Managing Management of Change

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Abstract

The Center for Chemical Process Safety (CCPS) has designated MOC as one of the areas where metrics need to be developed. One of the issues that CCPS is concerned about is the quality of the MOCs as much as the quantity of those that have not been completed. One of the reasons is that people tend to concentrate on the mechanics of MOC rather than the content because of limited resources and the need to be in compliance. So how do we ensure quality as well as prompt closure of changes? By recognizing the elements that are crucial to make a good MOC and using a database to accomplish the mechanics, thus freeing personnel to concentrate on the important requirements.

It will be proposed that a good MOC requires three main elements to be very well executed: the technical description of the change, the safety analysis (which includes its review) and the Pre-Startup Safety Review. Having achieved quality it is important to manage the process efficiently and this can be done with the help of a database that automatically provides the necessary metrics. The requirements of high-quality MOCs, the necessary workflow to have an efficient process, and the metrics that are necessary to do a good job in managing the MOC process will be discussed.

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1. INTRODUCTION

A watershed event in process safety, the 1974 Flixborough explosion in which 28 people perished and many more were injured, was due to a mismanaged change as its root cause. The change was to replace a malfunctioning reactor in the middle of two other reactors with a piece of 20" pipe. The reactor was part of a series of five low-conversion reactors used for the high-temperature oxidation of cyclohexane, in which the product of one reactor flowed into the next reactor. The change was done to minimize loss of production since repairing the reactor could have taken up to three months. It is obvious from the results, a pipe break caused by the pipe expansion and failure of the support (temporary scaffolding), that no safety analysis had been conducted. The review of the change had been done while engineers and chemists stood next to the equipment and decided that the change was technically feasible and would indeed minimize production losses. They then proceeded to implement the change.

This incident eventually led to the formulation of practices for managing changes that was codified in the U.S. by OSHA under 29 CFR 1910.119 in 1992. But, after all this time incidents caused by mismanaged change still happen. In the Citgo Refinery incident of July of 2009, in which there was a release of large amounts of HF resulting in severe burns to one employee, OSHA citations indicate deficiencies in the MOCs for changes in the equipment that failed and caused or contributed to the incident [1].

The Center for Chemical Process Safety (CCPS) considers MOC one of the main elements (out of five) that can be precursors to incidents and thus should be part of the leading indicators of process safety [2].

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2. CAUSES FOR MOC FAILURE

We won't address here *recognizing* the difference between a change and a replacement in kind as this would be a training flaw in the general process safety system. Avoiding the MOC and calling it a replacement in kind on purpose is addressed here as one of the problems of the MOC system.

We have determined the need for an MOC *system* that works. What are the most common problems of MOC that lead to incidents? The most common problem is the lack of completion of an MOC, either lack of completion of a permanent change or timely removal of a temporary change. When looking deeper, the significance and safety impact of the change was not well understood and the proper priority was not allocated leading to the unfinished implementation. The second problem is poor performance of the safety analysis resulting in added risk to the process, and the third problem is poor technical description of the change resulting in a different change than the one intended. CCPS in Appendix G of their book on MOC [3] mentions some other common MOC problems and proposed solutions. The recurring theme of the problems mentioned seems to be complexity and inefficiency of the MOC system.

3. EFFICACY VS. EFFICIENCY

But inefficiency is not the main problem, as quality of the MOC is the most important part of the change process. If the safety analysis is incorrect or the change was not done as indicated, serious problems can result that could lead to an incident. It seems that the efficacy of the MOC, i.e. ensuring that the desired change is the one implemented and that the change does not impact safety, should be the principal consideration. Yet most MOC systems concentrate on the process, i.e. the workflow, rather than on the content. Nevertheless, it is our contention that an inefficient system leads to an ineffective one. The reason is that with limited time and resources the emphasis lies with compliance rather than quality. As the complexity of the MOC process increases less time is available for working on the content. Furthermore, a new element is introduced: as the time interval between the start and finish of a change increases, the risk to the facility increases. This is due to the chain of incomplete changes that are part of the MOC that can easily lead to errors (e.g. unimplemented P&ID changes that can accidentally be used by other projects, tie-ins that can become dead legs, etc.).

We will discuss the elements that make a good MOC and show how to make the process efficient.

4. ELEMENTS OF A GOOD MOC

There are three elements that are crucial for having a successful change: the technical description of the change, the safety analysis, and the Pre-Startup Safety Review (PSSR). Let us see why.

1. The **technical description** is crucial for two reasons: it allows us to conduct a proper safety review and it allows us to ensure that the change that will be implemented is the desired change and not a similar one. We can do a safety analysis only of what is described and do it correctly if we understand the technical basis and the assumptions that have been made. Similarly, with a good technical description we avoid creeping changes within the change. Without a detailed technical description, the final product may be different from the conceptual one.
2. A good **safety analysis** is the crux of the MOC. The purpose of doing an MOC is to ensure that the change doesn't unknowingly increase risk or compromise the safety of the existing process. If the change is a complex change then a PHA may be necessary for a good safety analysis. If a PHA is not considered necessary, then peer review of the analysis should be undertaken to help ascertain that it was done correctly. Ensuring that a review of the safety analysis was performed by knowledgeable personnel is part of managing the MOC process and a part that usually is not undertaken. Often, the review is perfunctory and done by a supervisor who is only seeking to move the process forward and complete the MOC. A good MOC system needs to spell out how the review of the safety analysis is to be undertaken.
3. The **Pre-Startup Safety Analysis (PSSR)** makes certain that the desired change was the change that was implemented before it is activated. Again, to accomplish this we need to have a good technical description. The PSSR will also check that the personnel who are going to operate the new or modified equipment have been *properly* trained on it and that the operating procedures have incorporated the change. Lastly, it will check that a safety review was performed and that if there were any recommendations coming out of the review, they were correctly implemented. But, the PSSR will not check the quality of the safety review. If a quality review was not done immediately following the safety analysis, the opportunity to discover any potential hazards is lost.

So we see that if we prepare a good technical description, do a good safety analysis (which includes a review) and verify that the change is technically correct and we have the tools and training to operate the change, we will have implemented a safe change. The rest is ancillary and the MOC process is built to make certain that these three elements will be in place when making a change.

5. THE MOC PROCESS

The MOC process is a work flow that regulates the way an MOC will be conducted. As such, it ought to be a company approved procedure that guarantees the MOC process will contain the necessary elements and be properly executed. This procedure should allow management to estimate the resources necessary for carrying out all phases of the MOC, including the resources for the safety analysis, its review, training and PSSR elements, as well as the work and resources necessary to build or modify the equipment involved.

The work flow ought to be relatively simple: propose the change, obtain preliminary agreement on its need and availability of resources, prepare a detailed description of the change, conduct a safety analysis and have it reviewed, obtain approval to proceed as described and analyzed, build the change (preferably through the plant's work order system already in place but referencing the MOC), and verify it. This simple work flow is shown in Figure 1.

Required steps of the workflow should include (responsible person in parenthesis):

1. Appoint an MOC Coordinator to coordinate the MOC from start to finish (Line Management)
2. Develop a detailed technical description of the change (MOC Coordinator)
3. Determine the completion date of the change or date of removal of a temporary change (MOC Coordinator)
4. Develop a checklist of items and responsible persons that will ensure that the technical specifications and the safety requirements will be fulfilled (MOC Coordinator)
5. Perform a safety analysis of the change (MOC Coordinator; if a PHA is required, the MOC Coordinator will arrange for it)
6. Request approval of items 2 through 5 (MOC Coordinator)
7. Appoint a safety analysis reviewer (Line Management)
8. Review the safety analysis (MOC Safety Analysis Reviewer)
9. Make an assessment that all safety and technical requirements can be implemented, that sufficient resources are available to do so in the time required, and ratify the safety analysis by approving the MOC (Line Management)
10. Perform the work (MOC Coordinator will monitor progress with the persons in the checklist assigned to do the work)
11. Determine that the work is complete and ready for activation (startup) of the change (MOC Coordinator)
12. Ensure that all PSSR requirements are met:
    a. Technical specifications are met (MOC Coordinator)
    b. Safety recommendations have been incorporated (MOC Coordinator)
    c. Personnel have been trained and SOPs have been updated (Operations)
13. Coordinate startup date (MOC Coordinator)
14. Complete documentation and enter date when this step is completed signaling completion of MOC (MOC Coordinator)

6. MANAGING THE MOC PROCESS

As can be seen, there are quite a few steps in completing an MOC; and if a paper system is used to verify every step, there could be a lot of paper being carried around by, and to many people. This cumbersome process is a barrier to timely completion of the MOCs and we need to streamline it if we want to have an efficient system. As mentioned above, in the absence of an efficient system people will spend their time in verifying that other persons have done their part and won't have time to dedicate to the important issues. Many facilities require a signature for each step (and sometimes each sub-step) in order to have a record of who did what when. It becomes difficult to determine the status and progress of an MOC. Managing the process then evolves into a reactive system where corrective action is needed increasing the amount of work needed and a dislike for doing it.

A database where everyone can log in to indicate completion of an MOC or their assigned part to it or to view its status is needed in order to eliminate the bothersome mechanics of the system. The database should be able to automatically provide a status report of each MOC, collect the metrics that will help us manage the facility's (or the company's) MOC process and give us a measure of how well we are doing in this area.

The necessary features of a database in order to manage the process efficiently are:

1. Automatic assignment of a protected (cannot be changed), unique number to the MOC when it is created.
2. Have protected creation (automatically set) and modification dates of the MOC (the modification date serves as an audit tool).
3. Secure login that identifies and records the person doing the assigned functions of MOC coordination, safety review, approval, and confirmation of the various elements of the PSSR, as well as the privileges of each one of those persons in terms of what they can enter or modify in the MOC. The logins will serve as electronic signatures.
4. Required classification of the MOC as either permanent or temporary.
5. Required target date for completion of a permanent MOC or a firm date of removal of a temporary change. This date will be used to monitor whether MOCs are being closed out and to measure how many are open (in progress). It should allow a supervisor with approval privileges to extend the time of a temporary MOC after recording the justification for the extension.
6. It should have practically unlimited space to enter descriptions, safety analysis, checklist items, justification, etc. and have the capability of attaching relevant documents.
7. Requires following the preset work flow, that is, no data can be entered in one section unless the previous section has been completed. It automatically logs in the dates of completion of every section.
8. It has the capability of creating one-button e-mails that automatically include the relevant MOC information to request approval, ask for status, request input, warn of the approach of the target date, etc.
9. It should declare the MOC closed out only after confirmation that the documentation has been updated.
10. The database should be easily and fully searchable and reports should be able to be sorted by each heading.

With all the capabilities described above, it's possible to greatly reduce the time wasted in bureaucratic activities and have more time to concentrate on the important issues. These capabilities should also give management a picture (through automatic database reports) of:

1. The current number of open MOCs, past-due MOCs, and those that whose target date is approaching (let's say within 30 days)

2. The status of each MOC with dates for each stage of the workflow and the responsible person for the MOC (see Figure 2)
3. A one-button capability to send individual e-mails to the group of persons involved in one of reports (open, past due, due in 30 days) containing the relevant information.

The facility's process safety coordinator should be charged with monitoring the database to see the status of the MOC system and be able to communicate with management when the system starts to falter. For example, if there too many open MOCs it is a signal that the risk to the facility has increased (the cumulative potential for error is large) and an indication that too many changes are being made at one time. If there are too many past-due MOCs is an indication that not enough resources or priority have been allocated to these changes. If past-due MOCs are temporary MOCs, then it is an indication that the safety of some processes is being compromised. The MOCs that will become due in 30 days will serve as a warning of the amount of work and resources that will be needed in the short term in order not to decrease the safety of the facility. The e-mail feature of the database should be an excellent aide for this communications not only to management but also proactively to the people involved in the MOC process.

7. METRICS

Although we have seen how to easily manage the MOC system on a day-to-day basis, we need to have a measure of how well the system is doing long term. For this type of evaluation we need metrics. We will discuss first the CCPS metrics which are an industry-wide effort and then proposed use of the database to gather company metrics that are actual and directly related to the management of the MOC system.

7.1 CCPS Metrics

The metrics proposed by CCPS [2] are leading metrics for incidents and would have to be collected over a few years and be correlated with incidents and near misses with the participation of enough companies to be statistically significant. For companies participating in this effort, the database proposed in this paper would help collect these data and may help to avoid incurring the deviations described. The CCPS metrics for MOC are:

1. Percentage of audited MOCs that satisfied all aspects of the site's MOC procedure
2. Percentage of audited changes that used the site's MOC procedure prior to making the change
3. Percentage of start-ups following plant changes where no safety problems related to the changes were encountered during re-commissioning or start-up

We can see that by using the database for the MOC system we can easily satisfy the first and second metrics since the database is continuously audited and it forces the user to comply with all its aspects and all the changes have to follow the procedure. The only changes that may possibly not follow the procedure are changes classified as replacement-in-kind that bypassed the system because of a failure to recognize the change or because it was purposefully ignored. The former failure is a training problem and as for the latter, hopefully by having an easy-to-comply system there will be much less of an incentive to risk the wrath of management. A periodic audit of the *work order* system should uncover the culprits in both cases. In order to capture the third metric a note can be added to the specific MOC where safety problems occurred. Hopefully, they will be few and far between; and by having a procedure that concentrates on quality rather than compliance, they will be rare.

7.2 Management Metrics

In order to understand how the system is behaving over time, we need to collect data on the process as we go and analyze it at certain time intervals. As mentioned before, we want to increase safety and minimize risk by having a well performing system. Safety will be increased by performing good safety analyses, and risk will be minimized by minimizing the number of MOCs that are open at a given time and avoiding extending temporary MOCs past the time in which they were assessed to be safe.

By creating a graph of the number of open and past-due MOCs, both temporary and permanent, over a time period we can see if we are allocating the necessary resources to the system. Tracking the time element may help personnel understand why resources were not available at the needed time - perhaps because of a turnaround or a hiring freeze - and improve future planning. If, in addition, we compare these numbers with the number of MOC starts and completions over the same time period, we may realize that too many changes are undertaken given the facility's resources or perhaps not enough priority is given to their completion. The database should provide these graphs automatically (see Figure 2). By inspection of the database we can easily see if there is a specific stage of the MOCs that is being the bottleneck and address the specific problem (Figure 3).

8. CONCLUSIONS

We have shown that an MOC system that results in safe changes can be developed. The key to developing that system is to put emphasis on the important parts of an MOC such as the technical description, the safety analysis and the PSSR, and having tools that automatically take care of the mechanics and give us the time to focus on those emphasis elements. In addition, these tools should also easily provide us the information and feedback that will allow us to manage the system well.

Figure 1. Simple MOC Workflow

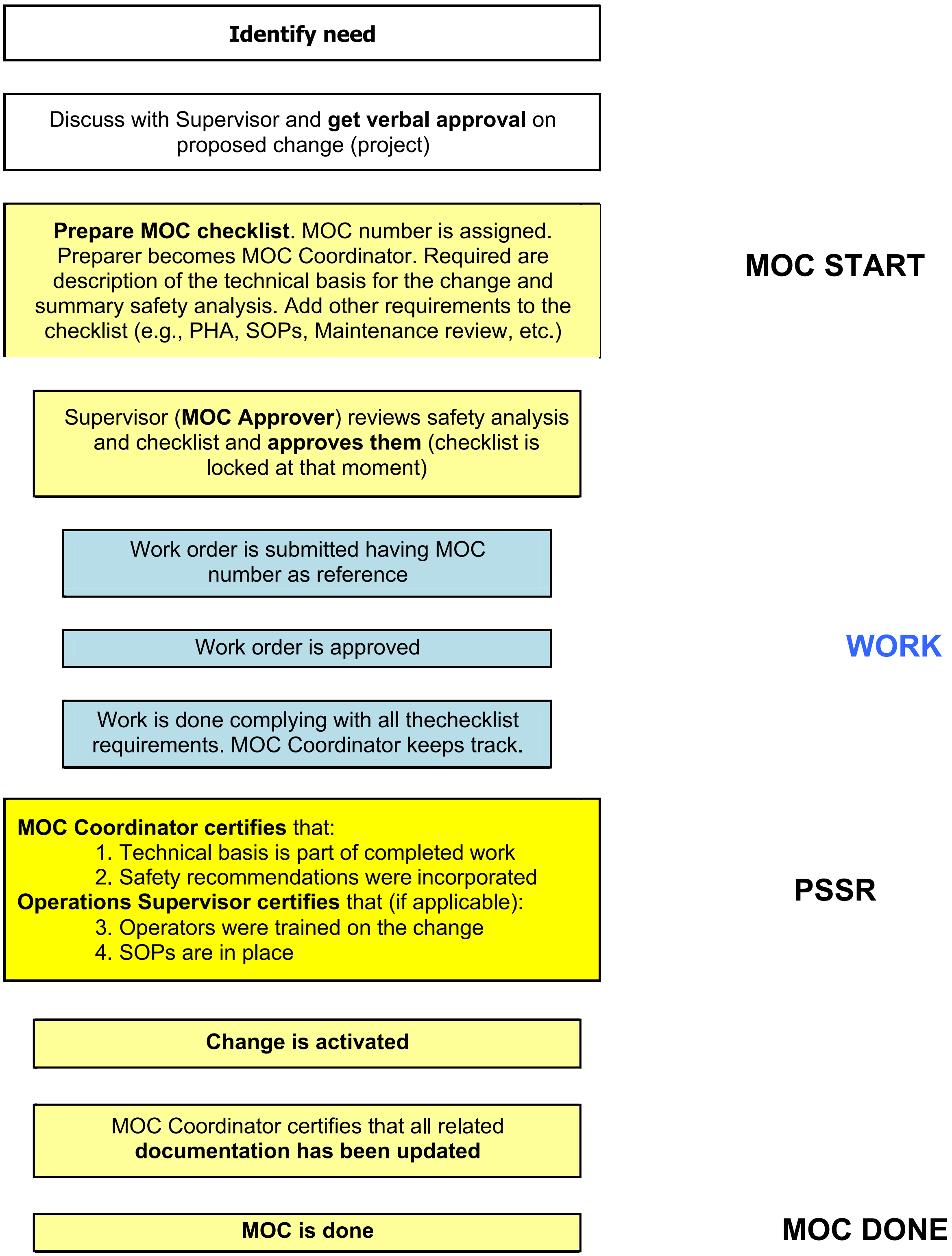

Figure 2. Open and Past-Due MOCs over a period of time compared to starts and completions over the same time period.

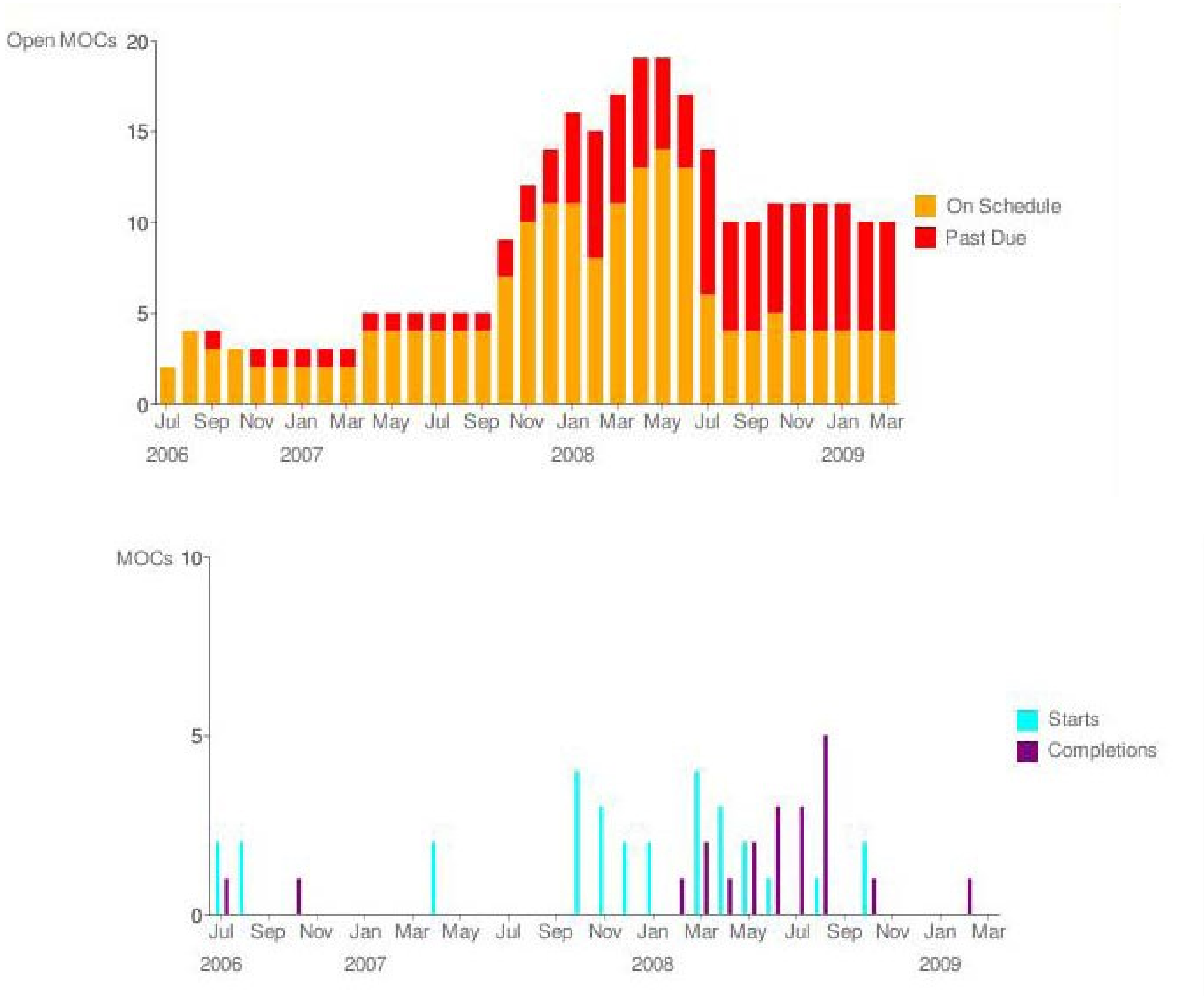

Figure 3. Database screen showing status of all MOCs

9. REFERENCES

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