Case Study of Emergency Disconnect Sequence in the Gulf of Mexico

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- Industry Standards
  - Recommended Practice 53
  - Standard 53 EDS provisions
- US Code of Federal Regulations
- Case Study
  - 2006 EDS on Semi-Submersible
  - 2006 EDS on Drillship 1
  - 2012 unable to EDS on Drillship 1 during deadman testing after latch-up to wellhead
- Considerations for EDS planning

Industry standards

API Recommended Practice 53 Blowout Prevention Equipment for Drilling Wells

- No provision for EDS

API Standard 53 provisions - 7.4.13 Emergency Disconnect System/Sequence

7.4.13.1 An EDS shall be available on all subsea BOP stacks that are run from a dynamically positioned vessel. An EDS is optional for moored vessels.

7.4.13.2 The EDS is a programmed sequence of events that operates the functions to leave the stack and controls in a desired state and disconnect the lower marine riser package (LMRP) from the lower stack.

7.4.13.3 The number of sequences, timing, and functions of the EDS are specific to the rig, equipment, and location.

7.4.13.4 There shall be a minimum of two separate locations from which the EDS can be activated e.g. located in the primary and remote control stations.

7.4.13.5 Frequency of testing and acceptance criteria shall be in accordance with Table 6 and Table 7.

Table 6 EDS tested prior to deployment – requirement to complete sequence in under 90 seconds.

Table 7 EDS tested subsea at Commissioning and 5 yearly – requirement to complete sequence in under 90 seconds.

U.S. Code of Federal Regulations

Requirement to prevent accidental disconnects of the LMRP

- 250.442

(i) Develop and use a management system for operating the BOP system, including the prevention of accidental or unplanned disconnects of the system.	The management system must include written procedures for operating the BOP stack and LMRP (including proper techniques to prevent accidental disconnection of these components) and minimum knowledge requirements for personnel authorized to operate and maintain BOP components.

Example 1: 2006 EDS on Semi-Submersible
Preparation & Procedural Discipline

2100 19 March 2006: High environmental loads experienced

- 6,844 feet water depth
- Weather conditions: > 2 knots current, 30 knots wind

0730 20 March 2006: Well suspension activities started

- Pull bottom hole assembly (BHA) into shoe; hang off; begin seawater displacement of riser
- Environmental loads continue to increase: yellow alert declared per rig contractor policy; 6-5/8" 27.7 ppf drill pipe is sheared on lower blind shear ram (LBSR)

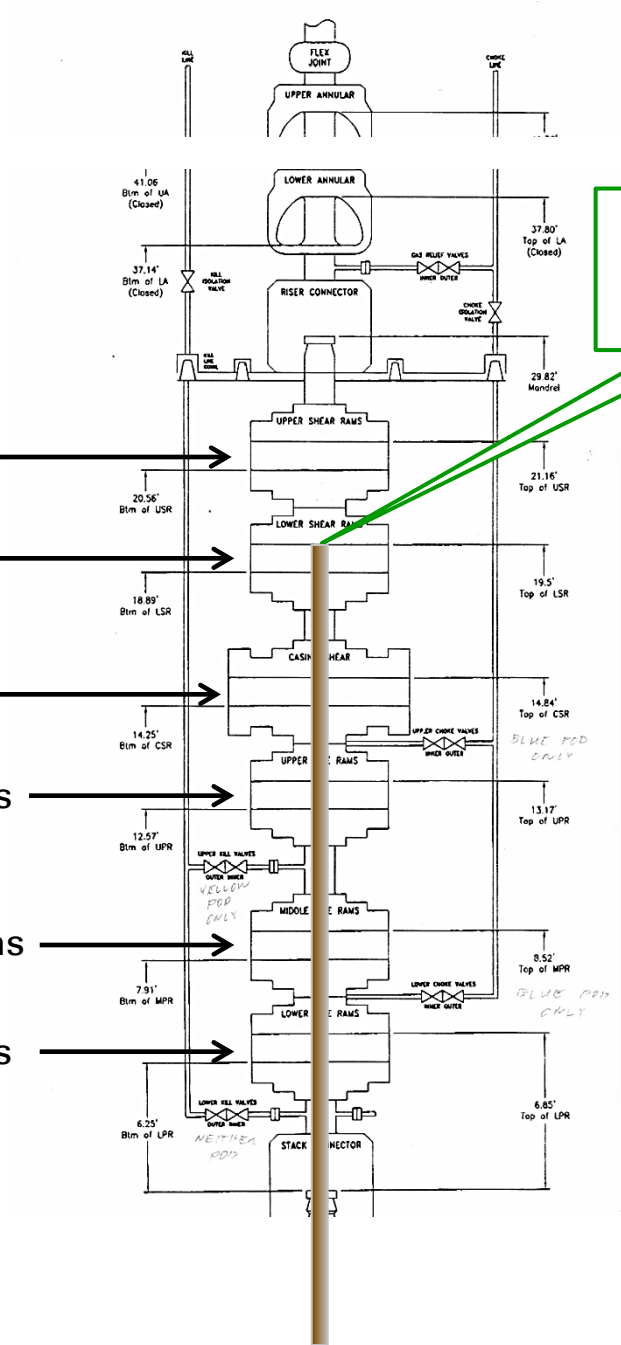
0817: Engine #7 fuel leak; engine taken offline; > 80% power load – rig contractor policy is red alert when >80% power load

0822: Offshore Installation Manager (OIM) orders emergency disconnect upon reaching red alert conditions (>85% power load at time of EDS)

- EDS Sequence – Casing shear closed, LBSR closed, LMRP disconnects

0825+: LMRP separated from lower BOP. Engine 5 trips offline due to temperature. 2 thrusters taken offline. Other 6 engines trip offline due to under voltage. Rig experiences blackout and drifts off location. Rig moves 1960 feet off location.

Well Status



Upper BSR

Lower BSR

Casing Shears

Upper Pipe Rams

Middle Pipe Rams

Lower Pipe Rams

6-5/8" 27.7# drill pipe cut at lower blind shear rams

Picture of sheared
6-5/8" drill pipe pulled to the surface

Example 2: 2006 EDS on Drillship 1
Preparation & Procedural Discipline

5 November 2006 Timeline: Blackout and EDS, water depth 6037 feet

0656: Port harmonic filter failure and main circuits experienced electrical power disruption (brown-out). Thrusters tripped offline and rig started drifting to northwest. Rig floor notified.

0657: Electrician notified Central Control Room (CCR) there had been an electrical fire in the port harmonic filter and that it was quickly extinguished.

0658: Yellow watch circle reached. OIM and Captain in CCR.

0659: Red watch circle reached; EDS initiated.

- EDS Sequence – CSR closes, BSR closes, LMRP disconnects

0700: Thrusters A/D on line; attempts initiated to slow rig to a stop.

0701: Thrusters B/C/E on line; attempts initiated to slow rig to a stop.

0702: Rig blacks out. All engines and thrusters offline.

0706: Engines 1A/2B/1D started and synchronized onto bus.

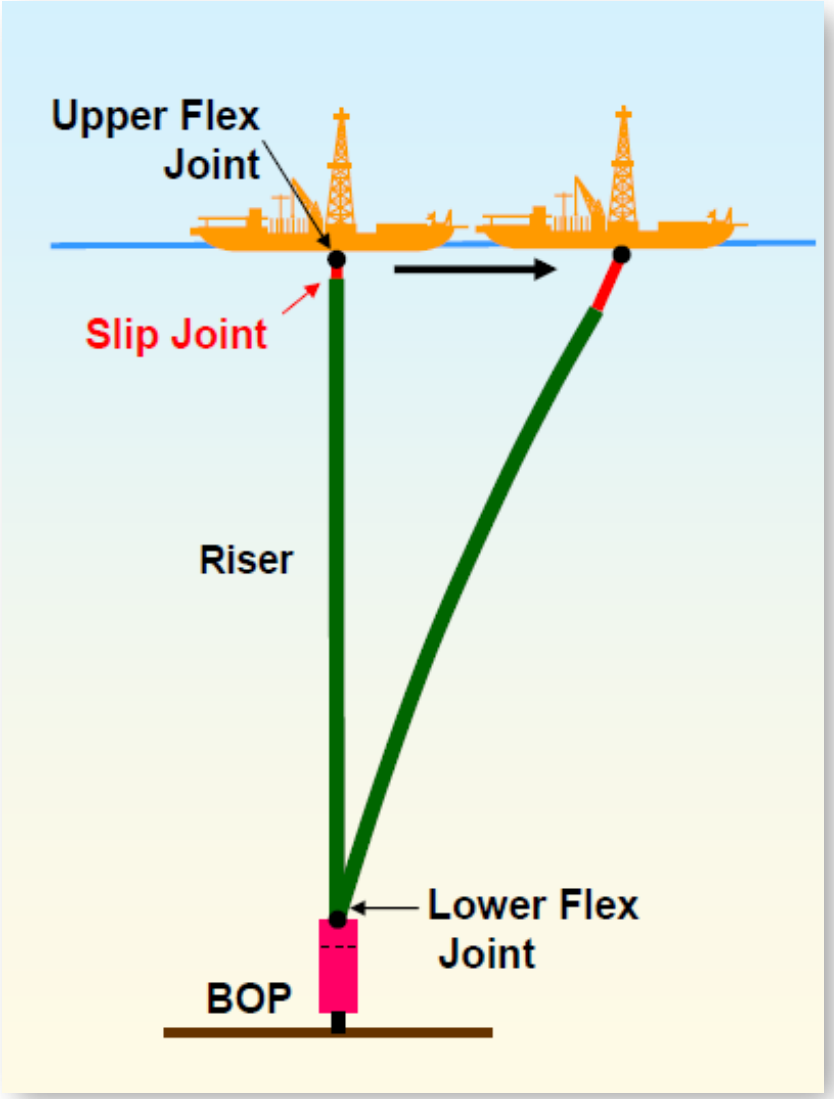
0707: Aft thrusters running but problems experienced allowing thrusters to start and deliver power.

0717: Power restored thrusters. Rig drift stopped at 1,456 feet from location bearing 295°.

0720: Began rig move back to well safe area at 0.3 knots.

2006 EDS on Drillship 1 Well Information

- Water depth 6037 feet
- Yellow watch circle of 81 feet, red watch circle of 136 feet
- 1.6 knots of current, 23 knots of wind
- All 6 thrusters online prior to incident; 2 engines online
- Drill pipe/cement stinger pulled above BOP in riser above the wellhead at time of incident
- Well secured by closing blind shear rams



Example 3: 2012 EDS on Drillship 1
Preparation & Procedural Discipline

22 April 2012: unable to EDS on Drillship 1 during deadman testing

8:47: Dynamic positioning (DP) logger registers the auto surge button being activated; vessel drift off starts.

8:48: Dynamic Positioning Officer (DPO) notices vessel has moved off well center.

8:49: Senior DPO takes corrective actions (manual intervention).

- EDS command given to driller when vessel is 131 feet off center; rig floor responds; unable to disconnect due to stack being in a 'dead' state following deadman test upon latch-up to well

8:53: Preset position activated; vessel returns to full auto adjustment and moves back onto location.

- Maximum distance off center – 195 feet
- Water depth – 3,529 feet
- Calculates less than 4 degrees of angle on lower Flex Joint

Learnings from inability to EDS

- Drillship inadvertently taken off of auto position mode by the double function of the ‘auto surge’ button which places the vessel surge axis in manual joystick control
  - Installed a cover over auto surge button after the event

- Training on personnel positioning – clarify requirements for DPO and Senior DPO presence in control room

- BOP stack was performing deadman test upon initial latch up to a well
  - Deadman activated by disabling electrical power, and bleeding off hydraulic power to the control pod
  - BOP stack was in a ‘dead state’ at time of DP event

- Develop and implement mitigations for performing deadman testing with the BOP latched to the wellhead

- Newer BOP control systems have the ability to de-energize the Loss of Electric solenoids from the control panel and to simulate Loss of Hydraulic for deadman testing with the BOP latched to the wellhead

EDS Considerations

- 3 EDS events: 1 associated with environmental load; 1 associated with dynamic position equipment failure; 1 associated with human error
- No standard for typical EDS from original equipment manufacturer (OEM)
  1. Shearless EDS – unlatch LMRP connector
     - May disable deadman/autoshear system (DMAS)
  2. Single blind shear, unlatch LMRP connector
  3. Casing shear, blind shear, unlatch LMRP connector
- API requirement to finish sequence in 90 seconds
  - Analyze shear test results of casing, heavy wall 6-5/8-inch DP
- Accumulator Capacity – BOP stack and Surface – Blackout considerations
- Review subsea deadman test procedure – mitigations for performing deadman testing with the BOP latched to the wellhead
- Review of rig contractor's policy and procedures
- Rig drills of EDS scenarios – Who is accountable? What if communication on the rig is disrupted?

Backup slides