OCS Report
MMS 92-0069

Investigation of January 1989 Blowout and Fire Well No. 11 Sulphur Lease OCS-G 9372 Main Pass Block 299

Gulf of Mexico
Off the Louisiana Coast

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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by
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U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

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Authority and Procedures for the Investigation and Public Report

Authority

A blowout and fire occurred on January 8, 1989, on the jack-up drilling rig *Teledyne Movible 16* while Sulphur Well No. 11 was being drilled for Freeport-McMoRan Resources (FMR) on Sulphur Lease OCS-G 9372, Main Pass Block 299, Gulf of Mexico, off the Louisiana Coast. Pursuant to Section 208, Subsection 22(d), (e), and (f), of the Outer Continental Shelf Lands Act as amended in 1978 and the Department of the Interior Regulations, 30 CFR Part 250, the Minerals Management Service (MMS) is required to investigate and prepare a public report of this accident. By memorandum dated January 18, 1989, the following MMS personnel were assigned to the investigative panel:

Jack Hendricks	New Orleans, Louisiana
Joseph Y. Chong	New Orleans, Louisiana
Floyd T. Bryan	New Orleans, Louisiana
Michael J. Saucier	Houma, Louisiana
Paul Schneider	Herndon, Virginia

Procedures

Personnel from MMS flew over the drilling location on January 9, 1989, the day after the blowout occurred, and photographed the burning rig (see attachment 1). They then proceeded to the nearby drilling rig *Teledyne Movible 18* where personnel from *Teledyne Movible 16* were evacuated when the blowout and fire occurred. The MMS personnel obtained firsthand accounts and other preliminary information about the accident from the personnel who were on *Teledyne Movible 16.*

An investigative hearing was held on March 22, 1989, at the MMS Gulf of Mexico Outer Continental Shelf Regional Office, 1201 Elmwood Park Boulevard, New Orleans, Louisiana, with Jack Hendricks presiding as chairman. The purpose of the hearing was to obtain more information about the accident. Following is a list of individuals who participated in the hearing:

Teledyne Movible Offshore

Stanley Pounds
Paul John Comeaux
Joseph C. Worley

FMR (Consultants)

William C. Elliott
Drake L. Norberg
Richard E. Beaugh

FMR

Douglas K. Vrooman

Minerals Management Service

Jack Hendricks
Joseph Y. Chong
Floyd T. Bryan
Michael J. Saucier
Paul Schneider

Observers

Ben Garacci - Teledyne
Richard Epstein - FMR

Introduction

Background

Sulphur and Salt Lease OCS-G 9372 covers 4,560.81 acres and comprises Main Pass Block 299, South and East Addition, off the Louisiana Coast approximately 32 miles east of Venice, Louisiana (see attachment 2). The lease was issued to Freeport-McMoRan Resources Partners, Limited Partnership; IMC Fertilizer, Inc.; and Felmont Oil Corporation on March 23, 1988, for a cash bonus of $3,401,757 with a fixed royalty rate of 12½ percent for sulphur, 5 percent for salt taken offsite, and an annual rental of $3 per acre. The operator of this lease is Freeport-McMoRan Resources Partners, Limited Partnership (FMRP). This sulphur and salt lease overlies Oil and Gas Lease OCS-G 1316, now operated by Chevron U.S.A., and Lease OCS-G 12362, (formerly OCS-G 1316A), operated by Freeport-McMoran Oil and Gas Company.

Exploratory sulphur drilling operations began on this lease on December 1, 1988, when FMRP began drilling Well No. 1. In total, seven sulphur wells were drilled on the lease prior to the drilling of Well No. 11 (attachment 3). There were three drilling rigs operating on this lease at the time of the blowout and fire, *Teledyne Movible 16, Teledyne Movible 17,* and *Teledyne Movible 18.*

Preliminary Activities

The Application for Permit to Drill (APD) for Well No. 11 was approved on January 4, 1989, and FMRP began drilling operations on January 7, 1989, using the mat-supported jack-up rig *Teledyne*

Movible 16. In the APD, FMR proposed drilling a straight hole to a total depth of 2,300 feet measured from the kellybushing (KB) or 1,986 feet from the mudline. The well is located in 210 feet of water. (Henceforth, all drilling depths, casing setting depths, and gas zone depths in this report are measured from the KB.) Freeport-McMoRan anticipated driving 30-inch casing to 419 feet, drilling a 20-inch hole with a remote control valve installed at the +12-foot elevation to observe returns during drilling of the conductor casing hole, setting 16-inch conductor casing at 800 feet, drilling a 13½-inch hole and setting 10¾-inch casing in the top of the caprock at 1,650 feet.

Soon after the rig arrived on location early in the morning on January 7, operations began. Thirty-inch casing was driven to 389 feet (105 feet of penetration). A diverter system was installed on the 30-inch drive pipe. Rotary drilling began and a 20-inch hole was drilled to 806 feet. Sixteen-inch conductor was run to 806 feet and cemented back to the Gulf floor. A casing head was installed on the 16-inch casing, and a full blowout preventer (BOP) stack with a diverter system was installed and tested. Drilling proceeded using a 13½-inch bit and 9.2-pound-per gallon (ppg) mud to 1,386 feet, where caprock was observed in the mud returns. Normal background gas for this well varied between 0 and 10 units. A gas sand was identified at 950 feet and another at 1,270 feet (attachment 4). The latter was verified when the background gas increased to 400 units before dropping back to normal. When the lower gas sand was encountered, drilling ceased, mud was circulated, a

six-stand 558-ft short trip was made, and the hole was conditioned in preparation to log. Logging operations continued for about 9½ hours. During this period, the hole took 15 barrels of fluid, or just over a gallon per minute. After the logging was completed, FMRP re-entered the well with drill pipe to total depth and conditioned the hole in preparation of running 10¾-inch caprock casing. The drill pipe was pulled out of the hole, and the 10¾-inch caprock casing was run to 1,386 feet and cemented inside the 16-inch casing with 375 sacks of 16.2-pound-per-gallon class "H" cement. Cementing operations appeared to proceed normally and were completed at 1:45 a.m. on January 8, 1989.

Description of Incident After cementing operations were completed, a crewmember opened the 16-inch casing valve to check for flow from the annulus between the 10¾-inch casing and the 16-inch casing. No flow was observed. Twenty to 75 minutes after cementing operations were completed, the BOP stack was unbolted and picked up off the well, and casing slips were installed and set with 45,000 pounds of casing weight. At approximately 3:00 a.m., less than one hour after the BOP was unbolted, mud, water, and gas began spraying from the 16-inch casing valve, indicating the well was flowing. At the same time, a sulphurous odor was detected. Because the BOP stack was detached, the well could not be controlled. Nonessential personnel were evacuated to *Teledyne Movible 17* and *Teledyne Movible 18.* Members of the drilling crew remained on board to attempt to regain control of the well. The BOP stack was lowered

over the wellhead but could not be reattached because well fluid was spraying out around the slips. Although the BOP stack was not bolted to the wellhead, the annular preventer was closed in an effort to divert the blowing gas from the wellhead area. Further attempts to reattach the BOP stack failed and all electrical power on the rig was shut down to prevent ignition of the gas. All remaining personnel evacuated the rig. Evacuation was orderly and readily accomplished by boat and survival capsule with no injuries. Evacuation operations were completed by 4:00 a.m., January 8, 1989.

Findings

Firefighting

In an attempt to prevent the uncontrolled gas flow from igniting, firehoses on the rig were trained on the well bay area. However, the fire water pumps shut down when the rig electrical power was turned off. On January 8, 1989, fireboats were mobilized to the area and began spraying water onto *Teledyne Movible 16* at approximately 1:30 p.m. At 2:30 p.m. the gas flow ignited. At approximately 7:30 p.m. the drilling derrick collapsed. Additional fireboats were dispatched to the location, and by 12:30 p.m., January 9, 1989, approximately 42,000 gallons per minute of seawater were being sprayed onto the rig and fire. Gas bubbling around the rig was noted at 12:01 a.m., January 10, 1989. At 5:00 a.m. the rig was listing to the east at a 10° angle, and at 8:53 a.m. on January 10, 1989, the rig capsized, with the mat section separating from the barge section. The well continued to flow and bubble to the surface of the water, and the gas continued to burn for the next 17 days. (See attachment 5 for pictures of the gas boil after rig capsized.)

Damages

The blowout and fire resulted in the total loss of the *Teledyne Movible 16,* a multi-million dollar, mat-supported jack-up rig. There were no injuries to personnel, and pollution was minimal.

Subsequent Operations

Monitoring of the well flow continued from the other two drilling rigs (*Teledyne Movible 17* and *Teledyne Movible 18*) and from boats that were earlier deployed to the area. Gas continued to boil to the surface

and burn until 10:00 a.m. on January 27, 1989. At this point the flow ceased and the fire went out.

Plug and Abandonment Operations

Various surveys and diver investigations indicated that rig debris had been scattered from the well site to approximately 500 feet southeast. The location was littered with small objects, and the drive pipe was bent 58° from vertical in a southerly direction from a shallow depression 8 feet below the mudline to a point about 6 feet above the mudline. At this point, the 16-inch casing lay parallel to the Gulf bottom.

The semi-submersible rig *Diamond "M" Century* was moved on location April 5, 1989, to begin plug-and-abandonment operations. Divers located the 30-inch casing and cut and recovered 4 feet each of the 30-inch and the 16-inch casings. The 10¾-inch casing could not be located. Slings were hooked up and the casings were straightened to about 30° to 35° from vertical. Additional 4-foot lengths of both the 30-inch and 16-inch casings were then cut and recovered.

A 3½-inch mule shoe was run into the wellbore to a depth of 357 feet, and circulation was confirmed between the 30-inch and the 16-inch casings while 9.8-ppg mud was being pumped. Various trips to mill and try to get deeper were made. A depth of 361 feet was reached using a 3½-inch mule shoe. A camera was run inside the 16-inch casing and gas bubbling was observed from 294 feet to 334 feet. The well was then reamed and milled to a depth of 750 feet. Gas bubbling increased at

this point, so the *Diamond "M" Century* rig was moved 200 feet off location. Gas bubbled to the water surface in a 300-foot diameter circle. No hydrogen sulfide was detected nor pollution observed.

The bubbling stopped and the rig was moved back on location on April 20, 1989. The next two weeks were spent trying to mill as deeply as possible into the well. No further gas bubbling was noted. Eventually, a 10¾-inch inflatable packer was run in the hole and set at 410 feet. The well was then cemented with 1,000 sacks of cement below the packer and 130 sacks of cement on top of the packer. The top of the cement was tagged at 300 feet. The 16-inch and 30-inch casings were then cut at a depth of 293 feet and pulled. Plug and abandonment operations were completed on May 4, 1989.

Conclusions

Probable Cause of Blowout

The blowout most likely occurred when gas migrated to the surface from the 950- or 1,270-foot gas zone via the annulus of the 16-inch by 10¾-inch casing strings shortly after the 10¾-inch casing string was cemented. The blowout was probably caused by the operator's attempt to cement the 10¾-inch casing using cement mixed to a density that exceeded the pressure necessary to fracture the formation opposite the 10¾-inch casing string.

Fracturing the formation causes fluid (cement and drilling mud) to be lost to the formation, which loss in turn lowers the fluid level and hydrostatic head in the annulus. This lowering creates an under-balanced condition that possibly allowed the upper gas sand to flow into the annulus and migrate to the surface. It is probable that the lower gas sand contributed to the uncontrolled gas flow when the fluid level in the well dropped further.

Factors Contributing to Blowout

(1). The operator did not submit all the information required by 30 CFR 250.64, Application for Permit to Drill, which requires the submittal of a plot of the estimated pore pressures and formation fracture gradients and the proposed mud weights and casing setting depths. This information was included in four of the previous seven APD's but was not submitted with the ADP for Well No. 11. A comparison of the formation fracture gradients with the calculated pressure to be exerted by the proposed cement column indicates

cementing program inadequacies. The following table (developed by the accident investigation panel) lists the calculated formation fracture pressure and pressure exerted by a 15.6-ppg cement and a 16.2-ppg cement (which was subsequently used) at key depths in the well bore:

Depth (KB) (Feet)	Formation Fracture Pres. (psi)	Pres. Exerted by 15.6 ppg Cement (psi)	Pres. Exerted by 16.2 ppg Cement (psi)
806	404	398	399
950	499	514	520
1,270	714	774	790

The pressure exerted by the 15.6-ppg cement on the formation exceeds the calculated fracture pressure of the 950-ft gas sand and the 1,270-ft gas sand. The pressure exerted on the formation by 16.2-ppg cement is even greater.

(2). The operator submitted, as part of the APD, a cementing program that was inappropriate for the encountered conditions. In the APD, the operator proposed to use 375 sacks of class "H" neat mixed with 5.2 gallons of water per sack of cement to yield 15.6 ppg and 1.18 cubic feet per sack of cement to cement the 10¾-inch casing string. This cement exceeded the calculated formation fracture pressure of the gas sands encountered at 950 feet and 1,270 feet.

(3). A 10¾-inch casing string was proposed to be set at 1,650 feet with a volume of cement calculated to overlap the 16-inch casing string by

200 feet, based on a gauged hole of 13½-inches. There was no factor of safety included or added to the calculation to account for hole enlargement due to washout. The well was ultimately drilled to 1,386 feet, 264 feet less than expected. A caliper log run just prior to the cementing operation indicated the average hole size was 15½ inches. A recalculation by the operator of the required cement volume based on the existing conditions would have shown that more cement would be required. Instead of increasing the cement volume and decreasing the weight of the cement to account for the actual conditions, the operator used 375 sacks of cement as originally proposed in the APD. Further, the volume of cement was decreased by mixing with less water to yield 16.2 ppg and 1.09 cu ft/sack.

(4). The operator was in violation of 30 CFR 250.65, Sundry Notices and Reports on Wells, when the cementing program was changed without prior approval of the Minerals Management Service. A 16.2-ppg cement was used, considerably heavier than the 15.6-ppg cement approved, which probably contributed to the breakdown of the formation.

(5). The operator was in violation of 30 CFR 250.50, Control of Wells, by performing in an unsafe manner by disconnecting the BOP stack before ascertaining the status of the cement job and the status of the well. Verification that the well was standing full, in addition to checking for flow, should have been accomplished prior to unbolting the

BOP stack. After cementing the 10¾-inch casing, the operator checked only for flow from the annulus. This check was accomplished by opening the 16-inch casing valve in communication with the 10¾-inch by 16-inch annulus. No flow was observed immediately after the cement job was completed, and the operator proceeded to nipple down the BOP stack. In the time it took to unbolt and lift the BOP stack from the well (20 to 75 minutes), gas entered the well bore, blew out below the drill floor, and could not be controlled.

Probable Cause of Ignition

The gas flow from the well ignited from an unknown source at 2:30 p.m. on January 8, 1989. Two possible causes of ignition are the following:

(1). Static electricity

(2). Sparking due to sand flowing out of the well and cutting metal

Probable Cause of Rig Loss

In addition to the fire damage, the rig was lost when it toppled and sank. Gas bubbling around the rig had been noted just after midnight on January 10, 1989, and by 5:00 a.m. that day the rig was listing about 10°. At 8:53 a.m. the rig capsized and sank, with the mat section separating from the barge section.

Because this rig was a mat-supported jack-up, the susceptibility to instability from bottom scouring was greater. It is believed that bottom scouring due to the gas flow was a factor in the rig capsizing.

Evacuation Procedures The evacuation of the rig was conducted orderly and without injury. Therefore, the accident panel did not investigate the operator's evacuation procedures.

Recommendations

As cement begins to obtain a compressive strength, gas can no longer flow through the cement. Depending on depth, it may take 36 hours or more for the whole column of cement to achieve a compressive strength sufficient to prevent gas migration in a shallow hole. Therefore, we recommend the following:

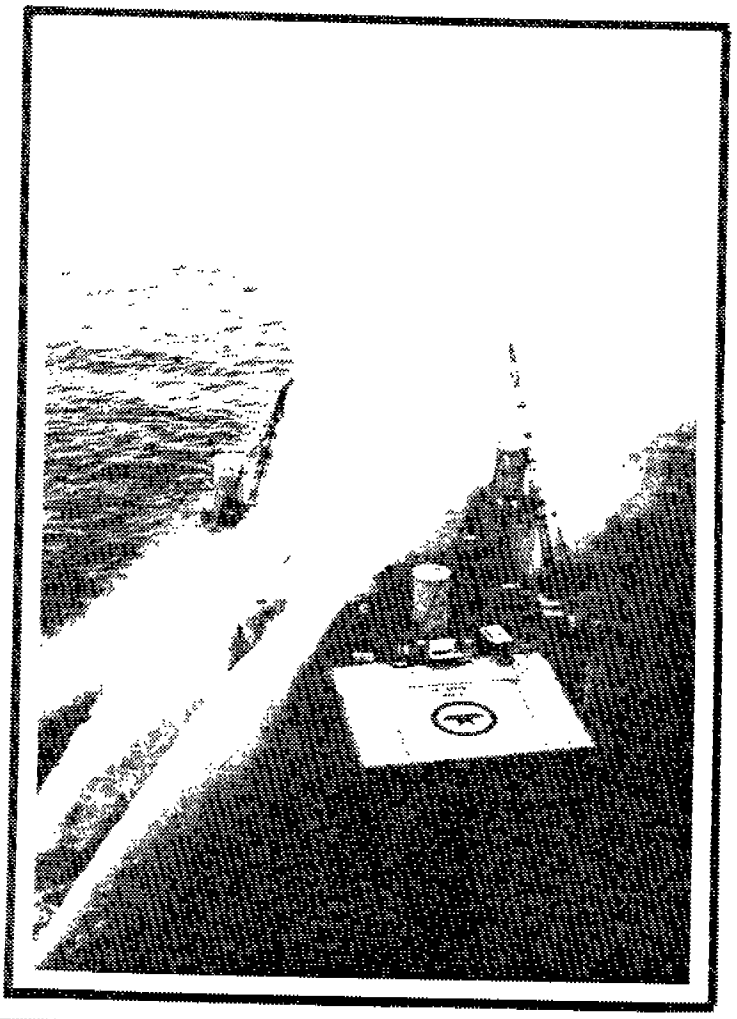
(1). Ensure the annulus is staying full of fluid and no flow is observed prior to nippling down the blowout preventer equipment.

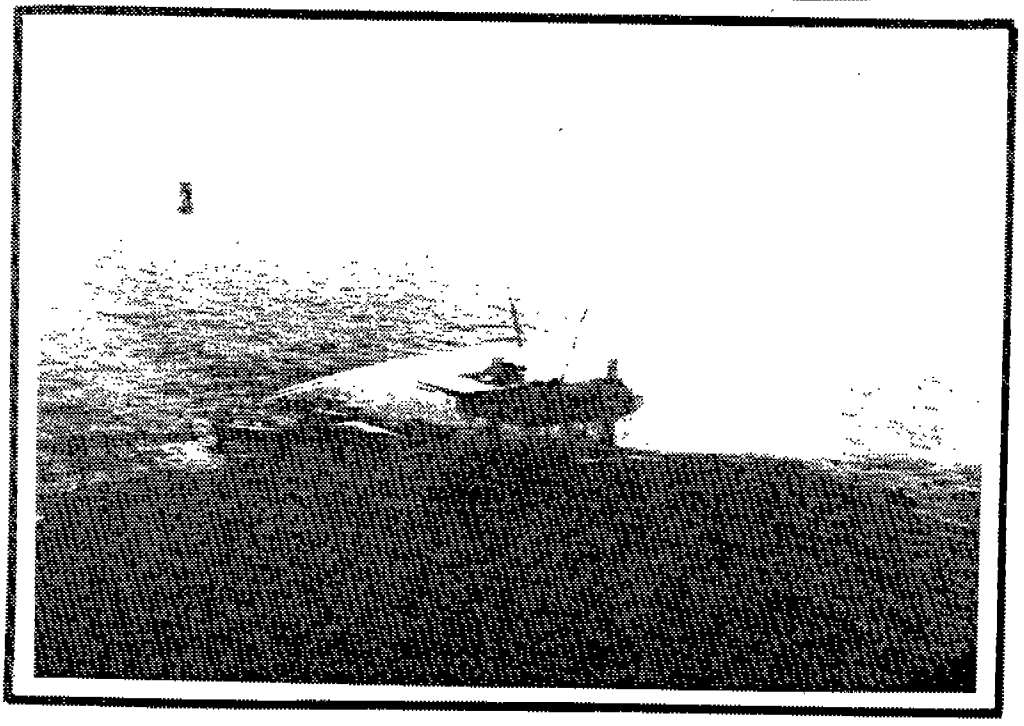
(2). Ensure the correct volume and weight of cement are being used.

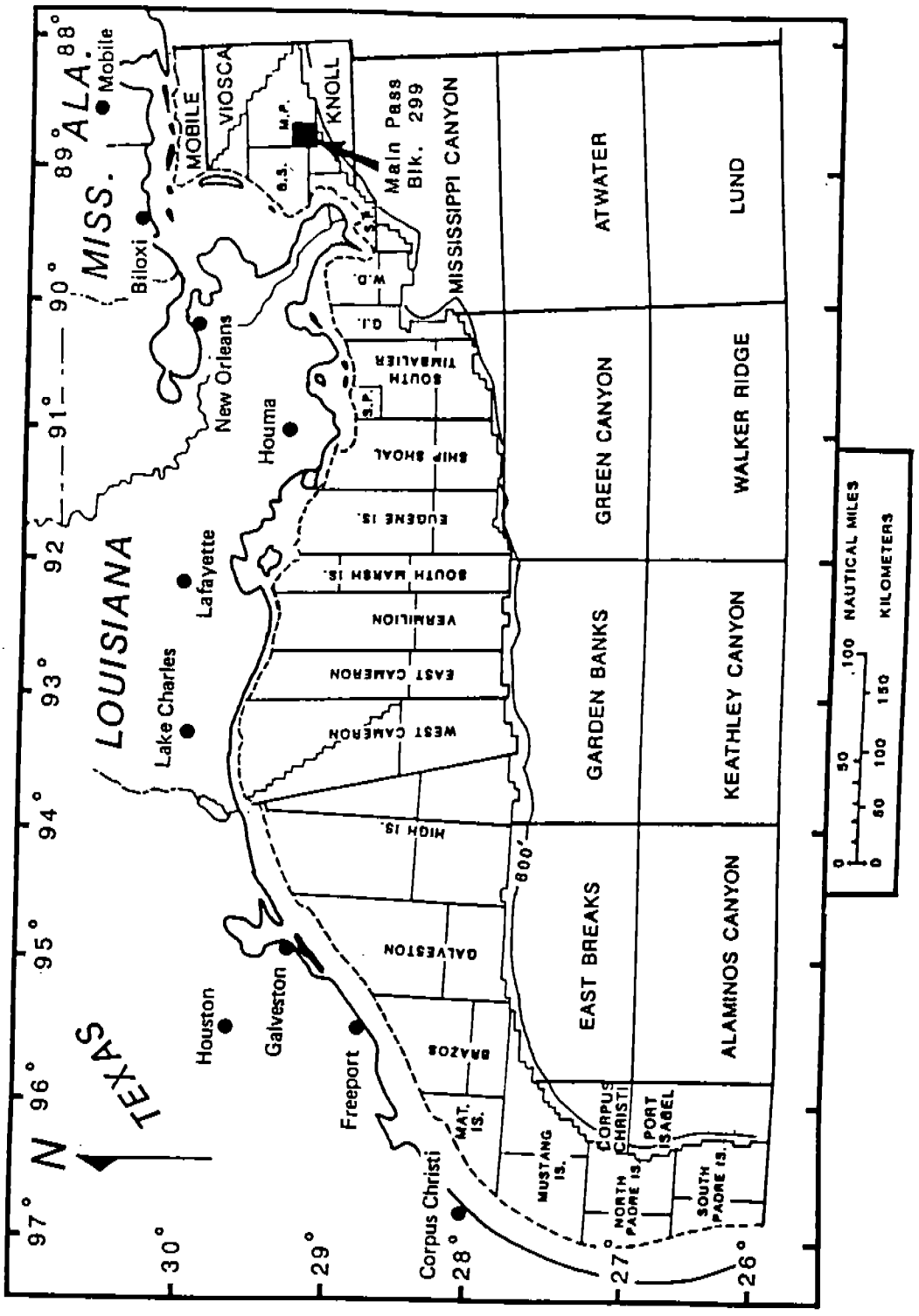
Appendix

Attachment 1	Photographs of Rig and Fire
Attachment 2	Index map showing Outer Continental Shelf leasing area off Texas and Louisiana and location of Main Pass Block 299
Attachment 3	Location of Well No. 11 and Previous Sulphur Wells Drilled on OCS-G 9372
Attachment 4	Freeport-McMoRan Resources OCS-G 9372 Well No. 11, Main Pass Block 299
Attachment 5	Photographs of Gas Boil and Fire After Rig Capsized

Photographs of Rig and Fire

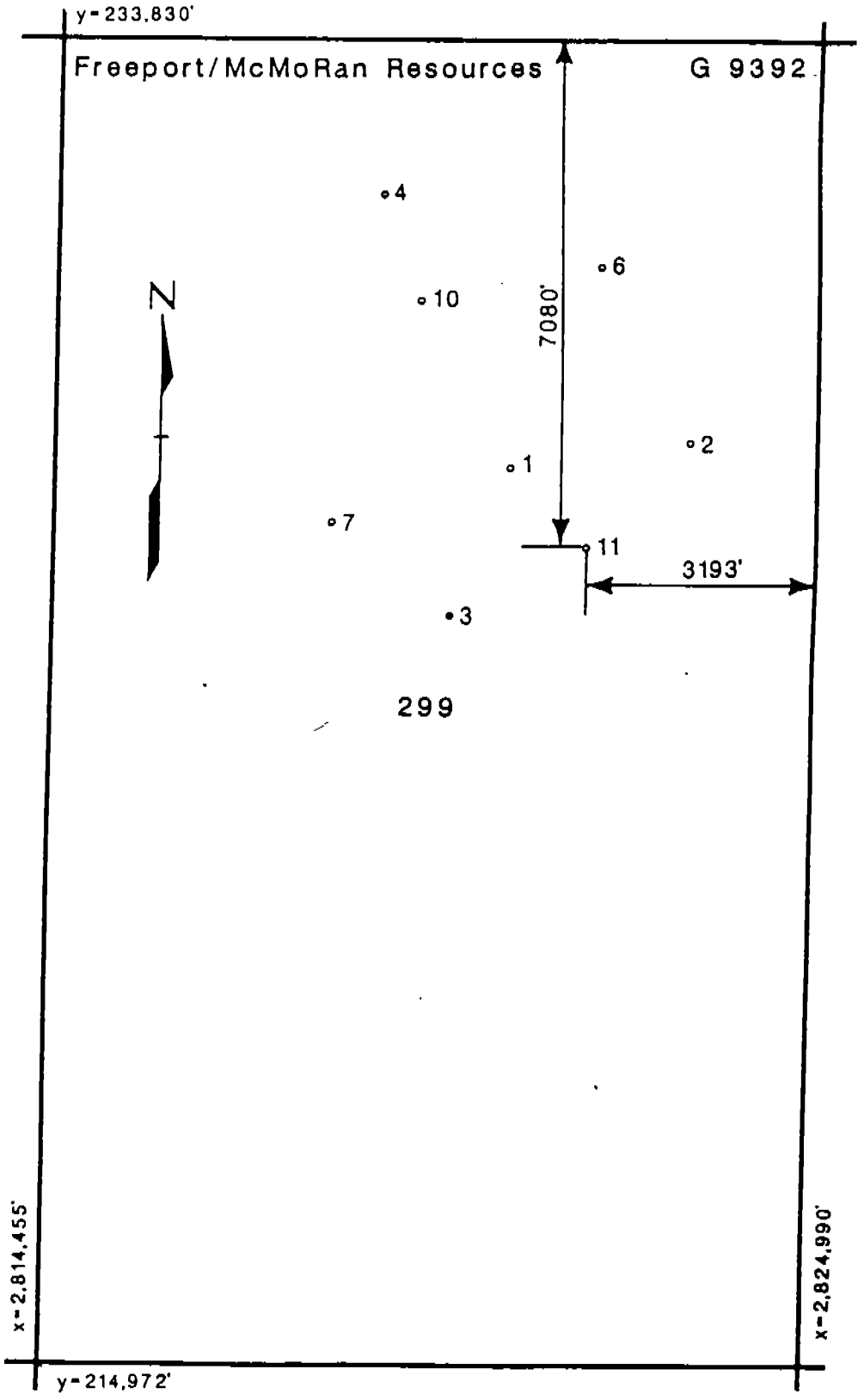




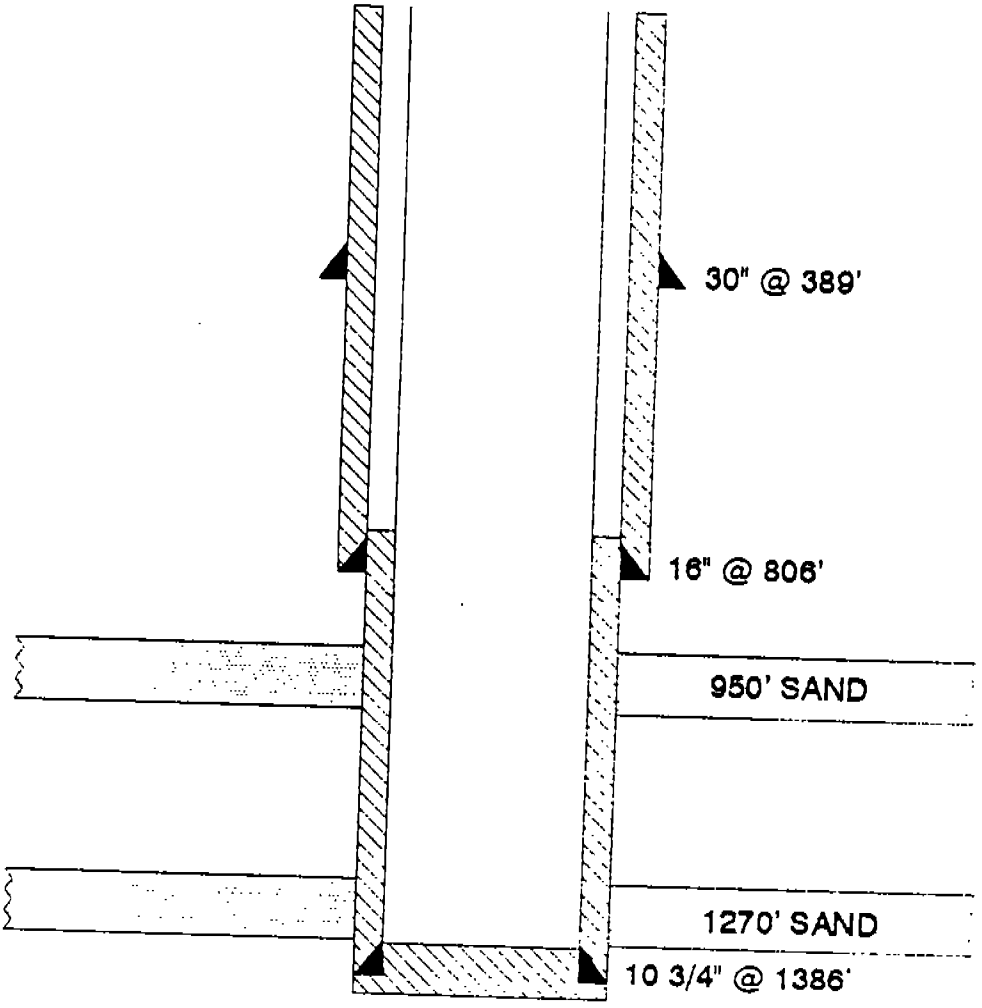


Outer Continental Shelf leasing area off Texas and Louisiana and location of Main Pass Block 299. Dashed lines, shown at 3 marine leagues (9 nautical miles) from the Texas coast and 3 nautical miles from the Louisiana coast, indicate boundary between state and Federal waters. Solid line indicates 600-foot water depth.

Main Pass Block 299
Location of Well No. 11 and
Previous Sulphur Wells Drilled
on OCS-G 9372



FREEPORT-McMoRAN RESOURCES
OCS-G 9372 WELL NO. 11
MAIN PASS BLOCK 299



Photographs of Gas Boil and Fire After Rig Capsized