Automation Ensures Safety, Extends Production

Hazardous occupations on offshore rigs and for land operations are being automated to prevent accidents and manage costs.

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In response to Norwegian Petroleum Directorate regulations limiting personnel on the rig floor, Weatherford Norway has developed a casing modem with remote-controlled power tongs.

In November 1993, the Norwegian Petroleum Directorate (NPD) began enforcing regulations aimed at reducing the number of people on the drilling rig floor. Many rig operations had to be remotely controlled or automated so rig personnel could remain at a safe distance of at least 4.9 feet (1.5 meters) from the well center. This area is referred to as Zone 1, where 30% of the accidents on a drilling rig occur. The automation of drilling rigs is expected to reduce accidents by a factor of four, according to NPD estimates.

Pipe handling is another dangerous operation—about 30% of all rig accidents occur on the pipe deck or between the pipe deck and rig floor. Individual joints of drill pipe

weigh between 200 pounds and 1,200 pounds and casing joints can weigh more than 5,000 pounds, so moving these safely and positioning them precisely is hazardous duty.

The most dangerous job on the rig is that of the stabber, the person who moves the tubing or casing string into position for makeup of the joint. Several stabbers have died while working between and under large, heavy machinery in the derrick in the harsh wind, waves and rain that are common to the North Sea.

"It is not unreasonable to assume that the use of people in offshore pipe handling operations will be eliminated in the future as a result of the NPD regulations," says Egill Abrahamsen, technical manager with Weatherford in Stavanger, Norway. "It is too hazardous." In addition to harsh weather and long periods of confinement to the rig, these jobs involve repetitive and stressful work in a noisy and difficult environment, which increases the risk of accidents. An Indonesian study of 208 offshore accidents at five companies showed that half of the accidents resulted in temporary disability, 29% were finger and hand injuries and 45% of the incidents involved being struck by an object.[1]

To protect rig personnel and comply with NPD regulations, service companies have designed automated pipe handling equipment.

In late 1993, a partnership was formed to develop an automated casing modem that combined the technologies of Maritime Hydraulic's hydraulic roughneck with Weatherford's mechanized casing tongs. A joint team of engineers worked through the winter at the Maritime Hydraulic workshop in Kristiansand in southern Norway, and by spring had developed and tested the casing modem and control software. The first installation was done on the Ross Rig on June 27, 1994.

How It Works

The hydraulic roughneck is railmounted and connects or disconnects the stands from the drill string. The casing modem is a framework temporarily installed on the same rails in front of the hydraulic roughneck which supports the casing modem and provides horizontal movement. The automated tong suspended from a carriage assembly of the casing modem has a free-floating, integrated backup. All torque is taken up internally between the tong and backup and is not transferred to any structure of the casing modem. Different automated tongs can be fitted inside the casing modem, enabling makeup over a wide range of diameters and torques.

Once the tong and backup doors are closed and the backup is clamped onto the pipe, the spin-in operation can begin. A special feature protects cross-threaded or misaligned pipe from damage due to excessive torque. After spin-in, the final torque is applied and the tong is reset, opened and returned to park position. There is also a rocker switch on the tong to switch from makeup to breakout mode. The hydraulic roughneck, casing modem and automated tong share one hydraulic system and use quick connects for easy installation and interchange. An umbilical connects the hardware to a control system. The complete operation of tong, casing modem and roughneck is controlled by one person from a remote control panel placed a safe distance from the well center.

"We anticipated challenges, but they didn't occur on the first few jobs," Abrahamsen said. "Some challenges

Piper Alpha Causes Proliferation of Regulations

Nearly 50% of the serious accidents on fixed platforms are due to fire, well blowout and explosions. One of the worst offshore disasters ever recorded was the explosion and fire on the Piper Alpha platform in the North Sea on July 6, 1988, which killed 167 people. As a result of the tragedy, several governments issued regulations to prevent this from happening again.

Britain. The Cullen Report on Piper Alpha presented 106 recommendations to the British Parliament. The Health and Safety Executive Offshore Division then issued regulations requiring all operators in UK waters to prepare a safety case, which includes a complete hazard analysis, prevention measures and emergency plans. These regulations applied to existing and planned, fixed and mobile installations and took effect May 31, 1993.

Norway. The Norwegian Petroleum Directorate (NPD) regulations to automate the drilling process and minimize the number of hazardous duty personnel were first released in October 1990. Offshore rig risk analysis has been required by the NPD since Feb. 1, 1991, with compliance expected by November 1993. NPD did not specify types of equipment to be used. In fact, companies were given considerable latitude to develop their own means of compliance. Yet, some rigs are still not in compliance. The NPD has created four accident statistics databases to measure the effectiveness of its regulatory acts.

United States. The American Petroleum Institute released its first edition of RP No. 75, "Recommended Practice for Development of a Safety and Environmental Management Program for Outer Continental Shelf Operations and Facilities" on May 15, 1993. This document contains guidelines for drilling and production based on the OSHA process and safety regulations.

popped up later, and the engineers were able to make modifications to the software and hydraulics to solve them. The latest update to the software is more flexible. It tolerates sensor failures better without stopping operations."

Mechanical failures that occur while operating automated equipment can result in serious consequences, sometimes halting drilling completely and costing up to $100,000 per day, depending on rig dayrates. To prevent this from happening, Weatherford modified their automated tongs to include valve sections with manual override levers, giving the appearance of a player piano while running by remote control.

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— Pat Ward, Total Engineering Services Team Inc.

Other companies have also risen to NPD's challenge to minimize the number of rig personnel. Varco International Inc. has developed a pipe handling machine that trips drillpipe and drill collar stands in and out of the well and performs makeup and breakout by remote control—without floor hands or a derrick man. Weatherford has partnered with Varco to outfit Varco's iron roughneck with automated casing tongs.

New Control Technology

Advances in programmable logic controllers (PLC) have made automation of many drilling operations possible, including drawworks, slips and elevators, thread dopers, pipe handlers and mud mixing and pumping. A main function of a PLC system is coordination of several actuators to produce a desired movement of a particular machine. The PLC system analyzes input from all sensors to locate the various machine parts and is programmed to prevent collisions.

Weatherford design engineers field tested these PLC-controlled casing roughnecks on a North Sea rig, making extensive equipment and software modifications during the field test period. The computer system now measures pipe torque, turns and revolutions per minute and displays the output in graphic form.

In addition to regulatory compliance and safety considerations, automated drilling equipment can be justified on the basis of economics. In the North Sea it can cost as much as $1.2 million per person annually to employ a rig hand, including accommodations, meals, helicopter support and factoring in the limited number of workdays per person. By eliminating personnel required to operate the equipment—the tong operator, two rig hands and one or two roughnecks—the savings can be considerable, even if the drilling job only takes 72 hours to complete.

Weatherford Norway now has 15 automated casing and tubing tongs. Projects that will apply this new technology include Shell's Brent Charlie platform offshore Scotland, the PRO-STAR 2000 onshore Holland, the Hibernia project offshore Nova Scotia, Canada, and four new projects offshore Norway. The company is also involved in a partnership with Noble Drilling Corp. to jointly operate automated equipment on the Hibernia project.

Moving heavy power tongs around on the rig floor used to be accomplished by several human roughnecks. Hydraulic roughnecks and casing modems have automated some of these functions, but they take up a considerable amount of rig space and take up valuable rig time during installation and removal. Weatherford has developed a light-weight device called Powermaster that uses special locking chains to push or pull heavy items suspended by wire from the derrick from parked position to well center by remote control. Because it is portable and does not tie up the hydraulic roughneck, rig-up of the Powermaster uses less rig time than installing tongs on a hydraulic roughneck. The Powermaster does not need to be rigged down prior to landing casing with drillpipe in deepwater situations with casing in open hole. A North Sea semisubmersible will install this technology in May 1996, and two neighboring platforms in the North Sea will share one Powermaster system beginning August 1996.

Production Automation

Automation is not used exclusively for making hole and running pipe; it can be applied throughout the life of a well. As oil and gas production declines in a mature well, it becomes less profitable to maintain the personnel required to operate an offshore platform. Rather than shutting in marginal wells, operators are automating the well control systems so that production can continue without being constantly manned.

"SCADA (supervisory control and data acquisition) systems can be very attractive for economic reasons," says Pat Ward of Total Engineering Services Team (TEST) Inc. in Harvey, La. "Cutting people is not the main thing. Extending the life of a platform through automation allows companies to re-assign those people where there is more opportunity. We're really saving jobs."

TEST, a Weatherford Enterra affiliate, also provides turnkey emergency shutdown (ESD) systems to monitor pressure, flow, temperature and fire—from the wellhead to the pipeline—on offshore platforms in the Gulf of Mexico. When the U.S. Geological Survey began enforcing the Offshore Continental Shelf (OCS) Orders demanding safe

and environmentally conscious offshore operations in the 1970s, TEST began manufacturing pneumatic, hydraulic, electrical and PLC control systems to automatically shut down production in emergencies. Since that time, Ward has seen a dramatic improvement in personnel and environmental safety offshore.

Arthur Zatarain, vice president of engineering for TEST, claims that these safety systems are virtually foolproof. "When a safety system is in operation, it's almost impossible to get around it. Control systems also can prevent blowouts, which helps save the environment. Automation protects people, property and the planet." □

REFERENCE

1. Rahardjo, Sudjoko and Sebayang: "Personal, Place and Time Characteristics of Offshore Accidents in Five Oil Companies Operating in Indonesia," SPE Paper 23300 presented at the First International Conference on Health, Safety and Environment, The Hague, The Netherlands (Nov. 10-14, 1991).

Automatic welding aids pipeline contractors

Installing a pipeline is a fairly straightforward process, right? But high-tech processes, computerization and fiber optics have permeated this very basic end of the oil and gas business too.

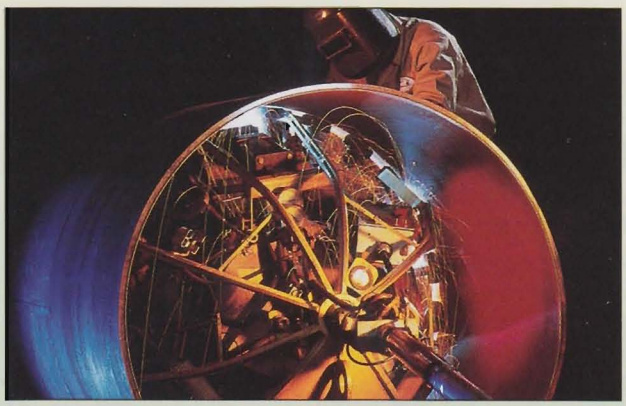
Since the 1970s, pipe welding technology has evolved in step with changes in pipe properties and increasing wall thicknesses such that manual welding isn't always acceptable any more.

Today, mechanized welding of higher-grade steels and corrosion-resistant alloys (CRA), in ever-smaller diameters, is no problem technically. On projects of appropriate size automatic welding can be done economically and efficiently to increase productivity (more welds per person per day). And, this can be done while elevating the quality of each individual weld.

"For projects suitable for automatic welding, we can tailor a system to fit customers' requirements at a cost that's comparable to manual welding," says Richard L. Jones, president of CRC-Evans Automatic Welding.

CRC-Evans' automatic welding systems are used in regions as diverse as the freezing tundra of Alaska, subtropical South America and Saudi Arabia. They're also used in the Gulf of Mexico, Persian Gulf, South China Sea and North Sea. The systems are based on gas-metal-arc welding technology that uses a narrow-groove, compound bevel that has several advantages over a standard 30-degree bevel. The combination internal welder-line-up clamp travels along the inside of the pipe to align and clamp the ends together, and it automatically welds the root beads inside the pipe. On a 42-inch diameter pipe, the root pass weld can take less than 75 seconds.

Research and new product development occur in Houston, where CRC-Evans is particularly focused on equipment for welding CRA pipe and pipe of diameters 20 inch and smaller. Current projects include developing an internal clamp with a backing system for an external root pass on pipe as small as 6 inches. Eight to 20-inch systems have already been tested successfully.



"Improvements could take a quantum leap forward in the near term, because the industry continues to improve pipe properties to the point that soon, acceptable welds may not be possible manually," says Jones.

He foresees increased automatic welding business worldwide, much of it because contractors are trying automated welding systems on smaller and smaller pipe. Recently a contractor in Brazil used a CRC-Evans automated welding machine to lay a 200-kilometer, 20-inch gas line on land; and an offshore contractor has welded two 12-inch projects automatically.

In the last few years, computerization has come into its own in the field. It allows increases in both speed and quality of the weld while guaranteeing that only qualified, consistent procedures are used. "Typically a welder gets a production bonus so there's an incentive to speed up the welding process beyond the limits of the qualified procedure. Computerization removes this possibility," Jones explains.

Naturally, customers demand quality, but the trend is for even more exacting requirements, which drives R&D. "We're working on a job now that's part of the Maghreb gas line from North Africa to Spain where essentially, because of Spanish government regulations, every weld has to be perfect."