Assessing Risk

A Simplified Methodology for Prejob Planning in Oil & Gas Production

By Angelo Pinheiro, Ben D. Cranor and David O. Anderson

Oil and gas production is an inherently hazardous activity due to the large volumes of flammable hydrocarbons stored or processed at a facility. Formal risk assessments are, therefore, necessary at various phases of the asset life cycle as they help personnel identify, evaluate and control hazards that could result in loss of life, injury, pollution, property damage or business disruption. Hazard evaluations of production development concepts or facility design are well-defined processes, for which much literature is available as guidance. Such evaluations are mandated in some jurisdictions for project regulatory approval (CNSOPB, 2009), and in others, where the facility stores more than 10,000 lb of flammable liquids or gas (OSHA, 1992).

Usually, the authority with jurisdiction prescribes the methodology and timing of the risk assessment. For example, OSHA's process safety management (PSM) regulations require an initial process hazard analysis (PHA) using what-if/checklist, hazard and operability study, failure modes and effects analysis, fault tree analysis (FTA) or an equivalent methodology. In Canada, offshore petroleum regulators mandate a concept safety analysis using qualitative and quantitative risk assessment methodologies as part of the project approval process.

In oil and gas production, formal risk assessment is rarely performed (or is sporadic) for short, albeit hazardous jobs, such as those involved in well servicing, construction and

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maintenance projects. They usually fall under the purview of day-to-day safe operating practices, for example, tailgate safety meetings, safe work permitting, job safety analysis (JSA) and safety inspections, and they may not address management challenges such as skills shortage (Peek & Gantes, 2009), worker fatigue (Enform, 2007) or substance abuse (Nate & Soper, 2007). If these management-type situations are not resolved, they may adversely affect safe job performance.

Second, when safety reviews are performed just before the work activity begins, long lead items such as training, safe contractor selection and procurement of critical spares cannot be addressed satisfactorily. Those reviews analyze a function only after it has been implemented, and much of the data is not factored into the system safety process (Vincoli, 2006). The resulting production versus safety dilemma imposes time constraints on job supervisors to adopt low hierarchy safety controls, such as administrative measures and PPE, for the work to be performed.

The following examples highlight the critical importance of prejob planning and risk assessments:

1) Three contractors died and one suffered serious injuries in an explosion involving four oil production tanks. The workers were preparing to weld piping to the tanks when a welding tool likely ignited flammable vapors from the tanks (CSB, 2006).

2) A contractor was fatally injured after being struck on the head by the counterweight arm of an oil pumping unit while installing insulation around the unit's oil header system and fuel line (Enform, 2010).

3) A bed truck transporting a steel tank off a lease came into close proximity with an overhead power line, causing a transfer of electricity. The lease had been constructed beside an existing roadway that had a ditch on both sides. The elevation changes between the ditches were not factored into the safe work plan (Enform, 2009).

This article proposes a risk management approach using a modified risk matrix for planning short-term, high-risk projects in oil and gas production. It recommends that a set of core SH&E management practices be implemented to ensure on-site compliance with policies and applicable regulations. The risk assessment criteria (RAC) of the modified risk matrix take into account site management conditions affecting SH&E, the role and interface between various system safety components, and the technical hazards inherent in each project phase.

The underlying assumption of this approach, however, is that short-term projects have been previously reviewed as meeting corporate RAC (e.g., an annual risk assessment of the operating area) and sanctioned. That risk assessment may prescribe prejob planning risk assessments for specific projects.

Comparison of Conventional & Modified Risk Matrixes

A discussion of the differences between RAC used in a conventional risk matrix and the proposed model is essential to understand their application to specific project phases.

PHA Using Conventional Risk Matrix

In the conventional approach to technical risk assessment, risk = probability x magnitude (Figure 1, p. 36). In this approach, the job or project is segmented into distinct phases of activity. The worse-probable consequences, and their causes and effects are then identified for each phase. The likelihood of the consequences is estimated using the risk matrix, after accounting for the mitigations in place. Recommendations commensurate with risk ranking follow, and residual risks are accepted and addressed or rejected in accordance with regulatory frameworks and corporate SH&E and social responsibility policies.

The benefits of a conventional risk matrix include convenience, flexibility to customize the RAC, justification of risk acceptance, use of engineering judgment in risk decision making and amenability to various risk methodologies. Those methodologies include basic risk techniques such as safety inspections and audits, and derivative forms of assessment such as management oversight and risk tree, FTA and probabilistic risk analysis. A conventional risk matrix is the norm for PHA for concept selection and facility design, management of change analyses and prestart-up safety reviews of large engineering projects.

However, conventional risk assessment has limitations with respect to planning short-term jobs. The planning is usually performed by field operations and maintenance personnel who may lack formal risk training, data for probability estimation or access to professional SH&E staff when the assessment is performed. Incorrect probability selection may result in risk amplification or, conversely, a false sense of security. Glendon (2006) notes this approach "ignores implications based on the possibility that workplace behavior that is considered to be risky may have individual, organizational, social or cultural origins."

Another limitation is that conventional RAC starts the risk determination process with consequence identification, rather than estimating the controls in place. Hubbard (2009) observes that the biggest risk for most organizations is that existing controls (e.g., policies and procedures, safe work systems, ef-

IN BRIEF
- Although formal risk assessments are performed by E&P operators as part of facility design and prior to undertaking major operational activities, the risk assessors are often constrained by the absence or lack of access to reliable data for estimating the likelihood of an event occurring, a criterion used in qualitative risk methods. This undermines the validity of the risk assessment and can lead to a false sense of security and, consequently, fewer safety controls.
- This article proposes a preliminary hazard analysis (PHA) model that uses a modified risk matrix for prejob planning in production operations. It incorporates elements of situational management and espouses shared responsibility for SH&E.
- A set of organization-specific core SH&E practices is recommended as the minimum acceptable risk mitigation controls. The acceptance of residual risks against predetermined risk tolerance criteria, verification of corrective actions and communication of the risk assessment results completes the PHA process.

Figure 1
Qualitative Risk Matrix

SH&E RISK DECISION MATRIX

Consequences										
Severity						Likelihood				
Rating		People	Environment	Assets	Reputation	1 Remote Has occurred in E&P industry	2 Unlikely Has occurred in company	3 Likely Has occurred several times/year in company	4 Frequent Has ocurred several times/year in asset area
1	Minimal	Slight injury or health effects (inluding first-aid cases) not affecting work performance or causing disability.	Minor envionmental damage; effects confined to lease.	Negligible production loss; production and/or equipment loss < $100k	Localized concerns; no media attention; minimal public impact.	1	2	3	4
2	Moderate	Medical aid injury; restricted work; evacuation of jobsite.	Moderate environmental damage; widespread impacts to land, water, air.	Short-term (< 1 week) facility/equipment outage; production and equipment loss >$100k.	Company-wide attention; brief local area attention; regulatory action resulting in administrative response.	2	4	6	8
3	Serious	Lost time injury; short term health impact; evacuation of facility and surrounding area.	Severe but reversible or short-term environmental damage; widespread impacts to land, water, air.	One week facility/ equipment outage; production and equipment loss >$1M.	Prolonged local area attention; brief operating region attention; regulatory action resulting in fines or punitive action.	3	6	9	12
4	Major	Fatality; multiple injuries; long-term health impact; permanent disability; evacuation of facility and community.	Severe irreversible or long-term environmental damage; widespread impacts to sensitive environments and/or major water bodies and/or air.	One month or more facility/equipment outage; production and equipment loss >$10M.	Widespread concerns with extensive adverse media coverage; prolonged operating region attention; action resulting in legal prosecution or suspension of operations.	4	8	12	16

RISK LEVEL=>	SERIOUS Stop activities unless risk controls have been implemented and the risk is reduced to a lower level.	HIGH Implement extensive risk reducing measures.	MODERATE Implement risk mitigation measures.	LOW Manage for continuous improvement.
APPROVAL TO PROCEED =>	Asset Team Manager	Operations Manager	Superintendent	Supervisor

Note. *Adapted from "Risk Management Within the E&P Industry," by International Association of Oil and Gas Producers.*

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fective hiring practices, training, defined roles and responsibilities, performance monitoring and measurement) are poorly implemented. The modified risk matrix attempts to address these limitations.

PHA Using the Modified Risk Matrix

The modified risk matrix (Figure 2) uses a simplified approach for risk determination. In this model, risk = available mitigation x confidence in implementation. The PHA process is similar to a conventional one, with the exception of the RAC. The process begins by identifying the hazards, then examining existing SH&E controls.

These controls encompass all aspects of system safety, including people, procedures, processes, facilities, equipment and materials. The confidence in implementation of those controls is then estimated by asking what could still go wrong, comparing residual risk against predetermined risk tolerance or acceptance criteria, and identifying any additional controls to reduce the residual risks to moderate or low.

Factors that ensure a high rating for available mitigations depend on a job's nature and complexity, type of hazards and order of hierarchy of the risk controls. Mitigations for people-related hazards include hiring and placement policies, training and competency, on-site supervision, fatigue management, substance abuse monitoring, and efforts to minimize communication and language barriers.

Examples of procedural mitigations include standard operating procedures, emergency response plans, safe work practices, job safety analyses, process hazard information, results of previous risk assessments, and inspections and audits. Process-related mitigations include tailgate safety meetings, journey management, inspections and audits, compliance assurance processes, safe work systems (e.g., work permits, lockout/tagout), management of change and prestart-up review.

Facility mitigations include work environment controls (e.g., illumination, noise, ventilation, ergonomic workstation design), active and passive fire protection systems, fire and gas detection systems, emergency and process shutdown arrangements, venting and emergency flaring arrangements, and secondary containment of fuel/chemical storage tanks. Finally, mitigations for equipment and materials include substitution of hazardous materials, procurement quality assurance, MSDS, periodic inspection and certification of safety-critical equipment and planned maintenance system.

In the U.S., oil and gas production operations and facilities are covered by numerous federal, state and local statutes. Where a gap exists in the regulations, the facility operator is expected to follow industry standards to address those gaps. Examples include API RP 54 (Occupational Safety in Oil and Gas Well Drilling and Well Servicing Operations), API RP 55 (Conducting Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide) and API RP 74 (Occupational Safety for Oil and Gas Production Operations).

Many oil and gas operators have comprehensive SH&E management systems and corporate responsibility policies that exceed regulatory compliance. However, failure to implement those policies and controls could result in major incidents and losses. Therefore, the confidence in implementation is a critical RAC in determining residual risks.

Factors that ensure a high rating for confidence in implementation include adequate lead time for planning and procurement, on-site supervision, use of high-performance teams, use of contractors conversant with the operator's SH&E policies and processes, availability of professional SH&E support, availability of resources needed for risk mitigation, and assurance that SH&E processes and procedures are understood.

The rating of this risk criteria calls on the assessor's knowledge, experience and professional judgment based on previous experience with similar jobs and the organization's risk tolerance/risk acceptance criteria. Acceptable risk is specific to each organization and industry, and is influenced by many factors, including risk reduction costs versus net benefits; societal values and conventions; time-dependency; regulations and industry standards; and other variables in individual risk situations (Manuele & Main, 2002).

The advantages of the modified risk matrix include its simplicity, elimination of probability criteria, proactive hazard assessment and control rather than management of consequences, and suitability for use by personnel who may not have an SH&E background.

The disadvantages of a PHA using the modified risk matrix include failure to identify all hazards; potential oversimplification of risks by incorrect RAC selection; difficulty in comparing results with assessments using conventional RAC; difficulty in scoping (may be confused with a JSA); and potential to introduce bias in interpreting and applying the RAC so that the work can proceed. Some of these limitations also apply to PHAs that use a conventional risk matrix.

Application & Use of the Modified PHA for Prejob Planning

Having addressed the what, why and where, let's now discuss the when, who and how of the modified PHA. The poster (Figure 3, p. 38) summarizes the process and the worksheet (Figure 4, p. 39) is used to record findings, risk evaluation, recommendations and risk acceptance. These documents were developed by the author for a U.S. oil and gas producer and are included as an example of how this approach might be implemented. Brief explanations on the petroleum company's SH&E processes are provided where necessary. As the hazard identification and mitigation examples are unique and specific to this company's operations, caution should be exercised when using that information in other applications. The PHA procedure is described below.

Determine When a PHA Is Needed

Since a PHA should be performed for short-term, high-hazard projects within the production phase, those responsible for performing the risk assessment may express some confusion because, in theory, many jobs would qualify for a PHA. Various approaches may be used to define what triggers a PHA, for example, preparing a job list or developing a process hazard list (PHL). The latter is arguably more convenient, as a job list could be extensive and might fail to include all foreseeable high-risk jobs within the production phase.

Many oil and gas organizations perform annual or periodic global risk assessments of their operations using conventional RAC aligned with

Figure 2
Modified Risk Matrix

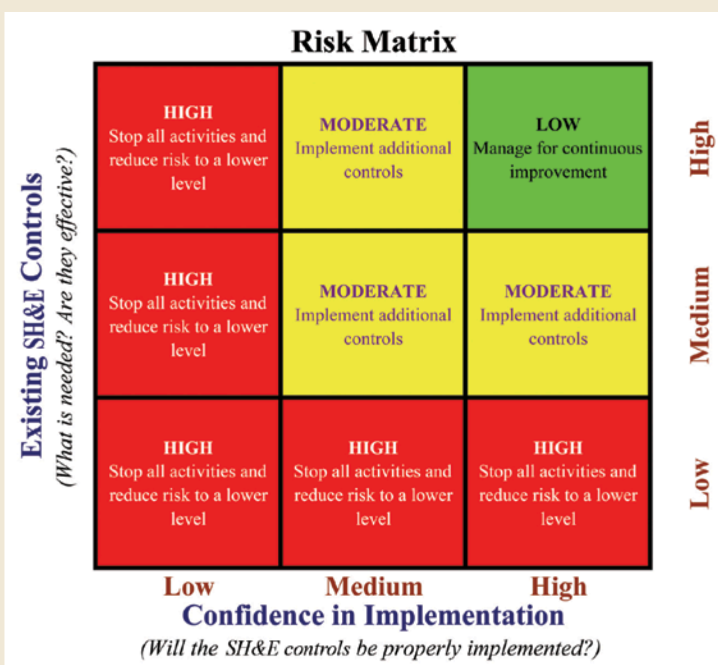

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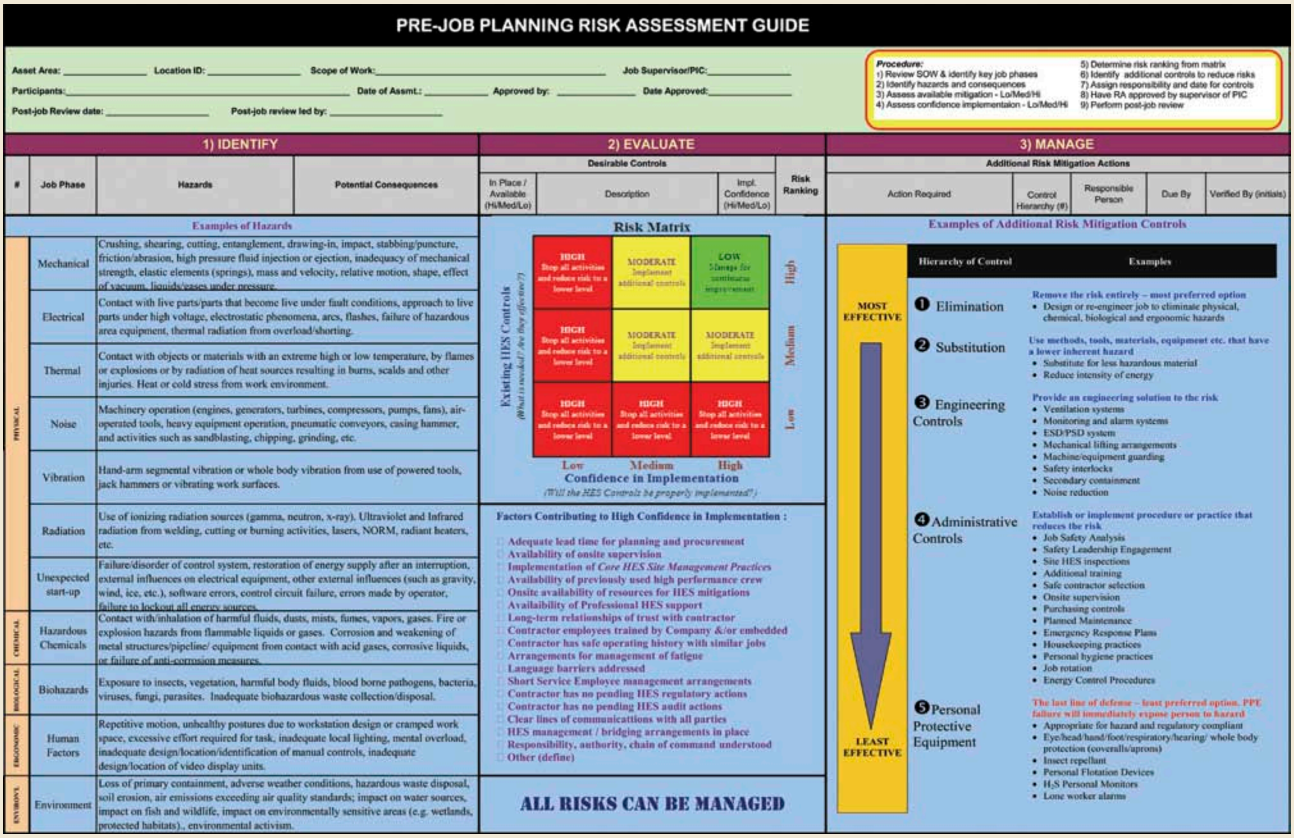
Figure 3
PHA Guidance Poster



The poster summarizes the PHA process. Brief explanations on the company's SH&E processes are provided where necessary.

corporate target levels of safety or risk acceptance criteria. Specific projects or jobs needing further risk assessment may be recommended by those assessments.

For the organization in this case study, a prejob PHA is required when:

•A conventional risk assessment of the site or operating area has identified the project as high risk.

•The work to be performed involves one or more of the following high-risk SH&E management or technical situation(s):

SH&E Management Hazards

1) Use of B3/C2/C3-rated contractor other than one embedded within operations. (Note: The organization's contractor selection process involves rating the contractor's safety culture and performance on a decreasing scale from A to C, and 1 to 3, respectively. B3/C2/C3 ratings are considered high risk. The rating is derived from the contractor's responses to a standardized safety questionnaire, which is based on API RP 76. Embedded contractors are those who are part of a client work crew and supervised by a client supervisor.)

2) The proposed contractor(s) is/are unable to meet the company's short-service employee (SSE) policy of less than 20% on-site SSE-status employees. (Note: An SSE, in oil field parlance, is defined as one who has spent less than 6 months in his/her current job or with his/her employer.)

3) A shortage of skills and/or equipment needed to perform the work safely exists locally.

4) The project or work to be performed is similar to project/work that resulted in a significant incident or high-potential near miss within the operations area in the past year.

5) Simultaneous production, drilling, completion, work-over, wireline (except routine operations) and major construction operations are/will be performed at the worksite.

6) The work to be performed has potential for an adverse effect on the surrounding community (e.g., closure of roads/railroads, community evacuation, spill to public waterway, drinking water source contamination, excessive noise/dust).

7) The work to be performed has associated environmental hazards (e.g., air emissions exceeding national ambient air quality limits) (EPA, 2008), potential for loss of primary containment, soil erosion, impact on fish, wildlife or environmentally sensitive areas (e.g., wetlands, protected habitats, migratory paths, seasonal spawning restrictions), environmental sabotage.

SH&E Technical Hazards

The work involves the following hazardous activities or situations:

1) hot work in Class 1 hazardous areas;
2) confined space entry;
3) work at extreme heights;
4) critical lifts;
5) handling of naturally occurring radioactive material (NORM)-contaminated oilfield pipes and equipment [NORM is associated with produced water and is manifested as radium-bearing scale (USGS, 1999)];

Figure 4

PHA Worksheet

PRE-JOB PLANNING RISK ASSESSMENT WORKSHEET

Asset Area: __________ Location ID: ______________ Scope of Work: ____________________________ Job Supervisor: __________

Participants: ____________________________________ Date of Assmt.: __________ Approved by: ________ Date Approved: __________

Post-job Review Date: ______________ Post-job Review Led By: ______________

Procedure:
1) Review SOW & identify key job phases
2) Identify hazards and consequences for each key activity within the job phase
3) Assess existing HES controls - Lo/Med/Hi
4) Assess confidence that controls will be implemented Lo/Med/Hi
5) Determine risk ranking from matrix
6) Identify additional controls to lower risks
7) Assign responsibility and date for controls
8) Have RA approved by supervisor of PIC
9) Perform post-job review

1) IDENTIFY					2) EVALUATE				3) MANAGE				
					Existing HES Controls				Additional Risk Mitigation Actions				
#	Job Phase	Key Activity	Hazards	Potential Consequences	In Place / Available (H/M/L)	Description	Impl. Confid. (H/M/L)	Risk Ranking	Action Required	Control Hierarchy (Number)	Responsible Person	Due By (date)	Verified By (initials)

Is the Risk Acceptable?
Am I AUTHORIZED to perform this job? Do I have the necessry TOOLS, SKILLS and TRAINING to safely perform this job? Can I obey all applicable LAWS and RULES?
Have I IDENTIFIED all the HAZARDS and eliminated or reduced them to the lowest reasonable level? Have the SAFETY CONCERNS of all members of the work party been addressed?

6) potential exposure to BTEX, asbestos or chemicals above IDLH;

7) operation of mobile equipment around energized power lines;

8) pressure testing of equipment, flow lines or pipelines;

9) use of explosives for well perforation;

10) use of radioactive sources;

11) abrasive blasting;

12) diving operations;

13) work performed while suspended over water (e.g., painting offshore platforms);

14) work in a known H_2S area or on sour hydrocarbon-bearing equipment;

15) trenching and excavation around buried pipelines and cables;

16) working alone;

17) working on live electrical circuits;

18) safety processes that cannot be implemented because of mechanical or engineering design limitations (e.g., circuit breakers cannot be padlocked, absence of overhead anchors for personal fall protection);

19) introduction of new material/technology/equipment/tools for which SH&E information is not available;

20) nonroutine work, or work involving infrequently used equipment/tools;

21) work performed under a written exemption from a company SH&E standard;

22) other hazardous activities warranting risk assessment but not included in this list (e.g., plant/facility turnaround and other activities spanning 24 hours of operation).

Prepare for the PHA

Proper preparation ensures PHA thoroughness. It enables employees to understand the hazards present within the various system components. To prepare for the PHA:

•Gather information and documentation needed for reference. Examples include project description, SH&E standards, industry codes of practice, company safe work procedures, layout drawings, P&ID/PFD, previous risk assessment findings, accident investigation findings, company and contractor audit reports, MSDS and process safety information.

•Prepopulate the PHA worksheet with available hazard information.

•Make meeting arrangements and inform participants. Production leader, area SH&E technician and contractor supervisor are required attendees.

Perform the PHA

Once preparations are complete and the team is assembled, follow this recommended procedure to perform the PHA.

Review the Scope of Work

1) Divide the job into distinct chunks or phases of work activity (e.g., site preparation, rig up/mobilization, operation, rig down/demobilization, site cleanup and restoration). Each phase may be further subdivided to properly identify hazards and risks.

For example, the operations phase of a drilling program may include drilling, running casing, cementing and wireline. Include details necessary to identify the hazards but avoid task-level subdivision, which is better addressed by JSA. Where necessary, JSA should be recommended in the PHA.

2) Identify the hazards and their causes, and potential consequences for each job phase using the PHA poster for guidance. Consult other risk assessment resources, such as ANSI B11.0-2010, for additional guidance.

The worksheet is used to record findings, risk evaluation, recommendations and risk acceptance.

Figure 5

Excerpt From a Completed PHA

PRE-JOB PLANNING/PROJECT RISK ASSESSMENT WORKSHEET

Asset Area: Mid-West   Location ID: Juniper   Scope of Work: Civil Construction of Well Pad   Job Supervisor: D. Smith

Participants: See Sign-In Sheet of Attendees   Date of Assmt.: 2/09/2011   Approved by: M. Smith   Date Approved: 3/31//2011

Post-job Review Date: 4/15/2011   Post-job Review Led By: T. Findlay

Procedure:
1) Review SOW & identify key job phases
2) Identify hazards and consequences for each key activity within the job phase
3) Assess existing HES controls - Lo/Med/Hi
4) Assess confidence that controls will be

1) IDENTIFY					2) EVALUATE				3) M	
					Existing HES Controls				Additional Ri	
#	Job Phase	Key Activity(s)	Hazards	Potential Consequences	In Place / Available (H/M/L)	Description	Impl. Confid. (H/M/L)	Risk Ranking	Action Required	Co Hiera (Nu
1	Planning	Permitting - Surface User Agreement (SUA), State Application for Permit to Drill (APD), Survey etc.	Not in Compliance, Landowner Relationship, Incorrect Setup Location	Citation and/or delay in obtaining needed permits.	H	Weekly update from regulatory group; Consistent SUA design & content.	H	Low	1.) Verify SUA with land and regulatory department - Final SUA Pending. 2.) Stormwater Pollution Prevention Plan (SWPPP) 3.) Confirm with Drilling dept. that pad civil design addresses their needs.	
2		Survey	Improper site build, Not in Compliance, producing well pad, rotating equipment, tanks venting gas, leaks, spills, unfamiliarity with active equipment including tools & equipment evaluations, SIMOPS, Unqualified Contractor	Citation and/or delay in obtaining needed permits, injury, exposure to combustable gases or liquids, Introduction of ignition source to production operations	H	Onsite review and expectations from PIC with land and surveyors, regulatory review of plats, Survey companies both exisiting contractors with prior experience,	H	Low	Verify with land and regulatory department to confirm latest plats are in hand.	
3	Mobilization	Contractor on boarding compliance, Equipment delivery (Semi Trucks & Construction Equip.)	Non-compliance with contractor onboarding process, producing wellpad, rotating equipment, tanks venting gas, leaks, spills, truck traffic on producing pad, possible workover activity, chemicals, High Profile Equipment, Unfamiliarity with HES policies, Inexperience to reclamations, SSE, Site specific hazards (poles/anchors, etc.), Site visitors, SIMOPS, equipment securing, cold/wet weather	Inadequate resources, delay, exposure to combustable gases or liquids, Incident	M	Construction company will be moving from previous project with many of the same crew members, Tailgate Sfety Meeting (TGSM), TGSM review process to identify those in need of orientation, Equipment status checklists, Flame Retardant (FR) Clothing, Personal Area Monitors(PAM), Boomer Policy, Prior Experience, CB Radio Communication,	H	Moderate	1.) Confirm status of crew orientations; 2.) Identify & set exclusion area on producing pad; 3.) Provide phone list to Contractor for notifications (Q&A and SIMOPS), 4.) Verify route clearance under electrical utilities; 5.) Traffic Control Program 6.) Identify safe fueling area (including enviro concerns).	

To view the complete PHA document, visit www.asse.org/psextra.

3) Describe the SH&E controls in place or available. At a minimum, they must include the organization's core site SH&E management expectations. Examples include:

•SH&E orientation (area- and location-specific);
•drug and alcohol policy compliance;
•safety training and competency verification;
•prejob safety meeting (two or more employees);
•prejob SH&E inspection;
•SSE management;
•hazard reporting system;
•incident and near miss reporting;
•implementation of company SH&E policies and standards.

4) Rate the mitigations available as high, medium or low.

5) Rate the confidence in implementation as high, medium or low for the mitigations identified. Factors contributing to high confidence levels include:

•availability of quality on-site supervision;
•adequate lead time for planning and procurement activities;
•resources for SH&E controls available;
•SH&E professional/technician support available throughout the job;
•contractor employees have been trained by company or are embedded;
•contractor has a safe operating history with company and its employees are experienced and familiar with company SH&E requirements;
•fatigue management;
•long-term relationship of trust between company and contractor(s);
•language barriers addressed;
•SSEs managed;
•contractors have no pending SH&E audit actions items;
•clear lines of communications exist with all parties involved;
•SH&E management/bridging arrangements in place;
•responsibility, authority and chain of reporting understood;
•other (define).

6) Determine the residual risk ranking using the PRA matrix, as follows:

•**Low risk.** Implement core site SH&E management expectations and manage for continuous improvement.

•**Medium risk.** Implement core site SH&E management expectations and additional risk mitigation controls. Attempt to reduce the residual risks to low.

•**High risk.** Implement core site SH&E management expectations and additional risk mitigation controls to reduce the residual risks to medium or low. If that cannot be accomplished, stop the activity or project, or obtain written approval from the operations manager to proceed with the work.

7) Identify additional risk mitigation controls. The priorities for risk mitigation in order of preference are:

) Determine risk ranking from matrix
) Identify additional controls to lower risks
) Assign responsibility and date for controls
) Have RA approved by supervisor of PIC
) Perform post-job review

IANAGE

sk Mitigation Actions			
ntrol archy mber)	Responsible Person	Due By (date)	Verified By (initials)
4	1.) G. Smith 2. D. Bower 3.) B. White	2/16/2011	ds
4	D. North	2/16/2011	ds
4	1.) R. Rogers 2.) Z. Ali, 3.) D. Smith 4.) B. White 5.) R. rogers, 6) C. Howard	2/16/2011	ds

• **Elimination.** Remove the risk entirely by designing out the hazard.

• **Substitution.** Reduce the inherent hazard by substitution. For example, replace less-experienced personnel with more experienced employees; use less-hazardous materials, tools and equipment; use safer alternative methods for the work to be performed.

• **Engineering controls.** Provide engineering solutions such as safety interlocks, fail-safe devices, mechanical lifting arrangements, emergency shutdown system or secondary containment.

• **Administrative controls.** Establish or implement procedures or practices that reduce the risk. Examples include JSA, site inspections, safety leadership engagements, additional training, prewritten energy control procedures, emergency response plans, job rotation, planned maintenance arrangements and good housekeeping.

• **PPE.** This is the last line of defense. PPE failure will immediately expose the employee to the hazard.

8) Assign a responsible person and due date for each corrective action.

Verify & Validate Completion of Corrective Action

The company supervisor/leader performing the PHA will validate the completion of additional risk controls by initialing the appropriate column in the worksheet. The mitigation for residual risks ranked as high must be completed before mobilization.

Approve the PHA & Communicate the Results

Once the PHA has been completed and documented, the individual who performed it has the worksheet approved by his/her supervisor. The approving supervisor may be a production or operations superintendent, up to the operations manager level. The risk assessment should be communicated to all parties at the project start-up meeting. Figure 5 presents an excerpt from a completed PHA for the construction of an onshore oil and gas production pad.

Conclusion

This article discussed the analysis, use and application of a modified risk matrix for prejob planning PHAs. This process ensures a forward-looking approach to hazard identification and management in short-duration, high-risk projects or jobs within the oil and gas production phase. Assessing risk by evaluating available controls and confidence in their implementation has advantages over conventional RAC, which often are difficult to grasp from a field operator perspective. A process to verify and validate the completion of corrective actions and to accept the residual risks through management approval of the PHA, provides assurance that the risks are understood, communicated and minimized before commencing the job. **PS**

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