Practical experience with Management of Change reflecting upon incidents, audits and gap analyses

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The topic of Management of Change (MoC) continues to be a concern for the process industries line management. Of all the process safety management topics it is the most likely keeps people awake at night. Why, well because they are directly responsible for the changes made "on their watch". Incidents continue to occur as a result of the inadequacies in companies MoC systems or in the ineffective application of such systems. This is clearly illustrated by the incidents such as at BayerCrop Science and Williams Geismar as investigated by the USA's Chemical Safety Board. The topic of MoC was central to the disaster at Flixborough in 1974 and contributed to a significant number of fatalities at Texas City in 2005. What's stopping industry from preventing such disasters? For topics such as HAZOP and Safety Instrumented Systems there are international standards such as IEC 61882 and IEC 61511/61508. Industry has given a strong focus to implementing IEC 61511/61508, often influenced by the regulator. Whilst in many countries there are regulatory requirements covering the topic of management of change there is no universally applied MoC standard within the process industries. Should we await the next industrial disaster to create such a standard or should we start making that change now? Conversely, should individual countries such as Canada lead the way in implementing new PSM standards? The Canadian Standards Association issued a PSM standard in February 2017. This paper highlights some key deficiencies found in the application and design of MoC systems as discovered through incident case studies, auditing and gap analyses conducted on this topic.

Keywords: MoC, audit, gap analysis, standard

Introduction

A number of the most significant Process Safety Incidents such as Flixborough (reference 1) and Texas City (reference 2) were related to the topic of MoC. More recent incidents such as those at BayerCrop Science (reference 3) and Williams Geismar (reference 4) and as investigated by the USA's Chemical Safety Board highlight that industry is still vulnerable to issues associated with MoC.

How well is industry doing on the topic of Management of Change and what can we learn from Incidents?

In the UK, the Health and Safety Executive's Control of Major Accident Hazard (COMAH) Safety Report Assessment Manual (SRAM), (reference 5) encourages industry to review past incidents. The central internet repository for all European Major Accident Hazard related incidents is called eMARS (European Major Accident Reporting System). eMARS is the official reporting repository for submitting accident reports to the European Commission according to the criteria established in the Seveso III Directive. The current eMARS database contains over 800 accidents and near misses collected since 1982 (but covering incidents that occurred since 1979) from the Member States. The purpose of eMARS is to facilitate exchange of lessons learned from accidents and near misses involving dangerous substances in order to improve chemical accident prevention and mitigation of potential consequences. Accident reports can be searched and analysed to extract specific lessons learned about substances, equipment etc. relevant to particular types of installations.

Research of this database conducted by ABB Consulting for MoC related incidents over the period from 1979 to August 2017. (There is a lag in time between the incident happening and being reported into the database as time is required for the investigation). Four out of a total of eight hundred and ninety one incident reports were explicitly identified as being related to the topic of MoC. In order to validate this data a wide range of search words was used and over 100 entries individually reviewed. The review of the entries suggests that the quality of the information entered is in general very poor. To have only four reported MoC related entries over a period of 38 years appears somewhat hard to believe. Table 1 summarises the information obtained from eMARS.

Table 1 - Summary of MoC related incidents contained in eMARS.

Date of incident	**Incident Summary**
3/9/06	Strainer used instead of a filter. No MOC used. Loss of containment of ethylene. No ignition. Bolts used were inappropriate. Wrong length and wire and corroded.
19/5/09	Large condensate leak from valve flange. Valve had been re-installed. Improper tensioning of the bolts of the flange. Due to a failure of procedures to mandate that the tension tag be removed. MoC issue.
1/21/11	One electrician was killed and two people injured. Many changes made to process and no MoC used. Oxygen gas at high velocity and containing metal particles damaged the protective layer on a valve disc. Gasses released then reacted with pure oxygen being released leading to a detonation.
26/12/12	Diesel leak from a dead-leg. No MoC used and out of use equipment left in place.

Aside from improving the quality of information reported into the eMARS database what can we learn from eMARS? The four incidents showed that no MoC was actually used. Perhaps that's the simple message we should take from this data and that we should be concerned about ensuring organisations have a good discipline of applying their MoC system when required? I.e. Management should create a process safety culture that promotes a "sense of chronic unease" about not using the MoC system to record and assess a wide range of changes.

What can we learn from the regulator?

Following the Texas City incident in 2005, OSHA (reference 6, 7) initiated a National Emphasis Program (NEP) on all USA refineries. Inspection audits were conducted over a 4 year period from 2007 to 2011. This has been the most significant PSM enforcement action since the OSHA PSM standard 1910.119 was promulgated in 1992. Prior to the NEP 73% of inspections were initiated due to accidents, complaints or referrals. Typically about 1000 hrs were spent per inspection. The average penalty per inspection was $76,821. The average penalty per violation was $6859. The average number of violations per inspections was 11.2 (reference 6). Data published by OSHA and as shown in table 2 shows that the PSM element of MoC accounted for 9% of all citations.

Table 2 - Refinery NEP Frequency Cited PSM Elements

Refinery NEP Frequency Cited PSM Elements			
Element	Description	Number	Percent
j	Mechanical Integrity	198	19.5%
d	Process Safety Information	177	17.4%
f	Operating Procedures	174	17.1%
e	Process Hazard Analysis	168	16.5%
l	Management of Change	92	9.0%
m	Incident Investigation	68	6.7%
h	Contractors	44	4.3%
o	Compliance Audits	41	4.0%
g	Training	29	2.9%
n	Emergency Planning & Response	14	1.4%
c	Employee Participation	12	1.2%

In relation MoC a total of 92 citations were made by OSHA resulting in companies being fined for non-compliance with the OSHA 1910.119 regulations. 39 (42%) of these citations were for not having a MoC system established or implemented. Table gives a further breakdown of frequently cited PSM sub-elements.

Table 3 - Refinery NEP Frequency Cited PSM Sub-elements

Refinery NEP Frequency Cited PSM Sub-elements		
Sub-element	Description	Number
119(d)(3)(ii)	Compliance w/ RAGAGEP	71
119(j)(5)	Correction of deficiencies	63
119(e)(5)	PHA Findings not addressed	52
119(l)(1)	MOC not established/implemented	39
119(d)(3)(i)(B)	P&IDs missing/incorrect	37
119(j)(2)	No written MI procedures	38
119(e)(3)(v)	PHA facility siting	29
119(f)(4)	Safe work practices not established	29
119(j)(4)(iii)	I&T frequency	25
119(j)(4)(i)	Inspections and tests not performed	24
119(d)(3)(i)(D)	Relief system design & design basis	24
119(f)(1)(i)(D)	Emergency shutdown in OPs	24

It would therefore seem that the next key lesson we can learn is that regulated facilities ought to focus on having a MoC system in place and ensuring that the system is in use.

What can we learn from the Chemical Industries Association (CIA)?

In 2006 the CIA and HSE jointly published HSG254 (reference 8) covering Process Safety Performance Indicators (PSPIs). A Process Safety Best Practice Guide (reference 9) produced by the CIA highlighted that an industry best practice is using PSPIs to help drive performance improvement in the topic of MoC. A company is reported that a leading indicator on failure to complete MoCs showed an improvement from 120 to zero by year in 2007.

What can we learn from Audits and Gap Analyses?

A number of gap analyses and audits have been conducted by ABB covering the topic of MoC. These have been performed across various industry sectors, both in the UK and overseas. There are a number of common recurring issues that this work has revealed. The common issues include the following:

1. Lack of a clear definition of what a change is both in relation to procedures that apply to chemical processes and to personnel and organisational change.
2. Lack of training provided to users of the MoC system and no clear definition of competency requirements.
3. Lack of guidance on when to conduct a hazard study and when to use alternative techniques to HAZOP.
4. Lack of a visible linkage to updating of Process Safety Information and no clear definition of what Process Safety Information is.
5. No or poor management systems in place for tracking the status of MoCs and actions associated with MoCs.
6. Lack of the use of Process Safety Performance Indicators on the topic of MoCs.

Top tier COMAH establishment Gas Terminal - PSM Audit

This company, a UK gas terminal and top tier COMAH establishment requested an audit of their Process Safety Management Systems as they wanted to proactively understand where they stood against industry good/best practices. A summary of the key issues are listed below:

- Provide a definition for organisational and personnel change.
- Provide a tracking system for all action items arising from a MoC.
- Define the process for tracking temporary changes.
- Establish a means to ensure that only trained and validated personnel can approve MoCs.

Seveso III Refinery - MoC Audit

An insurance audit highlighted some high level issues with the topic of MoC. In order to address the insurance audit findings an audit was conducted against industry good/best practices. A summary of the findings is detailed below.

- Provide a comprehensive definition of change.
- Provide a flowchart showing how different changes may be handled.
- Formally define competency requirements for those involved in the MoC process.
- Establish a document control process for updating P&IDs such that operations personnel have access to “as built” P&IDs.
- Include a prompt to identify the need for a short or long form of PSSR.
- Establish a document control process for hazard study reports.
- Define a means of formally closing out a MoC.
- Establish a formal tracking system for MoCs
- Include a time limit for temporary MoCs.

- Establish a means of dealing with changes during construction.
- Establish process safety performance indicators.
- Formally define arrangements for an emergency MoC.

UK Power Station - MoC Gap Analysis

A power station in the UK proactively requested a gap analysis of their MoC procedures against industry good/best practices. A summary of the findings is detailed below.

- Define competency requirements for personnel involved in the MoC process.
- Provide training for personnel involved in selecting a hazard identification and risk assessment technique and how to determine which stages of hazard studies should be applied.
- Include reference to any existing hazard identification and risk assessment reports as part of the MoC.
- Clarify what types of changes to operating procedures can be excluded from the MoC process.
- Include prompts to update Process Safety Information as defined by OSHA 1910.119.
- Include a prompt to identify relevant good practice.
- Encourage consultation with appropriate engineering disciplines and competent personnel.
- Conduct an audit of the plant to check to ensure that the MoC process is being followed i.e. conduct field tours and an audit of work orders.
- Establish process safety performance indicators.
- Conduct a review of performance of the MOC system on a routine basis.

Middle East Chemical plant - PSM Audit

An insurance audit highlighted some high level issues with the topic of MoC at a Middle East chemical plant. In order to address the insurance audit findings an audit was conducted against industry good/best practices. A summary of the findings is detailed below.

- Define training requirements for those involved with MoCs.
- Develop a short form of MoC for minor changes.
- Provide a procedure detailing requirements for hazard studies.
- Define competency requirements for Hazard study leaders.
- Implement a routine review process for all open MoCs to avoid temporary MoCs going past their termination date and unapproved MoCs being implemented.
- Define responsibilities for auditing MoCs.

Top Tier COMAH establishment Chemical Plant - PSM Audit

A power station in the UK requested a PSM Audit of their MoC procedures against industry good/best practices following a significant process safety incident. No loss of containment occurred but the incident investigation revealed significant process safety issues. A summary of the findings is detailed below.

- Define critical EHS roles and define requirements for job handovers for EHS critical roles.
- Include a handover of action items for actions handled in the EHS action tracking database.
- Define who should be involved in a risk assessment for organisational changes.
- Provide guidance on the selection of hazards study techniques in relation to the type of change.
- Include target completion dates for actions arising from use of a MoC form.
- Establish a management review process for outstanding actions.
- Conduct more frequent audits given the rate of MoCs processed.

When you discuss MoC what are the issues that people highlight?

Whilst conducting gap analyses and audits discussions and interviews are held with a variety of personnel and across multi-disciplines. Below are some of the most commonly raised issues:

1. Personnel view comprehensive MoC systems as being overly bureaucratic as "the system" requires multiple signatures from personnel who reside in a variety of departments. People "just want to get the job done". A "one size fits all" approach appears to be commonly adopted within industry. Is this really necessary? Could a short and long form of MoC process be used in a similar way to that promoted for Pre-Start-up Safety Reviews by the CCPS (reference 10)? If MoC systems are viewed as being overly bureaucratic then there is a concern about them being by-passed or "short-cuts" being created to get things done in a pragmatic timeframe. Providing training to personnel on the MoC system can help personnel understand the reasons for the content of a MoC system. MoC systems may have evolved to include more prompts and checks in order to address losses in key personnel and a feeling that inexperienced personnel may not apply sufficient rigour in their review and management of change. More signatories may have been added to address perceived shortcomings in an organisation's competencies.

2. Company's MoC systems have generally evolved over many years and changes to the system are sometimes made when decisions are made about IT systems and not necessarily as a result of an incident. (This may suggest a lack of rigour in applying root cause failure analysis when conducting incident investigations?) Historically industry has had paper based MoC systems. The most common problem encountered with paper systems is that the MoCs get lost as they move from person to person and office to office. Paper systems are not adequately tracked or are readily traceable. Moves to modern electronic systems can greatly improve the racking of the status of MoC work. The content of MoC systems will often get improved by

conducting gap analyses or through conducting audits although these processes are not always used across the entire Process Safety Management System to ensure that other supporting PSM elements are also improved e.g. Hazard studies/PHAs/PSSRs, Process Safety Information.

3. In some instances there is conflict between project personnel and operations personnel. Where operations "own" the MoC system they require all projects to be processed using the MoC system. For very large projects, companies often contract out the design to external contractors who have no knowledge or understanding of the plant MoC system but yet design is initiated. Linkage between the plant MoC system and project activity is important to help ensure that relevant operations input is received and that changes are managed in a manner that ensures that all relevant parties are involved.

4. Industry uses a variety of approaches to determine if a Hazard Study/ PHA and Pre-Start-up Safety Review or a number of Hazard studies/PHAs are required. These include involving:

- Use of an "independent" competent person
- Keyword prompts to help identify concerns with certain hazards
- A specific list of questions to help highlight potential hazards/risks
- Algorithms to define they type of study to be conducted

The introduction of the IChemE' s Professional Process Safety Engineer qualification and Process Safety Competency model may help provide some improvements in this topic as competency criteria continues to evolve.

Not all companies use a PSSR or HS4/5 forms but simply rely upon personnel creating punch-lists to ensure that projects/modifications are ready to start-up.

5. Industry tends to have a very strong focus on managing equipment/technology changes.
By comparison, the topic of organisational and personnel change is less thoroughly addressed. Some common issues are listed below:

- Often viewed as HR's responsibility
- Very basic procedures in place and not always practiced
- Some simple checks omitted (i.e. handover of tracked Process Safety related action items)
- No consistent approach adopted
- Poor at reviewing status of completion

The topic of competency is receiving more attention within industry and could be more closely linked to management of organisational/personnel change procedures.

Conclusions – How could industry improve on this topic?

Many improvements to relevant good practice are developed as a result of process safety incidents. Should this be the way for industry to drive continuous improvement in reducing risks to local communities and employees? Delivering effective and efficient Management of Change is a business issue and not merely a process safety issue as proposed changes are developed to address a range of business issues including productivity, reliability, quality and cost and not just safety and environmental issues.
Regulatory inspections, gap analyses and audits conducted on the topic of Management of Change show that industry still has issues with implementing MoC procedures despite the fact that significant incidents continue to occur in relation to MoC.
Much improvement in trip system design has been implemented within the process industry through the provision of industry standards such as IEC61511 and IEC61518 and these standards appear to have focussed industry on delivering on implementation in a relatively consistent manner.
Canada, a country who was at the forefront of implementing Process Safety Management through the Responsible Care initiative has recently issued a Canadian PSM Standard including MoC.
Development of a MoC standard that is applied globally would be of great benefit to both multi-national and national companies and should accelerate improvement in MoC, both for business benefit and in helping to reduce the risk of significant Process Safety incidents.

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