Analisi tecnica degli eventi occorsi sull'impianto MACONDO 252 nel Golfo del Messico nella primavera 2010. Estratto di carattere didattico dagli Atti della Conferenza tenuta il 9 luglio

POLITECNICO DI MILANO

Facoltà di Ingegneria Industriale

ANALISI TECNICA DEGLI EVENTI OCCORSI SULL'IMPIANTO MACONDO 252 NEL GOLFO DEL MESSICO NELLA PRIMAVERA 2010

TECHNICAL ANALYSIS OF WHAT OCCURRED AT MC 252 WELL SITE (GOM) DURING SPRING 2010

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Mainly, in the oil industry an accident is due to wrong application of drilling safety standards. The truth is that accidents can happen, the main cause being human error (not the technology in use).
That can affect oil spills, leaks, bursts, blowouts, tank collisions, pipeline corrosion and explosion.
A blowout is likely to occur whenever a bit pierces a pressurized gas layer. As a result, the drill string is strongly pushed up and a deal of hydraulic and mechanic troubles start occurring inside the borehole. (More than 6.5 out of 1000 cases degenerate into blowout nowadays: that means something more than 100 new cases per year).
The Deepwater Horizon oil spill (also referred to as the BP oil spill, the Gulf of Mexico oil spill, the BP oil disaster or the Macondo blowout) represents a massive ongoing oil spill in the Gulf of Mexico that is the largest offshore spill in U.S. history. Some estimates placed it by late May or early June, 2010, as among the largest oil spills in the world with tens of millions of gallons spilled to date.
The immediate cause of the Deepwater Horizon oil spill in the Gulf of Mexico is still uncertain.
However, while much still remains to be learned about causes for the Deepwater Horizon disaster, early indications are that like other disasters, it was caused by a combination of human error and mechanical failure.
The drill rig had discovered a large oil reservoir about 18,000 beneath the sea floor, and were in the process of disconnecting and capping the well for a future production rig. In this process, many wells in the Gulf use a liner along with the cement casing around the well stem as it provides a better seal from gas kicks. But as this takes a little longer and costs more, BP did not install a liner in the MC 252 well.
Although the rig had had several dangerous gas kicks from the well in previous weeks, the rig workers were ordered to perform a dangerous procedure to expedite the disconnect. The workers removed heavy drilling mud from the well stem, and began replacing it with lighter seawater, before the concrete plugs were installed down the pipe near the top of the reservoir. Without the heavy mud and concrete plugs in place, the only safety backstop to a dangerous gas kick to the surface was the Blowout Preventer (BOP).
The BOP was not built as designed, included some demonstration parts (a hydraulic ram intended to close an uncontrolled blowout), had a failed battery, and the design may not have allowed the shear ram to fully cut through the stronger well pipe. The only real solution to this uncontrolled blowout is the two relief wells being drilled to intersect the failed well stem near the top of the reservoir, in which they will then attempt a "dynamic kill" where seawater, drilling mud, and then cement are injected to kill the failed well.
These relief wells are now down over half way to the reservoir, but it will take many more weeks for them to complete this process. It is interesting to note that the Canadian government requires exploration wells in the Arctic Ocean to drill a relief

well simultaneously with the exploration well, so that if there is a problem, the relief well is already in place and ready to go. This adds time and cost to an exploratory well, but would add considerable safety to the process. The information from BP identifies several new warning signs of problems. According to BP there were three flow indicators from the well before the explosion. One was 51 minutes before the explosion when more fluid began flowing out of the well than was being pumped in. Another flow indicator was 41 minutes before the explosion when the pump was shut down for a "sheen" test, yet the well continued to flow instead of stopping and drill pipe pressure also unexpectedly increased. Then 18 minutes before the explosion, abnormal pressures and mud returns were observed and the pump was abruptly shut down. The data suggests that the crew may have attempted mechanical interventions at that point to control the pressure, but soon after, the flow out and pressure increased dramatically and the explosion took place. Several concerns identified by BP relate to the cementing process. Cement work that was supposed to hold back hydrocarbons failed, allowing the hydrocarbons into the wellbore. The float collar used in the cementing process did not initially operate as intended and required 9 attempts with higher than usual pressures to function properly. Moreover, the float test performed after cementing may not have been definitive, leading to concern that there may have been contamination of the cement due to density differences between the cement and the drilling mud.
Next concerns about the blowout preventer were identified by BP including the failure of its emergency disconnect system (EDS), the failure of its automated mode function or dead man switch, the failure of the BOP shearing functions, and the failure of the remote operated vehicle interventions. The BP investigation has also raised concerns about the maintenance history, modification, inspection, and testing of the BOP.

At the time of the Deepwater Horizon explosion, the well was significantly behind schedule, which appears to have created pressure to take shortcuts to speed finishing the well. BP assert that cost pressures played a part in the five following decision that may have led to vulnerabilities in the design of the well:

• the decision to use a well design with few barriers to gas flow (The use of a full string of casing from the wellhead to the bottom of the well was criticized as being inferior to installing a "liner-tieback" system which is more expensive but considered safer);

• the failure to use a sufficient number of "centralizers" to prevent channeling during the cement process (Centralizers are devices that ensure that the casing running down the wellbore is centered properly. If the casing is not centered properly, the "cementing" of the well can fail which can result in gas flowing up the spaces around the casing. Halliburton recommended the use of 21 centralizers but BP only used six of the devices);

• the failure to run a <u>cement bond log</u> to evaluate the effectiveness of the cement job (Once cementing is complete, engineers run an acoustic test called a "cement bond log" to determine whether the cement has bonded to the casing and the surrounding formation of the wellbore. This is done to detect the potential of gas leaks. The letter alleges that this work was not performed);

• the failure to <u>circulate</u> potentially gas-bearing drilling mud out of the well (Circulation of drilling mud allows engineers to test the mud for the presence of gas. The letter alleges that industry best practices calls for a full circulation of mud from the bottom of the well to the top. This is done prior to cementing in order to correct any gas leak issues before the key cementing stage. BP only performed a partial mud circulation test);

• the failure to secure the wellhead with a <u>lockdown sleeve</u> before allowing pressure on the seal from below (A casing hanger lockdown sleeve is supposed to provide a barrier to blowouts in addition to the cement at the bottom of the well and the seal at the wellhead on the sea floor. The letter claims that BP did not deploy the lockdown sleeve). In a complex engineering project, there are obviously many cases where good judgment must be used to select the best technique from a menu of possible choices. Even in cases where a company is committed to following best practices, there are risks that incentive systems will be set up in a manner that results in shortcuts being taken.

These procedural issues made by BP if accurate, paint a picture of a company that was taking shortcuts in an effort to contain costs and bring the well into production as quickly as possible given that the project was already late. In other words, human error played a major role in the disaster and it is likely that better safety procedures would have prevented the blow out.

Ensuring a safe environment remains a key element to any manufacturing site on safety shows automation professionals from all aspects of control disciplines (process, discrete, batch, hybrid and systems integration) find accidents happen and human error is usually the main culprit.

In order to make drilling a little safer, extensive training would be mandatory for all of the worker on the rigs and platforms, which would reduce the number of spills due to human mistake.

Furthermore, the technology requires to be improved, by introducing new tools able to decrease or to eliminate the amount of the released pollutants.