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Human Error Analysis of the Montara Well Blowout

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ABSTRACT

The 2009 blowout from the Montara wellhead resulted the total loss of the West Atlas drilling rig and caused massive ecological damage in the Timor Sea of Australia. The incident preceded the 2010 Macondo Deepwater Horizon blowout and shared many parallels. An analysis is performed to assess the Montara incident and finds it stemmed from a series of human errors including, but not limited to, miscalculations, procedural errors, hasty decision making, and failure to follow the American Petroleum Institute Recommended Practices 75 on drilling mud circulation. Twelve specific errors were identified and classified into eight categories. The results show that 10 of the 12 errors were latent errors preceded by the 2004 relaxation of the Australian Government's off-shore drilling industry regulations. Following industry guidelines, best practice procedures, and safe work practices are crucial to avoiding a well disaster and these were not a key aspect of the Montara wellhead operations; ultimately, safety was not a top priority.

Key Words: *West Atlas Well, latent error, active error, Macondo Deepwater Horizon, situational awareness*

INTRODUCTION

The Montara Wellhead Platform H1-ST1 was owned and operated by PTT Exploration & Production Australasia (PTTEPAA) a subsidiary of PTT Exploration & Production. It stood in 245 feet of water located approximately 430 miles west of Darwin in the Northwest Territory and 155 miles northwest of Truscott in the Western Territory of Australia in the Timor Sea. In early 2009, the West Atlas jackup drilling rig operated the Montara H1-ST1 wellhead. The rig was owned and operated by Atlas Drilling Ltd, a subsidiary of Seadrill Ltd, which was operating under contract with PTTEP Australasia Pty Ltd [1, 2].

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On August 20th, 2009 the trash cap and a pressure containing anticorrosive cap were removed from the Montara H1-ST1 well by the West Atlas rig [1]. After the caps were removed, corrosion and scaling were discovered and steps were taken to clean well casing threads. After completion of the descaling operation and corrosion removal, the anti-corrosion cap was not replaced [1]. The West Atlas rig was then moved to nearby wellheads G1-ST1 and then H4. While the West Atlas rig was operating nearby wells, H1-ST1 released an estimated flow of 40-60 barrels of crude at approximately 05:30 on August 21st, 2009, and the flow stopped on its own. Atlas Drilling, Ltd. decided to move the West Atlas rig back over H1-ST1 to set a plug and prevent any further release from the anti-corrosion cap [1]. During the process of moving the West Atlas rig over H1-ST1, the well experienced a second uncontrolled release, or blowout, of oil, gas, and condensate at 07:23. This release did not subside, a fire broke out, and the platform was evacuated [1].

All 69 employees of the West Atlas rig were safely evacuated to lifeboats and picked up by a nearby supply vessel [1, 3]. The West Atlas rig was considered a total loss due to the fire damage [4-6]. The H1-ST1 well flowed for 10 weeks, and estimates of the volume released ranged from 300-2,000 barrels daily. Flow from the H1-ST1 well was stopped on November 3rd, 2009 after a total of 3,400 barrels of heavy mud and 1,000 barrels of brine were injected into the relief well to stop the flow. During the spill, seaweed farmers from Rote Island, Indonesia reported losing more than 2,500 acres of crop and fisherman from in the Timor Sea reported seeing masses of dead fish [4, 7, 8].

METHODOLOGY

This incident analysis is based on available reports and proceedings regarding the Montara incident to identify the likely causes. This blowout shared many similarities to the 2010 Macondo/Deepwater Horizon blowout that resulted in the 'BP Oil Spill'. In both incidents, operators deviated from standard drilling and well operations practice (DWOP), failed to recognize clear signals of an impending catastrophic event, personnel lacked appropriate training for critical operational activities, and both well platforms suffered total losses. For additional information, see Smith et al. [9]. The authors developed a classification system to organize errors and critical events in the Macondo incident into eight categories related to human error. The Smith et al. error classification system [9] is applied to the Montara blowout to gain a better understanding of the events that preceded the incident so that these types of events can be further studied and prevented in the future.

Several critical events occurred prior to the Montara blowout and culminated in an ecological and economic catastrophe. A critical event is defined as an event or action which could have directly reduced or eliminated the likelihood of the disaster if it had been performed correctly or avoided. Critical events included the following: a) off-shore

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miscalculation of the required amount of cement to be used for the casing shoe; b) on-shore supervisors failed to notice the incorrect amount of cement used on the Daily Drilling Report; c) sea water was inappropriately used as a completion fluid and did not maintain the appropriate density to manage well pressure while pouring the blocking shoe; d) the cement was not tested properly; e) Pressure Containing anti-Corrosion Caps (PCCCs) were used instead of cement plugs; f) the use of PCCCs was approved in 30 minutes, a less than adequate amount of time for approving a deviation of a critical safety measure; g) the PCCCs were never tested as required by the Australian Well Construction Standards; h) only one of the two required PCCCs called for in the deviation was installed into the H1-ST1 well; i) the crew that installed the PCCCs was not trained on correct installation procedures; j) the PCCC was not reinstalled after the cleaning of the casing threads; k) the PCCC was not reinstalled after the initial release of gas and hydrocarbons; and l) failure to employ the use of a blowout preventer [10-12].

The twelve critical events in the Montara well blowout, as described above, were caused by multiple human errors. These human errors have been classified to identify lapses in:

- **Design**: Error resulting from a poor design that causes equipment or a process's failure to function as originally intended.
- **Maintenance/Testing:** Error resulting from a failure to follow the appropriate guidelines on maintenance and testing of equipment.
- **Policies/Procedures:** Error resulting from a failure to have an adequate policy or procedure.
- **Training**: Error resulting from a lack of adequate training.
- **Decision Making**: Error resulting from a decision made in which safety was not the primary factor.
- **Organization/Management**: Error caused by poor leadership in the organization or management due to a weakness in the safety culture.
- **Risk Perception/Risk Acceptance**: Error resulting from actions with an unacceptable level of risk due to a weakness in the safety culture.
- **Communication**: Error resulting from a failure to send or receive information.

In addition to these classifications, it is also important to note whether an error was active or latent. The effects of an active error can be seen almost immediately, and are usually associated with the performance of front line operators [13, 14]. Effects of latent errors may not appear for a long time until combining with other factors to cause an incident [13]. Latent errors are most often generated by those that are removed from the direct hazards of frontline operations; such as high-level decision makers, designers, managers, or maintenance personnel. The farther removed someone is from the direct hazards associated with the frontline operations, the greater potential there is for endangering the system. Smith and colleagues [9] found that 80% of the errors (20 out of

25) leading up to the Macondo disaster were latent errors, and were attributable to the organization as a whole, rather than a specific individual. Nineteen of the errors were classified as organizational or managerial in nature stemming from poor leadership, indicating a less-than-adequate safety culture within the organization itself. Latent errors present the greatest threat to safety in a complex system such as a drilling rig. Frontline operators frequently inherit system defects created by inadequate design, incorrect installation, improper maintenance, inadequate training, lack or resources, and poor management decisions.

RESULTS AND DISCUSSION

Situational Awareness (SA) and human cognition are crucial to the safe operation of complex systems. The level of SA is often directly related to the level of safety found during an operation [15]. If workers lack an adequate understanding of their surroundings and worksite they are more likely to commit an error which may lead to an incident. It has been shown that human factors cause 70-80% of incidents in high-hazard operations, such as drilling for oil [15]. The human error theory developed by Shappell and Wiegmann classifies human factors into four levels: operation, supervision, management, and organization [16]. During the drilling process (active operation and supervision), the occurrence of a kick or blowout has a high likelihood and high consequence and workers must maintain proper SA and monitor well conditions in order to reduce the risk of an incident.

There are three levels of SA: (1) perception, (2) comprehension or information integration, and (3) projection [15]. Most problems with SA occur during the first level when information and data is perceived. Some factors that affect SA have been identified as: fatigue, stress, workload, routine tasks, weather conditions, communication, experience level, and personal problems[17]. Some indicators of reduced SA have been identified as change in a worker's character, reduced communication, and the need for repetition of instructions, reduced expressions, and a reduced work standard [15]. Situational awareness can be improved by increased communication, removal from the situation, altering the work level, training, and discussion of events. Because surroundings on a drilling rig can change quickly and unexpectedly, maintaining a high level SA is imperative [15].

In addition to classifying each type of error, the American Petroleum Institute (API) Recommended Practice (RP) 75: *Development of a Safety and Environmental Management Program for Offshore Operations and Facilities* was applied to study this incident [18]. API RP 75 is a viable management program, the implementation of which would have prevented a majority of these errors had the RP been adopted at the time of the incident.

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Table 1 summarizes errors that led to the disaster, error classifications, and the relevant API RP 75 section. In Table 1 there are two symbols used. The first symbol "◊" denotes that the classification of the error can be made with a high degree of certainty based upon the evidence available. The second symbol "‡" denotes that the classification of the error is made with a lower degree of certainty because of the lesser supporting evidence.

Based on the data contained in Table 1, it is concluded that 83% of errors which led up to the release at the Montara wellhead were latent errors (10 out of 12) and are attributable to policies and procedures in place at the time of the incident. Figure 1 summarizes the number of errors that are considered to be significant contributors to the incident. Table 1 shows a majority of the identified errors relate to guidelines described in API RP 75 and may have prevented the release they had been in place.

Shortly after the Montara incident, the Macondo Deepwater Horizon blowout (BP Oil Spill) occurred in the Gulf of Mexico killing 11 workers and causing billions in damages. For an error analysis of the Macondo incident, see Smith et al. [9]. U.S. regulations were tightened following that incident, including the passing of The Workplace Safety Rule (30 CFR 250.1902) in November of 2010, which made the requirements of API RP 75 mandatory for all off shore facilities [19, 20]. The federal Bureau of Safety and Environmental Enforcement (BSEE) was founded in 2011 in response to the Deepwater Horizon Incident. In 2016, a Blowout Preventer and Well Control Rule was also enacted (81 Fed. Reg. 25888) [21, 22], which established equipment and operations requirements for well control activities associated with drilling, completion, workover and decommissioning operations.

More recently a push has been made in the U.S. to relax post Macondo regulations, drawing similarities to the Australian relaxation of regulations in 2004 and preceded the Montara blowout . The components of the U.S. Well Control Rule were revised in May of 2018 by the BSEE [23] in an effort to save the oil industry $228 million over 10 years [24]. Some of the key revisions included loosening requirements related to third-party audits of safety equipment, reducing the use of real-time equipment monitoring, and reducing the frequency of operational interruptions while waiting for government approval of permit revisions. These revisions have been controversial with proponents claiming the changes reduce unnecessary burdens on industry, and opponents claiming the changes place profits over safety. Only time will tell if relaxations of the regulations are justifiable.

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Table 1 – Montara Error Classification

		Error Classification									
		Design	**Maintenance/ Testing**	**Policies/ Procedures**	**Training**	**Decision Making**	**Organization/ Management**	**Risk Perception/ Acceptance**	**Communi-cation**	**Active/ Latent**	**Relevant API 75 Sections**
Critical Events	**Seawater used for casing shoe.**			◊	◊	◊		◊		Latent	3,5,6,7
	Cement shoe pour was miscalculated.				◊	◊				Latent	3,6,7
	Supervisors overlooked miscalculated cement pour.			◊			◊		◊	Latent	5
	Cement not tested.			◊		‡	‡	◊		Latent	5
	PCCCs used instead of cement plugs.			◊		‡	‡	◊		Latent	3,4,5,8
	Approval of PCCCs made in 30 min.			◊		◊	◊	◊		Latent	5
	PCCCs never tested.				◊					Latent	7
	1 of 2 PCCCs required were installed.			‡	◊	◊		◊		Latent	5,6,7
	Crew not trained to install PCCCs.			‡	◊	◊		◊		Latent	5,6,7
	PCCC not reinstalled after cleaning casing threads.			◊	◊	◊		◊		Active	5,6,7
	PCCC not reinstalled initial kick.			◊	◊	◊		◊		Active	5,6,7
	BOP not used.			‡			‡			Latent	3

Key

◊: Denotes that the classification of the error can be made with a high degree of certainty based upon the supporting evidence.

‡: Denotes that the classification of the error is made with a lower degree of certainty because of the lesser supporting evidence.

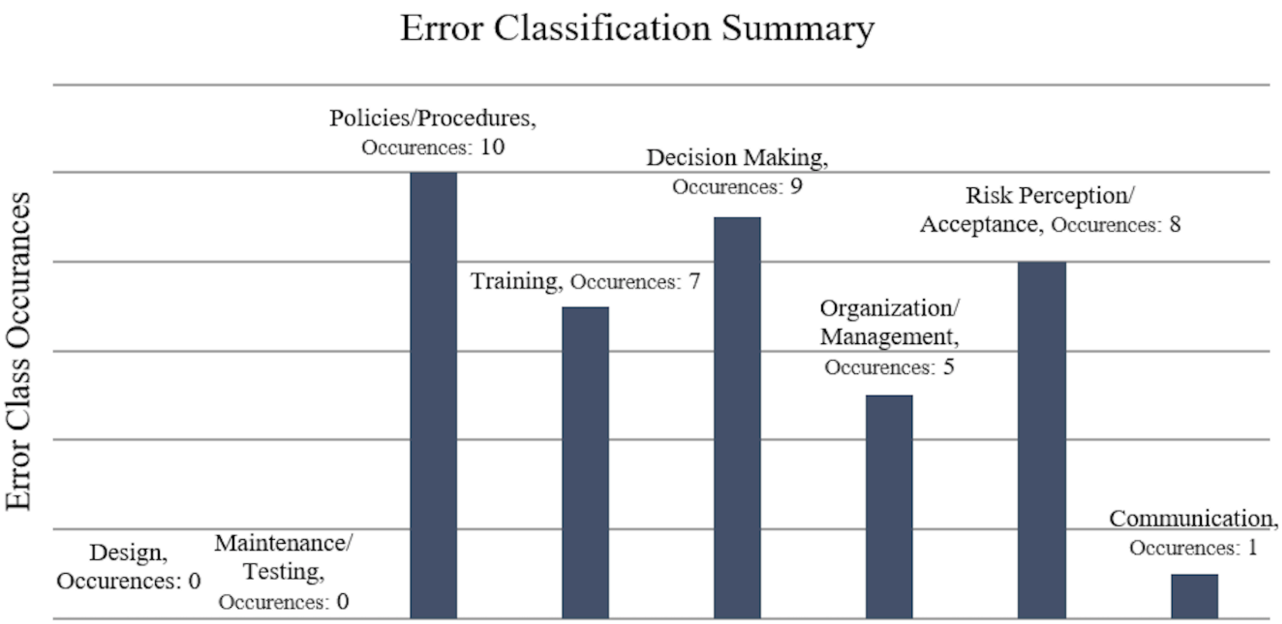

Figure 1. Montara incident error classification summary.

CONCLUSION

A collection of errors made at the Montara wellhead platform were latent errors that could have prevented the Montara H1-ST1 well blowout. The decision to leave the well unsecure to the atmosphere was an active error which directly led to the release of hydrocarbons. There were many levels of employees from multiple companies and agencies whose errors contributed directly to the disaster.

After the relaxation of Australian off-shore drilling regulations in 2004, PTTEP and other companies were self-regulated, by what the Australian Government deemed best working-practices, with minimal governmental oversight. Training and understanding responsibilities of platform supervisors and operators in combination with following industry guidelines, best practice procedures, and safe work practices are critical to avoiding a disaster. Ultimately, deviations from DWOP and the failure to implement standard guidelines, procedures, and practices led to the Montara well blowout and one of Australia’s worst oil-related disasters.

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