2008-5435/14/63-1-8
INTERNATIONAL JOURNAL OF OCCUPATIONAL HYGIENE

IJOH 9: 1-8, 2017

ORIGINAL ARTICLE

An Innovative Permit to Work System Disconformities Identification (PTWDI) in the Commissioning and Start Up Phases of South Pars Gas Complex, Iran

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Received January 07, 2017; Revised January 29, 2017; Accepted February 21, 2017

This paper is available on-line at *http://ijoh.tums.ac.ir*

ABSTRACT

The Permit to Work System (PTWS) provides a practical framework for the commitment of no harm to people or the environment to be respected by staffs and contractors. Furthermore, PTWS try to provide an effective means for identification of significant hazards and management of HSE risk activities that could result in serious or fatal injuries. The significance of PTWS role is more prominent in industries such as gas and oil refineries. Since a small failure or fault in these industries may lead to a catastrophic human and environmental disasters or enormous economic losses. South Pars Gas Complex (SPGC), Bushehr Province, Southern of Iran, is one of those industries which PTWS is an important part of operational risk and safety management. In this study in 2016, SPGC's PTWS disconformities are investigated, and an innovative checklist for system disconformity identification is proposed for auditing PTWS procedure. Surveys and interviews with 14 experts by using structured Delphi method in two rounds indicated that questions raised in the checklist are system identification. Finally, audit quarries suggested in the checklist are divided into 10 main categories. First: SIMOPS Immediate, data sharing, 2-High risk activity, 3-Confined space entry activities, 4- HNF activities immediate data sharing, 5-Protecting PTWS counterfeit, 6-Immediate risk assessment, 7-Capability of permits tracing, 8-Capability of MOC and any flexibility, 9-Cost saving capability, 10-Immediate MSDS. This study was promoted PTW systems to ensure that authorized and competent people have thought about foreseeable HSE risks and that these risks are eliminated or minimized by using suitable control measures.

KEYWORDS: *Permit to work system, Hazard, SPGC, Disconformity*

INTRODUCTION

The Permit to Work (PTW) is a fundamental part of a healthy and safe system, therefore, it can be useful and beneficial in the appropriate and timely management of a fully completed of activities and it may be likely or liable to be influenced or harmed by human error itself [1]. For instance, the lack of comprehensive implementation of permit to work system and some neglected invisible risks were major factors in the Piper Alpha oil and gas platform accident [1-2].

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In addition, a risk assessment must comprise all phases; activities contained within work domains, and must be performed before starting activities and the lack of an issued permit for the actual job was one of the reasons for the accident [3].

Human error has been known as any inappropriate decision or behavior with accepted rules or standards that may have a destructive impact on the effectiveness and safety system [1, 4].

A PTW is one of the most important and key subsystems of HSE Management System, which is formal written system, used to monitor and manage certain types of work

that are identified as potentially hazardous [1]. This system may need to be used in high-risk jobs such as hot works, confined space entries, maintenance activities, carrying hazardous substances, and electrical or mechanical isolations [5]. In this system, responsible individuals should assess work procedures and check the safety at all stages of the work. In addition, individuals who carry out the work, plant administrator and contractors affected permits communication [1].

Although a PTW is an important part of a safe to work system; it may be influenced or harmed by human error itself. For instant, a breakdown in the PTW system at shift changeover and in the safety procedures was one of the major factors that resulted in the explosion and fire accident of the Piper Alpha oil and gas platform [6].

Hickson and Welch accident that occurred in 1992 was due to lack of safety reasons and issued permit for the actual job [7]. Up to now, few studies have been done regarding human error and non-compliance of procedure analysis in the PTW system .The human error probabilities (HEPs) were investigated in a PTW using an engineering approach and estimated the HEP to range from 0.044 to 0.383 [8]. In the permit to work system, human errors were surveyed and determined using some related hazard analysis technique [9]. Insufficient and incomplete isolation of process equipment, incorrect equipment labeling, was starting the work with delay after permit to work issuing, unsafe and incomplete gas testing, and inadequate hazard identification procedures were most important identified errors [1].

Moreover, findings of a study on the evaluation of factors contributing to human error in the process of PTW issuing were indicated a significant correlation between the errors and training, work experience, and age of the individuals involved in work permit issuance [10]. Although, it can be found a limited number of studies have investigated about “the role of human error in the PTW process” [1].

Moreover, other studies were descriptive in nature and failed to quantify the human errors in the PTW issuance process [10]. In this context, the present study aimed to identify and analyze human errors in different steps of the PTW process in a chemical plant. A permit to work system for controlling all work done in the industries is one of the most important element safety systems existing in a chemical plant. With the permit, comes awareness of safety in general, safety rules, do’s etc. Some guidelines on selecting a safety work permit system are described below.

All maintenance work, working at heights and excavation works is to be covered by a work permit system. The objectives are:

a) To ensure proper authorization of non-routine work such as hot work in hazardous area like the chemical plant, storages, vessel entry excavation, working at heights etc.
b) To make clear to persons carrying out job, risk involved and precautions to be taken.
c) To ensure that the person responsible for the area is aware of all work being done there.
d) To provide a method of working and the precautions needed have been checked by the appropriate persons and if necessary a second opinion is obtained to prevent errors of judgment or adopting short cuts which may increase the risk.
e) The same work permit form could be used for company employees doing the work or for the engaged contractors. The contractor should inform his employees of the work permit procedure and ensure that they are followed.
f) A work safety permit is intended primarily to safeguard people and property, but it also may be needed as evidence in case of claims against the company or their legal actions.

Given on subsequent pages is a format of a safety work permit/excavation permit/confined space entry permit modified if necessary to suit the requirements. The safety department involves the plant managers before finalizing the format so that any practical difficulties in implementation of the permit system could be sorted out prior to printing the same.

The purpose of this study was to set out SPGC’s Permit to Work System (PTWS) disconformities and introduce the audit checklist for system identification.

MATERIALS AND METHODS

In mid-1997 and in the commissioning and start up phases (especially in phases 1, 2 and 3) of South Pars Gas Complex, Bushehr Province, Southern of Iran, has tried to provide a framework where all non-routine works are supported in a safe manner to prevent harm to workers, others affected by the work and the environment. The principles of the PTWS are aimed at adding value in terms of risk reduction to keep workers safe and eliminate or minimize HSE risks to an acceptable level for activities that fall within its application. This will be achieved through the following principles for SPGC’s PTWS:

Published online: March 28, 2017

- Focus for all parties is to keep workers safe
- Criteria based on severity level of risk for health, safety, security, and environment including acute, chronic, and catastrophic consequences
- Whole of business focus
- Trained, competent personnel involved
- Recordable permit process
- Clear and simple criteria
- Smart and accessible systems – user-friendly
- Information is current and up-to-date
- Built-in verification and assurance

Permits are required for the high-risk activities described below at all times, including a Safe Work Method Statement (SWMS) and any other supporting certificates and/or documentation.

Medium-risk activities (as detailed below) must be undertaken under the supervision of a prequalified contractor and in accordance with their HSE Management Plan for the project/contract, or operational manuals.

An exemption to engage a non-accredited contractor to perform unsupervised work may be requested. These will be reviewed on a case-by-case basis and be relevant to one-off activities. Exemptions must be prepared in advance of the work and be reviewed and approved by a HSE Business Partner before the work starts.

No works that are not set out as high-risk and medium-risk activities require a permit. However, a hazard identification and HSE risk assessment must still be completed and appropriate control measures are undertaken to eliminate or reduce HSE risk. A record is to be kept as evidence of this process. The works do require a work clearance form to be completed daily by the contractor. This may form part or all of the hazard identification and risk assessment required for low-HSE-risk activities.

Safe Work Method Statement/Job Safety Analysis (SWMS/JSAs) detailed specific safety requirements for the job. They are required for high and medium-risk works. The requirements are outlined in Table 1.

A SWMS/JSA is a process of breaking down work activities into individual tasks, identifying associated hazards against these tasks, risk assessing them, and then determining appropriate methods of eliminating, isolating, or minimizing the identified hazards for the tasks to be undertaken [1]. The steps for completing a SWMS/JSA are outlined in Table 2.

Persons performing the identified work and/or contractors must prepare SWMS/JSAs taking into account the:

- Circumstances at the workplace that may affect the way in which high-risk work is carried out
- Requirements detailed in any relevant Site Specific Safety Plan for the work and/or the HSE requirements for the workplace.

The SWMS/JSA must be expressed in a way that is readily accessible and understandable to those who use it. If work is not carried out in accordance with the SWMS/JSA for the work, the contractor or site representative must ensure that the work is: stopped immediately or as soon as it is safe to do so and resumed only in accordance with the SWMS/JSA.

Table 1. SWMS/JSAs detail specific safety requirements for the job

No	SWMS/JSAs requirements for the job
1	The Contractor who is to perform the work shall complete the SWMS/JSA
2	For work done under a permit, the Permit Issuer shall review the SWMS before authorizing the permit
3	For medium-risk activities, the SWMS/JSA shall be reviewed by the contractor's supervisor or representative prior to the work starting
4	The (Permit Issuer) PI shall document on the permit any additional controls that the contractor must undertake to manage hazards and associated risks present on the site. The permit shall align with and complement the Contractor's SWMS/JSA
5	The Permit Holder shall ensure that the SWMS/JSA and permit are followed *

*Attachment 6 has a template for a SWMS

Table 2. 8 steps for completing a SWMS/JSA

No	8th steps
1	Complete a task list (for example, break down of work activities into tasks)
2	Complete a hazard identification assessment for all tasks; specially Neglected Invisible Hazard Identification (NIHI) [11]
3	Identify the high-risk tasks or hazards through HSE risk assessment
4	Identify control measures to be implemented to eliminate, isolate, or minimize the identified hazards and HSE risks
5	Ensure the control measures reflect the Hierarchy of controls and the degree of HSE risk
6	Include the permit requirements for the task or hazard
7	Assess the residual HSE risk for the hazards identified (If the residual HSE risk is high, return to step 4 and reassess the control measures, If the HSE risk is medium, consider further control measures to reduce the HSE risk and/or monitoring and review requirements)
8	Assign a responsible person for high-risk work and describe how the control measures are to be implemented, monitored, and reviewed.

Permit to Work System Definition: A permit is not simply permission to carry out a dangerous job. It is an essential part of a system which, through consultation with affected parties,

determines how that job can be carried out safely and helps communicate this to those doing the job. It should not be regarded as an easy way to eliminate hazards or reduce HSE risk [5]. The issue of a permit does not, by itself, makes a job safe - that can only be achieved by those preparing for the work, those supervising the work, and those carrying it out. As well as the PTWS, other controls may be required (for example, process or electrical isolation, or access barriers) and these will need to be identified in task HSE risk assessments before any work is undertaken. In the underhand, a permit is a document used to describe the work to be performed, tools to be used, and hazards associated with the planned work. A permit is issued for a particular task or activity, not for multiple activities over a period [8]. It identifies the requirements to be in place to eliminate, isolate, or minimized the hazards or risks associated with the task or activity. Together the contactor's SWMS/JSA and the permit shall cover all risks and identify the necessary control measures to ensure the risks are as low as reasonably practicable and also, a permit is required for potentially hazardous work specified in the PTWS activity table at all times. The permit must be accepted by the (Permit Holder) PH and authorized by the PI before work starts. Once the work is complete, the PH signs and submits the completed permit to the PI. The PI must sign the permit to verify the job is complete and that the permit is closed.

The permit and all associated documents (such as the Work Clearance Form, SWMS/JSA, and so on) readily accessible to all contractor employees at the work site.

RESULTS

Audit and Review of PTWS: As a minimum requirement, audits of PTWS including high-risk activity documentation should be carried out as part of the HSE audit program every six months. The HSE Assurance Manager arranges these audits. The HSE Operations Manager, HSE Business Partner – Projects, and Senior Permit Issuer peer review the audit and it is also reviewed by the SPGC's HSE Assurance Manager (Table 3). The HSE Operations Manager, in conjunction with the HSE Assurance Manager, shall annually review the effectiveness of the PTWS and modify it where necessary as part of continuous improvement. Factors to be taken into account include:

- Changes in legislation
- Industry guides
- Review of Incident Reports
- Inspection and audit findings
- Feedback from users

The results of audits, reviews and assurance are reported to the Business Risk Meeting by the HSE Manager. Permits and supporting documentation must be retained according to legislative and requirements. Training and competency records for Permit Issuers must be retained according to legislative and requirements.

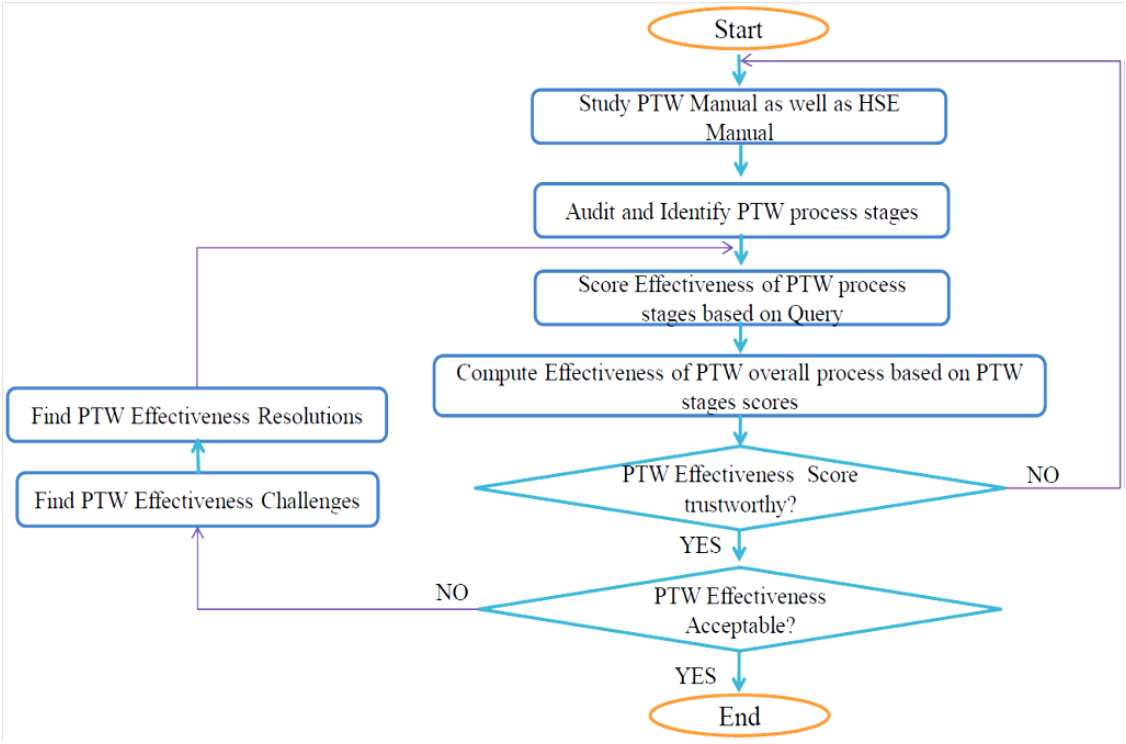

Fig.1. Schematics for process of Assessment and Management of PTW effectiveness

Published online: March 28, 2017

As the Table 3 depicts, the PTW process stages consisted of 12 main tasks and four score descriptions. Table 4 also presents the PTW Effectiveness Challenges (Fig.1.) and PTW Effectiveness Resolutions for all the 12 PTW process stage.

Table 3. PTW process stages for effectiveness assessment

Stage No	PTW Process Stage	Effectiveness Auditors	Effectiveness Score	Score Trustworthy	Score Acceptance
1	PTW Format Preparation	√	√	√	√
2	PTW Format Revisions	√	√	√	√
3	Request of PTW Organization/Unit	√	√	√	√
4	Audition of PTW HSE Unit	√	√	√	√
5	Filling in PTW Format	√	√	√	√
6	Provisions of PTW Requirements	√	√	√	√
7	Agreement of PTW HSE Unit	√	√	√	√
8	Presence of PTW HSE Inspector	√	√	√	√
9	Accordance of Work and PTW	√	√	√	√
10	End of Work	√	√	√	√
11	Documentation of PTW	√	√	√	√
12	Reviews of PTW Documentations in Regular Auditions and Inspections	√	√	√	√
	Overall Process	√	√	√	√

Table 4. PTW process stages for effectiveness management

Stage No	PTW Process Stage	PTW Effectiveness Challenges	PTW Effectiveness Resolutions
1	PTW Format Preparation	√	√
2	PTW Format Revisions	√	√
3	Request of PTW Organization/Unit	√	√
4	Audition of PTW HSE Unit	√	√
5	Filling in PTW Format	√	√
6	Provisions of PTW Requirements	√	√
7	Agreement of PTW HSE Unit	√	√
8	Presence of PTW HSE Inspector	√	√
9	Accordance of Work and PTW	√	√
10	End of Work	√	√
11	Documentation of PTW	√	√
12	Reviews of PTW Documentations in Regular Auditions and Inspections	√	√
	Overall Process	√	√

The results of surveys and interviews with 14 experts using structured Delphi method in two rounds (Fig. 2) indicated that questions raised in the checklist are system identification (Table 5).

In this study, first applications of the Delphi method after preparation of structure, top related experts selected and primary common questions released. In first round, responses to questions were evaluated. In the second round to select more appropriate questions, and released have been set. In addition, the objective of the method was to combine expert opinions on likelihood and expected development time, of the particular technology, in a single indicator.

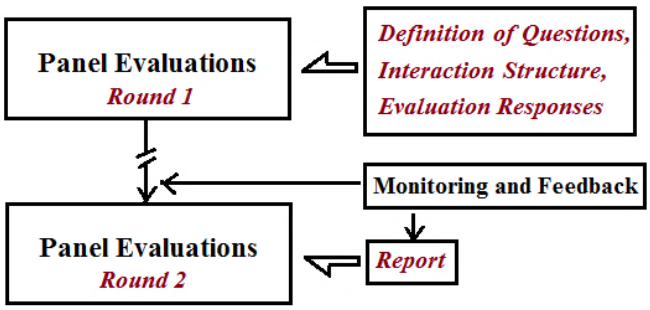

Fig.2. The Delphi method communication structure for preparation of identification checklists Questions

Published online: March 28, 2017

DISCUSSION

The data used in this study were obtained from the results of the last decade consequences of South Pars Gas Complex, Iran. The criteria indicators are health, safety, and environment management system performance indexes of Oil and Gas procedures and standards and sustainability regulations [12].

Introduce the Permit to Work System Disconformities Identification (PTWDI): In order to achieve disconformities identification of the work permits responsible person or a suitably competent work group, must be required to assess the work systems continually, but at least once per day, to observe some probable interruptions in work.

Another important case in permit to work is that responsible person must be ensuring that contractors and consultants are aware of the limitations and some of the visible disconformities, and the closure process. On permit expiry, or completion of the works (whichever is sooner), the contractor's supervisor shall be responsible for:

- Instructing their operatives to stop working and withdraw from the works area;
- Returning the display permit to the originating 'Competent' Person, or designated deputy;
- Signing the relevant section of the display permit indicating whether the works are complete or not, and confirming that all works have ceased and all operatives have withdrawn from the works area.

Four Audit indexes A, B, C and D can be characterized by Delphi communication structure rounds as it is known in accordance with the following described in Table 5 are visible.

A: Questions 1 to 9 are planned for primary steps of P.T.W.S (permit issuing before activity start)

B: Questions 10 to 13 are planned for confined spaces entry permits by considering to 1) confined space entry activity is one of high-risk activities; 2) every area authority maybe have issued several confined space activities; 3) firefighting team have core and basic function at executing confined space activities; 4) firefighting team should be ready, enough personal for every confined space, enough time, enough tools and subtle planning; 5) much of confined spaces have process connectivity.

C: Questions 14 to 18 are planned for HNF permits by considering to 1) hot naked flame(HNF) activity is one of high-risk activities; 2) every area authority may have issued several HNF activities permit; 3) firefighting team must be stand by at work location; 4) clinic team should be ready and on call. Therefore, is there any possibility which immediately and simultaneously to inform the issued HNF permits to firefighting center and clinic team? (HNF activity immediate inform)

D: Question 19 to 21 other important paper-based P.T.W.S aspects.

CONCLUSION

Questions raised in the checklist are divided into 10 main categories:

1. SIMOPS Immediate, data sharing and coordinating between all involved disciplines,
2. High-risk activities immediate, data sharing and coordinating with clinic center,
3. Confined space entry activities immediate data sharing and coordinating with rescue teams (firefighting and clinic centers),
4. HNF activities immediate data sharing, coordinating with rescue team (firefighting and clinic centers) and site executing team (area HSE and area operators),
5. Protecting P.T.W.S undergoes to any document counterfeit or illegal manufacturing,
6. Immediate risk assessment capability for every permit (every activity),
7. Easy and fast capability of permits tracing, statistics, and review,
8. Easy and fast capability of MOC and any flexibility,
9. Cost saving capability (human, resources, environmental),
10. Immediate MSDS providing and preparing capability for every chemical permit (every activity).

The Permit to Work System Disconformities Identification (PTWDI) introduced and applied in this study could be used to analyze and quantify disconformities and uncertainties, and extract the required measures necessary to reduce error probabilities in a PTW system. The following suggestions are provided to reduce the likelihood of PTW procedure errors (Cause a hazard) in South Pars Gas Complex and as a result surveys conducted, hazard classified to 3 major levels: 1) Definitely high risk and hazardous, and must urgently have corrective actions, 2) Intermediate risk and hazardous level, and should have corrective actions and 3) Risk tolerable but should be continuously monitored and controlled. These specified levels could help to provide correction actions for finding a modified PTW procedure (as a new version) to related activities in the South Pars Gas Complex.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the authorities at South Pars Gas Complex supports. The authors declare that there is no conflict of interests.

Table 5. Permit to Work System Disconformities Identification checklists, (Must be added to Auditing checklists)

Row	TITLE and STEPS	YES	NO	Hazard Classification H	S	E
	AUDIT INDEX A					
1	Is there any possibility for immediate and simultaneous informing the issued permit topics to all other area authorities?(SIMOPS immediate inform)		✓			
2	Is there any possibility for immediate and simultaneous informing the issued permit topics to all other area HSE supervisors?(SIMOPS immediate inform)		✓			
3	Is there any possibility to immediate and simultaneous informing the issued permit topics to all other area operators?(SIMOPS immediate inform)		✓			
4	Is there any possibility to immediate and simultaneous informing the issued permit topics to all other area task supervisors?(SIMOPS immediate inform)		✓			
5	Is there any possibility to immediate and simultaneous informing the issued permit topics to all area check points?(SIMOPS immediate inform)		✓			
6	Is there any possibility to immediate and simultaneous informing the issued permit topics to site firefighting center?(SIMOPS immediate inform)		✓			
7	Is there any possibility to immediate and simultaneous informing the issued permit topics to site clinic center?(SIMOPS immediate inform)		✓			
8	Is there any possibility to immediate and simultaneous informing the issued permit topics to site top managers?(SIMOPS immediate inform)		✓			
9	Is there any possibility to immediate and simultaneous informing the issued permit topics to all site Emergency Response Team members?(SIMOPS immediate inform)		✓			
	AUDIT INDEX B					
10	Is there any possibility to immediate and simultaneous informing the issued confined spaces permits to firefighting team?(confined space immediate inform)		✓			
11	Is there any possibility to immediate and simultaneous informing the issued confined spaces permits to clinic team?(confined space immediate inform)		✓			
12	Is there any possibility to immediate and simultaneous informing the issued confined spaces permits to all area authorities and operators?(confined space immediate inform)		✓			
13	Is there any possibility to immediate and simultaneous informing the issued confined spaces permits to related checkpoints?(confined space immediate inform)		✓			
	AUDIT INDEX C					
14	Is there any possibility to immediate and simultaneous informing the issued HNF permits to related checkpoints?		✓			
15	Is there any possibility to immediate and simultaneous informing the issued HNF permits to area HSE SV?		✓			
16	Is there any possibility to immediate and simultaneous informing the issued HNF permits to area authorities and operators?		✓			
17	Is there any possibility to immediate and simultaneous informing the issued HNF permits to Firefighting team?		✓			
18	Is there any possibility to immediate and simultaneous informing the issued HNF permits to related clinic?		✓			
	AUDIT INDEX D					
19	Is probability of involved peoples “signature counterfeit” definitely equals zero?		✓			
20	Is probability of" permit different parts and sections illegal manufacturing" definitely equals zero?		✓			
21	At current P.T.W.S (Paper based) in south pars gas refineries, by consider to: 1- risk assessment for every high-risk activity must be attached to permit 2 - area authorities may have issued several high-risk activities permit(daily approximate 200 to400 permit and at overhaul shutdowns daily approximate 800 to 1100 permits) 3-risk assessment is inherently time-consuming. Therefore, is there any possibility which all involved personnel have immediate and quick access to ready “risk assessments”		✓			

Row	color	Description
1		Definitely high risk and hazardous, and must urgently have corrective actions.
2		Intermediate risk and hazardous level, and should have corrective actions.
3		Risk tolerable but should be continuously monitored and controlled.

Published online: March 28, 2017

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Published online: March 28, 2017