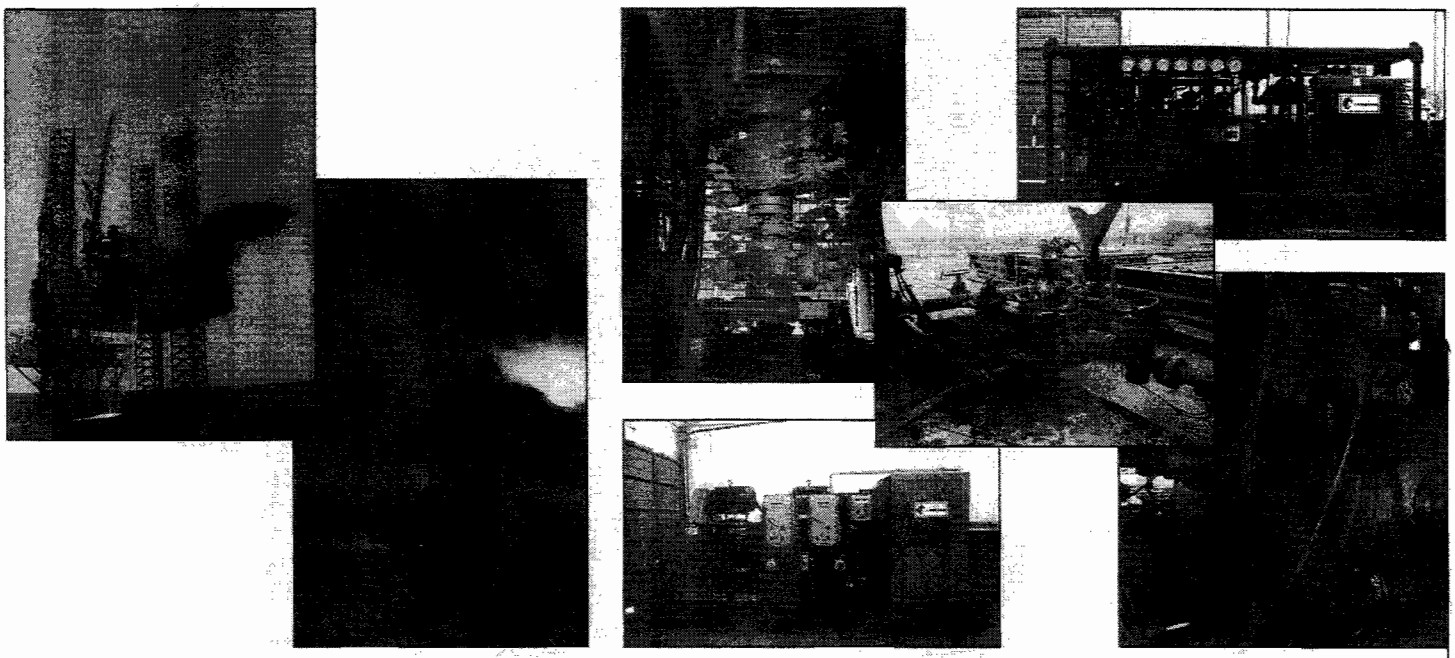
CAMERON

DRILLING SYSTEMS

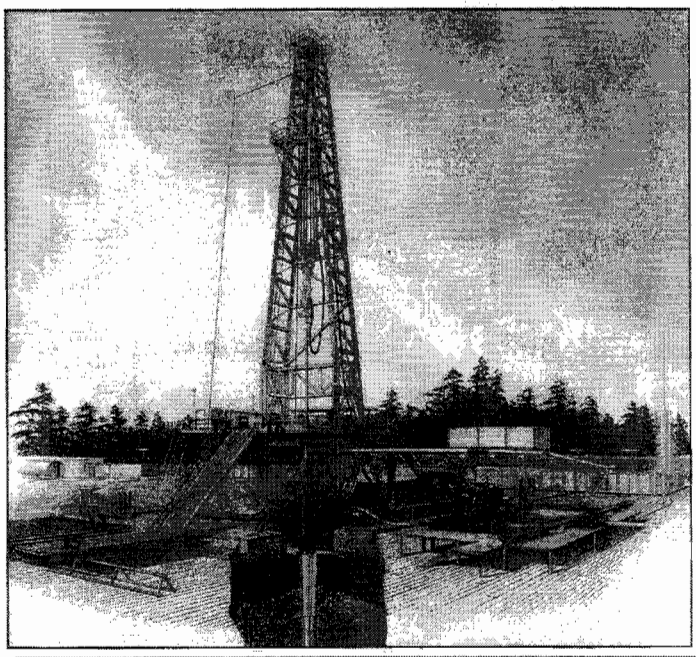
Performance
THROUGH LEADERSHIP

RAISING PERFORMANCE. TOGETHER™

Systems for Surface Applications



Surface Drilling Systems



Cameron BOP Stack

1. Annular BOP
2. Double Ram-Type BOP
3. Drill Spool
4. Manual and Hydraulic Gate Valve, Check Valve
5. Single Ram-Type BOP
6. Casing Head

Choke Manifold

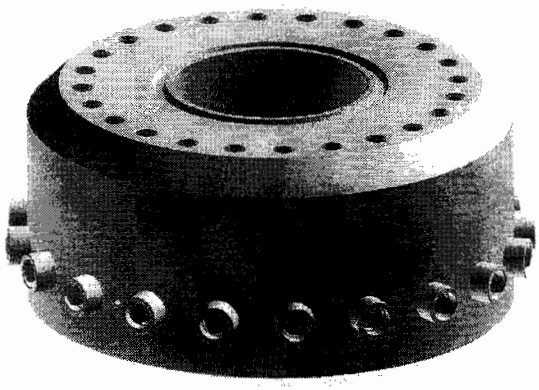
7. Transmitter
8. Pressure Gauge
9. Manual Gate Valve
10. Hydraulic Gate Valve
11. Drilling Choke
12. Control Panel
13. Standpipe Manifold

BOP Control System

14. Closing Unit
15. Pipe Rack
16. Remote Control Panel
17. Mud Pumps and Manifold Pressure Gauges
18. Mud Tank, Mud Valves, Degasser

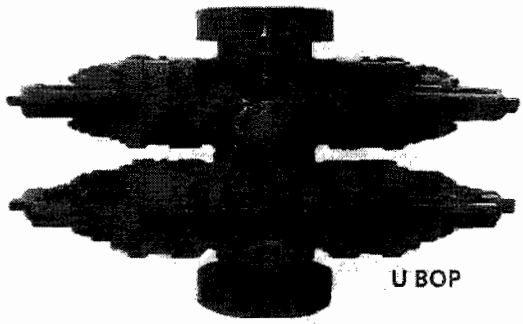
Fastlock Connector

- No handling/lifting of loose items and heavy tooling
- Minimal swallow reduces overall stack height
- CF Seal, a modified Cameron CX seal, reduces pressure end-loads and allows lower make-up torque
- Components subject to wear can be changed in the field



Ram-type Blowout Preventer

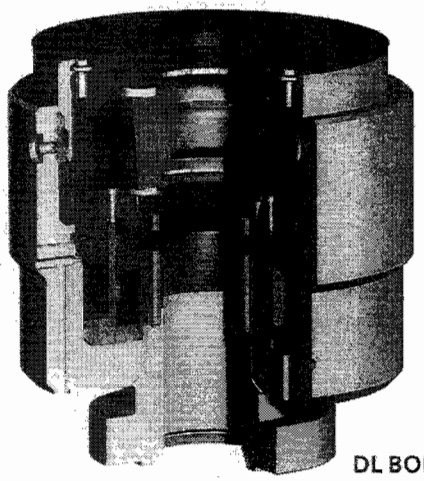
- Optional ram wear pads to reduce bore wear
- Optional bonnet seal carrier reduces torque on bonnet studs and nuts
- Bonnet studs eliminated body make/break
- Field accessible operating system
- Manual or Hydraulic locks are available for all sizes and pressures



U BOP

Annular Blowout Preventer

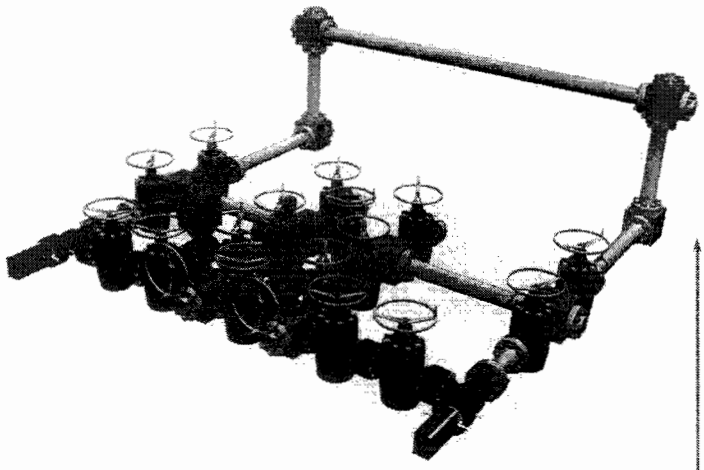
- Shortened height
- Quick-release top
- Simplified field maintenance
- Operating system may be removed in the field without removing the BOP from the stack
- Operating system isolated from wellbore pressure



DL BOP

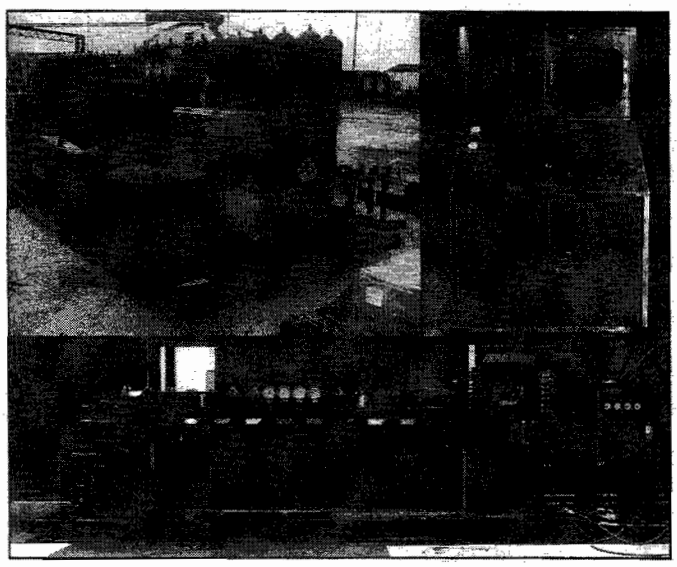
Surface Manifold System

- Consists of an arrangement of high pressure valves, lines, and chokes
- Gauges and transmitters allow for real-time pressure observation
- Designed to control the flow of mud
- Typical manifold includes at least two chokes for isolation for repair

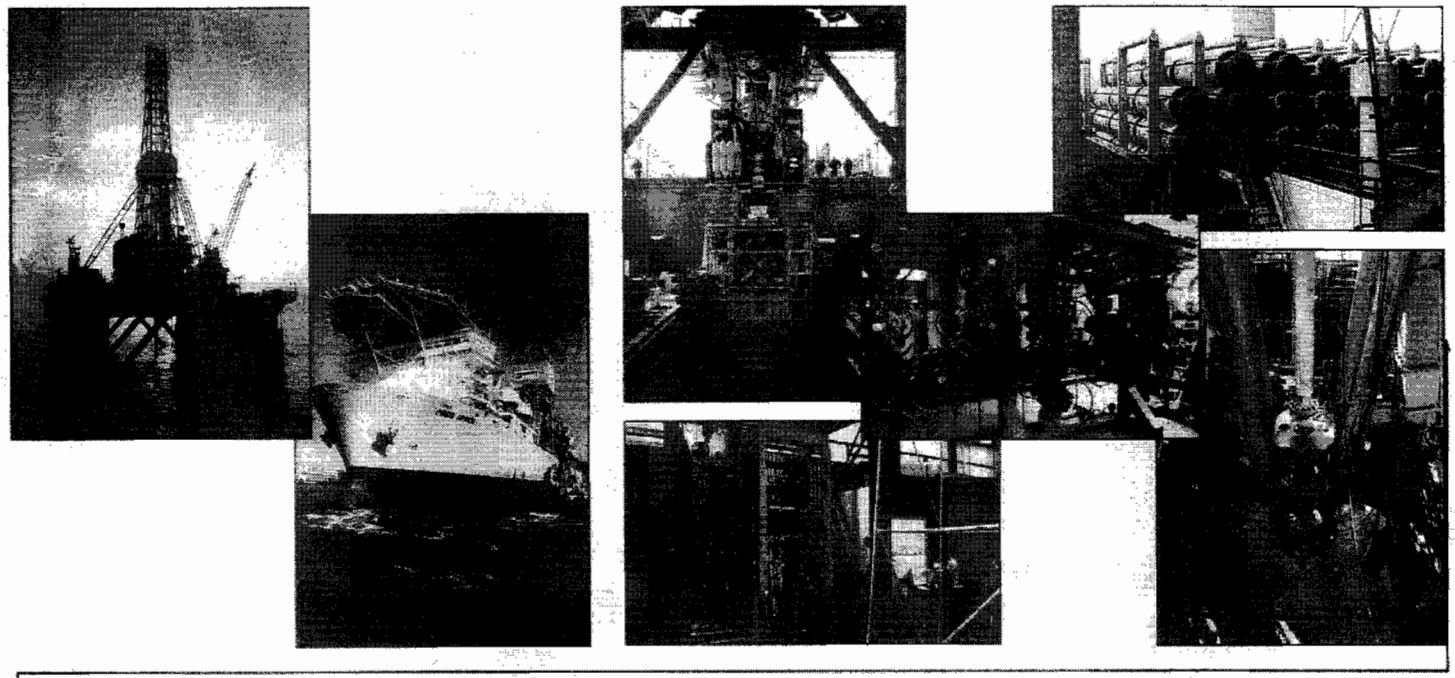


Surface Control System

- Primary purpose is to provide a mechanism for remotely operating well control equipment
- Allows for safe operation of BOP and gate valve functions
- Design allows for scalability based on individual customer requirements

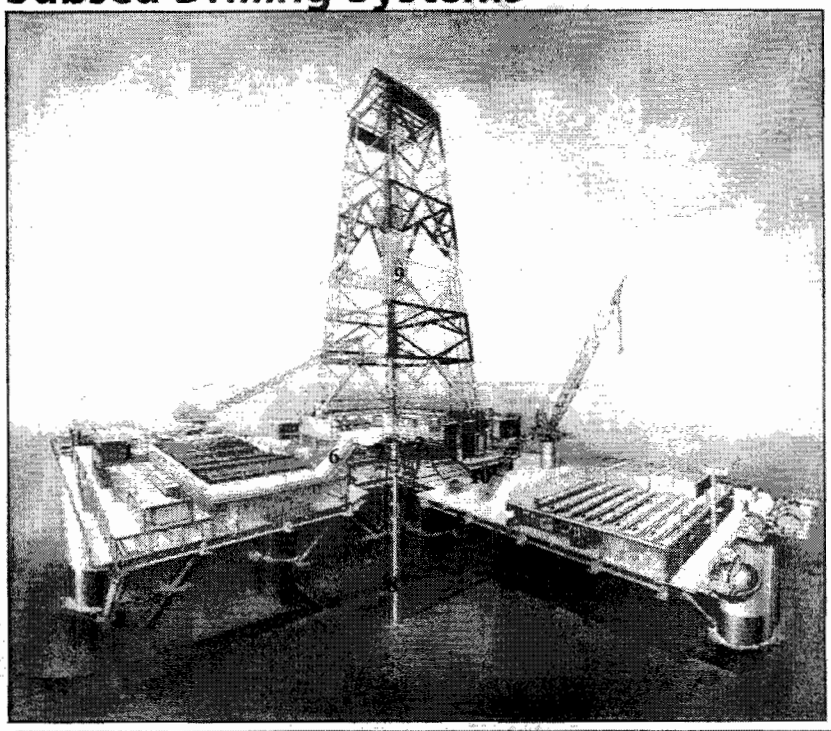


Systems for Subsea Applications



RAISING PERFORMANCE. TOGETHER™

Subsea Drilling Systems



Control System

1. Auxiliary Remote Control Panel
2. Driller's Panel
3. Hydraulic Power Unit
4. Accumulator Bank
5. Hose / Cable Reel

Choke System

6. Choke Manifold
7. Choke Manifold Control Console

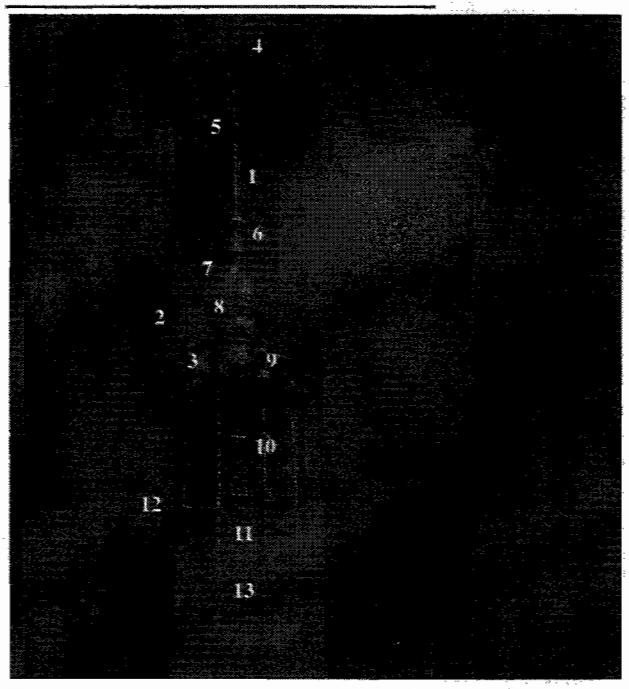
Riser System

8. Telescoping Joint

Motion Compensation Systems

9. Drill String Compensator
10. Deepwater Tensioners
11. Riser Tensioning String

Subsea Drilling Systems



Control System

1. Hydraulic Conduit Supply Line
2. MUX Control Pod
3. Conduit Valve

Riser System

4. Riser Joint
5. Riser Connector
6. Termination Spool

Lower Marine Riser Package

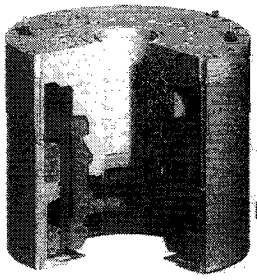
7. Flex Joint
8. Annular BOP
9. Choke / Kill Connector

BOP Stack

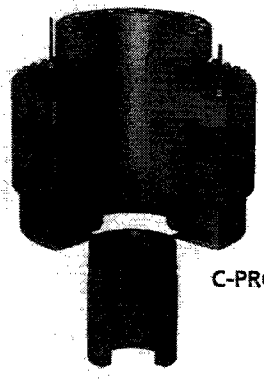
10. Subsea Gate Valve
11. RAM Type BOPs
12. Guide Structure
13. Collet Connector

Collet Connector

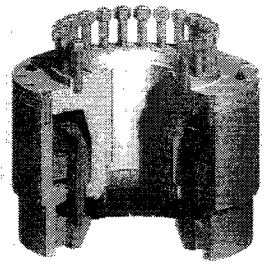
- Evolved to address issues concerning higher internal and external pressures
- Design addressed applied bending and tension loads, especially during extreme operating conditions
- Designed to fulfill a variety of requirements caused by restricted space, high preload and fatigue life
- Specific customer requirements for unique operating environments are also part of the connectors evolution



DWHC



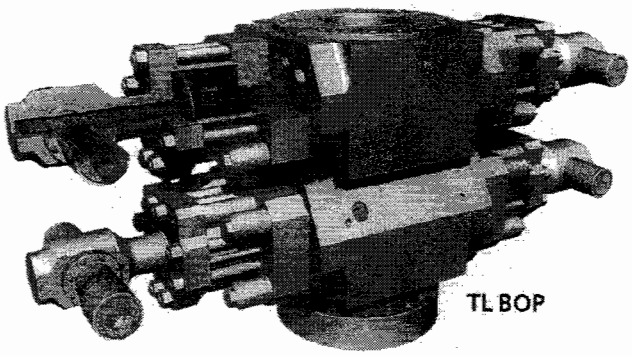
C-PRO



HC

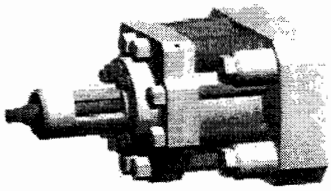
Ram-type Blowout Preventer

- Side ram removal reduces stack height and simplifies ram change-out.
- Ram wear pads
- Bonnet seal carrier reduces torque on bonnet studs and nuts.
- Bonnet studs eliminated body make/break
- Field accessible operating system
- Manual or Hydraulic locks are available for all sizes and pressures.

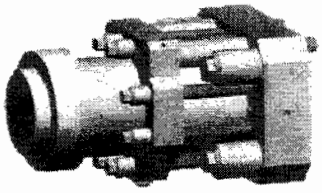


TL BOP

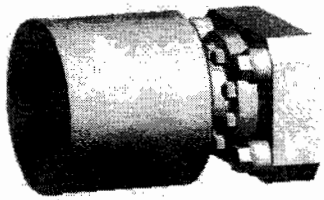
Ram-type Blowout Preventer Accessories
Bonnet Configurations



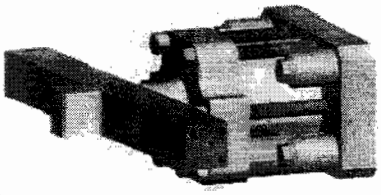
Manual Locking Screw



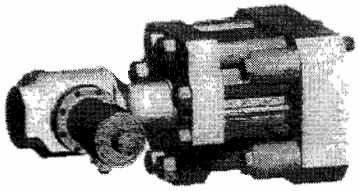
RamLock



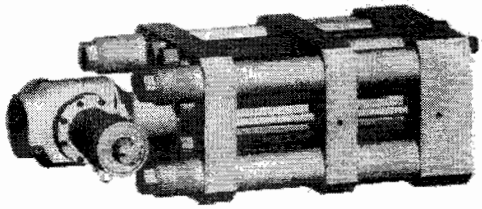
Super Shear



Wedgelock



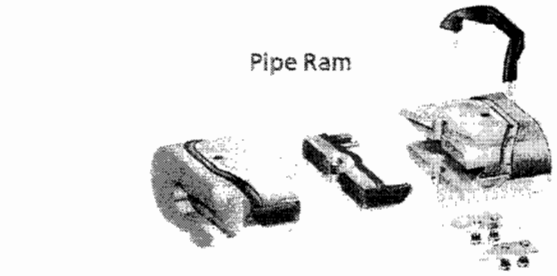
ST-Lock



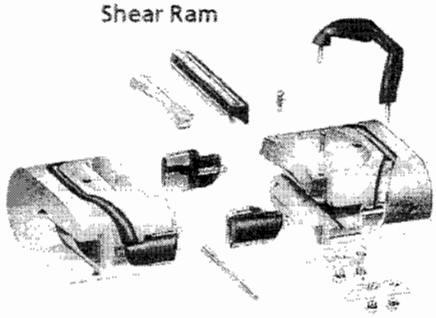
Tandem Booster
(shown with ST-Lock)

Ram-type Blowout Preventer Accessories

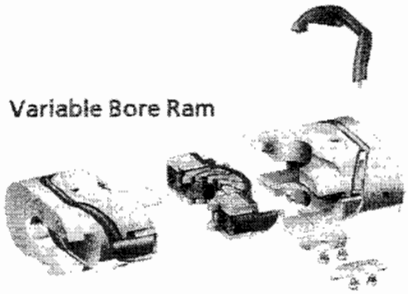
Available Ram Options



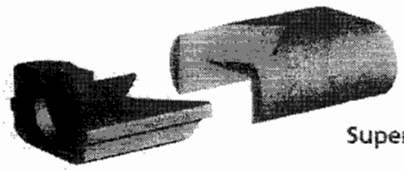
Pipe Ram



Shear Ram



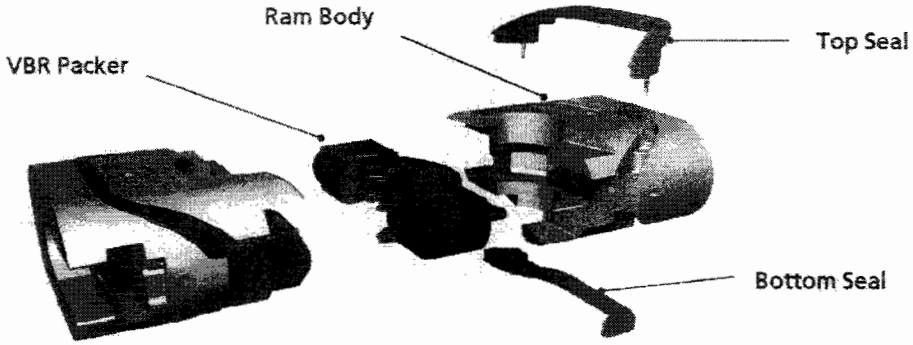
Variable Bore Ram



Super Shear Ram

Bi-directional Ram Assembly

- Rugged VBR assembly has similar functional characteristics to a standard TL ram assembly
- No modifications to the BOP body are necessary to utilize this ram
- Utilizes special or modified bonnet assembly



US Patent: 6,719,262

Benefits

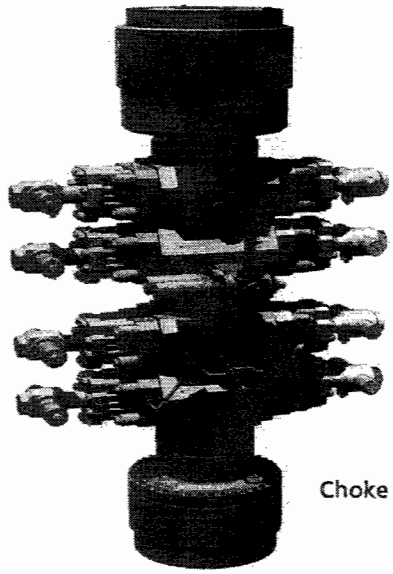
Bi-Directional Rams can be fitted to a conventional 4 cavity stack without sacrificing the lower cavity and retaining redundancy for well control.

Benefits to Drilling Contractor

- No need for additional cavity
- No major stack frame modifications
- No loss of ram redundancy

Benefits to Operator

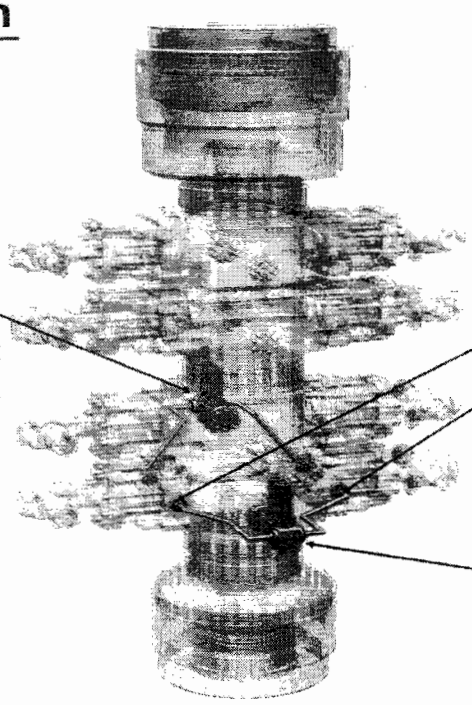
- Greater drilling productivity
- Can save tripping time per well



Choke Side

US Patent: 6,719,262

Basic Configuration



Dual MCS valves.

Valves "CLOSED to seal from below (Drilling Mode).

Valves "OPEN" to seal from above (Test Mode).

Bonnet Ports.

Provide communication to cavities behind Bi-Directional Rams.

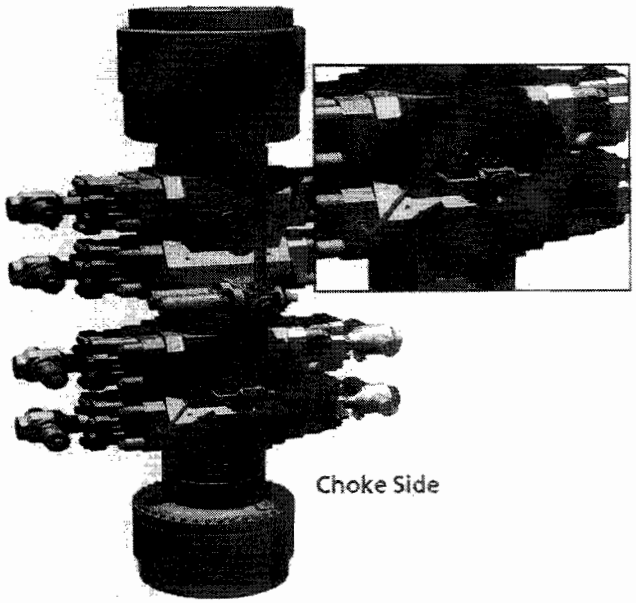
Dual MCS valves.

Valves "OPEN" to seal from below (Drilling Mode).

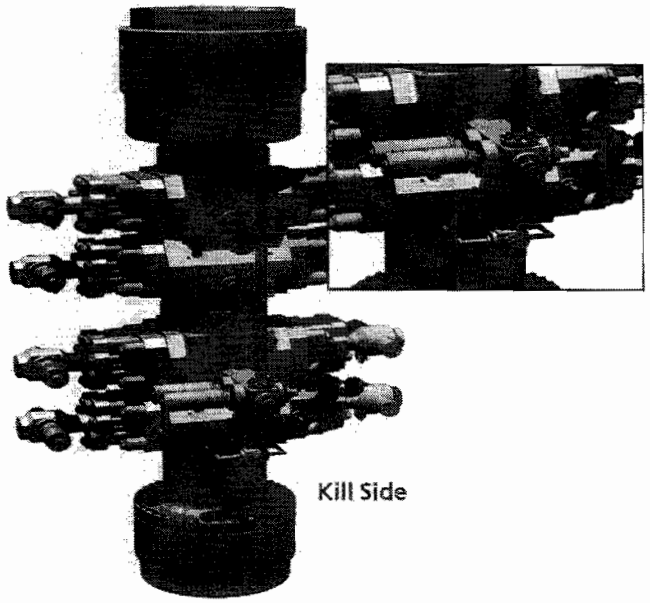
Valves "CLOSED" to seal from above (Test Mode).

US Patent: 6,719,262

Basic Configuration



Choke Side

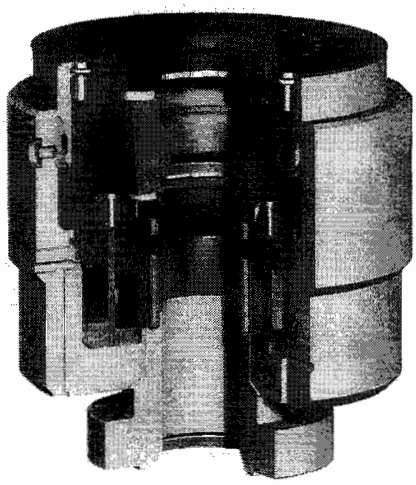


Kill Side

US Patent: 6,719,262, April 2004

Annular Blowout Preventer

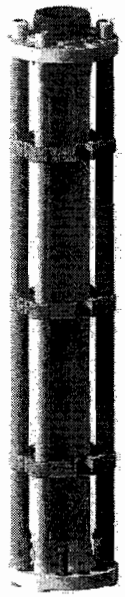
- Shortened height
- Quick-release top
- Simplified field maintenance
- Operating system may be removed in the field without removing the BOP from the stack
- Operating system isolated from wellbore pressure



Riser Systems

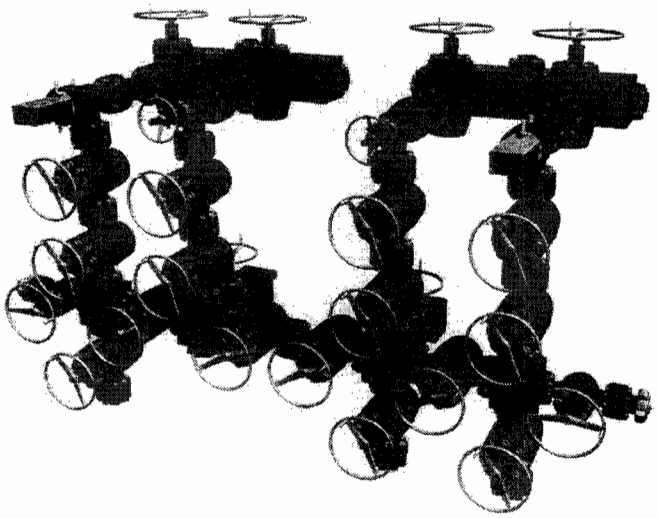
- Field proven Riser Systems
- Accommodates the stringent conditions encountered in deep water drilling
- Handles high tension loads and the need to quickly respond to changes in surface weather conditions
- Allows for multiple auxiliary lines, as well as the traditional Choke and Kill lines

LoadKing™



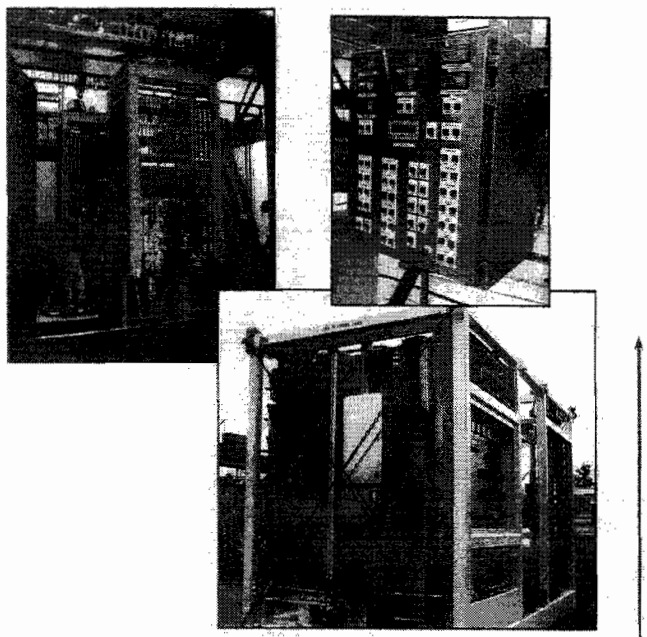
Subsea Manifold System

- Consists of an arrangement of high pressure valves, lines, and chokes
- Gauges and transmitters allow for real-time pressure observation
- Designed to control the flow of mud
- Typical manifold includes at least two chokes for isolation for repair



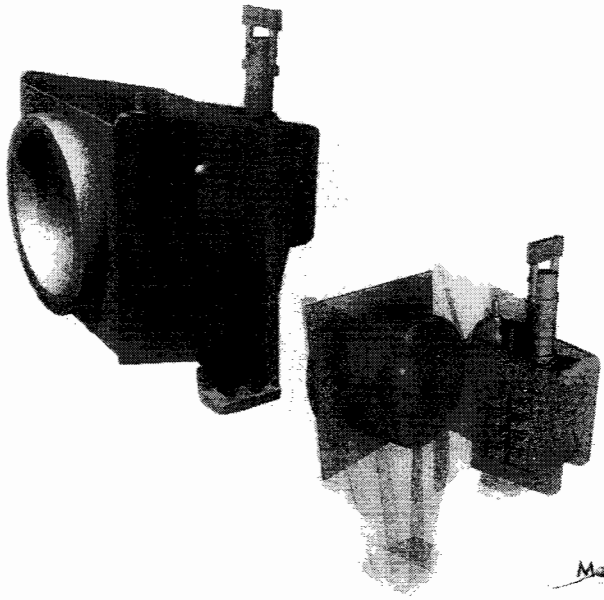
Subsea Control Systems

- Primary purpose is to provide a mechanism for remotely operating well control equipment
- Allows for safe operation of BOP and gate valve functions
- Design allows for scalability based on individual customer requirements
- Allows for implementation of an Emergency Disconnect in case of inclimate weather



MoRPH™ Control System

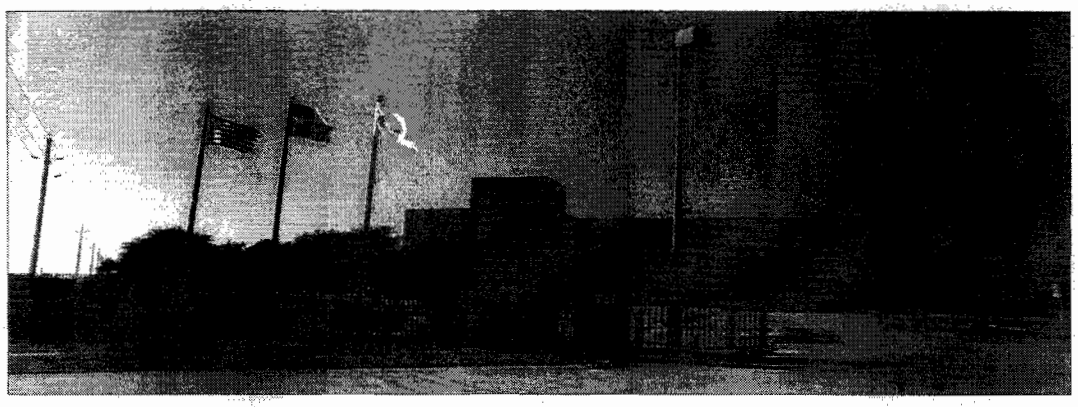
- Economically fills the gap between shallow water and deepwater drilling control systems
- Represents a quick, simple, and economical solution for extending the water depth range
- Retrofits to most subsea control systems on today's second to fourth generation drilling rigs



Cameron Elastomer Technology (CET)

CET supports the following activities:

- Product development
- Product Testing
- Research and Development
- Drilling Spares Warehouse



Cameron Elastomer Technology (CET)

Spare Parts Warehouse

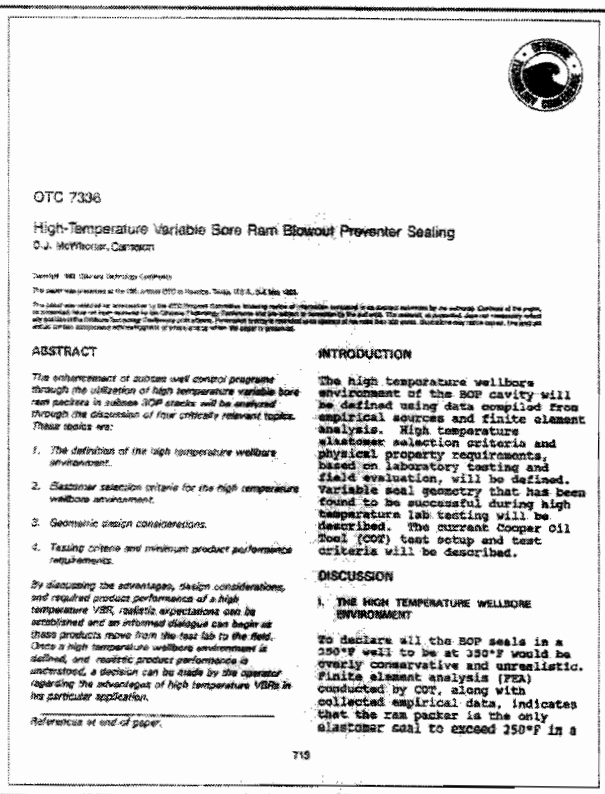
Research and Development

Laboratory Testing

Manufacturing

Variable Bore Ram Packer

- OTC Paper 7336 – May 1993
- Cameron develops the industry's first 350° F variable bore ram packer



OTC 7336

High-Temperature Variable Bore Ram Blowout Preventer Sealing

C.J. McWhorter, Cameron

This paper was presented at the 25th Annual OTC in Houston, Texas, U.S.A., 3-6 May 1993.

This paper was selected for presentation by the OTC Program Committee following review of information contained in an abstract submitted by the author(s). Contents of the paper, as presented, have not been reviewed by the Offshore Technology Conference and are subject to correction by the author(s). The material, as presented, does not necessarily reflect any position of the Offshore Technology Conference or its officers. Permission to copy is restricted to an abstract of not more than 300 words. Illustrations may not be copied. The abstract should contain conspicuous acknowledgment of where and by whom the paper is presented.

ABSTRACT

The enhancement of subsea well control programs through the utilization of high temperature variable bore ram packers in subsea BOP stacks will be analyzed through the discussion of four critically relevant topics. These topics are:

1. *The definition of the high temperature wellbore environment.*
2. *Elastomer selection criteria for the high temperature wellbore environment.*
3. *Geometric design considerations.*
4. *Testing criteria and minimum product performance requirements.*

By discussing the advantages, design considerations, and required product performance of a high temperature VBR, realistic expectations can be established and an informed dialogue can begin as these products move from the test lab to the field. Once a high temperature wellbore environment is defined, and realistic product performance is understood, a decision can be made by the operator regarding the advantages of high temperature VBRs in his particular application.

References at end of paper.

INTRODUCTION

The high temperature wellbore environment of the BOP cavity will be defined using data compiled from empirical sources and finite element analysis. High temperature elastomer selection criteria and physical property requirements, based on laboratory testing and field evaluation, will be defined. Variable seal geometry that has been found to be successful during high temperature lab testing will be described. The current Cooper Oil Tool (COT) test setup and test criteria will be described.

DISCUSSION

1. THE HIGH TEMPERATURE WELLBORE ENVIRONMENT

To declare all the BOP seals in a 350°F well to be at 350°F would be overly conservative and unrealistic. Finite element analysis (FEA) conducted by COT, along with collected empirical data, indicates that the ram packer is the only elastomer seal to exceed 350°F in a

715

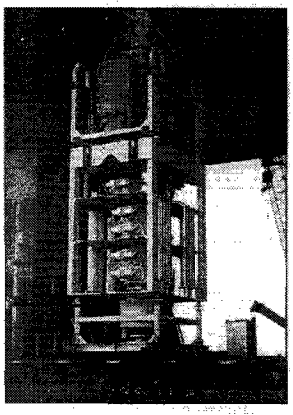
Project Portfolio

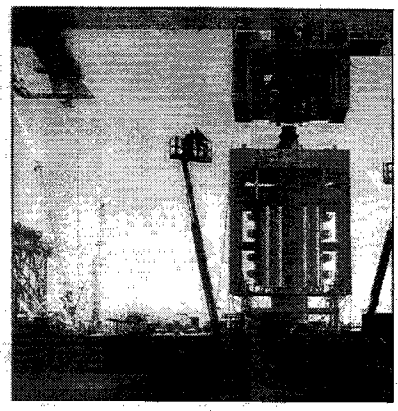
Project: BP Thunderhorse

Rated Water Depth: +10,000 feet

Scope of Supply:

- Blowout Preventer Stack
  - 18-3/4, 15K, 5 Cavity Stack
    - DWHC Wellhead Connector
    - (2) Double TL BOP with standard ST-Locks
    - Single TL BOP with Tandem Boosters
    - Annular
    - Adapter Spool
    - HC Lower Marine Riser Connector
    - Annular
    - Flex Joint / Riser Adapter
- Control System
  - MUX Control Pods



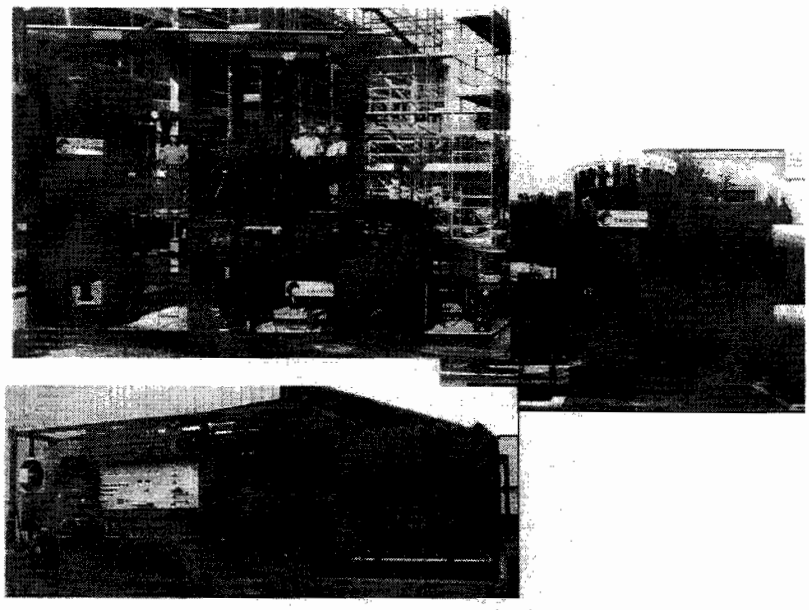


Project Portfolio

Project: Shah Deniz

Scope of Supply

- Blowout Preventer Stack
  - 18-3/4" 15K, 4 cavity stack
    - Fastlock Wellhead Connector
    - (2) Double TL BOP
    - Annular BOP
    - 2 level working & lifting platforms
- Control System
  - Hydraulic Control Unit
  - Accumulator Rack
- Choke Manifold
  - 3-1/16" 15K x 4-1/16" 10K
  - Mud gas separator
- Riser System
  - 18-3/4" 15K HP Riser



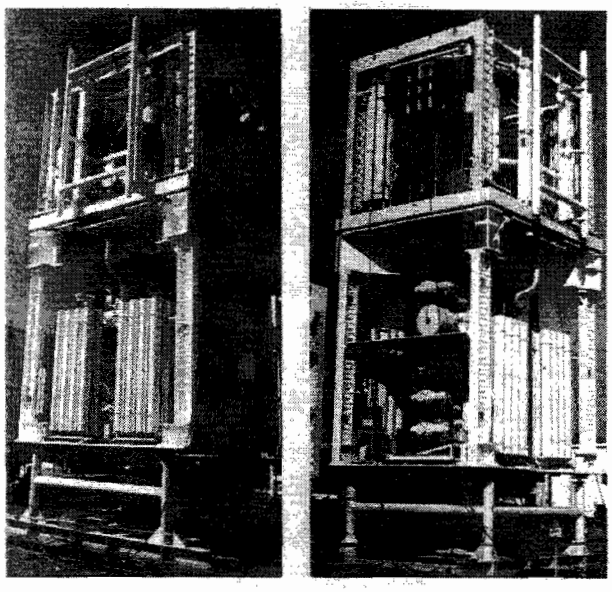
Project Portfolio

Project: OD-21

Rated Water Depth: +10,000 feet

Scope of Supply:

- Blowout Preventer Stack
  - 18-3/4, 15K, 5 Cavity Stack
    - Wellhead Connector
    - Triple TL BOP with Standard ST-Locks
    - Double TL BOP with Super Shears and Tandem Boosters
    - Adapter Spool
    - HC Lower Marine Riser Connector
    - Annular
    - Flex Joint / Riser Adapter
- Control System
  - MUX Control Pods

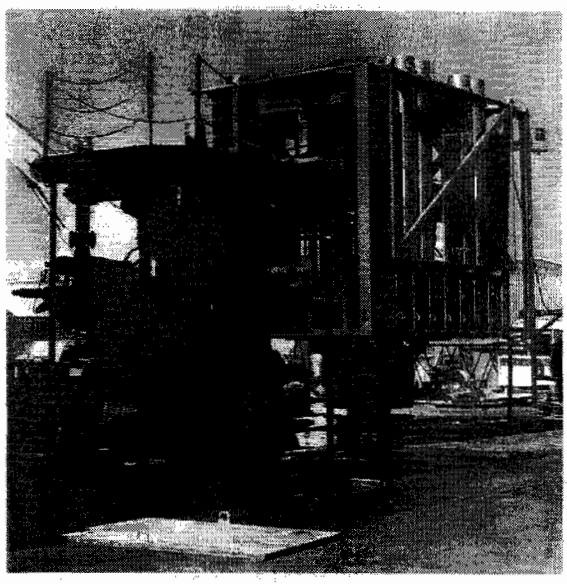


Project Portfolio

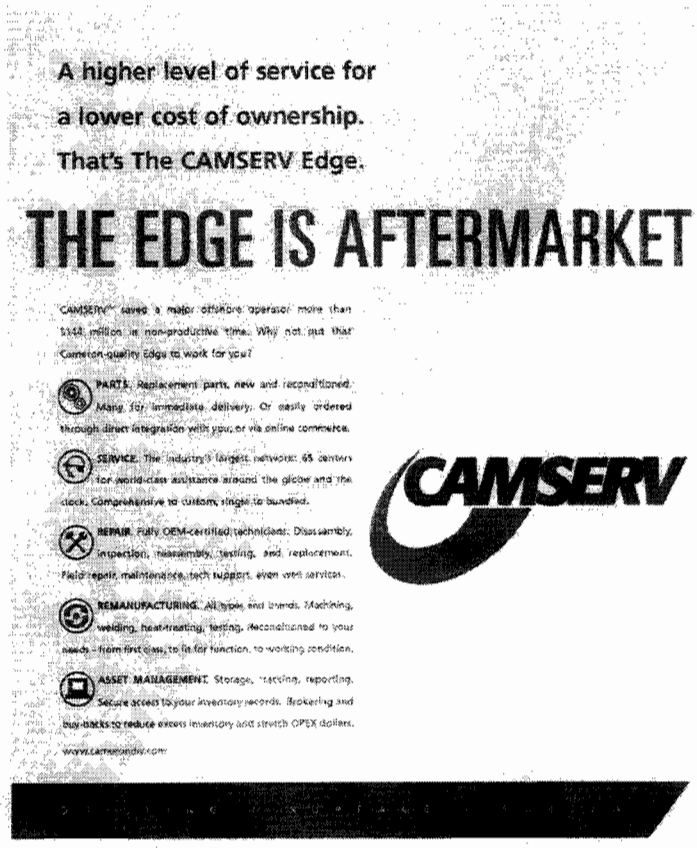
Project: Marinor SSA

Scope of Supply:

- Surface Blowout Preventer Stack
  - Fastlock Connector
  - 13-5/8" 10K Double UM BOP with manual locks
  - 13-5/8" 10K Single UM BOP with Tandem Boosters
  - 13-5/8" 5K Annular BOP
- Subsea Component
  - 18-3/4" 15M HC Wellhead Connector
  - 13-5/8" 10K Single UM BOP with Tandem Boosters and Wedgelocks
  - Spacer Spool
  - 13-5/8" 10K Single UM BOP with Tandem Boosters and Wedgelocks
  - 13-5/8" HC Connector
- Controls
  - Surface Control Unit
  - ROV Panels
  - Acoustical System and Umbilical Lines



Aftermarket Services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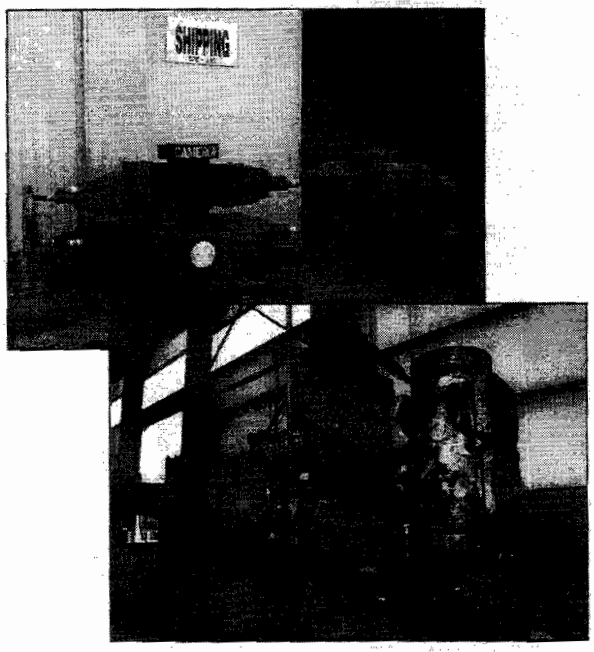

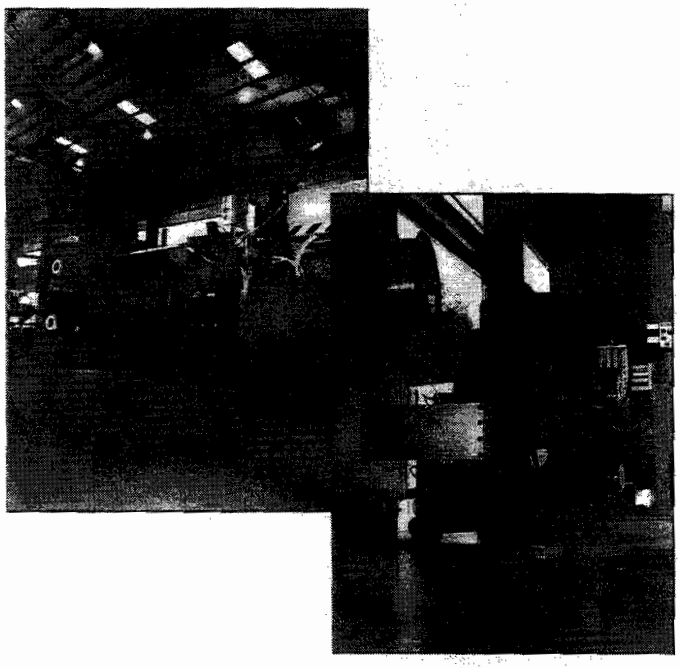

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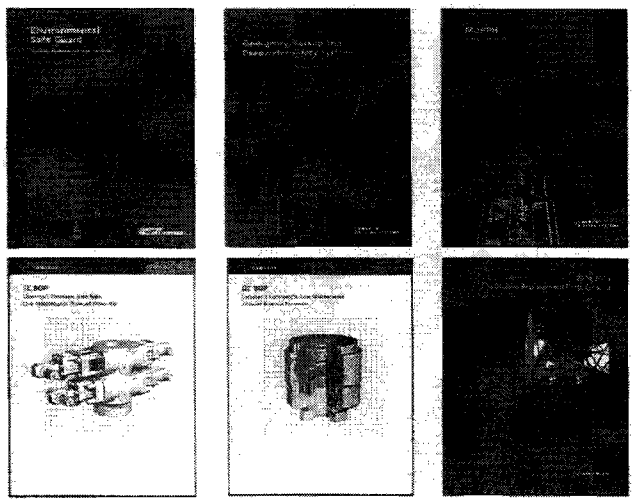
1. ESG™
2. EDS™
3. MoPRH™
4. TL™ BOP
5. DL™ BOP
6. Replacement Parts Catalog



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