Marsh

Marsh Specialty

# Management of change

Risk engineering position paper





# Contents

# Background

During the lifetime of a processing plant, many changes will occur. These could be changes to the physical hardware of the plant, the control systems, the business processes used, or ownership or management team changes.

Each one of these changes has the potential to increase the risks involved in operating the plant, for example, through inadequate:

- Identification or evaluation of the risks of making the change.
- Physical design or execution of the change.
- Communication and documentation of the change.

It is well-documented that poor control of plant changes has contributed significantly to large loss events in industry. A number of these examples are provided in this paper. The need to avoid such incidents and maintain good process safety management is why all sites operating processing plants need a robust management of change (MOC) process.

In a number of regions, change management of processing plants is also stated in guidance and expectations from government and statutory regulators. This includes, for example, the Health and Safety Executive (HSE) guidance within the UK, the Seveso II Directive in European law (Annex III section (c) (iv)), and Occupational Safety and Health Administration (OHSA) 1910.119 (l) in the US.

# Objective

This position paper aims to define the key attributes that by Marsh would rate as very good for a MOC system in the oil, gas, and petrochemical industry. These attributes reflect those in the Marsh risk ranking criteria. They can be used to support and define risk improvement recommendations, and to provide detailed advice to clients seeking to improve their management systems.

# Scope

This position paper discusses the development and application of a system for the management of changes to an operating plant and its related processes. References to corporate standards or organizational change do not relate to corporate policy-making. For guidance on organizational change (specifically, the maintenance of minimum staffing levels) please refer to the *Management of organizational change position* paper.

Throughout this paper, the word "site" is used to refer to the part of the organization using the MOC process. Depending on the nature of the organization, this could be a single plant, multiple plants on the same site, or multiple sites. In addition, it has become common practice for sites to use the term "MOC" to refer to the change process and an individual change. This convention is used on occasion within this document.

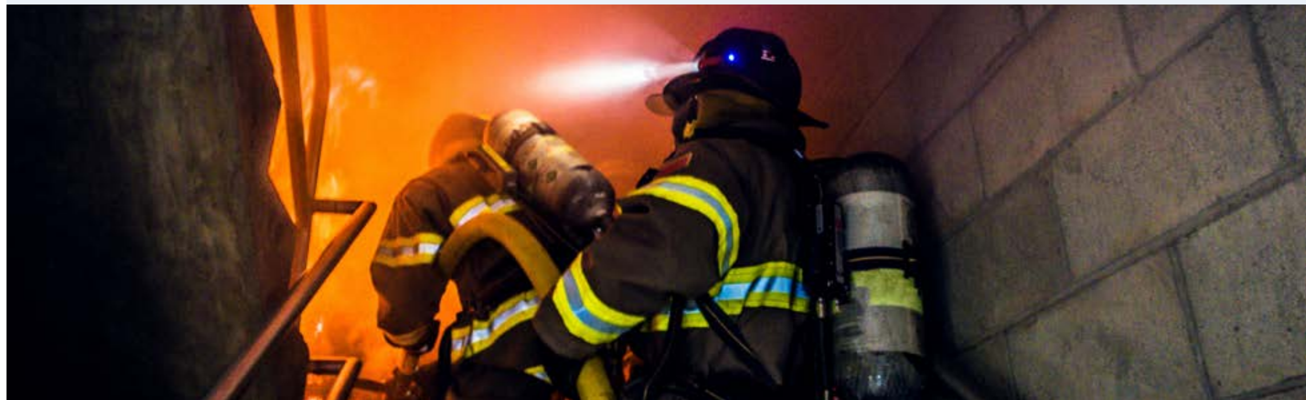
## INCIDENT SUMMARY #1

### Petrochemical Plant, Louisiana, US, 2013

Two people were killed and more than 100 injured in an explosion and fire at a petrochemical plant. The fire burned for more than three hours, and the explosion prompted the evacuation of about 300 people from the site.

The incident occurred on a propylene fractionation column. The column had two reboilers, originally designed to be operated together. As the tubes of the reboilers could become fouled over time, isolation valves were installed to allow each reboiler to be taken out of service and cleaned without needing to shut down the column. However, although pressure relief valves were on the column, there was no separate overpressure protection on each of the reboilers. This meant that it was possible to isolate each reboiler from its overpressure protection using the new isolation valves. On the day of the incident, as a part of the commissioning process, heating fluid was introduced to the tubes of the spare reboiler, which had been out of service for a period of time. The shell side of the exchanger was later found to contain some propylene from the column; when the hot fluid heated this propylene, the pressure inside the shell of the reboiler rose significantly and caused the shell to rupture, releasing propylene into the atmosphere and leading to the explosion.

The subsequent investigation found that the site had performed inadequate management of change when installing the additional valves. This included an inadequate process to access  the additional hazards that the installation of the new isolation valves had introduced.



# 4 Specific requirements

There should be a comprehensive, written, local policy, and procedure governing MOC. Any corporate expectations for MOC should be available to member sites and incorporated into the site documents.

The policy should clearly define:

- When it is applicable (section 4.1).
- The roles and responsibilities of the key people who operate the MOC process (section 4.2).
- What the key steps in the process are (section 4.3).

Certain infrastructure is also required to make an MOC system operate properly, most notably a system of documentation and a way of training the key people who operate the process. This is detailed in section 4.4.

## 4.1 Definition of a change

The MOC procedure must clearly define when it is applicable, and when it is not applicable. The site MOC procedure could apply to any change involving:

- **Plant:** changes to plant hardware (addition or removal).
- **Processes**: changes to the plant control.
- **People:** changes to the organization supporting the plant.
- **Procedures**: changes to operating procedures.

The types of change that may be excluded from the site MOC process are:

**REPLACEMENTS IN KIND**

Where an item is replaced with an identical item, usually in the course of routine maintenance, it is a direct like-for-like replacement.

**CREEPING CHANGE**

Operating and technical staff should be conscious of "creeping change": the concept that operating practices or conditions fundamentally shift over time, but in small increments that might not warrant specific attention. Examples include:

- Feedstock properties moving to the upper or lower ranges of acceptability for long periods of time.
- Operating conditions being at upper or lower operating envelopes (rather than varying within ranges) for extended periods of time.
- Occurrence of certain outside plant observations becoming common or routine rather than occasional or rare - for example, vibrating pipework.

Key plant staff should be aware of the creeping change concept and be willing to use the MOC process to assess the risk of these types of changes.

**CHANGES COVERED BY ALTERNATIVE PROCESSES**

The MOC process will not be applicable where other specific and documented processes exist on site to manage specific changes. Common examples include:

- Larger projects or modifications, usually where designed and executed by a project team (project function).
- Certain defined changes in feedstock to the site or defined changes to operating modes.
- Instrument or control system changes within defined parameters.
- Changes or updates to operating procedures.
- Organizational changes.

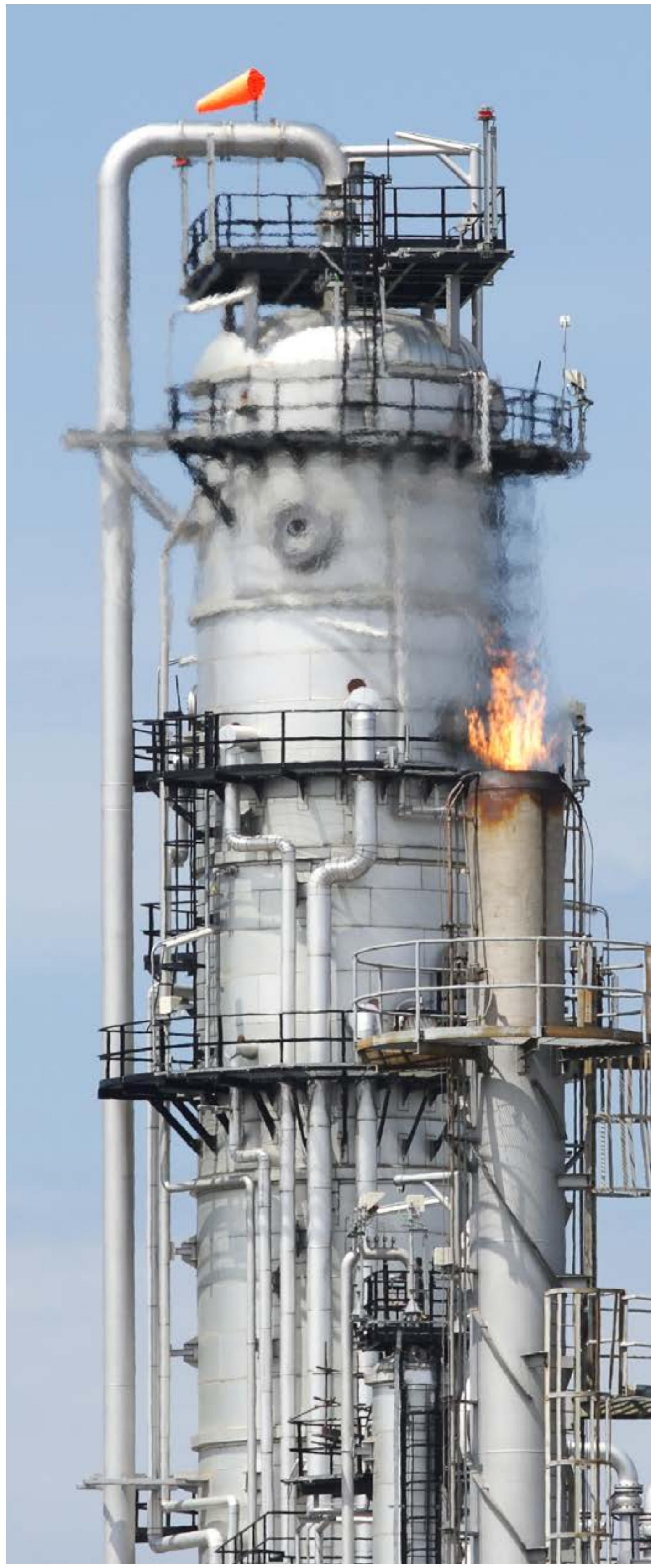
The MOC process should apply equally to both permanent and temporary changes. In the case of temporary changes, the process must ensure that a clear time limit for the validity of the change is defined. After this time, the change should be properly reviewed and either granted an extension, managed as a permanent change, or reverted to its original condition.

The MOC process must apply to removing plant items or safeguards as well as their addition.

For plants that operate on a continuous basis, the process must define how emergency changes are managed – often known as emergency management of change (emergency MOC) – and how the days-based organization follows it up.

Although this list is not exhaustive, some typical changes that should be covered by the site MOC process (unless covered by another process) include:

- Any alteration to the plant that makes a change to the piping and instrumentation diagrams (P&IDs).
- Physical changes in the piping configuration, whether or not a P&ID change occurs.
- Changes in materials of construction.
- Changes to relief valve type or manufacturer, whether or not a setpoint/size change occurs.
- Changes to pump type, manufacturer, or impeller size or speed.
- Additions or removals to insulation or change of insulation type.
- Changes to plant structures, such as platform types, materials of construction, or fireproofing.
- Electrical hardware changes in zoned areas.
- Alterations in control system hardware, such as changes to valve manufacturer, type, or trim.
- Changes to process control software, emergency shutdown logic, and alarm and trip settings.
- Changes (new supplier, type, increase, or decrease in rate) to process control chemicals or changes to process gases.
- Feedstock source, supplier, and quality changes.
- Product quality changes, including changes to product additives.
- Changes to operating modes, operating conditions, or operating envelopes.
- Changes to key spares, or spares suppliers (maintenance spares, lubricants, and so on).
- Suppliers of spares, lubricants, chemicals, and consumables.



## 4.2 Key roles required to operate the MOC process

Each site will have its own organizational structure and may have different titles for the key job roles within the organization. However, the following key roles in the MOC process must be fulfilled in some way on each site.

**MOC OWNER**

The process requires a person who takes ownership of driving the change through the MOC process. This person will typically:

- Produce a written proposal for initial approval.
- Ensure that the key people are involved at the right times.
- Ensure that the process has been followed properly.

The owner may not be a fixed role within the organization – it often varies depending on the nature of the change.

Although the most common owners will probably be members of the operations staff, it may be from a discipline appropriate to the type of change being proposed. For example, a piping change would typically be owned by mechanical engineers, or a process or relief change by process engineers.

**DISCIPLINE ENGINEERS**

Depending on the nature of the change, a number of different disciplines may input into the MOC process. As highlighted earlier, one of the discipline engineers may also be the owner of that change.

Discipline engineers may need their input to the MOC process to be checked or verified by the corresponding technical authorities on site, depending on their level of seniority or experience.

**RISK ASSESSMENT AUTHORITY**

As described in the Section 4.3, a MOC process requires risk assessment processes to be appropriately selected and executed based on the size and nature of the change. Sites should appoint a person or person(s) who can take this view and support the execution of these processes.

It is considered good practice that the risk assessment authority is independent of the change being made.

**MOC APPROVER**

There are a number of approval steps in the MOC process. The precise number of signoff steps will be site specific and may involve budget-related approvals in addition to safety and hazard evaluation steps.

The MOC approver on site must be an appropriate, competent person relevant to the part of the site that the change affects. MOC approvers are often senior members of the operations staff.

# INCIDENT SUMMARY #2

### Grangemouth refinery explosion, 1987

This incident resulted in one fatality, caused significant plant damage, the resulting noise could be heard 30 kilometers (km) away. It occurred on the hydrocracker unit, which converts heavy hydrocarbons to diesel and lighter products by a process operating at up to 180 barg. A 10 meter long, 3 meter diameter cylindrical vessel failed catastrophically when high pressure gas (significantly above its maximum design pressure) was introduced to it. The failure caused pieces of the vessel weighing up to 3 tons to be scattered over a distance of 1 km and a subsequent fire, which burned for more than six hours. The owners estimated that the total cost of the loss was more than US$100 million (see reference 10).

It is understood that one of the low liquid level indicators on the high pressure drum was electrically disconnected for a significant time before the incident with no MOC or other risk assessment process performed to evaluate the change. The owners identified this as a significant contributing factor to the incident; the maintenance of a liquid level in the high pressure drum would normally have prevented the high pressure gas breakthrough.

## 4.3 Key steps in the MOC process

The MOC procedure on each operating site will be different. The local procedure may combine or further subdivide the sections below, or call the steps by different names. However, each of the key elements below should be included in the local process in some way.

The site may mandate routine or scheduled meetings to manage key aspects of the site MOC process. This is sometimes done for efficiency and to promote direct discussion between the key participants. If this is not a part of the site process, the risk assessment authority needs to assess which changes merit the need for face–to–face discussions and meetings for key stages.

**MOC INITIATION, INITIAL APPROVAL AND REGISTRATION**

When an applicable change is required on a site, a written summary of the proposed change should be produced for review, initial approval, and authorization by one of the MOC approvers on site. Once approved, this initiation step then requires:

- Assignment of an owner/coordinator for the MOC (the MOC owner).
- Registration of the change within the site MOC system.

**PRODUCTION OF A DESIGN**

The purpose of this step is to ensure that a suitable design is made by a competent person makes a suitable design. This initial design then forms the basis of the risk assessment processes that are performed.

The MOC owner should ensure that a suitable design has been made with the following practices in mind:

- Checking that the design satisfies the fundamental requirements of the MOC.
- Consulting with all appropriate disciplines.
- Documenting of all calculations, referring to appropriate standards.
- Following the site's internal technical processes for approval of the design.

**CHOICE AND EXECUTION OF RISK ASSESSMENT PROCESSES**

The risk assessment element is central to the whole MOC process. It ensures that all of the consequences of the change are fully understood, with all risks appropriately managed.

The first step is determining which risk assessment processes will be used for the specific change under consideration. Normally, that different levels or types of risk assessment processes can be used within the MOC procedure, appropriate to the size and/or significance of the change being made.

A good practice is for the selection of risk assessment processes to be done by the identified risk assessment authority. Sometimes a structured approach, such as a complexity test, is used to assist in the selection of the appropriate risk assessment process. Marsh engineers can provide examples or advice in relation to this step.

Sites should have at least two levels of process available:

**SHORT FORM/CHECKLIST METHODS**

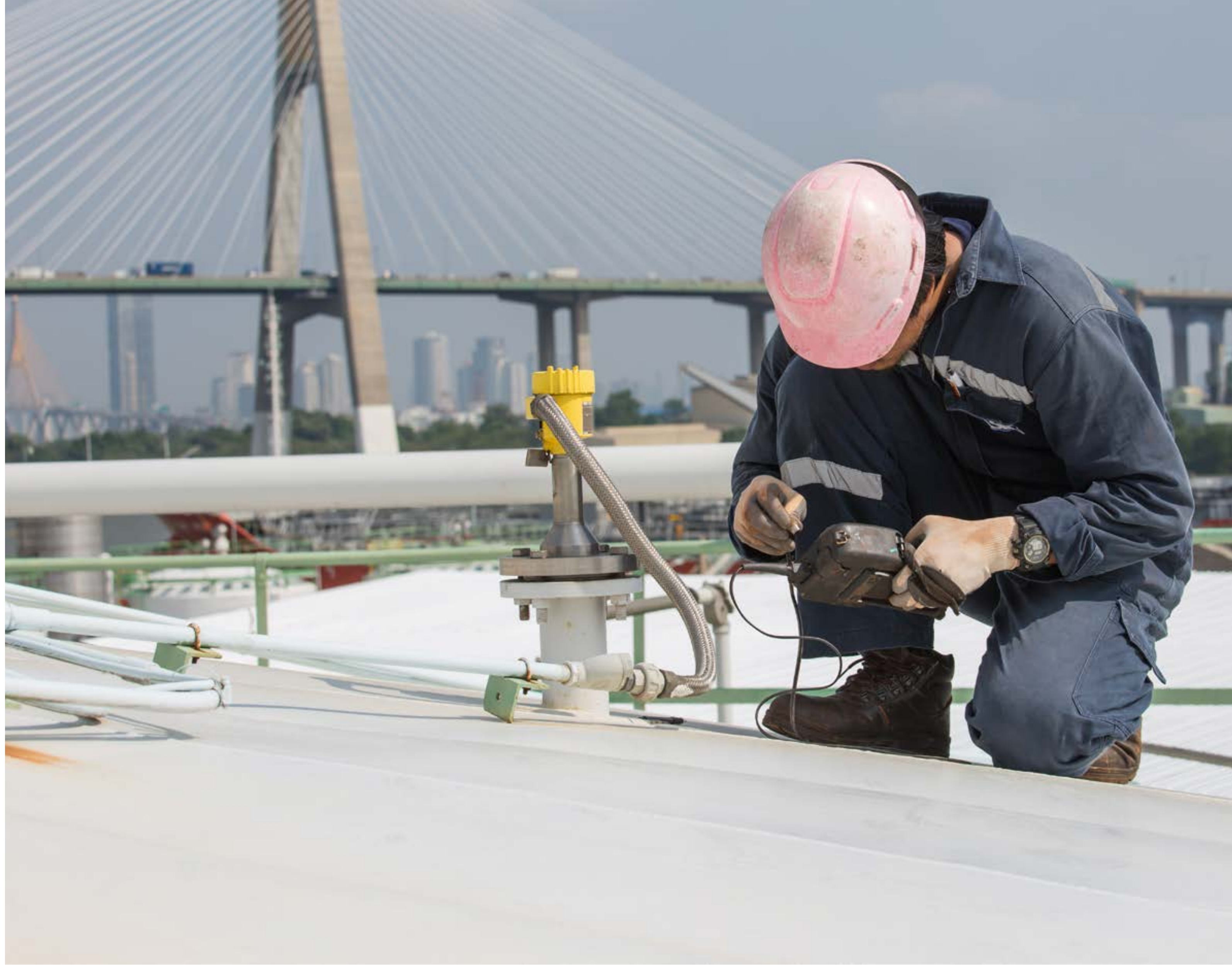
These can be paper or software based. In order to use this methodology, sites should have a suite of checklists available for different types of change. Note that:

- The risk assessment authority (defined above) should approve which checklists are applicable to the change in question.
- Actions from the checklists must be recorded in the MOC documentation system.
- Each checklist must be formally signed/authorized when it is completed.
- An example of a checklist structure is available in Appendix A.

**FULL HAZARD ANALYSIS**

It is expected that a more in-depth, rigorous method of hazard analysis will be performed for larger and more complex changes. In many cases, the HazOp process will be most appropriate. This technique is recommended by Marsh and is well known within industry. Many texts cover this. Some key points to note:

- The HazOp is based on a fixed/frozen design (it is not a design process).
- The HazOp team leader is trained and competent to lead a HazOp study.
- The HazOp team leader is independent of the change owner or site.
- The appropriate disciplines are included in the HazOp team, and team members have appropriate knowledge of the plant and the change.
- The team has all of the appropriate documentation and enough time to perform the HazOp study.



All of the changes required by the risk assessment processes must be incorporated into a new fixed design and the appropriate MOC documents updated. This may require the risk assessment processes to be repeated.

Where the nature of the proposed change is large enough that more fundamental risk assessment processes are appropriate, the risk assessment authority needs to consider whether a major project type process is more appropriate to manage the change than the MOC process.

**ENGINEERING DESIGN, CONSTRUCTION, AND INSTALLATION**

Progression to the design, construction, and installation of the change should only occur after the appropriate completion of the risk assessment processes.

This is often a stage where the site may have to follow formal steps for budgetary approval to complete the change. The delegation of financial authority is outside the scope of this position paper and is different to approval from a risk management perspective.

The site should have access to the appropriate capability to design the modification to the relevant codes and standards, through its own organization or third parties.

Depending on its nature, the physical installation of the change may require the appropriate practices to be followed in plant isolation and other aspects of safe control of work. These are outside the scope of this position paper.

**PRE COMMISSIONING SAFETY REVIEW**

Prior to the commissioning of the change, a number of check steps must be performed. Together these steps are often called a pre startup safety review (PSSR). The PSSR could consist of several different elements depending on the nature and complexity of the change.

At a minimum, it is expected that the PSSR will cover:

- Verification that the change has been properly installed according to the design. This usually involves the act of punchlisting the change in the field.
- Amendment (in written form) of any operating procedures required by the change.

- Training relevant personnel appropriate to the change on any changes to the operating procedures.
- Notification of any other personnel as required.

**FINAL AUTHORIZATION AND COMMISSIONING**

The authorization step ensures that all key steps have occurred properly prior to commissioning the change. Typically the designated MOC approver reviews all of the MOC steps and checks that the process has been followed and the correct individuals have been involved. This person then approves or rejects the change as suitable for commissioning.

Good practice for the commissioning step will involve providing a summary version of the MOC documentation to the local operations personnel. The role of the local operations personnel is to verify that the change has been fully authorized and check that any training and updates to procedures appear appropriate to the final change being implemented. The change can then be commissioned.

Once commissioned, the MOC documentation should be signed as such to confirm its status. This often constitutes a formal handover of the change to the operations team.

**CLOSE-OUT**

The close-out part of the process that all of the follow-up actions after commissioning the change are completed. This should include (but not be limited to):

- Updating of drawings, data sheets, and other key documents to "as built" status.
- Identification of new required spares and the addition of these to stock.
- Completion and documentation of any performance testing.
- Registration of new plant items in the maintenance management and inspection systems.
- Making and appropriately communicating any changes to operating procedures required after commissioning.
- Completion of any incomplete actions associated with the change (from the risk assessment processes, pre-commissioning punchlisting, and so on).

The close-out processes required are often identified on a checklist of potential actions and steps. They will be different depending on the nature of the change.

For temporary changes (handled under a temporary MOC), one of the key final actions is the return of the plant to the original design.

It is also expected that when executing a temporary MOC that involves a plant change, an appropriate inspection frequency for the change is determined, and documented within the plant maintenance management system.

The MOC owner should retain formal ownership of the change, and the MOC documentation should remain at "open" status within the tracking system until all the close-out processes are completed.

## 4.4 Required infrastructure for the MOC system

**SYSTEM OF DOCUMENTATION**

An appropriate system is required to register, track, and manage changes within the site. The system can take a several forms but is often integrated with the site records process and maintenance management system. For good practice it is generally expected that this is an electronic system designed for this specific purpose.

The system needs to be able to:

- Assign a unique number to each change.
- Provide overview information, for instance — type of change, reason for the change, and description.
- Document the key individuals involved in the MOC (owner, discipline engineers, authorizer) for this change.
- Store the key documents generated during the process (design, hazard analysis, and so on).
- Track the status of all actions associated with the change.
- Track key MOC dates (required by date if urgent, expiry date if temporary, and so on).
- Track the overall status and approvals of the change (often using a master control sheet).

The system must also be capable of producing key performance indicators (KPIs) that describe its operation and performance, as covered in section 5 of this document.

**SYSTEM OF TRAINING**

It is important that all of the key personnel involved in the operation of the site MOC process are trained in the reasoning behind the procedure, how it works, and their specific responsibilities in its operation.

People who require training include:

- MOC owners.
- All discipline engineers who might contribute to MOC.
- Risk assessment authorities.
- MOC approvers.
- Operations and maintenance supervisors and safe work permit issuers (to assist in the recognition of when the MOC process should be followed).

In addition, the site may also choose a wider group within the organization to have an basic understanding of the MOC process and procedure. This is so the broader organization can recognize when a change requiring the application of the MOC process occurs.

The training system should train people when they move into key roles for the first time, and deliver refresher training to those individuals with an appropriate frequency.

If there is a role within the organization that takes overall responsibility for MOC, this individual will often perform the training for the other key roles in the MOC process.

# Stewardship of the MOC process

The performance of the MOC process should be regularly monitored and assessed using a routine review of KPIs and a periodic audit. These steps help assure the site management team that the system is actually being used in the way it is designed and intended. An operating site will typically have a specific individual or role that has ownership for the MOC process and takes a lead role in operating and monitoring the system.

## 5.1 Key performance indicators (KPIs)

Each site should routinely produce KPIs to monitor the performance and health of its MOC system. The KPIs should be produced monthly and reviewed at an appropriate site forum, such as the site process safety management committee.

Routine KPIs typically include:

- Total number of open MOCs, with details showing when they were originally raised.
- The number of MOCs raised in the review period.
- The number of emergency MOCs raised in the review period.
- The number of temporary MOCs, and identification of any that are overdue.
- The number of completed MOCs with open and overdue close-out actions.
- The number of incidents and near miss reports attributable to failures in the MOC process. The discovery of any change that was not handled using the MOC system is expected to be raised as a near miss report.

In the case of overdue temporary changes and overdue actions, identifying the owners of overdue MOC items can be useful.

## 5.2 Audits

Each site should audit its MOC process in some way on a periodic basis, audits are typically completed annually. The audit should be performed by a small team knowledgeable in applying the MOC process. Consideration should be given to including people from outside the immediate local site. Findings from the audit should be reported to site management, through forums such as the site process safety management committee.

**An audit process would typically include:**

- Initiation of the MOC:
  - Are changes being identified and raised at the correct times?
  - Are work orders raised and carried out for plant changes without appropriate MOC processes being used?
- MOC process:
  - Review a selection of MOC dossiers — are the key steps followed?
  - Are the approvals being made at the right stages, and before commissioning?
  - Are the MOCs being closed out, with actions completed appropriately?
- Risk assessment processes:
  - Are the appropriate risk assessment processes selected?
  - Are the processes being followed properly/thoroughly?
- Personnel related:
  - Do the key personnel understand the process?
  - Do they understand their roles and responsibilities?
  - Have they been trained?

In addition to these stewardship steps, the understanding and support of senior site leadership is critical to the success and effectiveness of the MOC system. Management should reinforce the importance of MOC, and the requirement to apply it in all appropriate circumstances.

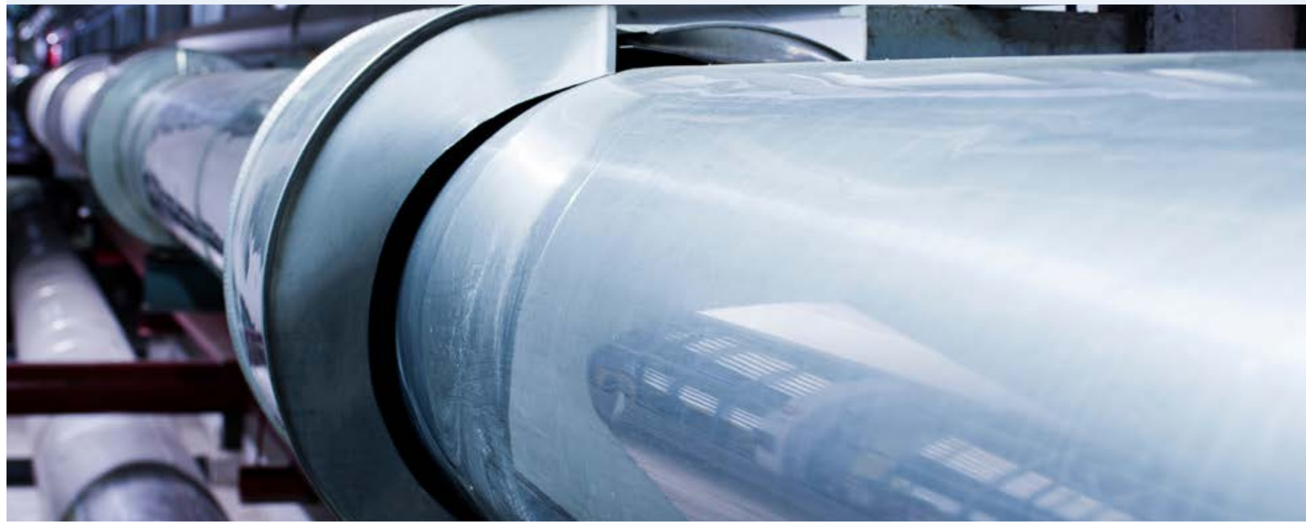
## INCIDENT SUMMARY #3

### A process plant incident, 2012

A pump's suction filter was frequently plugged, so the pressure needed to be monitored, both in the field and at the control panel. To minimize installation time for a pressure transmitter, it was decided to install a tap on the existing connection for the local pressure gauge and connect a pressure transmitter to this tap. Because of the rush and the temporary nature of the change, tubing was used for the change.

Though accepted as temporary, the installation did not follow appropriate design codes or engineering standards, and a MOC review was not done.

Approximately three years after the "temporary change" was made, the tubing ruptured and combustible material at a temperature of 360°C leaked into the atmosphere. The leaking material ignited and started a major fire that destroyed the plant.



# References

The following references have been used to help write this document and may provide further guidance:

1. OSHA 1910.119 (l) (Management of change) - United States.
2. OSHA 1910.119 (i) (Pre startup safety review) - United States.
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10. Integrity management – Learning from past major industrial incidents, BP safety series #14.
11. Managing change in manufacturing facilities, HarrisonC, ASSE by design 12 p6.
12. Eight common misperceptions of management of change, McNair S, RxToday July 2012.
13. AICE CCPS process safety beacon, October 2012.

# Appendices

## 7.1 Appendix A – Hazard identification checklists

The use of appropriate checklists is considered the minimum level of risk assessment when carrying out MOCs. Each site must decide which checklists are appropriate and put them into place. Some examples of the topics covered by checklists are listed below, although it should be noted that this is not an exhaustive list:

**General (may apply to all changes):**

- Environmental concerns checklist.
- Safety related concerns checklist (including emergency systems and management).
- Operations/operability review.
- Maintenance/maintainability review.

**Buildings related:**

- Permanent occupied buildings change.
- Temporary building siting or change of siting.

**Control and alarm systems related:**

- Control loop hardware change.
- Control or shutdown system change.
- Control valve failure mode change.
- Critical alarm change.
- Distributed control system (DCS) change.
- Electrical change.

**Miscellaneous equipment related:**

- Analyzer sample loop change.
- Piping change (outside battery limit).
- Piping change (inside battery limit).
- Rotating equipment change (pump manufacturer, type, seal type, bearing type, speed etc.).
- Temporary pump installation.
- Change of tank service.
- Vessel or equipment pressure/temperature rating change.

**Relief device related:**

- Relief system change.
- Temporary safety device bypass.
- Alternative relief path provision.

**Miscellaneous:**

- Process catalyst change.
- Process technology change.
- Process chemical treatment change.
- Process chemical cleaning for equipment access.
- Documentation checklist (a check of what document updates are required by the change).

Each checklist contains a list of items that must be considered as a minimum when making a change for which that checklist is relevant. The sites should update the checklists as learning occurs from incidents on-site or in the industry.

The risk assessment authority should decide which checklists will be used for the change in question. Note that it is usual for certain checklists to be mandatory for all types of MOC, for example, the safety, environmental, and operability checklists.

Administratively, each completed checklist should document which MOC it was for, when it was completed, who contributed to the review, and what required actions were determined to be required as a result of the review. The actions from each checklist must then be entered against that MOC in the MOC documentation system.

To illustrate the principle, an example of a checklist covering a piping system change is provided on p18.

## Example hazard analysis checklist – piping system change

| | Y | N | N/A |
|---|---|---|---|
| **1.** Are the piping specifications compatible with the: | | | |
| a. Process fluid or gas? | ☐ | ☐ | ☐ |
| b. Maximum temperature of the stream? (max -_) | ☐ | ☐ | ☐ |
| c. Minimum temperature of the stream? (min -_) | ☐ | ☐ | ☐ |
| d. Pressure of the system up to relief setpoints? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **2.** Are the gasket, valve seat, and packing specifications compatible with the: | | | |
| a. Process fluid or gas? | ☐ | ☐ | ☐ |
| b. Maximum temperature of the stream? (max -_) | ☐ | ☐ | ☐ |
| c. Minimum temperature of the stream? (min -_) | ☐ | ☐ | ☐ |
| d. Pressure of the system up to relief setpoints? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **3.** Are hydrogen, low temperature, caustic, wet H2S, amine, or tight shut off valves/piping required? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **4.** Does the metallurgy or process material require special treatment prior to opening such as passivation, neutralization or complete flushing? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **5.** Can the system be vented and drained properly for startup? | ☐ | ☐ | ☐ |
| a. Shutdown/maintenance? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **6.** Is freeze protection required? | | | |
| **ACTION REQUIRED:** | | | |
| **7.** Are there low points or dead-end sections where water could accumulate and freeze? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **8.** Are valves orientated such that their position, open or closed, is readily apparent? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **9.** Have check/non-return valves been mounted in the horizontal position? | ☐ | ☐ | ☐ |
| *Note: A vertical location can adversely affect the response of some types of check/non-return valves and should be avoided. For vertical upward flows, certain types of check/nonreturn valves are more suited to the duty, such as vertical/globe/angle lift check valve and tilting-disk check valve.* | | | |
| **ACTION REQUIRED:** | | | |
| **10.** Are control valves and controllers reasonably accessible for calibration and maintenance? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **11.** Are manual valves that could potentially be needed to respond to an emergency situation readily accessible? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **12.** Are utility connections adequately protected against backflow of the process into the utility supply? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **13.** Are there any safety consequences if the process flows backward through the piping system? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **14.** Can the process material be misdirected into an adjacent piping system potentially creating a safety problem? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **15.** Has the piping and support design considered the required allowances for expansion and contraction? | ☐ | ☐ | ☐ |
| **16.** Has the piping and support design considered sources of excess vibration that could lead to mechanical failure (e.g., critical flow conditions/flashing of liquid, mechanical vibration, etc.)? | ☐ | ☐ | ☐ |
| **17.** Is this piping subject to stress corrosion cracking (caustic in carbon steel, chlorides in stainless steel)? | ☐ | ☐ | ☐ |
| **18.** Is this piping affected by contaminants such as steam, nitrogen, etc., that can be introduced during startups or shutdowns? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **19.** Are the gaskets, valve seats, packing, etc. affected by contaminants such as steam, nitrogen, etc., that can be introduced during startups or shutdowns? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **20.** Is the piping subject to corrosive environments due to: | | | |
| a. Carryovers? | ☐ | ☐ | ☐ |
| b. Contaminants? | ☐ | ☐ | ☐ |
| c. Process upsets? | ☐ | ☐ | ☐ |
| d. Reduction in velocity due to low flow/dead end? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **21.** Can dense corrosive materials (e.g. sulfuric acid) accumulate in valve seats or drain nipples? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **22.** Do any portions of this system require cathodic protection? | ☐ | ☐ | ☐ |
| a. If yes, have inspection procedures been updated? | ☐ | ☐ | ☐ |
| b. If yes, do written procedures exist for working on this system? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |

| | | | |
|---|---|---|---|
| **23.** Will portions of this piping be installed in the vicinity of cathodically protected systems? | ☐ | ☐ | ☐ |
| a. If yes, do written maintenance procedures exist for this system and should it be bonded to a cathodically protected system? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **24.** Is the system adequately protected against over-pressure: | | | |
| a. Is the piping/equipment affected by the change adequately protected against over-pressure? Consideration should also be given to piping/equipment connected to the system that is being changed. | ☐ | ☐ | ☐ |
| b. Have the required relief valve (RV) files been updated with supporting calculations? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **25.** Has this change disabled, bypassed, or compromised: | | | |
| a. A safety system? | ☐ | ☐ | ☐ |
| b. A relief system? | ☐ | ☐ | ☐ |
| c. A critical alarm? | ☐ | ☐ | ☐ |
| d. A shutdown/interlock? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **26.** Have the materials of construction been identified (positive material identification (PMI)) and does the PMI documentation meet inspection requirements? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **27.** Do the spare parts inventory records need to be updated? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **28.** Is pressure equipment directive relevant? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **29.** Is the construction and equipment in accordance with the design specifications? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **30.** Are the safety, operating, maintenance, and emergency procedures in place and adequate? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |
| **31.** Any further actions required? | ☐ | ☐ | ☐ |
| **ACTION REQUIRED:** | | | |



## 7.2 APPENDIX B – SELF ASSESSMENT CHECKLIST

The following checklist is a quick tool a site can use to test its existing processes against this good practice guide.

| | Y | N | PARTIAL |
|---|---|---|---|
| **Setup and applicability** | | | |
| • Does the site have a formal, written MOC procedure? | ☐ | ☐ | ☐ |
| • Does it clearly define when it is and is not applicable? | ☐ | ☐ | ☐ |
| • Does it cover temporary as well as permanent changes? | ☐ | ☐ | ☐ |
| – Are temporary changes given a formal time limit within the process? | ☐ | ☐ | ☐ |
| • Does it cover emergency changes? | ☐ | ☐ | ☐ |
| **Staffing** | | | |
| • Does the process define which organizational positions perform the key roles of: | | | |
| – MOC owner? | ☐ | ☐ | ☐ |
| – Discipline engineers? | ☐ | ☐ | ☐ |
| – Risk assessment authority? | ☐ | ☐ | ☐ |
| – MOC approvers? | ☐ | ☐ | ☐ |
| **Key steps** | | | |
| • Is an approval step required when initiating an MOC? | ☐ | ☐ | ☐ |
| – Is a written summary of the change required to gain this approval? | ☐ | ☐ | ☐ |
| • Does the process require a formal, written design of the change to be made? | ☐ | ☐ | ☐ |
| • Does the process contain a formal risk assessment stage? | ☐ | ☐ | ☐ |
| • Does the site have the appropriate capability to perform formal engineering design, construction, and installation of the change? | ☐ | ☐ | ☐ |
| • Does the process include formal pre startup safety review (PSSR) activities? | ☐ | ☐ | ☐ |
| • Does the process require senior level approval prior to commissioning? | ☐ | ☐ | ☐ |
| • Does the process include a rigorous documentation close-out stage? | ☐ | ☐ | ☐ |
| **Risk assessment specifics** | | | |
| • Does the process contain different levels of risk assessment based on the nature of the change? | ☐ | ☐ | ☐ |
| • Are the risk assessment processes approved by a competent person independent of the change? | ☐ | ☐ | ☐ |

## Supporting infrastructure

| | | | |
|---|---|---|---|
| • Does the site have a structured way to individually number and track changes? | ☐ | ☐ | ☐ |
| • Can the system produce KPIs to describe how the MOC system is being used? | ☐ | ☐ | ☐ |
| • Does training exist for the key people involved in operating the MOC process? | ☐ | ☐ | ☐ |
| • Have all the key people had this training, and are they still considered competent, or is refresher training required? | ☐ | ☐ | ☐ |

## Stewardship and governance

| | | | |
|---|---|---|---|
| • Are KPIs describing the operation of the MOC system routinely generated? | ☐ | ☐ | ☐ |
| • Are they reviewed by senior level staff at an appropriate forum? | ☐ | ☐ | ☐ |
| • Is an audit of the MOC procedure operation performed at least annually? | ☐ | ☐ | ☐ |
| • Are the outcomes of annual audits reviewed by senior level staff at an appropriate forum? | ☐ | ☐ | ☐ |

## Marsh Risk Engineering

Marsh's Risk Engineering team has been established for over 30 years. It is uniquely qualified to provide risk managers and underwriters with the essential information they need to determine the right limit and scope of cover and the right price.

Each member of the team is a qualified engineer, with practical experience in design, construction, operation, and maintenance across a broad range of oil, gas, and petrochemical risks.

All engineers have all been trained in advanced insurance skills, and can assess and analyze operational risks. Many of our engineers are fluent in multiple languages.

Our engineering team aims to build bridges between risk engineering, insurance and risk management functions, and between clients and the underwriter. We use a benchmarking system that gives a global view of the risk, assessed against peer plants world-wide.

From the earliest planning stage to the last operational phase, our engineers can contribute practical and cost-effective advice, and assistance.

In addition to tailored programs, the team delivers a series of core packages, covering everything from managing a major emergency to risk reduction design features, and safe working practices.

The expertise, practical knowledge, and experience of our engineers, enables them to assess and compare common physical risks as they apply to your insurance arrangements and commercial operating environment.

For more information, please contact your local Marsh office or visit marsh.com

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## About Marsh

Marsh is the world's leading insurance broker and risk advisor. With over 45,000 colleagues operating in 130 countries, Marsh serves commercial and individual clients with data-driven risk solutions and advisory services. Marsh is a business of Marsh McLennan (NYSE: MMC), the world's leading professional services firm i n the areas of risk, strategy and people. With annual revenue over $20 billion, Marsh McLennan helps clients navigate an increasingly dynamic and complex environment through four market-leading businesses: Marsh, Guy Carpenter, Mercer and Oliver Wyman. For more information, visit marshmclennan.com, and follow us on LinkedIn and Twitter.