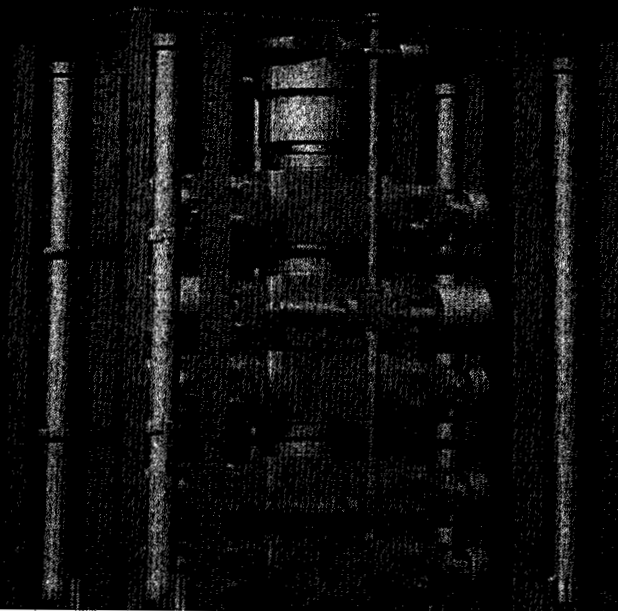
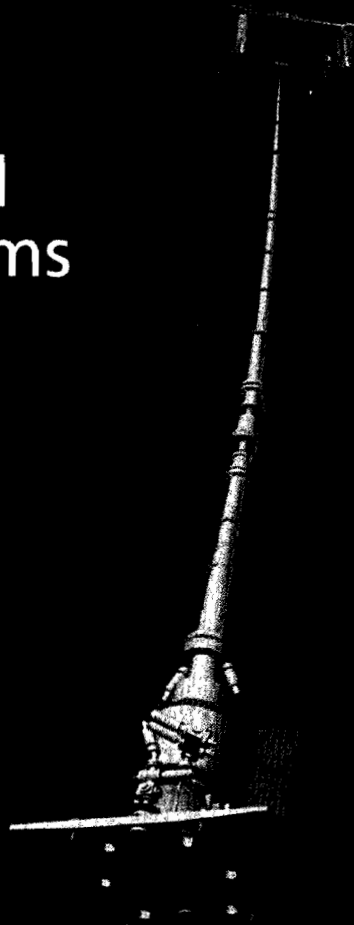


# Emergency, Back-up and Deepwater Safety Systems

Automated disconnect systems for shutting in wells



*Le Normand*  
Exhibit No. *3603*  
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## Emergency, Back-up and Deepwater Safety Systems

Here at Cameron, we are supporting the industry by giving a clear and concise description of some of the many variables concerning emergency, back-up and deepwater safety systems. As an operator or drilling contractor, the decisions you make are based on your anticipated operational environment.

We want to inform you of the options that are currently available to you. We want you to be knowledgeable of each system's intent, mode of operation and limitations. Armed with knowledge, you can make responsible decisions for your organization.

### EMERGENCY DISCONNECT SEQUENCES

Cameron System	Intent	Initiation of System	Electric Power	Hydraulic Power	Functions	Limitations
Emergency Disconnect (EDS)	Shut in and disconnect when deemed necessary by operator.	Operator pushes single button.	Main power	Main hydraulic power	Preprogrammed sequence of functions. Can be re-programmed between wells.	Requires operator action. Can only operate when full electrical and hydraulic connections are made to stack.

### BACK-UP CONTROLS

Cameron System	Intent	Initiation of System	Electric Power	Hydraulic Power	Functions	Limitations
Acoustic System	Shut in and disconnect without main controls.	Operator pushes multiple buttons.	Battery supply	Dedicated subsea accumulator bank	Functions are activated from subsea pilot valves which are energized via an acoustic signal from surface operator.	Limited to functions hard plumbed from subsea valve panel. Perception of unreliability in turbulent waters.
ROV Panels	Shut in and disconnect without main controls.	ROV operator	Umbilical to ROV	Hot line or ROV pump	ROV manually shifts valves on a subsea panel causing fluid to be directed to a selected function.	Limited to the hard plumbed stack valves. Requires that ROV be at the stack.

### SAFETY SYSTEMS

Cameron System		Intent	Initiation of System	Electric Power	Hydraulic Power	Functions	Limitations
Deadman (AMF)	Mux	Shut in and disconnect with loss of riser.	Automatic when loss of hyd & elec power & signal are detected.	Battery supply	Dedicated subsea accumulator bank	Operates a preprogrammed set of instructions through the normal pod valves.	Does not operate after an unplanned disconnect.
	Hyd	Shut in and disconnect with loss of riser.	Automatic when loss of hyd & elec power shift valves to default position.	None required	Dedicated subsea accumulator bank	Fluid from the signal valves energizes through hydraulics a sequence of shutting in the well and disconnecting.	Does not operate after an unplanned disconnect.
Automatic Disconnect System (ADS)	Mux	Shut in and disconnect if riser is at specific angle.	Automatic activation when a predetermined riser angle is reached.	Battery supply	Dedicated subsea accumulator bank	Signal from inclinometer activates preprogrammed sequence.	Does not operate after an unplanned disconnect.
	Hyd	Shut in and disconnect if riser is at specific angle.	Automatic activation when a predetermined riser angle is reached.	None required	Dedicated subsea accumulator bank	Fluid from the signal valves energizes through hydraulics a sequence of shutting in the well and disconnecting.	Does not operate after an unplanned disconnect.
Disconnect Autoshear		Shut in after inadvertent disconnect.	Automatic activation when LMRP plate separates from the stack.	None Required	Dedicated subsea accumulator bank	Fluid from the signal valves energizes through hydraulics a sequence of shutting in the well.	Does not initiate upon riser failure.

**EDS Systems** rely on an operator to engage a button in order to start a sequence of events to close in the well, lock the rams and disconnect the LMRP.

It operates through the normal lines of communication to the pod and uses the hydraulic power from the conduit.

#### FEATURES:

- When the button is pushed, the entire sequence always takes place under a 15 second time in disconnect.
- Program can be modified to different operations combinations.
- Series and parallel operations can be achieved through drilling rig action.

**Acoustic Systems** utilize a transmitter on the surface to send signals. The signal receivers are mounted on extended arms on the stack. They are then sent to a bank of dedicated solenoids. The solenoids in turn activate valves connected to the stack components via shuttle valves. The hydraulic power comes from an isolated and dedicated bank of accumulator bottles.

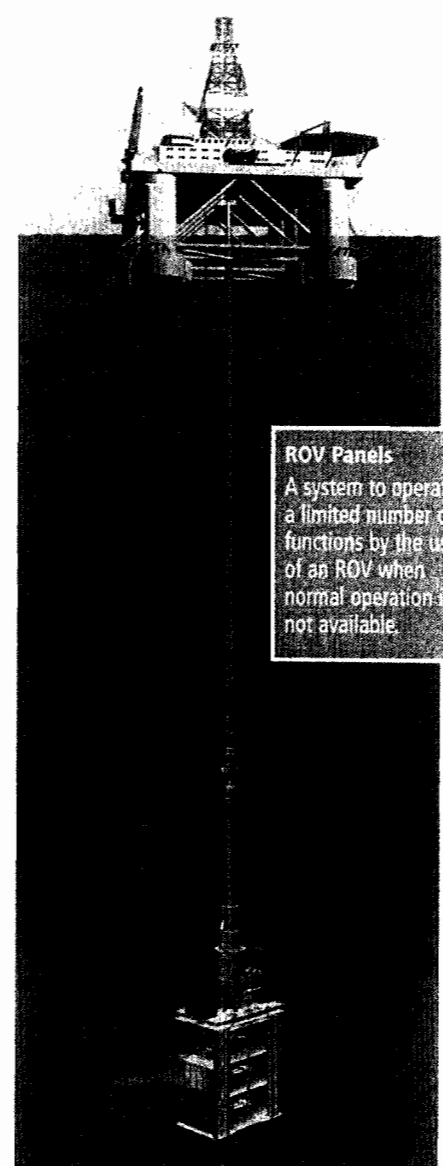
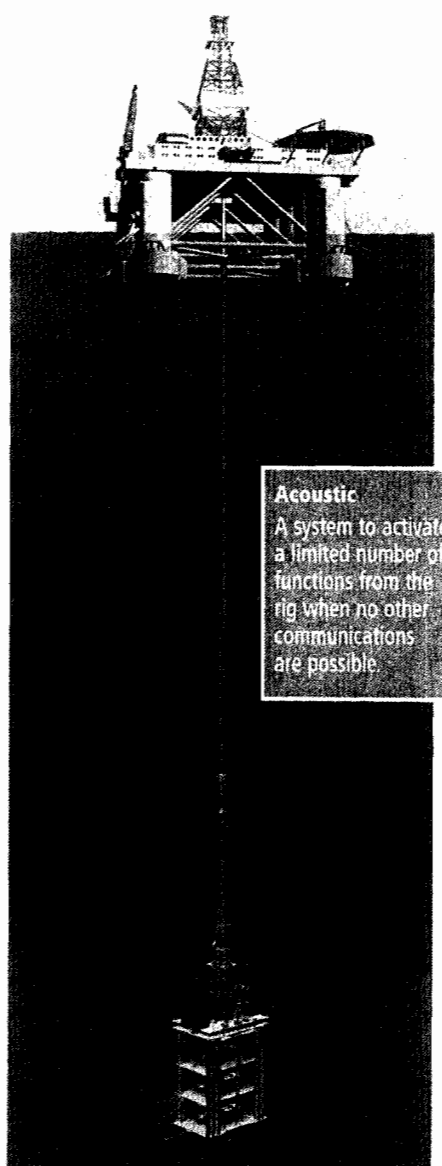
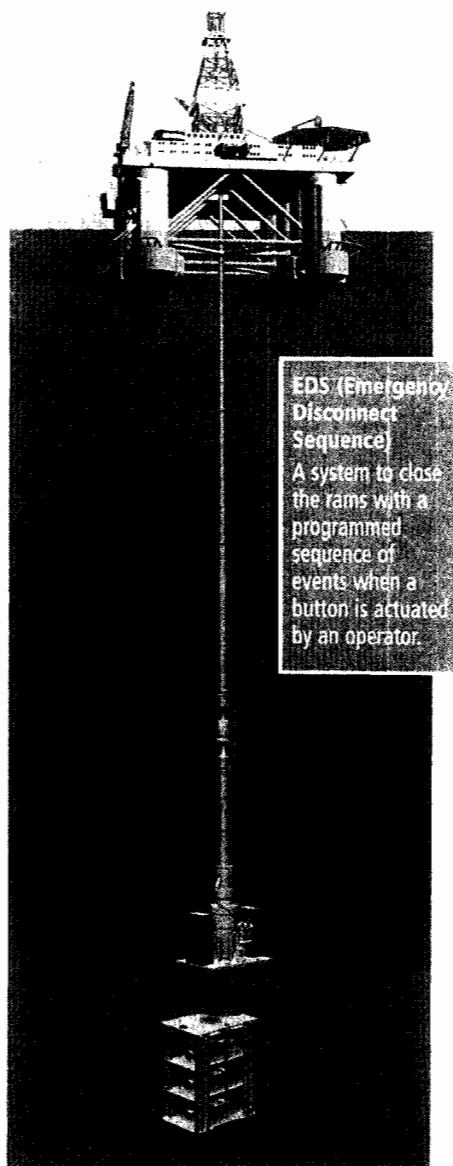
#### FEATURES:

- Only one button on the stack is required to activate the system.
- Can be used to signal, running to surface or down to the well to open or close shuttles.
- Can be used to activate the LMRP or other components of the system.

**ROV Functions** incorporate panels mounted on the stack containing valves. The valves are opened and closed with the Remote Operated Vehicle. The valves are connected to various ports on the rams and connectors via shuttle valves. The hydraulic power comes from either a bank of accumulators that are tied into the ROV supply or by the ROV pumping saltwater into the system.

#### FEATURES:

- Two hydraulic systems can be used to operate the system.
- Simple reliable system with no moving parts.
- Will be used during the entire life of the well.



**Deadman Systems** first determine if the riser is intact; second, automatically shut in the well if the riser is not functional. These types of systems sense hydraulic supply pressure and/or electrical power. If there is none from the surface, it sends signals to operate a sequence of functions, programmed on MUX systems, hydraulic on piloted systems. This system uses a dedicated and isolated bank of accumulators for hydraulic power to the stack.

#### FEATURES:

- System can be designed for multiple functions.
- Battery powered will allow up to five emergency functions at any time.
- Program can be modified to change time and function as needed per operational contract.

**Automatic Disconnect Systems** are intended to monitor the angle between the stack and the riser. When this angle reaches a predetermined limit, then a sequence will begin that closes in the well and disconnects the LMRP.

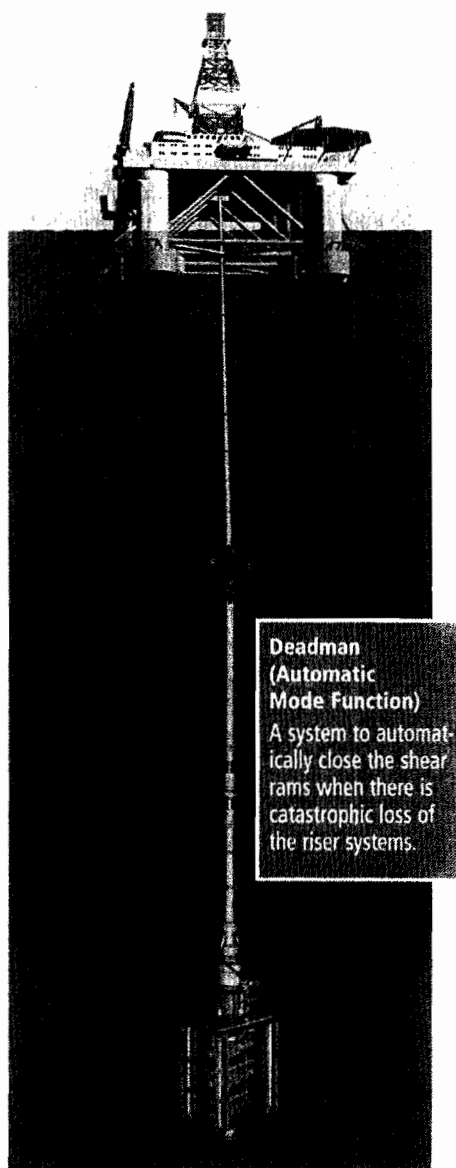
#### FEATURES:

- Can be retrofit to existing systems.
- Available with mechanical and electrical safety systems.

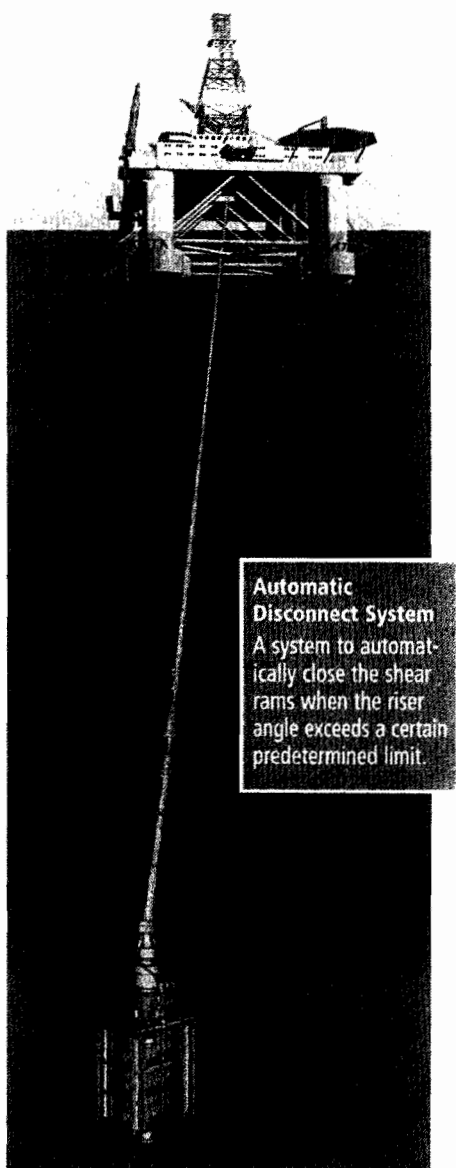
**Autoshear Systems** The system has a mechanical valve mounted at the LMRP plate. It is spring returned. When the LMRP and the stack plate are in normal proximity, the LMRP plate pushes the plunger against the spring. If the plates separate, the valve spring returns and allows hydraulic fluid to the shear rams from a bank of accumulator valves.

#### FEATURES:

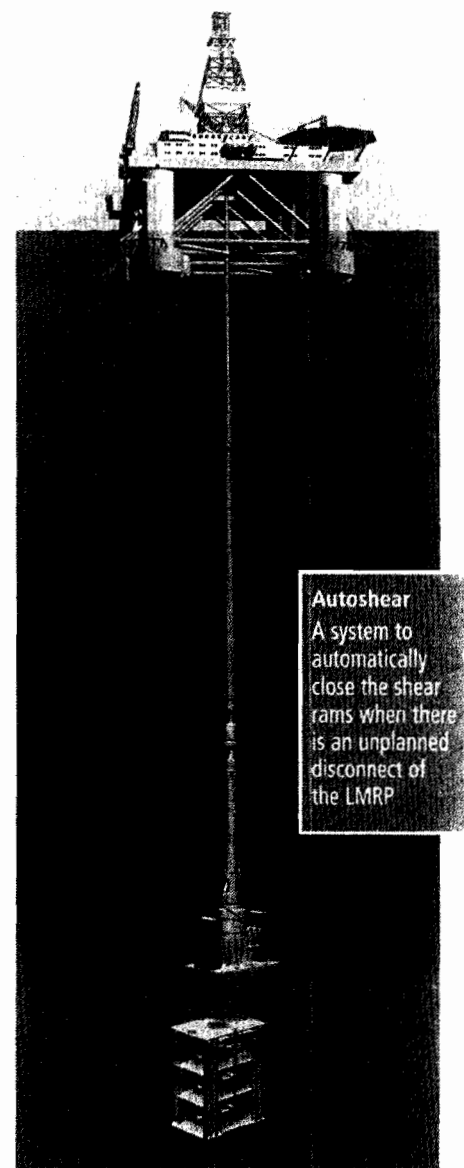
- For MUX or Hydraulically piloted systems.
- Can be retrofit to existing systems.
- This system is mounted on the LMRP plate, which already on the surface. The LMRP plate system is the only one that can be retrofitted.
- The stack plate is available for retrofit.
- The LMRP plate is available for retrofit.



**Deadman (Automatic Mode Function)**  
A system to automatically close the shear rams when there is catastrophic loss of the riser systems.



**Automatic Disconnect System**  
A system to automatically close the shear rams when the riser angle exceeds a certain predetermined limit.



**Autoshear**  
A system to automatically close the shear rams when there is an unplanned disconnect of the LMRP.

## Selecting an Emergency Back-Up System

**G**reater concerns for health, environmental and safety issues are impacting the drilling industry in a number of areas. As a result, automated systems for shutting in wells are becoming standard on all drilling rigs and more and more drilling customers are requesting automated emergency back-up systems and secondary systems for controlling BOP stacks.

### System Definitions

The Minerals Management Service of the United States issues regulatory requirements for drilling rigs in the Gulf of Mexico. In addition, the American Petroleum Industry has identified three categories of such systems in their 2004 edition of 16D. These three categories are:

- **Emergency Disconnect Sequenced Systems (EDS)** — systems initiated by an operator to sequentially disconnect the lower marine riser package (LMRP) from the BOP stack.
- **Back-up Control Systems** — systems that will allow the operator to control a limited number of functions when the main control system is unavailable.
- **Special Deepwater/Harsh Environment Safety Systems** — systems that operate automatically when catastrophic failures occur.

### Sorting Out the Variables

Equipment suppliers such as Cameron are responding in a variety of ways. In fact, there are so many options available for secondary, back-up, safety and emergency systems that it gets confusing.

Variables in these systems include:

- Extent of automation (operator controlled or automatic)
- Types of system activation (push button, ROV, acoustic)
- Type of power required (electrical or hydraulic) and how it is supplied
- Number of functions capable of being activated, and
- What functions are required in various situations.

Many factors are involved in the selection of a safety system including the type drilling vessel and the type of main control system. However, one of the most important factors as to which type of control system is required on a given rig is to consider what activity may cause the emergency system to intervene. Here are the three main categories and the systems used in these instances.

**Operator Decision** — Emergency disconnect sequences are utilized when it is an operator decision to disconnect upon determining eminent danger such as foul weather or an impending drive off situation.

**Loss of Main Controls** — When there is a loss of the main control system, back-ups such as acoustic systems or ROV intervention are the choices for temporary control of select critical functions.

**Major Catastrophes** — Several safety systems are available for shutting in the well after major catastrophes. In the event of a loss of riser, there are deadman or automatic mode function systems that will automatically activate. In the event of an unplanned disconnect, the auto-shear system will automatically engage. In the event of a large riser angle from an impending drive off or a riser failure, there is an automatic disconnect system that can shut in the well.

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