UBD startup challenge requires planning, training

BEFORE STARTING AN underbalance drilling (UBD) project, managers generally ask three questions.

What is the economic benefit of drilling and completing wells underbalance? This is an area of intense scrutiny by the industry to better understand how wells produce. Offset analogs currently provide the only credible answer.

What processes do we employ to give the results desired? The process exists within most operators safety management system (SMS).

How is a team chosen to achieve the goals?

PROCESS SYSTEM MANAGEMENT

Process safety management (PSM) originated in the chemical and processing industry—an appropriate analog for underbalance separation and compression packages. PSM exists in the public domain, as it is part of the OSHA recommended practice in the USA.

There are three primary components for PSM—Hazard Identification, Management Systems, and Communication. A system analogy is the three-legged stool with each component supporting the team. If any leg fails, the system will fail. Management, at all levels, must set the tone for operational safety.

HAZARD IDENTIFICATION

Intuitively, it is impossible to mitigate unknown hazards. Hazard Identification contains three elements - Process Hazard Analysis, Pre-Startup Reviews, and Process Information. These are pure planning elements utilized to identify and quantify risk.

The first element of hazard identification is process hazard analysis (PHA). There are many types of PHA. The most familiar will be the HAZID / HAZOP. The five most common types of PHA's performed are:

- What-If
- Checklist
- Hazard Operability (HAZID/HAZOP)
- Failure Modes and Effects Analysis (FMEA)
- Fault Tree Analysis

No method is intrinsically better than another. Each method is geared to different situations.

Hazards are defined by employ combinations of methods to identify hazards including experience, engineering knowledge, stochastic or deterministic methods, and brainstorming.

Hazard analysis is not an end unto itself. Identifying hazards without finding and implementing mitigations will accomplish nothing. Rank and categorize the risks, prioritizing the ones to address first. An action item register is highly recommended to capture all "to do's" including the person responsible for resolving the item. This is common in many drilling projects. Previous projects have kept the register in spreadsheets, databases, and project manage-ment software to track progress, assuring the action item is completed.

Hazard analysis should uncover and resolve mechanical, safety, and health issues. An UBD relevant example is wearing fire retardant clothing (FRC). Nomex is a great material. Nomex is responsible for sparing many people severe burns. However, in a desert environment (130° F ambient with high humidity) wearing FRC with the cotton undergarments increases the risk of heat exhaustion. FRC's life saving versus health risk needs to be assessed.

Management should not be disillusioned when HAZOP's or other PHA has failed to ferret out all problems. It is very difficult for even seasoned professionals to see all the possible modes of failure. What management does have the right to expect is a proper response to the failure, minimizing the consequences.

There has been significant discussion in the industry about whether drilling underbalance is safer than drilling overbalance. Investigating and comparing incident statistics from five underbalance-drilled wells (with total manhours exceeding 300,000) provided interesting results. The wells were in three different countries on two different continents. The total incident rate for all operations was 2.19. The most serious was a cut to the cook's thumb requiring five stitches. During UB operations, there were no accidents or incidents on any of the wells, not even a first aid case.

Extrapolating too much into the statistics is unwarranted. Bringing hydrocarbons to the surface can never be as low risk as drilling with an overbalance fluid because the primary barrier (drilling mud) to well control is removed. This primary barrier is the least likely to fail.

During UBD, a rotating control head, rigorous process, additional training, and heightened safety awareness replace the primary barrier. The side benefit achieved by the additional process and training, can be an improvement in general safety. Underbalance drilling is not inherently safer than overbalance drilling. Self-imposed processes with fanatical attention to detail, have delivered safety performance that exceeds conventional drilling.

PRESTARTUP REVIEW

A prestartup review encompasses many items including vendor meetings, prespud, an intra-company meeting inside the well team, TRUE training, Technical Limit, and an equipment walk-through. Conduct the meetings to identify hazards, barriers to performance, improved understanding of the total process, and how vendor services interface with others. This meshing of personnel is a fertile ground to insure elimination and proper resolution of interface problems.

PROCESS INFORMATION

The process phase involves defining the fluids and the fluid management process used to drill the well. It also involves identifying chemical reactions and interactions of reservoir and drilling fluids. This could be hydrate formation, condensate precipitation, foaming, emulsion formation, and health effects of liquids. It will also deal with interfaces.

For example, how do you drill out the shoe track? Where does green cement go? How do we purge vessels? These types of questions will be resolved in the process phase.

Environmental expectations have shifted thinking about flaring. An obvious

first instinct to meet the expectation is to send the reservoir fluid to the plant. Sending fluids from a drilling operation to the processing plant takes careful planning to avoid unintended consequences. Involving your facilities people to insure that no gas, liquids, or solids will disrupt the plant makes a totally closed loop drilling system possible. The drilling operation may be expensive at $4,000 to $8,000 per hour, but a processing plant is at least four times that rate. Shutting down a plant gets managements full attention especially when the problem was avoidable.

OPERATING PROCEDURES

The first element is Operating Procedures. There are two types of operating procedures - engineering procedures and field procedures. Including the physics and reasoning is appropriate for the engineering procedures. The inclusion of technical details reduces the loss of knowledge transfer as personnel leave the project. Cull technical detail as it transfers poorly to field procedures.

Clearl, name and index both sets of procedures. Implement full document control. Number each step in the procedure. The directions should be straightforward like “Open Primary Regulation Valve 1”. Do not use ambiguous commands like open slowly or crack valve. Cautionary notes go before the step in the procedure.

Good writing is essential to convey an unambiguous meaning. Avoid emotional words like ‘catastrophe’ and ‘tragic’. Avoid judgment words like ‘unacceptable’ or ‘serious’. Speculation should not exist in the procedures. Stick to factual words like ‘rapid erosion’, ‘corrosion’, ‘high dosage noise’, and ‘fire’.

TRAINING

Training is required for delivering a completed well without an accident, incident, or spill.

Classroom training for engineers unfamiliar with UB drilling is one of the first steps. Compressible multiphase flow, with pressure dependent density, requires a shift in cause and effect thinking compared to an incompressible pressure independent density.

Another training aspect is facilitating buy-in to UBD. Training to gain support requires listening and addressing coworker and management concerns. The most ardent critic can become the greatest supporter when you listen and address their concerns about safety, technical, and financial issues. It works even better when they help resolve the issues and own the solution.

Special mock up training is generally skipped for onshore UBD but is vital for offshore applications where space is at a premium, offshore well spacing is much closer, personnel on board (POB) constraints are greater, requirements for ESD more complicated, and the environment is more confined. For a land-based operation, it is more cost effective to use the rig as a mock up rather than take it to a special facility where the cost is similar but equipment is different. Land operations eliminate the weight, size and space constraints com-

mon to offshore platforms and jack-ups, resulting in reduced access problems.

Before going to a test facility, the UB team must establish goals for the mock up. Goals should include commissioning of equipment, testing communication protocol, testing operating procedures, and emergency drills. It should also address any rig up and rig down problems, access issues and noise abatement required.

Rig-site training starts with UB TRUE (Training to Reduce Unscheduled Events) sessions to familiarize the entire work force with the drilling plan. It also starts the team building process. New ideas to improve the original plan or process will come out of the discussions. Again, any action items must be registered, assigned and resolved.

The next step in training is to assemble a detailed overview of each phase of the UBD operation. From this overview, undertake training to improve crewmember understanding of the down hole process as it relates to each operational phase. Depending on the well specifics, this training can occur as part of classroom training, at the rig site, or both.

UB drilling and flow control practice is an essential component of the hands-on rig-site training program. Hands-on training requires a situation in the drilling sequence when hydrocarbon production from the reservoir is not possible. Use this time window to train the rig crews on the safe injection and processing of multiphase fluids while drilling. An obvious time in the drilling sequence is after landing and cementing casing above or just into the reservoir. Injecting gas or nitrogen in a controlled manner without the added risk of producing hydrocarbons is the safest pilot test. To resolve communication and operational problems, practice making connections, tripping, initiating underbalance, and snubbing procedures. Hands-on training will take between two and seven rig days to complete.

Total training costs can account for at least 10% of the total AFE on the first well. In a sustained program, costs will drop to three to five percent. If a break in the program occurs, the costs will again rise.

Training costs are money well spent. It is part of the due diligence required to deliver an incident free program on time and on budget. Allow for it in the drilling schedule.

MANAGEMENT OF CONTRACTORS

Management of contractors includes interfacing documents, working under one safety management system, understanding the permit to work system, and using STOP or its equivalent.

The management of an UB operation is similar to a typical drilling operation but with more contractors involved. As organizations grow, roles and responsibilities must change.

Contractors need to be at a different level of awareness when drilling underbalance. They must function as a team to meet the performance level required. If an incentive program is used, it must reward and penalize the team, not individual members. It must cover all members of the team including the shop hands building equipment and galley personnel cooking and cleaning.

MANAGEMENT OF CHANGE

Management of Change (MOC) is important to the success of an underbalance drilling operation. Processes and procedures address the identified hazards. Small changes can have large unintended consequences. Something as simple as changing vendors requires a management of change procedure. An example is a drilling fluid company change out, where each has similar products. However, the chemical or concentrations are different, giving rise to unexpected results.

Consider two examples. The first is a change in drilling lubricant. They are similar chemicals but the new lubricant causes foaming in the separator. Second, consider changing downhole motor vendors. The motor will have different elastomers; the drilling fluid may be incompatible, resulting in multiple failures. Changes require the same level of diligence that went into the original vendor selection, equipment selection, and procedure development.

MECHANICAL INTEGRITY

Mechanical integrity largely rests with the package vendors and the drilling contractor. Two serious concerns for the separation system are erosion and corrosion. To prevent loss of containment, monitoring these effects while drilling is essential. Therefore, nondestructive testing (NDT) becomes essential to delivering a safe well.

Another essential element of mechanical integrity is testing and certification. Vendors, in general, do a good job maintaining equipment. They can be less rigorous in the maintenance documentation.

Before commissioning, review the documentation for every valve, vessel and safety device. Serial numbers should be spot checked and matched against documentation. Check against ASTM or applicable standards testing for compliance. If any questions arise, then request recertification.

AUDITING

Auditing is required to assure all systems are in place and functioning as required. Auditing is the only way to assure systems are functioning as intended. Auditing should be ongoing, with both scheduled and unscheduled audits performed.

Key audits would include the rig contractor, UBD lead contractor, and directional drilling contractor. The audits should determine compliance with training requirements, gaps in their SMS and adherence to the Quality Management System (QMS).

A road map for auditing is:

• Determine facility or operation standards

• Gather data and verify against independent sources

• Identify any non-systemic problems

• Identify systemic problems

• Draw conclusion on management systems

• Optionally provide guidance for correction

• Document and deliver finding to contractor

The purpose of an audit is to identify areas of weakness and strength to allow the contractor to improve performance. Do not use auditing as a disciplinary measure.

PERMIT TO WORK

A permit-to-work system is essential to delivering safety performance. Permit-to-work systems are commonplace on drilling rigs. Use a common permit-to-work system for all contractors on-site.

Underbalance drilling requires rethinking working hazards. As an example, land rigs require redefinition of what constitutes a “confined space”.

A vertical flare stack earthen embankments can trap SO2 if H2S is present in the reservoir. While it is an open area, a person may not have time to climb out before inundation occurs.

The flare area is always restricted but a permit-to-work as a confined space is appropriate to enter the containment basin.

INCIDENT INVESTIGATION

Incident investigation is the last and hopefully least used process. Most operators have mature systems for dealing with this type of investigation.

Failure incident prevention, by obtaining quality post mortem information, must be the focus. Too often we repair equipment and resume operations without taking time to understand why the failure occurred. More importantly, there is no assurance it will not happen again. A key to improved performance is getting people to change how they view failures.

When a failure occurs, the first priority is maintaining the welfare of people, securing the well and bringing the system to a safe state.

The analysis phase starts next. Collect evidence as soon as possible. Get pictures, fluid samples, and recover failed-parts in as pristine a state as possible. Record eyewitness accounts immediately after the event. Document personnel

locations and actions just before the failure. Lack of detailed information hinders finding the root cause. Without identifying a root cause, preventing similar failures in the future is very difficult.

COMMUNICATION

Communication is a vital part of any drilling operation. It is essential to an UBD operation where safe connections and tripping require the coordination of multiple services.

Personnel require clear instructions to meet safety and performance expectations. Since radios will be a vital part of the operation, use protocols and short, easy to understand sentences. Having the delegate repeat the instructions is a time tested technique for insuring the instructions are understood and will be acted upon accordingly.

EMERGENCY RESPONSE

Most operators' SMS address emergency response. Write and implement bridging documents to cover any gaps that may develop in the system. An example is in international operations to include plans for dealing with contractors' and subcontractors' injuries differently. Also, seek increased participation from the local fire, police and emergency medical services departments.

Before startup, perform a full emergency response drill. The drill should involve both internal and external groups as above. Breakdowns in communications are the most likely scenario for an insufficient response to occur. The drill will help 'stress' the system and find weak points.

During one drill, giving quality directions to each agency proved to be a weak link. Consequently, the fire department did not find the rig until after the drill was over.

TEAM PARTICIPATION

Team participation is key to project success. To facilitate total participation you need to engage, empower, hold accountable, and recognize vendors when work is of exceptional quality.

A last item around communication is clear roles and responsibilities, especially at the rig site. The drilling supervisor can be quickly overwhelmed, managing all the additional services, if lines of communication are not established.

All personnel still have access to the drilling supervisor. However, delegating the flow of information and appropriate responses allows the drilling supervisor to maintain his perspective on the total drilling operation. The reporting and communication lines will be different for each operation.

As an example, communication between the directional driller, paleontologist, and geologist is important when paleosteering. The rotating control head supervision can report through the separation package personnel or through the snubbing unit personnel.

The project management must decide how the information will flow or strong personalities and historical hierarchies will decide it by default.

PRELIMINARY WELL PLANNING

During preliminary well planning, the team looks very conven-tional. The only exceptions are the UBD project manager, UBD engineer, and possibly the project planner.

Combining the project management and engineering roles for cost control is common until the preliminary specifications are completed. It is common to defer filling the project planning position until very late in the preliminary planning phase of the well.

Without the commitment to UBD technology, the complications and safety implications can distract managers to question the validity of the critical path and extend the front-end period with indecision.

Only the commitment from the PM, that UBD is best suited to deliver the production goals, will keep the project moving forward. Safety leadership is critical for the pro-ject manager because he or she sets the expectations and is re-sponsible for the safe delivery of the UBD well. UBD project manager is responsible for implementing the MOC process.

Another issue the UBD PM must focus on is the conventional drilling operation. The problems with accessing the reservoir do not go away simply because the well is drilled underbalance. The UBD PM must direct his focus, at the appropriate times, to the conventional well and not compromise the project due to normal drilling problems.

The UBD engineers (UBDE) primary function is to assure reser-voir access in an undamaged state without an accident, incident, or spill. The UBDE will work closely with the drilling engineer to estimate costs and preliminary project scope.

The UBDE will also be involved in the torque and drag study, multiphase flow analysis, and wellbore stability determination. From these analy-sis the UBDE will determine drill pipe size, hole size, injection points, injection rates, and general separation requirements. Expect the UBDE to provide comprehensive input into the prelimi-nary and final HAZID / HAZOP.

The project planner arrives late in the preliminary planning phase to populate the Gantt chart and determine the critical path. The planner will work closely with the logistics coordinator to maintain a single system that reflects all product delivery.

Government agencies are included as a part of the team early in the planning because they are a valuable resource for defining regulatory expectations and obtaining early feedback. They have no direct role in planning. However, involving them in the HA-ZOP process and risk mitigation is appropriate as they bring ex-pertise outside the normal drilling environment and from multiple operators.

Partners are resources that can add markedly to project success. On BP's first fully underbalance well, partners were engaged immediately. They reviewed the prospect, reviewed planning, attended peer and design reviews.

Partners were included as part of the team and added additional expertise to planning and execution of the project. View partners as the fresh set of eyes ensuring the operator has not lost sight of the big picture.

REFERENCE

This article was adapted from "Meeting the UBD Startup Challenge" by **Jon Gent** presented at the 2001 IADC Underbalance Technology Conference and Exhibition.