# Development Of Process Safety Management System (PSMS) For Process Industries: Management of Change (MOC)

By

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CERTIFICATION OF APPROVAL

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Approved by,

_____

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UNIVERSITI TEKNOLOGI PETRONAS

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September 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contain herein have not been undertaken or done by unspecified sources or persons.

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BALQEES BINTI ZAILANI

# ABSTRACT

Although the industrial facilities are equipped with safety design and operated to be safe, clean and profitable, yet incidents continue to occur. One of the root causes of many major accidents in process industries is uncontrolled change of process information. One of the essential features in managing risk of a process safety accident is managing the element of management of change (MOC). MOC is important in ensuring changes in a process do not inadvertently initiate new hazards or unknowingly increase any risk of existing hazards. One of the established industrial standards to manage the MOC is Management of Change (MOC) element of Process Safety Management (PSM) 29 CFR 1910.119(l). At present, there are numerous techniques of managing MOC have been developed but none of the available techniques addresses the completeness or depth of assessment on MOC as according to PSM standard. This dissertation presents a structures technique to manage MOC that could fulfil with PSM CFR 1910.119(l). The technique provides organized strategies to manage and track information, documents, recommendations and corrective actions related to MOC using Process and Instrumentation Diagram (P&ID) as the foundation for its development. A computer database prototype system known as Management of Change Management System (MOC-MS) is built based on the developed concept. MOC-MS will assist end user to manage the MOC implementation efficiently and helps in identifying the gap that hinders MOC of PSM compliance. The results of this system provide guidelines on how to drive a well-scoped MOC that comply with PSM standard thus lowering the risk of a process safety accident.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

**S**everal major disasters such as Flixborough, Seveso and Bhopal which strike the nuclear, petrochemical and transport industries have been an eye opener that triggers the public concern over the management of hazardous activities. Hale & Hovden (1998) mentioned that the irony of those disasters was that it took place in high technologies industries which people had believed to be appropriately managed by well developed, high bureaucratic safety systems. Investigations result showed that the root causes implicated more than technical or human failures. Turner's (1978) analysis of "man-made disasters" also looked beyond the technical and human factors to the organizational and cultural factors and Jens Rasmussen (1990) has pointed out that we tend to see, in accident analysis, only what are we looking for. Only till up to 1980's that we had not considered poor management of uncontrolled changed as a root cause of such accidents.

These major hazardous disasters had provided impetus, worldwide for authorities to develop legislation and regulations to minimize or eliminate the potential of the occurrence of future events. One of the establish standards that emphasise the above issue is the management of change element of Process Safety Management (PSM) 29 CFR 1910.119(l). This standard specified by Occupational Safety and Health Administration (OSHA) in the code of federal regulations Chapter 29 section 1910.119 covers the requirements for the management of hazard associated with the decision on whether to allow a change to be made, necessary risk control and follow up measures.

## 1.2 Problem Statement

OSHA PSM Standard (29 CFR 1910.119) necessitate the development and implementation of a program to prevent catastrophic accidents for covered process. It relies on performance based and therefore is subject to ongoing interpretations and clarifications from OSHA as well as technical advances in process safety. A PSM

program is wide-ranging and covered virtually every aspect of a company's operations and it is about achieving safety or achieving other objectives (e.g. oil & gas, chemical plant, power production) in a safe manner.

However, safety management is not judged entirely by its developed policies but by practises and positive impact. Therefore, when it comes to implementation of all the safety elements in an organization, the picture becomes fuzzy. Companies are often unsure on what requirement that represent full compliance with the regulation. Whilst the need to focus on the policy and procedures are important, it is not sufficient to represent a safety management system on its operational realisation. Hale & Hovden (1998) highlight that there are grown number of approaches or techniques in the safety and risk industries yet the safety management is still relatively little-understood.

Most of the techniques apply aim to assess organisational systems and determine whether the safety management are adequate or not. Barry Kirwan (1992) stated that these techniques give only aggregated feedback on the adequacy of process safety management and usually did not tend to link specific process safety management practices and activities to the process of accident causation.

According to CCPS (2008)

> Many companies have installed protocols for addressing changes without regulatory impetus because such controls represent sound business practices for achieving safety, quality and environmental objectives. However, many of guidelines and regulations now demand. That is, the MOC systems at many companies may lack the formal structure to help ensure that:
>
> - Designs of site processes are well understood and documentation is up to date
> - Proposed modifications are routinely evaluated for potential safety and health impacts before being implemented
> - The level of detail for each review is appropriate for the potential of hazard it poses

- The appropriate level of company management authorizes the changes
- Related activities required to safely implement the changes are conducted
- Training of personnel on the changes is effective
- Records are maintained to document the changes

Hence, there is a need to have an effective MOC management system to ultimately control and manage possible hazards due to change of process that is the widest range of beneficial uses of the resources without risk to safety or health, degrading the environment, and other unintended consequences.

### 1.3 Objectives

The objectives of this study are listed as follows:

- To analyse the requirements of Management of Change (MOC) element 29 CFR 1910.119(l).
- To develop framework and suitable model for MOC to comply with 29 CFR 1910.119(l).
- To conduct case studies from industries for concept validation.

### 1.4 Scope of the Project

The research is focusing on MOC element following the OSHA PSM Standard 29 CFR 1910.119(l). Thorough analysis has been done to understand the requirements of MOC and identified necessary action in order to improve the implementation technique. A framework has been developed based on 29 CFR 1910.119(l) requirements. The model is developed based on established framework and supported by a prototype tool using Microsoft Access for easy implementation and explanation. The cases study has been conducted using industrial data to validate the effectiveness of the concept.

### 1.4.1 The Relevancy of the Project

The purpose of this project is to develop a systematic system namely MOC Management System (MOC-MS) of MOC element for easy implementation in process industries. The subject is not new since there is plenty of safety programs existed but yet the OSHA PSM is still ambiguous once implemented in industries. Hence, there is a need to improve the implementation techniques in the PSM programs. In depth understanding on MOC is needed to develop the system. The system will guide the industries to systematically identify the gaps and solutions related to imperfection of design, equipments, chemicals, human operation in compliance with PSM. Therefore, the industries could effectively prevent the process industries from major accident such as fire, explosion and toxic release.

### 1.4.2 Feasibility of the Project within the Scope and Time Frame

This project begins by collecting reading material such as books, journals,
related websites and newsletter for more insight on the MOC element of PSM. In Final Year Project (FYP) 1, author is able to grasp the gist of the said elements and come out with a comprehensive system to be implemented in process industries. Meanwhile for FYP 2, the project is focused on implementing the system using the computer database tool to validate the developed framework based on case study from industry.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Lesson from Past Accidents

On 11 December 2005, explosions and fires occurred at the Buncefield oil storage and transfer depot, Hemel Hempstead, U.K. Buncefield (2007) highlighted in the incident report that the main cause of the spread of damage resulted from ignition of a vapour cloud released from spilled gasoline by overfilling a storage tank during the night. Through investigation, it was shown that the possible caused was probably the failing level gauge which possible override the high limit safety switch and automatic computer action to stop the filling process which leads to this disastrous event.

Apart from that, the unfortunate event of Flixborough accident has brought the significance of the management of change (MOC) clearly when it involves the temporary modification to piping between cyclohexane oxidation reactors.

According to AIChE (2007), in an effort to maintain production, a temporary bypass line was installed around fifth of a series of six reactors at a facility in Flixborough, England, in March of 1974. The bypass failed while the plant was being restarted after unrelated repairs on June 1, 1974, releasing about 60,000 pounds of hot process material, composed mostly of cyclohexane. The resulting vapour cloud exploded, yielding an energy release equivalent to about 15 tons of TNT. The explosion completely destroyed the plant and damaged nearby homes and businesses, killing 28 employees, and injuring 89 employees and neighbours.

Based on the report of the accidents, the temporary modification was constructed by individuals who were incompetent in designing large pipes equipped with bellows. Therefore, this accident can be avoided if there is an effective MOC system which can detect the design flaw before the change was implemented.

Figure 2.1 shows an overview of number of major accidents occurred in chemical plant over the last 20 years. For each accident, the year of occurrence, the number of fatalities and injuries is provided as indication of the severity (Erwin S, 2008).

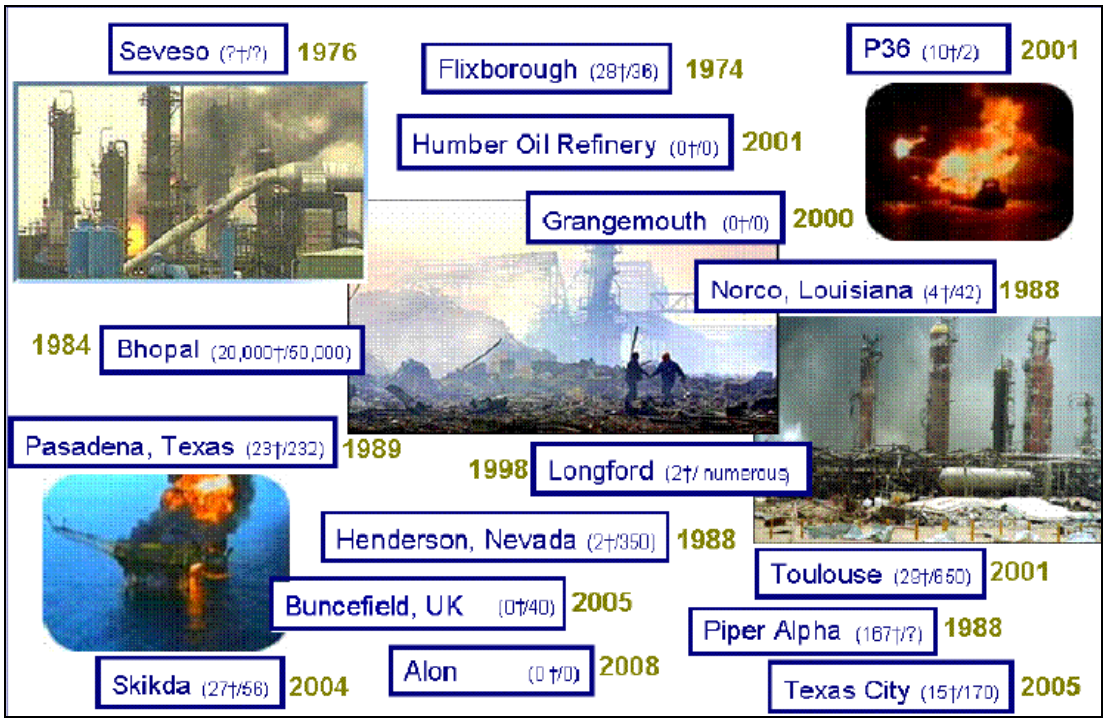



Figure 2.1 Example of Some Major Accidents in Last Decades

Every accidents displayed above has been investigated in a various settings and by different organisations and numerous investigation had been reported over time. Many of the listed themes below are the rooting to the causes that contribute to major accidents; eg:

- A need to improve hazard identification and analysis.
- A need to improve risk perception amongst the workforce and management.
- Poor sitting of control rooms/offices.
- Poor separation between high value assets.
- Low levels of redundancy in production systems.
- Poor of lacking Management of Change.

- Lack of ongoing training and competency assessment system for staff & contractors.
- Lack of an effective mechanical integrity programme.
- Lack of an effective energy isolation programme.
- Poor emergency response & control
- Poor onsite and offsite emergency planning
- Poor incident & near miss investigation or follow up.
- Lack of an effective integrated management system.

It is expected for the occurrence of major accidents to decline through lesson learnt and efforts in managing risk and safety throughout the industries. However, studies from Det Norske Veritas (DNV) through their internal R&D project recorded over 1800 incidents from 2005 till 2008 and it has been classified as in Table 2.1:

Table 2. 1 Incident Types from 2005 till 2008

| **Incident Type** | **Number** |
|---|---|
| Loss of containment | 745 |
| Fire | 538 |
| Explosion | 369 |
| Environmental release | 44 |
| **Consequence** | **Number** |
| Loss of life | 163 |
| Injury | 276 |
| Site evacuation | 114 |
| Regulatory fines | 674 |
| Production downtime | 219 |

However, the database obtained from the European Commission shown in Table 2.2 concluded that there are no declines in number of major accidents are noticed within Europe.

Table 2. 2 No of Major Accidents Based on European Comission Database

| Years | No of major accidents |
|---|---|
| 2000 | 27 |
| 2001 | 20 |
| 2002 | 29 |
| 2003 | 24 |
| 2004 | 22 |
| 2005 | 28 |

*Note*. Adapted from "Accident Risks at Onshore Process Plants Based on Historical Data for DNV ISA-I,"

Figure 2.2 shows the analysis that there is a substantial decrease of occupational safety incidents over the year from 1993 till 2005 (Erwin S, 2008). This proves that the industry practitioners have done effort in improving the level of health and safety in process industries.

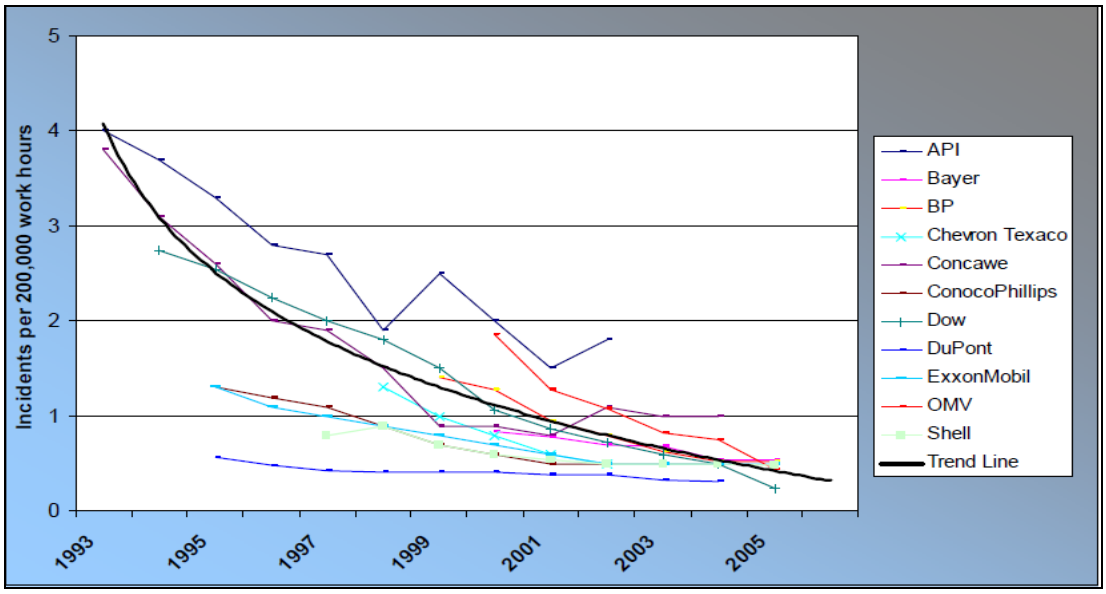



Figure 2. 2 Incident profiles from year 1993 – 2005

Contradict; the pattern is not applied to the occurrence of major accidents till present as much as the declining of occupational safety incidents.

## 2.2 Management of Change (MOC)

MOC is a process of assessing and controlling modifications to facility design, operation, organization or activities; to certify that no new hazards are introduced and the risk of existing hazards to employees, the public or the environment is not unknowingly increased. Even with the greatest awareness on industrial facilities which are designed and operated at safe operation, incidents are yet occurring till present. Therefore, appropriate system for management of change is the foundation of all safety and accident prevention programs; an effective Management of Change (MOC) creates an atmosphere of 'no surprises' (Sutton, 2012). MOC is a critical component of all Process Safety Management (PSM) programs because of its central role in assuring safety.

### 2.2.1 Overview of MOC

MOC element is one of the 14 elements integrated inside the PSM standard of 29 CFR 1910.119. The MOC element covers the review and authorization process for evaluating proposed adjustments to process chemicals, technology, equipment and facilities prior to implementation to ensure no unforeseen new hazards are introduced and the risk of existing hazards could increase significantly. OSHA highlighted in the requirement under 29 CFR 1910.119(l)(1) that written procedures must be established and implemented procedures to manage changes except replacement in kind to process chemicals, technology, equipment, and procedures, and change to facilities that affect a covered process. Eileen M. (2001) stated that any changes to a process may occur inadvertently through operations which are in the direction of optimizing the process or during repair. Although a process and its associated equipments have undergone thorough hazard analysis, some unnecessary changes had historically resulted in condition which far less safety than the original configuration. However, an exception is applied to "replacement in kind" where the

changes made meet the original design specifications and changes to the facilities that do not affect a covered process. Eileen M. (2001) highlighted that, the written procedures should address the following considerations prior to any change:

- The technical basis for the proposed change,
- Impact of the change on employee safety and health,
- Modifications to operating procedures,
- Necessary time period for the change, and
- Authorization requirements for the proposed change.

AIChE (2007) points out that MOC include steps to assist that potentially affected personnel are notified of the change and that pertinent documents, such as procedures, process safety knowledge and so forth are updated. Any proposal change must be reviewed and authorized by a qualified individual as specified in the employer's MOC procedures. Once the changes have been authorized, the employers should notify the employees as well as the contractor workers through training before the process is start up again. In case of the modification affects the process safety information basis or the standard operating procedures, the information must be updated appropriately.

### 2.2.2 Definition of Change

In the context of change in MOC by OSHA, they considered a change that is not a replacement in kind (RIK) and it seems vague on the distinction of a change and RIK. The definition of change should be clearly defined by one in order to manage MOC by identifying and reviewing them prior to implementing them. For instance, the operating procedures contain the information on the operating parameters such as flow rates, temperatures and etc and it is important for the panel men and field operators to operate within the safe limit being set as default. However, if the operation runs outside from these parameters, this type of change requires review and approval by a written management of change procedure. As MOC also covers the changes in process technology and changes to equipment, it involves changes in raw

materials, new equipment, and new product development, changes in catalysts and changes in operating conditions to improve yields. In addition, equipment changes can be in form of construction material, equipment specifications, alarms and interlocks. Hence, companies must be firm in identifying the change and establish means and method to detect both technical and mechanical changes.

### 2.2.3 Time and Place for MOC Reviews

MOC reviews are commonly done in operating plants and increasingly done throughout the process life cycle at any company that involves capital project design and planning (Sutton, 2012).

### 2.2.4 Participation in MOC

MOC begins when an individual requested a change in a process or etc. Qualified personnel usually independent of the MOC originator will review the request and look upon any potential risk impacts could result from the change and may suggest additional measures to manage the risk. Based on the review, the requested change is either approves, amended or rejected. Regularly, the final approval before the change being implemented comes from another designated individual independent of the review team. A variety of people are involves in making the change, notifying or training potentially affected employees and updating documents affected by the change (AIChE, 2007).

### 2.2.5 How is it done?

An established organization usually has written procedures for means of MOC to be implemented. All procedures involved are applied to all work that is not RIK. The results of the review process are typically documented on an MOC review form (AIChE, 2007). For the aid of MOC review, supplemental information is provided by system designers as attachment inside the MOC review form. Once the change is approved, it will be implemented. Upon the implementation, any affected personnel will be notify or provided with detailed training if necessary prior to start up of the change. Follow up activities are done by updating the records or documentation to the affected process safety information or any elements in PSM affected by the change which are required before start up and which may be deferred until after start up. All the activities are tracked down until completed.

A good MOC management implementation discipline is determined by the severity of the change and its facility. For a higher risk situations, usually dictate a higher need of formality and depth in the implementation of an MOC protocol. For instance, a detailed written program that details out how the changes are identified, reviewed and managed. As for companies that have a lower risk case, they have the flexibility to decide how to manage the changes in a less vigorous fashion for example through a general policy about managing changes via informal practices through trained employees (AIChE, 2007).

Facilities that have a high demand rate of changes for managing changes may need large resources of personnel as well as greater specificity in the MOC procedure to fulfil the defined roles and responsibilities. AIChE (2007) stated that facilities with a sound process safety culture are prone to choose a performance based MOC procedures allowing the trained employees to use good judgement in managing the changes. Facilities with uncertain process safety culture may require more prescriptive, more frequent training and greater command and control management system features (AIChE, 2007).

### 2.2.6 MOC Scoping

After an initiator introduced a MOC, the owner will develop a list of action items that need to be accomplished and this activity is called “scoping the MOC” (Hoff.R, 2012). A well-scoped MOC is effective and has a lower risk compared to a poorly-scoped MOC which is ineffective and higher in risk. In industries, many companies have developed their own methodology in implementing MOC. Some has even developed their technical standards that suit their business operation.

Nevertheless, (Hoff.R, 2012) stressed out that the quality of MOC scoping is dependent on the method used, with different sites using anything from no scoping at all, guesswork approaches, checklist approaches to a very sophisticated asset based scoping. A risk can be minimized when a fully scoped MOC consists of a correct and complete list of action items which anything less will increase the risk. At the end of scoping, the list of action items should be similar or analogous as in Table 2.3. Some action items are in asterisk (*) suffix, which imply they are always part of MOC while other actions are generated by the scoping activity.

Table 2.3 List of Action Items for a Hypothetical MOC

| Action Item | Type of Action Item | Execution Stage | Role |
|---|---|---|---|
| Redline P&ID | Perform | Change Design | Owner |
| Redline Instrument loop diagram | Perform | Change Design | Owner |
| *Conduct PHA** | Perform | Impact analysis | Process Engineer |
| Conduct environmental analysis | Perform | Impact analysis | Environmental rep |
| Review MOC | Review | Approvals | Process Engineer |
| *Approve MOC** | Sign-off | Approvals | Area Manager |
| Procure instrument | Perform | Implementation | Purchasing rep. |
| Install in facility | Perform | Implementation | Maintenance |
| Obtain instrument spec. sheet | Perform | Implementation | Owner |
| *Conduct PSSR** | Perform | PSSR | PSM Coordinator |
| Update instrument database | Perform | Close-out | Owner |
| Update fugitive emission database | Perform | Close-out | Environmental rep. |
| Update P&ID | Perform | Close-out | Drafting rep. |
| Update instrument loop diagram | Perform | Close-out | Drafting rep. |
| *Gather metrics** | Perform | Close-out | MOC Coordinator |
| *Close-out the change** | Sign-off | Close-out | MOC Coordinator |

*Note*. Adapted from "*MOC Scoping- Ensuring that MOC action items are correctly & completely described*," by Hoff, R, 2012.

In any guidelines or existing framework practices by industries organizations, they generally had the same structure of the listed action items. What distinguish it in the effectiveness of MOC are the scoping techniques which are evaluated in terms of cost and error susceptibility.

# CHAPTER 3

# METHODOLOGY

## 3.1 Project Activities Workflow

For this project, author has developed a framework; MOC Management System (MOC-MS) for Process Industries Based on Process Safety Management (PSM) which follows the maintenance workflow as in Figure 3.1:

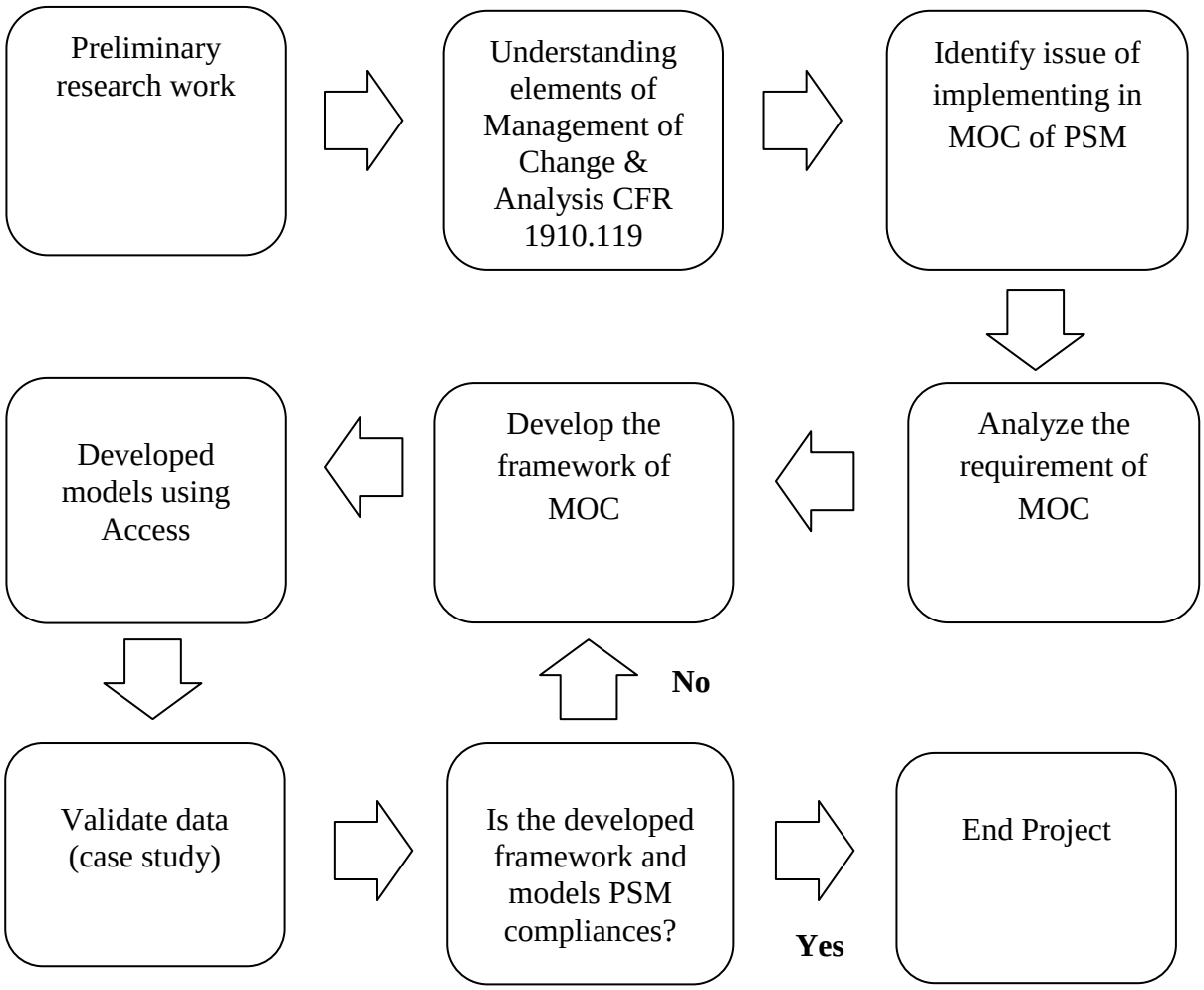



Figure 3. 1 Project Activities

### 3.2 Analysis the requirements of MOC of PSM

Basically, the project is started with analyzing the requirements of the MOC element of PSM standard. Analysing MOC requirements of PSM is important to discover the requirements to comply with the 29 CFR 1910.119(l).

### 3.3 Development of MOC Framework

Once the requirements are properly interpreted, the framework or process flow has been developed compliance with the MOC of PSM regulation. The framework illustrates step by step process that need to be perform according to the MOC requirements. Enhanced P&ID has been used as a basis for MOC information management.

### 3.4 Development of MOC Management System (MOC-MS) as Process Model

In order to develop the model, the software being used is Microsoft Excel & Microsoft Access.

| No. | Software | Part | Details |
|---|---|---|---|
| 1 | Microsoft Office Access (2007) | Creating the structure of the template. | This is the software that will be used to develop the template for MOC Management System (MOC-MS) |
| 2 | Microsoft Office Excel (2007) | Extract data, collect, trend data, creating the database system. | This is the software that will be used to develop MOC Management System (MOC-MS) during the model phase. |

For the development of the model, author used the Microsoft Office Excel (2007) to built the structure of the system (no live database). This is done in the phase of Final Year Project I whereas continuation of work in Final Year Project II covered the development of MOC-MS with database obtained from industry using Microsoft Office Access (2007). Progress of the work is continued until developing the final interface for end user. Details of the model and the development of MOC-MS are explained further in Chapter 4: Results and Discussion.

### 3.5 Proof of Concept Case Study

The best option in validating the concept is by using the real process plant data. The data used in MOC-MS was obtained from a refinery plant in Malaysia. The Refinery X has thousands of employees and highly hazardous chemicals found in Appendix A of the PSM regulations (OSHA, 1992) are exists but not at the majority of sites. All employees are obliged to use the MOC process, regardless they are at PSM regulated site or not. For validating the concept of the framework, author uses two nodes of changes from units in the Refinery X as the case studies.

### 3.6 Gantt Chart

| Activities | Week No/ Date | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Selection of Project Topic | | | | | | | | | | | | | | |
| Preliminary Research Work | | | | | | | | | | | | | | |
| Understanding elements of MOC & PHA | | | | | | | | | | | | | | |
| Familiarize with existing techniques or framework | | | | | | | | | | | | | | |
| Submission of extended proposal | | | | | | | | | | | | | | |
| Proposal Defence | | | | | | | | | | | | | | |
| Developed the framework and model using Access. | | | | | | | | | | | | | | |
| Submission of Draft Interim Report | | | | | | | | | | | | | | |
| Submission of Interim Report | | | | | | | | | | | | | | |

Figure 3. 2 Final Year Research Project I

| Activities Week | Week No/ Date | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Development of MOC-MS in Microsoft Office Access 2007 | | | | | | | Mid- Semester Break | | | | | | | | |
| Data Collection in Refinery Plant X | | | | | | | | | | | | | | | |
| Load data of Unit 1A into MOC-MS | | | | | | | | | | | | | | | |
| Submission of Progress Report | | | | | | | | 5/11 | | | | | | | |
| Completion of data loading Unit 1B into MOC-MS | | | | | | | | | | | | | | | |
| Troubleshooting & refining the interface of MOC-MS | | | | | | | | | | | 26/11 | | | | |
| Pre-EDX | | | | | | | | | | | | | | | |
| Submission of Draft Report | | | | | | | | | | | | 3/12 | | | |
| Submission of Dissertation (soft bound) | | | | | | | | | | | | | 10/12 | | |
| Submission of Technical Paper | | | | | | | | | | | | | 10/12 | | |
| Oral Presentation | | | | | | | | | | | | | | 10/12 | |
| Submission of Project Dissertation (Hard Bound) | | | | | | | | | | | | | | | 11/1 |

Figure 3. 3 Final Year Research Project II

# CHAPTER 4

# RESULTS AND DISCUSSION

For Final Year Project I, the outcome of the project work is to develop a framework of MOC and a model based from the developed framework. The research project is continued in Final Year Project II by refining the model of MOC Management System (MOC-MS) using Microsoft Office Access 2007 with data from Refinery X being loaded into the system.

## 4.1 MOC Requirements Based on the OSHA PSM 29 CFR 1910.119(l)

The MOC element specified by OSHA has outlined that the change which covers process chemicals, technology, equipment, and procedures, and change to facilities that affect a covered process, should follows all the sub standards outlined by OSHA. Table 4.1 shows the essential keys in the element of MOC that is used as a base to develop the MOC framework:

Table 4.1: Standards of MOC in 29 CFR 1910.119(l)

| Standards | Description |
|---|---|
| 1910.119(l)(1) | Employer should establish and develop written MOC procedures to manage changes. |
| 1910.119(l)(2) | Update or review written Procedures developed prior to any changes: 1910.119(l)(2) covering the below sub standards;<br>• Technical basis for proposed change 1910.119(l)(2)(i)<br>• Impact of change on safety & health 1910.119(l)(2)(ii)<br>• Modification to operating procedures 1910.119(l)(2)(iii)<br>• Necessary time period for change 1910.119(l)(2)(iv)<br>• Authorization requirements for proposed change 1910.119(l)(2)(v) |
| 1910.119(l)(3) | Notification and training (Refer to element Training: 1910.119(g) of the change prior to start-up of the process or affected part of the process to employees involved in operating a process and maintenance and contract employees whose job tasks will be affected by a change in the process. |
| 1910.119(l)(4) | Update or review changes in Process Safety Information |
| 1910.119(l)(5) | Update or review changes in Operating Procedures. |

## 4.2 Framework for MOC of PSM

### 4.2.1 Compliance with MOC of PSM Standard

The research work begins by understanding the element of Management of Change (MOC) specified by OSHA. However, OSHA did not provide the industry any specific methods in order to comply with the standard. As stated earlier, companies are in haze whenever it comes in implementing a technique that complies with all MOC requirements. Converging on regulatory compliance, the proposed framework shown in Figure 4.1 will assist the end users to close identified gaps in process plant safety based on the conducted MOC identification and assessment analysis such as an imperfection in designs, equipment, chemicals, etc. and ensure that the requirements of 29 CFR 1910.119(l) are practiced as intended.

Following the PSM standard as shown in Figure 4.1, the first step in MOC implementation is identifying the type of changes that affected the covered process whether it is a replacement in kind (RIK) or not. OSHA considers a change that is not a replacement in kind as one that requires an MOC review (Sutton, 2012). A replacement in kind change is a type of change that meets the original specification design. Therefore, other type of changes than RIK would follow this framework of MOC based on 29 CFR 1910.119(l).

Before the process of MOC could take place, an organization or employer should establish and implement a written procedure under 29 CFR 1910.119(l)(l). If the information is not available, the employer is required to take necessary actions for the development of the written MOC as required as the said substandard. The results from analysis of the written MOC procedure are documented, compiled and tracked following the requirements of MOC 29 CFR 1910.119(l)(2)(i-iv). It should address the aspects of technical basis for proposed change, impact of change on safety and health, modification to operating procedures and necessary time period for change.

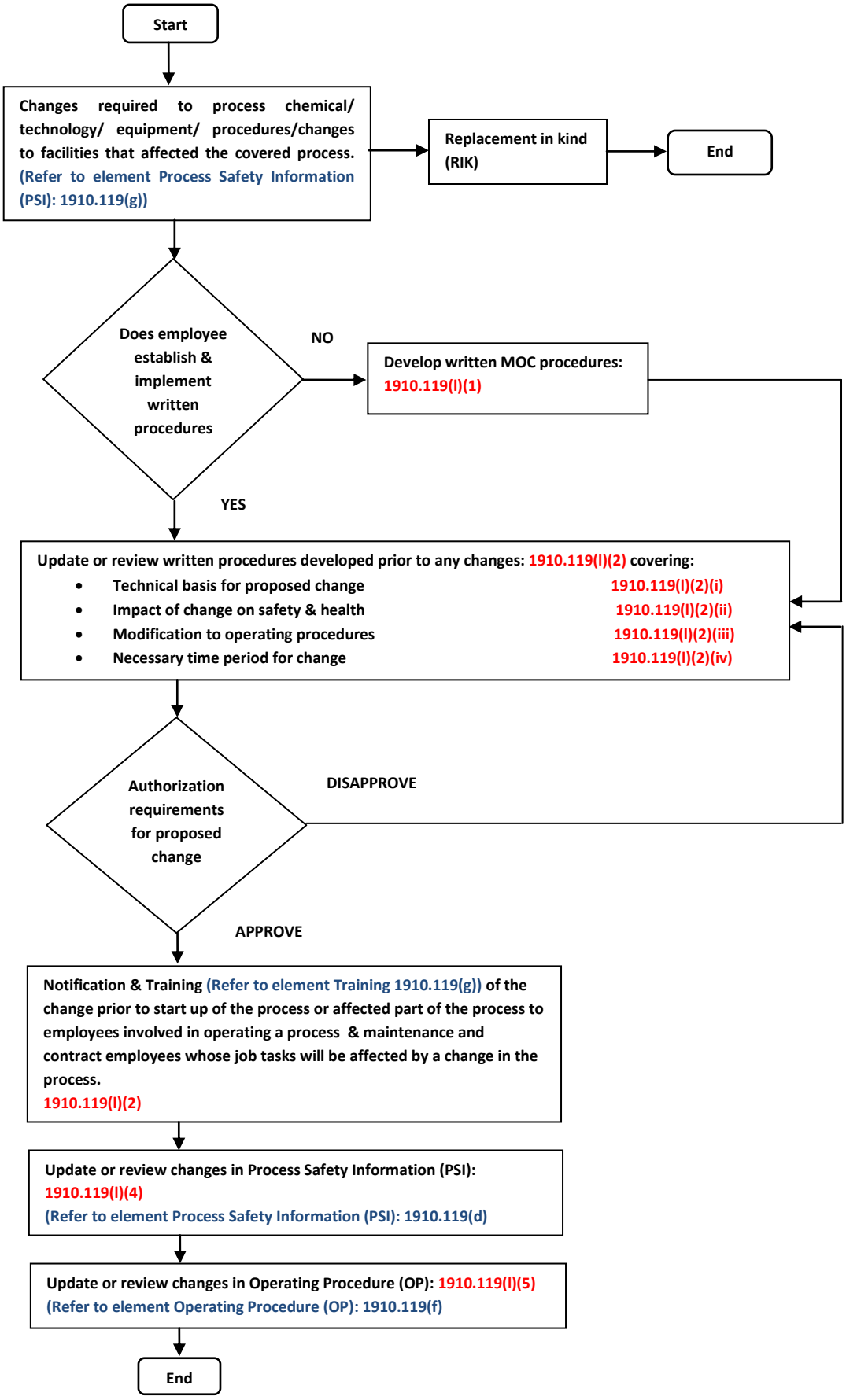



Figure 4. 1 Framework of Management of Change Based on 29 CFR 1910.119(l)

Before a change is implemented, authorization by plant management is needed for the proposed change. It should be formally approved and accepted by the plant management to meet the requirements of the process safety regulations. Apart from that, the approval can be used as a formal record as a possible cause if should there be any accident occurred. After gaining the approval for the proposed change, all parties that are affected by the changes are being notified. Usually the focal group or personnel affected are notified via email. Although notification and training are in the same substandard of 29 CFR 1910.119(l)(3), the notification is distinct from training. It involves the people who have some peripheral involvement with the consequences of the change but not to the individual or group that affected by it. Whereas for the training, it is only be done to the people who are directly affected by it if training is necessary.

All the Process Safety Information (PSI) needs to be updated and revalidated as stated in 29 CFR 1910.119(l)(4) once the changes has been approved. The PSI documents that usually being updated is the new safe operating limits, engineering documentation and etc. This part of MOC review could be referred to the PSI element of PSM 29 CFR 1910.119(g). The last process in the MOC implementation, is updating or reviewing the Operating Procedures (OP) under the substandard 29 CFR 1910.119(l)(5). This substandard can be linked to the training element of PSM 29 CFR 1910.119(f).

### 4.2.2 Using Piping & Instrumentation (P&ID) as a Foundation for MOC Information Management

The P&ID is used as a foundation in managing MOC because all the changes can be rigorously traced without possible missing of information. P&ID represents the detail equipment and auxiliary in the process plants hence it is commonly used in process plant making it favourable to be referred by end user. Hanida & Azmi (2012) highlighted the point of using P&ID as an interface could enhance users' acceptance since it is commonly used in a process plant. Figure 3.2 shows the P & ID framework for MOC.

The framework works by moving from one node to another as P&ID is divided into several nodes. The nodes selected depend on the number of equipment within the process plant determined by the end users. Once MOC has been performed or updated for the equipment or stream, the authorized personnel can choose other equipment or streams within the selected node. As the information within the node has been updated, the personnel can select the next node by performing or updating MOC information and the process continue until all the P&ID are covered.

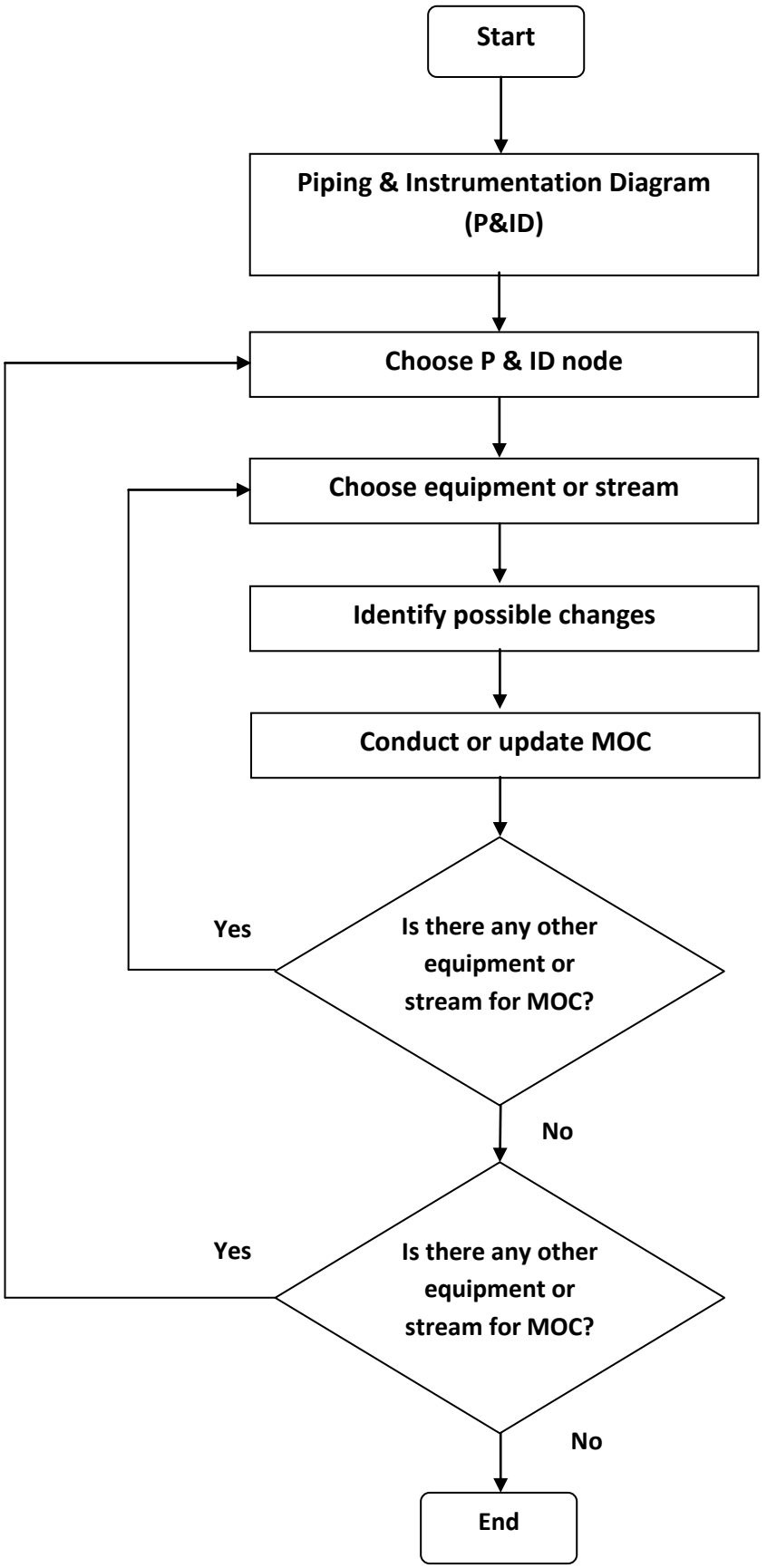



Figure 4. 2 The P &ID Framework for MOC

### 4.3 MOC Management System (MOC-MS)

The implementation of this concept will assist by computer technology. Even though the MOC implementation can be completed manually, the better results can be obtained by using the aid of a computer database system. The amount of time and effort can be significantly reduced and apart from that, implementation of MOC can be done effectively.

This MOC Management System (MOC-MS) is developed based on the framework in Figure 4.1 using Microsoft Office Access (2007). MOC-MS has the flexibility to allow for any changes of MOC information. MOC-MS interfaces capture the mandatory requirements by MOC to ensure end users provide all necessary MOC data for compliance. Any incomplete information can easily be identified for necessary actions by end users. The system itself is designed to allow witten data gathering either in softcopy or hardcopy format.

### 4.4 Case Study 1: Naphta Treating Unit (Unit 1A)

To demonstrate the implementation of MOC using MOC-MS, a case study is conducted in the refinery X involving two selected nodes. One is temporary change and another one is permanent change.

The permanent change in Unit 1A to be discussed is to increase the V-1A201 naphta inlet pipe line schedule from 40 schedule to 80 schedule to cater the higher expected corrosion rates. Following concept illustrated in section 4.2.2, Figure 4.3 shows part of the P&ID of the affected area for the said change. The selected stream from the node is in red box where the pipe line needs to be change is in highlighted in yellow. The MOC requirements' assessment process for designated personnel of Unit 1A is guided by main interface of MOC. If the data is not available, the end users are required to provide the required MOC information and this is the gaps that needed to be closed in order to reduce any potential risk.

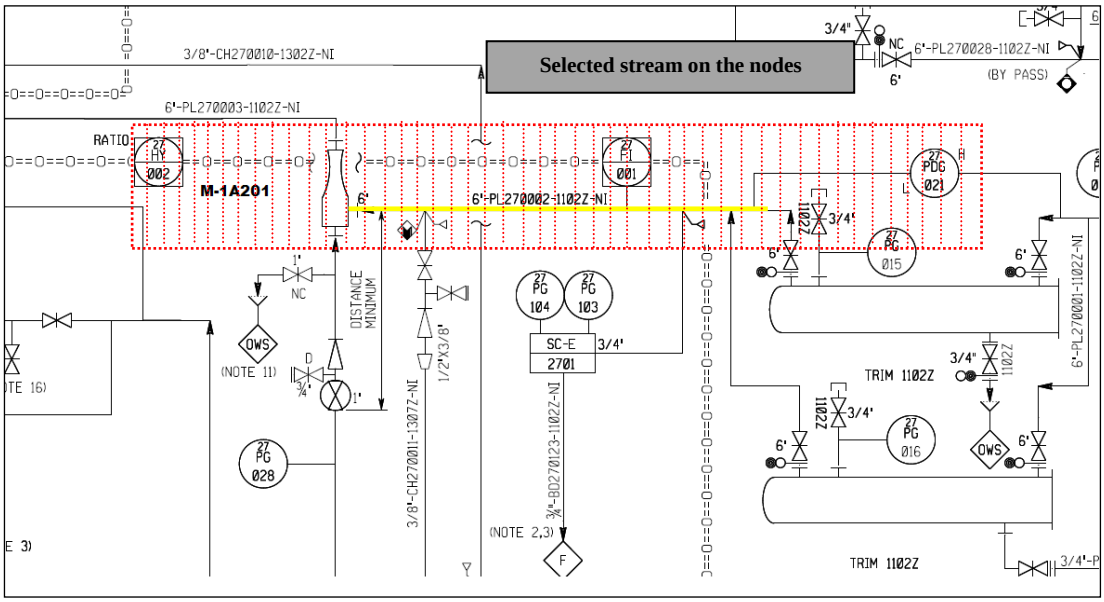



Figure 4. 3 Part of Overall P&ID Diagram for the Permanent Change in Unit 1A

### 4.4.1 MOC Development

Figure 4.4 shows the 'MOC Development' interface of MOC-MS that consists of several columns which are 'Sub-standard', 'Description', 'Complete', 'Incomplete' and 'Remarks'. This interface page will provide end user the current status of all the requirement of element MOC of PSM standards through the checklists of the completeness of the sub standards. Using the framework developed in Figure 4.1 as the stand, all the MOC sub-standard requirements can be easily monitored and managed by MOC-MS using data captured through computer forms which can be stored in a centralized database. MOC-MS ensures that data is sufficiently captured and verified using systematic checklist. Any comments such as specific incomplete information and conditions are put in the 'Remark' column. From the comments, the authorized personnel can take any required actions necessary in order to fulfil with the MOC requirements.

This MOC Development page acts as the summary page for end user to refer if there is any incompleteness of the MOC requirements. Based on the change of the inlet naphta pipe line V-1A201, all the requirements for the MOC does comply with the PSM standard. End user could refer to each sub standards of MOC by clicking on the description in blue colour where the hyperlink will navigate user to each of the sub standards interface pages.

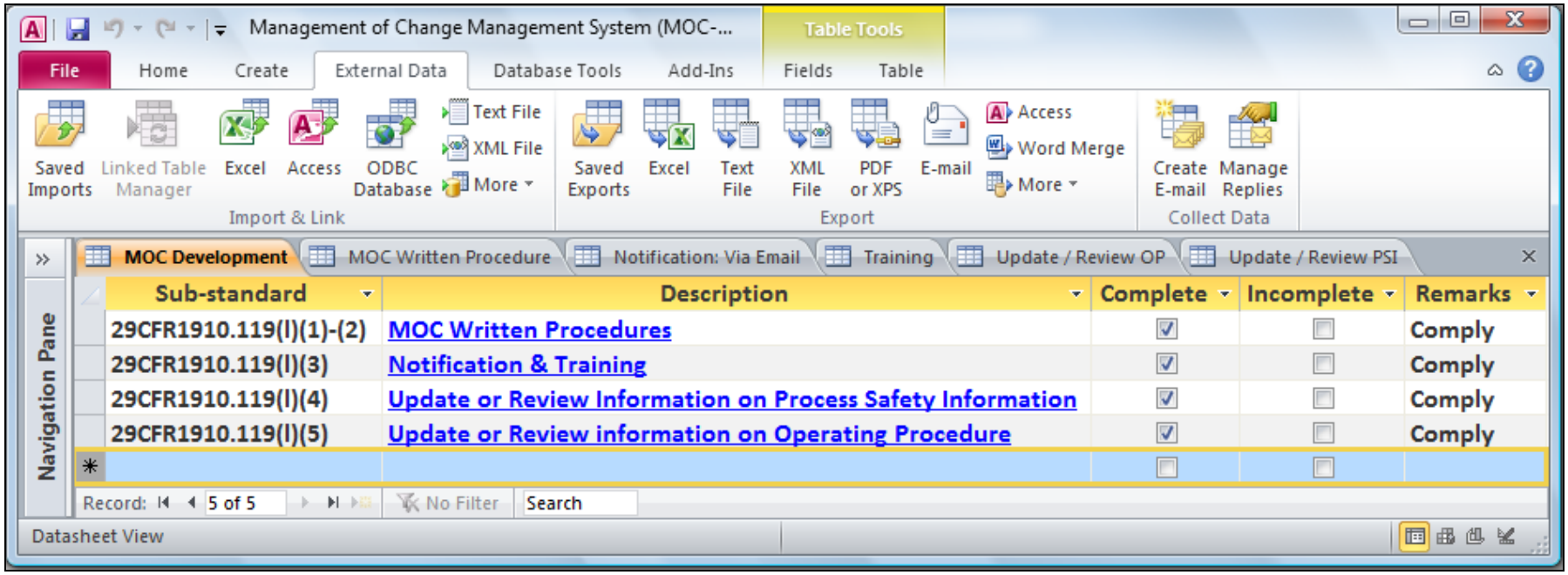



Figure 4. 4 Interface of MOC Development Unit 1A

### 4.4.2 MOC Written Procedure

Figure 4.5 show the interface for MOC Written Procedure of MOC-MS that requires an organization to manage their changes through a developed and established written procedure. It covers two sub standards which are 29 CFR 1910.119(l)(1): *establish and implement procedures to manage changes* and 1910.119(l)(2): *Update or review written Procedures developed prior to any changes.* The listed sub standard 29 CFR 1910.119(l)(2)(i-iv) in the interface guide the end users the requirement. Meanwhile the implementation of 29 CFR 1910.119(l)(2)(v); *Authorization requirements for proposed change* as referred to 'Approved by' column. The findings in the authorize changes is a standard set of approvers is part of the process. The written procedures have to be reviewed so that the latest or updated procedures are kept on the track for affected employees, PSM team reference and auditing purpose as refer to 'Evidence Location' column.

The check list will also assist them to identify which requirement does not comply with the standard. Gaps will be reduced once end user knows the level of completeness of their changes.

In this case, the technical basis for proposed change was approved by the area manager of Area 1A. In the attachment, user can track the evidence of the completeness by opening the Change Approval Form (CAF) numbered 1A01-001P. There is a freedom in the MOC Written Procedure interface for other companies to use with their own implementation of MOC. Apart from that, in the 'Remarks' field end user could double check the requirement in the interface of MOC Written Procedure whereby in this case, HAZOP is not required and there is no change in the Operating Procedure (OP).

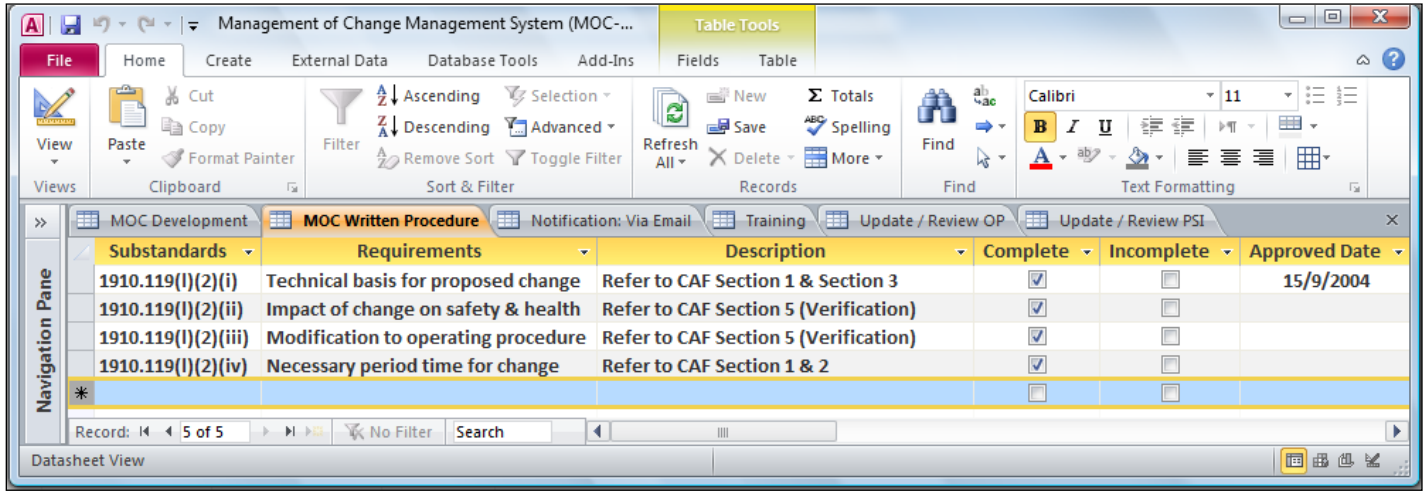



Figure 4. 5 Interface of MOC Written Procedure Unit 1A

### 4.4.3 Notification & Training

Derived from sub standard 29 CFR 1910.119(l)(3), any change that is approved and to be implemented should be notified to personnel or departments affected by the changes. If necessary a specific training is needed to train the personnel(s). In this case, the notification of change that involves process chemical, process technology and process equipment is carried out via email. Figure 4.6 shows the interface page of 'Notification: Via Email' with 'Action by, 'Due date', 'Completed Date', 'Evidence Location', and 'Checklist'. Authorized personnel ensure completeness of information notification through date stated in 'Complete' column. Consequently, outstanding tasks can be monitored and completed on time.

As for the 'Notification' interface, author decided to use via email as in industries, they usually notified the personnel or focus group which are affected through email. The checklist identified which department are being notified hence concluded those are the department that only being affected by the changes. The evidence can be found in 'Evidence Location' column whereby the location of email is recorded.

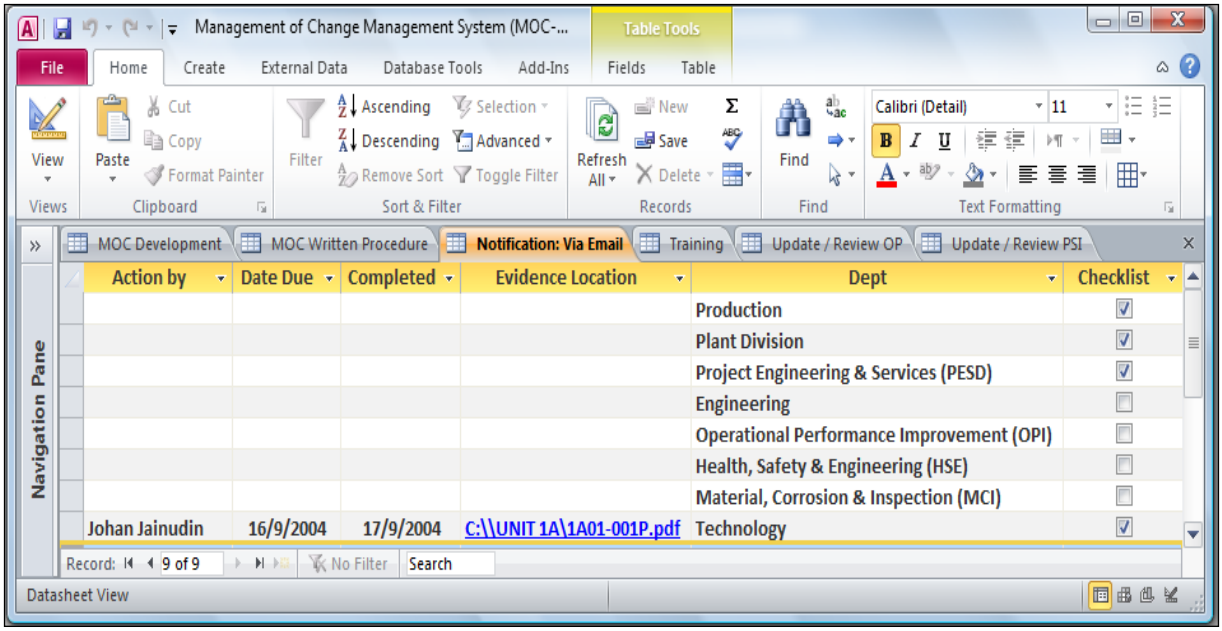



Figure 4. 6 Interface of Notification: Via Email Unit 1A

Figure 4.7 displayed the ‘Training’ interface of MOC-MS. It covers the focus group needed for initial or refresh training, and the area of training which are on ‘Operating Procedures’, ‘Specific Safety and Health Hazards’, ‘Emergency Operations and Safe Work Practices’. The training interface page does comply to the Training element of PSM 29 CFR 1910.119(g). This page also captures the data of who to verify the training courses and ‘Evidence Location’ column for tracking the evidence of training. As Referring to the CAF Form in Appendix 4-1, it has stated that no training is required for this change. Therefore, the requirements of training under sub-standard 29 CFR 1910.119(l)(3) is considered complete.

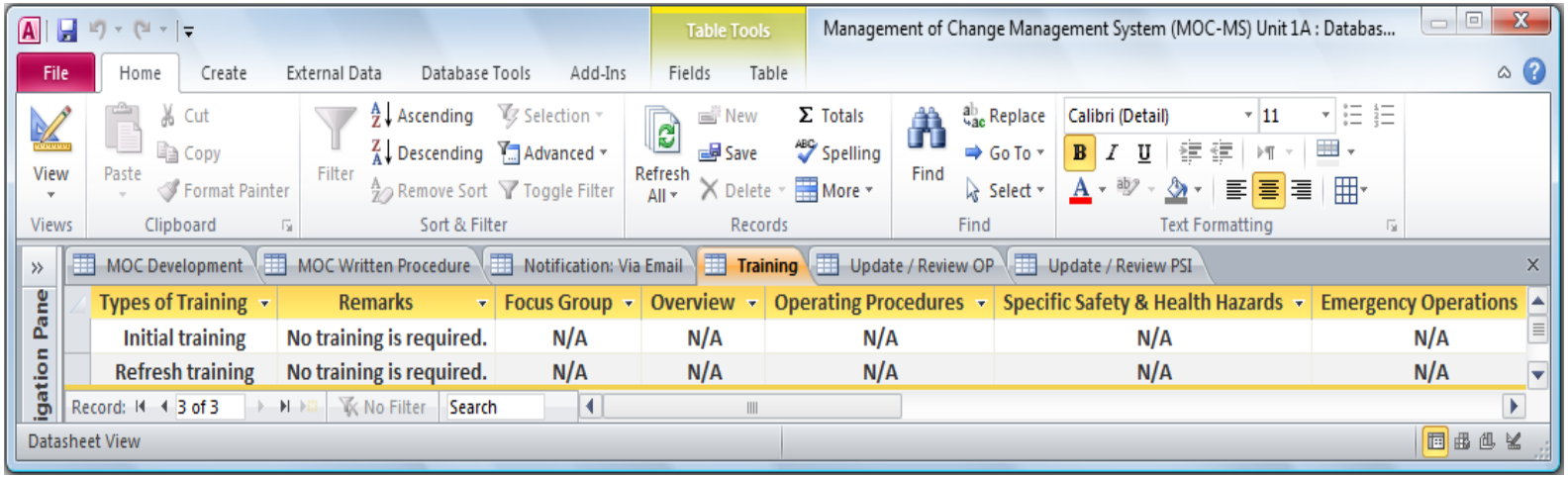



Figure 4. 7 Interface of Training Unit 1A

### 4.4.4 Update / Review Process Safety Information (PSI) & Operating Procedure

For the sub standards of 29 CFR 1910.119(l)(4): *Update or Review Process Safety Information* and 29 CFR 1910.119(l)(5): *Update or Review Operating Procedures*, the requirement of updating records or documentation are vital in order to manage and implement good MOC. All the information must be updated before the change is placed in service. Figure 4.8 and Figure 4.9 show the interface for Update/Review Process Safety Information (PSI) and Operating Procedure (OP) respectively.

In this case, the MOC data highlighted that the Piping & Instrumentation Diagram need to be updated by the drafting representative. The attachment is the updated P&ID formed. Other PSI documentation such as instrument database does not require any review. In addition, OP is not affected by this change. Thus the

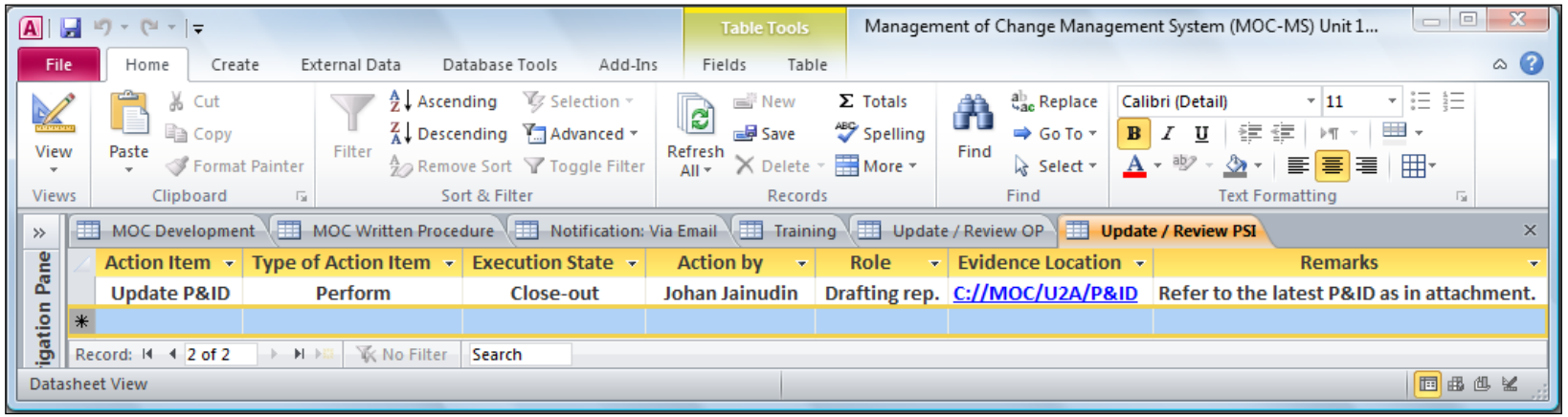



Figure 4. 8 Interface of PSI Unit 1A

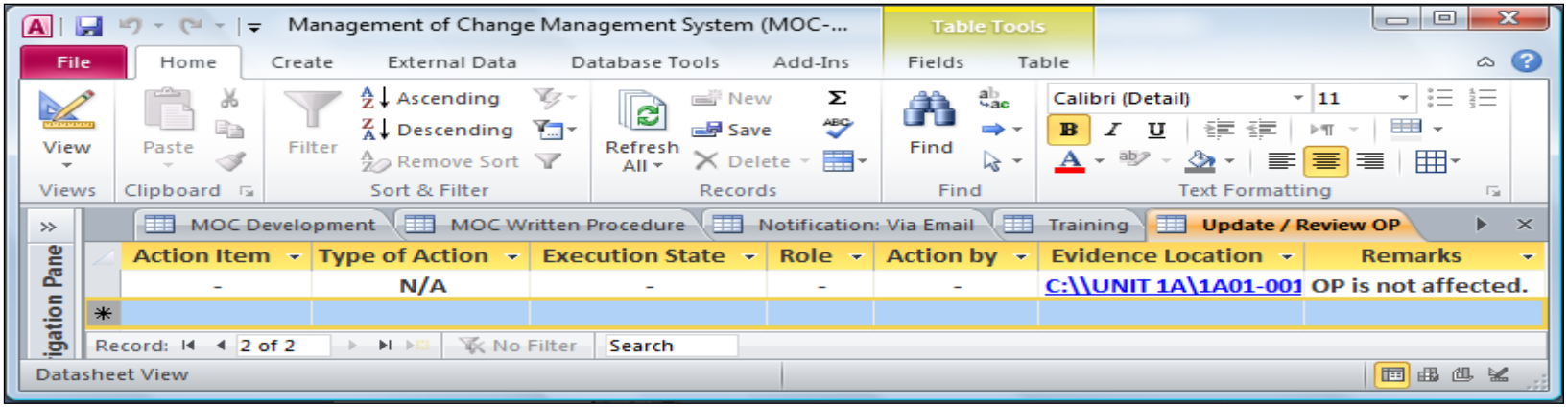



Figure 4. 9 Interface of Operating Procedure Unit 1A

### 4.5 Case Study 2: LPG Treating Unit (Unit 1B)

The permanent change in Unit 1B to be discussed is to change the differential pressure gauge measuring the differential pressure of vessel V1B206. Since it is a critical parameter to be monitored, the proposed change is to replace it with differential pressure transmitter and it should be put into the Distributed Control System (DCS). Figure 4.10 shows the node of affected area for the said change. The selected stream from the node is in red box where the differential pressure gauge needs to be replaced with differential pressure transmitter is highlighted in yellow. The MOC requirements' assessment process for Unit 1B has been done in similar way of case study 1.

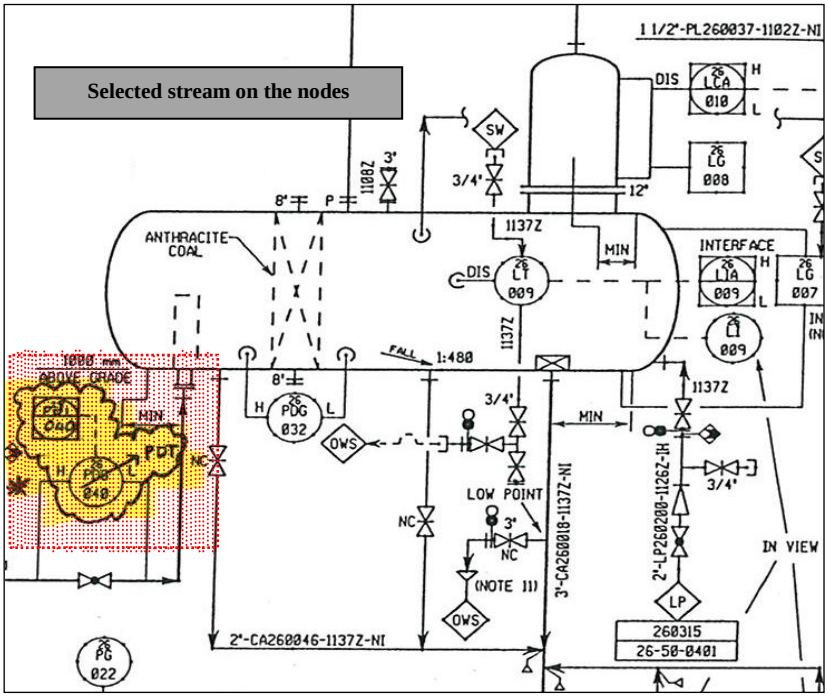



Figure 4.10 Part of Overall P&ID Diagram for the Permanent Change in Unit 1B

### 4.4.1 MOC Development: Unit 1B

Using the same interface page as the preceding case study, this MOC Development page in Figure 4.11 is used to assist end user if there is any incompleteness of the MOC requirements. Based on the change of the differential pressure gauge in Unit 1B, all the requirements for the MOC do comply with the PSM standard.

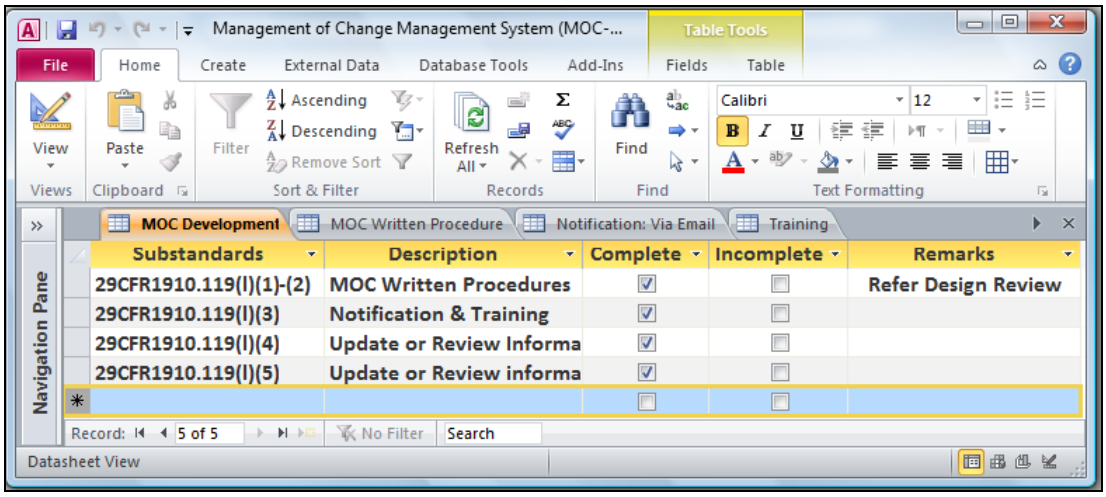



Figure 4. 11 Interface of MOC Development Unit 1B

### 4.4.2 MOC Written Procedures: Unit 1B

For the change in Unit 1B, the technical basis for proposed change was approved by the area manager of Area 1B as in Figure 4.13. In the attachment, user can track the evidence of the completeness by opening the Change Approval Form (CAF) numbered 1B04-0015P. There is a freedom in the MOC Written Procedure interface for other companies to use with their own implementation of MOC. As in the 'Remarks' column, it already stated that the sub-standard 29 CFR 1910.119(l)(2)(i) of 'Technical basis changes' can be referred to the design checklist in the attachment. In the 'Remarks' column too, the change does not required updating the operating procedures as well as HAZOP are not required.

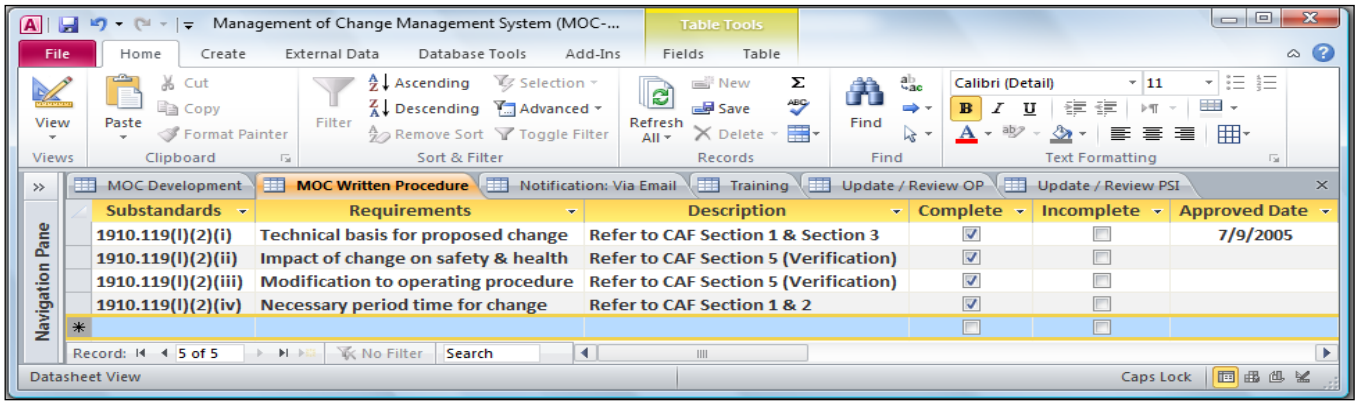



Figure 4. 12 Interface of MOC Written Procedure Unit 1B (i)

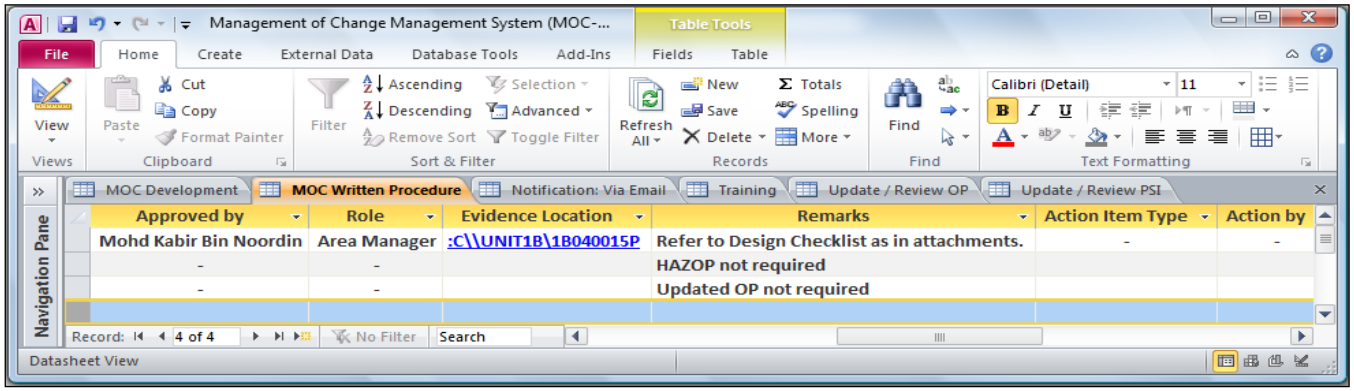



Figure 4. 13 Interface of MOC Written Procedure Unit 1B (ii)

### 4.4.3 Notification & Training: Unit 1B

Referring to Figure 4.14, the focus group that have been notified are the production, plant division and technology department. The email could be tracked through the CAF Form numbered 1B04-0015P through the 'Evidence Location' column. Hence, the change that has been approved had been notified to the departments affected by the change.

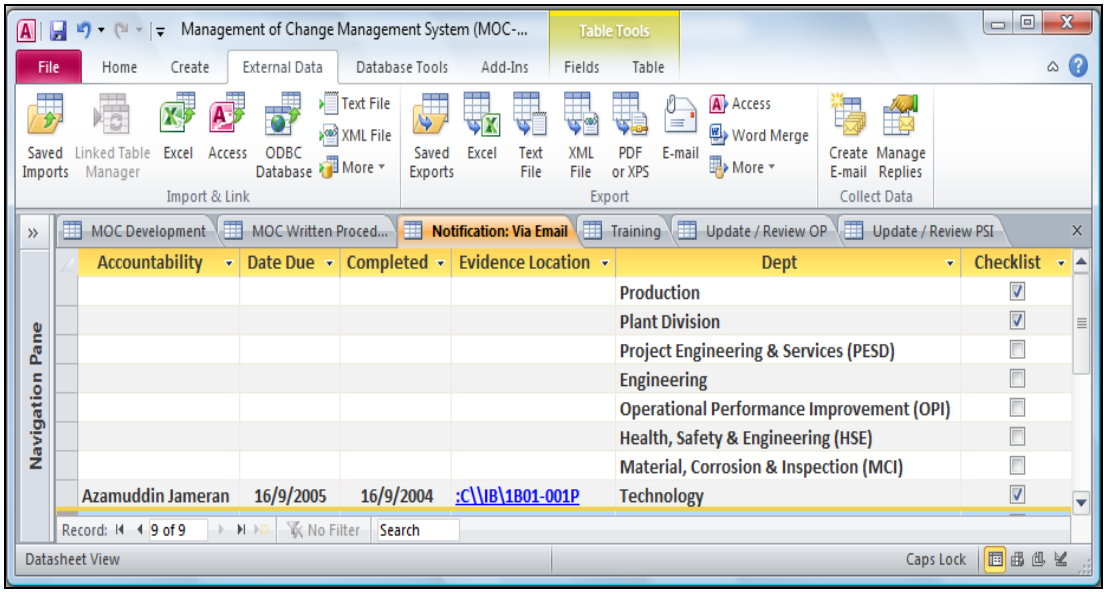



Figure 4. 14 Interface of Notification: Via Email Unit 1B

For this case there is no training is required due to change. Therefore, the requirements of training under sub standard 29 CFR 1910.119(l)(3) is considered complete.

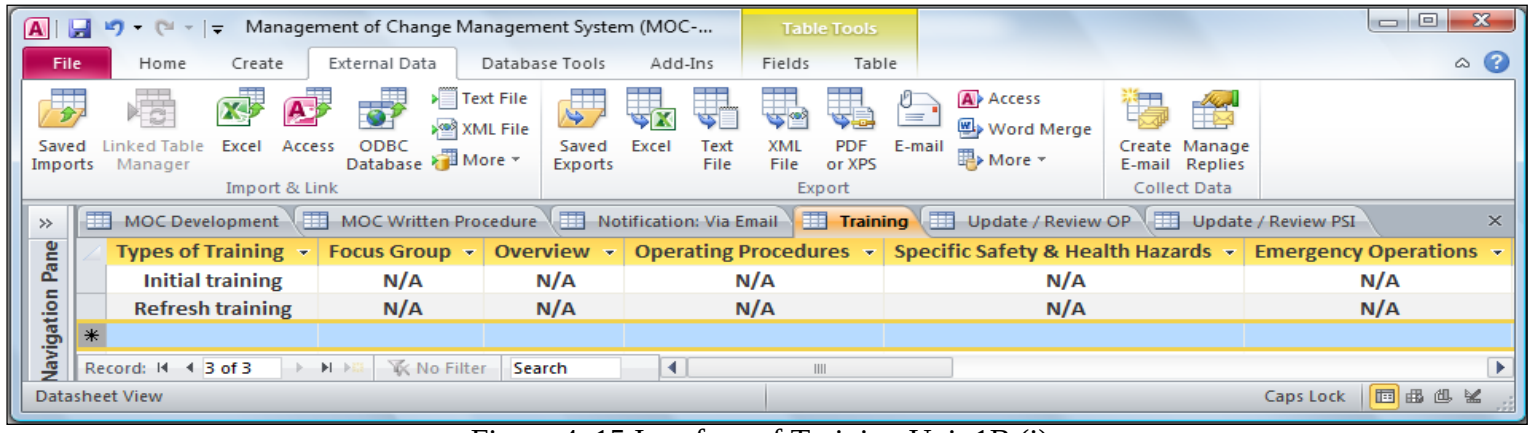



Figure 4. 15 Interface of Training Unit 1B (i)

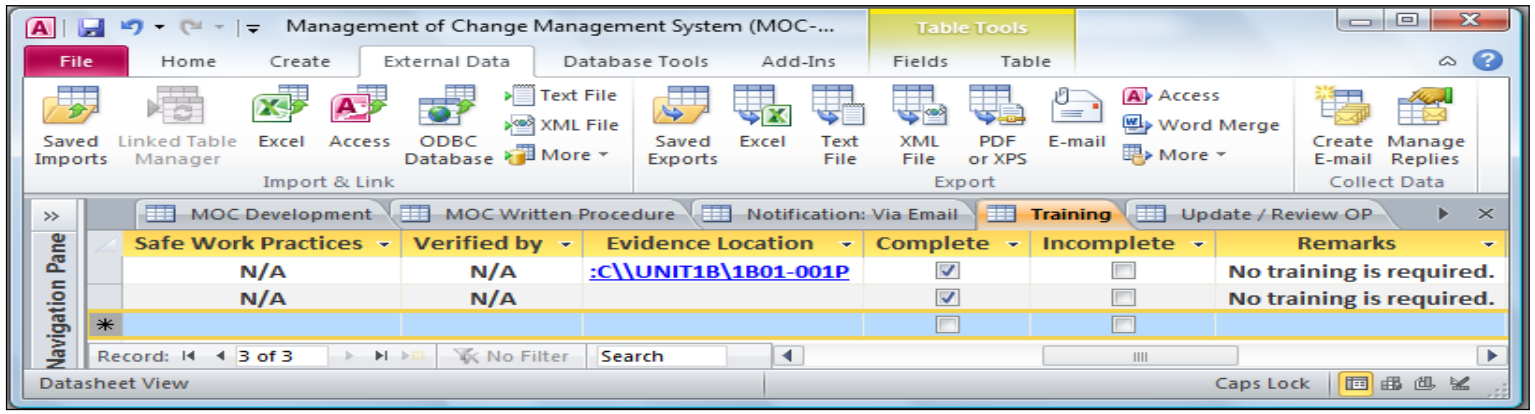



Figure 4. 16 Interface of Training Unit 1B (ii)

### 4.4.4 Update / Review Process Safety Information (PSI) & Operating Procedure: Unit 1B

In Figure 4.17, the change requires that the Piping & Instrumentation Diagram need to be updated by the drafting representative. The attachment is the updated P&ID formed. Other PSI documentation such as instrument database does not require any review. Operating procedure also not affected by this change. Therefore, author omitted this interface page as it is not applicable for this case but the plant is complies with the MOC standard.

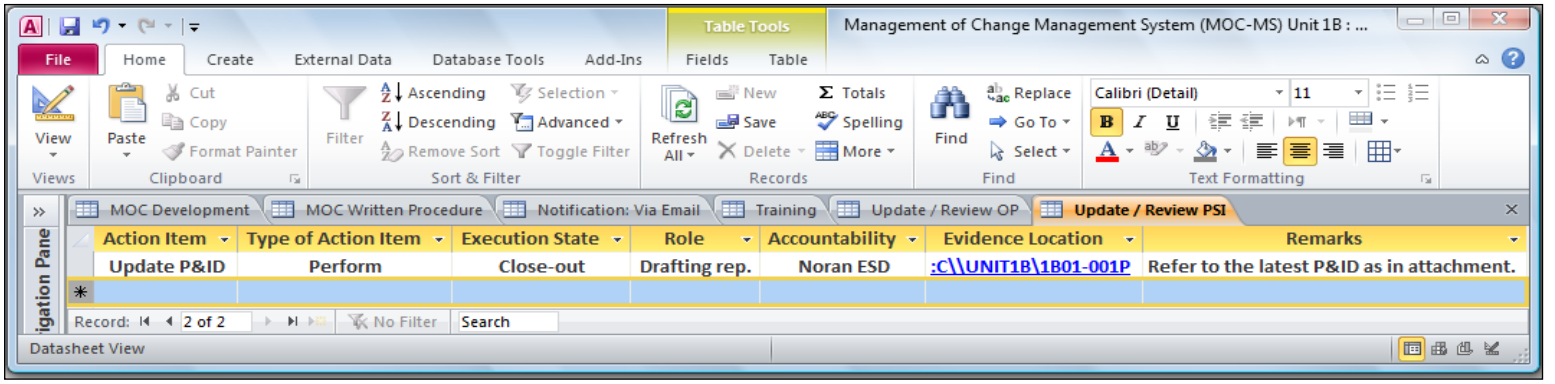



Figure 4. 17 Interface of PSI Unit 1B

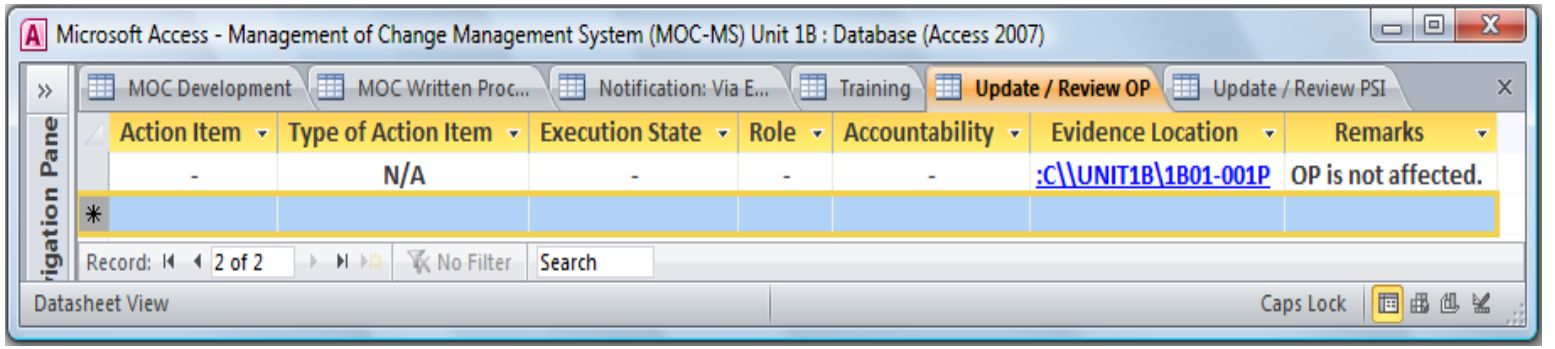



Figure 4. 18 Interface of Operating Procedure Unit 1B

The approach of implementing MOC in this Refinery X incorporates all of the positive attributes needed by a good MOC. Proper execution of MOC expected that the action item identified on the MOC form to be complete and sufficiently detailed.

Apart from that, author discovered the potential of MOC-MS in the purpose of auditing. Most of the industry practitioners highlighted that the challenge of MOC is that the current online software is not robust and there are no proper handover and missing MOC documents. Hence, by using MOC-MS, end user will be able to reduce the challenges by forward control in handling MOC data more efficiently and effectively by using MOC-MS.

# CHAPTER 5

# CONCLUSION

The present study introduces a useful technique that is beneficial for the process industries in applying the element of Management of Change (MOC) at a process plant. Apart from that, the concept is designed to ensure the end users are complying with MOC element of PSM 29 CFR 1910.119(l). MOC-MS uses P&ID as the foundation for its complete data compilation since it is commonly used and it represents the detail equipment and auxiliary in process plant. It helps the end users to track information, documents, recommendation and corrective actions of MOC. The system also will assist the end users to manage MOC and reduce the gaps in order to comply with MOC element of PSM requirements. The conducted case studies show that MOC-MS is able to manage MOC information effectively and also complies with MOC of PSM requirements. Thus, by implementing this technique it could help employer to prevent any catastrophic accidents. The proposed technique can be used by anyone to develop the system similar to MOC-MS to ensure that MOC element could be managed effectively according to MOC element of PSM.

# REFERENCES


AIChE. 2007, Guidelines for Risk Based Process Safety, John Wiley & Sons

Buncefield. March 2007<http://www.buncefieldinvestigation.gov.uk/reports/index.htm>.

Center for Chemical Process Safety (CCPS) 2008, *Guidelines for the Management of Change for Process Safety*, New Jersey, John Wiley & Sons

DNV (2002), "Accident Risks at Onshore Process Plants Based on Historical Data for DNV ISA-I".

Eileen M. 2001, "Elements of process safety management: part 2", *Journal of Chemical Health and Safety* **8(5):** 23-26

Erwin.S, 2008, "The Risks Arising From Major Accident Hazards; Lesson From The Past, Oppotunities For The Future", Refining Management Forum Copenhagen.

Hale A.R. and Hovden J. 1998, *Management and culture: the third age of safety, A review of approaches to organisational aspects of safety, health and environment*, London, Taylor & Francis.

Hanida & Azmi, 2012, *Management of Training for Safe Operation in Process Plant,*Universiti Teknologi PETRONAS, Perak.

Hoff,R., 2012, "MOC scoping-Ensuring that MOC action items are correctly and completely described", *Journal of Loss Prevention in the Process Industries* 1-12

Kirwan, B. And Ainsworth, L.K. 1992, *A guide to task analysis*, London, Taylor and Francis

OSHA. (1992, 20 December 2011). *Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119)*. Available: www.osha.gov.my

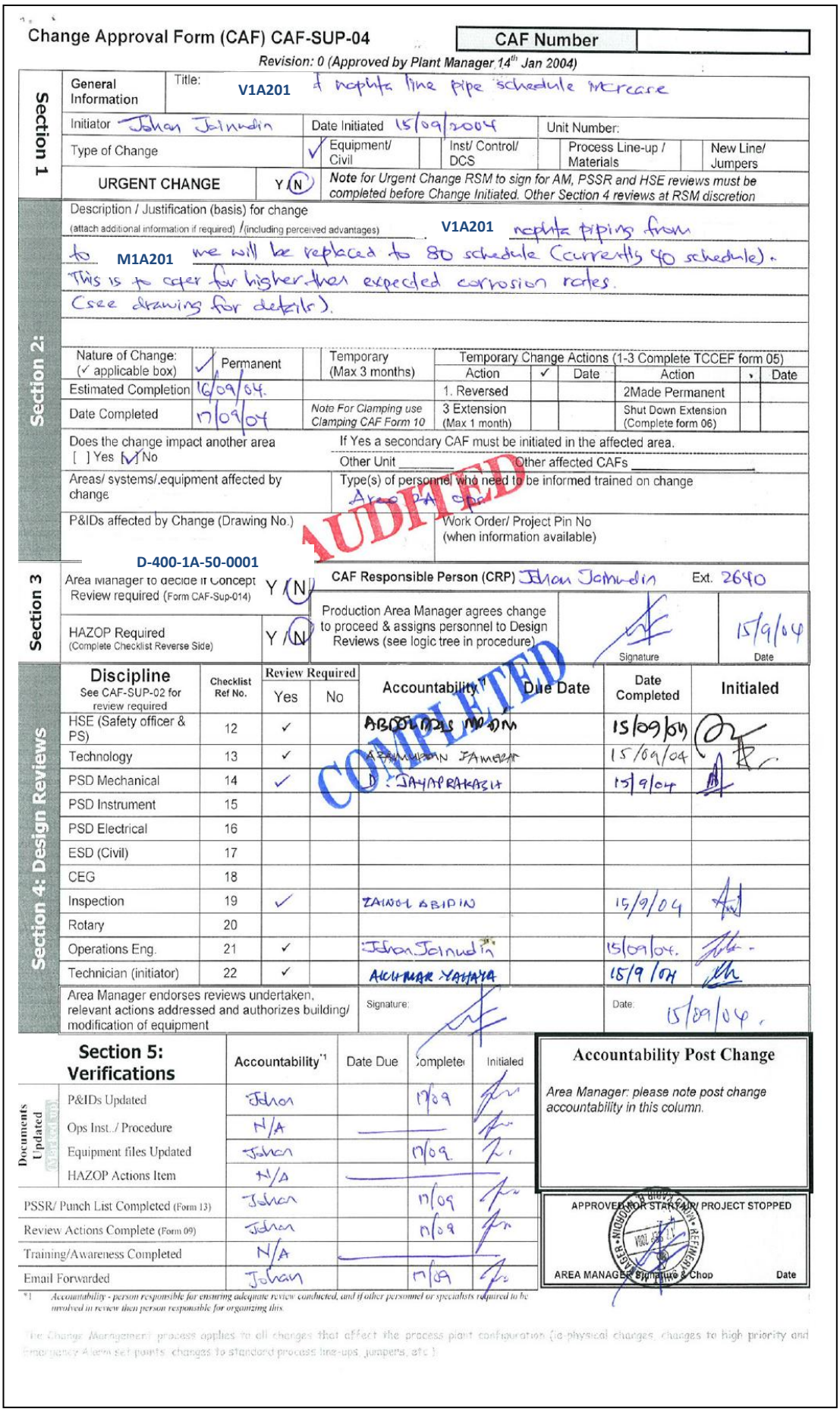
Rasmussen J., Brehmer B., and Leplat J. 1990, *Decision Making: Cognitive Models for Complex Working Environments*, Chiche, Wiley.

Sutton Ian. Management of Change (MOC) in the Process Industries: Managing Change in the Process Industries [Internet]. Version 3. suttonbooks. 2012 Apr 15. Available from: http://suttonbooks.wordpress.com/article/management-of-change-moc-in-the-process-2vu500dgllb4m-2/.

Turner B. 1978, *Man-made disasters*, London,Wykeham Press.

# APPENDICES

## APPENDIX 4-1: Change Approval Form (CAF): 1A01-001P



Change Approval Form (CAF) CAF-SUP-04 — CAF Number

*Revision: 0 (Approved by Plant Manager 14th Jan 2004)*

**Section 1**

General Information — Title: V1A201 naphta line pipe schedule increase

Initiator: Johan Jainudin — Date Initiated: 15/09/2004 — Unit Number:

Type of Change: ✓ Equipment/ Civil | Inst/ Control/ DCS | Process Line-up / Materials | New Line/ Jumpers

URGENT CHANGE: Y (N) — *Note for Urgent Change RSM to sign for AM, PSSR and HSE reviews must be completed before Change Initiated. Other Section 4 reviews at RSM discretion*

**Section 2:**

Description / Justification (basis) for change (attach additional information if required) /(including perceived advantages)

V1A201 naphta piping from to M1A201 we will be replaced to 80 schedule (currently 40 schedule). This is to cater for higher than expected corrosion rates. (see drawing for details).

| Nature of Change: (✓ applicable box) | ✓ Permanent | Temporary (Max 3 months) | Temporary Change Actions (1-3 Complete TCCEF form 05) Action | ✓ | Date | Action | ✓ | Date |
|---|---|---|---|---|---|---|---|---|
| Estimated Completion | 16/09/04 | | 1. Reversed | | | 2Made Permanent | | |
| Date Completed | 17/09/04 | *Note For Clamping use Clamping CAF Form 10* | 3 Extension (Max 1 month) | | | Shut Down Extension (Complete form 06) | | |

Does the change impact another area [ ] Yes [✓] No — If Yes a secondary CAF must be initiated in the affected area.

Other Unit _____ Other affected CAFs _____

Areas/ systems/ equipment affected by change: Area 2A Ops

Type(s) of personnel who need to be informed trained on change

P&IDs affected by Change (Drawing No.): D-400-1A-50-0001

Work Order/ Project Pin No (when information available)

AUDITED

**Section 3**

Area Manager to decide if Concept Review required (Form CAF-Sup-014): Y (N)

CAF Responsible Person (CRP): Johan Jainudin Ext. 2640

HAZOP Required (Complete Checklist Reverse Side): Y (N)

Production Area Manager agrees change to proceed & assigns personnel to Design Reviews (see logic tree in procedure) — Signature — Date: 15/9/04

**Section 4: Design Reviews**

COMPLETED

| Discipline (See CAF-SUP-02 for review required) | Checklist Ref No. | Review Required: Yes | Review Required: No | Accountability[1] | Due Date | Date Completed | Initialed |
|---|---|---|---|---|---|---|---|
| HSE (Safety officer & PS) | 12 | ✓ | | ABDUL RAZAK MOHD | | 15/09/04 | |
| Technology | 13 | ✓ | | AZHARUDDIN JAMBAR | | 15/09/04 | |
| PSD Mechanical | 14 | ✓ | | D. JAYAPRAKASH | | 15/9/04 | |
| PSD Instrument | 15 | | | | | | |
| PSD Electrical | 16 | | | | | | |
| ESD (Civil) | 17 | | | | | | |
| CEG | 18 | | | | | | |
| Inspection | 19 | ✓ | | ZAINOL ABIDIN | | 15/9/04 | |
| Rotary | 20 | | | | | | |
| Operations Eng. | 21 | ✓ | | Johan Jainudin | | 15/09/04 | |
| Technician (initiator) | 22 | ✓ | | AKHMAR YAHAYA | | 15/9/04 | |

Area Manager endorses reviews undertaken, relevant actions addressed and authorizes building/ modification of equipment — Signature: — Date: 15/09/04

**Section 5: Verifications**

| | Accountability[1] | Date Due | Complete | Initialed |
|---|---|---|---|---|
| Documents Updated — P&IDs Updated | Johan | | 17/09 | |
| Ops Inst../ Procedure | N/A | | | |
| Equipment files Updated | Johan | | 17/09 | |
| HAZOP Actions Item | N/A | | | |
| PSSR/ Punch List Completed (Form 13) | Johan | | 17/09 | |
| Review Actions Complete (Form 09) | Johan | | 17/09 | |
| Training/Awareness Completed | N/A | | | |
| Email Forwarded | Johan | | 17/09 | |

**Accountability Post Change**

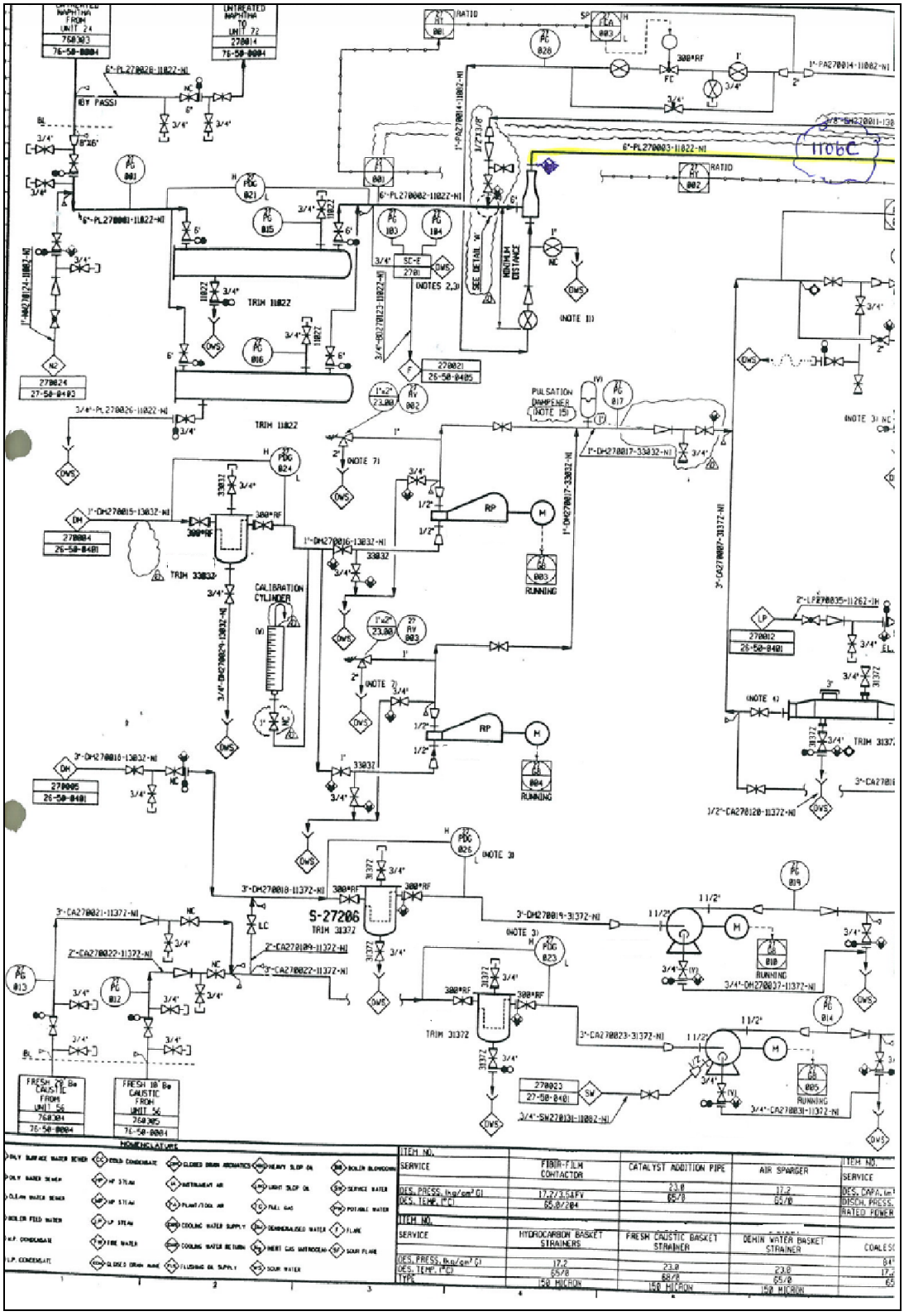
*Area Manager: please note post change accountability in this column.*

APPROVED FOR STARTUP / PROJECT STOPPED

AREA MANAGER Signature & Chop — Date

*[1] Accountability - person responsible for ensuring adequate review conducted, and if other personnel or specialists required to be involved in review then person responsible for organizing this.*

The Change Management process applies to all changes that affect the process plant configuration (ie physical changes, changes to high priority and Emergency Alarm set points, changes to standard process line-ups, jumpers, etc.).


UNTREATED NAPHTHA FROM UNIT 24
UNTREATED NAPHTHA TO UNIT 72
RATIO
TRIM 11822
TRIM 33832
CALIBRATION CYLINDER
PULSATION DAMPENER
S-27206
TRIM 31372
RUNNING
FRESH 2% Be CAUSTIC FROM UNIT 56
FRESH 10° Be CAUSTIC FROM UNIT 56
NOMENCLATURE
ITEM NO.
SERVICE
FIBER-FILM CONTACTOR
CATALYST ADDITION PIPE
AIR SPARGER
HYDROCARBON BASKET STRAINERS
FRESH CAUSTIC BASKET STRAINER
DEMIN WATER BASKET STRAINER
150 MICRON

## TECHNOLOGY REVIEW CHECKLIST

| Procedure No | Issue | Date | 14/1/04 |
|---|---|---|---|
| CAF-Supp-013 | Rev 0 | Approved by | Plant Manager |

PROJECT TITLE: V1A201 LET NAPHTHA LINE PIPE SCHEDULE INCREASE

CAF NO: | REVIEWER: AZAmuddin | DATE: 15/09/2004

| | Checklist Elements | Tick if Applicable |
|---|---|---|
| 1 | Heat and Material Balance | |
| 2 | Plot Plan | |
| 3 | P&ID and Process Flow Diagram | |
| 4 | Piping/Line Schedule | ✓ |
| 5 | Equipment – General | |
| 6 | Pumps | |
| 7 | Towers | |
| 8 | Knock-Out Drums | |
| 9 | Heat Exchangers | |
| 10 | Water Coolers/Condensers | |
| 11 | Air Coolers/Condensers | |
| 12 | Reboilers | |
| 13 | Fired Heaters | |
| 14 | Compressors | |
| 15 | Compressor Flow Control | |
| 16 | Steam Turbines | |
| 17 | Reactors | |
| 18 | Instrumentation/Controls | |
| 19 | Level | |
| 20 | Flow | |
| 21 | Pressure | |
| 22 | Temperature | |
| 23 | Control valves | |
| 24 | Advanced Controls | |
| 25 | Relief Systems | |
| 26 | Utilities | |
| 27 | Environmental | |
| 28 | Process Chemistry | |
| 29 | SOL's | |
| 30 | Fire Protection / Safety Equipment | |
| 31 | Area Classification | |

** If applicable then complete the relevant section of the attached Checklist*

***Detail any Documents that needs to be updated/ amend due to this change***

| | *Tick if required* | | *Tick if required* |
|---|---|---|---|
| *Piping and Instrumentation Diagrams* | | *Equipment Spec./Data Sheet* | |
| *Process Flow Diagrams* | | *Line List/Schedule* | ✓ |
| *Operating Procedures* | | *List of Alarm and Trip Settings* | |
| *Start-up Procedures* | | *Safeguarding Memorandum* | |
| *Shut-down Procedures* | | *Narrative Safeguarding by Instrument* | |

*Others Please specify the document:*

## INSPECTION CHECKLIST

| Procedure No. | Issue | Date Approve | 14/1/04 |
|---|---|---|---|
| CAF-SUP-19 | Rev 0 | Approved by | Plant Manager |

PROJECT TITLE:

| CAF NO: | REVIEWER: | DATE: |
|---|---|---|

| | Checklist Elements | Tick if Applicable | | | Tick if Applicable |
|---|---|---|---|---|---|
| 1 | P&ID and Process Flow Diagram | | 7 | Fired Heaters | |
| 2 | Line Schedule | ✓ | 8 | Tanks | |
| 3 | Equipment - General | | 9 | Piping | ✓ |
| 4 | Pressure Vessels, Boilers, and Heat Exchangers including Water Coolers/ Condensers | | 10 | Transmitters/Switches | |
| 5 | Fire Protection | | 11 | Control Valves | |
| 6 | Metallurgy/Corrosion | | 12 | Instrument Safety Systems | |

** If applicable then complete the relevant section of the attached Checklist*

| ***Detail any Documents you believe need to be updated/ amend due to this change*** |
|---|
| |
| ***Detail any person (group of persons) you believe may need to be trained or informed of the change*** |
| |

Record Any Recommendations/ issues that the review has raised

| ISSUE | Personnel responsible for close out |
|---|---|
| To apply 2nd & 3rd Coat after installation | Mech. |
| | |
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** Note - If more space is required attach a separate sheet*

## PLANT OPERATOR CHECKLIST

| Procedure No. | Issue | Date Approve | 14/1/04 |
|---|---|---|---|
| CAF-SUP-22 | Rev 0 | Approved by | **Plant Manager** |

PROJECT TITLE: V1A201 WET NAPHTHA LINE PIPE SCHEDULE INCREASE

CAF NO: | REVIEWER: AKUMAR YAMAHA | DATE: 15/9/04

| *Detail any Documents that needs to be updated/ amend due to this change* | | | |
|---|---|---|---|
| | *Tick If required* | | *Tick If required* |
| *Piping and Instrumentation Diagrams* | ✓ | *Equipment Spec/Data Sheet* | |
| *Process Flow Diagrams* | | *Line List/Schedule* | ✓ |
| *Operating Procedures* | | *List of Alarm and Trip Settings* | |
| *Start-up Procedures* | | *Narrative Safeguarding by Instrument* | |
| *Shut-down Procedures* | | | |
| *Others Please specify the document:* | | | |

| ***Detail any person (group of persons) that may need to be trained or informed of the change*** | | | |
|---|---|---|---|
| *PSD Electrical* | | *PSD Rotary* | |
| *PSD Instrument* | | *Inspection* | ✓ |
| *PSD Mechanical* | | *Others. Please specify the group or person* | |
| *PSD Civil* | | | |

***INSTRUCTIONS :***

*All boxes in the checklist shall be checked yes/no and additional concerns shall be recorded. If a question is not applicable, the relevant box(s) in the checklist shall be marked N/A.*

Record Any Recommendations/ issues that the review has raised

| ISSUE | Personnel accountable for close out | Date Due | Date Completed | Initialled |
|---|---|---|---|---|
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***Note - If more space is required attach a separate sheet**

**Page 1 of 4**

## HSE CHECKLIST

| Procedure No. | Issue | Date approve | 14/1/04 |
|---|---|---|---|
| CAF-SUP-12 | Rev 0 | Approved by | Plant Manager |

PROJECT TITLE:

CAF NO: | REVIEWER: [illegible] | DATE: 15/09/04

| | Checklist Elements | Tick if Applicable | | Checklist Elements | Tick if Applicable |
|---|---|---|---|---|---|
| 1 | Occupational Health | | 5 | Electrical/Area Classification | |
| 2 | Safety | ✓ | 6 | Human Factors | |
| 3 | Environment | | 7 | Procedures | |
| 4 | Fire/Emergency Response | | | | |

** If applicable then complete the relevant section of the attached Checklist*

***Detail any Documents you believe need to be updated/ amend due to this change***

CIMAH Report, Material Safety Data Sheet, Procedures & Guidelines, Incident Report Database, Incident Action Plan, Training Records, Shift Handover Records, Daily Instructions, Incident Investigation Record AND OTHERS

***Detail any person (group of persons) you believe may need to be trained or informed of the change***

Record Any Recommendations/ issues that the review has raised

| ISSUE | Personnel responsible for close out |
|---|---|
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** Note - If more space is required attach a separate sheet*

| | MECHANICAL REVIEW CHECKLIST | | | |
|---|---|---|---|---|
| | Procedure No. | Issue | Date Approve | 14/1/04 |
| | CAF-SUP-14 | Rev 0 | Approved by | Plant Manager |

PROJECT TITLE:

CAF NO: | REVIEWER: D. JANAPRAKASH | DATE: 15/9/04

| | Checklist Elements | Tick if Applicable |
|---|---|---|
| 1 | Furnaces/Boilers | |
| 2 | Heat Exchangers | |
| 3 | Piping and Valves | ✓ |
| 4 | Reactors | |

| | | Tick if Applicable |
|---|---|---|
| 5 | Vessels and Drums | |
| | | |
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| | | |

** If applicable then complete the relevant section of the attached Checklist*

***Detail any Documents you believe need to be updated/ amend due to this change***
Equipment Process Datasheet, Equipment List etc.

***Detail any person (group of persons) you believe may need to be trained or informed of the change***

Record Any Recommendations/ issues that the review has raised

| ISSUE | Personnel responsible for close out |
|---|---|
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** Note - If more space is required attach a separate sheet*

## OPERATIONS ENGINEER REVIEW CHECKLIST

| Procedure No. | Issue | Date Appove | 14/1/04 |
|---|---|---|---|
| CAF-SUP-21 | Rev 0 | Approved by | Plant Manager |

PROJECT TITLE: V1A201 Inlet naphta line pipe schedule increase

CAF NO: | REVIEWER: Johan | DATE: 15/09/04.

| *Detail any Documents that needs to be updated/ amend due to this change* | | | |
|---|---|---|---|
| | *Tick If required* | | *Tick If required* |
| *Piping and Instrumentation Diagrams* | ✓ | *Equipment Spec/Data Sheet* | |
| *Process Flow Diagrams* | | *Line List/Schedule* | ✓ |
| *Operating Procedures* | | *List of Alarm and Trip Settings* | |
| *Start-up Procedures* | | *Narrative Safeguarding by Instrument* | |
| *Shut-down Procedures* | | | |
| *Others Please specify the document:* | | | |

| *Detail any person (group of persons) that may need to be trained or informed of the change* | | | |
|---|---|---|---|
| *PSD Electrical* | | *PSD Rotary* | |
| *PSD Instrument* | | *Inspection* | ✓ |
| *PSD Mechanical* | ✓ | *Others. Please specify the group or person:* | |
| *PSD Civil* | | | |

### *INSTRUCTIONS :*

*All boxes in the checklist shall be checked yes/no and additional concerns shall be recorded. If a question is not applicable, the relevant box(s) in the checklist shall be marked N/A.*

Record Any Recommendations/ issues that the review has raised

| ISSUE | Personnel accountable for close out | Date Due | Date Completed | Initialled |
|---|---|---|---|---|
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***Note - If more space is required attach a separate sheet**

| PRE-STARTUP SAFETY REVIEW CHECKLIST Rev A | | | |
|---|---|---|---|
| Procedure No. | Issue | Approve Date | 14/01/04 |
| CAF-SUP-010 | Rev 0 | Approved by | Plant Manager |

Prior to startup of new facilities or facilities which have undergone changes or modifications which are significant enough to change the process safety information relating to those facilities, the following evaluation must be completed.

| | | |
|---|---|---|
| **PROJECT TITLE:** | inlet naphta line pipe schedule increase | |
| **CAF NO:** | **REVIEWER:** | **DATE:** 17/09/04. |
| **PROJECT (PIN) NO:** | **PSSR Leader (CRP):** Johan | |

**NOTE: Any "no" response to the questions listed below must be explained in "remarks" and must be noted in post accountability.**

1. The following drawings affected by the change must be red-lined for field use prior to startup. Record drawing numbers in "remarks".

| | | |
|---|---|---|
| Process flow sheets | Complete ____ | N/A ✓ |
| P&ID's | Complete ✓ | N/A ____ |
| Instrument drawings | Complete ____ | N/A ✓ |
| Electrical trouble shooting drawings | Complete ____ | N/A ✓ |
| Sewer/underground | Complete ____ | N/A ✓ |

Remarks: _____

2. Have the red-lined drawings identified in "1" above been submitted to drafting for updating in accordance with Management of Change Policy?
Yes ____ No ✓ N/A ____

Remarks: To be submitted by 30 sept 2004.

3. Has applicable supporting documentation been completed and attached to the Design Documents? (Examples: Orifice Calculations Form, ProcessInformation, etc.)
Yes ____ No ____ N/A ✓

Remarks: _____

4. Have equipment files been updated per Process Safety Information requirements?
Yes ✓ No ____ N/A ____ Equipment. No. __ - _____

Remarks: _____

5. Have the alarm listings and critical prooftest procedures been developed or updated per Process Safety Information Requirements?
Yes ____ No ____ N/A ✓

Remarks: _____

6. Have Operating Procedures and training materials been reviewed and revised as necessary?
Yes ____ No ____ N/A ✓