Absence of fatalities in blowouts encouraging in MMS study of OCS incidents 1992-2006

By David Izon, E.P. Danenberger, Melinda Mayes,
Minerals Management Service

WELL CONTROL OPERATIONS are critical in protecting the safety of the employees and the environment. Loss of well control incidents (blowouts) are known to be expensive and cause delays in bringing important production online. Blowouts may also lead to fires, explosions, injuries, property damage and pollution. It is important for industry to minimize the occurrence of these events by implementing safety programs and procedures that will prevent and reduce the severity of blowouts during drilling operations.

This article summarizes information about blowouts that occurred during drilling operations on the Outer Continental Shelf (OCS) from 1992 through 2006 and compares this information with the previous study conducted for drilling blowouts that occurred from 1971 through 1991. The paper utilizes data collected from incident reports submitted by OCS oil and gas operators and from the Minerals Management Service's (MMS) accident investigation reports.

Between 1992 and 2006, 39 blowouts occurred, compared with 87 during the time period of the previous study. Overall, the rate of blowouts per well drilled improved during the period. The current 15-year study period had a blowout rate of one for every 387 wells drilled, compared with a rate of one blowout for every 246 wells drilled during the previous study period. As in the previous study, most of the blowouts occurred in water depths of less than 500 ft.

The severity of blowouts, based on the duration and resulting fatalities and injuries, decreased significantly compared with the previous period. Similar to the 1971-1991 study period, shallow gas influx persisted as a major contributor to blowouts that occurred between 1992 and 2006. During the current period, the percentage of blowouts associated with cementing operations increased significantly from the previous period. To address this, MMS and the American Petroleum Institute (API) are working on a series of new standards detailing best cementing practices for offshore oil and gas operations. During the current period, one incident involving an accidental riser disconnect on a floating drilling rig resulted in a blowout.As drilling activity in deepwater increases, procedures for these operations should continue to be evaluated to identify how riser disconnects and the potential for blowouts associated with them can be prevented.

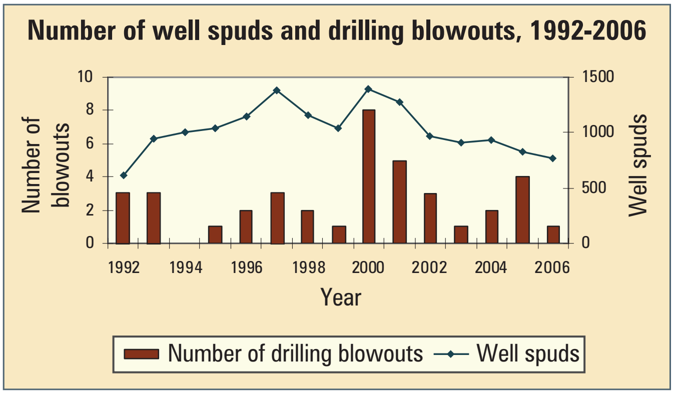

Figure 1: The percentage of blowouts per well spud decreased in 2006.

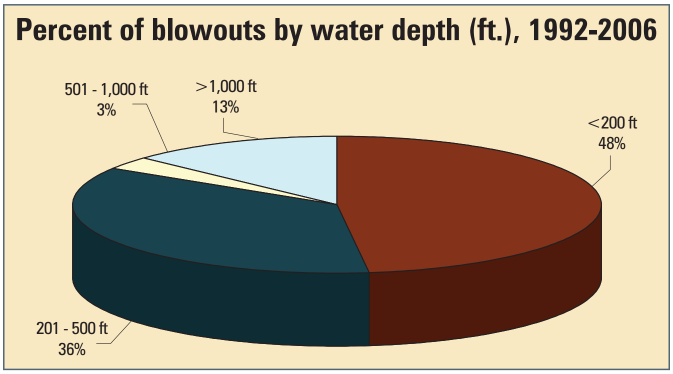

Figure 2: Blowout rates improved in all water depths during the current study period.

INTRODUCTION

One of the most important factors in the planning and conduct of oil and gas operations is the control of underground pressures. With continued increases in drilling depth come increasingly higher formation pressures that need to be controlled during the drilling process. Improper well control procedures can result in sudden, uncontrolled escape of hydrocarbons.

Water Depth (ft.)	Oil and Gas Exploration Wells	Oil and Gas Development Wells	Total Oil and Gas Wells	Total blowouts (minus sulfur blowouts)	Wells drilled per blowout (minus sulfur wells)
0 - 200	3,156	5,566	8,722	19	459
201 - 500	965	2,251	3,216	14	230
501 - 1,000	203	443	646	1	646
> 1,000	1,347	1,146	2,493	5	499
Total, all depths	5,671	9,406	15,077	39	387

Table 1: From 1992 through 2006, the average blowout rate was one every 387 wells drilled, compared with the 1971-1991 rate of one every 246 wells.

Such an event may lead to fires, explosions, injuries, property damage or pollution and can also delay drilling operations for days or even months.

The MMS maintains records on all blowouts resulting from oil and gas operations on the OCS of the United States. During the 15-year period, 39 blowouts occurred during OCS drilling operations. Like the previous study from 1971-1991, this report includes blowouts that occurred during all phases of oil and gas drilling operations. Blowouts that occurred during workover, production or completion operations and blowouts that occurred during sulfur well drilling are not included. During the current study, all but one drilling blowout occurred in the Gulf of Mexico (GOM). The one exception was a blowout that occurred in the Pacific Region, where 267 wells were drilled during this period.

RATES AND EFFECTS

Figure 1 shows the number of blowouts compared with the number of well spuds during the current period. The rate of oil and gas drilling blowouts improved compared with the previous period. From 1992 through 2006, the average blowout rate was one every 387 wells drilled (Table 1) compared with the 1971-1991 rate of one every 246 wells. In addition, blowouts during the current period resulted in significantly fewer fatalities and injuries. Only one fatality and two injuries resulted from drilling blowouts during the current period, compared with 25 fatalities and 61 injuries during the previous period. As in the previous study, environmental impacts were negligible. Blowouts during the current period resulted in the spillage of 341 bbls of oil/condensate and a total of 982 bbls of synthetic-based mud.

The severity of blowouts during 1992-2006, based on the duration and resulting fatalities and injuries, decreased significantly compared with the previous period of 1971-1991.

WATER DEPTH

Table 1 and Figure 2 depict the number of wells drilled, the number of blowout incidents, and blowout rates by water depth. As in the previous study, most blowouts occurred during the drilling of wells in water depths of less than 500 ft. There were improvements in the blowout rates for all water depths during the current period compared with the previous period. Between water depths of 0 to 200 ft, the blowout rate during the current period was 459 wells drilled per blowout, compared with 334 wells drilled per blowout during the previous period. For water depths between 201 feet and 500 ft, the blowout rate during the current period was one blowout per 230 wells drilled, compared with one blowout per 183 wells drilled during the previous period. There was only one blowout in water depths between 501 and 1,000 ft during the current period. This represents a rate of one blowout per every 646 wells drilled, compared with one blowout per 93 wells drilled during the previous period.

Part of the improvement in the blowout rate at these water depths is due to the fact that, in the previous period, four of the eight blowouts occurred on one facility. Without these repeated incidents, the blowout rate for the previous period in these water depths would have been lower. The blowout rate in deep water (water depths greater than 1,000 ft) was one every 499 wells drilled during the current period, compared with one per 359 wells drilled previously. This improvement in blowout rate is encouraging since deepwater drilling has increased significantly (2,439 wells drilled during the current period, compared with 718 wells drilled during the previous period) over the last 15 years and is expected to increase in the future.

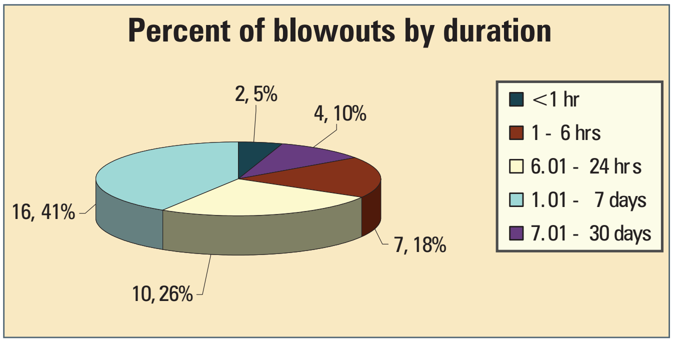

Figure 3: Like the previous study, a significant number of blowout events were of short duration.

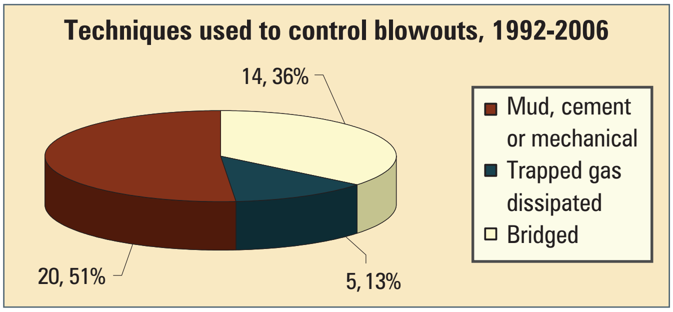

Figure 4: Just over 50% of the blowouts were controlled by pumping mud or cement or by actuating mechanical well control equipment.

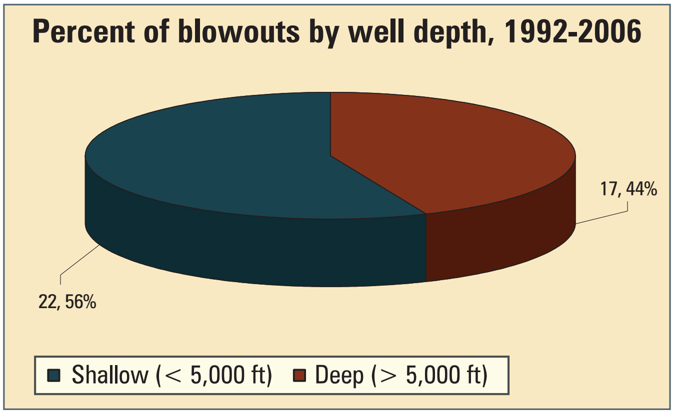

Figure 5: Similar to the previous study period, more than half of the blowouts during the current study period occurred before the well had been drilled to 5,000 ft TVD

DURATION AND CONTROL METHODS

Figure 3 illustrates the duration of blowout events during the current period. Overall, the current period saw an improvement (decrease) in blowout duration. Like the previous study, a significant number of blowout events were of short duration. During the current study, 49% of the blowouts stopped flowing in 24 hours or less, compared with 57% during the previous

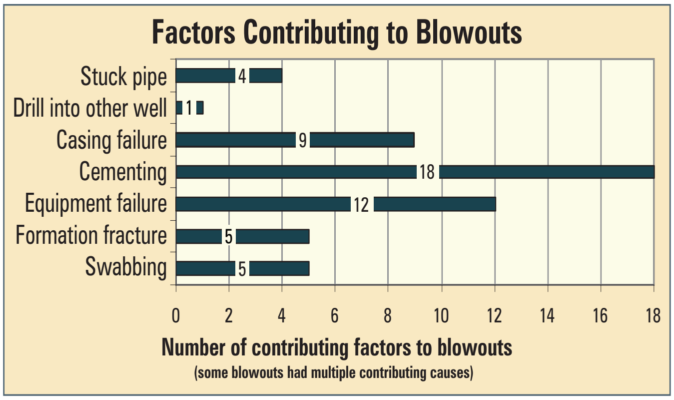

Figure 6: Cementing problems increased significantly during this study period, being associated with 18 of the 39 blowouts.

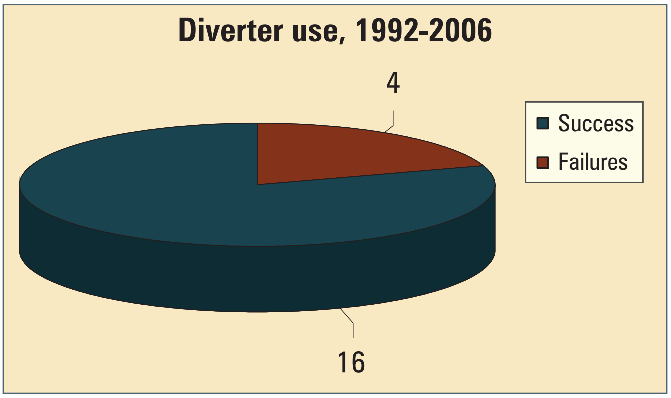

Figure 7: 16 of 20 diverter uses were considered successful because the venting of gas was sustained until the well bridged.

study. In the current study, 41% lasted between one and seven days, compared with 26% during the previous study. There were fewer blowouts that lasted more than seven days. The blowout with the longest duration during the current study period was 11 days, compared with more than 30 days in the previous period.

Just over 50% of the blowouts were controlled by pumping mud or cement or by actuating mechanical well control equipment during the current study (Figure 4). In 36% of the blowout events, the wells ceased flowing because sediments bridged or sealed the well. Thirteen of the wells ceased flowing when trapped gas or shallow gas pockets were depleted. Although relief wells were initiated in two of the blowouts, both wells were controlled by other means prior to completion of the relief well. Unlike the current study, almost three-fourths of the blowouts in the previous study were controlled when sediments bridged the well.

The most important improvement identified during the current study is the significant decrease in fatalities and injuries — only one fatality and two injuries resulted from blowouts from 1992 to 2006.

SHALLOW GAS

During the current period, the blowout rate for exploration wells was one every 298 wells drilled, and the blowout rate for development wells was one every 470 wells drilled. Development drilling during the current period accounted for a slightly greater percentage (51%) of blowouts than did exploratory drilling (49%). In contrast, although the relative percentages of development and exploratory wells drilled were the same during both study periods (62% and 38%, respectively), exploratory drilling accounted for a greater percentage (55%) of blowouts than development drilling (45%) during the previous period.

Similar to the previous period, over half of the blowouts during the current period occurred before the well had been drilled to 5,000 ft TVD (Figure 5) and were not triggered by hydrocarbon influxes from productive intervals. During the current period, shallow gas was associated with 49% of the blowouts and was most frequently associated with development wells.

CONTRIBUTING FACTORS

During the current period, more than one contributing factor was identified for just over half of the blowouts. The most significant factors included cementing problems resulting in gas migration during or after cementing of the well casing (18 blowouts), equipment failure (12 blowouts), and casing failure (nine blowouts). Figure 6 shows a break-out of these and other contributing factors to blowouts in the current study.

In the previous study, the primary contributing factors were swabbing, formation fracture equipment failure and cementing. Cementing problems increased significantly during the current period as these problems were associated with 18 of the 39 blowouts, compared with 18 of the 70 blowouts with identified contributing factors during the previous study. During the current period, all but one of the blowouts associated with cementing problems occurred in wells with water depths less than 400 ft.

During the current period, one incident involving an accidental riser disconnect on a floating drilling rig resulted in a blowout. As drilling activity in deepwater increases, procedures for these operations should continue to be evaluated to identify how riser disconnects and the potential for blowouts associated with them can be prevented.

RIG TYPES, DIVERTER SYSTEMS

Of the 39 blowouts during the current period, five occurred on platform rigs. Of the remaining 34 blowouts involving wells drilled with mobile units, 28 blowouts, or 82%, were drilled with jackups and six were drilled with semisubmersible rigs. It is noted that much of the exploratory and development drilling in the GOMR is conducted from jackups. In the previous study, no significant difference in the consequences of blowouts was found between jackups and other bottom-founded rigs. During the current study, blowouts on jackups and platform rigs were associated with the most significant consequences.

The only fatality that occurred during the current period was on a jackup rig when a crew member was found missing after an evacuation associated with a blowout. In addition, the seven fires/explosions associated with blowouts during the current period occurred either on jackups or platform rigs. Four of these seven blowouts resulted in major property damage.

The stability of bottom-founded rigs can be affected by disturbances to the sea floor. Such drilling structures can collapse if a shallow gas influx fractures the uncased portion of the hole and forms a crater around the wellbore. Many operators prefer to prevent such occurrences by not shutting in the shallow gas influxes, instead allowing the gas to flow to the surface, where it is directed downwind through diverter lines. Such diverter systems are intended to provide time for safe evacuation of rig personnel, to deplete the shallow sand, or to allow the well to bridge. Because capabilities for controlling diverted gas flows are extremely limited, all of the gas diversion events during the study period were counted as a blowout.

Type of Rig	Diverter Uses	Failures
Platform	3	0
Jackup	14	4
Semisubmersible	2	0
Submersible	0	0
Drillship	0	0
Unknown rig type	1	0
Total	20	4

Table 2: A contributing factor to the improvement in diverter performance may be the revised diverter regulations that were published in 1988 and became effective two years later, according to MMS.

As indicated in Figure 7, the success rate for diverter systems was very high during the current period and improved significantly from the previous study. During the current period, diverters were used in 20 of the 39 blowouts. Sixteen of the 20 diverter uses were considered successful because the desired venting of gas was sustained until the well bridged, allowing all personnel to be safely evacuated. During the previous period, 22 of the 41 diverter uses were considered successful. Table 2 presents information on diverter use and failures by rig type. A contributing factor to the improvement in diverter performance may be attributed to the revised diverter regulations that were published in 1988 and became effective two years later.

CONCLUSIONS

MMS drilling blowout data shows that blowout rates during the current study period improved, seen in drilling at all water depths. The duration of blowouts also improved. Drilling through shallow gas sands was a major contributing factor causing blowouts, as was found in the previous study, and needs continuing attention by OCS operators. The percentage of blowouts during or after cementing operations increased significantly during the current period. Effective application of better cementing practices and well control procedures could reduce the problems and prevent costly delays in drilling programs. To address this, MMS and the American Petroleum Institute are working on a series of new standards detailing best cementing practices for offshore oil and gas operations.

In 2000, one blowout occurred during an accidental riser disconnect on a floating drilling rig. From this event, 200 bbls of oil and 956 bbls of synthetic mud were spilled into the GOMR. As drilling activity in deepwater increases, procedures for these operations should continue to be evaluated to identify how riser disconnects and the potential for blowouts associated with them can be prevented.

The most important improvement identified during the current study is the significant decrease in fatalities and injuries — only one fatality and two injuries resulted from blowouts during the current period, compared with 25 fatalities and 65 injuries during the previous study period. This result may be partially attributable to prompt evacuations of personnel and improvements in diverter performance. Continued success will depend on sustained efforts by industry and government to improve safety management practices related to drilling and well control operations.

This article is based on a presentation scheduled for the IADC Well Control Conference of the Americas, 28-29 August 2007, Galveston, Texas.

References

1. Danenberger, Elmer P.: Outer Continental Shelf Oil and Gas Blowouts, 1971 – 1991, Minerals Management Service, OTC paper # 7248, 10p.

2. Levine, Joseph: Personal Communication 2006.

3. Mayes, Melinda: Personal Communication 2006.