Investigation Item : **Diverting Equipment Capacity**
Ticket Reference No. : **0185**

Document Control

Rev No.	Description	By
00	Draft for review and comment	Bob Walsh

1 QUESTION/EVENT OF INTEREST

Did the flow diverted through the mud gas separator exceed the design capacity?

2 SCOPE AND METHOD OF INVESTIGATION

2.1 Scope

Aspects Covered

Mud Gas Separator (MGS) design and operation

Aspects Not-Covered

2.2 Method of Investigation

2.3 Reference Documents

Document No.	Title
	Stress Engineering Report

3 SUMMARY OF INVESTIGATION

After review of the data and results of the hydraulic analysis of the Macondo 252 well by Stress Engineering, along with review of the witness testimony that indicated flow had been diverted through the mud gas separator, it is highly likely that flow and pressure exceeded the design capacity of the mud gas separator, resulting in sending gas to multiple locations on the vessel.

4 FINDINGS AND CONCLUSIONS

4.1 Failures/Direct Causes

Typically, diverting the return mud through the MGS would only be done to remove small quantities of background gas. Flow exceeded the capacity of the MGS because the diverter system was selected to divert through the mud gas separator when it should have been lined up directly to the overboard lines. Excess flow was caused by expansion of gas in the riser, above the BOP. This large quantity of gas flooded various locations on the rig and migrated to non-hazardous areas where it ignited causing explosions. As the gas rose toward the surface the rapid expansion forced the mud column out of the riser flooding the MGS and overwhelming the system. After the MGS was completely flooded, flows up the vent line on the MGS caused the 15 PSI rupture disc to open sending mud and gas through the six inch starboard overboard relief line, as well as down through the return line to the gumbo box and back up to the mini trip tank through the tank overflow line.

Contributory Factors/Underlying Causes
The BOP should have been closed as soon as there was a detectable influx into the well bore from the formation, however, a number of factors including simultaneous mud transfers contributed to the lack of early detection. Once gas migrated up the well bore and reached the riser, the BOP should have been closed to isolate additional flow from the well and the diverter system should have been closed and lined up to divert all flow coming to the surface through the open ended overboard lines and away from the rig. With flow routed through the MGS, the design flow for the MGS was very quickly exceeded as the gas pressure would have forced the mud out of the MGS mud seal (20ft U-tube), allowing gas to flow freely down the return line to the mud processing area. In addition large amounts of gas flowed up the overflow line to the mini trip tank, out of the MGS vent line, through the MGS overboard relief line and up the MGS vacuum breaker line. The vacuum breaker line had a 180 degree turn at the top causing this high velocity gas to be directed back down, flooding the drill floor and surrounding area.

Organizational

Training – Possible lack of early well kick detection and incorrect response to the well control event. The fact that the normal line up of the diverter was through the MGS to reduce the possibility of mistakes causing mud discharge overboard and environmental issues may have contributed to the driller's response. Diverting through the MGS prevented riser gas from being diverted to overboard.

People

Environmental

Standard operating procedures for this rig to reduce the possibility of overboard discharge.

Technical

There are significant limitations in the ability of the systems to accurately measure flow in and flow out during some operations.

4.2 Potential Learning for Ongoing Operations

Area	Learning	Importance
Equipment	Review pressure ratings for and the way that the well control equipment is operated.	High
Equipment	Improve the methods for accurately measuring Mud pump efficiency, mud flow in and return mud flow out of the well. Additional automatic monitoring to assist and alert the driller to changes that may take place.	High
Equipment	Improve data logging capabilities for critical information from control systems. Drilling.	High

	BOP, DP. Power Management etc with emphasis on streaming information to town and retrieval of information during or after an emergency. Black box information would have greatly assisted with understanding exactly what happened on the DWH.	
Equipment	Review ventilation systems with an emphasis on gas migration to avoid possible explosions resulting in low of power.	High
Training	Additional training in the area of well control, kick recognition and safest response, diverting to overboard rather than through the MGS.	High
Training	Additional training in the area of simultaneous operations and times when these should be avoided to reduce confusion when interpreting mud volumes into and out of the well.	High

5 TABLES AND FIGURES

Figure 1 [Caption Title (S-00000)]

Table 1 [Table title Here]