DEVELOPMENT OF
IMPROVED BLOWOUT PREVENTION PROCEDURES
TO BE USED IN DEEP WATER DRILLING OPERATIONS

submitted to
The United States Geological Survey
Department of the Interior
Reston, Virginia

PETROLEUM ENGINEERING DEPARTMENT
Louisiana State University
Baton Rouge, Louisiana 70803

MAY 1980
PROGRESS REPORT

Development of Improved Blowout Prevention
Procedures for Deep Water Drilling Operations

Contract No. 14-08-0001-17225, Mod. 1
Effective Date: August 23, 1978
Expiration Date: August 31, 1982
Funded Amount - $187,096.00

Sponsored by
The United States Geological Survey
The Department of Interior
Reston, Virginia

Principal Investigators:

William R. Holden, Professor
Petroleum Engineering Department

A. T. Bourgoyne, Professor and Chairman
Petroleum Engineering Department

Bill R. Hise, Professor
Petroleum Engineering Department

May 16, 1980
RESEARCH OBJECTIVES

The primary objectives of the proposed research are the development of improved blowout prevention procedures to be used in deep water, floating drilling operations. The overall research plan was divided into eight tasks which would take approximately four years for completion. The project funding received under the present contract was $187,096 to perform Tasks 1, 3, 4a-b, and 5. These tasks include:

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design of a well for accurately modeling blowout control operations on a floating drilling vessel in deep water.</td>
</tr>
<tr>
<td>a.</td>
<td>Well scaling and design.</td>
</tr>
<tr>
<td>b.</td>
<td>Preparation of bids and specifications.</td>
</tr>
<tr>
<td>3</td>
<td>Documentation of blowout control equipment configuration and procedures used on all floating drilling vessels capable of drilling in deep water.</td>
</tr>
<tr>
<td>a.</td>
<td>Equipment configuration.</td>
</tr>
<tr>
<td>b.</td>
<td>Shut-in procedures.</td>
</tr>
<tr>
<td>c.</td>
<td>Start-up procedures.</td>
</tr>
<tr>
<td>d.</td>
<td>Pump-out procedures.</td>
</tr>
<tr>
<td>4</td>
<td>Experimental study of shut-in procedures for blowout control on floating drilling vessels in deep water.</td>
</tr>
<tr>
<td>a.</td>
<td>Experimental determination of frictional area coefficient profile of modern adjustable chokes and HCR valves used in Blowout Control operations.</td>
</tr>
<tr>
<td>b.</td>
<td>Experimental determination of frictional area coefficient profile of modern annular Blowout Preventers During Closure.</td>
</tr>
<tr>
<td>5</td>
<td>Experimental Study of Procedures for Handling Upward Gas Migration during the Shut-in Period.</td>
</tr>
<tr>
<td>a.</td>
<td>Evaluation of conventional approach requiring use of surface drill pipe pressure.</td>
</tr>
</tbody>
</table>
b. Evaluation of volumetric methods.

c. Laboratory investigation of gas bubble fragmentation while rising in a static annulus.

d. Development of mathematical model of well behavior during shut-in period following a gas kick.

e. Determination of optimal method of handling upward gas migration during shut-in period.

ACCOMPLISHMENTS

Task 1, well scaling and design, has been completed. A scale model of the proposed new facility has been constructed. The scale model will facilitate obtaining industry support for much of the needed equipment as well as provide a model for the construction phase of the project.

Work on Task 3, the documentation of blowout control equipment configurations and procedures, is well underway. Several of the vessels currently capable of drilling in water depths of 2000 ft. or more have been visited. Attached photographs were made Easter Sunday during a visit to the Alaskan Star by Bob Surcouf and A. T. Bourgoyne. Much of the needed industry literature and drawings has been collected.

The experimental work on Task 4, an experimental study of shut-in procedures, is almost complete. Kerry Redmann, who has been assigned this task as part of his MS thesis research has begun the data analysis and mathematical modeling phase of the work. Problems with failures in high pressure seals in the flow loop has slowed the collection of data. Completion of Task 4 is now estimated to be August 30, 1980.

The experimental work on Task 5a and 5b, an experimental study of procedures for handling upward gas migration during the shut-in period, is complete. Jeff Mathews has completed his MS thesis and a copy of this thesis will be forwarded to the USGS with our annual report. A technical paper will be prepared for submission to the Society of Petroleum Engineers
on the results of this project. Additional work on tasks 5c, 5d, and 5e is being continued by Vicente Casariego and Scott Doyle.

Before additional experimental tasks can be undertaken, task 2a and 2b must be completed. A proposal for funding of task 2a was submitted during February, 1980. Professor B. R. Hise would have primary responsibility for this task. A presentation on our work to date was made by Dr. A. T. Bourgoyne at the USGS Research and Development Seminar held in Reston, Virginia on April 8-9, 1980.

PROBLEMS

No major technical problems have been encountered since our last progress report. A review of our budget shows that the tasks funded to date can be completed without need for additional USGS funding, although a small amount of additional departmental funds from other sources may have to be committed to this research.

At the request of the Procurement and Contracts branch, a revised budget estimate was made for Tasks 2b, 4c, d, 6a,b, 7a,b, 4e, 6c, 7c, and 8 to include the effect of inflation since our last budget estimate in July, 1979 and the projected effect of inflation to the end of the project in 1982. The effect of inflation was not taken into account in the July, 1979 estimate which was audited later in 1979. The revised budget estimates for the remaining subtasks are shown in Tables 1-8. The revised total cost estimate is summarized in Table 9.

Adam T. Bourgoyne, Jr., Chairman
<table>
<thead>
<tr>
<th>ITEM</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Move Rig on Location</td>
<td>$2,360</td>
</tr>
<tr>
<td>2. Rig Time for Well Completion 6 Days at 1400 $/day</td>
<td>9,912</td>
</tr>
<tr>
<td>3. Wireline Work to Set Plug</td>
<td>2,950</td>
</tr>
<tr>
<td>4. Cementing Services</td>
<td>1,180</td>
</tr>
<tr>
<td>5. Disposal of Old Mud and Displacement of Completion Fluid</td>
<td>1,652</td>
</tr>
<tr>
<td>6. Supervision</td>
<td>3,186</td>
</tr>
<tr>
<td>7. Tubulars</td>
<td></td>
</tr>
<tr>
<td>a. 6000 ft. of 1.315 in. tubing</td>
<td>14,200</td>
</tr>
<tr>
<td>b. 3000 ft. of 2.375 in. tubing</td>
<td>18,656</td>
</tr>
<tr>
<td>c. 6000 ft. of 2.875 in. tubing</td>
<td>44,307</td>
</tr>
<tr>
<td>8. Dual Christmas Tree</td>
<td>23,600</td>
</tr>
<tr>
<td>9. Dual Packer</td>
<td>8,850</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>17,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$164,853</strong></td>
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</tbody>
</table>
1. Direct Costs
   a. Personnel
      (1) Principal Investigator $ 17,040
         A. T. Bourgoyne
         4.125 man-month (12.5% time for 9 months
         plus full-time for 3 months)
      (2) Graduate Assistant 7,768
         9.75 man-months (50% time for 13.5 months
         plus full-time for 3 months)
      (3) Research Associate 4,458
         3.0 man-months (25% time for 12 months)
      (4) Typist/Clerk 1,644
         2.4 man-months (20% time for 12 months)


   b. Employee Benefits 5,100
      (16.5% of la.0)
   c. Computer Services 4,840
   d. Equipment, Drilling Fluid Supplies, 12,100
      and Nitrogen Gas
   e. Office Supplies and Report Reproduction
      Costs 1,210
   f. Travel 1,210

2. Indirect Costs 15,300
   (49.5% of la.)

TOTAL $ 70,670
TABLE 3
SUBTASK 6a AND 6b COST SUMMARY

1. Direct Costs
   a. Personnel
      (1) Principal Investigator
          W. R. Holden
          4.125 man-months
          (12.5% time for 9 months
           plus full-time for 3 months)
          $ 15,331
      (2) Graduate Assistant
          7.5 man-months
          (50% time for 9 months
           plus full-time for 3 months)
          5,975
      (3) Research Associate
          3 man-months
          (25% time for 12 months)
          4,458
      (4) Typist/Clerk
          2.4 man-months
          (20% time for 12 months)
          1,644
      Sub $ 27,408
   b. Employee Benefits
      (16.5% of la.) 4,522
   c. Computer Services 1,815
   d. Equipment, Drilling Fluid Supplies, and Nitrogen Gas 12,100
   e. Office Supplies and Report Reproduction Costs 1,210
   f. Travel 1,210

2. Indirect Costs
   (49.5% of la.) 13,567

TOTAL $ 61,832
# TABLE 4

**SUBTASK 7a AND 7b COST SUMMARY**

1. Direct Costs
   a. Personnel
      (1) Principal Investigator
      B. R. Hise
      4.125 man-months
      (12.5% of time for 9 months
      plus full-time for 3 months)
      $ 16,628
      
      (2) Graduate Assistant
      7.5 man-months
      (50% time for 9 months
      plus full-time for 3 months)
      $ 5,975
      
      (3) Research Associate
      3 man-months
      (25% time for 12 months)
      $ 4,458
      
      (4) Typist Clerk
      2.4 man-months
      $ 1,644
      
      **Sub $ 28,705**

   b. Employee Benefits
      (16.5% of la.)
      $ 4,736

   c. Computer Services
      $ 1,210

   d. Equipment, Drilling Fluid Supplies, and
      Nitrogen Gas
      $ 13,310

   e. Office Supplies and Report Reproduction Costs
      $ 1,210

   f. Travel
      $ 1,210

2. Indirect Costs
   (49.5% of la.)
   $ 14,209

   **TOTAL $ 64,590**
TABLE 5
SUBTASK 4e COST SUMMARY

1. Direct Costs
   a. Personnel
      (1) Principal Investigator
         A. T. Bourgoyne, Jr. $ 5,141
         1.125% man-months
         (12.5% time for 9 months)
      (2) Graduate Assistant 3,966
         4.5 man-months
         (50% time for 9 months)
      (3) Typist/Clerk 683
         0.9 man-months
         (10% time for 9 months)

      Sub $ 9,790

   B. Employee Benefits
      (16.5% of 1a.) 1,615
   c. Computer Services 5,280
   d. Office Supplies and Report Reproduction Costs 1,320
   e. Travel 1,320

2. Indirect Costs
   (49.5% of 1a.) 4,846

   TOTAL $ 24,171
TABLE 6
SUBTASK 6c COST SUMMARY

1. Direct Costs
   a. Personnel
   (1) Principal Investigator
      W. R. Holden $16,959
      4.125 man-months
      (12.5% time for 9 months
      plus full-time for 3 months)
   (2) Graduate Assistant
      4.5 man-months
      (50% of time for 9 months)
      3,966
   (3) Research Associate
      3.0 man-months
      (25% of time for 12 months)
      4,931
   (4) Typist/Clerk
      0.9 man-months
      (10% of time for 9 months)
      683
      Sub $26,539
   b. Employee Benefits
      (16.5% of 1a)
      4,379
   c. Equipment, Drilling Fluid Supplies, and
      Nitrogen Gas
      11,880
   d. Office Supplies and Report Reproduction Costs
      1,320
   e. Travel
      1,320
   2. Indirect Costs
      (49.5% of 1a)
      13,137
      TOTAL $58,575
### TABLE 7

**SUBTASK 7c COST SUMMARY**

#### 1. Direct Costs

##### a. Personnel

<table>
<thead>
<tr>
<th>Description</th>
<th>Man-Months</th>
<th>Rate</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>B. R. Hise</td>
<td>1.125</td>
<td>$5,018</td>
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</tr>
<tr>
<td>Graduate Assistant</td>
<td>7.5</td>
<td>$6,610</td>
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<td>Research Associate</td>
<td>3</td>
<td>$4,931</td>
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<tr>
<td>Typist/Clerk</td>
<td>1.2</td>
<td>$910</td>
<td></td>
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</table>

Subtotal: $17,469

##### b. Employee Benefits

- (16.5% of 1a) $2,882

##### c. Equipment, Drilling Fluid Supplies, and Nitrogen Gas

- $11,880

##### d. Office Supplies and Report Reproduction Costs

- $1,320

##### e. Travel

- $1,320

#### 2. Indirect Costs

- (49.5% of 1a) $8,647

**TOTAL** $43,518
### TABLE 8
#### TASK 8 COST SUMMARY

1. Direct Costs
   a. Personnel
      (1) Principal Investigator
         A. T. Bourgoyne, Jr.  
         4.125 man-months  
         (12.5% time for 9 months  
         plus full-time for 3 months)  
         $18,850
      (2) Graduate Assistant
         7.5 man-months  
         (50% time for 9 months  
         plus full-time for 3 months)  
         6,610
      (3) Research Associate
         3 man-months  
         (25% time for 12 months)  
         4,931
      (4) Typist/Clerk
         1.2 man-months  
         (20% time for 12 months)  
         910

   b. Employee Benefits
      (16.5% of la.)  
      5,165
   c. Computer Services  
      1,980
   d. Drilling Fluid Supplies, and Nitrogen Gas  
      14,520
   e. Office Supplies and Report Reproduction Costs  
      1,320
   f. Travel  
      1,320

2. Indirect Costs
   (49.5% of la.)  
   15,494

   **TOTAL**  
   $71,100
<table>
<thead>
<tr>
<th>Date</th>
<th>Facility Travel</th>
<th>New Well</th>
<th>Equipment &amp; Supplies</th>
<th>Indirect Costs</th>
<th>Benefits</th>
<th>Employee Salaries &amp; Grad. Stu.</th>
<th>Faculty Salaries &amp; Stacks</th>
<th>Total</th>
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<td>5,150</td>
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<td>7/5</td>
<td>10,510</td>
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<td>11,083</td>
<td>3,990</td>
<td>4,930</td>
<td>6,830</td>
<td>5,140</td>
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<td>8/1/81</td>
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<td>13,467</td>
<td>4,379</td>
<td>3,990</td>
<td>16,995</td>
<td>5,140</td>
<td>7c</td>
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<tr>
<td>9/1/80</td>
<td>10,210</td>
<td>0</td>
<td>14,029</td>
<td>4,736</td>
<td>5,979</td>
<td>16,628</td>
<td>4,468</td>
<td>16a</td>
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<td>1,210</td>
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Table 9 - Recommended Use of Funds Schedule