Managing a Blowout: A Case Study

During a well-control crisis, most operators aren’t able to efficiently handle the numerous technical, organizational, and time demands while continuing to manage the other aspects of their business.

At a Mississippi wellsite recently, Boots & Coots provided on-site management during a well-control operation. The company’s Incident Command System (ICS) insulated the operator from the resource drain of dealing with regulatory agencies, subcontractors, and public health and logistical issues. This not only allowed the operator to concentrate on normal business activities, but allowed important well-control tasks to be handled by specialists.

Situation
Twenty-six joints of 4 1/2 in. production liner had been run in this Mississippi exploration well (18,500 ft) when a kick was taken. Boots & Coots was mobilized to bring the well under control. With the annular blowout preventer (BOP) closed on the liner, shut-in pressure increased to 2,200 psi, and 11 joints of liner were expelled from the hole.

In an effort to secure the remaining liner, rig personnel closed the blind rams, splitting the pipe and resulting in an uncontrolled blowout. When on-site air monitors detected high levels of hydrogen sulfide gas, the decision was made to ignite the gas. Rig personnel and local residents were evacuated without injury.

Project-Management Structure
The operator is insured through the Wellsure insurance program, a proprietary risk management product which includes the service of Boots & Coots acting as lead contractor during critical well-control events. On arrival, company personnel activated the ICS through which public safety, regulatory, and well-control operations were coordinated.

The ICS consisted of three major management groups.
• The Wellsure Crisis Team assumed the project management role at the top of the chain of command. The Incident Commander, who acted on behalf of the operator to manage the overall event, including engineering, technical, financial, and accounting matters, led the Crisis Team. The Incident Commander also was the designated point contact for the many agencies, subcontractors, citizens, and other parties involved.
• The Well-Control Response Team, led by the Well-Control Supervisor, managed well-control operations, logistics of equipment and material acquisition, on-site fabrication requirements, and project scheduling. This group was composed of experienced well-control and firefighting professionals.
• The Environmental Response Team (ERT) consisted of members of Boots & Coots’ Special Services organization that pro-
vides air and water quality monitoring, remediation services, and a professional interface with related regulatory agencies.

**Unique Challenges**

Firefighters chose to cap the burning well because extinguishing the fire prior to capping would have resulted in unacceptable risks due to the presence of H₂S gas and to the possibility that the gas could be unexpectedly reignited.

Residents located within 2 1/2 miles of the well were evacuated to hotels for the duration of the incident. ERT members assisted local law enforcement officials in the evacuation, then provided air monitoring, neighborhood security, resident escort, and pet/livestock-maintenance services throughout the incident.

Available water sources were limited to a creek located approximately 1.5 miles from the location. Local authorities were initially reluctant to approve of using this water source for the firefighting effort, but approval was obtained through cooperation between the on-site U.S. Environmental Protection Agency (EPA) representative, the ERT, and local authorities.

The large volume of water used in fighting the fire required the construction and operation of a wastewater treatment system on location. No wastewater or other pollution was allowed off location during this extensive operation. Wastewater was collected, treated on location, sampled, analyzed for contaminants, then released under the supervision of the EPA representative.

The Federal Aviation Admin. (FAA) created a no-fly zone to prevent aircraft from approaching the location below an altitude of 3,000 ft within a radius of three miles of the well. ICS personnel were responsible for monitoring aircraft.

ICS members provided information and documentation when necessary and represented the operator in ensuring that legal and regulatory liabilities were minimized with the U.S. EPA; FAA; U.S. Coast Guard Strike Team; Mississippi’s Emergency Management Agency, Civil Defense Board, Office of Public Health, Oil and Gas Commission, and Dept. of Environmental Quality; and Laurel, Mississippi’s Fire Department and Sheriff’s Office.

**Preparations**

Removal of debris from around the wellhead was the most time-consuming task of this project. There was a 7-day maximum time period in which to gain sufficient access to cap the well and complete all other preparations in order to control the well in the shortest time possible. The response team’s success in completing the staggering amount of preparations within the 7-day limit ensured the success of this project. This success was achieved in spite of weather conditions that necessitated shutting down operations on two occasions.

Much of the equipment needed for this operation was fabricated on location. Between 10 and 15 welders per day were employed during the preparation period. An on-site water pit was dug, and a prefabricated custom polyethylene pit liner was installed. A 10-in. water line was fabricated to bring water 1.5 miles from the creek to the on-site water pit, then 500 ft of 12-in. lines were fabricated to supply water from the fire pumps at the pit to the water header for distribution to the monitor stations.

Because of the enormous radiant heat generated by the burning gas (up to 2,500° Rankine), water monitors were positioned to spray water into the fire to cool the metal and response personnel. Welders fabricated heat shields from roofing material, structural tubing, and angle iron for each water monitor or bulldozer working near the flames. Skidded barns were constructed to provide protection for personnel and tools stored close to the fire.

As debris was cleared away from the wellhead, welders cut the metal, including over 15,000 ft of heat-damaged drillpipe, into manageable sizes. All debris was transported from location so that approximately 90% of the rig was off location by the time the capping operations were completed.

Both the location and the roads were maintained with fresh rock to enable them to support the equipment traffic. Continuous air monitoring was performed, both onsite and in the neighboring communities. The wastewater treatment plant was assembled and ready for service by the time cooling water was necessary for debris removal operations. Butane flares were installed in case the well had to be reignited.

**Capping Operations**

Existing BOP’s were obviously damaged by fire; therefore, the capping strategy included removal of the stack down to the bradenhead. Once debris had been cleared sufficiently to allow access to the stack, Halliburton’s abrasive jet cutter was used to sever the studs beneath the lower flange of the upper BOP’s. The jet cutter uses high-pressure water to convey sand particles in a thin stream to perform the abrasive cut. Mounted on a boom extension, the jet cutter was conveyed to the stack on a tracked vehicle (Athey Wagon) guided by a bulldozer. Once the cut was complete, the upper BOP’s and remaining sections of the substructure were cleared.

To redirect flames to above the work area, a 24-in. venturi tube was placed atop the upper flange of the lower BOP’s using the Athey Wagon and a modified boom. Firefighters then removed the studs from the lower BOP’s and attached a cable to provide a remote means of pulling the BOP’s off the bradenhead. After clearing the venturi tube, the lower BOP’s were pulled off to expose the bradenhead flange. The well was then ready for capping.

A snub-down cable system was fashioned to help guide the capping stack into position, and a ring gasket was tack-welded to the bottom of the stack flange. After a practice run to ensure that the path to the well was clear and that all equipment was functioning, the stack was positioned atop the bradenhead, and flow was allowed to continue through the stack until the stack was secured and the 4-in. diverter lines had been attached. The flow was then diverted to flare pits, and capping operations were complete.

In preparation for snubbing and killing operations, the wellhead was reinforced. The rock was excavated from
the cellar, and a concrete-reinforced I-beam structure was built to provide protection for the heat-weakened metal and to support the weight of the snubbing unit.

**Kill Operations**

Two methods for killing the well were considered: a bullhead kill and a dynamic kill. A bullhead kill involves shutting in the well and pumping kill fluid from the surface, whereas a dynamic kill requires that tubing be “snubbed” to near the bottom of the wellbore to allow a circulating kill.

Inflow performance data indicated that if the well were shut in, high surface pressures would result in a short period of time.

Although casing had been set to a sufficient depth to allow a top kill without risking an underground blowout or surface broach, the fire had compromised wellhead-sealing mechanisms.

Because of the questionable integrity of wellhead components, a bullhead kill was deemed to be too risky. An unsuccessful attempt to bullhead would likely have resulted in protracted and extremely expensive relief well operations or in having to cut off the surface casing and recap at a depth significantly below ground level.

A dynamic kill was chosen as the kill method to be used. This proven method of well control is generally the most desirable where the integrity of the wellbore or wellhead is questionable. In dynamic kill operations, tubing is snubbed into the well, and kill mud is circulated down the tubing. A combination of surface restriction and dynamic annular-fluid friction is used to create a circulating bottomhole pressure sufficient to kill the well.

**Conclusions**

No injuries occurred during the approximately 1,000 man-days of work required to cap the well.

By completing the capping operations in only 10 days, the response team reduced direct costs by approximately 60% compared to a similar well-control operation performed in 1998 on a similar nearby well. Because of the “pay on behalf of” feature of the operator’s insurance policy, his operational cash flow was not impacted during the well-control event. This minimization of actual costs to the operator helps ensure that this discovery well will remain economically viable when completed.

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**Guest Editorial**

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