AADE -04-DF-HO-44

Field Application of "Integrated Fluids Management"

Mario A Ramirez, Jose Limia, Baker Hughes INTEQ Drilling Fluids;
Cecilia Suasnabar, Roxana Pozo, BP Bolivia

Abstract

Environmental law has been historically dominated by national regulations commonly known as"command and control" frameworks. However, it can be demonstrated that creating market-based incentives and allowing the industry to self-regulate could achieve even improved levels of protection. The most important step of the new approach is the use of an environmental management system (EMS).This system follows a defined sequence of steps, drawn from established project management practices routinely used in business management, with the objective of achieving continuous improvement. Throughout this document this management system will be referred to as Fluids Environmental Services (FES). Within BP this process is known as PFM (Performance fluids management) and applied in all of its global operations that integrate drilling fluids, solids control and waste management services.

This paper presents the results of the process implementation made by BP in Bolivia during 2000 and 2001. The data related to Fluids and Waste Management cost for three wells is presented. The historical data showed that the Fluids Environmental Services cost were reduced during 2001 as a consequence of the process implementation. In addition, the new EMS became a core for BP's subsequent ISO 14001 certification.

Introduction

The Oil and Gas Drilling Industry has been the focus of new environmental regulations around the world for the last 20 years. The main focus of these new regulations has been the control of the "quality" and the "quantities" of drilling fluid discharges. These environmental regulations have developed in different directions. Thus, some areas such as the North Sea have evolved into what is known as "zero discharge" for invert emulsion drilling fluid, whereas others had a more practical approach and have implemented some controls on the quality of the discharge, which leaves open the discharge option.

The environmental regulations of a country very much define the technologies to be used for compliance. For example, dryers are used to minimize discharges, but ship to shore or cuttings re-injection is required for areas operating under zero discharge regimes.

Once the technological needs have been outlined by the regulatory requirements, the contractor for the provision of environmental compliance services has to be selected. This selection process could be complicated. Most service companies can offer the same technologies, with minimal differences. Because of the lack of clear technological differentiation, often contracts are awarded based on unit prices. However, some projects are more successful than others, even when utilizing the same technologies. This is a good indication that the best differentiation between contractors comes with the application of the technology and the execution of the job, and not necessarily with the technology itself.

The introduction of a quality process in the drilling operation refines the evaluation of performance and can also be applied in the area of drilling fluids waste management. Indirectly, the improvements in the capability of measuring and reviewing performance will result in improvements in the environmental performance of drilling activities. Cost reductions resulting from efficiencies in the overall drilling process can also be expected.

The increased visibility that characterizes quality management systems fosters more active participation in the decision making process from field and office personnel. The result is a situation that evolves from a typical command-and-control condition into a collaborative system to deliver improved execution. The improvements that have been noted are not only related to Drilling Fluids and Waste Management, but also in areas such as HS&E and Well Engineering.

Fluids Environmental Services (FES) Process for BP in Bolivia

The Bulo Bulo field is located in the province of Carrasco, department of Cochabamaba, Bolivia. Cochabamba tropics are located in the Eastern Andean foothills and present exuberant vegetation and a rich variety of fauna in its rain forests.

The Carrasco area population is mainly composed of Indian and "meztizos" and has several

complicated issues with the local communities. The Bulo Bulo field is located near to the town of Bulo Bulo (half way between Santa Cruz de la Sierra and Cochabamba cities) and its development wells are inside a national park. Environmental concerns about the impact of the project as well as the possible contamination of water bodies and rivers that feed the local communities were are great concern during the execution of the drilling campaign.

CHACO's first well, Bulo Bulo 9, had encounter several problems while drilling and a considerable amount of resources were used trying to minimize the environmental impact of the operation. Increased pressure from international NGO and local communities, and the pressure to reduce operational costs created a good scenario for INTEQ's FES implementation

The Performance Fluids Management process[1] was first introduced in Colombia in 1998. This implementation resulted in reduced overall costs of fluids and waste-related activities. The improved environmental performance was demonstrated by a 41% reduction in oily wastes, compared to the 1997 benchmark. The process also has been implemented in Argentina and Trinidad and has delivered similar value to those drilling operations[2].

Expectations

The FES team identified several areas for improvement, as starting points for process development:

1. Communication issues between local waste management contractor and the operator.
2. Lack of commitment and trust between all the parties.
3. Service companies' lack of knowledge of the expectations for the process.
4. The need for project improvement leadership.

To overcome the observed problems, the team defined an organizational learning process that would:

- Define specific goals linked with bottom line performance.
- Ensure that all actions are directed at achieving these goals.
- Remember how decisions were made.
- Accurately monitor performance.
- Build an accessible database.
- Use this database to improve future performance.

After one year of process implementation, a total of three (3) FES projects were completed. These included the Bulo Bulo-11, El Dorado X-1002 and the Camatindi X-1000 operations. The COJ, a shallow exploratory well, was not included as a FES project. However, it indirectly benefited from the process in place. An example of the learning process works is in Figure 2.

Benchmarking and Goals Setting

One of the first steps in a learning process is to develop a database. The purpose of this stage of the organizational learning process was to collect and discuss the past history and performance of the FES-related services in the operations in Bolivia. The cost associated with fluids and waste management was obtained from the Chaco database and it included the cost of drilling and completion fluids, waste management and environmental costs (cuttings downhole injection, land farming), cuttings and OBM transportation, environmental monitoring and location cleaning.

The information obtained reflected actual service companies' invoices and payments by the operator. The information was collected for 1998, 1999 and 2000. In addition to this, total footage and the volume of rock drilled per well were calculated. In-gauge hole figures were used to calculate hole volume due to the lack of information about actual hole sizes in several wells.

The establishment of a database was the foundation to develop the continuous improvement process. It would serve as a key tool in collecting project information and monitoring the performance of the operation once the FES process implementation started.

Once the database was in place, the team defined clear goals for the next well project, the Bulo Bulo 11. The objectives were established per section and reviewed periodically after completing each interval. Both operational and HSE issues delineated the level of performance. An example of those goals included:

- Zero FES-related days away from work resulting from accidents.
- Zero FES-related spills and non-compliant discharges of waste.
- Zero FES-related NPT during the drilling operations.
- Run and cement 12¼" casing within 80% of average historical time for similar sections
- Zero sidetracks resulting from operational problems.

Planning of the FES Process

The FES management system is a total quality process aimed at facilitating the integration of various fluids-related services during a drilling operation. The drilling fluids, completion fluids, solids control equipment, environmental monitoring, waste handling and waste disposal were included in this process. To be successful, the process should extend beyond simple integration and into optimization. The quality cycle that starts with the understanding of the expectations. Relevant data are collected and analyzed, attainable goals are established followed by the execution of operational plans. Finally results are reviewed to evaluate performance and to

initiate a new cycle of sustained learning. A graphic representation of the process is shown in Figure 1.

The first FES contract in Bolivia was signed in March 2000. The Service Company provided fluids and FES technical support for the entire operation, as well as the co-leadership in process development.

Execution of FES Process and Results

Figure 3 compares the FES historical cost in the Bulo Bulo field and the progress that the developing FES approach achieved. However, sustaining the progress required an understanding of what had worked and what needed to be improved.

The figure shows that the cost of FES per barrel of rock drilled increased from 1998 to 1999. This is partially the result of a higher emphasis in HSE that required additional expenditures for environmental compliance.

During 2000 the cost of FES per barrel of rock drilled decreased as well as the cost per meter in all wells with the exception of Camatindi, an exploratory well drilled in a highly sensitive area that featured higher waste management costs.

A normalized figure for FES was used to facilitate the comparison between years and fields and to reduce the influence of optimized drilling practices in the overall FES cost. This normalized figure was calculated dividing the total FES cost by the volume of rock made during a calendar year. Using this approach, it appears that if the wells drilled in 2000 had shown a performance similar to those drilled in 1999, the cost of the operation would have been approximately $3.3 million more. Figure 4

Environmental Performance

Generally speaking the FES cost (per barrel of rock) of the wells drilled during 1998 was lower as compared with 1999. The FES cost increase observed during 1999 is partially explained by a stronger BP focus in HSE to reduce the environmental impact. In addition, the handling of waste associated with OBM required additional investments. The use of OBM, also called for better and more frequent monitoring of solids and liquid wastes. Injection and land farming techniques were also introduced to comply with the Bolivian regulations for hydrocarbon-contaminated solid waste disposal.

However, operational problems in some wells contributed to an increase in the FES cost beyond the original budgetary plan. Severe lost circulation problems were encountered in exploratory wells while deeper than expected depths were also reached.

As shown in figure 5, during the year 2000 the reduction in the cost per barrel of rock drilled continued when compared with the previous year. A 3-well moving average costs remained low at the end of the period, even when the high cost of the exploratory well was taken into consideration. The following factors contributed to this improvement in environmental performance during 2000:

- The FES process implementation
- The change over from OBM to WBM in the Dorado field
- The overall improvement in drilling efficiency in the Bulo Bulo field
- The use of WBM in the shallow exploratory well.

Strengths of the FES Process

The following strengths were identified from the FES Process development:

- The process contributed to decrease the overall FES cost for the operation in Bolivia, as indicated by the reduction of waste management cost per barrel of rock drilled during 2000, when compared with previous years.
- FES had the strongest team, as noted by the operator.
- FES was able to build a strong relationship with the operator's HSE department, through identification of common goals and common problems. The teamwork approach of both the operations team and the HSE group also contributed to the strengthening of the relationship.
- FES contributed to increase the HSE awareness throughout the operation.
- FES introduced a formal documentation process to record and track drilling waste.
- The process included the hands-on training of one expat and three (3) local Facilitators

Weaknesses of the FES Process

The following weaknesses were also identified:

- It was difficult to clarify the roles and responsibilities of each person in the early stages of the operation. This was partially caused by false expectations created during process implementation. Consequently, there was significant confusion as to the facilitator responsibility to guide the team to meet expectations.
- The initial focus of the facilitator was directed to handle the operational issues related to waste around the location. Frequently, there was an overload of non-planned roles and responsibilities that required his entire dedication to solve operational issues while putting aside critical documentation activities.
- In the early stages of the process implementation, the operational issues and data collection consumed the total efforts of the facilitator. Therefore, the planning process and cost data tracking was poor. Only when the process started to gain momentum at

the rig site could the facilitator focus on planning and potential problem identification.

Audit of the FES Process in Bolivia-Review

BPA and BHI representatives audited the FES process at the end of the year. The purpose of the audit was to verify that the process was aligned with the operator's global HS&E policy. Several field and office personnel were interviewed using a questionnaire designed for this purpose. Following is a description of the audit process and methodology.

FES Audit

The objectives of the audit were to establish:

- The scope and expectations of the FES activities.
- Whether a plan-execute-review-improve process was in place.
- Whether the elements of this process were of appropriate quality for the activity.
- Whether the team actions matched the team reports and perceptions.
- Whether the performance delivered was within the original expectations.

Supporting Programs

Establish whether the supporting programs below were consistent with the objectives of the FES initiatives

- Mud Engineering Program
- Waste Management Program
- EMS/EMP/Compliance Programs
- Mud and Waste Contracts

Note. It was not the purpose of this audit to perform a full evaluation of the above plans. The primary purpose of this audit was to establish that these programs were aligned with the FES activities. However, any obvious issues that came to light regarding the quality of these programs and/or the ability to carry them out were commented on and recommendations were made for further investigation.

Evaluation Method

The evaluation was conducted through interviews with BP and service company personnel in operational and HSE roles and by a visit to the site where FES was in practice. A questionnaire was designed to target specific questions at people in specific roles within both organizations and for evaluating specific activities at the well site. Items that were evaluated included:

- Scope of work
- Organization & management
- Site Supervision
- Procedures
- Performance
- Learning
- Training & Awareness
- Communication
- Documentation
- Contracts
- Third parties

This evaluation was summarized in a simple risk assessment that described the status of the process in terms of compliance with what was required for effective implementation of FES. The requirements were classified in 3 areas: existence; appropriateness, and evidence it was being implemented. Compliance in each area was ranked as Low, Medium or High as presented Table 1.

Team

The audit team consisted of personnel from both BP and BHI that were not directly involved in the operation process. It included the operator's worldwide PFM coordinator and the service company's global project manager.

Deliverables

Upon completion of the audit, a review of the findings was conducted by key members of the team and a report was to be issued within 14 days of the completion of the visit. This report was to include the recommendations on how to improve the performance of the FES activities.

Documentation Review List

A number of documents were reviewed by the auditing team:

FES Process:

- The FES report of the last well.
- The documentation of transfer of lessons (internal, external).
- A list of agreed Key Performance Indicators of the last well.
- A discussion of the drilling performance of the last well.
- The mud and cost recap of the last well.
- The waste management cost and recap of the last well.
- A training matrix and training history.
- The organization charts of the companies involved in the process.
- The roles and responsibility definition of the FES staff.
- The documentation of pre-spud/review meetings.
- Example spill reports.

Supporting Documentation:

- Waste management program of the current well.
- Mud program of the current well.
- Copy of contract scope and schedule of remuneration, mud and waste.

FES Post Audit

The preliminary results of the FES audit were presented to the operating unit and discussed. The Highlights of the FES Audit were as follows:

- The contribution of FES to HSE awareness was recognized by almost every person that was part of the project
- There was a documentation process in place.
- The FES process was better understood by the office staff than by the field personnel.
- The office staff actively supported the process.
- Some roles and responsibilities required better definition.
- The facilitator was performing some activities outside of his area of responsibility.
- There was a clear FES tracking procedure at the office.
- A stronger effort was required to explain to the team the steps of the FES process.

A training module for FES was designed and executed by the team. Module I explained the six steps of the FES process and included a test to be taken by the trainee. The following action items were defined and applied to reinforce the weak points highlighted during the audit:

1. The results of the FES audit were distributed.
2. The results were discussed during the regular FES lunch meetings.
3. Module I of the training program was given to the FES team at the office.
4. The facilitators trained the FES team at the wellsite.
5. The FES support engineer discussed the results with both teams at the wellsite.
6. The steps of the FES process were presented in the Patujusal workshop.

Conclusions

1. The implementation of the FES process contributed to achieving fluids and waste management cost reduction for the operator in Bolivia.
2. The FES Environmental Management System facilitates the implementation of the ISO-14000.
3. FES introduced a formal documentation process to facilitate the continuous improvement process for the operation.
4. FES contributed to increase the HSE awareness in the operation.

Acknowledgments

The authors thank the many people that contributed to the success of this process, both in BP and Baker Hughes INTEQ. Special recognition goes to BP Operations Managers in Bolivia George Trimble and Alan Alanitz for the permission to publish this data.

References

1. Greaves, C., Rojas, JC., Chambers, B, "Field Application of Total Fluids Management of Drilling Fluids and Associated Wastes," SPE Paper No. 66522, presented at the 2001 SPE/EPA/DOE Exploration and Production Environmental Conference, San Antonio, Texas, Feb. 26-28, 2001.
2. Rojas, J,C.,Schonacher,D., Gharst,J., Paluk, B., Billon, B.: "Successful Utilization of Performance Fluids Mangement in Gulf of Mexico Region 6 Assures Environmental Compliance," SPE Paper No. 80605, presented at the 2003 SPE/EPA/DOE Exploration and Production Environmental Conference, San Antonio, Texas, March. 10-12, 2003

	Existence	Appropriate for activities	Being implemented
Low	Does not exist	Inappropriate	Not at all
Medium	-	Partial	Partially implemented
High	Exists	Appropriate	Fully implemented

Table 1. Audit Process

Figure 1. FES Process

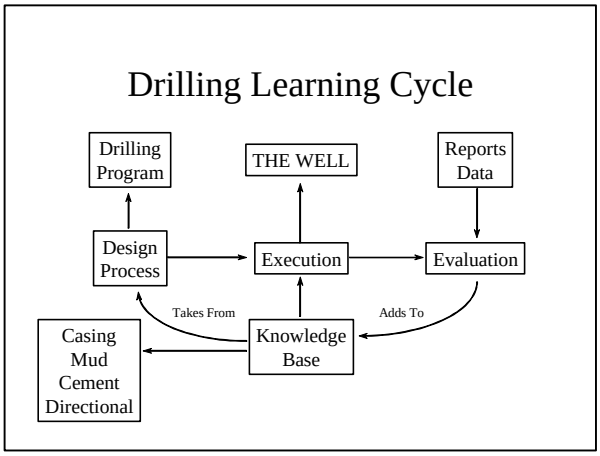

Figure 2. Drilling Learning Cycle

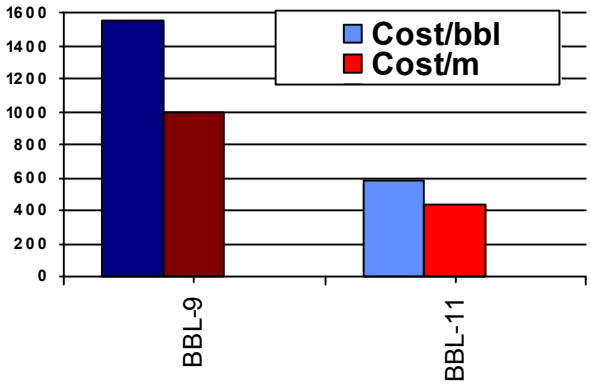

Figure 3. FES cost comparison Bulo Bulo field before and after FES process implementation

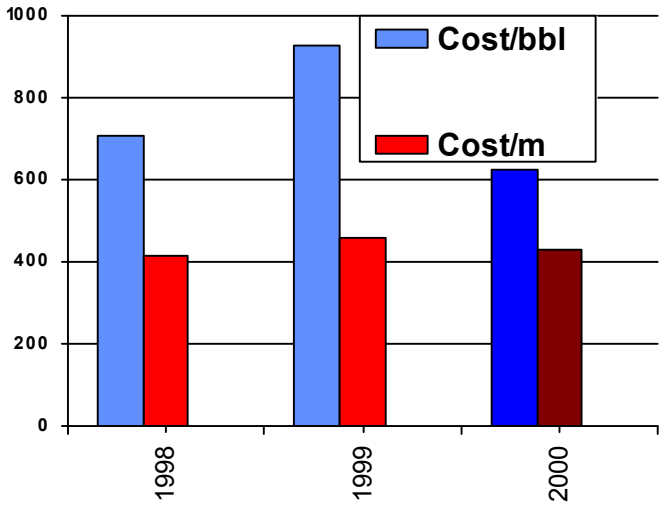

Figure 4. Normalized FES Cost per year (1998 – 2000)

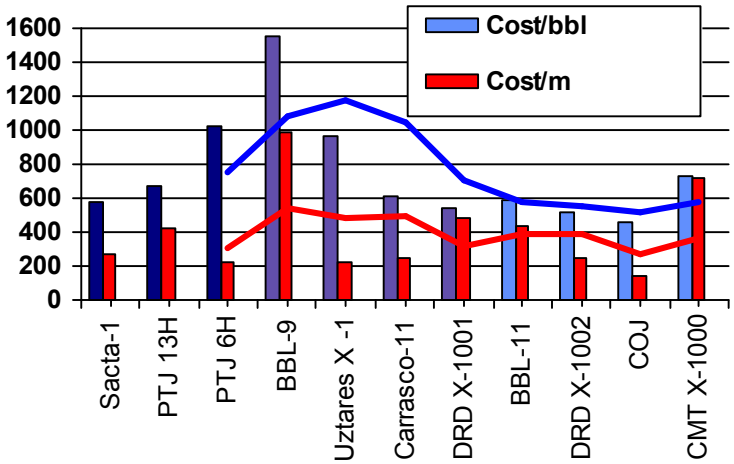

Figure 5. FES Cost evolution per well (1998 – 2000)