PSF
Process Safety Forum
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Knowledge Exchange Note: 004

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Management of Change

This knowledge exchange note is shared in order to promote learning and improve safety. You should seek appropriate guidance regarding the relevance, accuracy, and completeness of this alert to your circumstances prior to implementation.

Themes

People, Plant and Process – Management of Change

Summary of Query

Following a review of the Grenfell report *Building a Safer Future Independent Review of Building Regulations and Fire Safety: Final Report,* the PSF has created this Knowledge Exchange to highlight the need for an organisation to have in place a robust Management of Change process that will, for example, adequately consider departure from design intent, and be able to identify possible unintended consequences during the change processes.

Management of change (MoC) is a term well used across the major hazard industries and with that comes a wealth of information, guidance and standards available across multiple sectors. Yet MoC is often considered to be one of the most difficult elements of process safety to implement and control[1], and incidents occur as a result, typically when a change was made without passing it through the MoC process, meaning that it did not get thoroughly reviewed and risk assessed.

Response

The PSF learning brief on lessons from the Grenfell Tower accident highlighted that when the refurbishment was undertaken in 2015/16 which involved the addition of Reynobond PE (Polyethylene cored) ACM (Aluminium Composite Material) cladding, stakeholders failed to understand that this 'change' was a departure from design intent.

Recommendation 2.9 of the Independent Review of Building Regulations and Fire Safety: Final Report stated *"A stronger change control process that will require robust record-keeping by the duty holder of all changes made to the detailed plans previously signed off by the Joint Competent Authority (JCA). More significant changes will require permission from the JCA to proceed".*

The specific focus of the query was on changes to the original design intent however, the subject matter lends itself to a more expansive response in this knowledge exchange which has been developed to highlight key areas and provide a signpost to other resources and good practice.

Learning from the Past

Whilst it would be incorrect to say that MoC weaknesses were the only cause of the following incidents, they were clearly a contributing factor.

Design Intent Change

Flixborough – The Nypro (UK) site at Flixborough was severely damaged when a large quantity of cyclohexane escaping from a ruptured bypass line, formed a flammable mixture and exploded. It was found that a plant modification occurred without a full assessment of the potential consequences and only limited calculations were undertaken on the integrity of the bypass line. No calculations were undertaken for the dog-legged shaped line or for the bellows. No drawing of the proposed modification was produced.

Piper Alpha - Piper Alpha was designed to produce and export oil and the requirement to export gas was an afterthought and involved extensive modification. The retrofitting went on in several phases, starting with separation of condensate and ending with production of export-quality gas. The new facilities were located beside the control room, under the electrical power, radio room and accommodation modules, so that when the explosion occurred, it did so with disastrous effect.

Process Change

DuPont-Belle WV Facility – A stainless steel braided hose failed catastrophically spraying an operator with liquid phosgene. It was found that a maintenance software program change was not documented or reviewed in accordance with the MOC process which resulted in the hose not being changed out in accordance with the SOP.

Creeping Change

Space Shuttle Columbia - In February 2003, the Space Shuttle Columbia disintegrated as it re-entered Earth's Atmosphere, killing all on board. Damage to the shuttles, caused by debris, occurred on every flight, most of which was caused by strikes from foam insulation from the external tank. With each successful flight, the foam shedding came to be regarded as inevitable and either unlikely to jeopardise the shuttle or an acceptable risk. Damage due to debris eventually was viewed as a "turnaround" issue rather than a safety risk.

T2-laboratories - In December 2007, a failure in the cooling water circuit for a reactor at the T2 Laboratories site in Florida resulted in the violent rupture of the reactor and four people were fatally injured. A root cause of this incident pointed to reaction scale-up which had been carried out numerous times without key safeguards being proportionally increased. These safeguards included the relief device which was undersized for a runaway reaction overpressure incident and the cooling water system which had not increased in surface area to achieve the required cooling to prevent a runaway reaction.

Temporary Change

Bhopal - The highly toxic substance methyl isocyanate (MIC) gas was released into the environment when water entered one of the storage tanks which resulted in a runaway exothermic reaction. It was found that direct atmospheric venting should have been prevented or at least partially mitigated by at least three safety devices that were all out of service for one reason or another.

Organisational Change

Fire at Hickson & Welsh - A clean out operation of a vessel used to manufacture mononitrotoluene was organised in order to remove residues. This vessel had never been cleaned since it was installed; some 30 years. An operator dipped the sludge to examine it and reported the sludge as gritty with the consistency of soft butter. No sample was sent for analysis nor was the atmosphere inside the vessel checked for a flammable vapour. It was mistakenly thought that the material was a thermally stable tar. An exothermic decomposition and auto-ignition of nitration residues created a jet fire killing five people. Root causes included inadequate organisational management of change that allowed inexperienced team leaders to be present at a time when critical decisions were being made

The Texas City and Buncefield incidents also provided insightful learning opportunities and were instrumental in the development of the Process Safety Leadership Group's report titled Safety and Environmental Standards for Fuel Storage Sites

Legislation

- The Offshore Installations (Offshore Safety Directive) Regulations 2015 Schedule 3 - L154
- The Control of Major Accident Hazards Regulations 2015 Schedule 2- L111

Good Practice

The introduction of any form of change into an organisation, if not appropriately managed, can significantly increase the levels of process safety risk. An organisation and its senior leadership should ensure that risks arising from any form of change are systematically identified, assessed and managed.

There is an abundance of guidance to help companies ensure they have a robust MoC process in place, but the following set of essential criteria and supporting indicators provide a high-level overview on what are key attributes of a good system of controls.

Essentials	Indicators
1. Implement and maintain a Management of Change (MOC) process for temporary and permanent changes.	A Management of Change procedure has been implemented and is maintained to cover "Changes" - meaning permanent, temporary, or emergency "Changes", whether to Plant, Process or People, that could introduce HSSE or operational hazards and the process for removing such changes or converting them to a permanent change is clearly defined.
2. Monitor legal and regulatory requirements and company requirements to be aware of changes in these that might necessitate changes to the entity operating activity.	A documented process has been implemented to monitor legal and regulatory requirements to identify changes that may require planned changes to the entity operating activity
3. Specify criteria for determining which proposed changes to entity operating activity require application of the MOC process, paying particular attention to those affecting plant, material, equipment, technology, process, products, services, procedures, practices, people and organization.	An entity Management of Change procedure has been documented and implemented that: • Details the change criteria indicating when an MoC is required for: - Technical: Plant, equipment, safety instrumented systems, materials, technology, process chemicals, IT systems, facilities - Process: Standards, operating procedures, maintenance procedures, emergency response plans, feedstock & product specifications, contracts, services, legal and regulatory requirements and technical codes - Organisational: People, individual post roles and responsibilities, training and competence needs and contractor change-out • Specifically addresses emergency and temporary "Changes" including maximum duration of operation under a temporary change and the authority to extend a temporary Change.
4. Include in the MOC process: risk assessment, identification and application of risk reduction measures; the required level of management approval; application of a review prior to implementing the change to verify that identified risk reduction measures are in place and identified training completed; and updating of relevant documents.	The procedure outlines the MoC process that includes the requirements for: • A risk assessment • Identification and application of risk reduction measure • Verification of the implementation of risk reduction measures prior to implementation of changes • Training and training completion date • Document change requirements • Levels of approval and authorisation • Involvement of both relevant subject matter experts and representatives of those impacted by the change • Follow-up to verify changes were implemented as planned
5. Communicate the details of the proposed change to affected members of the workforce.	A communication process has been implemented for communicating proposed changes to the affected workforce The communication process includes a process for gaining input from affected personnel

	Changes, risks, consequences and risk mitigation information has been documented and communicated to and acknowledged by affected personnel, including shift personnel and contractors, prior to implementation of the change During conduct of the MoC, the status of analysis, key issues and actions and schedules are communicated to affected members of the workforce
6. Track MOC actions to closure.	A documented process has been implemented to track MoC actions to closure. Changes are kept open until the accountable person has signed for acceptance and closeout, signifying that all associated actions, including documentation updates, training, or other specified items are completed Outstanding MoC actions are reviewed by the appropriate leadership level on a regular basis.
7. Verify the original scope and duration of temporary changes are not exceeded without review and approval.	The MoC procedure requires that the original scope and duration of temporary changes are not exceeded without review, approval and authorisation. The procedure should also require that permanent changes are identified and implemented prior to the expiration of the temporary change to prevent repeat renewals.

It is also important to remain alert to change that occurs slowly, perhaps over many years. This "creeping change" (e.g., gradual change in process fluid composition or gradual reduction in a team's experience level) also requires evaluation. Taking time out to discuss creeping change or perhaps the impact of multiple small changes on the same system, can be useful in avoiding incidents and teams can seek advice or alert supervision if they have concerns

Some industries such as the offshore oil and gas sector, use other methods that stand apart from the MoC process, yet perform a similar function. The Safety Override Risk Assessment (SORA) and Operational Risk assessment (ORA) are systematic risk management processes that determine the level of residual risk and inform decisions on whether to continue operating or require a shutdown of the plant/ equipment when abnormal operating conditions occur. The SORA process is used when overriding safeguards for a defined period. The ORA process is used in assessing the risks to continue operating for a defined period when a safety and/or environmental critical element (SECE) is not meeting its Performance Standard. Where these processes are being used, a temporary MoC would not be raised.

TIPS

1. Consider undertaking an assessment of the MoC process on your site using the indicators provided above and the scoring process below. Note the need for processes to be well understood and practiced. Conduct the assessment with representative teams or individuals and look for evidence through interview, observation and documentation.

1. Indicators* are not in place, poor compliance	* - Indicators in place means that the listed indicators fairly state the way things are within the entity being assessed. ** - systematic means the activities that deliver indicated performance are in place, documented, well understood and practiced. *** - control means there are ongoing checks and other activities that verify compliance over time
2. Indicators partially in place	
3. Indicators in place but not systematic**	
4. Indicators in place and systematic	
5. Indicators in place, systematic and in control***	

2. Undertake a review of previous incidents for the last 3 years. Have they been reviewed as separate occurrences or is there evidence that this is more of a systemic problem for the site/company? Are actions to prevent a reoccurrence robust and have they been satisfactorily closed out?
3. In many MoC related incidents, it is often stated that change was instigated for what people believed were valid reasons. Cladding of high-rise buildings was being carried out to improve thermal efficiency

and meet environmental targets. The technician who installed a small-bore tubing assembly (See PSF Safety Alert 013) did so because he thought it would simplify the sample collection process. Consider running awareness programmes to help individuals think through the unintended consequences of the change they are about to make. Also consider engaging site teams to challenge creeping change risk, introduce the topic in safety meetings and encourage people to raise concerns.

Further reading

1. Process Safety Forum Learning Brief 018, Lessons from the Grenfell Tower Accident
2. Energy Institute: Guidance on meeting expectations of EI Process safety management framework Element 12: Management of change and project management (registration required).
3. CSB video Explosion and Fire at Williams Olefins Plant, Geismar, Louisiana
4. IChemE Symposium Series No. 160 - Creeping Change
5. HSE - Plant Modification/Change Procedure
6. HSE Info Sheet CHIS7- Organisational change and major accident hazards
7. CCPS Red Guide: Risked Based Process Safety (aiche.org) and supporting publications

[1]Management of Change, Sutton Technical Books, 6th Edition, Oct 2012