

Subsea BOP Control Systems

Five-Day Course Outline
(WEST DEC Center, Brookshire, Texas)

Note: A Job Safety Analysis (JSA) will be presented before each lab exercise.

Section I - Introduction

A. Shop safety

1. Fire awareness
2. Toolbox meetings (JSAs)
3. Awareness of potentially hazardous activities of other groups
4. Personal protective equipment
5. Trapped pressure
6. Compressed air
7. Security of equipment being worked on or mounted on work benches
8. Working under suspended loads
9. Load rating of lifting equipment
10. Rotating machinery
11. Hand tools and electric power tools
12. Chemical storage and identification
13. Tool care and maintenance
14. Housekeeping

B. Safety equipment required in the shop

1. Steel-toed work boots
2. Safety glasses with side shields
3. Work gloves
4. Coveralls

Section II - General System Overview

Students will be presented with an integrated functional system description by major subsystem. Component and subsystem schematics will be used to show command paths and actuation characteristics. A description of a typical piloted control system and a MUX control system will be explained; along with a description of the system differences between the two types of controls. Fluid mixing and fluid quality assessment will be discussed. Detailed descriptions of the major sub-systems will be carried out during each day's activities followed by a lab session to troubleshoot each system. The overall system command and response characteristics will then be described and a system level troubleshooting session will be carried out by each student group. The following subsystems will be individually discussed:

1. HPU – fluid power and fluid mixing system
2. HPU – pilot pressure control system
3. Master control panel controls and electrical system
4. Hose reels and hoses
5. Subsea pods

Section III - HPU – Fluid Power and Fluid Mixing System

- A. A discussion of the operation and maintenance of the main fluid power pumps, the fluid mixing system, and the system accumulators will be carried out. BOP fluid mixing and fluid contamination problems will be discussed and assessment techniques will be evaluated.
- B. **Lab**
1. Presentation of system overview by subsystem of a Koomey 32-line system
 2. Teardown, troubleshooting, and analysis of a triplex fluid pump assembly
 3. Accumulator removal from rack and accumulator bladder replacement
 4. Pre-charge accumulator
 5. Functional checkout of reservoir float valves
 6. Fluid quality assessment testing and analysis

Section IV - HPU – Pilot Pressure Control System

- A. The pilot pressure generation and control system operation and maintenance will be discussed in detail:
1. Air-operated hydraulic pumps
 2. Hydro/pneumatic pressure switch
 3. Solenoid valves
 4. Pressure switches
 5. Pressure regulators
 6. Hydraulic control manifold
 7. Pneumatic cylinders
 8. RBQ plates
- B. **Lab**
1. Remove and inspect RBQ plate
 2. Remove, disassemble, and inspect hydro-air pressure switch
 3. Remove, disassemble, and inspect pneumatic cylinders
 4. Disassemble, inspect, and repair AKR failsafe regulator
 5. Operate and evaluate solenoid valves and evaluate relationship to pressure switch operation

Section V - Master Panel Controls and Electrical System

- A. The driller's control panel operation and maintenance will be discussed in detail. Use of control panel schematics will be described and importance of keeping schematics up-to-date will be demonstrated.
1. Pressure gauges
 2. Flow meters
 3. Switches
 4. "Push to Operate" switch
 5. BOP, system locking mechanisms, and valve position indicator lights
- B. **Lab**
1. Electrical safety
 2. Use of voltmeters and troubleshooting techniques
 3. Trace system function from driller's panel to RBQ plate on HPU

Section VI - Hose Reels and Hoses

The operation and maintenance of the hose reel control panel will be described. This will include a description of the problems that an improperly configured control panel can cause. The operational characteristics of umbilical hoses and their affects on BOP opening and closing times will be discussed in detail.

Section VII - Subsea Control Pods

A. The operations and maintenance of subsea control pods will be described. The effects of "blue" or "yellow" pod selection will be discussed regarding the common and unique command functions that result from pod selection. The control characteristics of Subsea Plate Mounted (SPM) valves will be evaluated. Pod seating on female receptacles of the LMRP will also be discussed. Hydraulic hose maintenance and repair will be included:

1. Kidney plates
2. Regulators
3. Pressure sensor comparisons between MUX and piloted systems
4. Temperature and inclinometer sensors on MUX systems
5. Pod latching mechanisms
6. Hydraulic flex hoses



Students reviewing subsea control pods

B. Lab

1. Remove, disassemble, inspect, and repair $\frac{3}{4}$ inch SPM valve
2. Remove, disassemble, inspect, and repair 1 inch SPM valve
3. Remove and inspect pod packer seals
4. Disassemble and inspect manipulator valve and selector valve and evaluate valve differences
5. Make-up hydraulic hose assembly to specific size and dimension requirements

Section VII - Combined Control System

A. Describe the complete BOP control system using system schematics and command logic diagrams. Descriptions of command sequencing, command/response indicators, problem indicators, and troubleshooting techniques will be included.

B. The importance of keeping system schematics up-to-date will be discussed and demonstrated.

C. Lab

1. Each student group will be given a system problem using the combined driller's panel, HPU, hose, and control pod system. They will demonstrate the proper technique to

- systematically troubleshoot, replace, and repair a simulated failed component that will be placed in the system.
2. Each student group will photo-document the troubleshooting techniques used, document the problem assessment process used, and develop a problem analysis report to document the result of the system analysis.