Deep Water DP Operations

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Introduction

- **Purpose of the Presentation:**
  - Explain DP operations in deepwater drilling.
  - Discuss key subsea equipment: Blowout Preventer (BOP), Riser Systems.
  - Highlight safety and operational efficiency.

- **Importance of DP in Deepwater Drilling:**
  - Precise station-keeping over the wellhead.
  - Supports critical subsea deployment operations.

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Drilling Rigs and Water Depth

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What is Dynamic Positioning

- Dynamic Positioning (DP) is an advanced computer-controlled system used to keep a vessel in a particular position or moving in a particular direction at a particular speed and a particular rate of turn with the help of the thrust generated by its own thrusters. The technology was first developed for scientific research and geological surveys in the 1960s and was rapidly taken up by the offshore oil and gas industry. Today, it is used in many different sectors of the maritime industry around the world.

- The DP system controls the vessel's motion in the three horizontal degrees of freedom, these being Surge, Sway and Yaw as illustrated. The DP system measures the vessel's movements by utilising the gyro compass system, the MRU's and the position reference systems. The position reference system readings are corrected for heave, pitch and roll using readings from the MRU system.

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DP Classes – Redundancy Levels

Classification societies set the standards for DP system classes. In general, the rules set by the main classification societies (DNV-GL, ABS, LRS) are similar and are based on IMO MSC 645 guideline.

Class 1: Automatic and manual position and heading control. No redundancy =>Loss of position can occur in the event of a single fault.

Suitable for operations with minimal risk.

Class 2: Automatic and manual position and heading control. Loss of position should not occur from a single fault of an active component or system such as generators, thrusters, switchboards, remote control valves etc. However, loss of position can occur after failure of static components such as cables, pipes, manual valves etc.

Used in more critical offshore operations.

Class 3: Automatic and manual position and heading control. Loss of position should not occur from any single failure including a complete burn fire subdivision or flooded watertight compartments. Redundant and separated components.

Required for high-risk operations like drilling.

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Components of a Dynamic Positioning System

- **The DP system can be divided into seven components:**

- Power
- Thrusters
- Environmental sensors
- Position reference sensors
- DP controller
- Hardware (generally referred to as the HMI, or human-machine interface)
- DP operator

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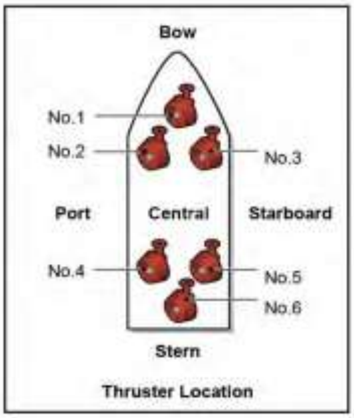
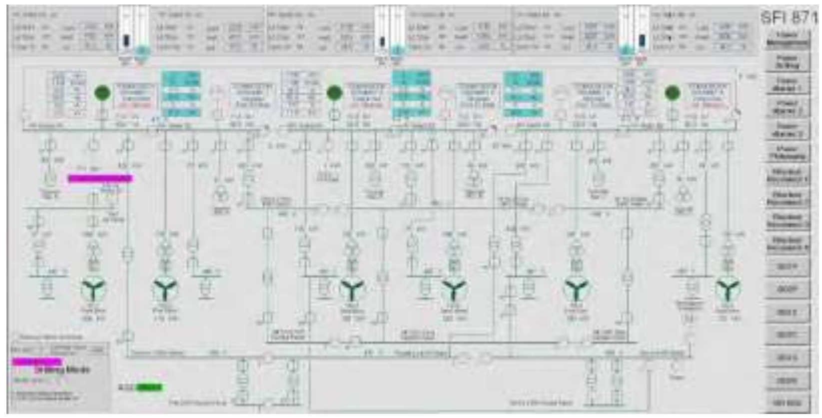
Components of a Dynamic Positioning System
Propulsion and Power Management System





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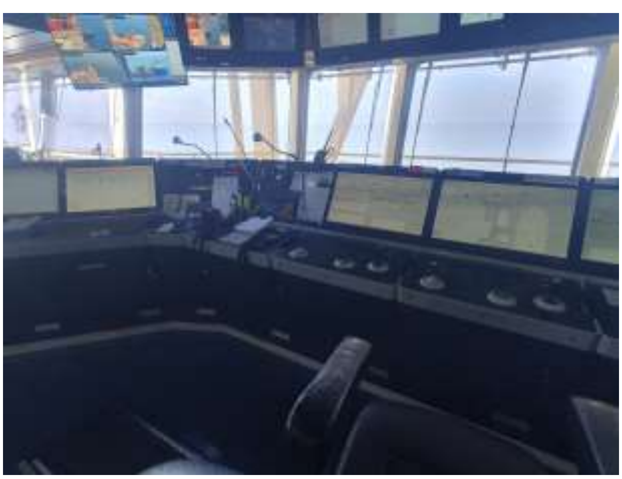
Components of a Dynamic Positioning System
Human Machine Interface



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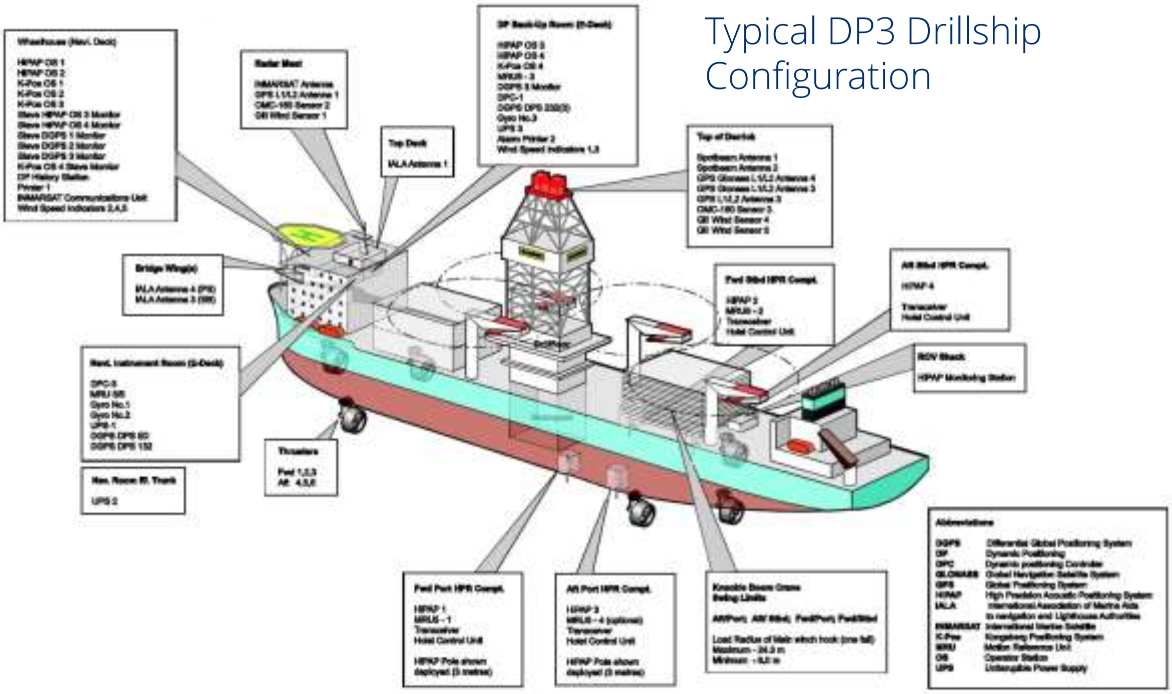
Typical DP3 Drillship Configuration



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Position Reference Systems

HiPAP and DGPS

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Position Reference Systems
HiPAP

Operating Principles:

The HiPAP system utilizes two primary acoustic positioning techniques:

1.Super Short Base Line (SSBL): This method involves measuring the range and direction to a single subsea transponder attached to the target object. The system's transducer emits an acoustic signal, which the transponder receives and replies to. By analyzing the returned signal's travel time and angle of arrival, the system calculates the target's position relative to the vessel.

2.Long Base Line (LBL): In this approach, multiple transponders are placed on the seabed to form a network. The HiPAP system measures the distances to these seabed transponders and computes the vessel's position based on these measurements. This technique is particularly useful for high-accuracy positioning over larger areas.

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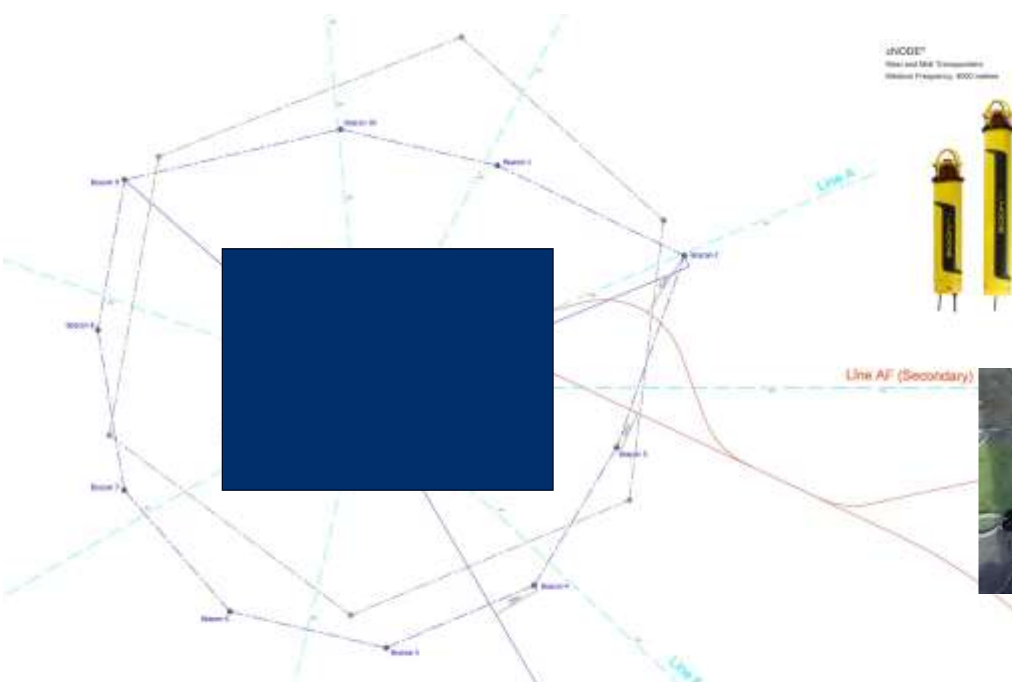

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Operations

Drillships are specialized vessels used primarily for offshore drilling operations, particularly in deepwater and ultra-deepwater environments. Their key operations include:

1. **Exploratory Drilling** – Used to drill test wells to locate and evaluate potential oil and gas reserves.

2. **Development Drilling** – Drilling production wells after a reservoir has been confirmed.

3. **Well Completion** – Preparing the drilled well for production, which includes casing, cementing, and installing necessary equipment.

4. **Well Intervention & Workover** – Performing maintenance, repairs, or enhancements on existing wells to improve production.

5. **Decommissioning & Plugging** – Sealing off wells that are no longer productive to prevent environmental hazards.

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Deep Water Drilling Short Video

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Subsea Wellhead

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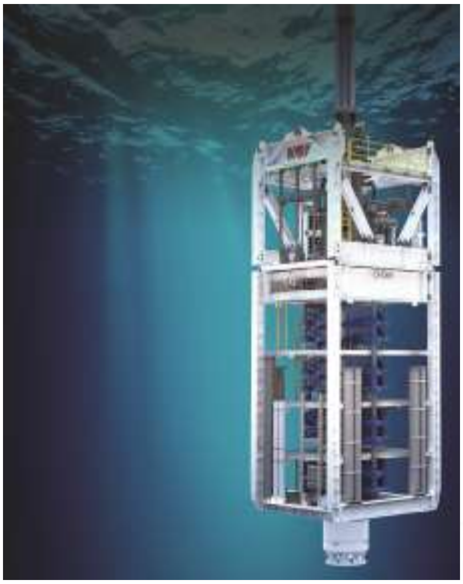
BOP – Blow Out Preventer



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BOP – Blow Out Preventer

There are four primary ways by which a BOP can be controlled:

•Electrical Control Signal: sent from the surface through a control cable;

•Acoustical Control Signal: sent from the surface based on a modulated/encoded pulse of sound transmitted by an underwater transducer;

•ROV Intervention: remotely operated vehicles (ROVs) mechanically control valves and provide hydraulic pressure to the stack (via “hot stab” panels);

•Deadman Switch / Auto Shear: fail-safe activation of selected BOPs during an emergency, and if the control, power and hydraulic lines have been severed.

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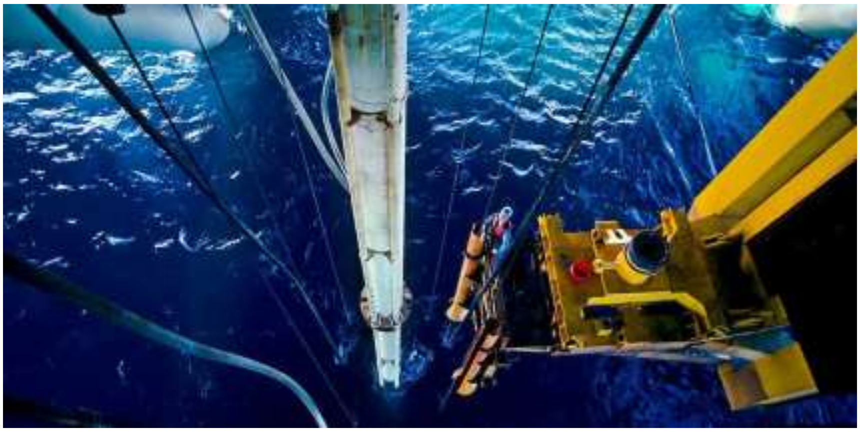
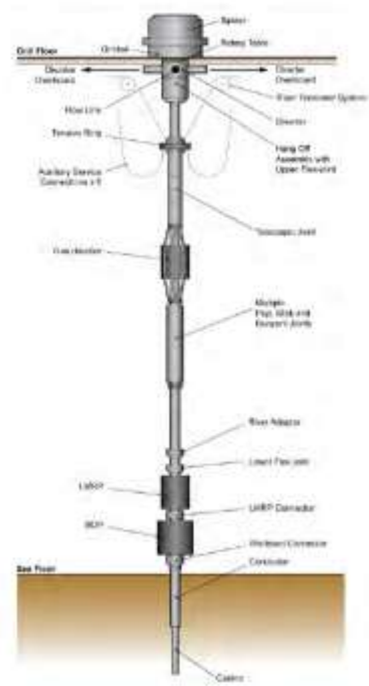
Riser Components





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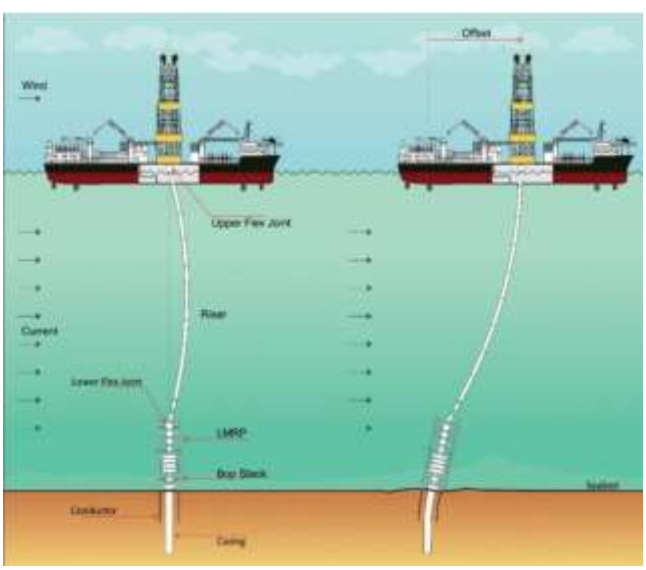
Riser Analysis



- Drilling riser, subsea components and well casing are subject to stresses that depend on several factors, most notably the environmental forces acting on the riser (current and wave) and the rig offset referenced to the point at sea level right above the wellhead.
- During an event of drive-off/drift-off, when the rig is no longer able to keep its fixed position and starts to move away from the original position due to the environmental forces (current, wind and wave), the increasing horizontal offset between the rig and the wellhead causes additional stresses on the riser and well components (wellhead, surface conductor, casing, welds, etc.).

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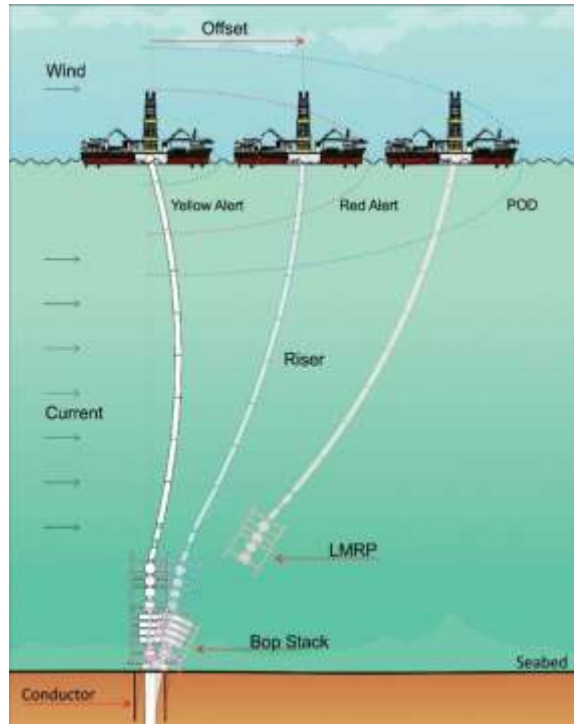
Riser Analysis

The question that arises is related to the maximum allowable offset (referred to as POD – point of disconnect) in a scenario of drift-off/drive-off before the structural limits of the components of the system are reached and when the Emergency Disconnect Sequence (EDS) needs to be activated to prevent damage to the well, which could have catastrophic consequences.

The EDS closes the rams on the BOP stack so that the well is isolated from the sea and then it disconnects the LMRP from the BOP stack, and as a result, the riser and the LMRP would remain attached to the rig as it moves away from the wellhead. By defining the “red alert” as the maximum point at which the EDS needs to be initiated so that it is completed before the rig reaches the POD, mechanical integrity is maintained.



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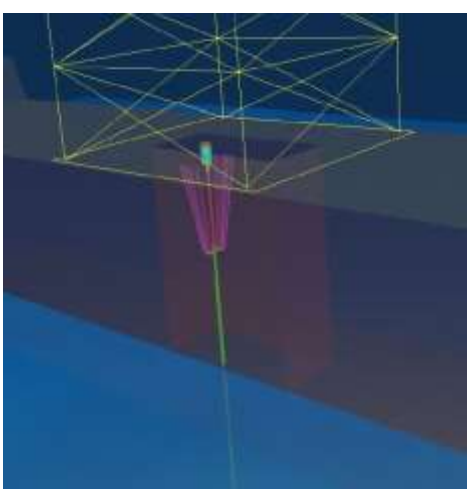
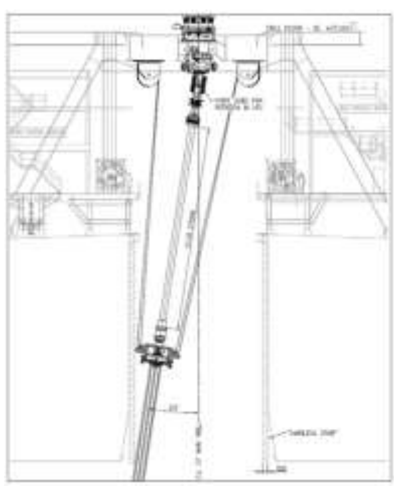
Riser Analysis





Environmental Conditions and Riser Details

Metocean Conditions
Water Depth
Riser Stack Up and Tension
Soil, Casing and Wellhead Condition
Lower Stack
Telescopic Joint and Tensioner
Flex Joints
Vessel

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Drift Off Studies

Env. Condition / Return	Initial Env. Heading [deg]	Mud Density [ppg]	POD Time [sec]	POD Distance [ft] / [%WD]	Red Alert [illegible] [illegible]	Red Alert Distance [ft] / [%WD]	Yellow Alert Time [sec]	Yellow Alert Distance [ft] / [%WD]	Limit Criterion
99% NX Hs=3.35m, Tp=10.0s Ws=18.49m/s Cs=0.84m/s	160	SW	209.6	568.1 6.14%	140.6	252.3 2.74%	100.6	125.9 1.37%	Tensioner Stroke
		10.0ppg	215.6	591.6 6.42%	146.6	273.5 2.97%	104.6	136.3 1.48%	Tensioner Stroke
		10.0ppg 1500psi	218.0	605.3 6.57%	149.0	283.4 3.07%	106.2	141.1 1.53%	Tensioner Stroke
99% NX Reverse Current Hs=3.35m, Tp=10.0s Ws=18.49m/s Cs=0.84m/s		SW	160.4	259.9 2.82%	91.4	[illegible] [illegible]	68.8	39.9 0.43%	Upper Flex Joint Angle
		10.0ppg	169.4	284.2 3.08%	100.4	96.7 1.05%	73.0	48.3 0.52%	Upper Flex Joint Angle
		10.0ppg 1500psi	168.2	279.2 3.03%	99.2	93.5 1.01%	72.0	46.6 0.51%	Upper Flex Joint Angle
1-year Extreme Hs=4.20m, Tp=10.1s Ws=26.5m/s Cs=1.34m/s		SW	136.0	483.5 5.25%	67.0	108.3 1.17%	49.0	54.0 0.59%	Upper Flex Joint Angle
		10.0ppg	137.6	492.7 5.35%	68.6	114.2 1.24%	50.0	56.8 0.62%	Upper Flex Joint Angle
		10.0ppg 1500psi	137.2	491.1 5.33%	68.2	112.6 1.22%	49.6	56.1 0.61%	Upper Flex Joint Angle
1-year Extreme Reverse Current Hs=4.20m, Tp=10.1s Ws=20.5m/s Cs=1.34m/s		SW	79.4	113.5 1.23%	10.4	0.3 0.00%	8.4	0.1 0.00%	Upper Flex Joint Angle
		10.0ppg	84.8	129.6 1.41%	15.8	1.3 0.01%	12.8	0.6 0.01%	Upper Flex Joint Angle
		10.0ppg 1500psi	83.6	125.1 1.36%	14.6	0.9 0.01%	12.0	0.5 0.00%	Upper Flex Joint Angle

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Dual Derrick SIMOPS

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WSOG – Well Specific Operational Guidelines

Microsoft Excel Worksheet

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Well Testing & Flaring

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