Human Failure In Control Of Work:

Plugging Holes In The Swiss Cheese?

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Abstract

Many serious events in the major hazard sector occur during human intervention under a "control of work" or "permit-to-work" system. In this paper, the term COW or COWS has been used to refer to all such systems.

In a previous paper (Lardner & Maitland, 2009) it was observed that some COWS, despite being labelled a "safe system of work", do not recognise that the humans involved in operating the system are fallible. Such systems rely upon the human performing flawlessly on every occasion, which is clearly impossible.

This paper describes a project undertaken in a petrochemical manufacturing plant, where management noted some early warning signs indicating some vulnerability may exist in the design and application of the COW system. The project sought to identify such vulnerabilities via the following process:

- Identifying known types of human failure during 12 phases of COW, via the existing literature, subject matter experts, and the company-specific incidents, which were the "warning signs" referred to above
- Conducting an independent table-top review of the COW system to establish whether, if the COW system was applied to the letter, it would protect against each type of human failure. In other words, what should happen "in theory"
- For those aspects of the COW deemed particularly vulnerable (for example which were less likely to be followed to the letter), conducting a survey of COW users to establish how these aspects were applied "in practice"
- Writing recommendations to amend the COW system to close those gaps which could result in a human failure leading to an incident.

The current author has informally described this work to operations and COW specialists in hazardous industries. They have requested that the methodology be published, so it can be used / adapted by those in the chemical process industries.

Introduction

Major hazard sites typically use a documented system to control hazardous work. Such systems may be known as “permit-to-work system”; “safe system of work”, or “control of work system”. For the purposes of this paper, all such systems are referred to as “control of work system”, abbreviated to COWS.

This paper describes a project conducted at ABC Ltd, a hazardous facility which manufactures petrochemical feedstock for international markets. The site management were concerned about several minor non-compliances with their COWS, discovered during routine audits. The site management considered these non-compliances as “early warning signs” of a potential COWS-related incident. They realised that, to become a high-reliability organisation, they had to maximise the opportunity to learn from any “weak signals” of impending failure (Weick et al, 1999). They therefore commissioned a project to review COWS design and operation.

In scoping the project, ABC Ltd wrote “since the COWS is one of our most important safety-critical procedures we would like to undertake a human factors review of all aspects of the system, including some recent incident investigations…”, which included the following objectives:

- Ensuring that the COWS, as applied at this manufacturing site, is as error-tolerant as possible
- Understanding any gaps in the COWS training, procedures, culture or application with regard to human factors
- Providing recommendations on any changes necessary to bridge gaps
- Checking that robust systems are in place to maintain competence and carry out application and quality audits of the system for on-going compliance and continuous improvement
- Supporting a high degree of engagement and the appropriate level of accountability for all personnel involved with the COWS and its application.

Methods used

The review objectives were broadly to:

- identify how error-tolerant the system was, both in theory and in day-to-day application
- identify any significant human performance-shaping factors which were adversely affecting its reliable and safe use
- develop recommendations to address any deficiencies or improvement opportunities.

To meet the above objectives, the following three main types of analysis were conducted. These analyses have been described in this paper in sufficient detail to enable others to use or adapt the method for their own COW system.

1. Testing COWS defences against a range of incidents "in theory"

The author followed this process

- Identification of known human failures in control of work systems from three sources (i) openly-published incident data external to ABC Ltd (ii) expert opinion from several UK specialist human factors safety regulators, and (iii) seven incidents at the ABC Ltd manufacturing site facilities (see Appendix 1 for details)
- Mapping these incidents onto the twelve phases of this organisation's COW system (see Appendix 1, Column 1 for details).
- Examination of the COWS to determine whether, if it was applied as intended, it would protect against each human failure
- In the course of this analysis, identification of other COWS features requiring improvement.

A wide range of real incidents involving control of work were used to test the ability of the COWS, if correctly applied, to defend against such events. In conducting this analysis, it was necessary to be critical, and avoid assuming that the COWS users would cover any gaps in the system. Although the COWS was able to defend against many incidents, some vulnerability was found.

The table below shows an example of this analysis. The entire table is reproduced in Appendix 1.

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**Does ABC Ltd COWS defend against this type of human failure?**
APPLY PERMIT-TO-WORK CONTROLS, AND ISOLATIONS	**Incorrect electrical isolation of pump and fan rotor. Correct type of isolation erroneously applied to GT1 instead of GT2**	✓			This is a very common and serious type of human failure during maintenance work in many industries. "Check you are working on right equipment" is not a specific step in the COWS flow-charts. For isolations, there is verification by an independent check. For permits, the Issuing Authority is required to sign to verify that other controls are in place, but a physical check by field visit is not mandatory. The COWS says "if required, a field visit should be completed" – but little guidance is offered on how to judge if one is required. However, it is stated that field visits are required for high-hazard hot work, and work which could potentially trip the plant.
	Isolation applied to wrong equipment. Equipment tag numbers were not clearly identified by operator prior to equipment isolation.			✓	

This analysis revealed a potential weakness in the COWS, namely that "in theory" permit-to-work controls were not independently verified via a field visit, whereas the applications of isolations were.

2. COWS survey "in practice"

Testing of the COWS defences against a range of incidents was a theoretical table-top exercise, and therefore did not address the possibility that COWS procedures may not be followed as described, and / or performance of the COWS may be compromised by the circumstances or conditions in which it is used. To help determine the perceptions of those using COWS, an online survey was conducted, which covered the following key topics:

(1) general conditions that may affect the reliable use of the COWS
(2) conditions that are specific to twelve key phases of the COWS
(3) adequacy of COWS training
(4) other suggestions on how COWS could be improved.

The table below shows the results of two questions from the survey, for the COWS phase "Apply permit-to-work controls, and isolations". This is the same COW phase as the "in theory" example shown above.

	Percentages. Shaded = areas of concern			
Please indicate how frequently, in your experience, these conditions apply now, or have applied in the past six months	Never	Sometimes / Seldom	Often	Always
Being unclear about when a site visit is required by COWS	25.4	46.3	25.4	3.0
Not consulting P&IDs to identify correct plant or equipment to work upon	52.3	43.1	3.1	1.5
Mistakenly applying controls or isolations to wrong plant or equipment	58.5	41.5	0.0	0.0
No independent verification of whether controls have been correctly applied	67.7	30.8	0.0	1.5
No independent verification of whether isolations have been correctly applied	69.2	29.2	0.0	1.5
Poor access (eg for valves) for isolation tasks	16.9	64.6	18.5	0.0
Poor working environment (eg lighting), for isolation tasks	16.9	69.2	13.8	0.0

COWS stated that a site visit should be conducted "when required", but provided no guidance on the circumstances under which it is a requirement. The survey responses shown above indicate that a lack of clarity exists about when a visit is necessary. Furthermore, it appears greater rigour should be applied to ensure isolations are correctly applied to the right equipment, and this may be aided by better access and lighting.

The format and wording of the entire COWS survey is reproduced in Appendix 2, so it can be used / adapted by others.

3. Ergonomic review of COWS procedures and training materials

A review of COWS training material, duration, mode, refreshers and supporting material was conducted to ensure that it was sufficient to result in permit issuers and permit users who were competent in hazard awareness, hazard identification and control, irrespective of their trade.

An ergonomic review of one key COWS procedure – Confined Space Entry – was conducted to determine the extent to which it adhered to recognised ergonomic criteria for developing, designing and writing procedures (e.g. Klein and Isaacson, 2003; Energy Institute 2011). This procedure was chosen due to its criticality. The review included calculation of two reading indices (Kincaid et al, 1975), which help to determine whether the language is suited to the audience who need to be able to read, understand and follow the text. Both indices are readily available in Microsoft® Word, as part of the grammar tools. This analysis indicated this procedure was too complex for the intended audience.

Reading index	Description of scoring	Result for Confined Space Entry procedure	Comments
Flesch reading ease	A score of 90 is similar to a child's comic, with a score of 10 being typical of a dense legal text.	9	Length of sentences and words need to be shortened.
Flesch grade level	The US school age and grade that could readily understand the text	17 graduate / post-graduate level	

Conclusions

By following this process, and deploying three methods described above, ABC Ltd was able to identify vulnerabilities in how their COWS was designed, used in practice, and supported by training for key personnel. Their willingness to act on early warning signs may have averted a serious COWS incident. As a result of this project, ABC Ltd

- Recognised the importance of designing their COWS from the perspective of the end user, and ensuring the possibility of human failure is defended against
- Simplified language within COWS
- Initiated a review of COWS training materials and processes
- Trialled the use of eLearning modules for some aspects of COWS
- Commenced broader work on document design, formatting, and competence document authors

It is hoped that other companies will use the methodology described to test whether their COWS is adequately defended against known human failures, and thus avoid repeating past incidents. In doing so, it will be important to update Appendix 1 to include known COWS incidents in their own company, and other COWS incidents which may have come to light in their industry sector since this project was undertaken.

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Personal communication with three UK safety regulator / human factors experts as follows:

(1) Chartered Engineer and human factors psychologist working for UK health and safety regulator, in UK offshore oil and gas industry

(2) Registered Ergonomist and Chartered Psychologist, ex-nuclear safety inspector, with 30 years experience

(3) Engineer and head of human factors in UK civil nuclear industry.

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Appendix 1 – Mapping of human failures to COWS

		Source			
Control of work phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
1. IDENTIFY HAZARDOUS TASK	**Record any general comments opposite**				
	Inexperienced contractor exposed to high levels of hazardous product whilst taking measurements. Product was being pumped to tank when sampling occurred. Hazard ID was not conducted, nor was permit raised – by either contractor or ABC Ltd field operator, or supervisor who knew what was happening			✓	
2. CONDUCT RISK IDENTIFICATION FOR MAIN TASK, AND SUB-TASKS	**Record any general comments opposite**				
	Hazard ID does not reflect the tasks being carried out			✓	
	Hazard ID does not identify all hazards present			✓	
	Site visit not performed by performing authority. Hazard ID inadequate			✓	

		Source			
Control of work phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
3. DECIDE WHETHER PERMIT-TO-WORK REQUIRED	**Record any general comments opposite**				
	Too many PTWs – situational awareness goes haywire – e.g. covering major maintenance through to painting a door with PTWs		✓		
	Not raising a PTW, when one is actually needed		✓		
	Raising permits for prep work, but not main job		✓		
	A cleaner entered a PVC autoclave to check on the need for cleaning and was overcome by vinyl chloride fumes. The vessel was entered on average twice a week, and although a permit-to-work system had been in place, it had fallen into disuse	✓	✓		
	Hazardous work conducted with no PTW & controls		✓		
	Isolation applied without a permit to a specific piece of electrical equipment – this had been common practice for years, despite being contrary to COWS			✓	

		Source			
Control of work phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
4. COMPLETE PERMIT-TO-WORK AND ASSOCIATED RISK ASSESSMENT & CONTROL MEASURES	**Record any general comments opposite**				
	Use of generic, cut-and paste permit and controls, leading to inadequate or missing hazards and controls		✓		
	Use of standard format, pre-prepared permits		✓		
	Your procedures should specify the requirements for risk assessment of isolation and associated activities. Your assessment should include the potential for, and consequences of, human error. All relevant hazards should be considered (HSG 253 Safe Isolation para. 102)		✓		
	Clashes between two permits (e.g. isolations clash, or permits interferes with normal operations)		✓		
	Welder attempted to weld onto a tank that had neither been emptied nor purged	✓			

		Source			
Control of work phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	An explosion occurred in a tank containing aqueous waste contaminated with hydrocarbon solvent. Welding work was being carried out on pipe work supports carrying pipes which led to the top of the tank. The welding ignited fumes in the pipes and the flame spread along the pipes into the tank. Because the work was not being done on pipes containing flammable materials the permit made no reference to the surrounding risks	✓			
	Signatures not completed on forms			✓	
	Paperwork not completed		✓		
	Signatories no longer exist due to organisational changes		✓		
	In the permit-to-work system in place at the time of the Piper Alpha disaster, there was no cross-referencing when the work carried out under one permit affected the work under another. Reliance was placed on the memory of the designated authority	✓			

		Source			
Control of work phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	A major vapour cloud explosion at a chemical complex in Pasadena, USA in 1989 killed 23 people and injured 300. The incident occurred during maintenance work on a reactor vessel which was being carried out by a maintenance contractor. During the investigation, it was discovered that there was no effective permit-to-work system in operation that applied to both company employees and contractors. This lack of an effective system led to a communication breakdown and work taking place on un-isolated plant	✓			
	Not considering human performance-shaping factors as a potential hazard		✓		
	Permit prepared with no site visit. Permit issuer incorrectly recalled location of equipment, and did not specify necessary controls for actual location. Incident occurred thereafter	✓			
	Further to above incident, performing authorities noticed discrepancy, but did nothing about this, and continued work	✓			

5. WHERE RELEVANT, DESIGN ISOLATION	**Record any general comments opposite**				
	The potential for human failure, including error, should be addressed and, wherever possible, minimised in the (isolation) design. (HSG 253 Safe Isolation)		✓		
	This isolation did not have adequate provision for testing, i.e. no vent/drain and no means of monitoring pressure. Isolation procedures should specify testing and monitoring requirements. (HSG 253 Safe Isolation)	✓	✓		
	Confined space entry requires stringent planning and extraordinary measures, as even short exposure to asphyxiants, and/or toxic chemicals can be fatal. Double-valved isolation is not adequate for vessel entry purposes. A thorough examination of P&IDs and the worksite should have revealed the nitrogen supply. This should have been physically disconnected and recorded on the isolation documentation. (HSG 253 Safe Isolation p.5)	✓	✓		

	During replacement of a heat exchanger, a vent line linking the system to a second reactor was not identified during risk assessment or during installation of the isolations. No reference had been made to P&IDs, even although the plant was congested and spread over several floors. Because of the failure to isolate the vent line, a substantial release of hydrogen bromide gas occurred when the line was opened, P&IDs should be used to plan isolations. Always check that they reflect the as-installed equipment. You should also walk the system to be isolated to ensure that there are no unauthorised modifications, or temporary interconnections e.g. by hoses, (HSG 253 Safe Isolation para. 142)	✓	✓		
	A permit-to-work was issued for the job by a maintenance operator. The permit identified the mechanical and electrical isolations necessary but did not specify the process isolations because the issuer was not aware of the necessary process controls. (HSG 250, case study 3)	✓	✓		
	Wrong or out of date information / P&IDs		✓		

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
6. APPLY PTW CONTROLS, AND ISOLATIONS	**Record any general comments opposite**				
	Incorrect electrical isolation of pump and fan rotor. Correct type of Isolation erroneously applied to GT1 instead of GT2 (Error)	✓			
	Alternator cooling valve found in the (wrong) closed position during isolation. (Error)	✓			
	Cooling water valve left in (wrong) closed position	✓			
	Failure to complete isolations fully before starting work	✓	✓		
	Failure to prove and monitor isolated valves	✓	✓		
	Failure to check P&IDs/schematic diagrams against the actual installed plant and equipment	✓	✓		
	Miss a step in isolation procedure, due to being distracted by other non-critical tasks	✓			
	No independent checks on isolations (and de-isolations)		✓		

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	Isolation applied to wrong equipment **Equipment Tag Numbers on the isolation plan were not clearly identified by the Operator prior to equipment isolation** **Part of ICC form not completed, which asks for verification that isolation will have intended effect** **Two operators involved in applying isolations in parallel, rather than one applying, and the second checking?** **Once problem identified, original permit was changed, rather than cancelling original and re-issuing a new one**			✓	.

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
7. COMMUNICATE BETWEEN VARIOUS PARTIES INVOLVED	**Record any general comments opposite**				
	Poor communication (e.g. at shift handover)	✓	✓		
	Two fitters were sprayed with 98% sulphuric acid while removing an accumulator from an acid pump to repair a seal. Pressure on the discharge side of the pump had not been vented, although their permit-to-work indicated that the line had been cleared. Lack of liaison between the engineering and operating departments over who had done what resulted in the permit being wrongly issued. (HSG 250 Case study 8)	✓	✓		
	During the Piper Alpha inquiry it was found that contrary to the written procedure, the performing authority's copy of the permit was frequently not displayed at the job site, and was commonly kept in the performing authority's pocket	✓			

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	On Piper Alpha suspended permits were kept in the safety office, NOT in the control room, as it was claimed there was not enough room. A lead production operator could be aware of a permit-to-work if it was one of the permits which came to him for suspension in the 45 minutes before he officially came on shift. However, it would be completely unknown to him if it had been suspended days before, or earlier on the same day before he arrived in the control room for the handover. The correlation of suspended and active permits was made more difficult by the fact that in the safety office, suspended permits were filed according to trade involved rather than location. This made it difficult for any supervisor to readily check which equipment was isolated for maintenance. **It was also found that there were often large numbers of suspended permits, some of which had been suspended for months e.g. in February 1998, five months before the disaster, 124 permits-to-work were found to be outstanding. This added to the difficulty of checking which equipment was undergoing maintenance**	✓			

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	In his report on the Piper Alpha public inquiry, Lord Cullen found that the handovers between phase 1 operators and maintenance lead hands on the night of the disaster had failed to include communication of the fact that PSV 504 had been removed for overhaul and had not been replaced. This missing PSV was the source of the leak which subsequently ignited. (HSG 250 Case study 12)	✓			
	Insufficient on-site job-specific briefing and identification of equipment		✓		
	Poor communication during PTW process (verbal, written, via procedures)		✓		
	Poor labelling, contributing to misidentification of equipment		✓		
	Isolation applied to correct equipment, then circuit breaker moved to other equipment, leaving original equipment not properly isolated - no permit used. Human performance-shaping factors: – inadequate communications about job, due to no permit being used; poor labelling			✓	
	Hot work permit issued, but remained in central control room. Hazard ID inadequate. During audit found that contractor working with no permit in possession			✓	

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
8. CONDUCT HAZARDOUS WORK	**Record any general comments opposite**				
	Isolation removed by contractors under instruction of Performing Authority, in violation of COWS and isolation procedure	✓			
	Lack of technical competence or knowledge about the job being conducted		✓		
	Working on wrong equipment - usually not a mistake in paperwork, but mis-read or mis-located		✓		
	Deliberately ignoring control measures (e.g. not isolating electrical equipment, crossing barriers)	✓			
	Installing wrong part (error)	✓			
	Tools left behind		✓		
	Isolations applied correctly, then mechanical technicians worked on the wrong equipment. Confusing pipe labelling contributed to misidentification of equipment			✓	

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
9. RE-ASSESS IF CHANGES OCCUR	**Record any general comments opposite**				
	An operator was carrying out a routine pigging operation. On conclusion of the interlock sequence he opened the telltale bleed valve to ensure that the launcher was free of toxic and flammable gases. The gas test was negative He then realised that he had omitted part of the procedure, requiring the interspace between the kicker line isolation valve and the pipeline isolation valves to be vented to flare. This procedure is normally carried out at the beginning of the operation. He opened the kicker line isolation valves and the pipeline isolation valves without closing the telltale door This caused a gas release from the telltale bleed valve. If a process isolation deviates from the plan, whether controlled by permit-to-work or operating procedure - STOP! Re-evaluate the task. In this case, the interlock arrangements which permitted the human error to occur should be reviewed with a view to modification (HSG 253 Safe Isolation p.10)	✓	✓		
	Deviations from plan without review		✓		

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	During work, it became unclear whether drains were free of hydrocarbons. Foul-smelling liquid found, discussed, and drained then flushed with water. Drains tagged as open and air hose attached to purge with air. Gas test conducted. Area Authority leaves air hose connected to tagged open isolation valve. This represented a uncontrolled energy source to the isolation plan			✓	
10. REMOVE CONTROLS AND ISOLATIONS	**Record any general comments opposite**				
	Oil cooler bypass valve de-isolated in (wrong) open position. (Error)	✓			
	Plant reinstatement is a critical aspect of any intrusive activity. Incorrect or incomplete reinstatement is likely to result in loss of containment. (HSG 253 Safe Isolation)		✓		
	Failure to reverse isolations fully before restarting plant	✓	✓		
	Investigation found that the review conducted to bring the valve back into service was inadequate and did not identify the need to replace the bleed plug		✓		

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	A valve and vent line had been used to verify mechanical isolations made on a 30 cm gas line during maintenance. The valve had been left in the open position. When the system was pressurised, a gas leak resulted. The appropriate position for vent valves during intrusive work is indicated by risk assessment. Correct reinstatement is critical. The worksite should be inspected prior to reinstatement, and a sample of such isolation work should be monitored by an independent person	✓	✓		
	A fitter was scalded by an escape of high-pressure steam from an open pipe. Two fitters were carrying out work on the pipes under a permit-to-work. The first fitter thought the job was complete and returned the permit to the process operator who opened the steam valve. The second fitter had not completed his part and was still working on the open pipe. The permit-to-work system did not contain a signing off procedure	✓			
	Incorrect or no de-isolation		✓		

		Source			
Work control phase	**Description of human failure**	**Published incident**	**Subject matter expert**	**ABC Ltd Incident**	**How does your company's COWS defend against this type of human failure?**
	A work permit was issued to a performing authority to close the package boiler mud drum, steam drum and furnace without an equipment closure form. It seems that closures occur after work has been done on equipment, and the certificate confirms no equipment has been left inside etc…and that no permits are outstanding for the item being closed. In this case lack of the equipment closure form meant that operations had to reopen the vessels to conduct an inspection			✓	
11. REINSTATE PLANT	**Record any general comments opposite**				
	PTW not signed off properly - incomplete return to normal condition. If too many 'open' PTW have problems with job handover and return to normal working - keeping track of incomplete jobs or return to work conditions		✓		

12. MONITORING AND REVIEW	**Record any general comments opposite**				
	No monitoring and audit of system		✓		
	Weak or inadequate audits (too often, too shallow)		✓		
Human performance-shaping factors applying to isolations generally	**For errors** • Establishing and maintaining adequate understanding of hazards and the integrity of isolation arrangements • Providing well-designed, clear, concise, available, up-to-date procedures and instructions, including checklists and other job aids that are accepted and used by the workforce • Clear identification of plant and equipment, including valves • A clear system for tagging valves, and recording on P&IDs and schematic diagrams • Providing good access (e.g. for valves) and working environment (e.g. lighting), for isolation tasks • Effective checking (independent where necessary) and supervision for isolation proving and monitoring, and for reinstatement • Good communications (e.g. at shift handover) • Considering the potential for human error in risk assessments and incident investigations				

Human performance-shaping factors applying to isolations generally	**For violations** • Establishing a positive safety and organisational culture, with clear expectations and good reporting systems for recognising and acting on work pressures • Planning realistic work schedules - including managing competing demands e.g. between maintenance and operation, contract work and operation, shutdown modifications and maintenance - and providing adequate resources for the work • Well-designed isolation tasks • Good staff understanding of the reason for procedures and instructions and their roles and responsibilities within the system • Workforce participation in drawing up procedures and instructions • Effective supervision • Compliance checking e.g. procedural compliance audits, performance monitoring (including routine tasks)				
Data from analysis of maintenance errors	Errors of omission more common (34% of all) – within that repair and modification (41%), testing and calibration (33%), inventory control (9%) and manual operation and control (6%) (Reason, Managing Maintenance Error, p. 6)				

APPENDIX 2 – COWS SURVEY

REVIEW OF CONTROL OF WORK SYSTEM

The ABC Ltd Control of Work System (COWS) plays a vital role in ensuring that those conducting hazardous work do not come to any harm.

To ensure there are no gaps in how COWS is designed or used, ABC Ltd has commissioned an independent review, conducted by The Keil Centre Ltd.

As part of this review, we would like your opinions on the following subjects:

- general conditions which may affect the reliable use of the COWS
- conditions which are specific to key phases of the COWS
- COWS training
- your suggestions on how COWS could be improved.

This survey is anonymous. You will be asked to indicate your main role in the COWS, but you cannot be identified by name. Please give your frank and honest opinions.

The survey should take about 15 minutes to complete.

Which of the following best describes your ***main role in COWS***? (choose one only):

- Area Authority and / or Issuing Authority
- Performing Authority
- Shift Supervisor/ Operations Manager / Superintendent
- COWS auditor
- Other

Are you a…

- ABC Ltd Technical Department employee
- ABC Ltd Operations Department employee
- ABC Ltd Maintenance Department employee
- ABC Ltd contractor

GENERAL CONDITIONS WHICH MAY AFFECT THE RELIABLE USE OF THE COWS

Please review the following conditions, and identify how frequently they apply when you are working with COWS. Please indicate how frequently, in your experience, these conditions apply now, or have applied in the past six months.

	Always	Often	Sometimes / Seldom	Never
Poor planning, prioritisation or co-ordination of work				
Trying to do several tasks at once				
Insufficient time available				
Excessive length of shift				
Excessive overtime worked				
Inexperienced team members				
Wrong skill mix in team				
Unclear allocation of responsibility in team				
Lack of coaching or mentoring from experienced supervisors or managers				
Shortage of manpower				
Procedures not available				
Procedures inaccurate				
Procedures impractical				
Procedures out-of-date				
Procedures unclear				
Procedures difficult to remember				
Procedures frequently-changing				
Procedures incompatible with other procedures				
Plant / equipment labelling missing or illegible				
P&IDs inaccurate or illegible				

CONDITIONS WHICH ARE SPECIFIC TO KEY PHASES OF COWS USE

Below you will find the main phases of the COWS. Under each phase, you will find conditions which may apply to that phase. Please indicate how frequently, in your experience, these conditions apply now, or have applied in the past six months.

1. IDENTIFY HAZARDOUS TASK

	Always	Often	Sometimes / Seldom	Never
Being unsure whether a task is hazardous				
Being unclear about what the hazards are				
Hazards and consequences are not properly considered				
Confusing paperwork				

Please briefly describe any areas where the Hazard ID process can be improved

(insert text box here)

2. CONDUCT RISK IDENTIFICATION FOR MAIN TASK, AND SUB-TASKS

Not conducting a site visit to identify hazards				
Being unclear about when a site visit is required by COWS				

3. DECIDE WHETHER PERMIT-TO-WORK REQUIRED

Being unclear about whether a permit is required				

4. COMPLETE PERMIT-TO-WORK AND ASSOCIATED RISK ASSESSMENT & CONTROL MEASURES

Being unclear about when it is allowed to use a Permission to Work Card, instead of a Permit				
Not identifying hazards associated with adjacent work				
Not identifying conflicting permits				
Not identifying human hazards (e.g. fatigue, error)				

5. WHERE RELEVANT, DESIGN ISOLATION (applies to AA and IA only, so requires skip-logic in survey design)

Not consulting P&IDs				
P&IDs inaccurate or unavailable				
Not conducting a site visit to aid isolation design				

6. APPLY PTW CONTROLS, AND ISOLATIONS

Not consulting P&IDs to identify correct plant or equipment to work upon				
Mistakenly applying controls or isolations to wrong plant or equipment				
No independent verification of whether controls have been correctly applied				
No independent verification of whether isolations have been correctly applied				
Poor access (e.g. for valves) for isolation tasks				
Poor working environment (e.g. lighting), for isolation tasks				

7. COMMUNICATE BETWEEN VARIOUS PARTIES INVOLVED

Poor communication at permit issue				
Too many permits in use at the same time				
No on-site briefing prior to starting work				
No on-site identification of correct plant or equipment to work upon, prior to starting work				
Permit not kept at job-site				
Poor communication within team				
Poor communication at shift handover				
Poor communication between operations and maintenance personnel				
Communication equipment unreliable				
As a Performing Authority, being unable to properly supervise the work team, due to other demands on my time				

8. CONDUCT HAZARDOUS WORK

Finding hazards which had not been identified during earlier hazard identification				
Working on wrong plant or equipment, by mistake				
Installing wrong part, by mistake				

9. RE-ASSESS IF CHANGES OCCUR

When changes occur, continuing to work without re-assessing hazards and controls				
Being unclear what type of changes require a reassessment to be made				

10. REMOVE CONTROLS AND ISOLATIONS, AND REINSTATE PLANT

Incorrect or incomplete de-isolation				
Incorrect or incomplete removal of other controls				

11. MONITORING AND REVIEW

Lack of rigorous COWS audits				

TRAINING

We would now like to ask you about the COWS training you have received. Please indicate your agreement with the following statements

	Strongly agree	Agree	Neither agree not disagree	Disagree	Strongly disagree
The training was easy to understand					
The training was good quality					
The training equipped me with the skills and confidence I need to use COWS					
The training was too general					
The training was not tailored for my discipline (e.g. electrical)					
I am using COWS, but have not received any training					

Please comment of the following aspects of the training:

- Pace of training (too fast / about right / too slow)
- Length of training (too short / about right / too long)
- Training content (too complicated / about right / too simple)

What would you recommend to improve the COWS training?

(insert comments box here)

COWS IMPROVEMENTS

Please list the top three things which, in your opinion, would make the COWS more effective. Please consider both the COW system, and how the system is used in practice.

(insert comments box here)

CLOSING PAGE

Many thanks for your comments. These will be considered when making improvements to COWS.