Chapter 6
The Macondo 252 Disaster:
Causes and Consequences

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ABSTRACT

The disaster of the Deepwater Horizon platform, while drilling the Macondo 252 well in the Gulf of Mexico in 2010 is for now the last of numerous tragedies, blowouts, and oil spills resulting from petroleum engineering activities. After the accident, several commissions, investigation groups, advisory committees, and company reports were prepared. They investigate causes and consequences of the disaster from different standpoints, but mainly come to the same conclusions. The "n^{th}" approach is presented in this chapter.

INTRODUCTION

The Macondo 252 well supposed to be an exploratory well in Macondo prospect onshore, at the water depth of about 1,500 m (5,000 ft). It was at the same time designed to serve as a production well if sufficient hydrocarbon reserves were proved. Unfortunately on April 20, 2010, after lot of bad decisions, human errors and safety barriers malfunctioning, gas that has found the way from the layer to the surface caused the explosion and fire. The consequences were dramatic. From the standpoint of families, the worst one was the loss of 11 lives and 17 people injured. As the efforts to fight the fire were unsuccessful, the platform sank in the morning of April 22, 2010 (the Day of the Planet Earth). All attempts to

DOI: 10.4018/978-1-4666-4777-0.ch006

close the well were also unsuccessful so the oil spill continues at the seabed level for 87 days more. About 210,000 gallons of oil was spilled every day and in only three days it covered over 580 square miles. Spreading to the coast it has influenced the coastal marine life as well.

SAFETY IN DRILLING OPERATIONS

To that time one of the best standards for elaboration of well integrity in drilling operations was NORSOK standard D-010 (2004) due the extensive activities offshore. It defines the requirements and guidelines related to well barriers with adequate schematics and tables determining features and acceptance criteria for primary and secondary barriers.

Drilling Concern

At the moment of the accident the Macondo 252 well was in phase of drilling and tripping with shearable drill string. According to adequate schematics primary well barrier has to be drilling fluid column. It must exert the pressure on the bottom of the well that will prevent any influx (kick) of formation fluid. Such pressure should be equal or adequate to control estimated or previously measured reservoir (pore) pressure with respect to surge or swabing pressure changes. The properties of the drilling fluid should be controlled. Pressure on the bottom should never exceed the formation fracture pressure. Control and verification is done by control of the fluid level/s in the well and spare tanks, the amount and intensity of fluid returns over the vibration screens and in the tanks. To maintain circulation all the time enough fluid should be prepared (about 20% of the fluid in circulation system at the moment). Secondary well barriers are casing, cement sheet in the annulus, wellhead, drilling blowout preventer system (BOP) and high pressure riser if installed. Casing design is one of the most important parts of the well design process. It determines casing material quality, wall thicknesses, joints and placement (from the bottom to the top of the well, or as a liner). The purpose of the casing/liner is to serve as the physical barrier against the well bore wall rocks (API Bull 5C2, 1999; Bull 5C3, 1994). All fluids inside the formation, formation pressure, and the weight of the casing are acting on the string all the time the drilling of the next section is in the process. Also casing must withstand those stresses through the well lifetime (API Spec. 5CT, 1995; API Spec. 5B, 1996). Casing design should be done on the basis of nominal dimensions and material quality. The ellipse of plasticity, showing allowed triaxial stresses is the best representation. The use of different design factors as is the practice in most of companies is not the best way because it can be misleading (Adams et al., 1993). To avoid uncontrolled fluid flow casing or liner should be leak tested after the placement. Usually casing/liner is cemented. That means to place cement slurry in the annular space and below the cementing shoe, wait for cement and continue with drilling if needed after tightness testing. Doing so the continuous and permanent assuming impermeable hydraulic seal is set along determined hole length in the annulus, to prevent any formation fluid flow and even more stabilize the formation rocks. The proper placement and quality is the primary demand for such kind of barrier. The predetermined length/casing to liner overlap, of the column should be achieved and proper cement sheath quality as well. Of great importance is the adequate "wait on cement" time that should be determined through testing on surface samples. The pressure in the annulus should be monitored regularly (not only through the drilling process). All casing strings are sus-

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