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Inspection Quality Depends on People, Procedures, and Policies
Not All Acceptance Tests are Equal

Summary

There is a proven, direct relationship between quality equipment, operating and maintenance practices, and the cost effectiveness of a drilling operation. A significant component in maintaining quality is adequate rig inspections. However, your selection of inspection companies and who that company sends to your rig are the major factors in whether deficiencies that will cause downtime, safety, or environmental incidents are identified.

This paper utilizes a case study approach to illustrate specific critical deficiencies that were not identified by the prior audit(s). Following the presentation of the case studies, reasons for differences in the effectiveness of a given inspection and testing program are suggested.

Background

Inspection and testing has long been accepted as a significant component in ensuring that your drilling rig will be able to operate at peak effectiveness. As a result, every rig undergoes some inspection prior to spudding the first well on each drilling program. However, there is a tremendous range of what these inspections include and how they are conducted.

The first key point to establish in comparing results is the definition of inspection objectives. Objectives are impacted by risk analyses, drilling program and location, and prior experience with a given program, equipment or contractor. Once objectives are determined, work scope can be defined and the best company and inspector selected. Scope can vary from a one day "subjective feel" to multiple week comprehensive reviews. Inspector expertise also varies greatly from a generalist working for the operator (often the company man to be assigned to the rig or one between drilling assignments) to third parties with narrow specialties. Only when the inspection objectives are coupled with inspectors of the required skills can one compare inspection findings or evaluate the previous audit(s) for your particular needs.

Specific examples at opposite ends of the spectrum may best illustrate this findings and inspection objectives relationship.

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 prior background could be as a drilling contractor's rig manager. In reviewing the findings, one might expect broad descriptive analyses of generalized capabilities mixed with specific deficiencies that were obvious to the inspector after only a brief investigation. While hopefully recognizing the limitations of this style of inspection, the customer would receive assurances that significant deviations from "normal oilfield practices", if any, were identified.

A comprehensive, in-depth inspection provides a clear contrast to the previous example. The objective would be to identify critical rig components (be they equipment and systems, procedures, or people issues) that could be expected to cause your drilling program downtime, reduced efficiency, safety or environmental events. This objective might be contracted 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 the inspection objective, three inspectors might best be used, each spending 20 days on the rig. Their specialties might be 1) well control, 2) drilling, electrical, and mechanical, and 3) marine, safety, and environmental.

Findings would be very detailed, including items such as inspection and testing of specific safety devices (e.g. overspeed trip of the generator engine) and procedure critique (e.g. emergency disconnect procedure not sufficiently clear to ensure correct sequence of actions). With this type of inspection, every subsequent event impacting the drilling operation should be analyzed to identify possible improvements to future inspection programs of this type, while acknowledging the tradeoff between time spent on the rig and the impact of events suffered.

With this understanding of inspection objectives and work scopes, the case studies can be reviewed and compared with the goal of understanding why identified deficiencies were possibly overlooked in prior inspections.

The Case Studies

Inspections are conducted regularly on rigs for a variety of purposes. In selecting studies for this paper, critical parameters to be met included identifying inspections conducted within close known proximity to other inspections. However, as noted in the background, the objectives of the prior inspection were not known. At the same time, as these items are discussed, you will realize that the critical deficiencies highlighted were highly likely to impact rig operation, yet were limited to those problems that almost certainly existed at the time of the previous audit. This means that the prior drilling program was conducted with these deficiencies. Thus, whatever safety, environmental, or downtime risks were associated with using equipment in this condition were unknowingly accepted. In several of these cases, the second audit was contracted only after suffering downtime to identify and correct the cause of such downtime and possibly to see if other important deficiencies were overlooked.

A corollary to this opening idea is the need for recognizing and clearly transmitting inspection objectives. Not infrequently, significant equipment or systems related events or near misses occur which might have caused downtime, serious safety, or environmental problems. These might not really be a surprise if the objectives were articulated when the inspection was contracted. At the same time, not all inspection companies have thought through this aspect of conducting inspections.

The fact that rigs are audited regularly increases the likelihood that they have been held to a high degree of fitness for purpose. On the other hand, once again you must ask both about the inspection objectives and quality. The following case histories illustrate differences between inspection findings and how these differences impacted the subsequent drilling programs.

Case 1: Rig in Southeast Asia; Operator contracted inspection

In early 1994, this rig had experienced significant BOP related downtime. 142 days into a drilling program that was originally anticipated to take 70 days, the operator's resident drilling manager called WEST to see if we might offer a solution to his array of problems. The rig had originally been accepted by another company, and this company had been back to the rig to suggest solutions to the extensive BOP problems without success.

A WEST consultant was mobilized to the rig. Before the rig resumed drilling, he had assisted both on the rig and with shop repairs. Although a complete audit was not done, he was able to identify and implement solutions to the list of problems plaguing the operation.

Major deficiencies included:

1. The McEvoy wellhead connector required shop repairs due to a washed out AX ring groove.
2. The male kill line connector retaining nut catastrophically failed, causing damage to the kill outlet beneath the lower pipe rams. This damage required shop repairs.
3. The lower annular was replaced due to its failure to drift test and severe wear.
4. The shear rams leaked. Hydril's latest lateral T seal design had not been installed.
5. The BOP stack mandrel was repaired in-situ following the initial inspection. This repair was unsuccessful and the AX ring groove failed again during the first well.
6. Hoses for the ram BOP functions were not rated to 3,000 psi, the maximum working pressure of the ram operating chambers.
7. Equipment damage occurred when the bridge crane failed during BOP handling.

Recalling that a comprehensive inspection and testing program was **not** conducted, the above list of deficiencies becomes even more significant.

Case 2: Rig in Southeast Asia; Operator contracted inspection

Before this rig was deployed from the Mediterranean theater to Southeast Asia in early 1994, the operator contracted another company to provide acceptance testing. Because the stack was to undergo some modifications upon arrival in Singapore to prepare for their high temperature drilling program, the operator’s drilling manager decided to have the stack re-inspected by WEST.

There were several items identified that should have been found on the earlier audit (and were not affected by the modifications). The more significant included:

1. A wellbore test could not be achieved with the middle pipe rams using the Shaffer Multilock. Locking pressure for the upper pipe rams was too low, 400 psi, as opposed to the Shaffer recommended pressure range of 1,000 - 1,200 psi.
2. Wellbore pressure leaked from the ram shaft packing of the middle rams.
3. The upper outer kill AF valve that was installed backwards was corrected. This prevented the valve from becoming hydraulically locked in the closed position, preventing future ram shaft failures.
4. Wellbore pressure leaked from the wellhead connector during stump testing. The connector was disassembled and cleaned onboard the rig to increase the stroke of the connector and obtain a wellbore seal.
5. Wellbore fluid leaked from the choke stab between the LMRP and BOP and was visually detected. The kill stab required shimming.
6. Fifty percent of the choke and kill lines on the Vetco riser had no end float. Shims were in the c/k lines; Vetco has advised shim removal since 1981.

This operator also has a policy to conduct inspections at least annually when they use a rig on an extended contract. When the annual inspection was due on this rig, a full rig inspection was contracted. The significant drilling systems findings included the following. Again, the following list only includes those identified deficiencies which most likely did not develop in the prior 12 months, but had existed through this operator's prior 12 month operation:

1. The mud pit room was inadequately ventilated.
2. Hydrocarbon oil/fuel transfer hoses were unmarked and untested.
3. Mud pump suction manifold relief valves had ball valves installed underneath them and were not secured.
4. No eye wash stations were installed in mud mixing hopper or water maker areas.
5. The breathing air compressor did not have an oil scrubber and carbon monoxide filtration with warning device installed before using system to refill bottles for use.
6. The main engine exhaust required modification to eliminate rig breathing hazards.
7. Landing, ladders, and handrails on the emergency escape routes from the living quarters should be replaced.

8. No warning signs regarding gas alarm and actions to shut down laundry equipment were posted in laundry room. Facilities are close to substructure and area was not sealed off in event of gas escape from wellbore.

9. Air receivers and dry chemical surge can did not have pressure relief valves installed.

Case 3: Rig in Southeast Asia; Operator contracted inspection

This operator's current operating policy is to conduct what is one of the more extensive audits in the industry before accepting a rig for its floating drilling programs. Their in-house lists provide a level of consistency in the audits conducted by third parties for them. This particular case underscores the importance of technically qualified consultants, even when the inspection procedures are comprehensive.

This rig was inspected by another company prior to the short drilling program immediately before this operator picked up the rig. In this instance, WEST provided not only a BOP inspection, but also the rest of the rig, including an in-depth safety and marine survey.

The list of deficiencies was extensive. Some of the more significant ones which most likely had not just developed during the prior short drilling program include:

Well Control Equipment

1. Wellbore pressure leaked from seven of the eight ram shaft packing vent ports. These ports were discovered to be plugged. This bad practice masked the leaks and allowed the wellbore pressure to pass into the BOP control system on the open side of the rams.

2. There were inoperative Shaffer Multilocks on the UPRs and incorrectly adjusted Multilocks and Poslocks on MPRs and shear rams.

3. Cracks were found in two Shaffer ram holders and three ram connecting rods.

4. The Vetco wellhead connector would not release due to insufficient gap between the upper wear band and the dog segments.

5. Wellbore testing failed on the Hydril annular. A seal had been installed upside down.

6. The upper outer AF kill valve had an obsolete bladder in the operator.

7. Over 40 discrepancies were noted within the control system during the preliminary function test.

8. Two cracks were found in the telescoping joint at the inner barrel lock.

9. Two 50 foot riser joints and three pup joints had insufficient wall thickness.

Other Rig Equipment

1. Low rotor resistance was measured on a generator, requiring shop repair or replacement.

2. Numerous motor heaters were inoperative.

3. A SCR bay was inoperative.

4. Ballast system pumps were inoperative, valves leaking, and gauges out of calibration.

5. Weight/load moment indicators on the Markload were inoperative.

6. Excessive corrosion was found on the port crane boom and lacing, warranting NDE.

Considering the proximity to the prior inspection, one would not have expected such a long list of items requiring repair or replacement. A likely conclusion would be that this inspection was inadequately done due to different work scope, other priorities, insufficient procedures, or less qualified personnel.

Case 4: Rig in Southeast Asia; Operator contracted inspection

Again, this inspection was a parallel to case #2 - an annual audit conducted on the drilling systems one year after the original acceptance inspection was completed by another inspection company.

1. Hydrocarbon oil/fuel transfer hoses were unmarked and untested.

2. No potable water treatment and testing program was in place.

3. Derrick deficiencies previously identified by Pyramid were not corrected.

4. Anti-jump protection was not properly installed on both sides of crown block assembly sheaves.

5. Crown block bumper block was mounted above steel spreader beam.

6. Crown cluster pin retainer bolts were not lockwired.

7. No traveling hook track roller guards were installed to prevent rollers from falling to rig floor in the event of failure.

8. Sack room/chemical mixing area ventilation was inadequate.

9. No relief valves were installed on bulk storage surge tanks.

10. Main diesel engine salt water heat exchangers were severely corroded.

11. No eye wash station was in water maker area.

12. No relief valves were on engine room and sub-base air receivers.

13. Protective devices on main AC switchboards had not been tested for two years.
14. Lines and valves on mooring hydraulic systems were severely corroded.
15. Numerous safety warning signs were not posted, schematics not installed, and procedures not in place.

Case 5: Rig in Southern Africa; Operator contracted inspection

In the last quarter of 1995, rough weather due to a storm prompted the decision to unlatch the stack and move off the wellhead until the weather improved. The stack was hung off with a landing joint in the rotary and the slip joint in the collapsed position and locked. The stack remained in this position for about seven hours in rough seas. As the rig began moving back to the wellhead to reconnect, the slip joint failed, extended, and the rig lost the stack and riser in 2,000 ft of water.

During the course of the final acceptance testing, the consultant discovered that the diverter control panel was physically installed, but the control tubing not connected. This was a particularly significant deficiency when drilling in deep water, since you effectively have wells both above and below the stack on the seabed. The drilling operations plan included the operation of the diverter.

As you reviewed these lists of deficiencies, you saw the number and potentially serious nature of items uncovered that others missed. Admittedly, no one is perfect. However, when time after time additional non-conformances are identified immediately after others completed their audits, you become compelled to begin to draw conclusions about the differences in the quality of the services normally received.

Case Study Post Mortem - Why Were There Differences?

Upon reviewing the above case studies, there is no doubt that not all inspections are equal. With the assumption that in most of the instances the objectives were at least similar, the question that arises is, “Why were there such significant findings so soon after the prior inspection?” There may well be two expected parts to the answer, a) that the deficiency arose after the previous audit, or b) the inspections were in fact quite different. Although the possibility of having surfaced between inspections exists, the case study items were selected for the paper on the basis of that being unlikely. Therefore, in answer to the question, “Why were there differences?”, three critical reasons are proposed:

"The Three Ps"

1. People,
2. Procedures, and
3. Policies.

Again, this commentary assumes that the objectives of the inspection were identical, which is often not the case.

The impact of each of the “Three P's” will be reviewed. Critical components of WEST's “Three Ps” are described to provide you a basis from which to help you select your next inspection company to ensure the best value. Finally, quality programs, including certification by ISO, API, etc. will be briefly reviewed, as well as what guarantees such certification provides you.

People

Everyone in the drilling industry recognizes that the division of labor exists to allow people to specialize in specific areas. As individuals progress in experience, their job descriptions might also grow to include supervision of specialists outside their own personal area of expertise and training. Over time, additional knowledge is gained when working with these other specialists through problems that occur.

As a result, the best people conducting inspections are those with many years of working on drilling rigs. However, even with 20+ years in the business, it is not realistic to expect one individual to possess sufficient knowledge and experience to single-handedly and comprehensively inspect a floating drilling rig. In this instance, most inspections should consider at least two, perhaps three people with knowledge more limited in range, but more comprehensive in depth. At the other extreme, it is often not cost effective to use more than a single person to inspect a land based rig for most programs. Thus a balance must be struck that considers factors such as rig and drilling program complexity, cost of operation, and so forth.

Currently, the fourteen employees and contractors working for WEST have cumulative experience of 309 years, averaging 22.1 years per man. When you then consider that a considerable amount of the accumulated time included working in the capacity of subsea or rig engineer, you know that your inspector will be able to identify (and suggest solutions to) deficiencies which can significantly impact your program. Contrast this experience with that of some inspectors who have worked in the capacity as rig manager or tool pusher with the “overview” perspective that accompanies this job, rather than the nuts and bolts skill best suited to top flight inspectors.

Therefore, there is a clear tradeoff when considering inspection scope, degree, and staffing. Although a better qualified inspector can compensate in some degree for deficient procedures, your inspection is always limited by your inspectors’ knowledge and experience.

Procedures

Inspection procedures vary widely in format and content. At the same time, they can be generally grouped according to what is included in and excluded from them.

The most commonly used procedure can be identified as the checklist type. This type is characterized as containing simply a list of the equipment to be reviewed. Some might include subassemblies and/or specific features and functions. The biggest drawback to this procedure is the variability of the inspection depth since it is so heavily dependent upon the knowledge and experience of the person conducting the inspection.

The procedure that provides the most consistency is one that is prescriptive in its description of the required inspections and tests, the method by which they should be conducted, and the criteria that determine acceptance or failure. Clearly, this type of procedure is difficult to write in adequate detail. However, once written, they can be reviewed and enhanced by many people, which results in including the expertise of many individuals. The importance of detailed procedures increases as the inspection comprehensiveness and depth increases for a given group of inspectors.

As an example, an elementary, though often overlooked procedure of this nature is one that describes an acceptable pressure test. Components of this procedure would optimally include size and range of pressure gauges, range and speed of chart recorders, required times to maintain pressures at specified levels, and acceptable leak rates (or no visible leaks as specified in API Spec 16A).

WEST's uses several types of written procedures for maintaining technical excellence and consistency. One type of written procedure is our ITP (***Inspection and Testing Procedure***). Now over 60 in number, these ITPs were written to take advantage of the accumulated experience of all WEST staff. They are detailed, very prescriptive in nature, and feature specific acceptance criteria. Thus, the best known techniques for identification and correction of uncovered deficiencies will be consistently applied. ITPs are the vehicle used to accomplish the transfer of knowledge to each employee.

ATPs, (Acceptance Testing Procedures), are the second type of written procedure. These are more broad based procedures customized for a specific inspection. Factors affecting the ATP include type of rig, location, geographic area (and associated regulatory requirements), critical reservoir fluid characteristics (H_2S, high temperature or high pressure), and special customer requirements, which includes their risk analysis. ATPs reference ITPs, as appropriate, and offer the customer the opportunity to understand the recommended procedure and modify it to reflect their priorities and concerns.

Policies

Critical as people and procedures are, without policies in place to clarify the standard way to use the available tools, inconsistencies in inspection quality are quite likely. The key policies relate to the quality system.

Recently, attention to quality systems has increased greatly. As a result, there have been a number of organizations who have developed similar standards for quality systems, the most common being those by API (American Petroleum Institute) and the International Organization for Standardization, also known as ISO. While both have made great strides in helping companies improve their quality policies, there are many who do not really understand what certification to these standards really mean.

As described in more detail in another paper presented at this conference, certification only has meaning when the standards to which it was certified are also understood. Quality certification by either API or ISO includes critical policy areas to ensure good communication between vendors and their customers, as well as consistency of the quality of the delivered goods or services. However, notice the key thought with this statement, namely, the quality is consistent. This does not indicate high quality, simply consistent quality. Thus, it would be a mistake to conclude that a company that has obtained quality certification provides better quality goods or services that one that has not been so certified, rather that the quality you receive will most probably be consistent every time you purchase.

A good, yet simple, example is the quality of a purchased hamburger. When you go to a major hamburger chain anywhere in the world, the hamburger you buy will be exactly like the last one you bought anywhere else in the world. Now this hamburger may not be your favorite. You might not even really like this hamburger. However, the quality policies of this chain provide you an assurance that the hamburger will be the same. If you go to another hamburger outlet that is either a regional chain or an independent store, you really don't know what you will get. It might be better than those bought at the major chains, it might not.

Although WEST's quality policies have not yet been certified, effort is underway to be certified to ISO 9002 standards. However, many of the requirements of such certification have been implemented by WEST years ago in recognition of the value to the customer of internal quality systems and policies. WEST considers it particularly important, as an inspection company, to maintain high quality standards because our job scope is to identify problems which are often related to quality system deficiencies for our customers.

Conclusion

Every time an inspection is contracted, whether internally or by a third party, the client knows the objectives he expects to achieve. Only through a good understanding of the range of inspection objectives and the various factors that impact the quality of the inspection can one's inspection goals be reached. However, a good understanding of the inspection process will allow the careful selection of the inspection company (and/or inspector) through a review of their past results or their published people, procedures, and policies. This, coupled with a clear description of their inspection objectives, will ensure that the inspection process will provide the dividends desired.