Appendix for Chapter 2

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Appendix 2

APPENDIX 2.1 DRILLING FROM A FLOATING VESSEL

This paper discusses the sequential steps of drilling a well from a floating vessel. The sequence of events in this description is commonly used; however, is not necessarily followed for every well drilled from a floating vessel. For a guideline system, the typical steps used to drill the well are as follows: spudding the well, running the structural casing, installing the Diverter System and the Conductor Casing, running the blowout preventor (BOP) stack, completing the well, and plugging and abandoning the well.

Spudding the Well:

The first step in drilling from a floating vessel is to lower the temporary guide base to the ocean floor. The temporary guide base is a heavy steel device with an opening in the center and four cables called guidelines attached to its four outside corners. A drill pipe is fitted into the center opening to lower the guide base to the ocean bottom. The drill pipe is removed and pulled back up to the semi-submersible leaving the temporary guide base on the ocean bottom with the four guidelines running back up to the rig.

With the temporary guide base in position, the hole for the structural casing is drilled. The bit is made up on drill collars and drill pipe as usual; however, a guide frame is installed on a drill collar near the bottom. The guide frame has two to four arms where the guidelines are threaded. As the bit and drill stem are lowered into the water, the guidelines keep the guide frame, drill stem and drill bit in line with the center opening in the temporary guide base.

When the drill bit reaches the seafloor, circulation and drilling begin, and the hole for the structural casing is made. As the drill grinds and gouges rock into small pieces or cuttings, drilling mud is used to move cuttings away from the bit to the ocean floor. A remotely operated vehicle (ROV) is often used to observe returns on the ocean floor. Drilling mud is ejected out of nozzles in the bit with great speed and pressure.

Running the Structural Casing:

The next step is to put the permanent guide base and the structural casing in place. It is called structural casing because it provides lateral support for the BOP stack. The structural casing is lowered into the water and down the hole one joint at a time. A guide frame is attached to one of the bottom joints of structural casing and is used to guide the casing into the center opening of the temporary guide base and into the borehole. The permanent guide base is attached to the top of the topmost structural casing joint and the guidelines threaded through the guideposts. After the final joint of structural casing is run down the guidelines into the hole, the permanent guide structure and housing are landed in the temporary guide base. The permanent guide base provides a structural base for additional casing strings and additional equipment, such as the BOP stack, that are run later.

Next, the structural casing is cemented in the hole. To cement the structural casing, a drill pipe is lowered down inside the structural casing to a point near the bottom where it is connected to a fluid-tight seal. Cement is pumped down the inside of the drill pipe. Because of the fluid-tight seal, the cement goes out the bottom of the structural casing and back up the annular space between the wall of the hole and the outside of the casing. Again, cement returns are taken on the ocean floor and may be observed with a ROV camera.

Installing the Diverter System and the Conductor Casing:

A hole is drilled for the conductor casing after the cement sets. Once again, the drill bit is guided by the guide frame and guidewires down to the guide base. The hole for the conductor casing is a few inches in diameter smaller than the inside diameter of the structural casing.

Before the hole for the conductor casing is started, the shoe of the conductor casing is drilled out. A marine riser fitted with a subsea dump valve is run and latched onto the structural casings wellhead housing. The next steps are to install the diverter and diverter system and then to test the operation of the subsea dump valve.

A diverter system is installed to negate the hazards associated with drilling in shallow gas zones. If shallow gas is encountered, the diverter system will direct the well bore fluids and the high volumes of low-pressure gas overboard and downwind from the semi-submersible.

After the hole is drilled, the conductor casing is run down the guidelines and cemented back to the ocean floor. The top of the conductor is fitted with a high-pressure wellhead housing prepared internally to receive subsequent casing strings.

Running the BOP:

The BOP stack is a combination of individual BOP's designed to shut in a well under pressure so that formation fluids that have moved into the wellbore can be circulated out while continuous control of the well is maintained. When drilling from a floating vessel, such as a semi-submersible, the BOP stack is placed on the ocean floor in order to compensate for vessel motion. Although several steps are taken to control unusual well conditions before use of the BOP becomes necessary, the BOP equipment is designed with reliability as its ultimate criterion since it is considered a last resort for preventing a well kick from becoming a blowout. In addition, the subsea BOP is designed with several redundancies because of its inaccessibility on the ocean floor.

The BOP is normally lowered on the drill pipe. Once the stack is attached onto the permanent guide base, the drill pipe is retrieved. Marine riser pipe is then run and attached to the top of the BOP stack. The riser pipe serves as a conduit for the drill stem and drilling mud returns. Once the BOP stack is put in place on the ocean floor and the stack is function and pressure tested, drilling to total depth can begin. The BOP must be tested according to 30 CFR 250.616.

Drilling to Total Depth:

As the hole is drilled, additional casing strings may be run through the riser and BOP, depending on the depth of the well. The casings set between the conductor casing and the final production string are called intermediate casing strings. The total depth of the hole is drilled beyond the producing formation.

The system responsible for getting drilling mud down the hole and the cuttings to the surface is called the circulating system. Mud pumps pick up mud from mud pits, put it into and down the drill pipe and drill collars, send it out nozzles in the bit, and move it back up the hole to the surface with the drill cuttings. The mud and cuttings return to the surface through the annular space between the outside of the drill pipe and the inside of the hole. At the surface, the mud and cuttings leave the well through a mud return line. At the end of the return line, mud and cuttings fall onto a vibrating screen, or shale shaker. The shaker screens out cuttings but allows liquid to pass through and fall into the mud pit, where it is once again picked up by the mud pumps and sent back down the hole. This circulatory system is continuous and goes on as long as the bit is drilling.

Completing the Well:

The casings and cement block the hydrocarbons in the reservoir from flowing into the well. Therefore, perforations in the casing must be made to allow the oil or gas to flow into the wellbore. Perforations are simply holes that are made through the casing and cement and extend some distance into the formation. The most common method of perforating is using shape-charge explosives.

Shaped charges accomplish penetration by creating a jet of high-pressure, high-velocity gas. The charges are arranged in a tool called a gun that is lowered into the well opposite the producing zone. When the gun is in position, the charges are fired by electronic means from the surface resulting in several perforations that allow reservoir fluids to flow into the wellbore.

Plug and Abandonment:

To abandon a well, it must be plugged first. Abandonment plugs generally consist of laying cement plugs in the wellbore at specified intervals to just below the ocean floor. The plugs must be set according to the regulations at 30 CFR 250.700. The plugs are pressure tested as they are installed.

Next, the subsea wellhead and bases must be recovered. This is accomplished by cutting the casing strings approximately 15 feet below the mudline. Cutting is usually done with explosives, although, it can be done by mechanical means.

Modern Drilling Techniques:

Over the years, significant advances have been made with drilling and completion practices. In recent years, much success has been achieved through horizontal or near-horizontal wells by exposing the completion interval to more productive formation than is possible with vertical wells. Horizontal drilling is not a new technology, but rather an existing technology that has advanced significantly in the last decade.

APPENDIX 2.1 REFERENCES

Baker, Ron. 1985. A Primer of Offshore Operations. 2nd Edition. Austin: Petroleum Extension Service, Division of Continuing Education, The University of Texas at Austin.

Baker, Ron. 1979. A Primer of Oilwell Drilling. 4th Edition. Austin: Petroleum Extension Service, The University of Texas at Austin.

Bradley, Howard B. 1992. Petroleum Engineering Handbook. Texas: Society of Petroleum Engineers.

APPENDIX 2.2 DRILLING PROCEDURES FOR POINT SAL UNIT[1]

Step-by Step Drilling Procedures - Pilot Hole

1) Mix 500 barrels of 14.5-ppg kill mud before spudding in. Pick up 26 in bit and 36 in hole opener and drill 36 in hole to 100 feet BML (below ocean floor). Circulate hole clean, check for flow, and pick up and run 30 in structural casing on temporary guide base. Cement 30 in casing.
2) Drill 26 in hole to 500 feet BML. Circulate hole clean, check for flow, and POOH to run conductor casing. Pick up 20 in conductor casing with permanent guide base and low-pressure wellhead assembly. Circulate and cement the 20in casing. Washout and rig up 21in riser system with diverter.
3) Drill 17 ½ in surface hole to 1500 feet BML. Circulate hole clean, POOH with drilling assembly and pick up and run high-pressure wellhead on 13 3/8 in surface casing. Circulate and condition the drilling mud and cement the $13^{3}/_{8}$ in casing back to the mudline. Rig up 18 ¾ in BOP system. Perform a complete pressure test of the BOP's, casing.
4) Drill 12¾ in hole to 3200 feet BML (or 500 ft above oil and gas); set $9^{5}/_{8}$ in-production casing; cement $9^{5}/_{8}$ in-casing.
5) Drill 8½ in hole to TD (6750 feet BML). Possibly conventionally core selected intervals during the drilling process.
6) Evaluate hole with wireline logs. Determine optimal zone for production testing.
7) Abandon entire 8½ in open hole section.

Step-by step Procedure - Sidetrack Hole

1) Pick up 8½ in bit and polish off cement plug to shoe of $9^{5}/_{8}$ in-production casing. Kick off with directional tools and drill 8½ in hole in a near-horizontal angle for up to 2000feet.
2) Circulate well clean, pick up drill pipe conveyed logging tools and log open hole. Evaluate hole with wireline logs to determine optimal testing interval.
3) Pick up 7in-production liner and run in hole. Set liner with 200ft lap and cement it in place.
4) Pick up 8½ in bit and polish off to top of 7 in liner lap. Pressure test lap and prepare to complete well for testing.

Well Site Abandonment

Once all drilling and testing operations are complete, a series of cement plugs will be set in the well at several zones according to MMS approved abandonment procedures. Drilling mud of sufficient density will be placed between the plugs and will prevent fluid migration beneath the ocean floor. This procedure will be approved by the MMS. Casing will be removed to a depth within 15 feet below the mud line. The ocean bottom will be cleared of all obstacles.

APPENDIX 2.3 DRILLING PROCEDURES FOR PURISIMA POINT UNIT[1]

Step-by Step Drilling Procedures - Pilot Hole

1) Mix 500 barrels of 14.5-ppg kill mud before spudding in. Pick up 26 in bit and 36 in hole opener and drill 36 in hole to 100 feet BML (below ocean floor). Circulate hole clean, check for flow, and pick up and run 30in structural casing on temporary guide base. Cement 30 in casing.

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[1] Aera Energy LLC, Point Sal Unit Project Description Information (September 2000), Drilling Operations, Page 4-2.

[1] Aera Energy LLC Purisima Point Unit Project Description Information (September 2000), Drilling Operations, Page 4-2.

2) Drill 26 in hole to 500 feet BML. Circulate hole clean, check for flow, and POOH to run conductor casing. Pick up 20in conductor casing with permanent guide base and low-pressure wellhead assembly. Circulate and cement the 20in casing. Washout and rig up 21in riser system with diverter.

3) Drill $17^{1}/_{2}$ in surface hole to 1500 feet BML. Circulate hole clean, POOH with drilling assembly and pick up and run high-pressure wellhead on $13^{3}/_{8}$ in surface casing. Circulate and condition the drilling mud and cement the $13^{3}/_{8}$ in casing back to the mudline. Rig up 18¾ in BOP system. Perform a complete pressure test of the BOP's, casing.

4) Drill 12¾ in hole to 3200 feet BML (or 500 ft above oil and gas); set $9^{5}/_{8}$ in production casing; cement $9^{5}/_{8}$ in casing.

5) Drill 8½ in hole to TD (6750 feet BML). Possibly conventionally core selected intervals during the drilling process.

6) Evaluate hole with wireline logs. Determine optimal zone for production testing.

7) Abandon entire 8½ in open hole section.

Step-by step Procedure - Sidetrack Hole

1) Pick up 8½ in bit and polish off cement plug to shoe of $9^{5}/_{8}$ in-production casing. Kick off with directional tools and drill 8½ in hole in a near-horizontal angle for up to 2000 ft.

2) Circulate well clean, pick up drill pipe conveyed logging tools and log open hole. Evaluate hole with wireline logs to determine optimal testing interval.

3) Pick up 7in-production liner and run in hole. Set liner with 200-ft lap and cement it in place.

4) Pick up 8½ in bit and polish off to top of 7 in liner lap. Pressure test lap and prepare to complete well for testing.

Well Site Abandonment

Once all drilling and testing operations are complete, a series of cement plugs will be set in the well at several zones according to MMS approved abandonment procedures. Drilling mud of sufficient density will be placed between the plugs and will prevent fluid migration beneath the ocean floor. This procedure will be approved by the MMS. Casing will be removed to a depth within 15 feet below the mud line. The ocean bottom will be cleared of all obstacles.

APPENDIX 2.4 DRILLING PROCEDURES FOR BONITO UNIT[1]

Step-by Step Drilling Procedures

1. Drill 36 in hole to 160 ft ± below ocean floor with seawater. Returns to be left on ocean floor. Run and cement 140 ft of 30 in, 310-lb casing, 30 in wellhead housing, and permanent guide structure with sufficient cement to fill to ocean floor.

2. Install diverter and diverter system.

3. Drill 17-1/2 in hole to 500ft below ocean floor. Run open hole logs. Open hole from 17 ½ in to 26 in.

4. Check for flow. After it is determined that the well is completely dead, pull marine riser and run 20 in, 133 LB, K-55 casing and 20 in x 18 ¾ in wellhead housing on drill pipe to 500 ft below ocean floor. Land and lock the 18 ¾ in wellhead housing into the 30 in wellhead housing. Cement the 20 in casing at 500 ft below ocean floor through drill pipe with sufficient cement to fill to ocean floor.

5. Run 18¾ in, 10,000 psi, Class IV BOP stack on 21in O.D. marine riser and latch onto the 18¾ in wellhead housing. Test BOP per Nuevo Operating Instruction D-17 and OCS Order No. 2[2].

6. Drill $17^{1}/_{2}$ in hole to 1520 ft below ocean floor and run open hole logs.

7. Run and cement $13^{3}/_{8}$ in, 61 LB, K-55 buttress casing at 1,500 ft, below ocean floor with sufficient cement to fill to ocean floor.

8. Drill 12¼ in hole to 50 ft below $13^{3}/_{8}$ in shoe and make leak off test. Drill 12½ in hole to ±4500 ft below ocean floor and run open-hole logs.

9. Run $9^{5}/_{8}$ in, 43.5 LB, N-80, buttress casing and land near ±4500 ft below ocean floor. Land in $18^{3}/_{4}$in wellhead housing and cement with sufficient cement to fill 200 ft above $13^{3}/_{8}$ in shoe.

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[1] Nuevo Engergy Company, Expoloration Program Overview, Bonito Unit-Southern Santa Maria Basin (September 2000), Drilling Operations, Page 2-11.

[2] OCS Order No. 2 is superceded by the regulations at 30 CFR 250.407.

10. Drill $8^1/_2$ in hole to 50 ft below $9^5/_8$ in shoe and make leak-off test.

11 Drill $8^1/_2$ in hole to total depth and run open-hole logs.

12. Well testing program to be developed pending evaluation of open-hole logs

Plug and Abandonment Procedure

The proposed wells will be drilled as an expendable well and will be permanently plugged in accordance with abandonment procedures approved by the MMS. The plug and abandonment will include the following steps:

1. A cement plug will be placed to extend from a minimum of 100 ft below the bottom to 100 ft above the top of any oil, gas, and fresh water zones in the uncased portion of the hole.
2. A cement retainer with backpressure control will be set between 50 ft and 100 ft above the $9^5/_8$ in casing shoe. Cement will be displaced to a level at least 100 ft below the casing shoe and spotted a minimum of 50 ft above the retainer.
3. Any casing perforations in the $9^5/_8$ in casing will be isolated as per 30 CFR 250, Subpart G.
4. A cement plug at least 150 ft long will be placed in the $9^5/_8$ in casing with the top of the plug within the first 150 ft below the sea floor.
5. The $9^5/_8$ in, $13^3/_8$ in, and 20 in casings will be cut a minimum of 20 ft below the sea floor and recovered.

6 The 30 in structural casing will be cut and recovered a minimum of 15 ft below the sea floor.

7. Once all casing and wellhead equipment have been recovered from the sea floor, a side-scan sonar survey will be run covering the area within a 4,000 ft radius of the well to be certain no obstructions remain.

A detailed drilling, casing and cement program will be contained in the revised Bonito Unit EP to be submitted in September 2001.

APPENDIX 2.5 DRILLING PROCEDURES FOR GATO CANYON UNIT[1]

Based on the information currently at hand, the following is a general description of the procedures that will be undertaken to perform the delineation operations. All operations will be in accordance with appropriate OCS orders and regulations, Coast Guard regulations, OSHA regulations and Samedan's own safety practices and procedures.

Step by Step Drilling Procedures

a. Drill 36 in hole to 1,005 ft KB (160 ft below ocean floor); set 30 in structural casing, top of housing 5 ft above ocean floor; cement 30 in casing with 1,100 cubic feet of class "G" + 2 percent calcium chloride.

b. Mix and store 500 bbls of 10.2 ppg gel mud before spudding in.

c. Drill out cement; drill 26 in hole from 1,005 ft KB to 1,395 ft KB (550 ft below ocean floor); set 20 in conductor casing; cement 20 in casing with 1,850 cubic feet class "G" + 2 percent calcium chloride.

d. Test BOP stack, test pipe rams, test blind/shear rams, test annular preventers.

e. Run BOP stack on 21in riser and land on wellhead, test BOP.

f. Begin formation-logging service

g. Drill out cement, drill $17^1/_2$ in hole 10 ft, perform leak-off test; drill to 2,670 ft KB, begin hole deviation at 2,000 ft KB, 5°/100 ft, heading 073°, run directional tool for continuous monitoring.

h. Run e-logs at 2,670 ft

i. Run and land $13^3/_8$ in surface casing at 2,670 ft KB (1,825 ft below ocean floor); cement $13^3/_8$ in casing with 1,150 cubic feet of Class "G" + 16 percent blended gel + 2 percent calcium chloride followed by 500 cubic feet of Class "G" + 2 percent calcium chloride.

j. Test BOP's weekly.

k. Drill out cement, run directional and logging while drilling tools, drill $12^1/_4$ in hole to 2,940 ft KB building at 5°/100 ft to maximum angle

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[1] Samedan Oil Corporation Gato Canyon Unit, Description of the Proposed Project (August 2000), Drilling Operations, Page 4-1, August 2000

of 57°, drill $12^1/_2$ in hole to 7,523 ft KB, (Top Monterey target at - 5200 ft).

l. Run logs.

m. Run and set $9^5/_8$ in intermediate casing; cement $9^5/_8$ in casing at 6,550 KB with 1,125 cubic feet + 16 percent dry-blended gel, follow with 500 cubic feet Class "G" neat.

n. Run directional and logging-while-drilling tools, drill $8^1/_2$ in hole to TD at 10,802 ft KB (-7,000).

o. Run e-logs.

p. Run and set 7 in liner at 10,802 ft KB (or at depth determined by log analysis program), cement liner.

Casing Program

21 in Marine riser to wellhead, from 845 ft KB

30 in Structural at 1,005 ft KB, 160 ft below ocean floor

20 in Conductor at 1,395 ft KB, 550 ft below ocean floor

$13^3/_8$ in Surface casing at 2,670 ft KB, 1825 ft below ocean floor

$9^5/_8$ in Intermediate casing at 7,523 ft KB (-5200 ft)

Abandonment Procedures

All perforated intervals will be cemented off. A series of cement plugs will be set in the borehole at pre-selected depths beneath the ocean floor to prevent any future leakage. Procedures will be approved by the MMS. Casing will be removed to a depth of 16 feet below the ocean floor. The ocean bottom will be surveyed and cleared of all obstacles.