

**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

- ↓ Usually decreases with hole depth  
Why?

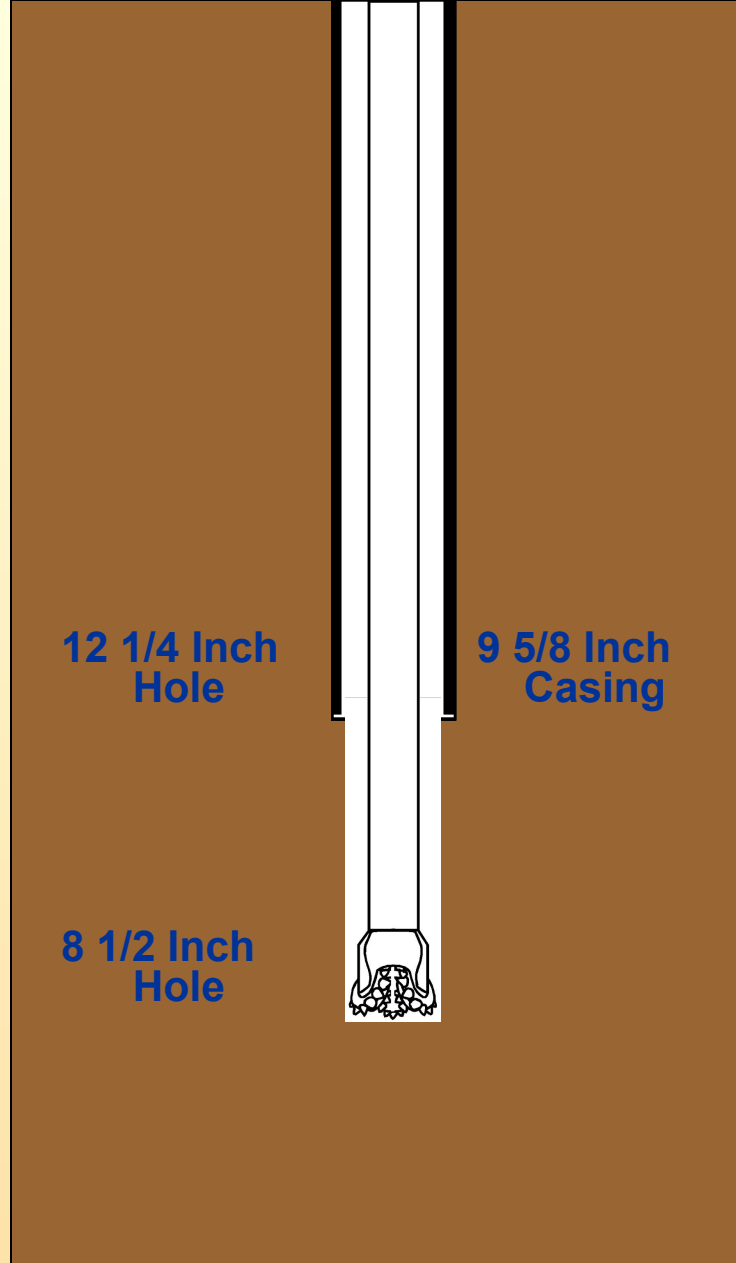
# System Specifications

## Hole Size

**↓ 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

<b>System</b>	<b>Collar OD</b>	<b>Typical Hole Sizes</b>
1200	7- <sup>3</sup> / <sub>4</sub> to 11	24 to 12 1/4
650	6- <sup>1</sup> / <sub>2</sub> to 9- <sup>1</sup> / <sub>2</sub>	8 1/2 to 12 1/4
Slimhole	4- <sup>3</sup> / <sub>4</sub>	6 to 6 1/2
Superslim	3- <sup>1</sup> / <sub>8</sub> to 3- <sup>1</sup> / <sub>2</sub>	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

- ↓ Usually decreases with hole depth
- Why?

# System Specifications

## Mud Flow Rate

**↓ 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

<b>System</b>	<b>Flow Range gpm</b>
1500 option	1200 to 1500
1200	400 to 1200
650	225 to 650
Slimhole	150 to 350
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

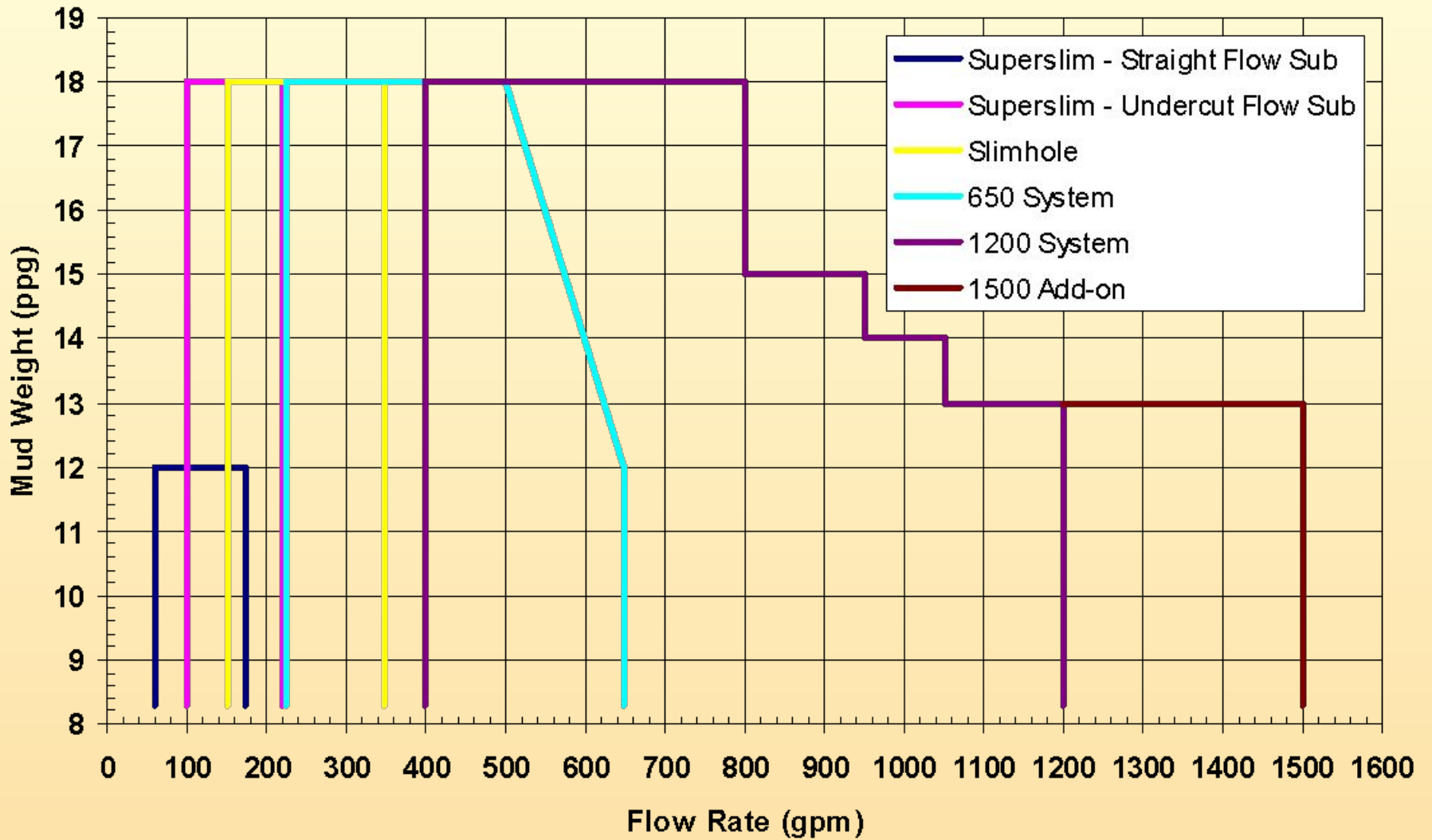
## Mud Density

 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

**T** Increases with true vertical depth

Why?

# System Specifications

## Temperature

**T** 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**

<b>Pulser</b>	<b>Maximum Temperature</b>
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

## Select

1200 System

Any pulser

## 8 1/2 inch hole

6-3/4 inch collars

620 gpm

13 ppg

145° C at 14,000 ft

## 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

## Select

1200 System

Any pulser

Any directional probe

## 8 1/2 inch hole

6-3/4 inch collars

620 gpm

13 ppg

145° C at 14,000 ft

## 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**

<b>Sensor</b>	<b>Maximum Temperature</b>
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

## 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

145° C at 14,000 ft

## 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?

- $\text{Pressure} = 0.052 \times \text{TVD (ft)} \times \text{Mud Density (ppg)}$

# 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	Pressure	
	Standard	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 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

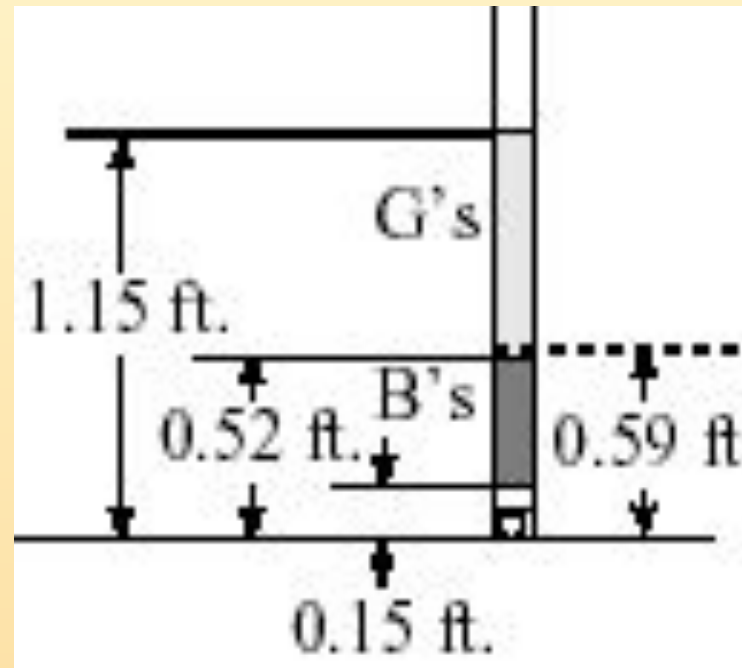
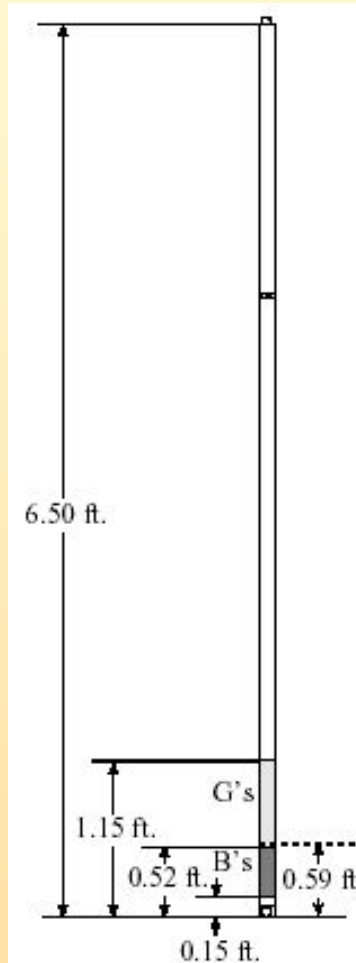
## Tool Joint Torque

- 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

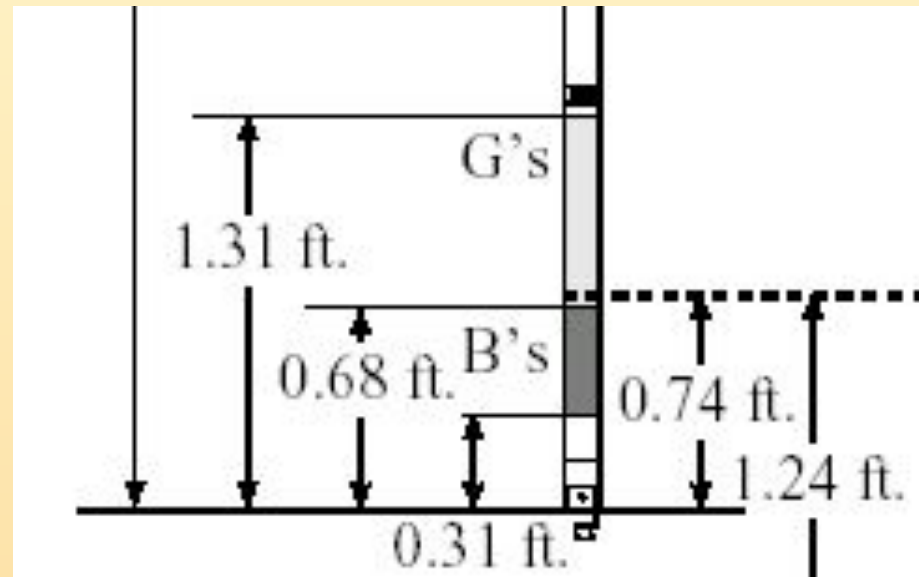
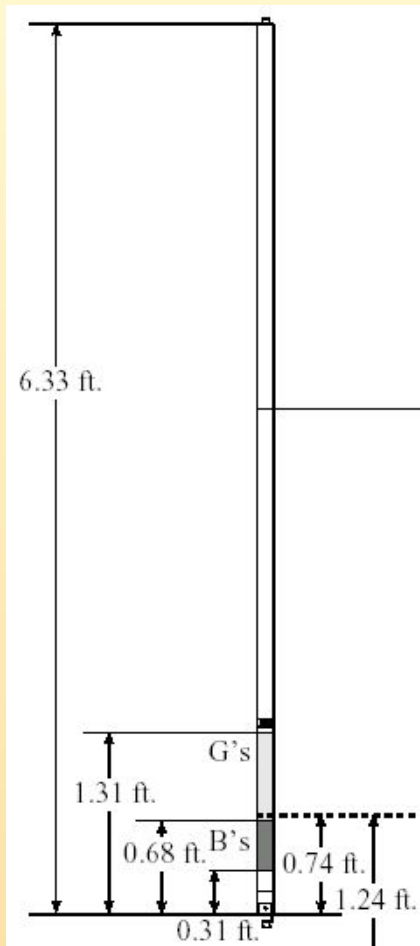
# Sensor Measure Point

- **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**

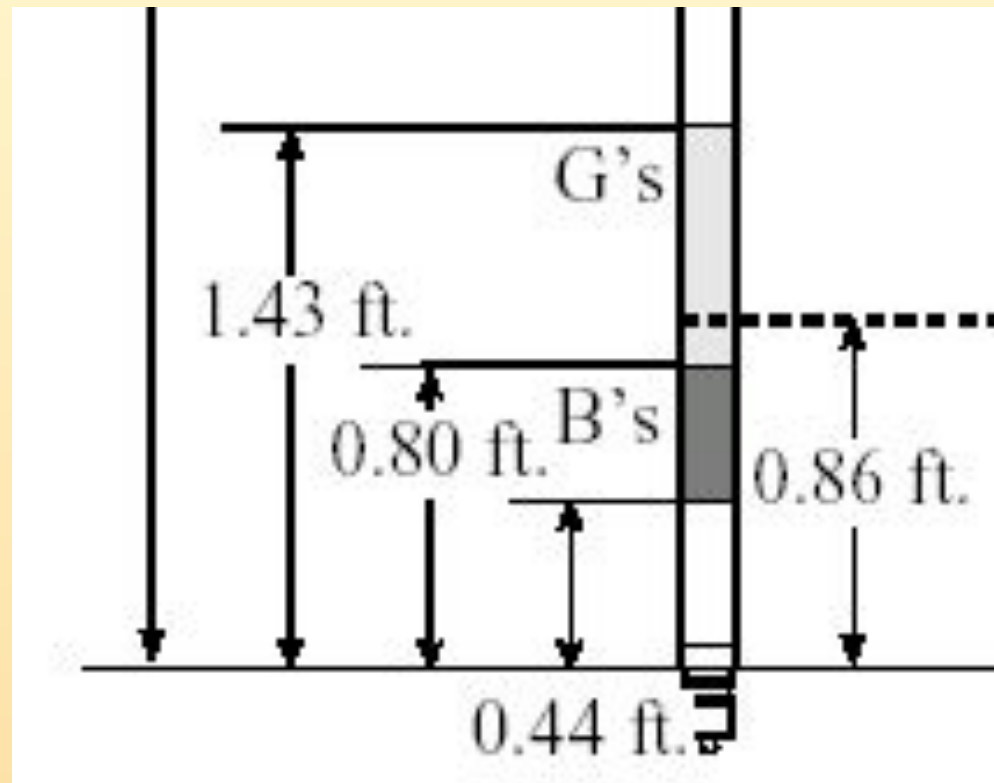
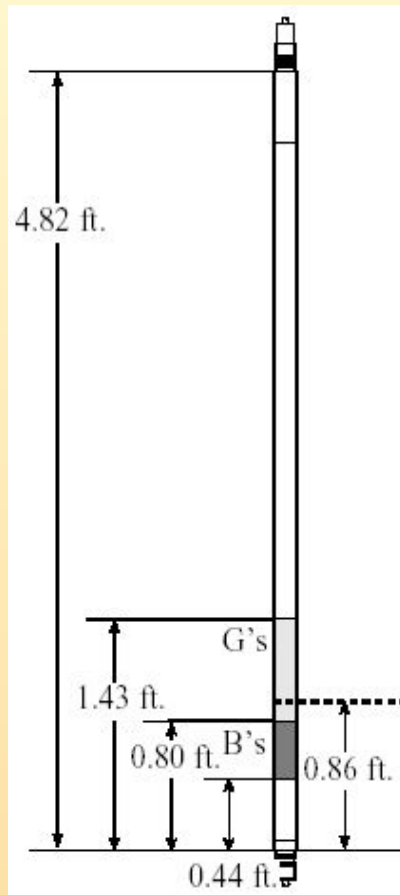
# Sensor to bit distance - DEP



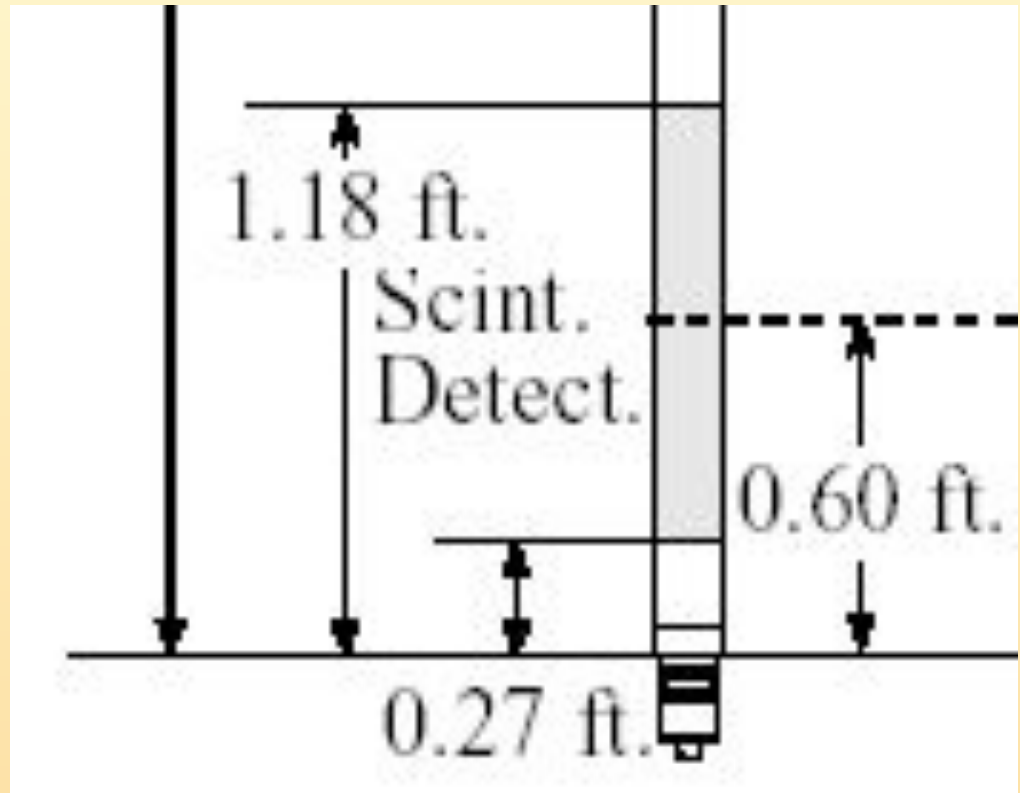
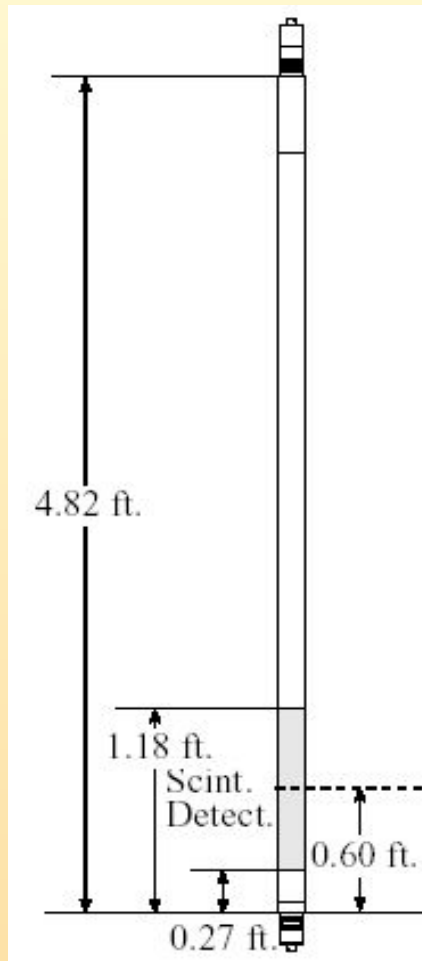
# Sensor Measure Point – DEP2



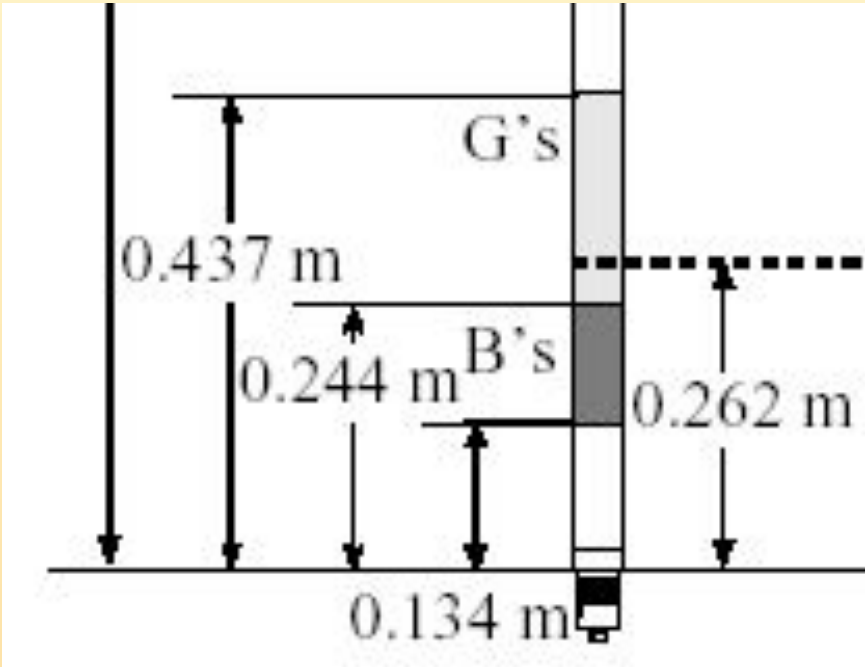
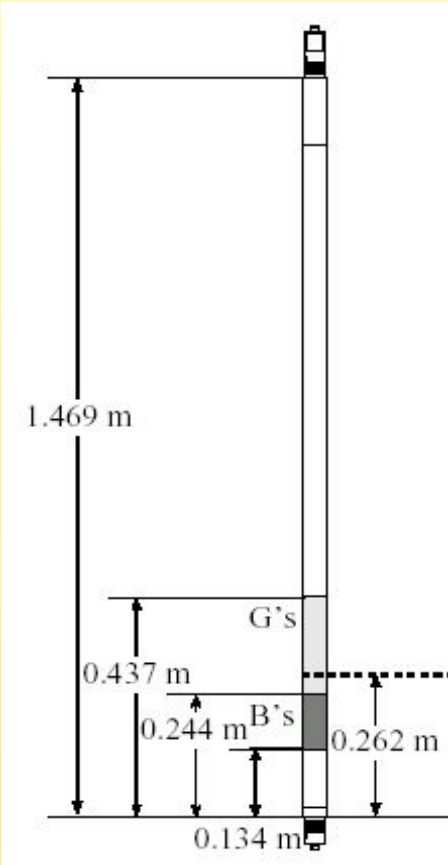
# Sensor Measure Point - PCD



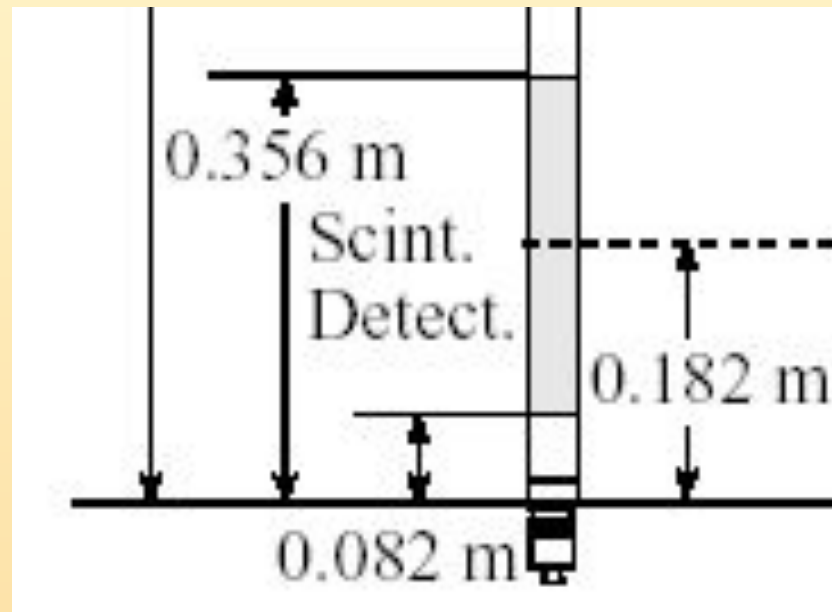
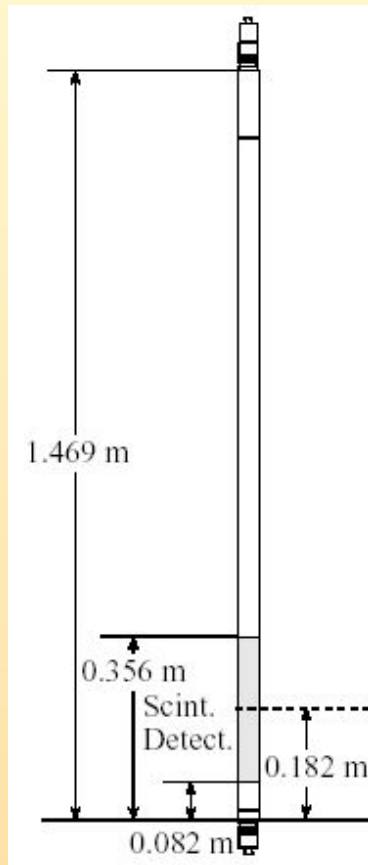
# Sensor Measure Point - PCG



# Sensor Measure Point – PCD Metric Units



# Sensor Measure Point – PCG Metric Units





# 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

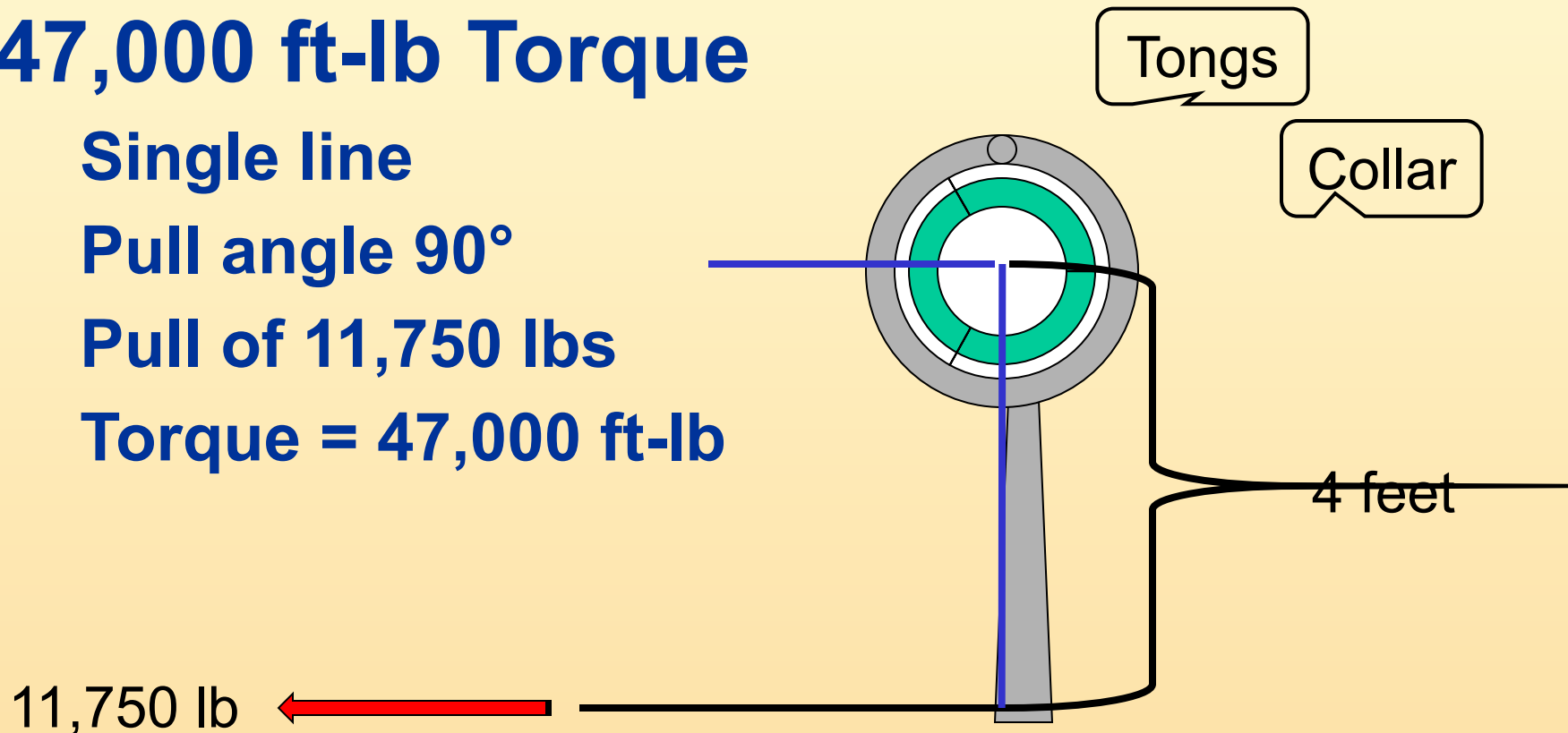
**47,000 ft-lb Torque**

**Single line**

**Pull angle 90°**

**Pull of 11,750 lbs**

**Torque = 47,000 ft-lb**



# System Specifications

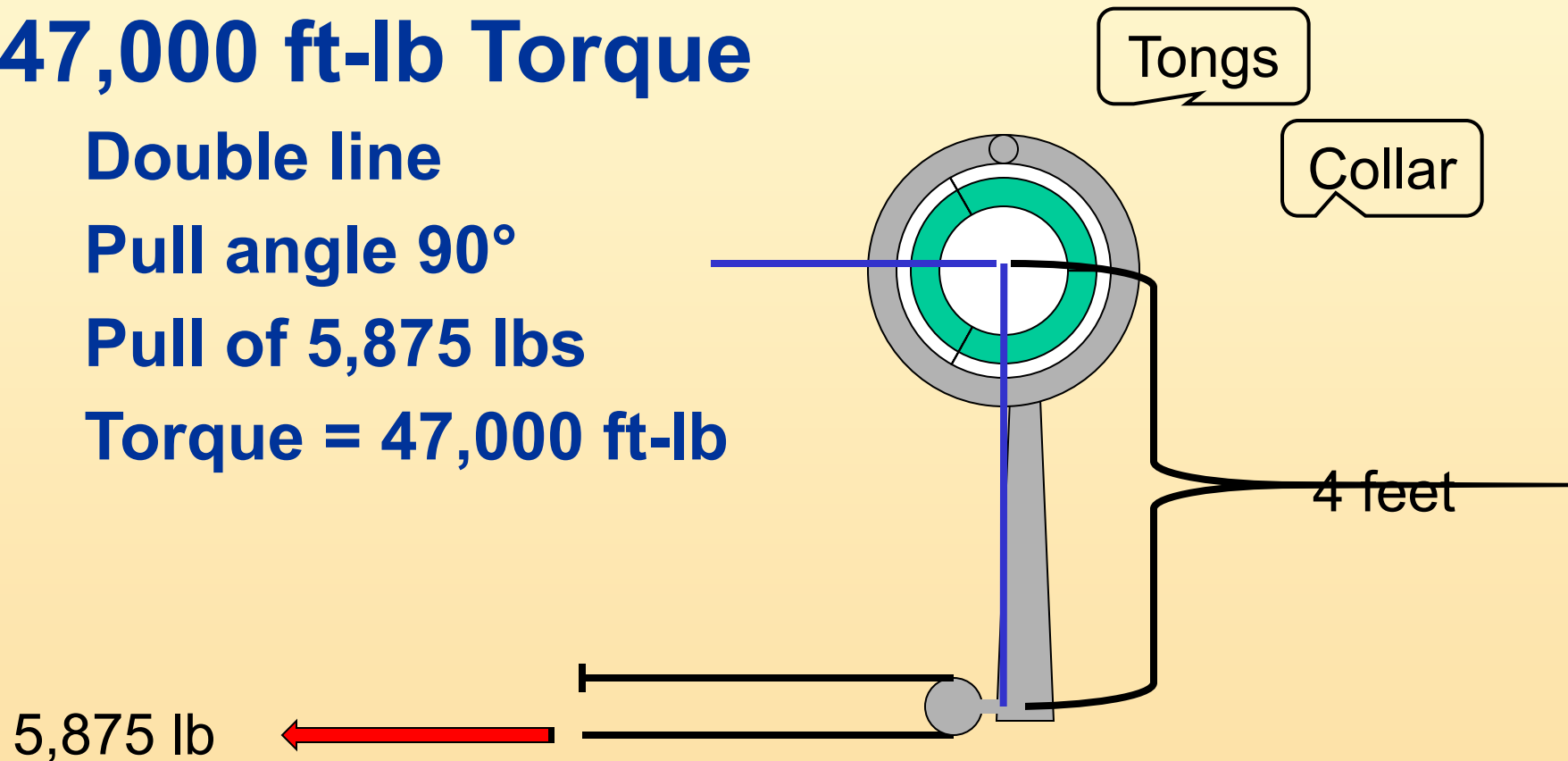
**47,000 ft-lb Torque**

**Double line**

**Pull angle 90°**

**Pull of 5,875 lbs**

**Torque = 47,000 ft-lb**



# System Specifications

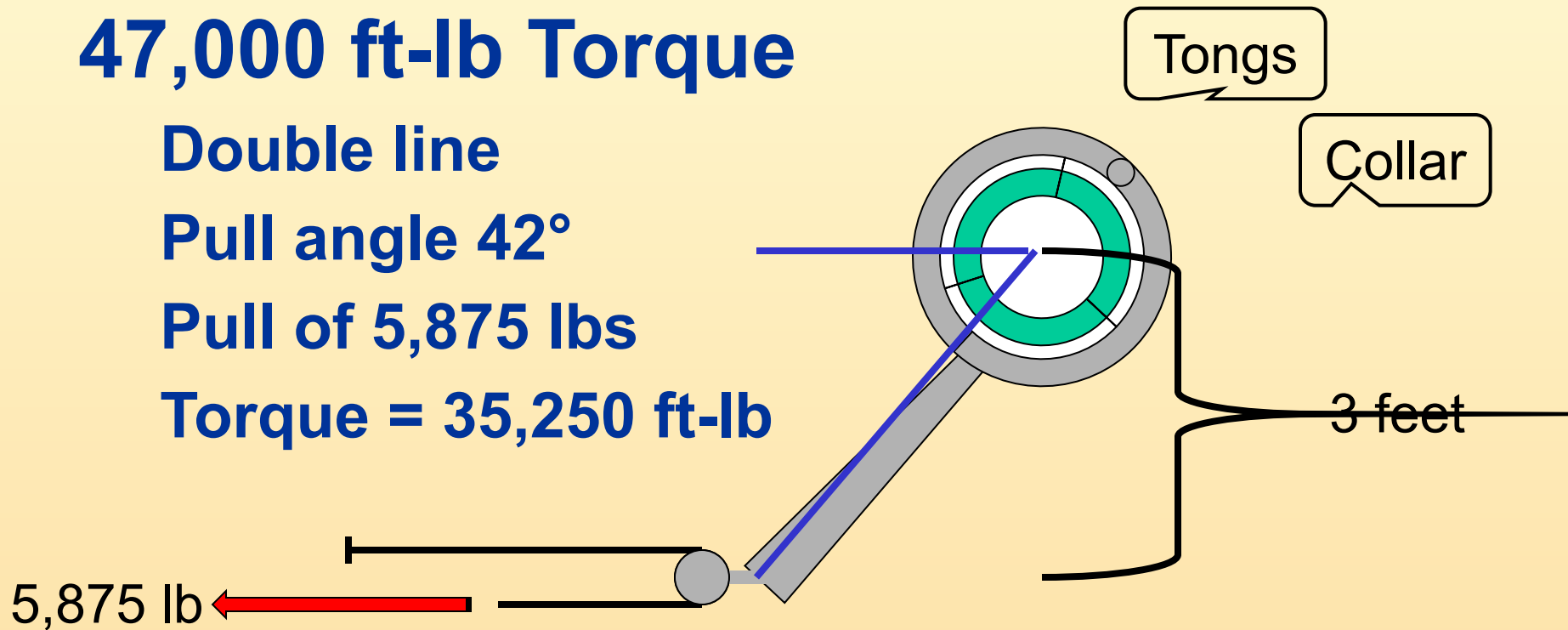
**47,000 ft-lb Torque**

**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**

