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OUTER CONTINENTAL SHELF OIL AND GAS BLOWOUTS

By

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ABSTRACT

Blowouts are the most costly and feared operational hazard related to oil and gas operations. During the 8-year period, 1971-78, 46 blowouts occurred on the Outer Continental Shelf of the United States. Thirty of the blowouts occurred during drilling operations; however, most of these blowouts were of short duration and had minimal effect. The remaining 16 blowouts occurred during completion, production, and workover operations. Blowouts during these nondrilling operations have historically posed the greatest threat to human safety and the environment. During the 8-year study period, 7,553 new wells were started and one blowout occurred for every 250 wells drilled. Oil and condensate production amounted to 2.8 billion barrels with the total blowout spillage less than 1,000 barrels.

INTRODUCTION

The control of underground pressures is the most important factor in the planning and conduct of oil and gas operations. Improper well control procedures can result in the sudden, uncontrolled escape of hydrocarbons. Such an incident is commonly referred to as a blowout. Blowouts are the most spectacular, expensive, and feared operational hazard. At best, they result in costly delays in drilling or production programs. They also may lead to fires, explosions, casualties, serious property damage, and pollution.

Since 1971, the U.S. Geological Survey has maintained a computerized file of all blowouts, spills of greater than one barrel, fatalities, serious injuries and major property damage, and fires and explosions. During the 8-year period, 1971-78, 46 blowouts, all in the Gulf of Mexico, occurred in the Outer Continental Shelf (OCS) waters of the United States. Seventeen of these blowouts occurred during exploratory drilling operations from mobile drilling units. An additional 13 blowouts occurred while drilling development wells from fixed OCS platforms. The remaining blowouts occurred during production (5), workover (8), and completion (3) activities.

EXPLORATORY DRILLING BLOWOUTS

Although the greatest number of blowouts occurred during drilling operations, most of these blowouts were of short duration and had minimal effect (table 1). Of the 17 exploratory drilling blowouts, 10 lasted for periods of 15 minutes to 1 day (approximate). The remaining seven exploratory blowouts had durations of 21 days or less; only two lasted for more than a week. Twelve of the 17 blowouts "bridged" or sealed off naturally. The remaining blowouts were controlled by pumping down mud or activating rams on the blowout preventer (BOP) stack. None of the blowouts required a relief well to regain control.

Almost half (eight) of the exploratory blowouts were caused by influxes of overpressured shallow gas into the wellbore. Drilling through such gaseous zones requires utmost caution. Because the hole is shallow, gas can reach the surface with very little warning. A delicate drilling mud overbalance of the formation pressure is necessary to prevent a gas influx without fracturing near surface formations. Protecting against fracturing can be a particular problem in deepwater drilling because of the relatively greater increase in pressure exerted by the mud column than the increase in pressure exerted by the overburden.

Special caution has been exercised in drilling these deepwater wells, and the resulting safety record has been quite favorable to date. During 1975-78, 67 exploratory wells were drilled on the United States' OCS in water depths of 600 feet or more. No blowouts occurred during the course of drilling these wells. Of the 17 blowouts during exploratory drilling in the 1971-78 period, only seven occurred while drilling from floating units (semisubmersibles or drillships). None of these wells were drilled in water depths of more than 400 feet. The blowout distribution by rig type was roughly proportional to their use in the Gulf of Mexico: eight of the blowouts involved jackup rigs, five involved semisubmersibles, two involved submersibles, and two involved drillships. A consequence of the blowouts during exploratory drilling was the loss of two jackup drilling units. The two rigs were valued at $8 million and $10 million dollars. No fatalities or serious injuries resulted from these blowouts. Only natural gas was released during these incidents.

DEVELOPMENT DRILLING BLOWOUTS

Thirteen blowouts, all gas, occurred during development drilling operations. As indicated in table 2, most of these incidents were caused by shallow gas influxes. All of the blowouts were controlled within 17 days, and only one lasted more than a week. However, one well continued to release gas around the outside of the surface casing for several months after the blowout. Eleven of the blowouts bridged or ceased flowing naturally. The other two blowouts were quickly controlled by mechanical means.

The major consequences of the development drilling blowouts were four minor injuries, the loss of two platforms, and some serious damage to equipment. No oil was discharged as a result of these incidents.

NONDRILLING BLOWOUTS

The remaining 16 blowouts occurred during completion, production, and workover operations (table 3). The presence of flowing wells and production equipment on the platform increases the potential severity of these incidents. No fatalities or serious injuries resulted from these blowouts.

The worst nondrilling blowout during this period occurred on October 16, 1971, when five oil and gas wells blew out after an oil pump exploded on the platform. Although there were no fatalities or serious injuries, the platform was destroyed, thousands of barrels of crude were burned in a fire that raged for 55 days, and an estimated 450 barrels of oil were spilled. This blowout occurred after two serious platform fires in the Gulf of Mexico in 1970 and the Santa Barbara blowout in 1969. These incidents triggered several industry and Government investigations regarding the safety of OCS oil and gas operations. The results of the investigations were significant changes in offshore operating practices and in Government regulatory requirements and an improved safety record.

CONCLUSIONS

Because of the differences in local geology (from both hazards and resource standpoints) and operating conditions, the complex human factors that are involved, and continuous technological changes, one cannot realistically expect to forecast blowouts by analyzing historical records. This applies to mature areas and especially to frontier areas. Attempts to make forecasts and extrapolations are often misleading and should not serve as the bases for policy determinations. One can, however, cite historical data regarding the occurrence of blowouts in different types of areas and operations. For example, during the 1971-78 period, one blowout occurred for every 250 wells drilled (table 4) on the Outer Continental Shelf. Twenty of the 30 blowing wells bridged within a week (tables 1 and 2). No fatalities, serious injuries, or significant pollution resulted from the blowouts. Major property damage did occur when two mobile drilling units and two steel platforms were completely destroyed. In frontier OCS areas, 70 wells have been drilled (through July 30, 1979) without a blowout. These include 37 off Southern California, 10 in the Gulf of Alaska, 4 in the Lower Cook Inlet, 18 in the Mid-Atlantic, and 1 in the South Atlantic.

Sixteen nondrilling blowouts occurred during the 1971-78 period. During this same period, 2.8 billion barrels of oil and condensate were produced. The total spillage from the 16 blowouts was 725 barrels (plus some minor amounts of condensate that remain undetermined).

Although the blowout record is generally a good one, further improvements can be expected in detecting and controlling shallow gas, in measurement-while-drilling

(MWD) technology, in combating lost circulation, in mud measurement, in understanding the frictional effects related to gas influxes, and in well-control training programs. Improvements in the nondrilling blowout record should result from advances in surface and subsurface-safety devices, completion and workover techniques, and training programs.

In addition to the obvious safety considerations, the economic incentives for such improvements are strong. Typical OCS exploratory wells cost from $1 million to $15 million, and daily costs are as high as $100,000 or more. Fully equipped production platforms can cost from $20 million to $300 million or more. Pollution abatement and control costs can also be extremely high. More than $10 million were spent in controlling the October 16, 1971, production blowout cited in this report. Today, (1979) costs would be several times higher for controlling a similar blowout. Such incidents can also have major social costs and implications because of their effect on OCS oil and gas leasing programs and Government regulatory policies.

We must, therefore, anticipate continued industry and government emphasis on the development of blowout prevention technology and training programs. The U.S. Geological Survey is now researching three important topics related to well control and blowout prevention. These are the development of improved blowout prevention procedures for deepwater drilling operations, an investigation of overpressured marine sediments, and an evaluation of the feasibility of applying fluidics technology to down-hole data telemetry. The Geological Survey will continue to carefully investigate blowouts occurring in U.S. waters and to monitor reports on foreign blowouts. The intent of these investigations is to identify operating problems and to evaluate potential solutions that could lead to further improvements in the OCS accident record.

Table 1.--Exploratory drilling blowouts.

Date	Location	Type rig	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
3/3/71	West Cameron 639	semisubmersible	none	none	4 days	bridged	shallow gas
6/30/71	Vermilion 147	jackup	none	none	2 hours	bridged	deep gas
10/27/72	West Cameron 28	jackup	none	none	2 hours	bridged	deep gas
12/3/72	South Pass 78	jackup	none	none	3 days	bridged	shallow gas, lost rig
5/5/73	South Marsh Island 268	submersible	none	none	21 days	bridged	deep gas
12/11/73	South Marsh Island 184	semisubmersible	none	none	1 day	pumped down mud	shallow gas
3/19/75	High Island A-471	jackup	none	none	6 days	bridged	shallow gas, lost rig
4/22/75	High Island A-595	semisubmersible	none	none	3 days	bridged	shallow gas
10/7/75	Eugene Island 327	drillship	none	none	1 day	bridged	shallow gas
10/27/75	High Island A-545	drillship	none	none	9 days	pumped down mud	shallow gas
11/19/76	West Cameron 405	jackup	none	none	2 hours	bridged	shallow gas
9/19/77	Vermilion 25	jackup	none	none	6 days	bridged	deep gas
12/26/77	Eugene Island 361	semisubmersible	none	none	3 hours	BOP blind rams	deep gas

Table 1.--Exploratory drilling blowouts. (Continued)

Date	Location	Type rig	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
2/14/78	Matagorda 664	submersible	none	none	1 day	bridged	shallow gas
8/4/78	Grand Isle 41	semisubmersible	none	none	15 min.	BOP blind rams	shallow gas
8/10/78	Ship Shoal 120	jackup	none	none	26 hours	pumped down mud	deep gas
9/4/78	High Island A-551	jackup	none	none	2 hours	bridged	shallow gas

Table 2.--Development drilling blowouts.

Date	Location	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
12/14/72	Ship Shoal 269	none	none	6 hours	bridged	shallow gas
10/1/73	West Cameron 543	3 minor injuries	none	2 days	bridged	deep gas, all equipment badly damaged
6/10/74	East Cameron 338	none	none	5 hours	bridged	shallow gas
3/15/76	Eugene Island 380	none	none	17 days	ceased flow	shallow gas
7/30/76	South Marsh 281	none	none	3 days	bridged	deep gas
8/17/76	High Island A-511	none	none	6 days	bridged	shallow gas
11/6/76	High Island A-563	none	none	bubbled gas for 3 months before diminishing		damage to surface casing, shallow gas, lost platform and rig
1/16/77	South Marsh 146	none	none	6 hours	bridged	shallow gas
7/6/77	South Marsh 96	none	none	1 day	pumped down mud	shallow gas
3/15/78	West Delta 79	1 minor injury	none	5½ hours	bridged	drilled into another well

Table 2.--Development drilling blowouts. (Continued)

Date	Location	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
7/15/78	Vermilion 23	none	none	45 min.	bridged	drilled into another well
8/1/78	South Timbalier 37	none	none	2 hours	mechanical shut-in	gas pressure bent and broke snub pipe
9/9/78	West Cameron 180	none	none	3 days	bridged	shallow gas, platform destroyed

Table 3.--Nondrilling blowouts.

Completion

Date	Location	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
6/12/75	South Marsh 50	none	some condensate	2 days	bridged	deep gas, platform badly damaged
6/23/77	Eugene Island 307	none	none	1 day	pumped down mud	deep gas
11/26/77	Eugene Island 307	none	none	1 day	pumped down fluids, installed drill string valve	deep gas, recompletion

Production

Date	Location	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
6/4/71	West Cameron 180	none	none	2 days	pumped down mud	subsea gas leak
10/16/71	Eugene Island 215	none	450 bbls	55 days	activated safety valves, drilled 4 relief wells	explosion at oil pump, destroyed platform
9/7/74	South Pelto 20	none	75 bbls	1 day	pumped down well fluids	casing valve broken off during hurricane

Table 3.--Nondrilling blowouts. (Continued)

Date	Location	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
9/20/74	South Timbalier 26	none	none	3 days	bridged	hurricane bent casing which later broke
3/24/76	West Cameron 165	none	none	7 days	bridged	gas leak in annulus between production and surface casing

Workover

Date	Location	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
7/16/71	South Pass 28	none	none	3 days	pumped down mud	casing valve failed permitting gas to escape
12/22/74	South Pelto 19	none	200 bbls	10 days	casing and tubing sheared while repairing hurricane damage	well reentered and flow directed to storage tanks
3/18/75	West Cameron 289	none	none	1 day	pumped down mud and cement, plugged well	gas seepage around structural casing
2/27/77	Ship Shoal 208	none	none	12 hrs.	closed BOP blind rams with a hand pump	uncontrolled flow after attempting to gas lift well following workover

Table 3.--Nondrilling blowouts. (Continued)

Date	Location	Injuries and fatalities	Pollution	Duration	Control method	Cause, comments
3/16/77	West Cameron 165	none	none	17 days	plugged well with snubbing unit	gas blowout while attempting to repair leak in 7" casing
7/20/77	West Cameron 110	none	none	17 days	pumped down mud	gas began to flow while coming out of hole with tubing
10/18/78	East Cameron 81	none	light condensate slick	10 days	well No. 1 bridged, well No. 3 diverted to sales line	lost control while attempting to repair well No. 3; communication developed with well No. 1
11/14/78	South Marsh 11	none	none	1 hr.	bridged	mud began flowing from surface casing valve during wireline work

Table 4.--Blowouts and spillage as compared to drilling and production data.

Year	New wells started	Drilling blowouts	
		Exploration	Development
1971	841	2	0
1972	847	2	1
1973	820	2	1
1974	816	0	1
1975	882	4	0
1976	1,041	1	4
1977	1,158	2	2
1978	1,148	4	4
	7,553	17	13

Nondrilling Blowouts

Year	Oil and condensate production (million bbls)	Production		Workover		Completion	
		Number	Spillage (bbls)	Number	Spillage (bbls)	Number	Spillage (bbls)
1971	418.5	2	450	1	0	0	0
1972	411.9	0	0	0	0	0	0
1973	394.7	0	0	0	0	0	0
1974	360.6	2	75	1	200	0	0
1975	330.2	0	0	1	0	1	0
1976	316.9	1	0	0	0	0	0
1977	303.9	0	0	3	0	2	0
1978	292.3	0	0	2	some condensate	0	0

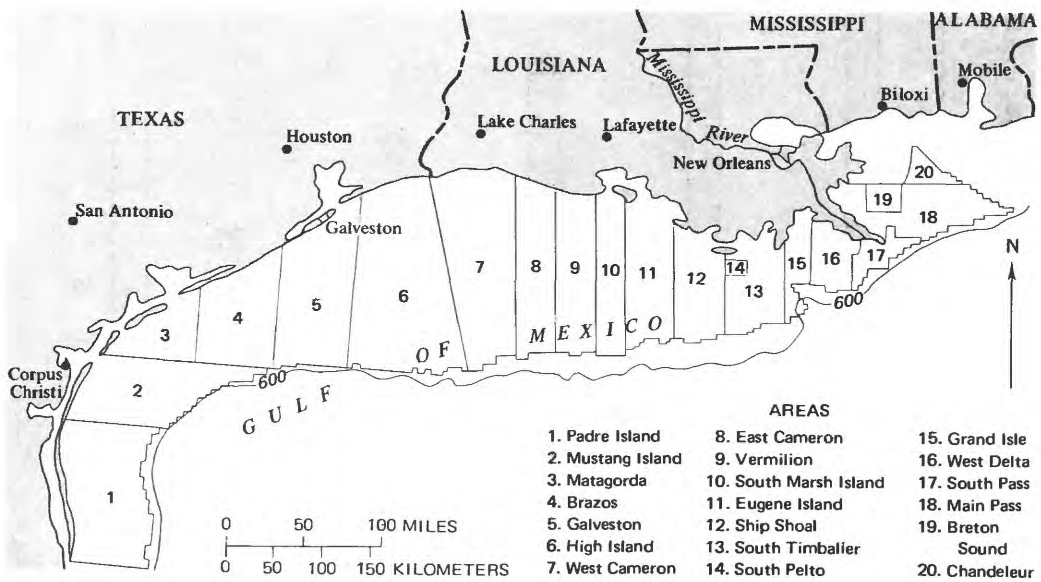

Figure 1.--Index map showing Outer Continental Shelf leasing areas off Texas and Louisiana. Line indicates 600-foot water depth.

SYSTEM OF MEASUREMENT UNITS

(The following report uses the English system of units. The English units can be converted to metric units by multiplying by the factors given in the following list)

To convert English Unit	Multiply by	To obtain Metric unit
Barrels (oil)......................	0.159	Cubic meters (m^3).
	1.590×10^2	Liters (l).
Barrels (36° API oil).............	0.1342	Metric tons.
Cubic feet........................	2.83×10^{-2}	Cubic meters (m^3).
	28.32	Liters (l).
Feet..............................	0.3048	Meters (m).
Miles, statute....................	1.609	Kilometers (km).
geographical or nautical...	1.852	Kilometers (km).

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