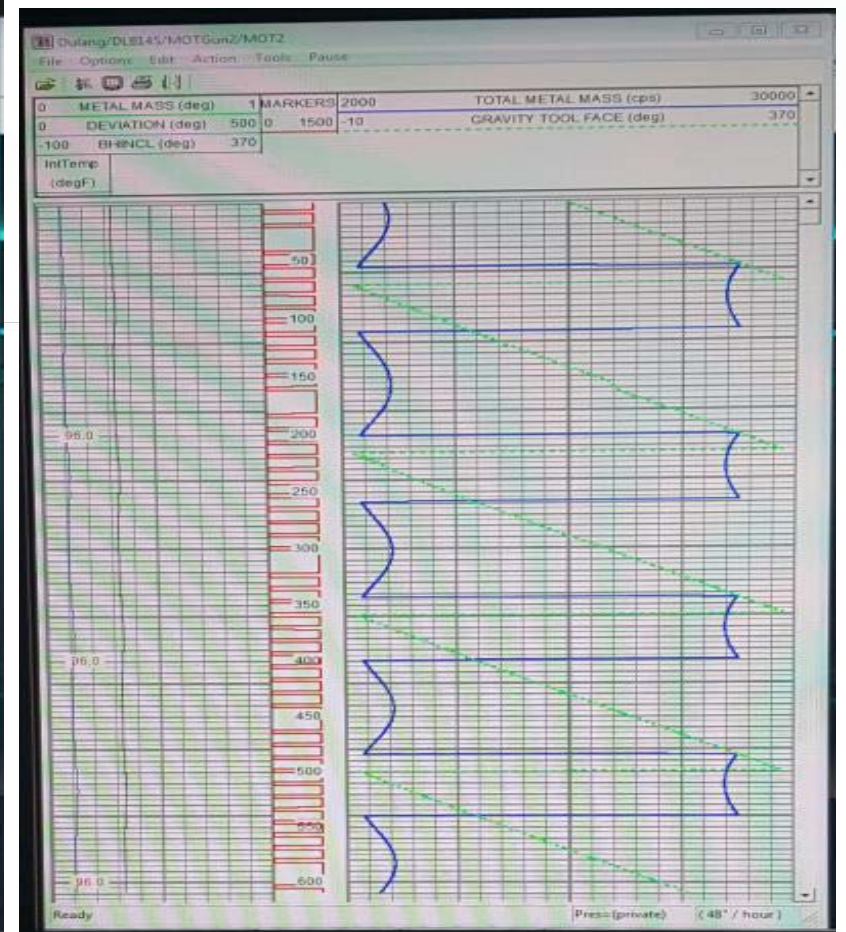
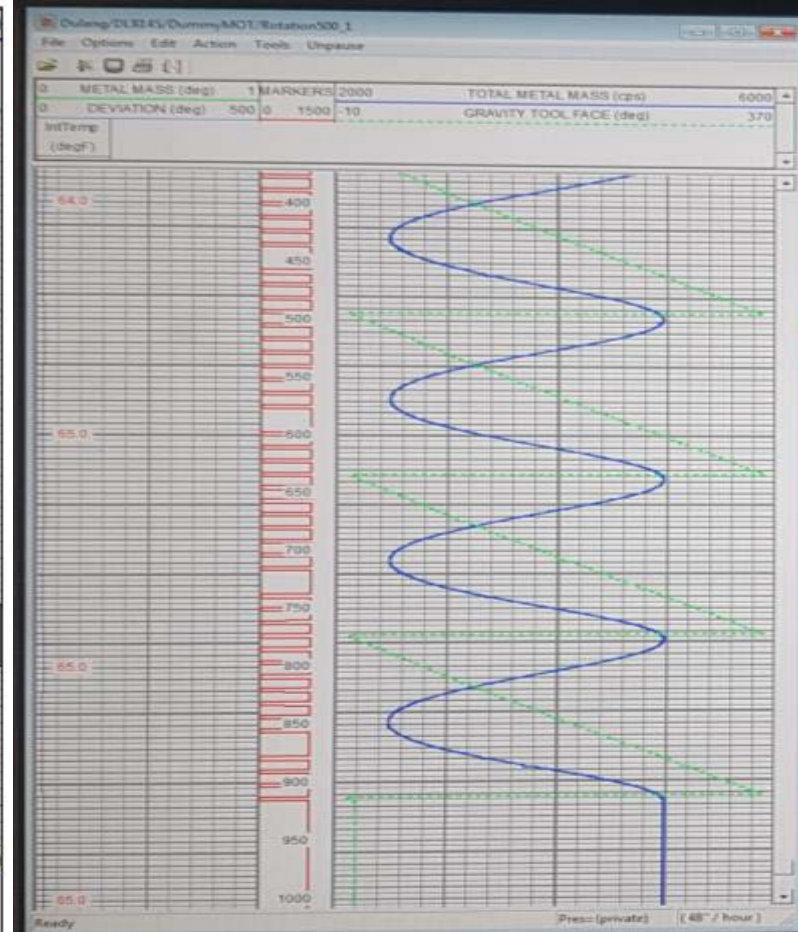
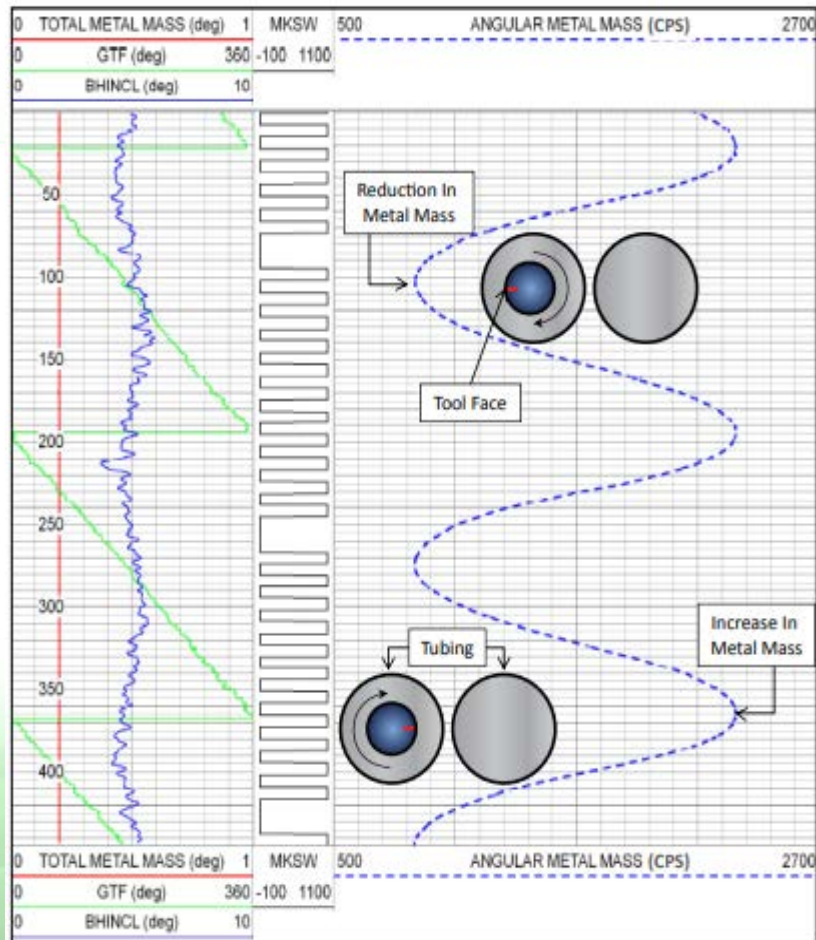
1. MOT-DC is designed to orient perforation job in wells completed with multiple string of pipe (tubing).
2. MOT-DC produces a uniform electromagnetic field to the tubing and detecting their effect on it by rotating a directional sensor around in that field produces directional information.
3. Metal mass measurement to detect other magnetic anomalies in the pipe or casing
4. Surface monitoring of this information allows the perforation to be pointed away from other string.
5. Advantage compare to previous version:
 - Borehole inclination (BHINCL)
 - Gravity Tool Face (GTF); GTF will facing 0degreee where the notch for 0degreee gun facing.



MOT-DC Mapping Principle



Multi Orientation Perforation Tool – MOT-DC



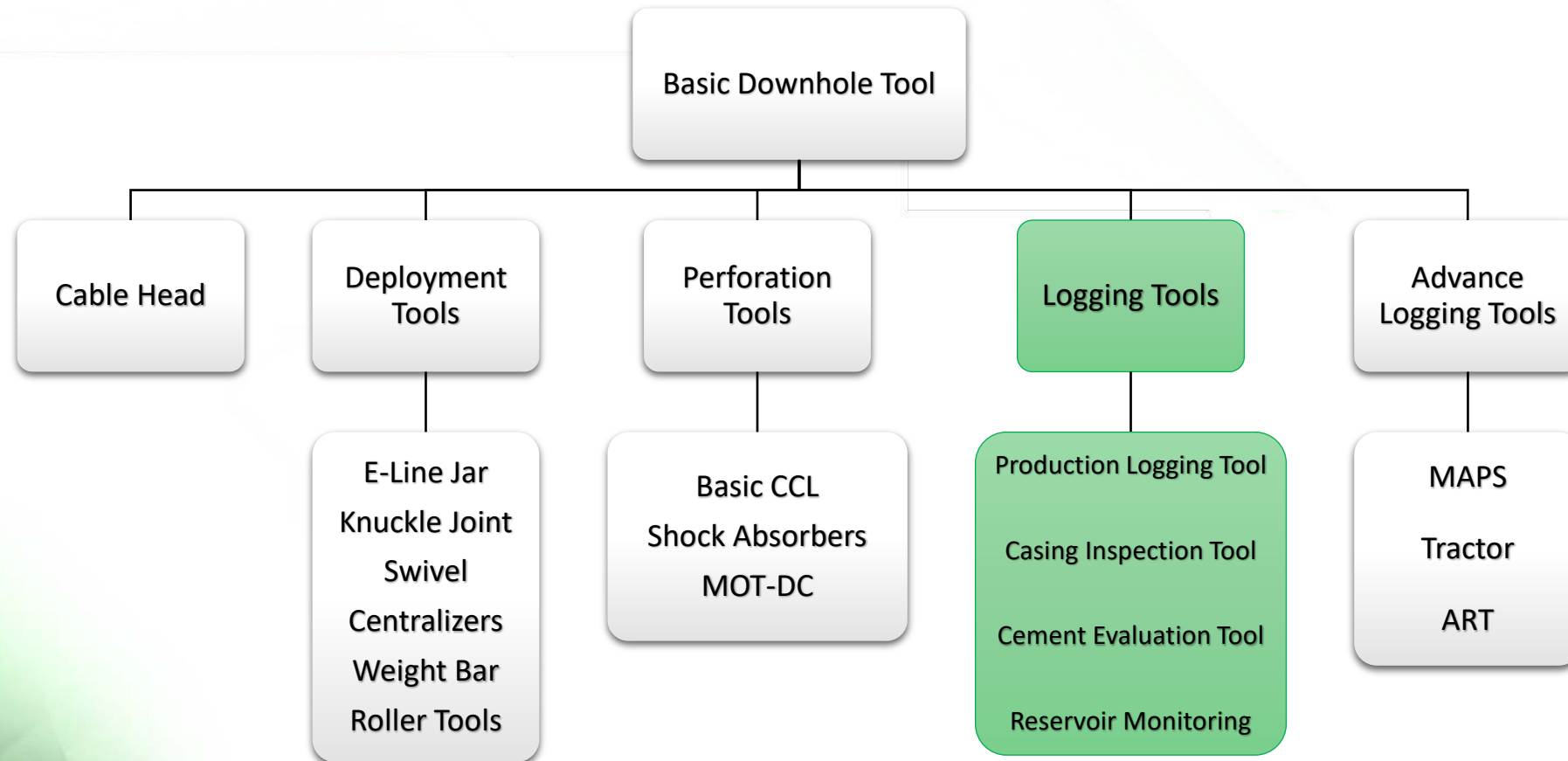
Coffee Brake..



INTRODUCTION TO LOGGING TOOLS

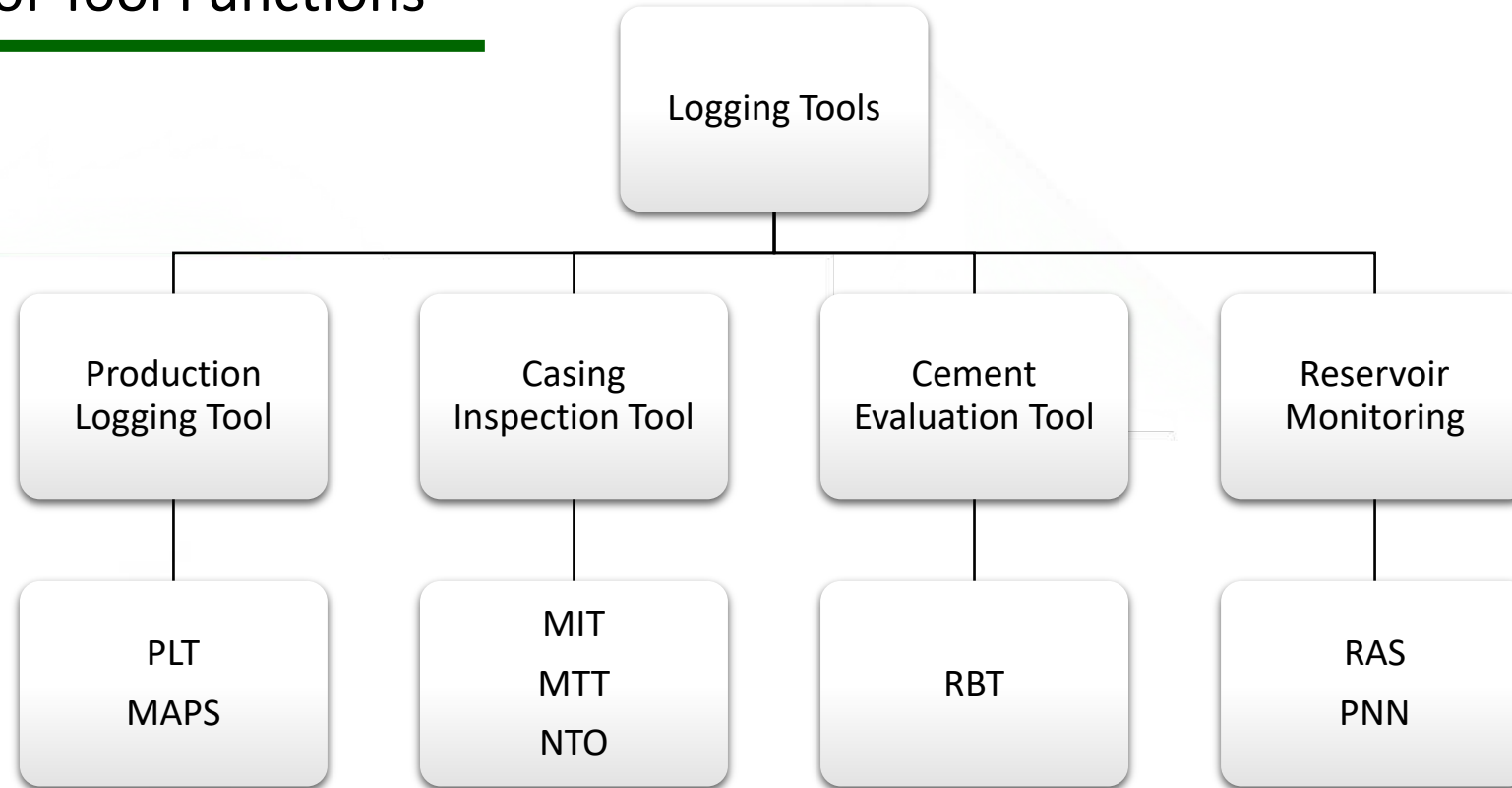
Introduction to Logging Tools

General types



Introduction to Logging Tools

Segregation of Tool Functions

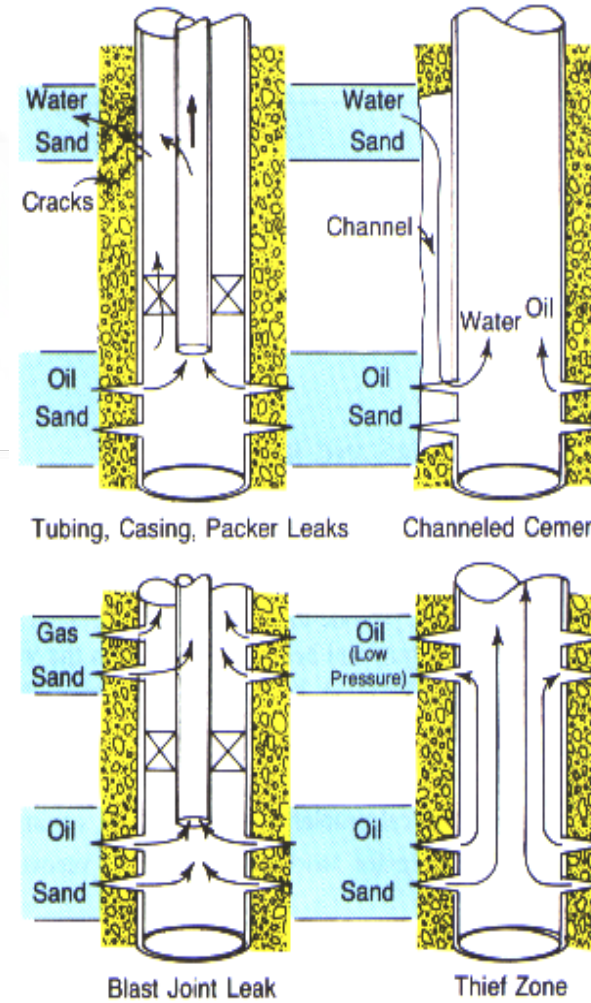


Production Logging Tool (PLT)



PL Applications

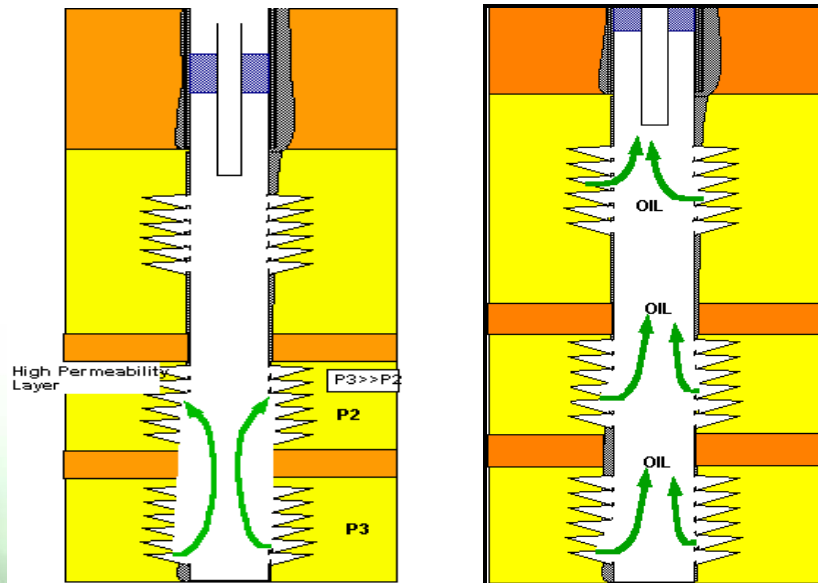
1. Evaluation
 - Production profile distribution
 - Zonal productivity
2. Monitoring
 - Production profile changes
 - Fluid type changes: Water or Gas breakthrough
3. Diagnosis
 - Source of high GOR or Water Cut
 - Detection of leaks and crossflow
4. Production Enhancement
 - Data for workover planning
 - Completion and treatment effectiveness



Typical PL program

1. Shut-In conditions

- Perform passes at different speeds across the interval of interest
- Perform spinner calibration
- Determine fluid levels
- Detect Cross-flows (if any)



2. Flowing conditions

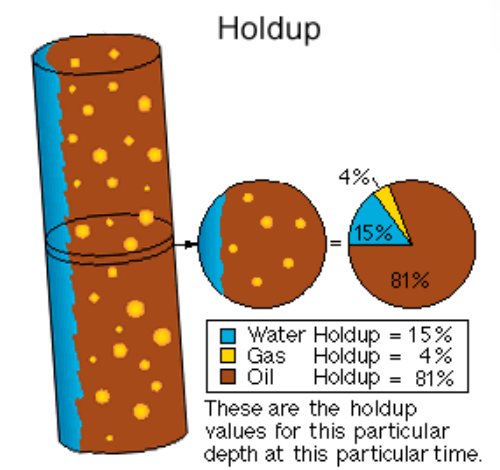
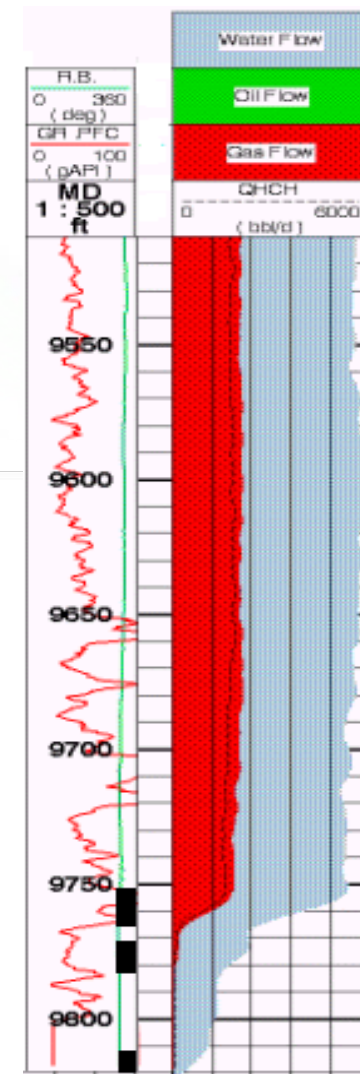
- Wait for stable flow
 - **pressure, spinner, density ?**
- Log interval of interest (passes up and down at different speeds)
 - Perform spinner calibration
 - Identify flowing profile & cross-flow
 - Identify fluid entries
- Log stations if requested

Shut-In the well
before POOH in the
Tubing !

Production Logging Interpretation

FACTS

- Single phase: determination of downhole profile and interpretation of downhole data is straight forward.
- Multiphase flow : phenomena like holdup, slippage velocity and phase segregation complicates the flow behavior.
- For the interpretation of production logs under multiphase flow conditions, **Holdup is of major importance.**
- Water Hold Up vs Water Cut



PLT Toolstring

The standard tool for PLT can be divided into several section which are:

- Telemetry/communication section (XTU)
- Pressure section (QPS)
- Temperature section (PRT)
- Depth correlation section (PGR, CCL)
- Fluid ID section (CWH, FDR) – **Water Hold Up & Density**
- Flowmeter section (ILS, CFBE ,CFSM) – **Phase Speed**
- Deployment section (PRC, PKJ, weight bar)

$$Q_w = V_w \times A \times H_w$$

$$Q_o = V_o \times A \times H_o$$

$$Q_G = V_G \times A \times H_G$$



15K Psi & 170 degC rating

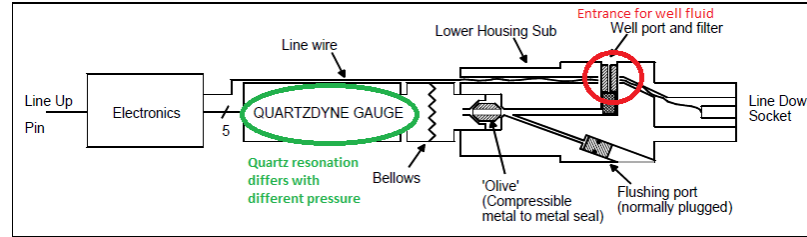
Quartz Pressure Sensor (QPS) & Platinum Resistance Thermometer (PRT)

Quartz Pressure Sensor, QPS

Measures changes in flowing and shut-in pressures.

Measurement Principal

- Pressure from well fluid will enter through the well port, and will then be measured by the quartzdyne gauge which is protected by the bellow
- Since the resonation of the quartz is effected by both temperature and pressure, another quartz was incorporated in the circuit to solely measure the resonation effected by temperature.
- This second quartz is not subjected to well pressure at all. It will then act as the "corrector" for the first quartz to get a more precise data.



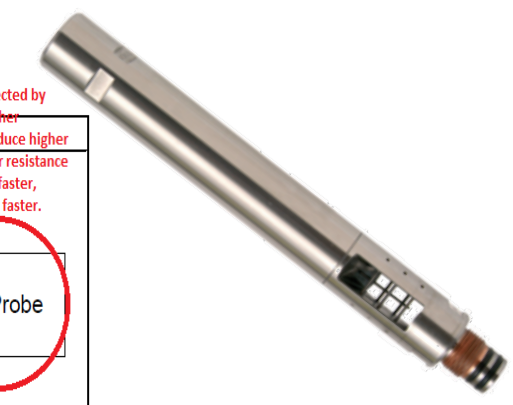
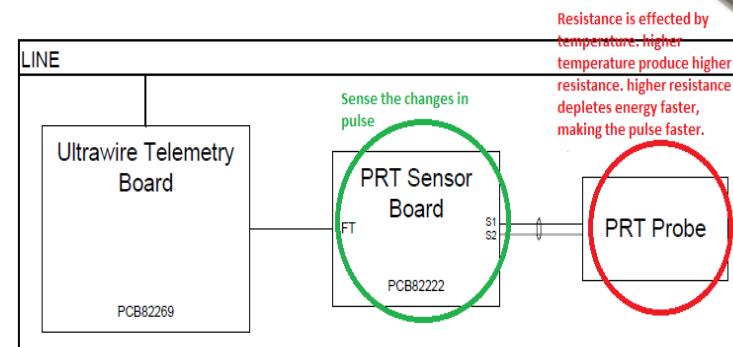
Platinum Resistance Thermometer, PRT

The temperature sensor responds to small temperature changes - indicating fluid movement inside and/or outside of the completion.

Measurement Principal

- A fast-sensing platinum is used as a resistor in the sensor system (RLC circuit), where the temperature effects the resistance of the platinum, and at the same time effecting the frequency produced by the circuit.
- Higher temperature creates higher resistance in platinum, which depletes energy faster in the circuit, thus creating faster pulse

BLOCK DIAGRAM



Production Gamma Ray (PGR) & Casing Collar Locator (CCL)

Production Gamma Ray, PGR

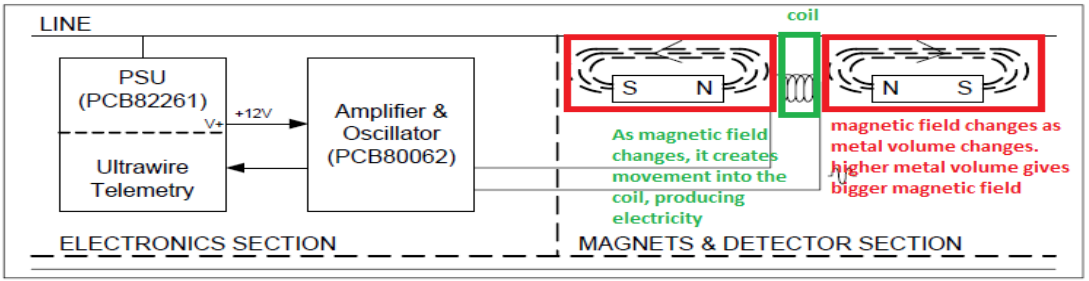
Measures natural gamma ray radiation levels in the wellbore. Used, for depth correlation, lithology and radioactive scale identification which is associated with water production.

Casing Collar Locator, CCL

The **CCL** sensor responds to changes in metal volume such as at casing joints, completion items or perforations. It is mainly used for depth correlation though can be used to detect holes and perforations.



BLOCK DIAGRAM



Capacitance Water Hold-Up (CWH) & Fluid Density Radioactive (FDR)

Capacitance Water Hold-Up, CWH

Oil, water and gas have different dielectric responses, the capacitance tool has different frequencies in gas, oil and water but it is principally used to measure the water fraction in the mixture.

Measurement Principal

Using concept of dielectric to identify fluid, thus knowing the fraction volume of water.

Dielectric is an insulator that can be polarized by electrical field.

Dielectric constant for water = 80, air = 1, and oil = 10.

Fluid Density Radioactive, FDR

Oil, water and gas have different densities. By measuring the overall density of the wellbore fluid the fraction or holdup of each phase can be calculated

Measurement Principal

- The lower section of the tool has a radiation source, that will travel through a slot filled with well fluid, and a detector above the slot to count the value of radiation that arrives.
- Higher density fluids absorb more gamma rays from gamma rays source, hence the low number of arrival at detector vice versa.
- The logarithm of tool response to density is linear for liquid with 0.0 to 0.9 g/cc density.



Flowmeter

Flowmeters

The flowmeter measures well fluid velocity using a turbine (spinner) impeller, the higher the fluid velocity, the faster the spinner rotates. Knowing fluid velocity and tubing size, volumetric flow rate can be calculated. Spinner mechanical sections should be selected to suit completion size and fluid velocity. However in general, the largest spinner impeller that can be used will give the best results.

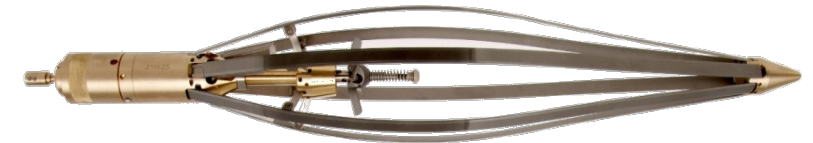
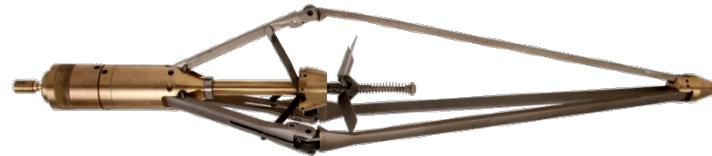
1. Continuous Flowmeter Spinner:

This spinner rotates continuously. It is typically used in tubing and in casing for high rate gas wells. It has roller bearings.



2. Caged Fullbore Flowmeter:

The spinner impeller is closed in tubing and opens up in casing to present a large diameter impeller, giving high sensitivity. It is protected by a springbow cage.



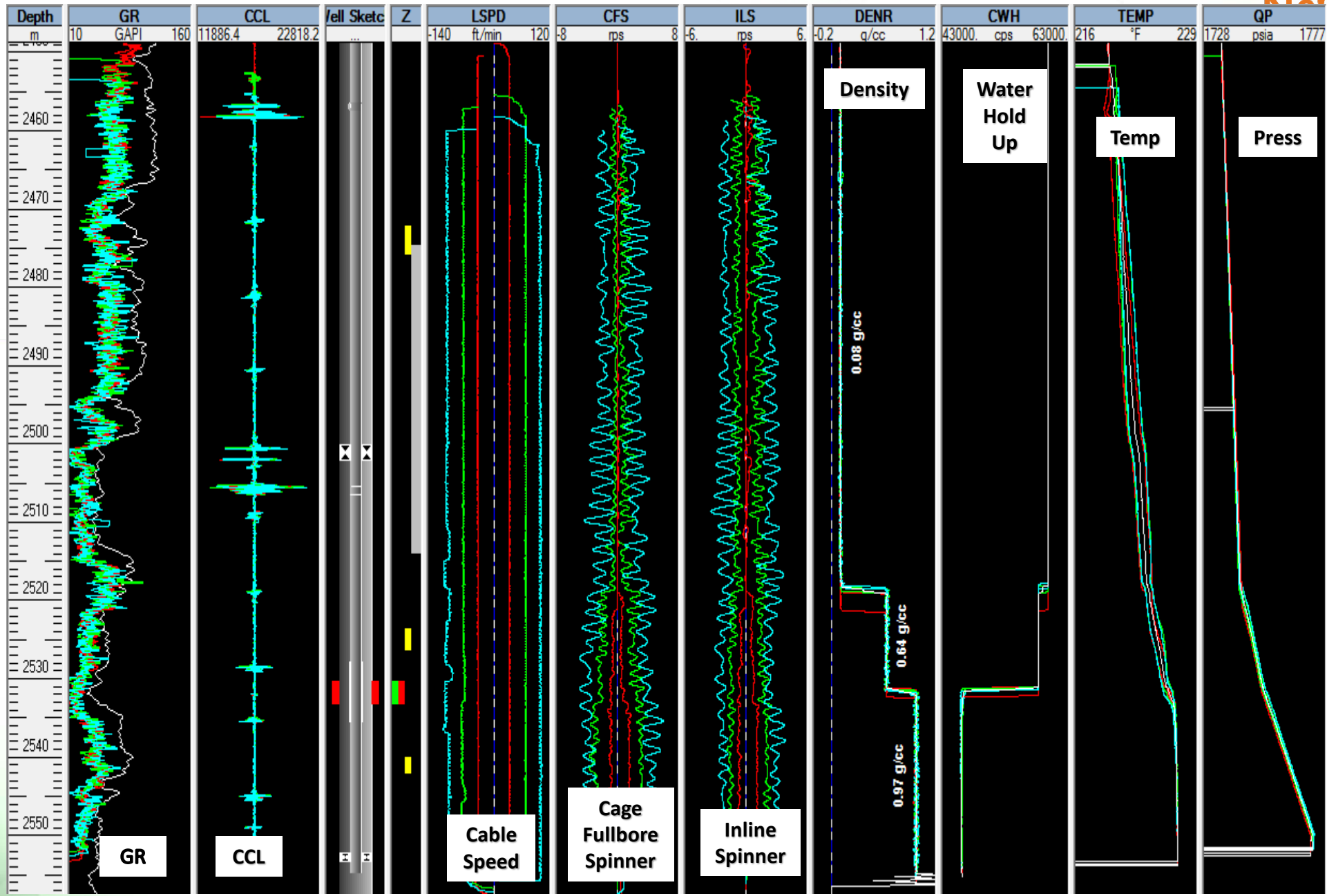
3. In Line Spinner:

The back up spinner. Positioned at the middle of toolstring.



Standard E-Line Production Logging Toolstring Configuration

Sensor	Offset (m)	Schematic	Description	Len (m)	OD (in)	Wt (lb)	
			ABM-003 (10022814)	0.45	1.69	8.00	
			UMT-007 (10015270) Ultrawire	0.32	1.69	5.90	
			QPS-019 (10010369) Quartz Pressure Sensor	0.48	1.69	9.00	
QTMP	5.20						
QP	5.20						
QTMP	5.20			PRT-016 (10013779) Platinum Resistance Thermometer	0.32	1.69	6.00
TEMP	4.85						
				PGR-020 (10022800) Production Gamma Ray	0.59	1.69	9.50
GR	4.37						
				CCL-015 (10018736) Casing Collar Locator	0.47	1.69	9.00
CCL	3.92						
				PKJ-013 (000001) Production Knuckle Joint	0.17	1.69	3.50
				PKJ #2 -013 (000002) Production Knuckle Joint	0.17	1.69	3.50
				PRC-001 (000001) Production Roller Centraliser (3 Arm)	0.59	1.69	7.00
				CWH-013 (10009617) Capacitance Water Holdup	0.66	1.69	10.00
CWHC	2.38						
CWH	2.38						
				ILS-022 (051428) Inline Spinner	0.44	1.69	6.00
ILSRATE	1.82						
ILSDIR	1.82						
			FDR-020 (10016110) Fluid Density Radioactive	0.59	1.69	10.00	
FDRC	1.24						
DENR	1.24						
			PRC-001 (100001) Production Roller Centraliser (3 Arm)	0.59	1.69	7.00	
			CFRE-05 (10020087) Caged Fullbore Electronics	0.29	1.69	2.50	
CFSRATE	0.04						
CFSDIR	0.04		CFSM-01 (10022712) Continuous Flowmeter Spinner Mechanicals	0.26	2.13	1.00	
Dataset: Total Length: Total Weight: O.D.			Sondex Ultrawire 6.37 m 97.90 lb 2.13 in				



Multi Array Production Suite (MAPS)



MAPS Function & Applications

1. **MAPS Function:** Identify oil & gas production and locate water entry points in all types of well conditions. (Vertical to horizontal) *{PLT string use in well with phase segregation due too deviated well}*
2. Specifically required for wells where phase separation occur normally in high deviation well
3. MAPS combines the **Spinner Array Tool (SAT)**, **Capacitance Array Tool (CAT)** and **Resistance Array Tool (RAT)** to measure phase hold-ups and velocities
4. CAT is used for fluid ID, RAT for water hold up, and SAT as flowmeter.
5. Since the flowmeter, fluid ID and water hold up sensor gives individual data, it is very important to line up the sensors in the same plane as the tools are usually in cylindrical shape and can rotate 360 degree. To make sure of this, Production Inclinometer Accelerometer can be used.

Flow Regime

In c
reg

Eye
ph
side



Stratified
Smooth Flow

Stratified

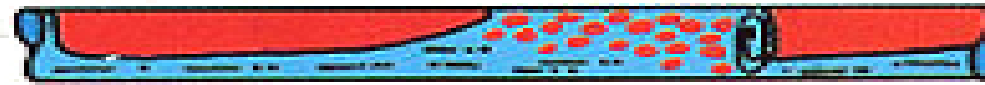


Stratified
Wavy Flow



Elongated
Bubble Flow

Intermittent



Slug Flow

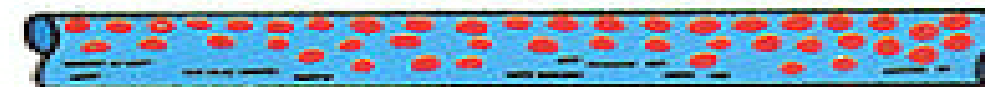


Annular
Flow

Annular



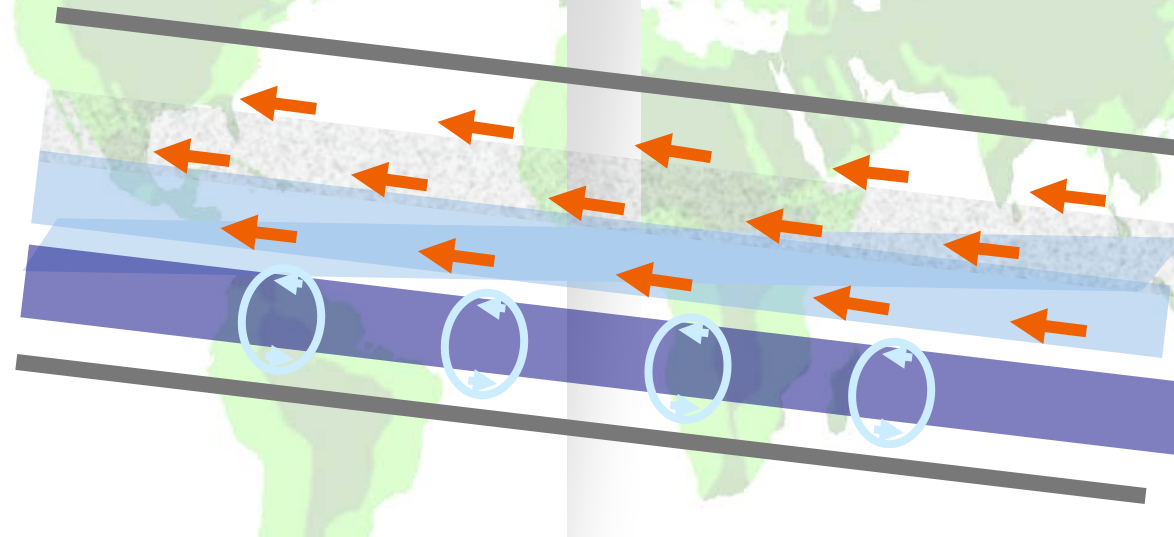
Wavy Annular
Flow



Dispersed
Bubble Flow



Multiphase Flow in Slanted Well – Upward Flow

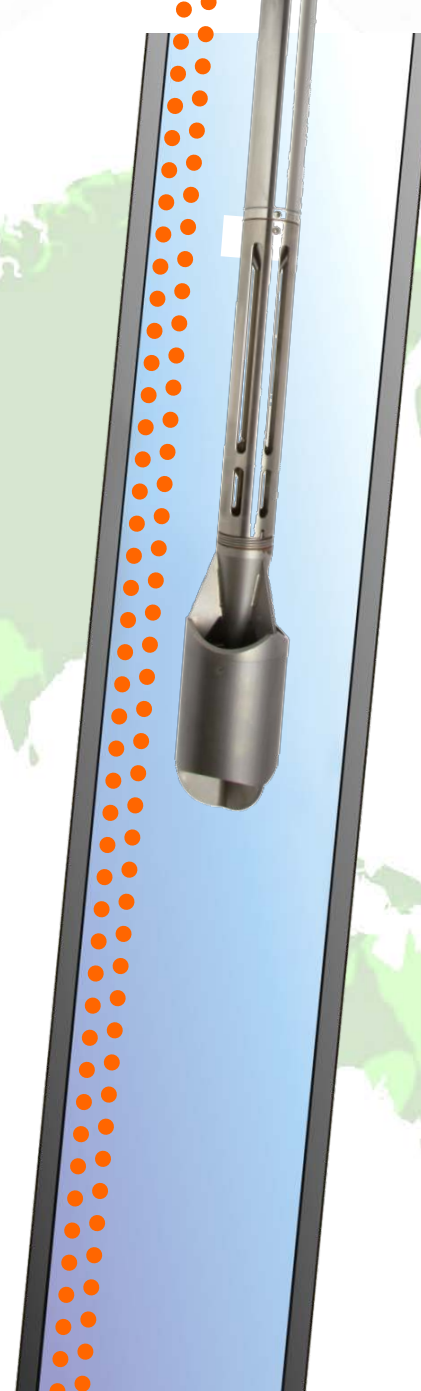


Lighter oil flowing
on the high side

Heavier water re-circulating on
the low side

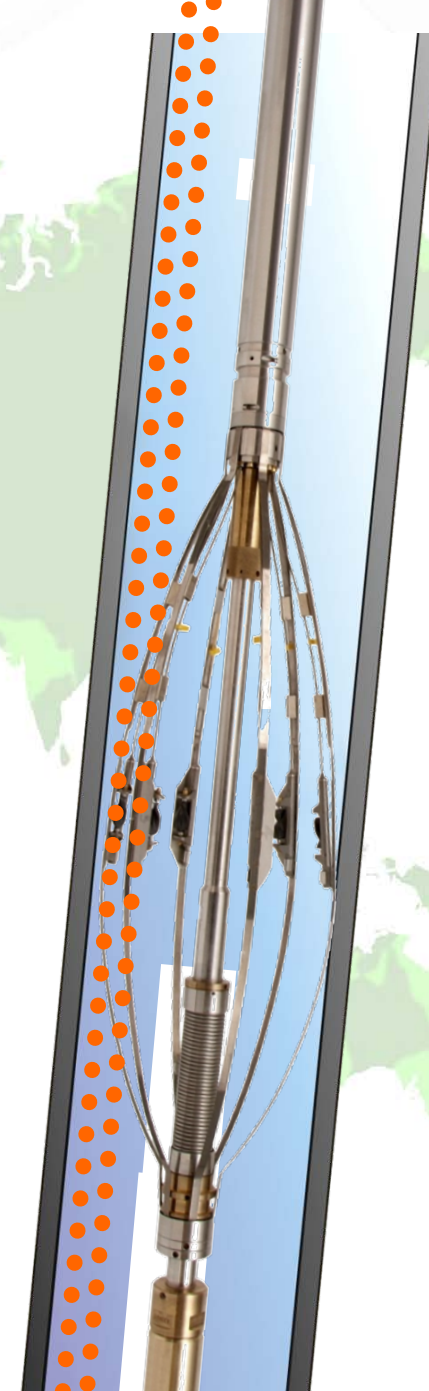
Standard Tool

Tools positioned in the centre of a well may miss oil, or gas flowing on the high side, or water on the low side of the pipe



MAPS Tool Design

Bowspring style tools deploy sensors to intercept minority flows at the perimeter of a pipe

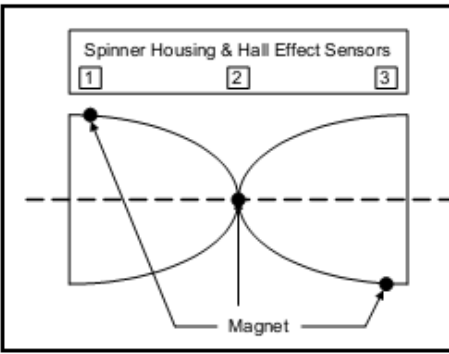
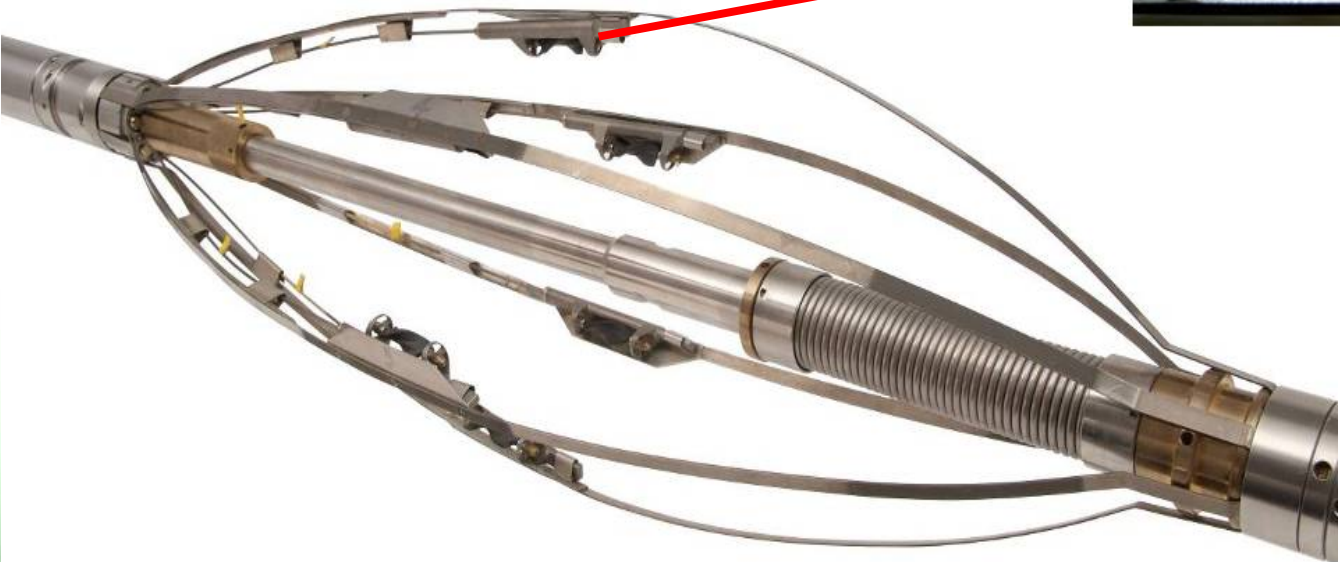


Spinner Array Tool (SAT)

6 miniature flowmeters mounted on bowsprings

Measure the velocity of surrounding fluid

Spinner OD	Minimum Tool OD
0.6in	2.125in
0.4in	1.90in



Capacitance Array Tool (CAT)

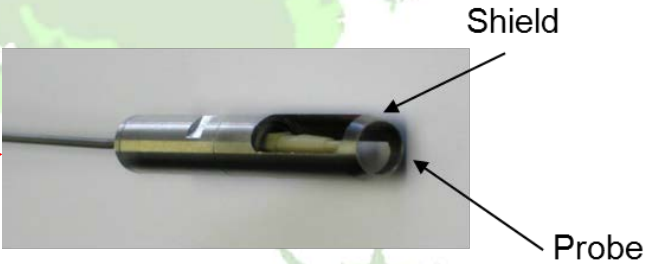
- 12 miniature sensors mounted on bowsprings
- Specially developed to measure the capacitance of surrounding fluid

Typical Calibration Values	
Gas	200 - 240
Oil	150 - 180
Water	35 - 55

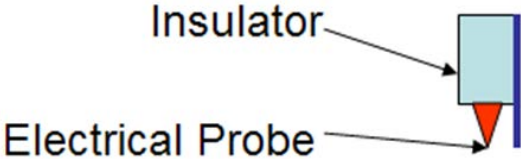


Resistivity Array Tool (RAT)

12 miniature sensors mounted on bowsprings
Specially developed to measure the electrical resistance of surrounding fluid



RAT Typical Value
Gas: 1
Oil: 0.8
Water: 0.4



Multifinger Imaging Tool (MIT)



MIT Function & Application

1. **MIT Function:** Generate information about the internal surface of the well tubing.
2. Application:
 - Corrosion Assessment
 - Casing Wear
 - Casing Deformation
 - Drill string damage
 - Perforation Mapping
 - Well Construction
 - ID Confirmation
 - Quantification of scale build up and corrosion
 - Accurate location of holes or anomalies.
3. Logging Speed : <10ft/min (recommended)

MIT Tool Specification

24 finger MIT (1.69"OD)

- Measurement Range: 1.75" to 4.5"
- Full String Length: 15 ft
- Full String Weight: 72 lbs

24-E finger MIT (1.69"OD)

- Measurement Range: 1.75" to 7.0"
- Full String Length: 15 ft
- Full String Weight: 72 lbs

40 finger MIT (2.75"OD)

- Measurement Range: 3.0" to 7"
- Full String Length: 17 ft
- Full String Weight: 120 lbs

60 Finger MIT (4"OD)

- Measurement Range: 4.5" to 9 5/8"
- Full String Length: 17 ft
- Full String Weight: 160 lbs

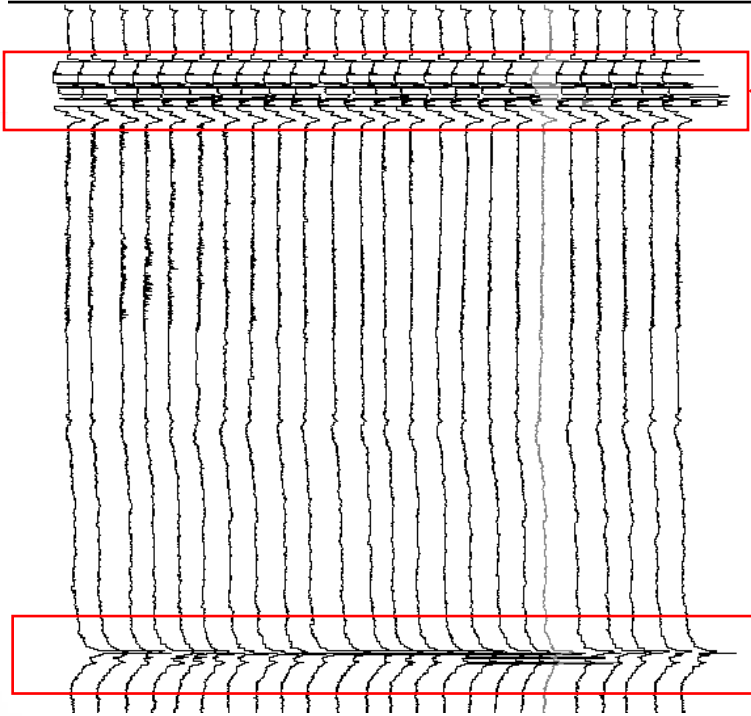
Radial Accuracy: + / - 0.030"

Temp. Rating : 177 degC

Pressure Rating : 15000 psia

MIT

1	FING01 (in)	5
0.9	FING02 (in)	4.9
-1.2	FING23 (in)	2.8
-1.3	FING24 (in)	2.7

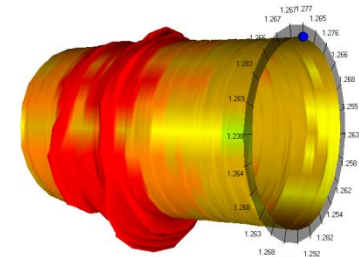


SSD

POSSIBLE HOLES

3D View on Possible Holes

Depth: 1.311 02 in
Length: 1.50 in
Line Spd: 25.25 ft/min
Rotation: 20.55 rpm
Nom Dia: 2.64 in
Nom ID: 2.59 in
Max Dia: 2.56 in
Min Dia: 2.52 in
Avg Dia: 2.53 in



Magnetic Thickness Tool (MTT)



MTT Function and Applications

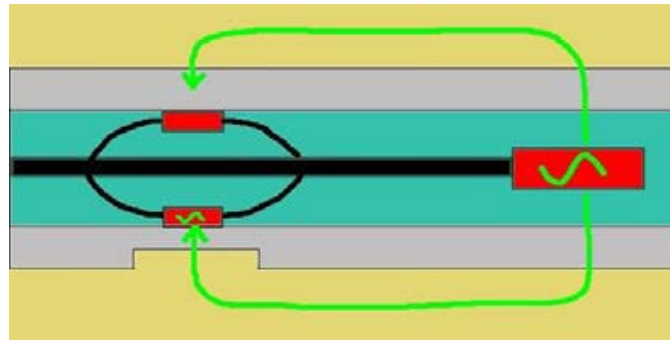
1. **MTT Function:** Obtain a measurement of casing or tubing wall thickness and an indication of corrosion that may be present
2. Applications :
 - Inspection of tubing and casing for internal & external metal loss.
 - Measures absolute wall thickness.
 - 3D visualizations provide powerful qualitative images of well condition.
 - Detects pitting and gradual wall loss.
3. Logging Speed : <10 ft/min (recommended)

MTT Specification

1. Sensors: 12 radially deployed sensors.
2. Range: Up to 7" casing.
3. Thickness Accuracy: depends on the size of the defect.
4. In undamaged pipe accuracy is better than 15% of wall thickness.
5. Defect Resolution: Depends on the size of the defect.
 - Ø 3/8" diameter defect: 50% wall thickness, 35% metal loss.
 - Ø 3/4" diameter defect: 30% wall thickness, 20% metal loss.
 - Large extent defects better than 10% of wall thickness.
6. Pressure: 15,000 psi. Temperature: 150 deg C
7. Tool Dimensions :
 - OD : 1 11/16"
 - Length : 85.8" w/o centralizers
 - Weight : 30 lbs

Measurement Principal

1. MTT consists of two basic elements: a single centrally located transmitter coil and 12 small coil sensors deployed radially on bowsprings.
2. Transmitter generates an AC magnetic field which permeates through the casing wall and travels along the outside of the casing. The field then re-enters the casing adjacent to the sensor coils to complete its loop. The travel time of the signal from the transmitter to the sensor is dependent upon the magnetic properties and **thickness** of the metal.
3. In the example on the right, because of the localized reduction in wall thickness, the lower coil will detect the signal before the upper coil. This is measured as a phase change.

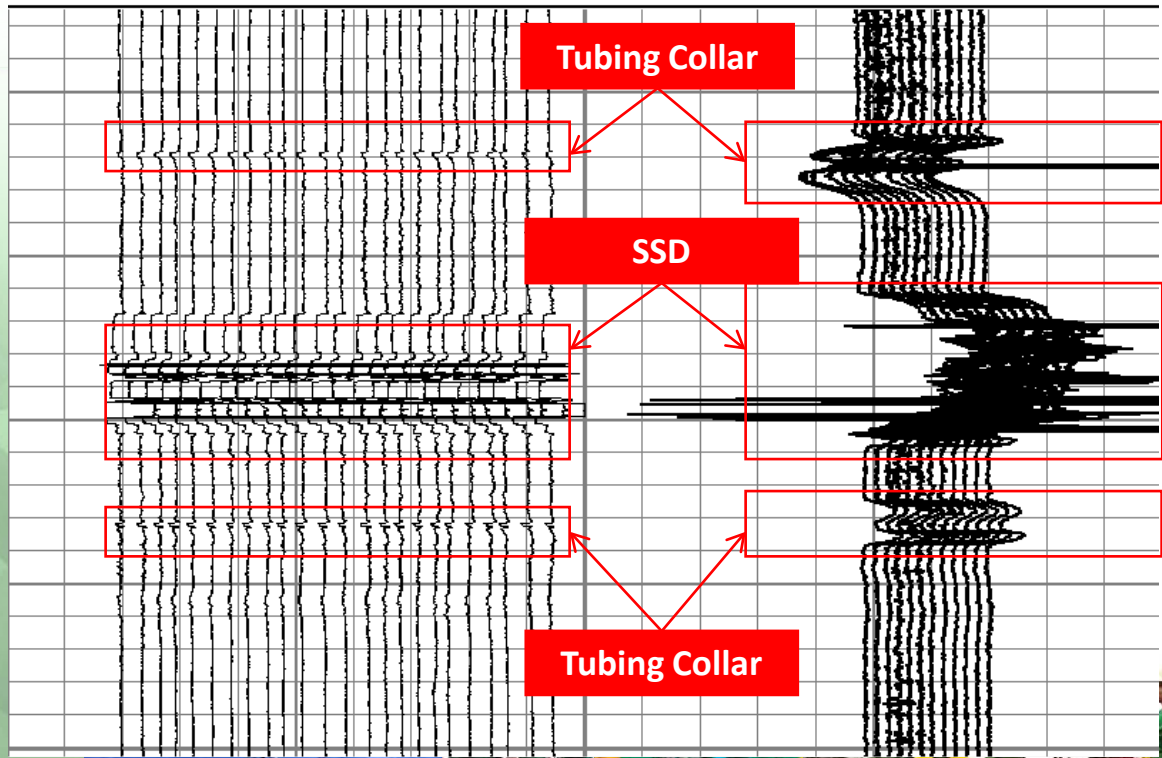


3D View on SSD

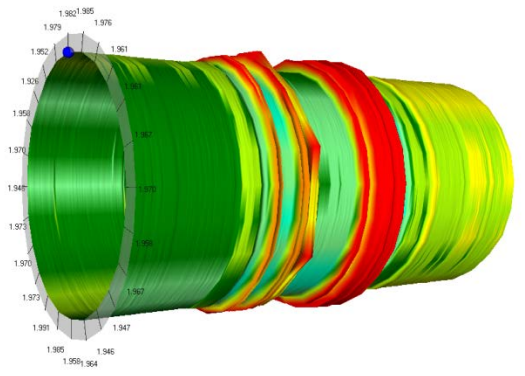
MIT

MTT

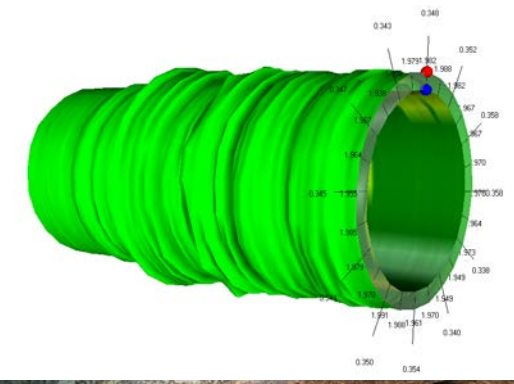
1.4	FING01 (in)	4.5	-1.4	MTTP01 ()	8.6
0.8	FING07 (in)	3.9	-2	MTTP04 ()	8
0.1	FING14 (in)	3.2	-2.6	MTTP07 ()	7.4
-0.6	FING21 (in)	2.5	-3.2	MTTP10 ()	6.8



Depth: 3073.69 ft
Length: 10.00 ft
Line Spd: 29.00 ft/min
Rotations: 62.56 deg
Nom ID: 3.96 in
Nom OD: 4.50 in
Max Dia: 3.97 in
Min Dia: 3.87 in
Avg Dia: 3.93 in



Depth: 3073.69 ft
Length: 10.00 ft
Line Spd: 29.00 ft/min
Rotations: 62.57 deg
Nom ID: 3.96 in
Nom OD: 4.50 in
Max Dia: 3.98 in
Min Dia: 3.88 in
Avg Dia: 3.94 in
Max Thk: 0.36 in
Min Thk: 0.24 in
Avg Thk: 0.30 in



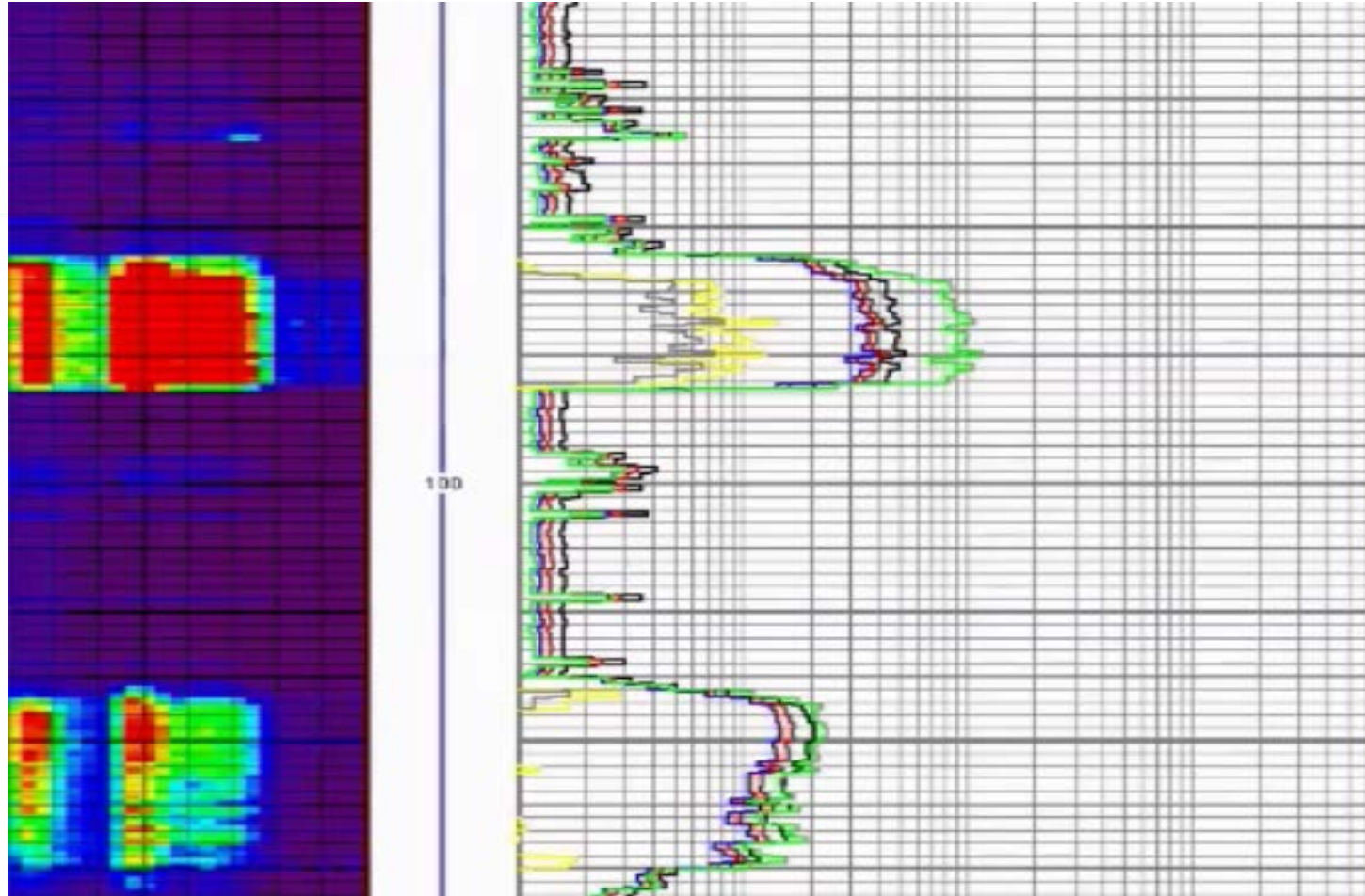
Noise Tool (NTO)



NTO Function & Applications

1. NTO Function : Measure downhole noise in the frequency range of 100Hz to 12.7kHz.
2. Application :
 - Detect flow both inside and outside casing
 - Evaluate flow profile
 - Locate channels behind casing
 - Locate Gas-Liquid interfaces
 - Locate leaks in casings
3. Logging Speed : <10ft/min (recommended)

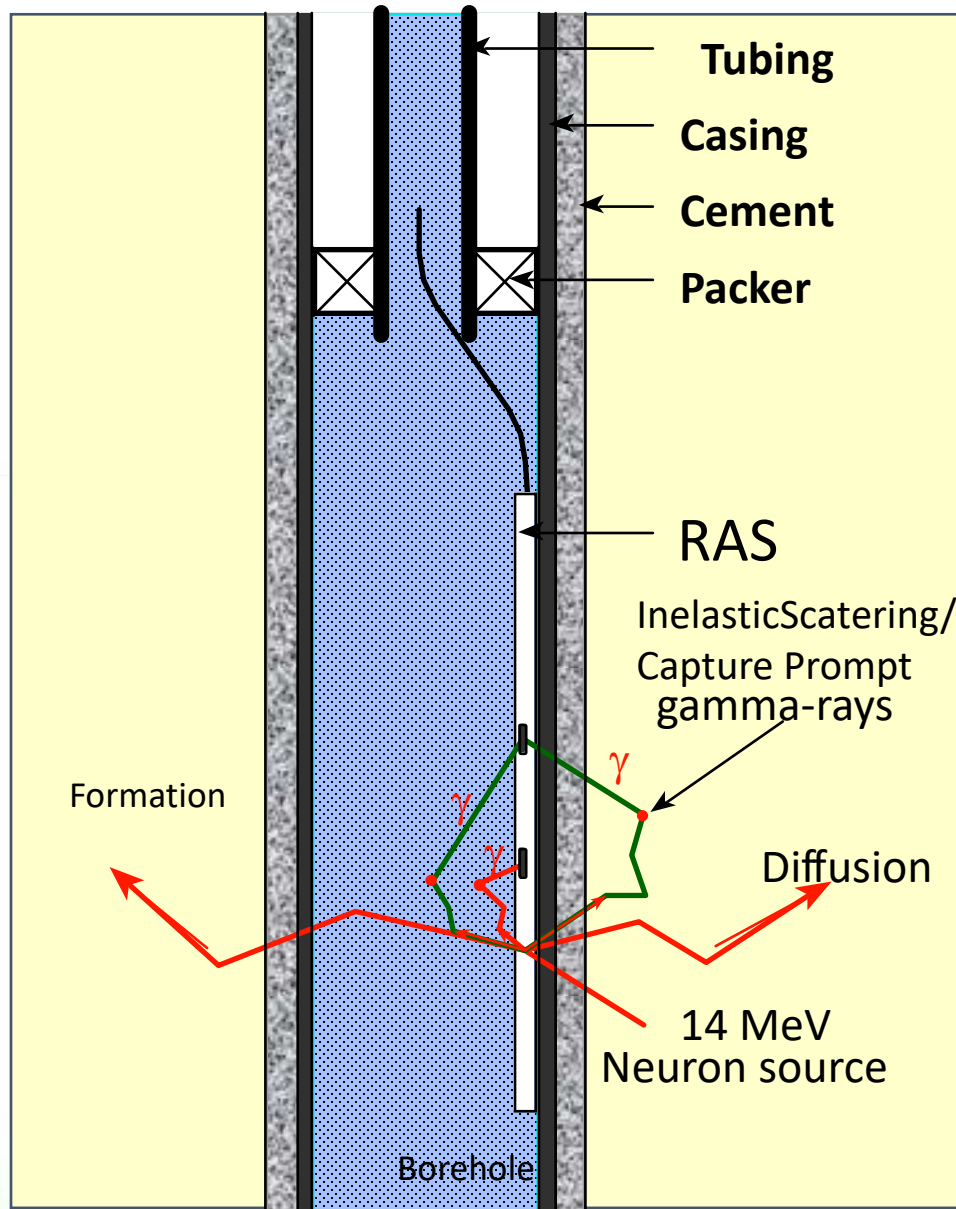
Noise Tool Log Example



The background features a white space with abstract, colorful elements. In the top right corner, there are overlapping circles and lines in shades of purple, pink, and yellow. In the bottom left corner, there is a green geometric pattern of overlapping triangles. A dark grey rounded rectangle is positioned on the left side, containing the main text.

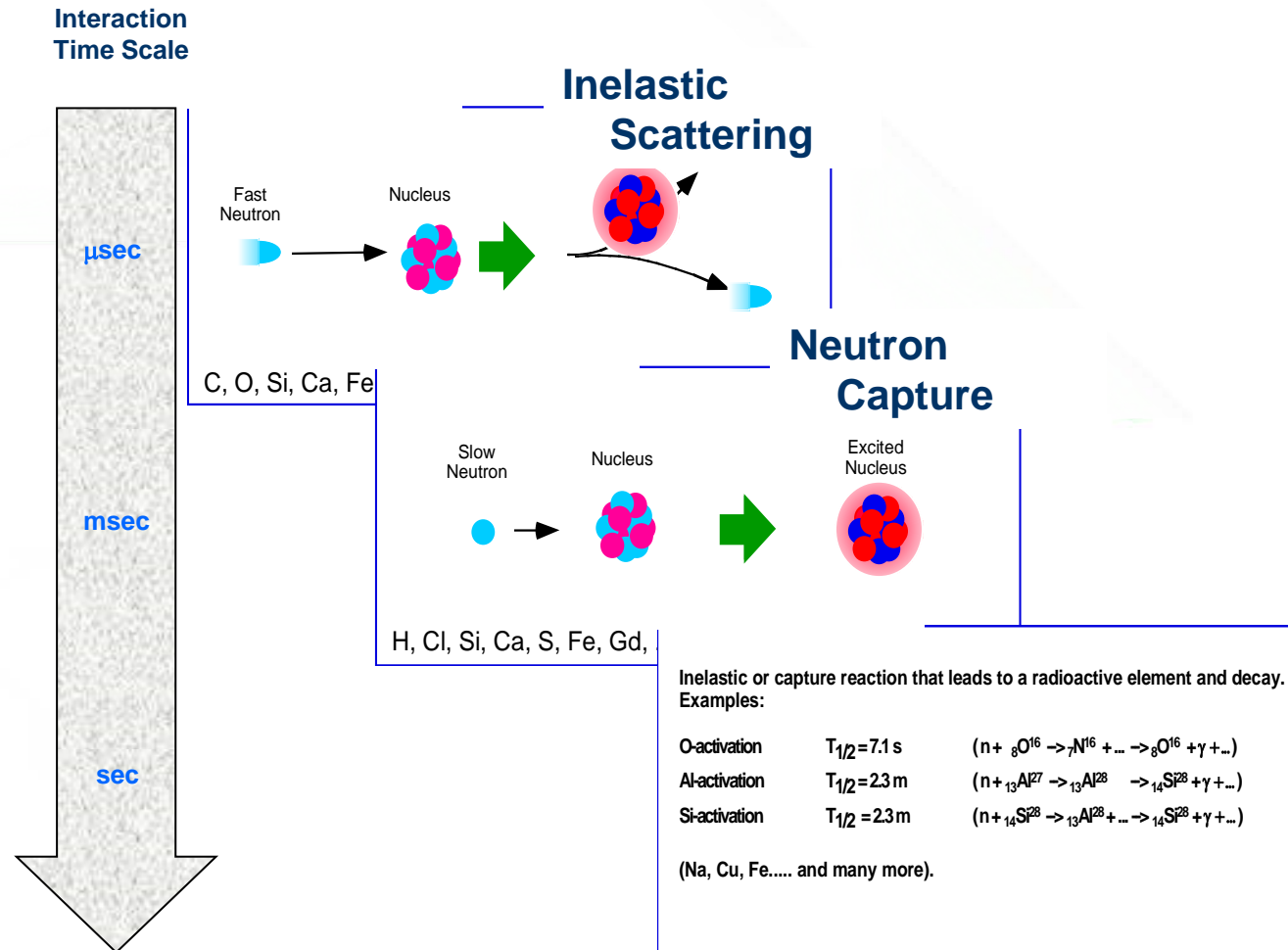
INTRODUCTION TO LOGGING TOOLS

RESERVOIR MONITORING/SATURATION TOOL

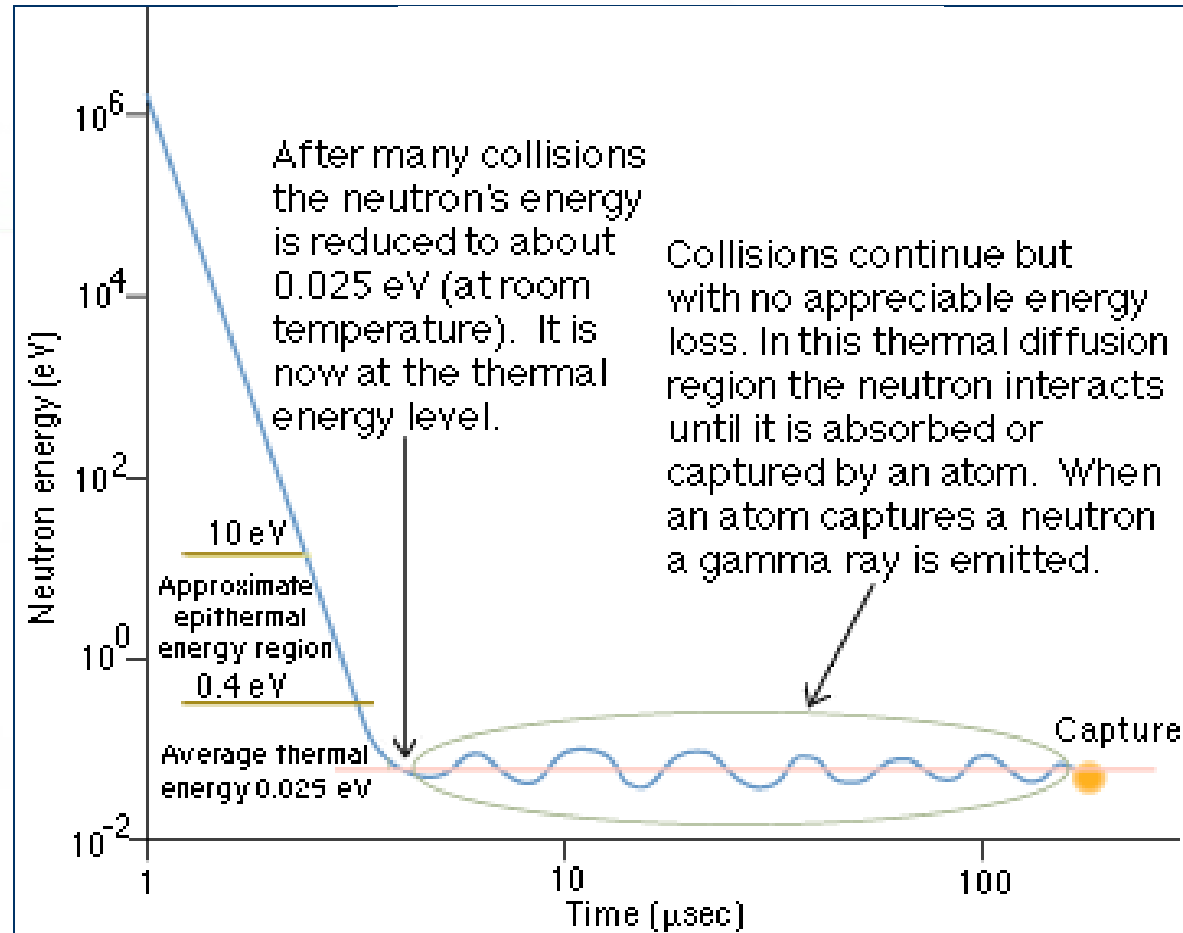


- Tool generates neutrons
- Neutrons interact with the formation, the borehole and tool
- Measures GR
- Then we get SATURATION

Neutron Interaction Timing



Life of a neutron

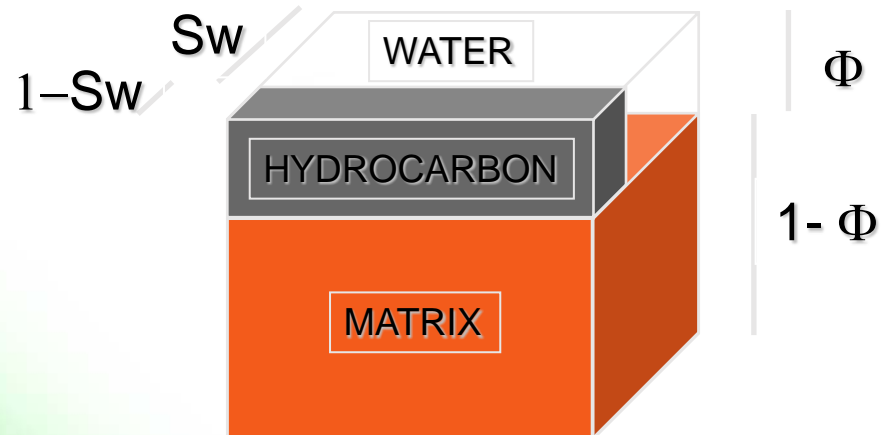


Basic interpretation

Response equation is based on volumetric quantities of formation components

Assuming a unit cube of formation

$$\Sigma \log = (1-\Phi)\Sigma_{\text{matrix}} + S_w\Phi\Sigma_{\text{water}} + (1-S_w)\Phi\Sigma_{\text{hc}}$$



knowing :

- Σ_{hc} & Σ_{matrix} (standard values)
- Σ_{water} (history or sample measurement)
- Φ (TPHI or open hole logs)
- $\Sigma \log$ (measured)

→ **Sw** Dual-water model

Why do we want Sigma?

- Elements have a Capture Cross section property called → Sigma

Gas	0-12
Oil	18-20
Water	22-130 (fresh -> saline)
Shale	35-55
Matrix	8-12

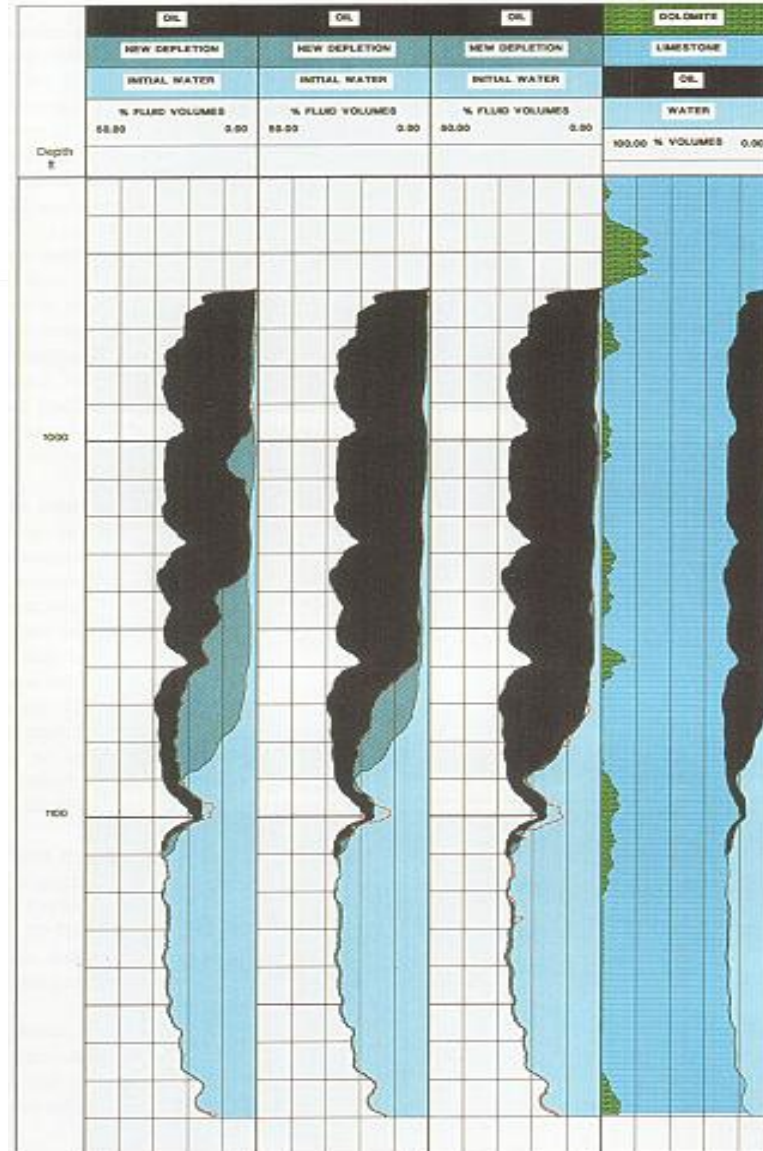
Knowing Sigma, the water saturation can be derived:

$$S_w = \frac{(\Sigma_{LOG} - \Sigma_{ma}) - \phi(\Sigma_h - \Sigma_{ma}) - V_{sh}(\Sigma_{sh} - \Sigma_{ma})}{\phi(\Sigma_w - \Sigma_h)}$$

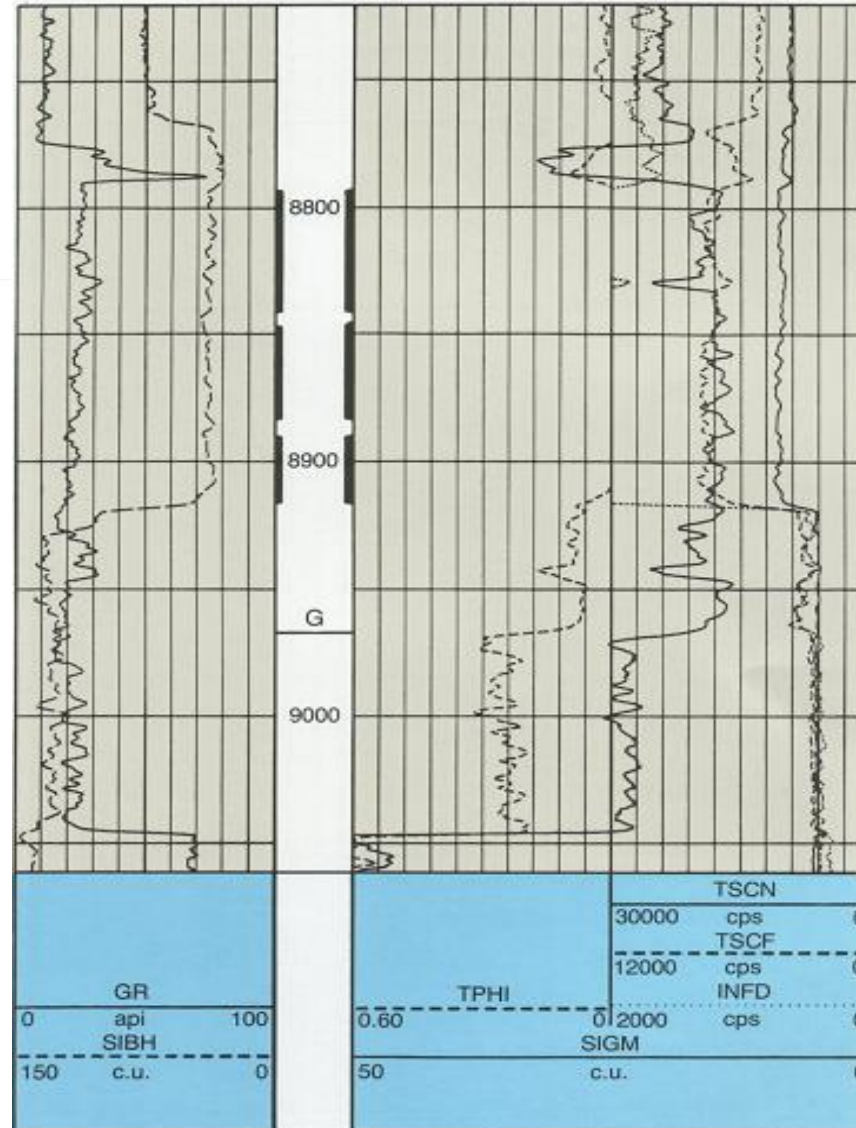
Sigma applications

- Stand-alone Sw when formation water is saline
- More ~ 35,000 ppm (NaCl equivalent)
- Calculate today Sw using time lapse technique
- Monitoring Porosity through casing
- Production logging applications
 - Gas well monitoring
 - Gas-Oil & Water-Oil contacts (GOC & WOC)
 - Borehole salinity monitoring (BSAL)
 - Helps on C/O interpretation

Time lapse technique



Gas detection



Reservoir Analysis System (RAS)



RAS Function & Applications

1. **RAS Function:** Multi-detector pulsed-neutron system for measuring reservoir saturation using Sigma and Carbon-Oxygen techniques
2. Applications :
 - Reservoir Monitoring
 - Wellbore performance and integrity
 - Prospecting in existing well
 - Primary reservoir description where Open-hole logging is constrained
 - Harmonization of field data sets
3. Logging speed: < 20ft/min (Recommended for SIGMA mode)
< 5ft/min (Recommended for IC mode)

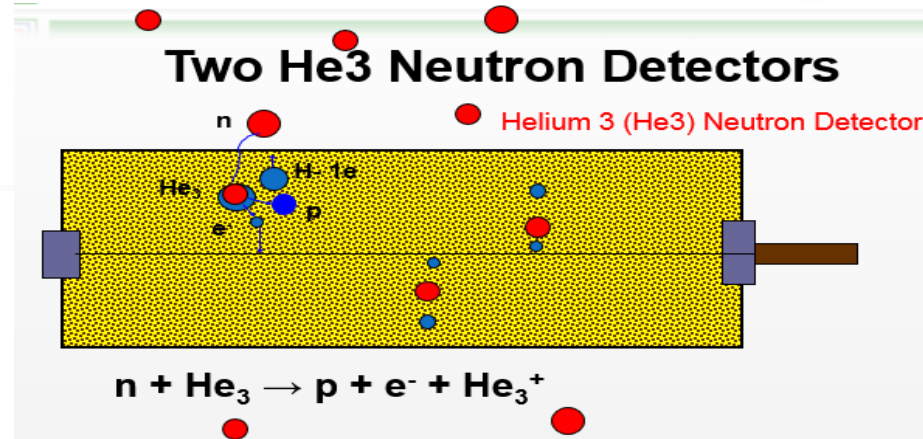
Neutron Generator

Deuterium Tritium Neutron Tube : not dangerous when not in use

- higher neutron energy (14.1 MeV)
- it is pulsed
- 100 - 200 working hours
- 150 C (300F) max. operating temperature
- 1.5×10^8 n/s neutron output

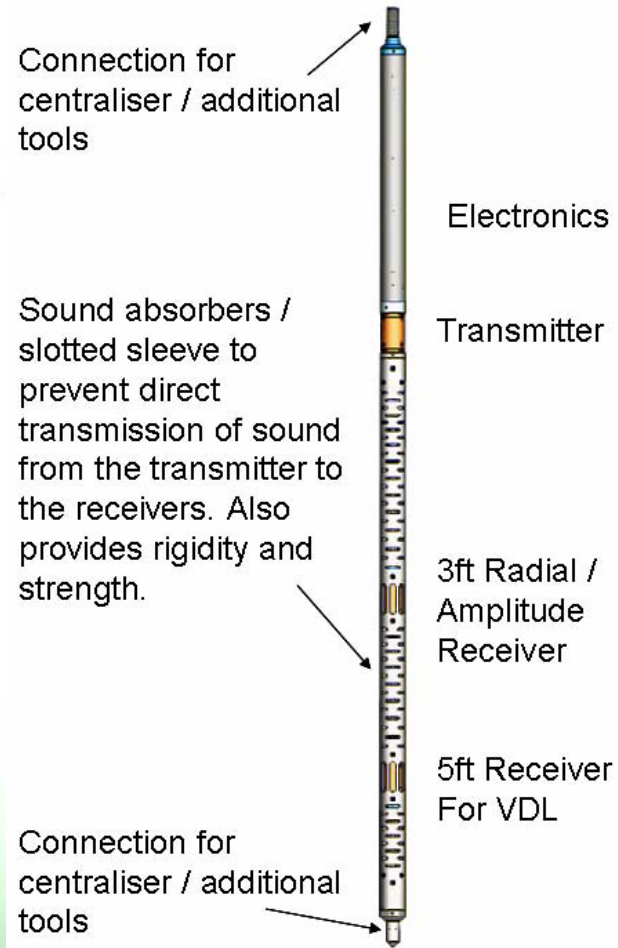


Measurement Principal



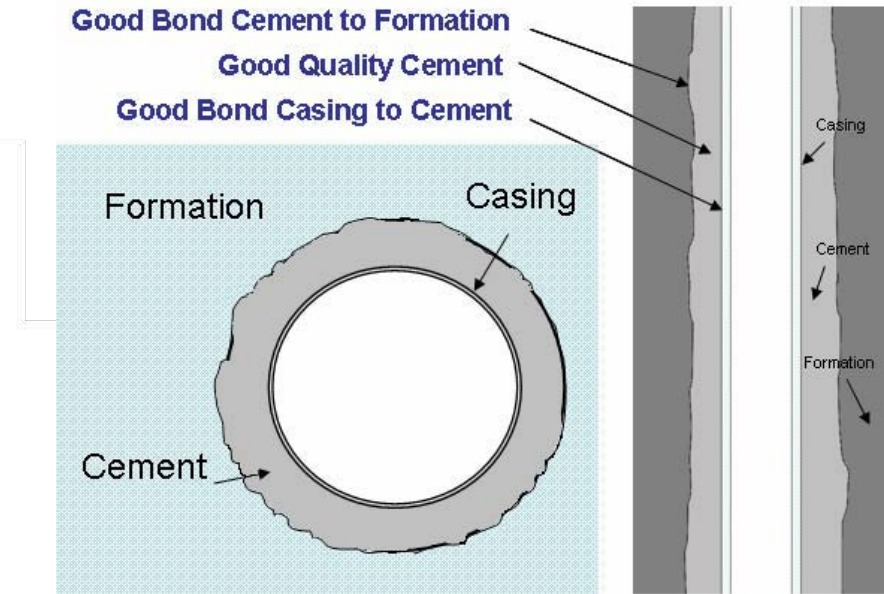
1. Thermal neutrons (He3 detector) are detected directly being captured within detector's volume.
2. The detectors can be set up to detect thermal neutrons.
3. Thermal detector counts neutrons with energy of around 0.025 eV.
4. PNN system detects thermal neutrons which came to the detector volume on the energy level of 0.025 eV.

Radial Bond Tool (RBT)



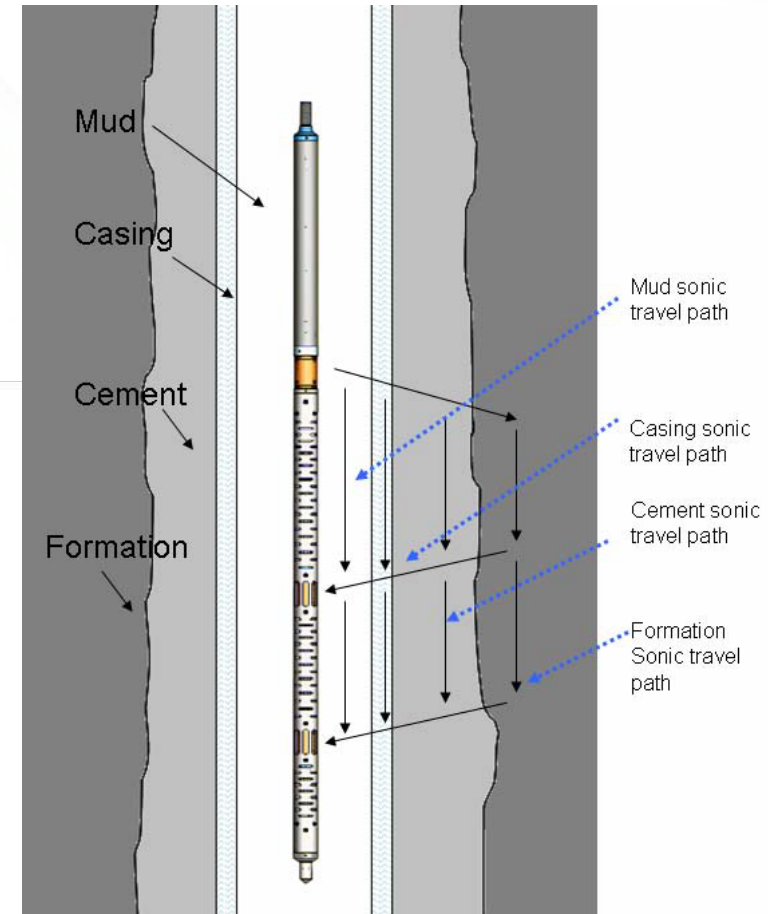
RBT Function

1. **RBT Function** : Evaluate isolation between producing and non-producing zones, and the integrity of the well, by the effective placement of the cement between the well tubulars (typically casing) and the formation.
2. Poor cement can result in unwanted water or gas production, fluid migration in the annulus and inadequate support of the casing. In some instances the safety and integrity of the entire well can be threatened.



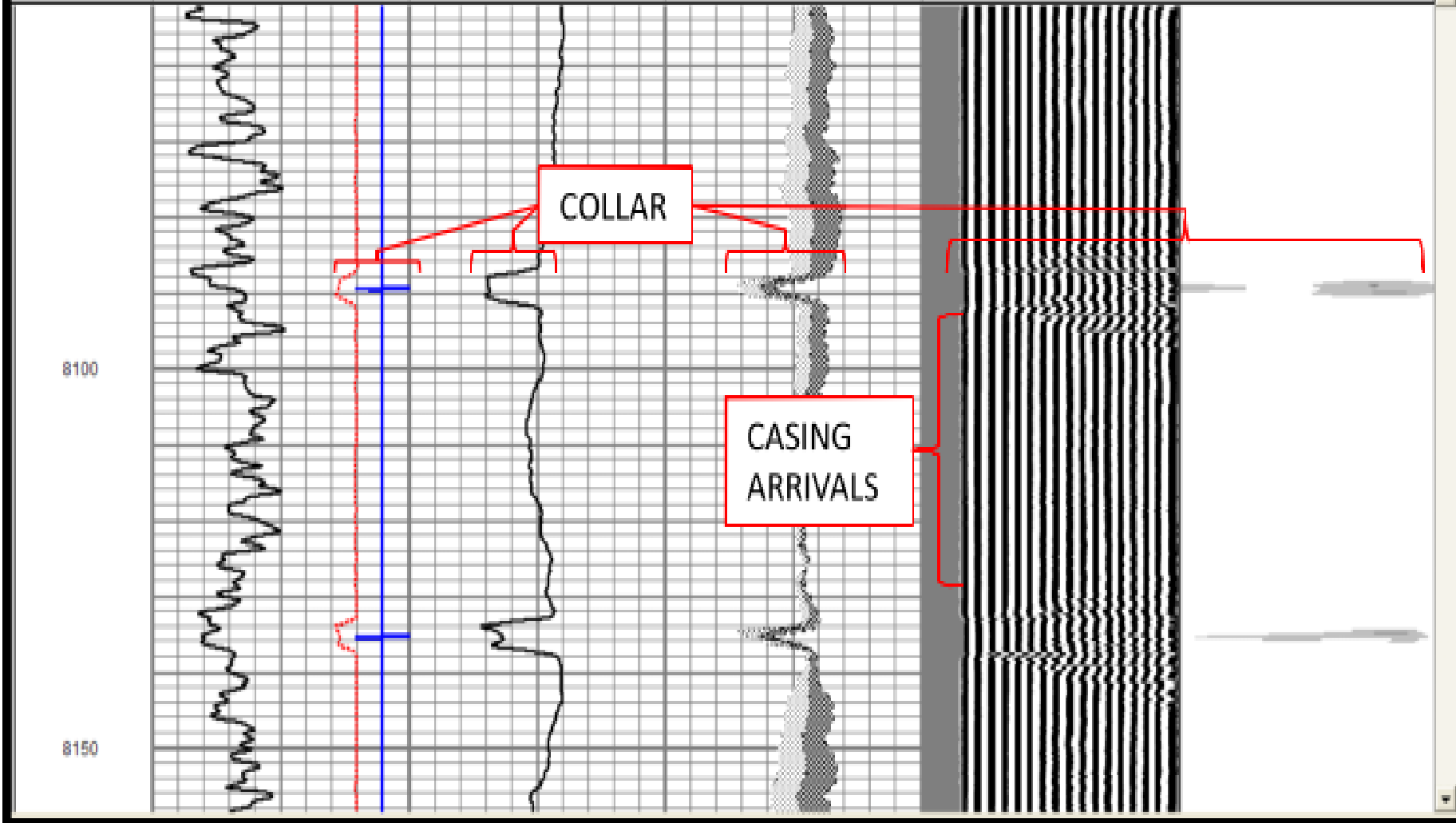
Measurement Principal

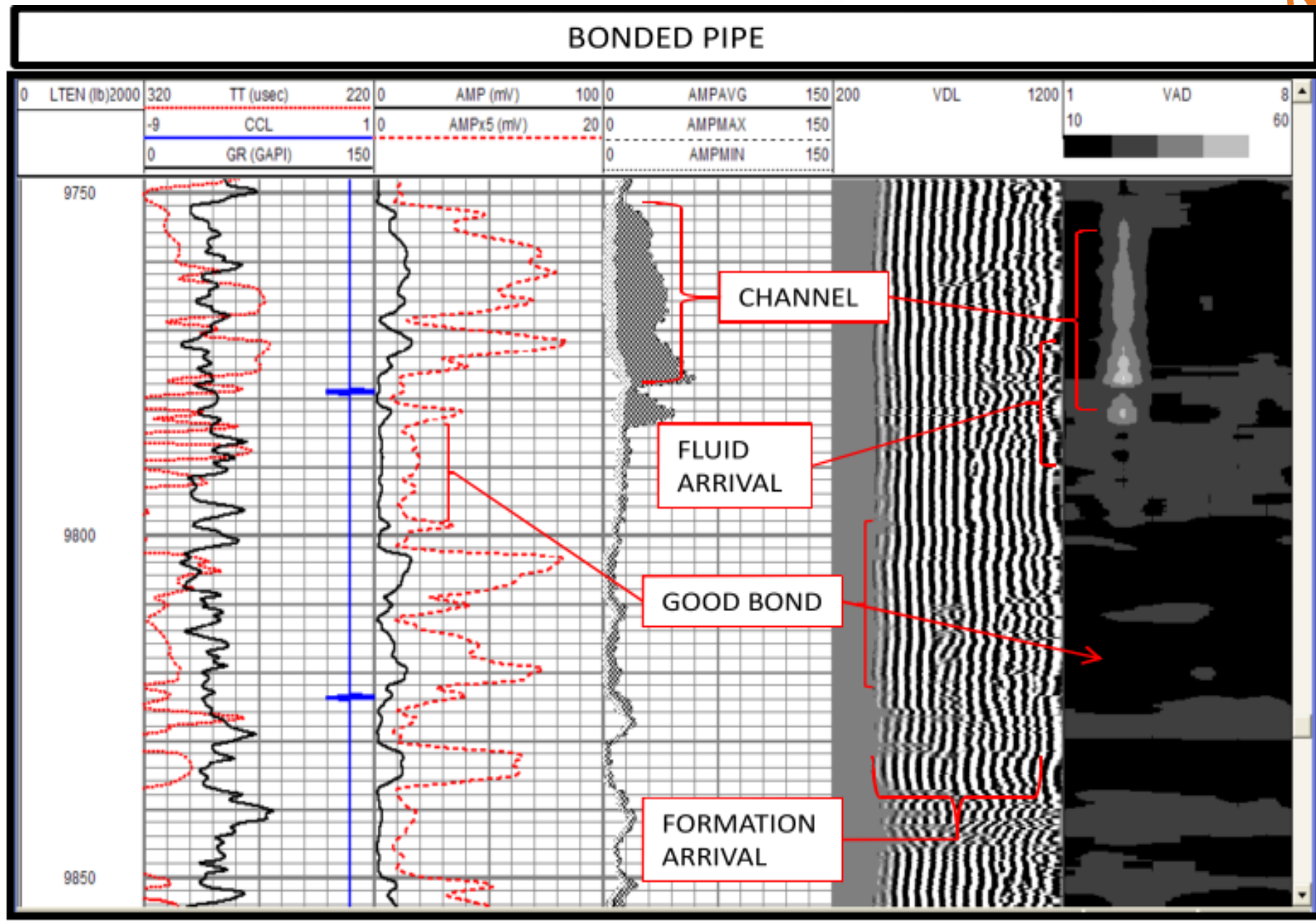
- A high frequency acoustic pulse is transmitted out to the casing at regular intervals.
- Sound travels through the borehole fluid, contacts the casing and travels along it before returning through the borehole fluid back to the receiver.
- 3ft receiver determine the casing-cement bond.
- 5ft receiver used to generate a VDL which is used to evaluate the cement-formation bond.
- The return signals contain components from several sources - compressional waves returning from the casing and fluid, and also compressional/shear waves from the cement and formation.



FREE PIPE

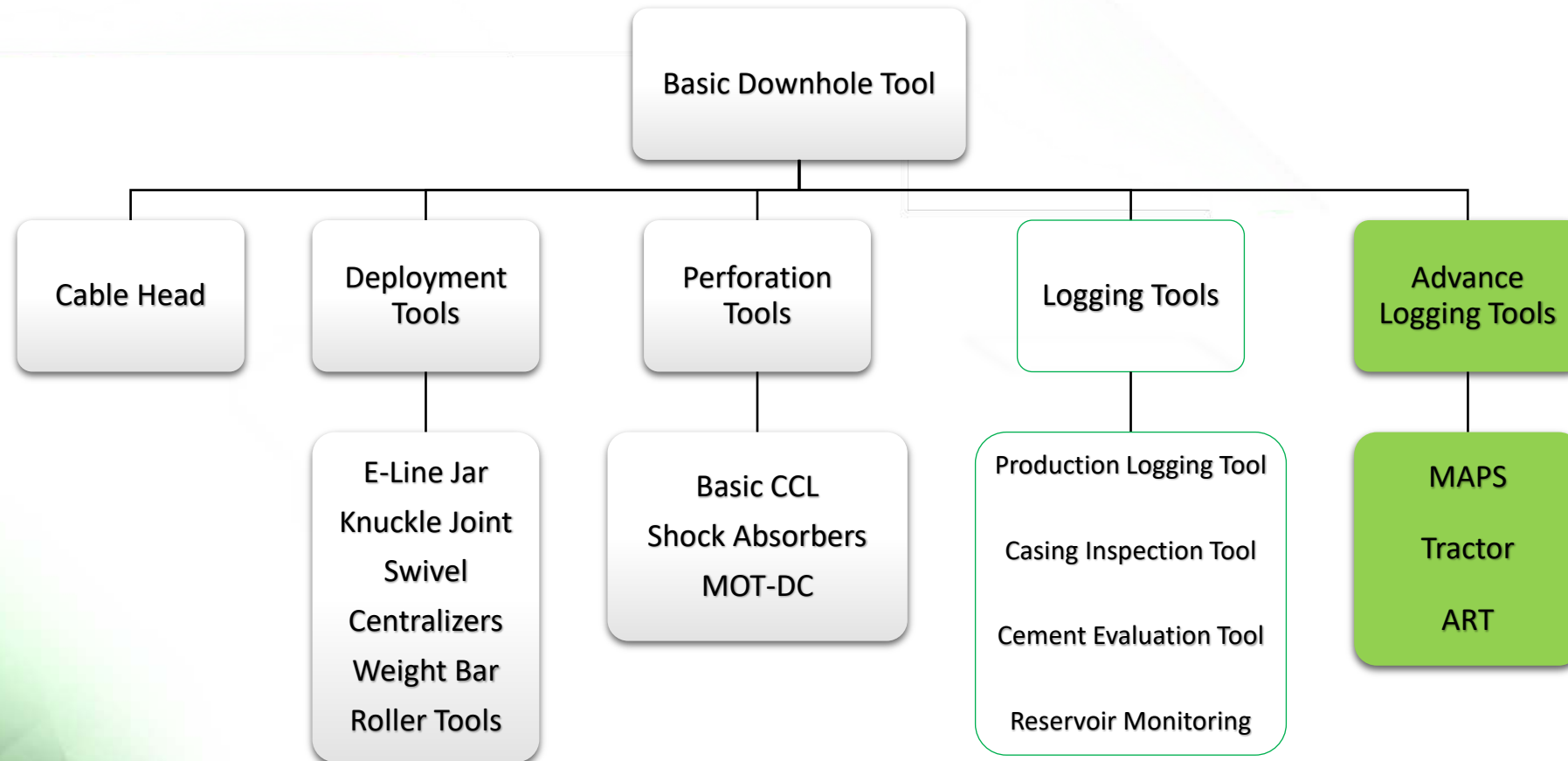
0	LTEN (lb)2000	320	TT (usec)	220	0	AMP (mV)	100	0	AMPAVG	150	200	VDL	1200	1	VAD	8
		-9	GCL	1	0	AMPx5 (mV)	20	0	AMPMAX	150				10		60
		0	GR (GAPI)	150				0	AMPMIN	150						



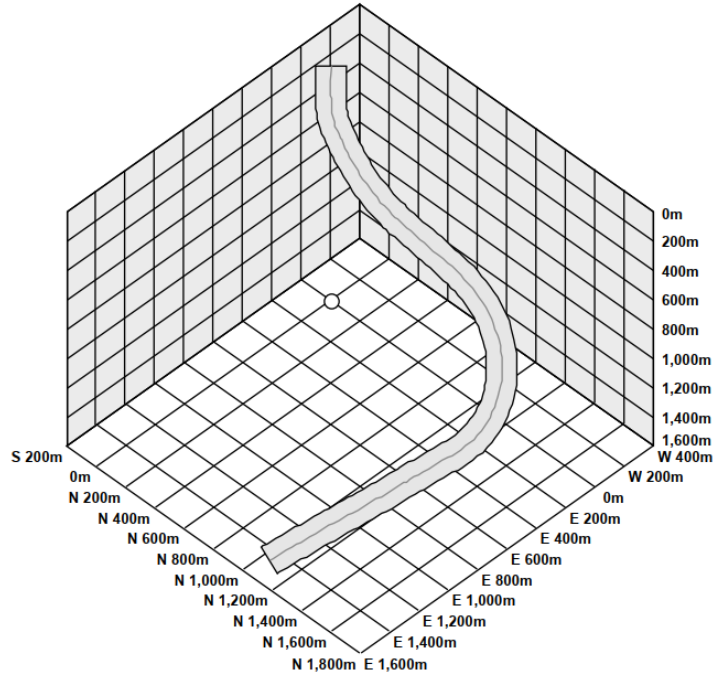


Introduction to Logging Tools

General types

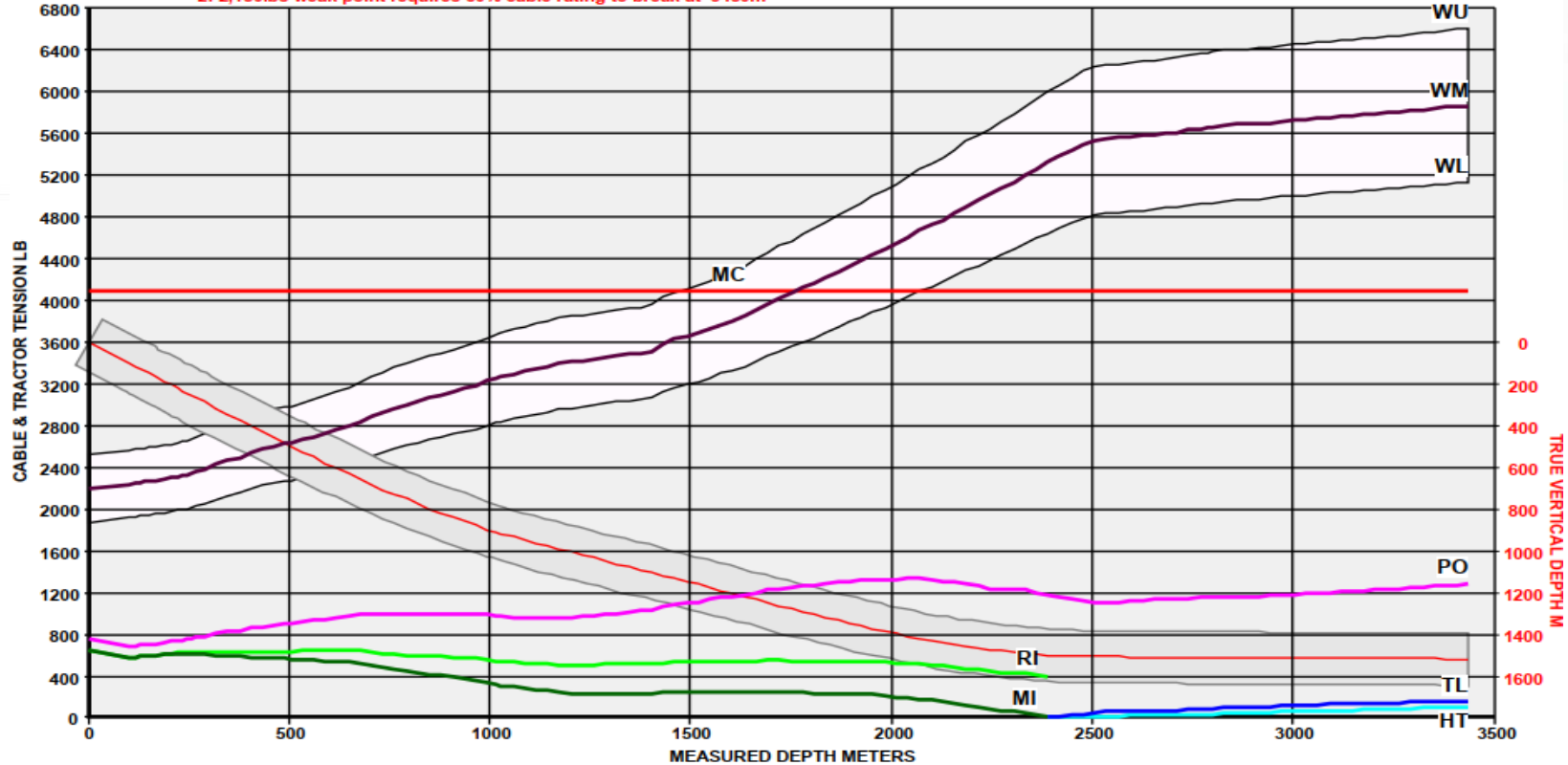


WEST Simulation



Summary of Results
 * Free Fall Limit = 2,392 m (83.5 deg)
 * Peak Cable Pull = 1,334lbs @ 2,041 m (33% limit)
 * Peak Tractor Pull = 168 lbs @ 3,469 m (28% limit)
 * Maximum cable stretch = 3.4 m @ 3,469 m
 * Cable limit (4,100lbs) can break 1,150 lbs(+15%) weak point at 3450m
WARNINGS: 1: Pull to break selected weak point below 1,491m exceeds cable limit
 2: 2,150lbs weak point requires 80% cable rating to break at 3450m

WEST SCENARIO - A Dummy GRCCCL



	CABLE DATA:	TOOLSTRING DATA:	WELL CONDITIONS:	PRODUCTION DATA:	<ul style="list-style-type: none"> ■ Cable Tension POOH (PO) ■ Cable Tension RIH (RI) ■ Max Cable Pull (MC) ■ Weak point Upper Limit (WU) ■ Weak point Mid Limit (WM) ■ Weak point Lower Limit (WL) ■ Min Downhole Tension RIH (MI) ■ Tractor Load (TL) ■ Head Tension (HT) ■ Well Profile
	Make: CAMESA 1N29-S77 Size & Weight: 0.288in 161lbs/1000ft Allowed Pull: 4100lbs (50% max) Speed RIH: 30.5 m/min Speed POOH: 30.5 m/min Surface Drag: 50lb (IN) 50lb (OUT) Weak Point: 2150 lbs +/-15%	Tool Weight: 533lb Tool Length: 46.0ft Rigid Length: 15.0ft Tool Diameter: 2.300in Tractor Weight: 200lb Tractor Length: 20.3ft Rigid Length: 20.3ft	Well Shut in Surface Gas density: 0.70 sg Fluid Level: 0 Fluid density: 1.00 sg Wellhead Pressure: 500 psi		
	FRICTION DATA:				
	From: 0 To: 3,634m	Cable-Contact: 0.25 Cable-Drag: 1.0	Tool-Contact: 0.10 Tool-Drag: 1.0		

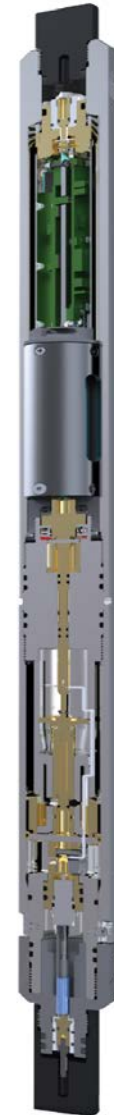
Tractor

1. Tractor conveys downhole tools along horizontal or highly deviated sections of cased oil wells, allowing normal wireline services to be carried out beyond the usual freefall depth without the need for coiled tubing or other mechanical deployment system.
2. The tools being pushed are referred to as "Passenger tools" and may include production logging tools, casing inspection tools, CBL tools, plugs and packers, perforating guns, and other mechanical or electronic equipment.
3. The Downhole Tractor runs on standard single conductor cables from 7/32" and larger, as well as multi-conductor cables.



Addressable Release Tool (ART)

1. **ART Function:** Used in horizontal or deviated wells in conjunction with high-voltage devices - such as tractors or setting tools - where the controllable release of all or part of a stuck tool-string may be required.
2. Deployment of an ART can eliminate risk of cable damage or breakage due to excess over-pull and significantly reduces the risk of a retrieval operation.
3. ART is robustly designed to withstand high voltages used to drive downhole tractors and is able to carry a maximum safe load of over three tonnes, enabling it to be run both above and below most devices. If deployed with ballistic devices, a shock absorber (SAT) is strongly recommended.
4. Three fail-safe mechanisms are incorporated in the device to ensure safe and reliable operation. Each tool is addressable by means of a user-selected code, transmitted from a surface control box.
5. This enables up to seven ART's to be run in a single tool-string. Once released, a fishing neck remains to facilitate further recovery operations, with both upper and lower heads being pressure isolated to prevent entry of well fluids. Until released, the entire tool is pressure sealed, thereby minimizing maintenance and service time.



Q&A