

LWD 1

System Specifications

System Specifications

**What changes during the drilling
of a well that may affect the
selection of an MWD system?**

System Specifications

- **Hole Size (Collar Size)**
- **Mud Flow Rate**
- **Mud Density**
- **Formation Temperature**
- **Bottom Hole Pressure**

System Specifications

Hole Size

I Usually decreases with hole depth

Why?

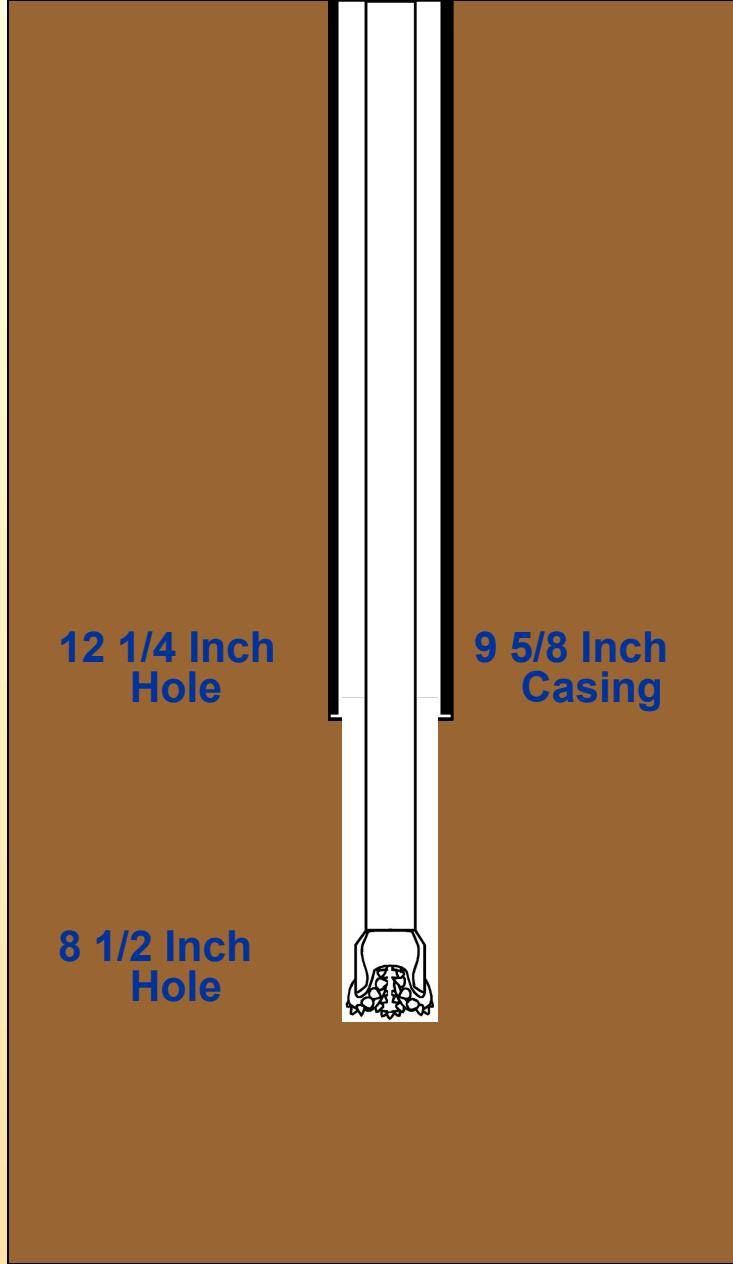
System Specifications

Hole Size

I Usually decreases with hole depth

Why?

- Casing or liner is run to isolate shallower hole sections.
- A smaller diameter drill bit is then required to pass through the casing.
- Smaller diameter drill collars are used.



System Specifications

System	Collar OD	Typical Hole Sizes
1200	7- ³ / ₄ to 11	24 to 12 ¼
650	6- ¹ / ₂ to 9- ¹ / ₂	8 ½ to 12 ¼
Slimhole	4- ³ / ₄	6 to 6 ½
Superslim	3- ¹ / ₈ to 3- ¹ / ₂	4 to 5 ?

Hole Size

12 1/4 inch hole

8 inch collars

Select

650 or 1200 System

8 1/2 inch hole

6-3/4 inch collars

Select

650 system

System Specifications

Mud Flow Rate

I Usually decreases with hole depth

Why?

System Specifications

Mud Flow Rate

I Usually decreases with hole depth

Why?

- As hole diameter decreases less flow is required to clean the hole.
- As hole depth increases circulating pressure also increases
- Flow is reduced to keep the circulating pressure within limits.

System Specifications

System	Flow Range gpm
1500 option	1200 to 1500
1200	400 to 1200
650	1512-4536 l/m 225 to 650 850-2457 l/m
Slimhole	150 to 350 567-1323
Superslim	
Straight	60 to 175
Undercut	100 to 220

Flow Rate

12 1/4 inch hole

8 inch collars

850 gpm

Select

1200 System

8 1/2 inch hole

6-3/4 inch collars

620 gpm

Select

650 system

System Specifications

Mud Density

 Changes with hole conditions

Why?

System Specifications

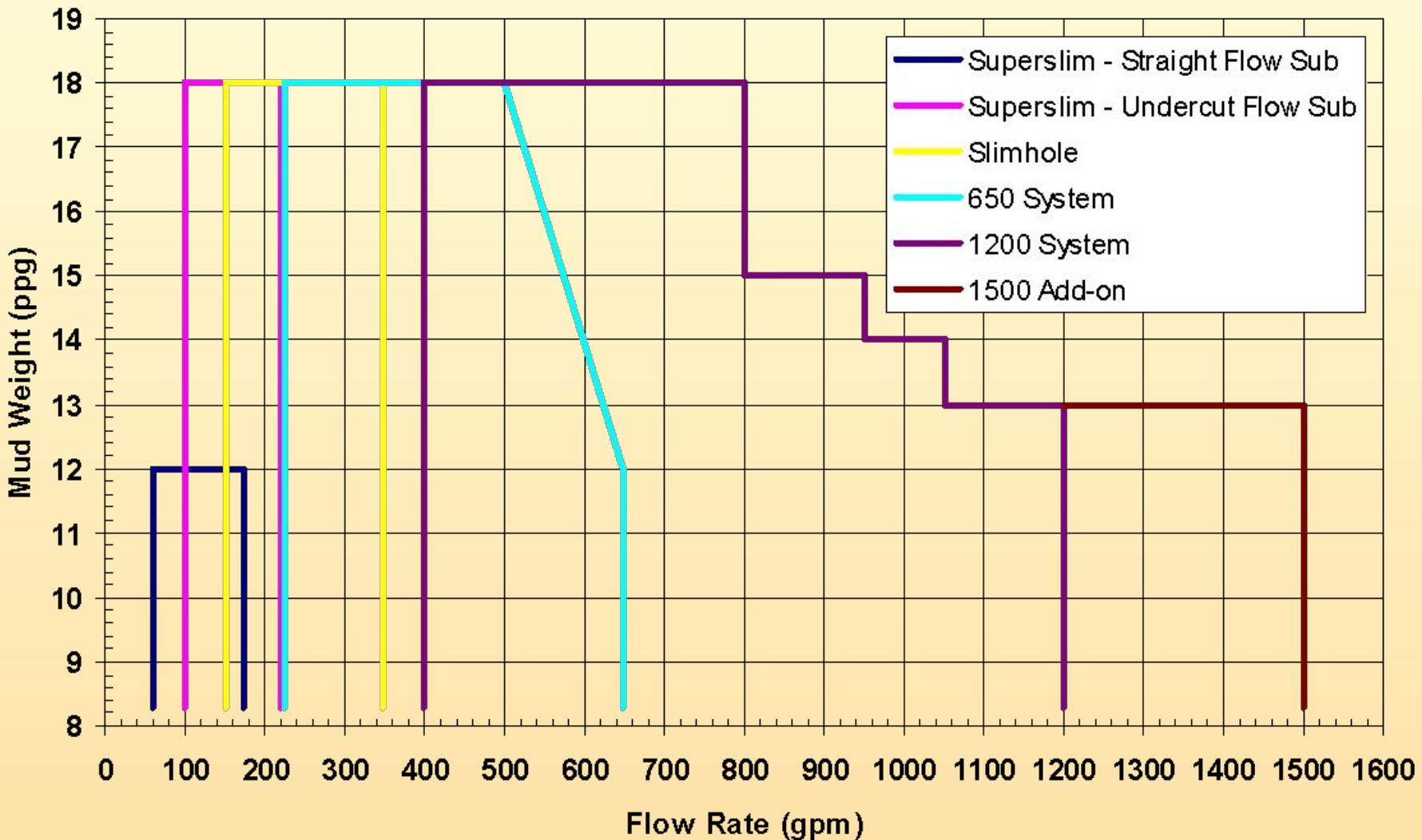
Mud Density

Changes with hole conditions

Why?

- Mud density is adjusted to balance the formation pressure.
- It usually increases with depth, but may decrease again after casing is set.

Flow Rate Envelopes



Mud Density

12 1/4 inch hole

8 inch collars

850 gpm

12 ppg

Select

1200 System

8 1/2 inch hole

6-3/4 inch collars

620 gpm

13 ppg

Select

650 system

System Specifications

Temperature

Increases with true vertical depth

Why?

System Specifications

Temperature

Temperature Increases with true vertical depth

Why?

- Due to conductance of heat from earth's core to surface.
- Temperature increases between 0.5°-5°C per 100 m, average 2.5°C per 100 m
- Temperature increases between 0.25°-2.5°F per 100 ft, average 1.5°F per 100 ft

System Specifications

Temperature

- Affects the selection of:**
 - Pulser**

System Specifications

- Pulser Temperature Ratings

Pulser	Maximum Temperature
Mk VI	175° C (347° F)
Mk VII	200° C (392° F)
Mk VIII	200° C (392° F)

Temperature

12 1/4 inch hole

8 inch collars

850 gpm

12 ppg

100° C at 10,000 ft

8 1/2 inch hole

6-3/4 inch collars

620 gpm

13 ppg

145° C at 14,000 ft

Select

1200 System

Any pulser

Select

650 system

Any pulser

System Specifications

Temperature

- Affects the selection of:**
 - Pulser**
 - Directional sensor**

System Specifications

- **Directional Sensor Temperature Ratings**

Sensor	Maximum Temperature
DEP, DEP II	140° C (284° F)
PCD, PCD-K, PCD-R	150° C (302° F)
DM	175° C (347° F)

Temperature

12 1/4 inch hole

8 inch collars

850 gpm

12 ppg

100° C at 10,000 ft

8 1/2 inch hole

6-3/4 inch collars

620 gpm

13 ppg

145° C at 14,000 ft

Select

1200 System

Any pulser

Any directional probe

Select

650 System

Any pulser

Do not use DEP/DEPII

System Specifications

Temperature

– Affects the selection of:

- Pulser**
- Directional sensor**
- Gamma sensor**

System Specifications

- **Gamma Sensor Temperature Ratings**

Sensor	Maximum Temperature
PCG, PCG-R	150° C (302° F)
GM	175° C (347° F)

Temperature

12 1/4 inch hole

8 inch collars

850 gpm

12 ppg

100° C at 10,000 ft

8 1/2 inch hole

6-3/4 inch collars

620 gpm

13 ppg

145° C at 14,000 ft

Select

1200 System

Any pulser

Any directional probe

Any gamma sensor

Select

650 System

Any pulser

Do not use DEP/DEPII

Any gamma sensor

System Specifications

Pressure

Two components

- Hydrostatic Pressure
- Circulating Pressure

System Specifications

Hydrostatic Pressure

- | Increases with true vertical depth
 - | Increases with increases in mud density
- Why?

System Specifications

Hydrostatic Pressure

- | Increases with true vertical depth
- | Increases with increases in mud density

Why?

- Pressure = 0.052 x TVD (ft) x Mud Density (ppg)

System Specifications

Circulating Pressure

- ─ **Increases with hole depth.**
- ─ **Increases with increases in flow rate.**
- ─ **Increases with increases in Mud Density, PV, YP.**
- ─ **Increases with decreases in flow area of drillstring, jets, and annulus.**

System Specifications

Pressure

What pressure is the tool exposed to?

System Specifications

Pressure

What pressure is the tool exposed to?

- Hydrostatic Pressure plus the following circulating pressure losses:
 - Pressure loss in the BHA below the tool
 - Pressure loss at the jets
 - Pressure loss in the annulus

System Specifications

Sensor Pressure Ratings

- Sondes are limited by pressure case.
- Superslim pressure cases have molded on centralizers, hence thinner walls, lower pressure rating.

System Specifications

Sensor Pressure Ratings

Sensor	Standard	Pressure Superslim
DEP, DEP II	18,000 psi	15,400 psi*
PCD-R/PCG-R	20,000 psi	??,??? psi*
DM/GM	22,500 psi	16,500 psi*

* Unofficial pressure rating

Pressure

12 1/4 inch hole

8 inch collars

850 gpm

12 ppg

100° C at 10,000 ft

6,240 hyd + 1,500 circ

Select

1200 System

Any pulser

Any directional probe

Any gamma sensor

8 1/2 inch hole

6-3/4 inch collars

620 gpm

13 ppg

130 ° C at 14,000 ft

9,464 hyd + 1,200 circ

Select

650 System

Any pulser

Do not use DEP/DEPII

Any gamma sensor

System Specifications

What other specifications are important?

Dogleg Severity

Sand Content

Plastic Viscosity

Lost Circulation Material

Tool Joint Torque

System Specifications

Dogleg Severity

– Rotating is the worst situation

Collar Size	Rotating	Sliding
3-1/2, 4-3/4	14°/100 ft	30°/100 ft
6-1/2 to 7-1/4	10°/100 ft	21°/100 ft
7-1/4 to 9-1/2	8°/100 ft	14°/100 ft

System Specifications

Sand Content

- Less than 2%, recommended less than 1%.**
- Above 1100 gpm limited to 1% or less.**

Plastic Viscosity

- Maximum 50 centipoise**

System Specifications

Lost Circulation Material (LCM)

- 40 lb/bbl fine to medium non-fibrous (nut plug) and some fine fibrous (kwik seal).
- Superslim is less tolerant to LCM
 - Straight flow sub less than 7.5 lb/bbl
 - Undercut flow sub greater than 7.5 lb/bbl

System Specifications

Tool Joint Torque

- Pin ID on positive pulse 1500, 1200, 650
System HOS/HOC's are bored-out.
- Use torque specifications for standard sizes
 - For Pin ID 2.88 inch, use 2-13/16 inch
 - For Pin ID 3.31 inch, use 3-1/4 inch
 - For Pin ID 4.04 inch, use 4 inch

System Specifications

Tool Joint Torque

How do we apply it correctly?

For example:

8 inch collar

6-5/8 API Regular Connection

3-1/4 inch pin bore

47,000 ft-lb Torque

4 foot tongs

System Specifications

47,000 ft-lb Torque

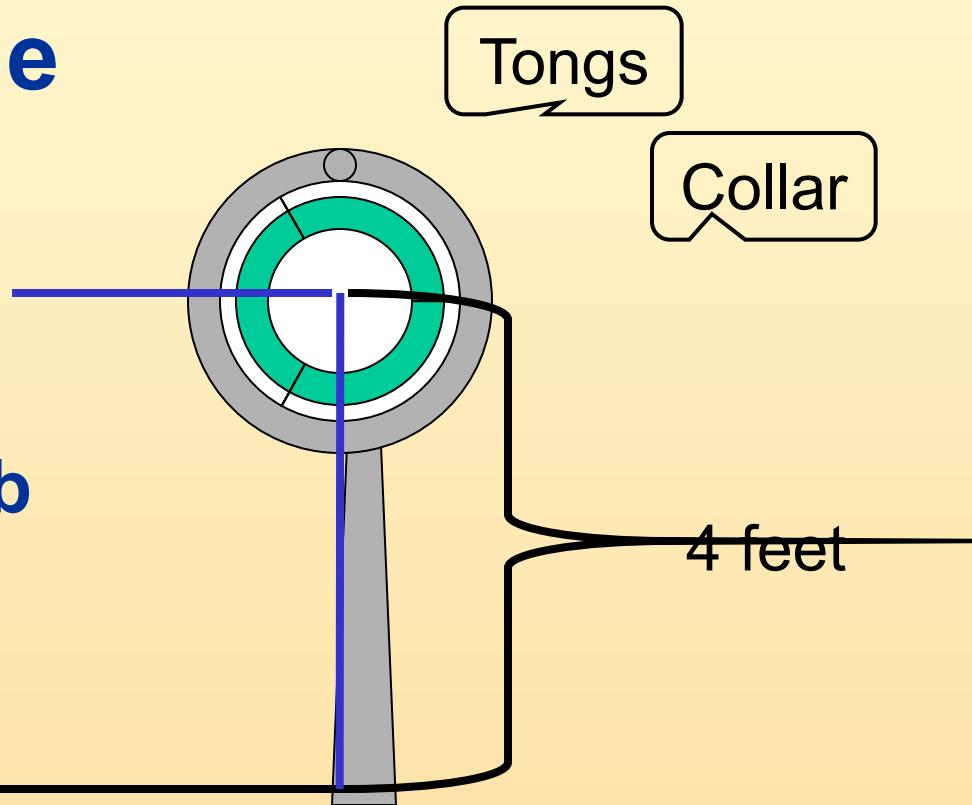
Single line

Pull angle 90°

Pull of 11,750 lbs

Torque = 47,000 ft-lb

11,750 lb



System Specifications

47,000 ft-lb Torque

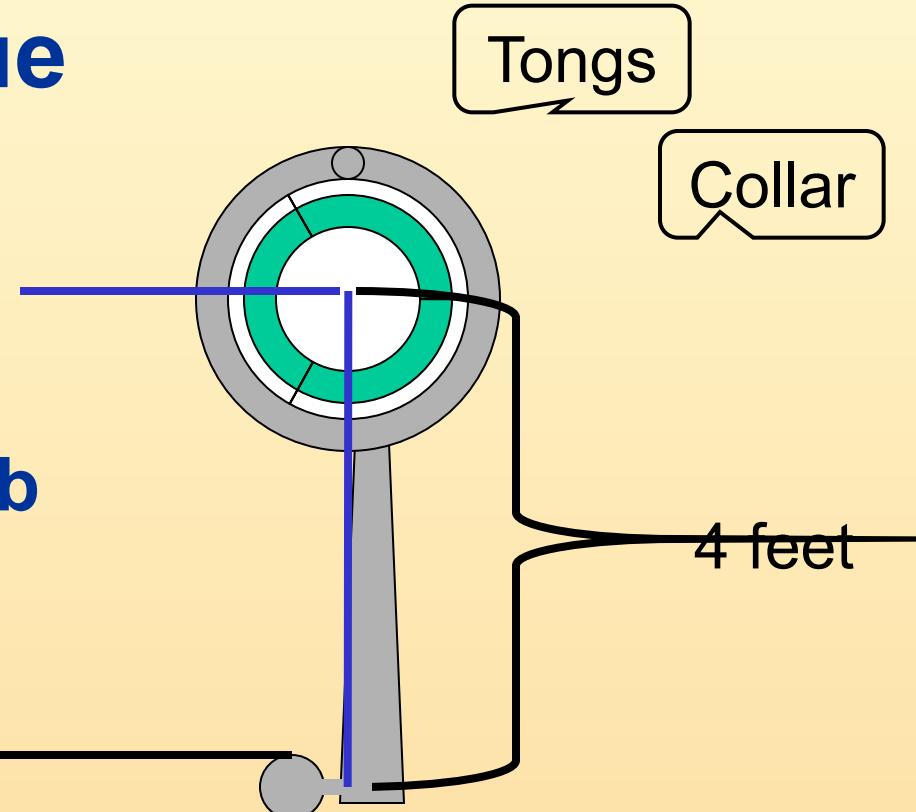
Double line

Pull angle 90°

Pull of 5,875 lbs

Torque = 47,000 ft-lb

5,875 lb



System Specifications

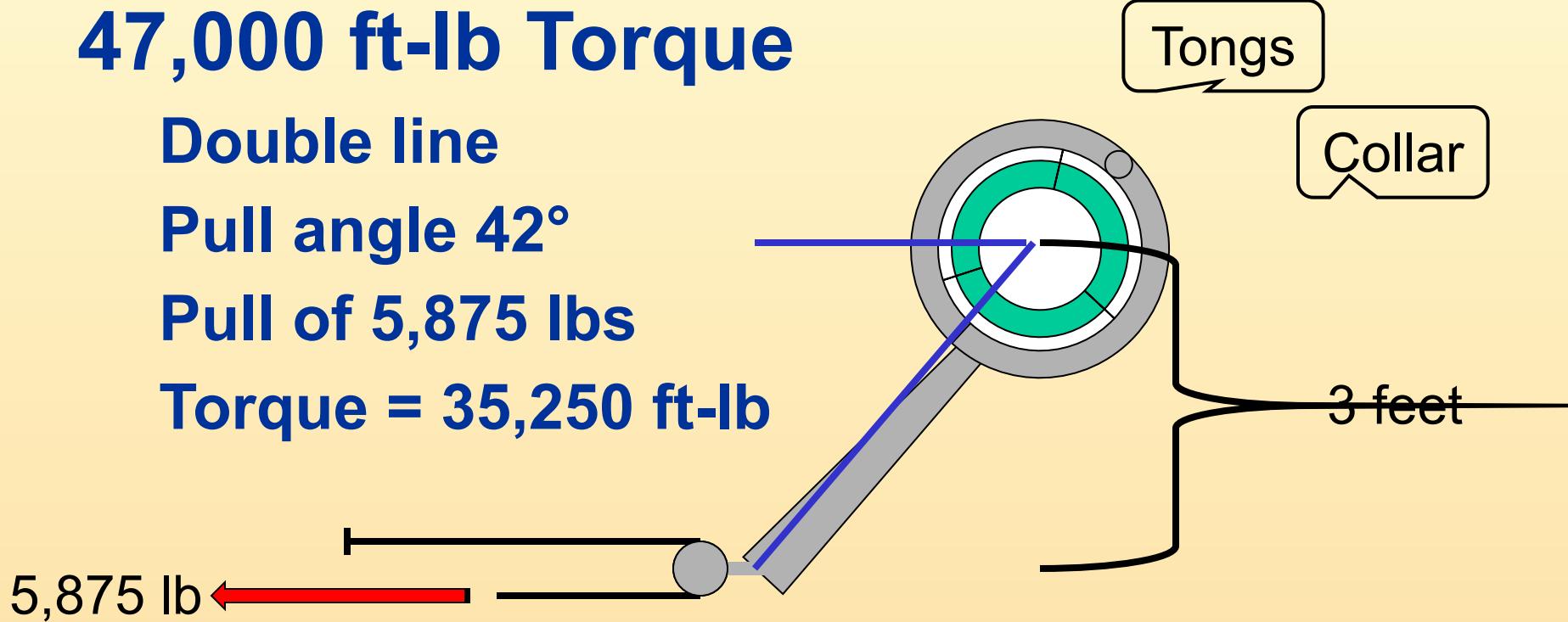
47,000 ft-lb Torque

Double line

Pull angle 42°

Pull of 5,875 lbs

Torque = 35,250 ft-lb



System Specifications

47,000 ft-lb Torque

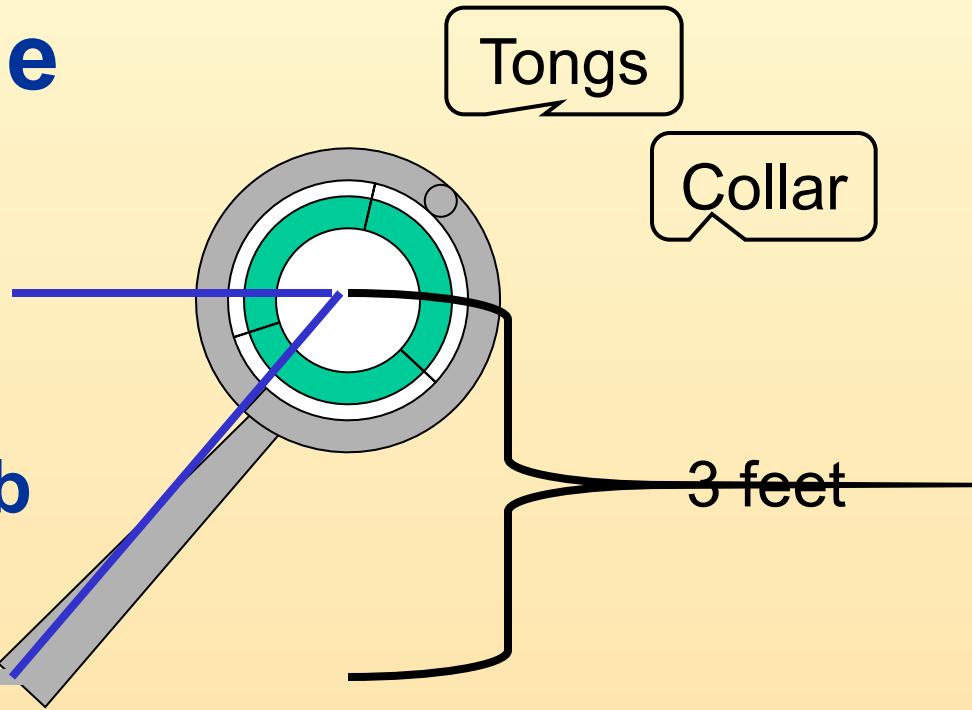
Double line

Pull angle 42°

Pull of 7,833 lbs

Torque = 47,000 ft-lb

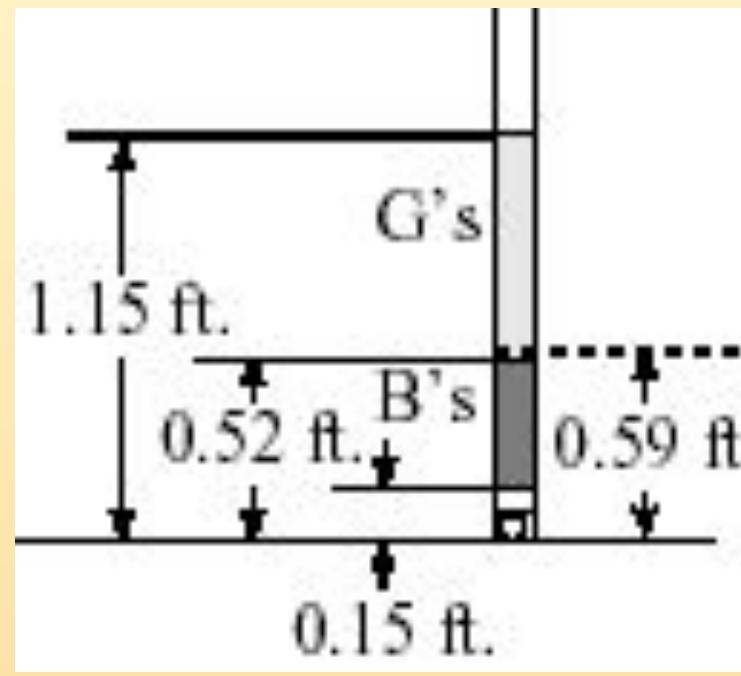
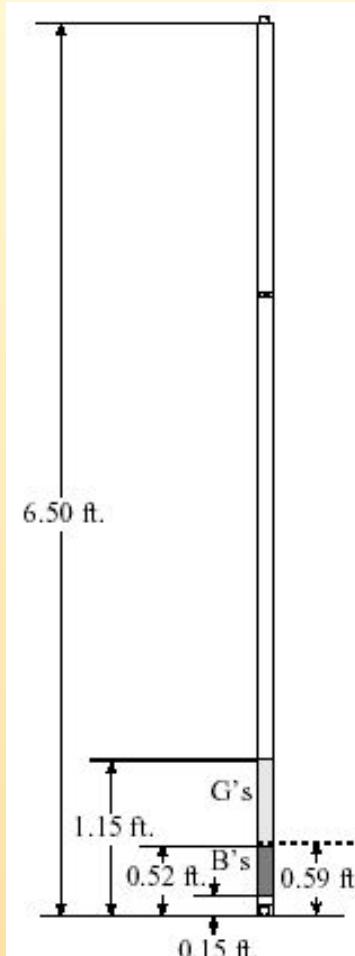
7,833 lb



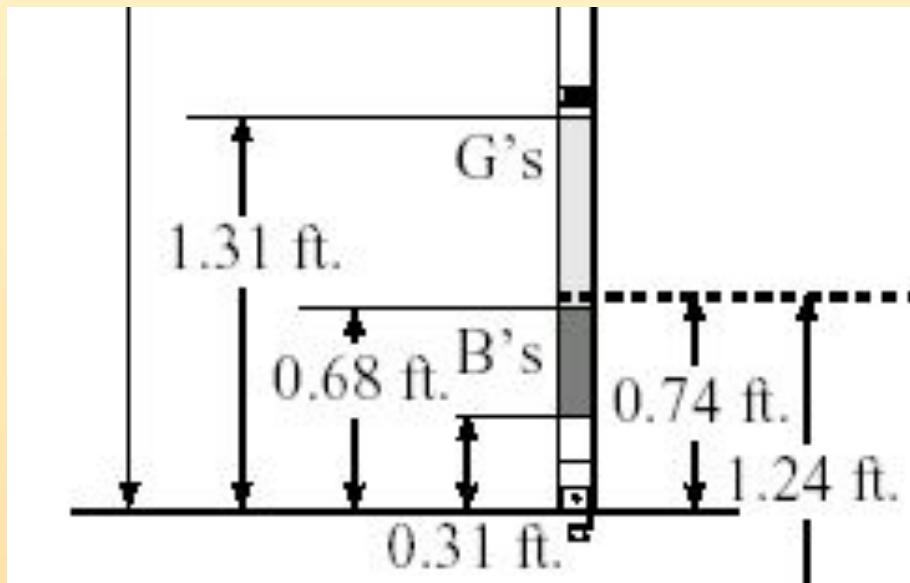
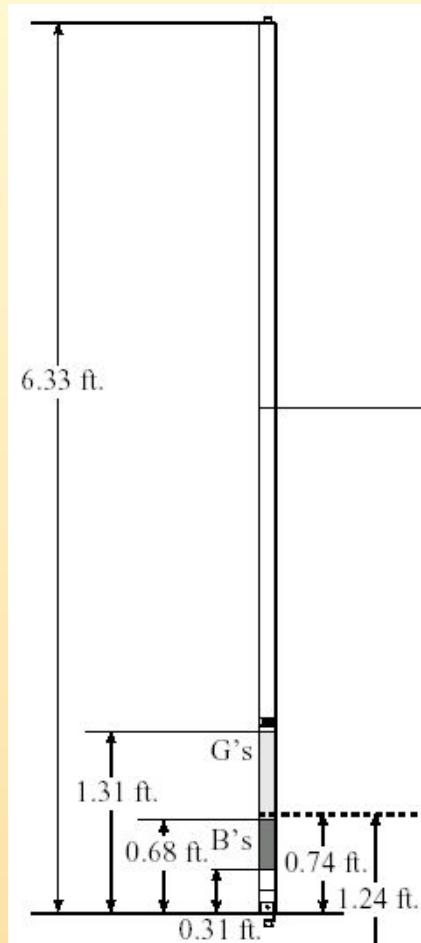
Sensor Measure Point

- Used to calculate sensor to bit distance
- Surveys referenced to where measurements made, not to bit
- Gamma referenced to where measurements made, not to bit

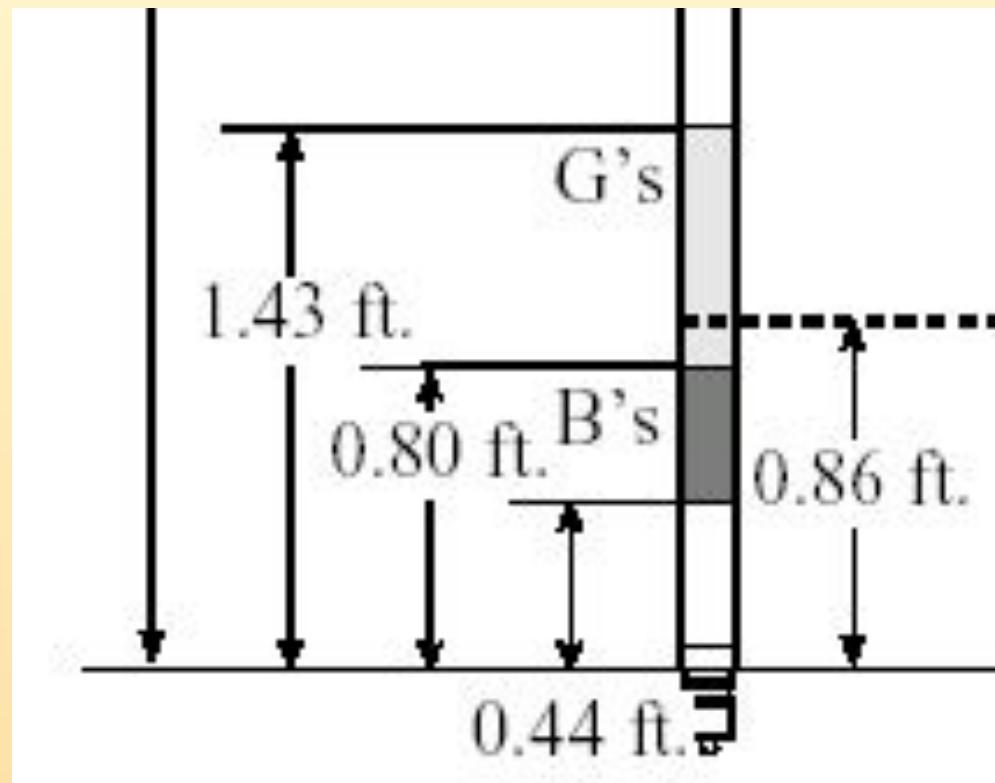
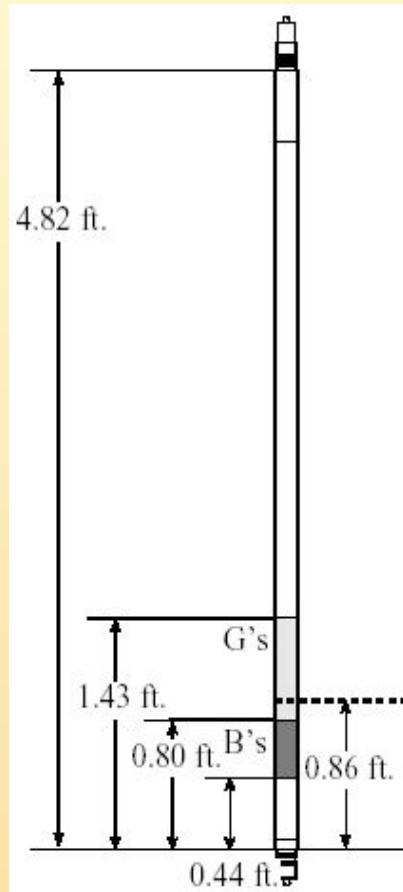
Sensor to bit distance - DEP



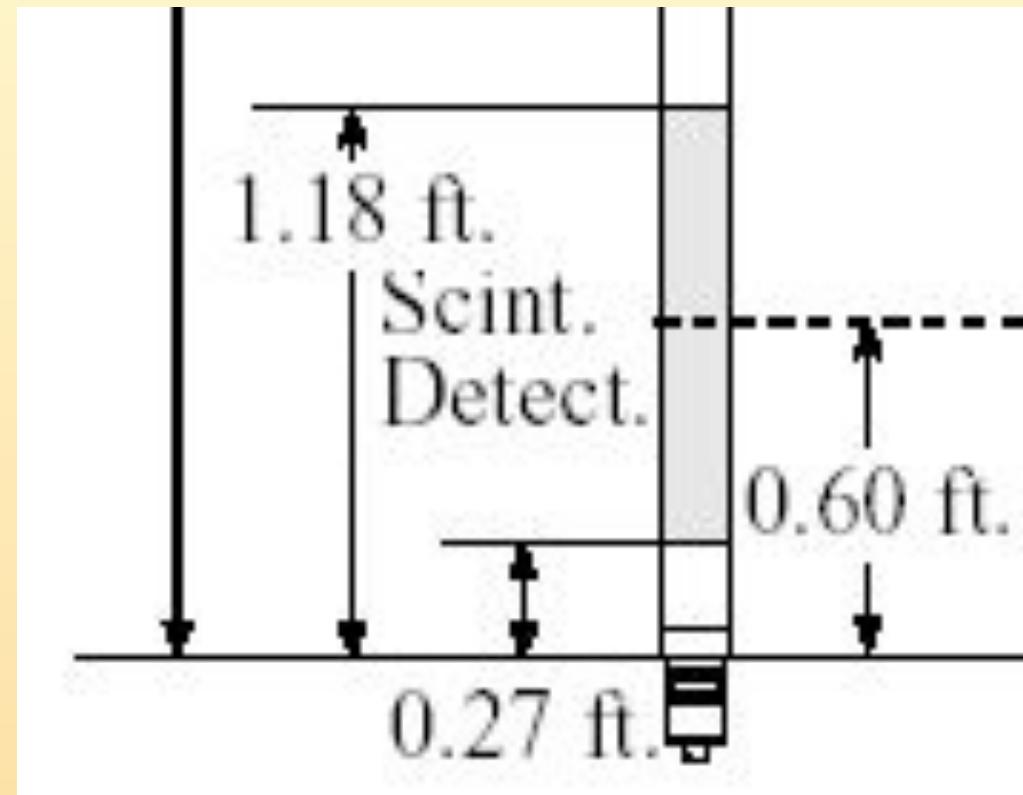
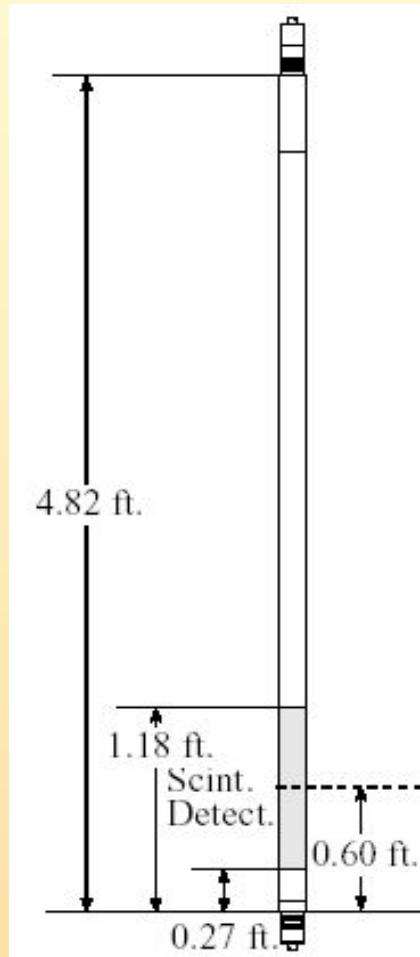
Sensor Measure Point – DEP2



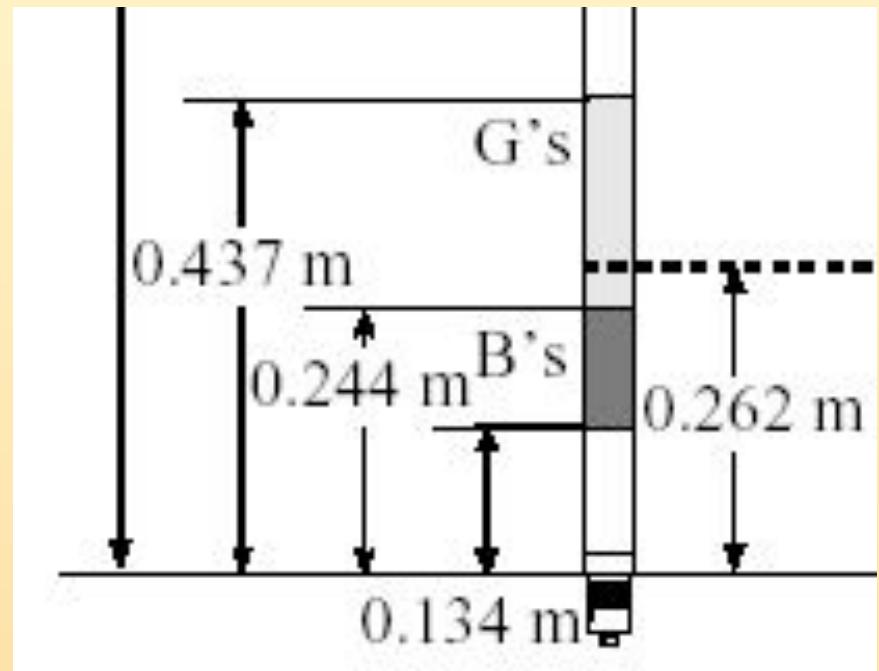
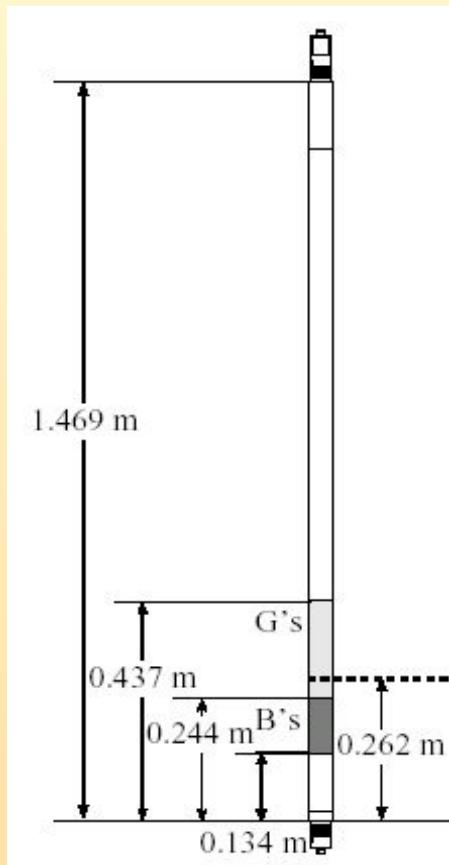
Sensor Measure Point - PCD



Sensor Measure Point - PCG



Sensor Measure Point – PCD Metric Units



Sensor Measure Point – PCG Metric Units

