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Innovations in Rig Surveys Increase Reliability

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Abstract

The past 20 years have witnessed the increased use of third party surveys to assist operators and drilling contractors in reducing equipment related NPT (Non-Productive Time) that is so costly to both. Due to the increasing complexity and sophistication of both equipment and drilling programs, particularly in the offshore floater arena, it has been necessary for these surveys to become increasingly refined to continue the progress made in NPT reduction. Unfortunately, this growth has sometimes resulted in occasions of frustration and decreased manpower utilization for a variety of reasons.

This paper utilizes a case study approach to illustrate benefits realized from identifying potentially significant issues as a result of innovations in rig survey techniques and systems. These innovations span a wide range, from processes to staffing to technology application.

Introduction

When the first third party rig surveys were conducted in 1984, the parties involved found the review by a different set of eyes and an independent perspective valuable on many fronts. Often, the findings suggested that a false sense of confidence could result if considering fitness for purpose based only on the lack of NPT. In order to have equipment and system deficiencies cause NPT or lesser inefficiencies, specific operating conditions must arise that are impacted by the particular deficiency. Latent or undetected inadequacies can be particularly problematic in the case of safety related equipment.

The increased frequency with which third party surveys now occur in some areas and types of rigs have led to a different type of concerns to the parties involved. Redundant activities have resulted in inefficient manpower use and frustration precisely in those situations when time is critical, such as the window between wells. This happens for a variety of reasons, including surveys being conducted:

- Without consideration of prior surveys,
- With generic procedures not customized to the job's specific requirements, namely, equipment installed, reservoir and drilling program particulars, and regulatory requirements,
- Without sufficient survey personnel depth to continue high intensity rig based activities when unusual circumstances are encountered that require research with vendors or corporate experts.
- With personnel not familiar with newest technology or recently experienced failures elsewhere in the industry, and
- Without consideration of all on the team (operators, drilling contractors, and other service providers).

Attention to these enumerated issues by their nature can have two quite obvious effects:

1. a reduction in the days spent on rigs, and
2. the migration of some work onto technical staff remote from the rig.

Although the resultant efficiencies are welcomed especially by both operators and drilling contractors (who pay the cost for these consulting services, either directly or indirectly), most survey companies consciously or unconsciously resist the adoption of modern techniques and systems because they negatively impact short-term billings and margins and require a different philosophical focus. Stated differently, the value provided by all third party surveys, reflecting the combination of direct consulting cost, focus on areas with the most prospective impact, and likelihood of identifying all issues that can negatively impact drilling operations, varies greatly.

Overview

Inspection and testing has long been accepted as a significant component in ensuring that your drilling rig will be able to conduct your planned program at peak safety and efficiency while avoiding environmental releases. Accordingly, every rig undergoes some review prior to spudding at least the first well on each drilling program. Some are also surveyed at various periodic frequencies. However, there is a tremendous range of what these inspections include and how they are conducted.

A flow chart describing one process for planning and executing inspection programs can be found in Figure 1. Review of this process will also reveal components designed to allow continuing technical improvements to the system, which is obviously critical to performance improvement.

The paper is organized to provide explanations of factors, details, and the reasoning behind many of the items in this illustrative process, using a few case studies to demonstrate the reliability enhancements that resulted from recent innovations.

Survey Planning

Most industries have learned that there is always a tradeoff between planning and efficiency of execution. While every program balances the two based on situation and risk parameters, only the inexperienced starts without a plan of some sort.

Definition of Objectives

The first key point is the definition of inspection objectives. Objectives are impacted by risk analyses, drilling program and location, and prior experience with a given program, equipment, rig and/or drilling contractor and their staff. Once objectives are determined, work scope can be defined and the best company selected.

Scope can vary from a one day “subjective feel” to multiple week comprehensive reviews. Individual inspector expertise ranges from a generalist to third parties with narrow specialties. While generalists, often the company man to be assigned to the rig or between drilling assignments, or a former operation (only) experienced drilling contractor, are frequently effective in spotting big picture deficiencies quickly, they most often are unable to suggest possible solutions as they are accustomed to depending on the expertise of rig technical staff. Therefore, the definition of inspection objectives is critical to determining the optimal survey company.

Specific examples at opposite ends of the survey objective spectrum may best illustrate this range of possibilities.

At one extreme, a semi-submersible overview inspection with the objective of identifying potential areas of major impact to the drilling program could be desired. In order to accomplish this broad scope, but limited depth inspection, a single inspector spending seven days on the rig might be most appropriate. This inspector’s skill level could be that of almost anyone that has spent considerable time on an operating floater. Unless the individual had significant experience in maintenance, the findings one might expect would be broad descriptive analyses of generalized capabilities mixed with specific deficiencies that were obvious after only a brief review. While hopefully recognizing the limitations of this style of inspection, the client would receive assurances that significant deviations from “normal oilfield practices”, if any, were identified.

The desire for a comprehensive, in-depth inspection provides a clear contrast to the previous example. The objective would be to identify critical rig components (equipment and systems, procedures, or staffing issues) that could be expected to cause your drilling program downtime, reduced efficiency, and safety or environmental events. While some consider this prudent for any offshore program because of the cost of drilling with floaters, others might only entertain this depth when planning for a group of exploratory wells encompassing a long time frame in different prospective areas. High pressures and temperatures or sour gas possibilities would also increase the justification for this type of audit. To meet this inspection objective, as many as four inspectors might best be used, each spending 10 to 20 days on the rig. Their specialties might include 1) well control, 2) drilling and mechanical, 3) electrical and dynamic positioning, and 4) marine, safety, and environmental.

Findings would be very detailed, including items such as testing of specific safety devices and/or software (e.g. recovery from black ship), procedure critique (e.g. riser retrieving procedure does not take advantage of possible unique inspection opportunities), and staff capabilities (e.g. inability to describe the correct response to operating events, regardless of training certificates held). With this type of inspection, it is critical to focus on items most likely to impact the critical parameters of safety, environment, and cost. If the stated objective were to review “everything” on the rig, many additional man months would be required. While certain items such as galley sanitation and refrigerator/freezer operation are critical to staff health, attitude, and outlook, deficiencies in these areas quickly become self-evident. Additionally, reviews in these areas can be more cost effectively conducted by lesser-paid professionals. The tradeoff between time spent on the rig and the impact of events suffered from issues not identified can only be done by companies experienced in this analysis.

Procedures Preparation

Once objectives are defined, the list of possible qualified service providers can be generated. While all programs can benefit from using those providers most technically competent with the necessary support staff and information tools, it is especially important for high impact programs and those with unusual or high profile risks. A checklist of the most important capabilities of service providers can be found in Table 1 on the next page.

As noted in Figure 1, optimal results can be expected if the survey procedure utilized takes into account industry standards, regulatory requirements, vendor recommendations and revisions, and prior known failures on other rigs, as well as recommendations from previous surveys. Procedures customized with these data sources can mean the difference between identifying a deficiency and having it go unnoticed.

Two examples illustrate the value of the inclusion of these data sources.

Table 1
Survey and Consulting Qualifications Checklist

Qualification	Provider #1	Provider #2	Provider #3
1. Engineering Capabilities			
A. Number of degreed engineers on staff			
B. Number of licensed professional engineers			
2. Head Office Engineering Support of Field Personnel			
A. Number of full time personnel			
B. Number split between office and field personnel			
3. Number of Experienced Project Managers on Staff			
4. Information Databases (yes/no)			
A. Equipment problem database			
B. Manufacturers' information database			
C. Prior survey records			
5. Quality System Certification (ISO 9001-2000) (yes/no)			
6. Safety Management System (yes/no)			

Case Study #1 – Hydraulic Connector

The innovation highlighted here is the development of several information databases and the procedures implemented that result in identifying new and changed knowledge.

A rig in the Australasia region was unable to unlatch the wellhead connector after finishing drilling a well in the third quarter of 2004. All resolutions attempted were unsuccessful, which required cutting off the wellhead to retrieve the BOP stack. Investigations of the root cause were unsuccessful, since neither the wellhead nor the connector inspections and detailed measurements revealed a plausible explanation. Four more wells were drilled without an additional incident with this connector.

However, when the fifth well was completed by another operator, difficulties were again experienced in unlatching the well connector. 5300 psi applied with a ROV finally unlatched the connector on this occasion.

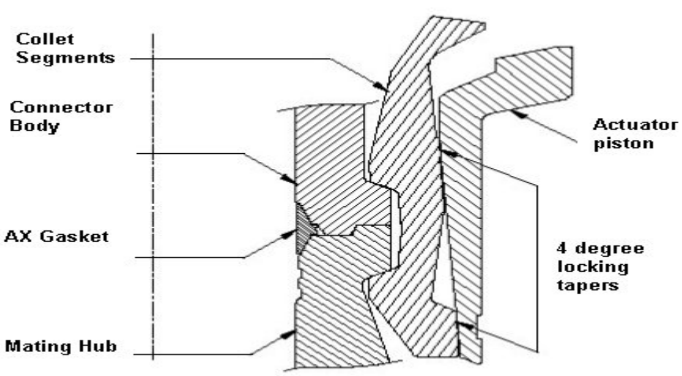

Figure 2 Connector Cross Section

In reviewing several proprietary databases, information suggesting the probable root cause was retrieved.

The prior failure database recorded an incident report dated September 2000 with similar connector unlatching problems. This report identified the cause as the incorrect coating being applied to the actuator piston. Reference Figure 2 for the relationships between the various parts of the connector. It further referenced the vendor's engineering bulletin, 2nd revision, dated April 2002, describing coating and lubrication requirements for the actuator piston of this company's connector. A photo of the piston with the correct coatings can be found as Figure 3.

Figure 3 Connector Actuator Piston

Although the expected root cause was never confirmed because of the replacement of the problem connector, the rig management stated that earlier investigations did not mention either actuator piston coating or lubrication. Considering the dates of both the prior failure and the vendor's technical publication, it is possible access to this information would have identified the deficiency prior to the first failure, and more certainly the second. Without the databases and an active procedure to identify new information both from vendors as well as from other surveys, knowledge such as this would not become available quickly. In this case, this knowledge took over two years from publication dates.

Case Study #2 – Riser Fasteners

The value of centralized technical support remote from the rig is the innovation of note in this case study.

Failure analysis by the riser's manufacturer determined a latent problem developed over time with the fasteners used. Simultaneously to the release of this report, a survey was being conducted in a yard in West Africa. With the release of the failure analysis, the surveyor was requested to run an additional set of tests, which resulted in identifying a number of fasteners that were not fit for purpose and required replacement. Interestingly enough, the vendor had representatives in the same yard on the same job and was unaware of the new inspection requirements.

Survey Execution

No one likes surprises.

Most rig surveys are conducted within time constraints, commonly the time available on the transit from one location to another or between wells. As a result, the better each of the parties doing work on the rig understand what the other is trying to accomplish prior to the beginning of the time window, the more time these parties can spend doing their workscope rather than discussing it. Again, two case studies provide examples of how the early steps in survey execution led to improved results.

Case Study #3 – DP Survey

Home office technical support and the process of a pre-survey meeting including operator, contractor, and survey company are the innovations providing operational benefits in this example.

One operator experienced a number of smaller problems with station keeping with the DP rig they were using, prompting the commissioning of a DP survey. A procedure reflecting the various information inputs depicted in Figure 1 was prepared and transmitted to the client (the operator), who transmitted it to the contractor. The three parties subsequently met to discuss the goal and objectives of the survey, as well as the specific means planned to accomplish this.

The opening statement by the drilling contractor was concern over the time anticipated to complete the procedure, coupled with his limited expected value. As a result, it was agreed to walk through the procedure one line item at a time, allowing all parties to discuss the technical merits of the item versus other parameters, the major ones being time to complete, prospect of identifying deficiencies, and rig staff required to support the testing.

After the entire 22 page procedure had been completely reviewed, only two items were deleted. All agreed that, although the meeting lasted almost two hours, the value of achieving consensus on each detailed step of the procedure was tremendous. Although no major findings were identified, the cumulative effect of resolving a number of smaller issues resulted in subsequent trouble free DP operation. The satisfaction of both parties was validated by the fact that both of them subsequently used the survey company soon thereafter on other rigs.

Case Study #4 – Ram Locking System Predictive Testing

The benefit of the innovation of staffing depth which includes licensed professional engineers working as technical support to the field personnel is demonstrated by this case study.

As ram locking systems wear, their performance deteriorates. Many years ago, the application of API Specification 16A recommended wellbore pressure testing using locks only (close hydraulic pressure vented) began to be used offshore when stump testing. While innovative at the time, these locks only pressure tests only demonstrate satisfactory current performance; they do not provide any indication of how long they will continue to do so. After studying a published technical bulletin, in-house discussions resulted in the development of a procedure to predict future failure of ram locking systems. See Figure 4 for before and after predictive tests, demonstrating their benefit. The significant engineering principles behind this particular predictive test include friction, force vector analysis, and deflection. The procedures provide background and historical data as well as specific test equipment and procedures. They also include a detailed cutaway drawing and excerpts from pertinent vendor technical publications. A series of three tests conducted using this predictive technique illustrates its effectiveness. You should note that the ram successfully passed standard wellbore pressure tests prior to identifying unacceptable locking system condition.

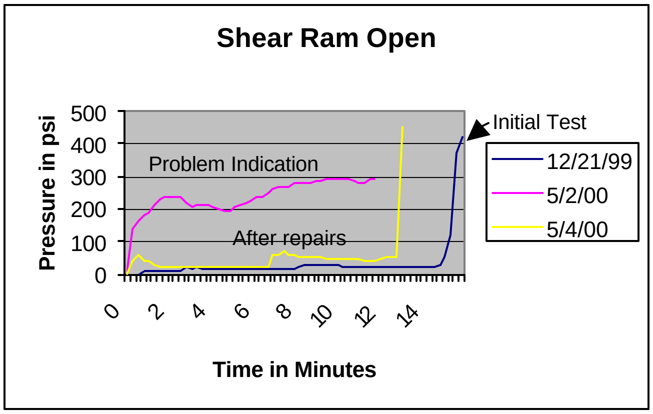

Figure 4 Predictive Tests

Today, predictive tests for major ram manufacturers have been developed. Although the optimal equipment to conduct this test is minimal, discussions between the survey company and the drilling contractor once again allow adequate preparation prior to the survey, accompanied by a clear understanding of what is desired and why it is of value.

Technical Review

It is literally impossible for even the most brilliant individual working by himself conducting surveys or reliability studies to accomplish the same consistently top value results as a group of people synergistically operating under a system that takes advantage of their individual knowledge and makes it available to all.

A key attribute of organizations that manage to identify, categorize, collate, and distribute information effectively throughout the company is the position(s) of individual assigned as technical reviewers. The simple and obvious result of a technical review is ensuring technical accuracy, utilization of all known applicable knowledge, and clear articulation of information, integrating and analyzing said information to provide knowledge to clients. This by itself is critical to maintaining quality on all surveys.

A less evident function of this technical review is the identification of new data. When the job description of the technical team responsible for reviewing daily and final reports includes this task, it provides the means for continuous improvement. Reviews of the efforts of dozens of people on rigs all over the world allow clients to see the benefits of the application of new knowledge to his operation much more quickly than either just a few people loosely affiliated or large organizations without the requisite people or processes.

Case Study #5 – Drill Floor Equipment Software Setup

The value of reviewing daily and final reports in the identification of new data is demonstrated by this case study.

Many nuisance issues are reported in daily and final reports. These issues do not cause downtime directly, but they do affect the efficiency of rig operation, not to mention staff morale. The technical staff reviewing these reports starts to see a pattern and informs inspectors to be aware of these issues.

Software controlling drill floor equipment is one issue that is seen over and over again. The software becomes slowly corrupted, resulting in an ever increasing number of equipment functions operating in manual override. As a result, drill floor operations run more slowly, since equipment does not run at optimal settings. An inspector aware of this can assist in identifying and solving software issues enabling the operations to run at maximum efficiency.

Conclusions

Every time a rig survey is contracted, whether internally or by a third party, the responsible party knows the objectives he expects to achieve. Only through a comprehensive understanding of the inspection objectives, the various factors that impact the quality of the inspection, and the required capabilities of the survey company and the field surveyor(s) can one's goals be realized. Clearly, results will vary as a function of these parameters. When state of the art processes and technology are coupled with technically excellent people, the reliability of your rig operation will be improved, maximizing your drilling budget.

Acknowledgments

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Nomenclature

Acronyms used in the paper are defined below.

API = *American Petroleum Institute*
BOP = *Blowout Preventer*
DP = *Dynamically Positioned*
NPT = *Non-Productive Time*
ROV = *Remotely Operated Vehicle*

Figure 1 Rig Survey Process