Development of Employee Participation Model Based on OSHA Process Safety Management (PSM) Requirement

by

SHAZWANI BINTI AZMI

14919

Dissertation submitted in partial fulfillment of

the requirements for the

Bachelor of Engineering (Hons.)

(Chemical Engineering)

JANUARY 2015

Universiti Teknologi PETRONAS

Bandar Seri Iskandar

32610 Seri Iskandar

Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

Development of Employee Participation Model Based on OSHA Process Safety Management (PSM) Requirement

by

SHAZWANI BINTI AZMI

A project dissertation submitted to the

Chemical Engineering Programme

Universiti Teknologi PETRONAS

in partial fulfillment of the requirement for the

BACHELOR OF ENGINEERING (Hons.)

(CHEMICAL ENGINEERING)

Approved by,

_____

(DR. DZULKARNAIN ZAINI)

UNIVERSITI TEKNOLOGI PETRONAS

SERI ISKANDAR, PERAK

JAN 2015

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 contained herein have not been undertaken or done by unspecified sources or persons.

_____

SHAZWANI BINTI AZMI

ABSTRACT

US Occupational Safety and Health Administration (OSHA) developed a program called Process Safety Management (PSM) due to the increasing major accidents in the process industries which has resulted in the losses of life, monetary and asset, as well as pollution to the environment. The PSM program has been regulated in many countries such as US and Europe. In Malaysia, the regulation related to PSM is still under review and many companies such as PETRONAS have implemented voluntarily. PSM covers 14 elements under the OSHA 29 CFR 1910.119. Employee Participation provides the means through which workers develop and express their own commitment to safety and health, for both themselves and their fellow workers. Currently, an employee participation model that complies with PSM regulation requirement is not available in open literature. The main goal of the research is to develop a prototype model for employee participation that complies with PSM regulation. The framework is developed based on PSM OSHA 29 CFR 1910.119(c) and piping and instrumentation diagram (P&ID) is used as a platform for the development of the model. The model is programmed using Microsoft Access and verified with the data from participation of the employer and employees for one of the PSM element that is Emergency Response Plan (ERP) at Plant X in Malaysia. The developed prototype could be extended for the development of full model in order to suit with the need of industries and also to comply with PSM regulation requirement.

ACKNOWLEDGEMENT

First and foremost, all praises to The Almighty Allah S.W.T as for His Mercy and grace, I was able to complete my Final Year Project at Universiti Teknologi PETRONAS. I would like to seize this opportunity to thank all parties who have contributed along the project's journey.

A special acknowledgement and gratitude is expressed to my supervisor, Dr. Dzulkarnain Zaini for his guidance and assistance throughout the period of the research study. His advices and input of knowledge into this research is certainly priceless, and thank you once again Dr. Dzulkarnain for your valuable time despite your busy schedule.

Besides, a special credit is delivered to Noor Diana Abd. Majid for her valuable experiences and also technical knowledge who has been a good mentor throughout the research. Her insight and comments have been very beneficial and has improved this project remarkably.

Special thank is conveyed to FYP coordinators for their efforts in organizing this course and for their generosity in providing all the facilities for students to ease the process flow of the project throughout the 2 semesters. A heartfelt appreciation is extended to Zackaria Abdulah and his team at Plant X in welcoming us warmly to conduct our case study. Sincere appreciation also to my family and colleagues for being supportive and giving help during the research period.

Lastly, sincere gratitude to the lecturers from Chemical Engineering Department of Universiti Teknologi PETRONAS who have been supportive. Thank you once again.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 Background of Study

Any kind of unexpected release of highly toxic, reactive and flammable in gaseous or liquid form in the process can cause a possibility of a major disaster to occur (OSHA, 2000; Hendershot, 2009). The unplanned releases of hazardous chemicals have been around for years in the process industries and cause the occurrence of various incidents to happen. The incidents result in the loss of life, monetary and also potential impact to the environment (OSHA, 1992, 2000).

A number of major disasters in 70s, 80s and 90s in the process industries such Flixborough, England (1974), Bhopal, India (1984), Phillips Petroleum Company, Pasadena, Texas (1989) and BASF, Cincinnati, Ohio (1990); has initiated the introduction of stringent process safety regulation (OSHA, 1992; Joseph et. al., 2005). In 1992, US Occupational Safety and Health Administration (OSHA) issued the "Process Safety Management of Highly Hazardous Chemicals" (29 CFR 1910.119) standard to help ensure a safe and healthy workplace. In the standard, it contains the requirements for the management of hazards associated with processes using highly hazardous chemicals in the process industries that also integrate technologies, procedures and management practice.

OSHA PSM 29 CFR 1910.119 comprises of 14 elements that is implemented in process industries to manage highly hazardous chemicals which is listed as Appendix A in 29 CFR 1910.119 (OSHA, 1992). The 14 elements of PSM are employee participation, process safety information, process hazard analysis, operating procedures, training, contractors, pre-startup safety review, mechanical integrity, hot work permit, management of change, incident investigation, emergency planning and response, compliance audit and trade secrets (Mason, 2001a, 2001b).

Employee Participation, also refer as Workforce Involvement was place the first out of the 14 PSM elements by OSHA. Employee Participation plays a vital role in PSM

as the involvement of all employees at every level is fundamental to the success of such program.

1.2 Problem Statement

Even though, industries are aware on the importance of employee participation in PSM program, however they are not clear on the coverage and the best way to implement according to the need of PSM OSHA 1990.119(c) requirement. PSM OSHA regulation does not provide any specific technique for industries to follow and how detail the evidence should be provided as a proof of compliance. Open literatures regarding the technique, model and tool for employee participation to ensure significant contribution of process safety and ensure PSM compliance are very scarce. There is clearly lack of proper system or model for employee participation that could be easily used by the industry to ensure compliance with PSM regulation.

1.3 Objective

The objectives of this project are:

1. To develop framework of employee participation according to Process Safety Management (PSM) regulation.
2. To develop employee participation model that could be used by the industry based on the developed framework.
3. To utilize the model and validate using case studies from real process plant data.

1.4 Scope of Study

The scope of study of this project includes:

1. The framework is developed based on Occupational Safety and Health Administration (OSHA) PSM 1910.119 (c).
2. The developed model is for the purpose of prototype and programmed using Microsoft Access 2010.

3. P&ID is used as a platform to guide for PSM compliance.
4. The case study is from the participation of the employer and employees for Emergency Response Plan (ERP) at Plant X.

1.5 Relevancy & Feasibility of the Project

This project is relevant to the process industries as the results from this project can be utilized by the industries to enhance the Process Safety Management system. The implementation of developed technique for employee participation element of PSM could help industries to comply with PSM 1910.119 (c) requirements. Nevertheless, a clear participation of employee that following the PSM regulation and standard could reduce the frequency of accidents in the workplace and perhaps to prevent the world's worst industrial disaster involving life of workers like one that occur in Bhopal, India.

CHAPTER 2: LITERATURE REVIEW

2.1 Defining Employee Participation

Employees at all levels and positions have diversity of roles, responsibilities, knowledge and expertise which capable to fulfill process safety management system development, implementation, and enhancement to ensure the safety of the organization's operation. However, there is lack of participation from employees as they may not be aware of all their opportunities to contribute (CCPS, 2007).

In response to the US's Clean Air Act Amendments (CAAA) enacted in 1990, OSHA issued the Process Safety Management (PSM) of Highly Hazardous Chemicals standard in 1992. Section 304 of the CAAA states that employers are to consult with their employees and their representatives in the development and implementation of the PSM program elements and hazard assessments. In addition, Section 304 also required employers to train and educate their employees and to inform affected employees of the findings from incident investigations required by the PSM program (Martineau & Novello, 2004). These requirements of Section 304 CAAA are issued in OSHA 1910.119(c) under Employee Participation. Employee Participation standard in OSHA PSM 1910.119(c) is intended to provide active participation and essential flow of information between management and employees on process safety to eliminate or mitigate the consequences of catastrophic releases of highly hazardous chemicals in the workplace.

2.2 OSHA 29CFR 1910.119 (c): Employee Participation

2.2.1 OSHA 29CFR 1910.119 (c)(1)

Employers are required to prepare a written plan for employee involvement. No specific documentation of employee involvement beyond that specified in the written plan which the degree of employee participation should be evident in such PSM documentation as PSM reports and minutes of safety meetings. The plan must address the minimum requirements for consultation on the development of PHAs and other PSM elements. It must also address worker access to PHAs, PSI, and all other documentation developed under the PSM Rule (DOE, 1996).

2.2.2 OSHA 29CFR 1910.119 (c)(2)

OSHA expects employers to consult with employees and their representatives on each PSM element (including development of employee participation plan). Employees with a working understanding of chemical process should serve as informational resources in the development of chemical process accident prevention plans, the performance of PHAs, and the conduct of incident investigations and audits. As a minimum, employees and representatives must be consulted (i.e., information

exchanged and input solicited). The effectiveness of PSM programs depends on the employers' and employees' sense of ownership and accountability. Accountability in this context is the obligation of an individual or organization to account for its activities, accept responsibility for them, and to disclose the result in a transparent manner. Management commitment at all levels is necessary for PSM to be effective. The objectives of accountability are to demonstrate the status of process safety compared to other business objectives (e.g. production and cost), to set objectives for safe process operation and to set specific process safety goals. These objectives should be internally consistent i.e. supported by appropriate resources (DOE, 1996).

The key components for accountability are:

1. Continuity of operations
    - To avoid compromising process safety, continuity of operation is best addressed at the planning stage by features such as:
        - spare and redundant equipment,
        - multi-train rather than single stream operations,
        - independent capability to shut down small sections of the plant, etc.
2. Continuity of organization
    - Accountability should be flexible enough to accommodate changes in organizational structure while ensuring that process safety tasks are properly assigned and performed throughout the change.
3. Quality process
    - Process safety problems can be seen as non-conformance with specifications, and many of the techniques used to establish systems for quality can be applied to control process safety performance.
4. Control of exceptions
    - Variance procedures should allow expectations to be managed with appropriate controls by assigning accountability to qualified personnel.

5. Management accessibility & communication
    - Senior managers and accountable to be accessible for guidance on process safety decisions, and for resolving conflicting views among safety.
    - Include communication of the understanding on process safety accountability and coordination of overlapping responsibilities between individuals/ units to ensure no gaps occur.
6. Company expectations
    - Establish broad process safety goals which include both philosophical issues & detailed targets.
    - Decision-making process should be driven by safety culture rather than by ad hoc/ reactive solutions.
    - Metrics should be established to monitor performance and compare results with design intent.

2.2.3 OSHA 29CFR 1910.119 (c)(3)

Access under the PSM Rule means that information must be made available for employees and their representatives in a reasonable manner. Reasonable access may require loaning documents or placing copies in more convenient places (DOE, 1996).

2.3 Implementation of Employee Participation

According to CCPS (2007), implementation of Employee Participation usually consists of:

1. Identification of additional mutual roles that employees can and should play in the implementation of PSM and
2. The establishment of mechanism to facilitate this participation.

However, detail implementation of PSM participation is not available in the open literature. The closest literature published for the employee participation is from United Kingdom Health and Safety Executive (UKHSE) (2001). Table 1 below shows the lists

of general areas of activity in which employee participation could be implemented as suggested by UKHSE, 2001.

Table 1: UK HSE Employee Participation Suggestion

Policy	Employee Participation in development or review of policy statement.
Organizing	
Control	Giving employees specific health and safety responsibilities.
Communication	Employees are involved in delivering health and safety responsibilities.
Competence	Employees are involved in design and delivery of training.
Cooperation	Structure of safety committees. Suggestion schemes.
Planning	
Objectives/plans	Employees are involved in setting health and safety plans/objectives.
Risk Assessments	Employees participate in risk assessments.
Procurement	Employees are involved in the procurement of equipment, materials, etc.
Design	Employees help design new ways of working.
Problem Solving	Employees are involved in problem solving.
Operation of risk control systems	Employees are involved in planning risk control systems.
Measurement	
Active monitoring	Employees assist in carrying out inspections, observations, etc.
Reactive monitoring	Employees participate in accident and near miss investigations and hazard spotting.
Audit and Review	Employees participate in audit of the efficiency, effectiveness, and reliability of the health and safety system and in systematic reviews of performance, based on data from monitoring and audits

2.4 Key Principles of Employee Participation

The following are key principles stated by CCPS that should be address when developing, evaluating, or improving any management system for employee participation element:

2.4.1 Maintain a dependable practice

A company wants any activities or jobs to be performed properly and consistently throughout the life of the facility. The following are some essential features that need to be considered for employee participation practice to be executed dependably across a company or facility:

1. **Ensure consistent implementation**

   In order to ensure consistent implementation, the employee participation program should be documented in details and addressing the general management aspects. All the activities in each PSM element should be identified and documented in element-specific program documentation for employees to be involved in the design, development, implementation, and continuous improvement of the element.

2. **Involve competent personnel**

   All employees in a company should have basic awareness of employee participation program to enable them to interact with it and contribute to it. This awareness can be maintained through periodic reminders within employee safety and information meeting. For ensuring active participation of employees in PSM

element, it is important for the employees to understand their personal responsibility.

2.4.2 Conduct work activities

1. **Provide appropriate inputs**

   Some of the inputs to the employee participation program are the suggestion form, and active participations of, employees in the design, development, implementation, and continuous implementation, and continuous improvement of the PSM element. Written plan documentation should, at a minimum, identify opportunities for employee participation that are required by corporate or regulatory requirements.

2. **Apply appropriate work processes and create element work products**

   Employee participation work practices and products will be specific to the various elements. The resulting work product(s) could be the revised procedure and the records of the submitted suggestion and its resolution.

2.4.3 Monitor the system for effectiveness

1. **Ensure that the employee participation practices remain effective**

   Once the employee participation program is completed, periodic monitoring, maintenance, and corrective action will be needed to keep it operating at peak performance and efficiency. In enhancing the effectiveness of specific PSM elements, a carefully selected set of relevant metrics should be identified for monitoring the role of employee participation.

2.4.4 Actively promote the workforce involvement program

1. **Stimulate employee participation**

   The employee participation program cannot achieve its intended goals without active participation from employee in PSM elements. In order to stimulate such participation, initial initiatives may be required. This may be particularly true for

organizations that are lack in a tradition of seeking or accepting worker input or whose past management support for safety programs has been weak.

2. **Adopt new employee participation opportunities**

   A list of tasks included in the program documentation is unlikely to comprehensively address all opportunities for employee participation in the design, development, implementation, and improvement of the RBPS management system. As the culture matures, new opportunities for employee participation may be created or otherwise become apparent. The employee participation program should be sufficiently flexible to embrace such opportunities as they are identified.

3. **Publicize the success of employee participation program**

   Sharing the results from the implementation of the employee participation program should help stimulate worker interest in participation. Demonstrating the positive benefits yielded by the program should illustrate both a return on the investment of effort made by employee participation and receptivity of management to the involvement of workers in PSM system.

2.5 Industrial Case Accidents Related to Employee Participation Issues

2.5.1 Fire at Refinery Plant in Sunray, Texas

Figure 1: Fire in Sunray, Texas

Hardy (2013) summarize on a fire that occurred on 16 February 2007 at a refinery plant in Sunray, Texas which resulted from issues related to employee

participation. The fire resulted in extensive damage to the facility and four employees were injured. The major contribution for the accident is the cracked of unused pipe for about 15 years that lead to the leaked of liquid propane. Apart from that, an isolation valve was leaked causing the pipe poorly isolated. According to U.S. Chemical Safety and Hazard Investigation Board (CSB) in its accident investigation report, the cracking of the pipe is due to the accumulation of water in the low portion of the pipe that froze during cold weather. The propane in the pipe expanded when the outside temperature warmed, vented out of the crack and ignite. As the remotely operated valves had not been installed, the operator are unable to shut the flow of propane thus made the fire became worse. The CSB blamed the refinery's hazard analysis processes and its freeze protection process. The CSB identified several aspects of the hazard analysis that led to the failure to identify the potential for a "dead leg" that led to freezing, and did not identify the need for remotely operated valves. Moreover, the CSB found that the hazard analysis was not involve the operator of the facility and only performed by a contractor. This failure to involve the personnel running the facility may have led to the failure to uncover these hazards. Lastly, there was no hazard tracking process prepared to follow up on recommendations made as part of the hazard analysis process.

2.5.2 Toxic Release at DuPont Belle

Figure 2 : Toxic Release at DuPont Belle

A release occurred at DuPont facility in Belle, West Virginia on 23rd January 2010 exposing a veteran operator which results in his death one day later. DuPont officials told the CSB that a braided steel hose connected to a one-ton capacity phosgene tank suddenly ruptured, releasing phosgene into the air. An operator who was exposed to the chemical was transported to the hospital, where he died the following day. The phosgene release followed two other accidents at the same plant in the same week, including an ongoing release of chloromethane from the plant's F3455 unit, which went undetected for several days, and a release from a spent sulfuric acid unit. The plant announced over the weekend that it would be shutting down a number of process units immediately for safety checks. The CSB is also investigating a November 2010 accident at the DuPont facility outside Buffalo, NY, that fatally injured one worker.

The CSB investigation found common deficiencies in DuPont Belle plant safety managements systems springing from all three accidents: maintenance and inspections, alarm recognition and management, accident investigation, emergency response and communications, and hazard recognition. The CSB found that each incident was precede by an event or multiple events that triggered internal incident investigations, which then issued recommendations and corrective actions. But this activity was not sufficient to prevent the accident from recurring. The CSB recommended that the facility revise its near-miss reporting and investigation policy to emphasize anonymous participation by all employees so that minor problems can be addressed before they become serious (CSB, 2011a). The CSB report also recommends the Belle plant ensure that its computer systems will provide effective scheduling of preventive maintenance to require, for example, that phosgene hoses get replaced on time (CSB, 2011b).

2.6 OSHA Employee Participation Inspection

Appendix A shows an example of the checklist used by OSHA officials when inspecting a plant for compliance with the PSM Standard related to Employee Participation. The checklist helps the employer to identify the gaps of their employee participation system for improvement.

CHAPTER 3: METHODOLOGY

3.1 Research Methodology

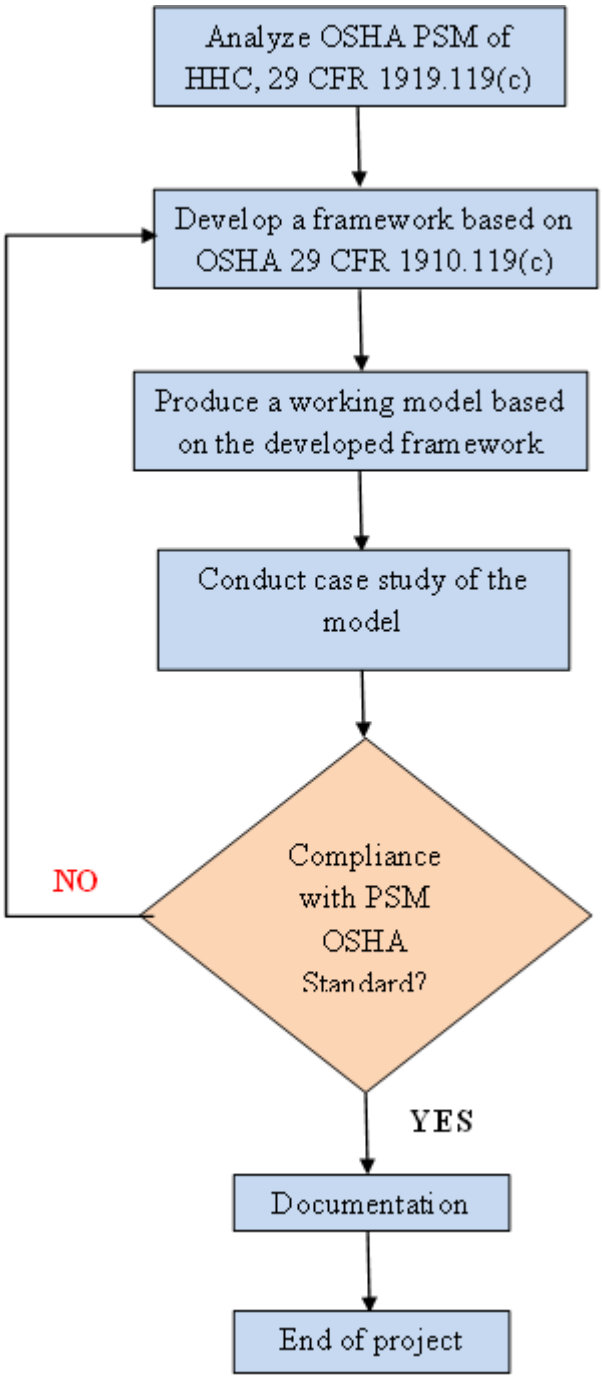


Figure 3: Flow Chart of Research Methodology

Figure 3 shows the flow of conducting this study. The framework of Employee Participation is develop based on Occupational Safety and Health Administration (OSHA) Process Safety Management (PSM) of Highly Hazardous Chemicals (HHC), 29 CFR 1910.119(c). The framework provides a basis on the steps to conduct employee participation of PSM. The employee participation model is developed using Microsoft Access. The model is analyzed and validated using case study from the data provided for Emergency Response Plan (ERP) at Plant X to check the effectiveness of the model. The Plant X is used as the plant gave the permission to use the plant data related to this project only and did not allow to reveal the name of the plant. The model focuses to make it user-friendly and effective in performing employee participation for PSM. The model is in the form of a computer database for manual checklist. In addition, the model allows process industries to check for the gaps and provide recommendations to close the gaps related to employee participations. Therefore, the process industries could benefit in terms of a successful implementation of process safety management program while preventing major disaster such as fire, explosion and unplanned release of toxic materials due to issues related to employee participation.

3.2 Tools/ Software

Microsoft Access 2013:

Microsoft Access, also known as Microsoft Office Access, is a database management system from Microsoft that combines the relational Microsoft Jet Database Engine with a graphical user interface and software-development tools. It is a component of the Microsoft Office suite of applications, included in the Professional and higher editions or sold separately. Microsoft Access stores data in its own format based on the Access Jet Database Engine. It can also import or link directly to data stored in other applications and databases.

3.3 Project Activities

The project activities must be accomplished in order to meet the objective of this project, which is represented in Figure 4.

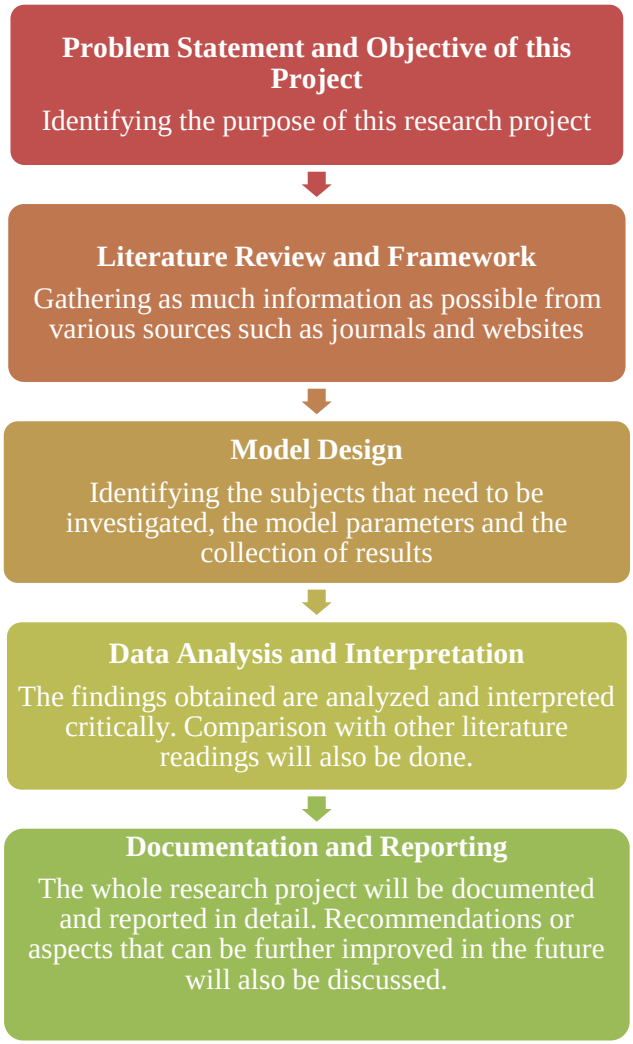


Figure 4: Project Activities

3.4 Gantt Chart and Key Milestone

Table 2: Gantt Chart and Milestone for FYP1

Activities	Week No													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Selection of Project Topic														
Preliminary Research														
Familiarize and identify Employee Participation OSHA requirements														
Study incidents related to Employee Participation to identify gaps														
Familiarize with existing techniques or framework														
Identify gaps or improvement methods														
Submission of extended proposal														
Proposal Defense														
Develop Employee Participation Framework & familiarize with Access software														
Learn from previous model developed														
Develop finalized Employee Participation framework in comliance with PSM System														
Submission of draft interim report														
Submission of interim report														

Table 3: Gantt Chart and Milestone for FYP2

Activities	Week No													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Develop Access model based on Employee Participation framework created														
Test run model and collect data for analysis														
Diagnosis and trobelshooting														
Testing and diagnose of feasibility of prototype														
Submission of Progress Report														
Remodelling and retesting of data														
Finalizing model final data collection and comparison														
Pre-Sedex														
Submission of Draft Final Report														
Submission of dissertation (soft bound)														
Submission of Technical Paper														
Viva														
Submission of dissertation (hard bound)														

Gantt Chart

Key Milestone

CHAPTER 4: RESULT AND DISCUSSION

4.1 Employee Participation Framework

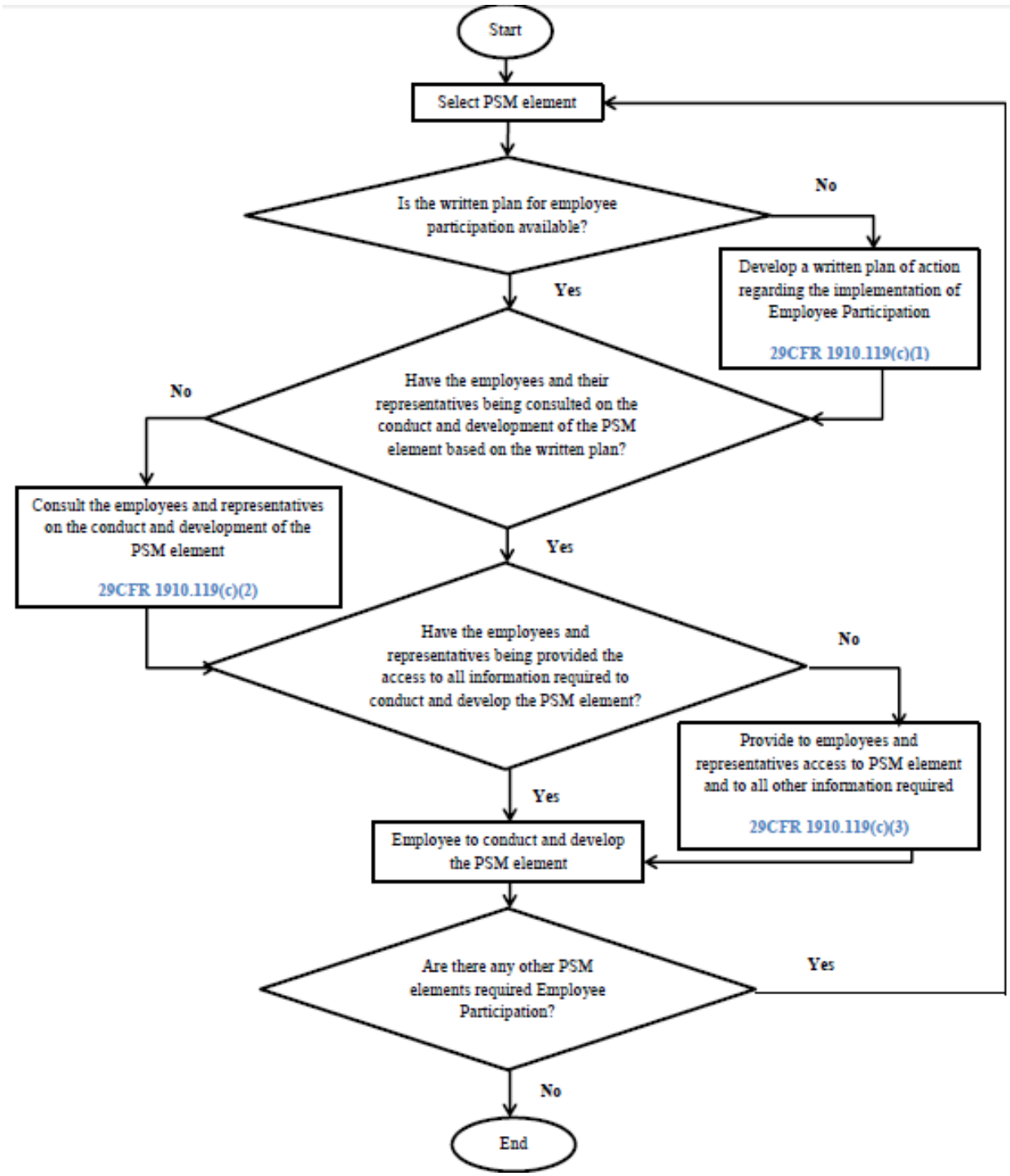


Figure 5: Employee Participation Framework

4.2 Framework Description

Figure 5 shows the Employee Participation framework that was developed based on the interpretation of OSHA 29 CFR 1910.119(c). The Employee Participation element involves 3 main principles, with the first one requires written plan of action of Employee Participation (**29 CFR 1910.119(c)(1)**), the second is to consult the employees and representatives on the conduct and development of PSM element (**29 CFR 1910.119(c)(2)**), and lastly the third is to provide access to all information required to conduct and develop the PSM element to the employees and representatives (**29 CFR 1910.119(c)(3)**).

The implementation of Employee Participation begins with selecting the PSM element to be developed. The Employee Participation documentation may need to be developed for all 13 other elements that are process safety information, process hazard analysis, operating procedures, training, contractors, pre-startup safety review, mechanical integrity, hot work permit, management of change, incident investigation, emergency planning and response, compliance audits and trade secrets.

Once the PSM element has been selected, the employer needs to check the availability of the written plan. If the written plan is not available, the employer needs to develop the written plan of action on how the employee can perform the task of actions for the selected PSM element. The written plan should also include employee involvement on the conduct and development of PSM element. The next step is the employer to provide the employee on the method of consultation on the conduct and development of PSM element based on the provided written plan. The active employees' participation in all elements through consultation will enhance the overall PSM program. The last principle is to allow the employees and the representatives on the access to all information that deem necessary to conduct and develop the PSM element. The PSM standard requires employees to have the access to all information and materials for the development of PSM element.

Once the employee participation requirements based on the three main principles of Employee Participation have been accomplished, employees can start to develop and

conduct the PSM element. The cycle continues until the requirements of Employee Participation element have been developed and conducted to all other PSM elements.

4.3 Use of Piping and Instrumentation Diagram (P&ID) for Employee Participation

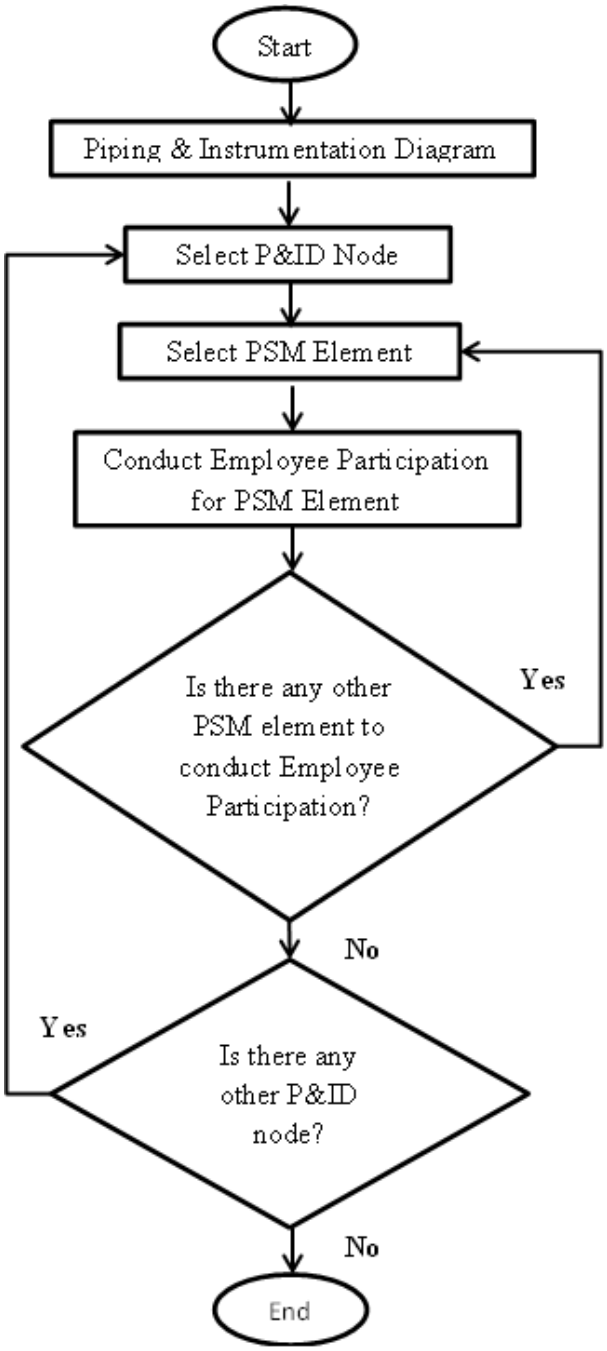


Figure 6: P&ID as a platform for the implementation of Employee Participation

Piping and Instrumentation Diagram (P&ID) contains schematics for all equipment, piping, valves, various components such as pneumatic air lines and control mechanisms such as control valves. It provides an additional level of detail for the design of a process plant. P&ID is commonly used by people in the plant as a major reference for example whenever problem occurs or for training purposes. The P&ID is used as a platform to conduct and manage the information and documentation of employee participation in a more structured manner. P&ID is also used as a platform to develop the employee participation model. Thus, P&ID is useful as it contains information that is essential to develop an employee participation written plan of action and could also be easily implemented in a process plant.

Following the concept of HAZOP, P&ID can be divided into nodes. The number of nodes is depending on how big the process plant which normally reflecting the number of equipment and its auxiliary components. Commonly, bigger the process plant will have more P&ID. It is common to have hundreds of P&ID for one process plant. Thus, it is appropriate to divide the P&ID into smaller groups known as nodes to develop, conduct and manage the Employee Participation element easily. Referring to Figure 6, once the node has been selected, the development and conduct of the Employee Participation for the selected PSM element can be initiated. The implementation of employee participation element involves preparing a written document for ease of consultation on the conduct and development of PSM element as well as to provide active participation of employees. The use of P&ID nodes also helps the users to easily trace the experts who have help in the conduct and development of PSM element. The active participation of employees can be achieved as employees provide detail information on the roles and responsibilities in accomplishing the conduct and development of PSM element for certain nodes from P&ID. The process is repeated in the same node until all the PSM elements have been selected for the conduct of Employee Participation. After Employee Participation has been developed and conducted for all PSM elements within the node, then another node from the P&ID will be chosen. The cycle continues for each node for the corresponding P&ID.

4.4 Development of Employee Participation Model

4.4.1 Employee Participation Preliminary Model Using Microsoft Excel 2010

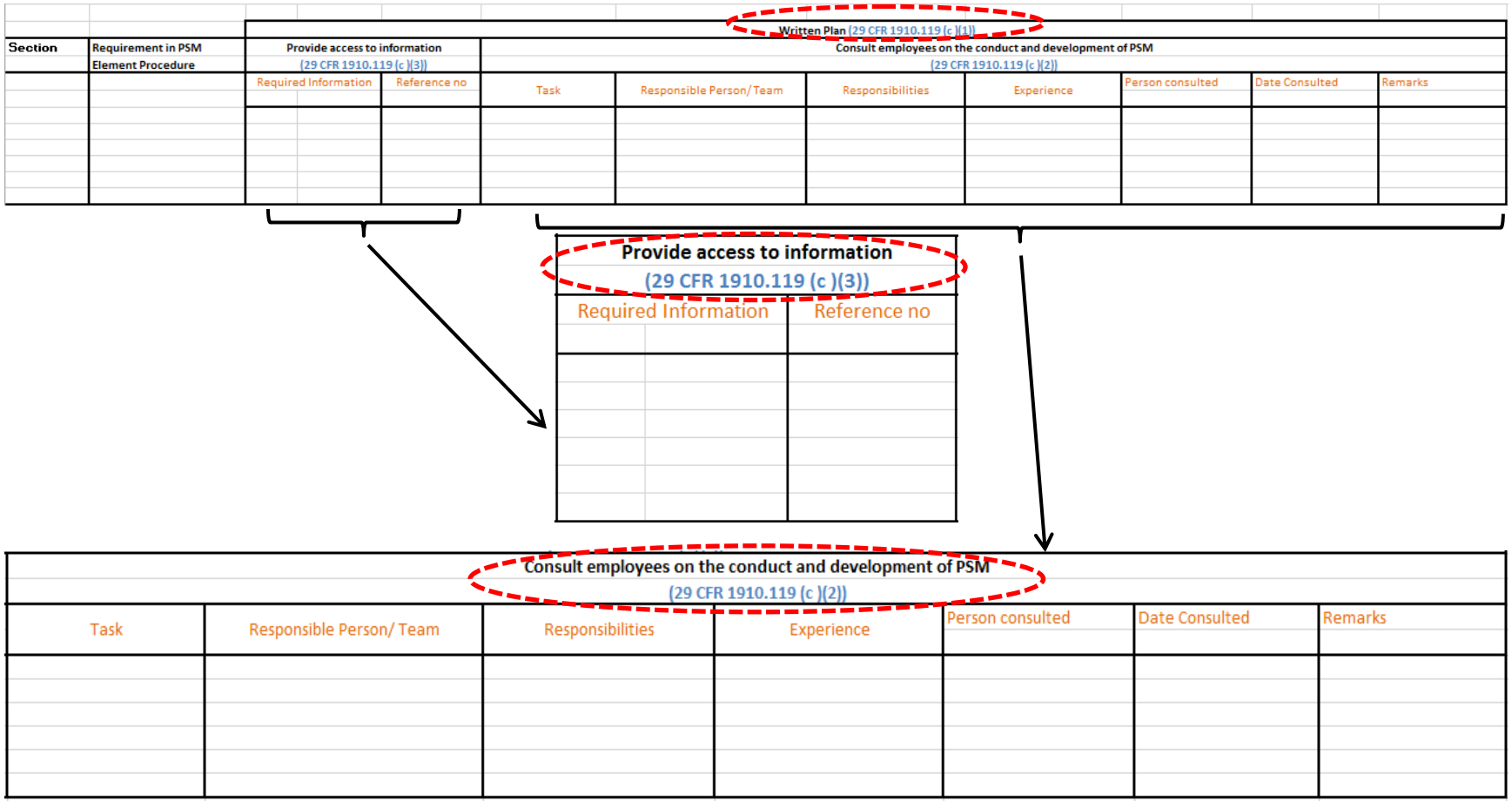


Figure 7: Preliminary Model of Employee Participation

The implementation of the usage of P&ID as a basis for employee participation can be further strengthen by the use of model to manage the participations and responsibilities for every level of employees in an organization. The use of computer database software can be utilized for the said purpose.

The function of the employee participation model is as following:-

i. To evaluate the participation of employees and to provide consultation in every PSM program.
ii. To provide access of information to employers and employees.
iii. To ease the Employee Participation auditing process.
iv. To provide proper documentation of data in database and tracking of information.
v. To ease the process of identifying and closing the gaps in Employee Participation program.

Microsoft Excel can be used as a medium for the development of Employee Participation Model to generate a general idea before it was transfer to a more convenience database software, Microsoft Access. Figure 7 shows a preliminary model for Employee Participation that was developed based on the Employee Participation framework (refer figure 5). The preliminary model shown in Figure 7 is for the prototype purpose to verify the effectiveness of the developed framework to ensure the compliance to the OSHA requirement. Once the model has been verified, actual model is developed using Microsoft Access 2013. Process Hazard Analysis (PHA) has been chosen for the validation of the preliminary model (refer Appendix B and C). Appendix B shows PHA framework that is used as a basis for validating the preliminary model of Employee participation in order to check all requirements of PHA are met.

The general Employee Participation model for Employee Participation consists of 'Section', 'Requirement in PSM Element Procedure' and 'Written Plan (**29 CFR 1910.119(c)(1)**)' columns. The 'Written Plan (**29 CFR 1910.119(c)(1)**)' is further divide into 'Provide access to information (**29 CFR 1910.119(c)(2)**)' and 'Consult employees on the conduct and development of PSM (**29 CFR 1910.119(c)(3)**)'. By further divide

this written plan, all the requirements to conduct Employee Participation can be accomplish.

'Provide access to information (**29 CFR 1910.119(c)(2)**)' contain subsection of 'Required information' and 'Reference no'. In this section, all the information needed in the process of conduct and development of PSM element is provided to employees together with the reference number for particular information for ease of referencing.

Under the 'Consult employees on the conduct and development of PSM (**29 CFR 1910.119(c)(3)**', there are 7 subsections which are 'Task', 'Responsible person/ team', 'Responsibilities', 'Experience', 'Person Consulted', 'Date Consulted' and 'Remarks'. By assigning who responsible for specific task and stated their responsibilities, employees will be aware of their opportunities to contribute for enhancing and ensuring the safety of the organization. Hence, active participation of employees can be achieved. Besides, defining the responsibilities of employees will also ease the employers to provide consultation.

4.4.2 Employee Participation Model Using Microsoft Access 2013

The model takes into account on the requirement for employers and employees to commit to the OSHA PSM Employee Participation Standard. The model is designed to ensure that the participation of employees in every activities are kept in systematic manner for the ease of consultation and tracking of information. The model is divided into two parts which is Main Interface showed in Figure 8 and Data Collection showed in Figure 9.

Main Interface:

The main interface provide the user an overview of the Employee Participation based on the requirements set upon by OSHA PSM Standard 1910.119 (c) where stated that there are 3 requirements to be considered. Moreover, this functions provides an initial understanding to the end user before they start key in the data to the Employee Participation Model.

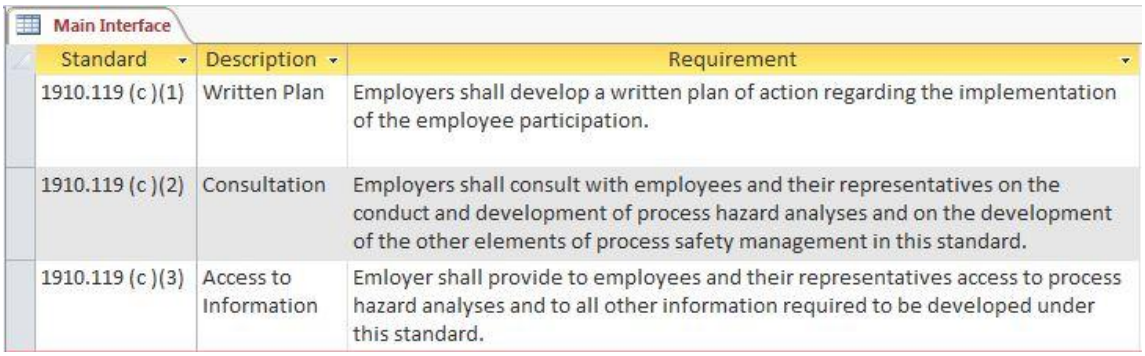


Figure 8: Main Interface of Employee Participation Model

Data Collection:

The employee participation data is needed to gauge whether the PSM element comply with the OSHA PSM standard. The user of the model will have to input the employee participation findings into the model to enable the data is recorded and stored in the model. This will centralize the collection of the data and could help to manage the data systematically. This data collection refers to information of the previous employee participation review and to assist user to plan on which element that will need to conduct the review on employee participation. The model for data collection as shown in Figure 9 consists of 'Standard', 'PSM Element', 'Requirement based on Employee Participation', 'Compliance?', 'Complete?', 'Date of Completion', and 'Remarks' section.

The 'PSM Element' section with specific 'Standard' shows the 9 elements out of 14 elements in OSHA PSM that required for an employee participation review. According to (DOE, 1996), employee participation is not required for all PSM elements, just where the involvement of employee is relevant. The user could click each of the PSM elements in blue colour in this section where there is hyperlink that will navigate the user to the 'Main Menu of the PSM element' to conduct the review. The 'Requirement based on Employee Participation' is to direct the user on which area to focus in when doing the review for specific element. The 'Compliance?' is also important as to gauge on whether the element comply with OSHA PSM standard. If an element does not satisfy the requirements set upon, it is needed to determine the

deficiencies or gap in the implementation of employee participation in the element of PSM program. There is also ‘Completion Date’ section to show when the previous reviewed had been completed and to remind the user to keep the model up-to-date. As it is not stated in OSHA requirement on how often to conduct the review, it is proposed that the review is done every 3 years to keep track with the audit process which is done every 3 years. Lastly, there is also ‘Remarks’ section to marks any gaps in each PSM element. If the gaps is found to be critical, and in need of immediate rectification, the review team can suggest on a scheduled date for rectification to avoid any potential accident to occur.

Main Interface | Data Collection

Standard	PSM Element	Requirement based on Employee Participation	Compliance?	Complete?	Date of Completion	Remarks
1910.119 (e)	Process Hazard Analysis	Employees participate on the PHA team or in support of the analysis effort. Employees are advised of any necessary changes brought about by the PHA and may be involved in the design and implementation of required changes.	☐	☐		
1910.119 (f)	Operating Procedure	Employee involvement in the development and implementation of operating, maintenance, and safe work practice procedures may take several forms.	☐	☐		
1910.119 (g)	Training	Employees may be involved through self managing learning, coaching new employees, working with training guides, and one-on-one, on-job training in the field.	☐	☐		
1910.119 (l)	Pre-Startup Safety Review	Whenever possible, cognizant employees will be involved in the performance of PSR.	☐	☐		
1910.119 (j)	Mechanical Integrity	Employee typically providing input for equipment history and reliability; recording observed data; maintaining the inspection and maintanences database. Employees take part in equipment failure reviews, participate in work progress critiques, and are encourage to make recommendation for change.	☐	☐		
1910.119 (k)	Hot Work Permit	Employees are involved planning and implementing safe work procedures documented in hot work permits and other nonroutine work authorizations.	☐	☐		
1910.119 (l)	Management of Change	Essential to the success of MOC system is the active participation by both site and affected subcontractor employees in the review and evaluation process to determine the impact of proposed changes.	☐	☐		
1910.119 (m)	Incident Investigation	The team investigating the incident shall consist of at least one person knowledgeable in the process involved; a contract employee, if a subcontractor was involved; and other cognizant and informed individuals. Employees are ususally involved in incident investigations since their knowledge and skills in operations or maintanence are necessary for the conduct of the investigation.	☐	☐		
1910.119 (n)	Emergency Planning and Response	Employees may critique drills and actual incidents to identify opportunities for performance improvememts, and improve both emergency response planning and responder performance.	☑	☑	2/20/2015	Lack of information regarding employees experience to be involved in specific activity conducted.

Figure 9: Data Collection of Employee Participation Model

4.5 Case Study – Validate Model

The best way to validate the feasibility of Employee Participation model is by implementing it in a process plant. Thus, a case study was conducted using a real data from a local oil and gas refinery in Malaysia, named as Plant X for confidential purposes. The proof of the model concept is via prior PSM element studied in Plant X. To demonstrate the employee participation model concept, a PSM element have been selected which is the Emergency Response Plan (ERP).

Referring to figure 6, P&ID is used as a platform for the implementation of Employee Participation. Thus, Figure 10 shows the P&ID for Plant X that is being used as a case study to testify the model. The P&ID is divided into several nodes, and node 1 has been selected for this case study. Node 1 represent a storage tank labelled T-3280. Figure 11 basically shows the location of tank T-3280 in a plant layout of Plant X. Tank T-3280 consist of aqueous hydrochloric acid (HCl) used for adjusting pH of related streams. HCl is stored in the utilities area in amounts exceeding 1000 kg, therefore it is necessary for Plant X to comply with PSM Standards. The scenario provided is the release of HCl to the surrounding area and how the situation is mitigated through ERP management.

The current involvement of workers for ERP is to be cross-checked with the model developed in this study. The model aims to identify any gaps in Plant X for complying with PSM requirements.

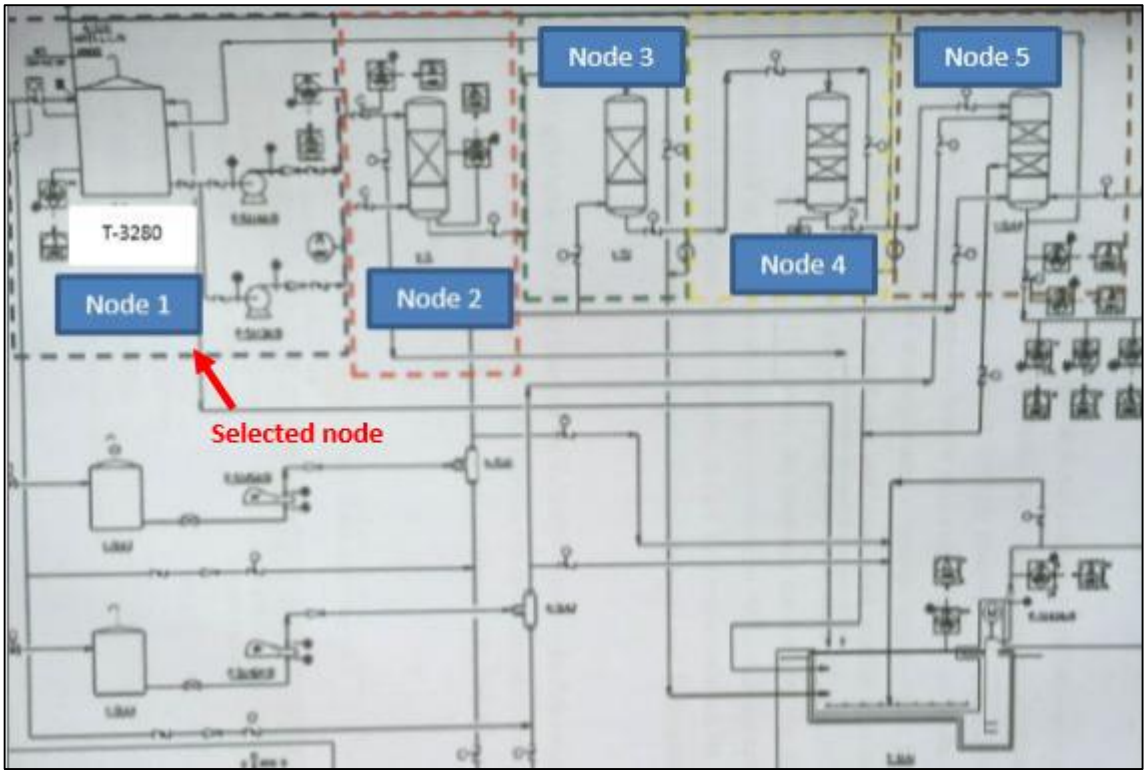


Figure 10: Node 1 Selected As Case Study

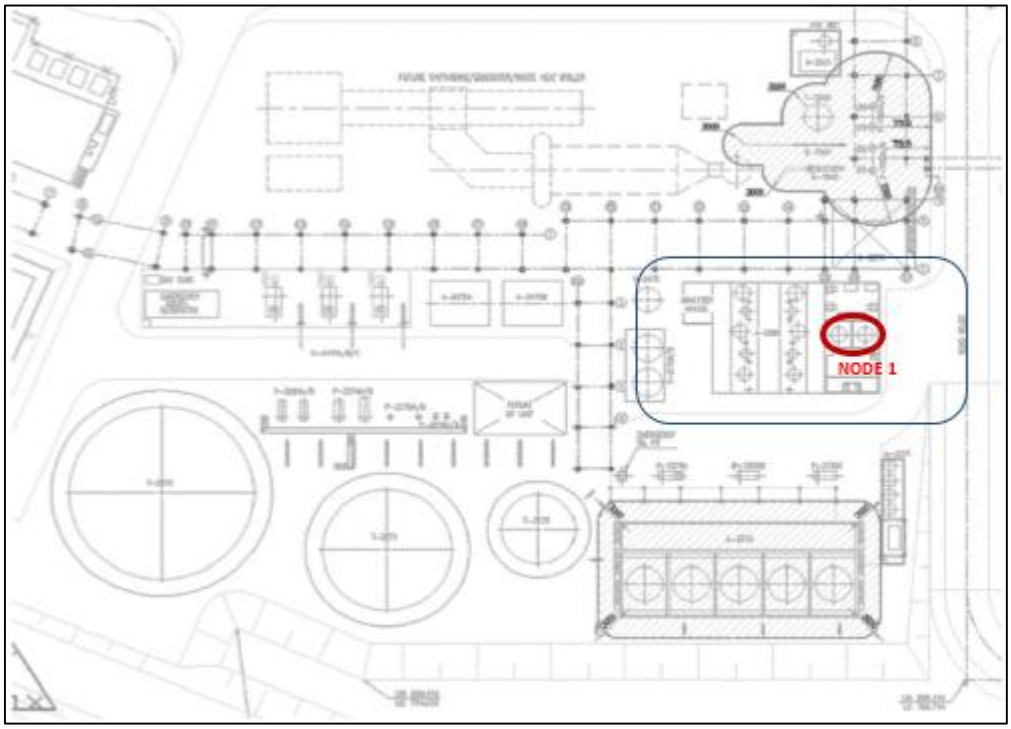


Figure 11: Location of Node 1 from Plant Layout

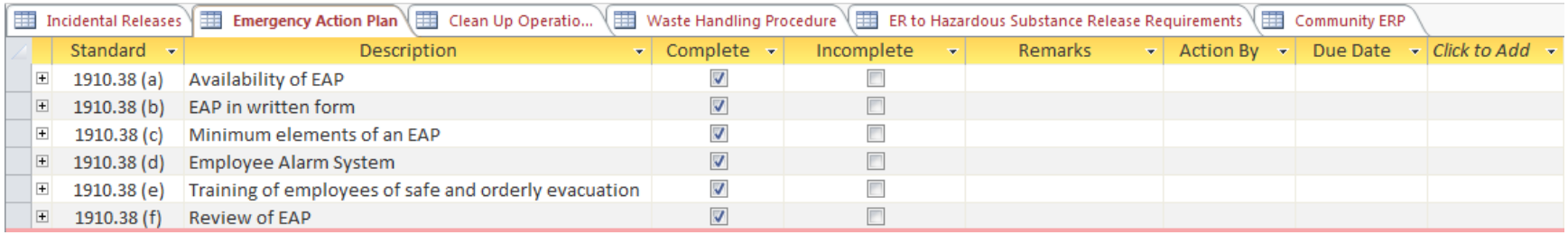
4.5.1 Emergency Response Plan (ERP) Element – Validate Model

As mentioned earlier, as the user click the PSM element in Data Collection, it will hyperlink to 'Main Menu of the PSM element'. Figure 12 shows ERP Main Menu that link with the Emergency Planning and Response in Data Collection. The ERP Main Menu basically shows all the ERP Requirements from ERP Model that is developed based on ERP PSM Framework as shown in Appendix D. This page also captures data for easy monitoring and tracking of incomplete items as well as the accountable persons and when the action items should be completed. Any incomplete sections can be verified with supporting information under 'Remarks'. From Figure 12, it can be seen that Plant X complies with half of the PSM requirements for EPR except for Clean-Up Operations, Waste Handling Procedures and ER to Hazardous Substance Release. This is due to incomplete information regarding its training content, decontamination procedures and sanitation in temporary emergency sites. Basically, the completion of ERP element will also affected the completion of Employee Participation for ERP. From this main page Plant X can know which areas they are currently having difficulties in complying with. When the user click on one of the 'ERP Requirements' in Main Menu, it will create a hyperlink to that specific requirement for example as shown in Figure 13. Figure 13 shows Emergency Action Plan as one of the ERP Requirements. Certain requirements of the ERP may have sub-standards which are additional requirements set by PSM. Figure 14 shows an example of how sub-standards are checked for 'Minimum elements of EAP 1910.38 (c)' and how Employee Participation have been implemented in this sub-standards. Figure 15, 16 and 17 shows an enlarge image of Figure 14 named as 'Part a', 'Part b' and 'Part c'. 'Part a' is the data obtained from ERP model, while 'Part b' and 'Part c' are the extension of the ERP model to include the element of Employee Participation. However, some columns in 'Part a' have relationship with the Employee Participation element which is 'Location of Report'. The 'Location of Report' relate with '**Provide access to information (1910.119 (c)(3)**'. Other columns have been explained in detail in previous section which is 'Employee Participation Preliminary Model Using Microsoft Access 2013'.

ERP Main Menu

ERP Requirements	Compliance?	Remarks	Action By	Due Date
Incidental Releases	☑			
Emergency Action Plan	☑			
Clean Up Operations	☐	Incomplete training, decontamination, illumination and sanitation in workplace documentation	ZA	2/27/2015
Waste Handling Procedure	☐	Incomplete training and decontamination documentation	ZA	3/6/2015
ER to Hazardous Substance Release Requirements	☐	Incomplete responders' training program	ZA	3/27/2015
Community Response Procedure	☑			

Figure 12: ERP Main Menu



Incidental Releases | Emergency Action Plan | Clean Up Operatio... | Waste Handling Procedure | ER to Hazardous Substance Release Requirements | Community ERP

Standard	Description	Complete	Incomplete	Remarks	Action By	Due Date	Click to Add
1910.38 (a)	Availability of EAP	☑	☐				
1910.38 (b)	EAP in written form	☑	☐				
1910.38 (c)	Minimum elements of an EAP	☑	☐				
1910.38 (d)	Employee Alarm System	☑	☐				
1910.38 (e)	Training of employees of safe and orderly evacuation	☑	☐				
1910.38 (f)	Review of EAP	☑	☐				

Figure 13: Example of ERP Requirement - (Emergency Action Plan)

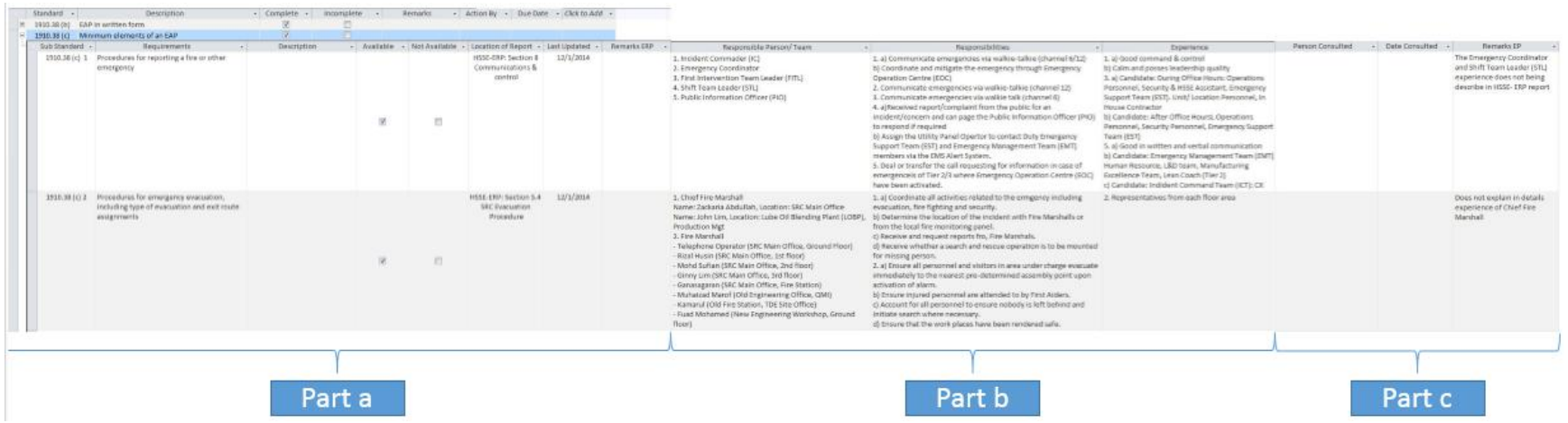
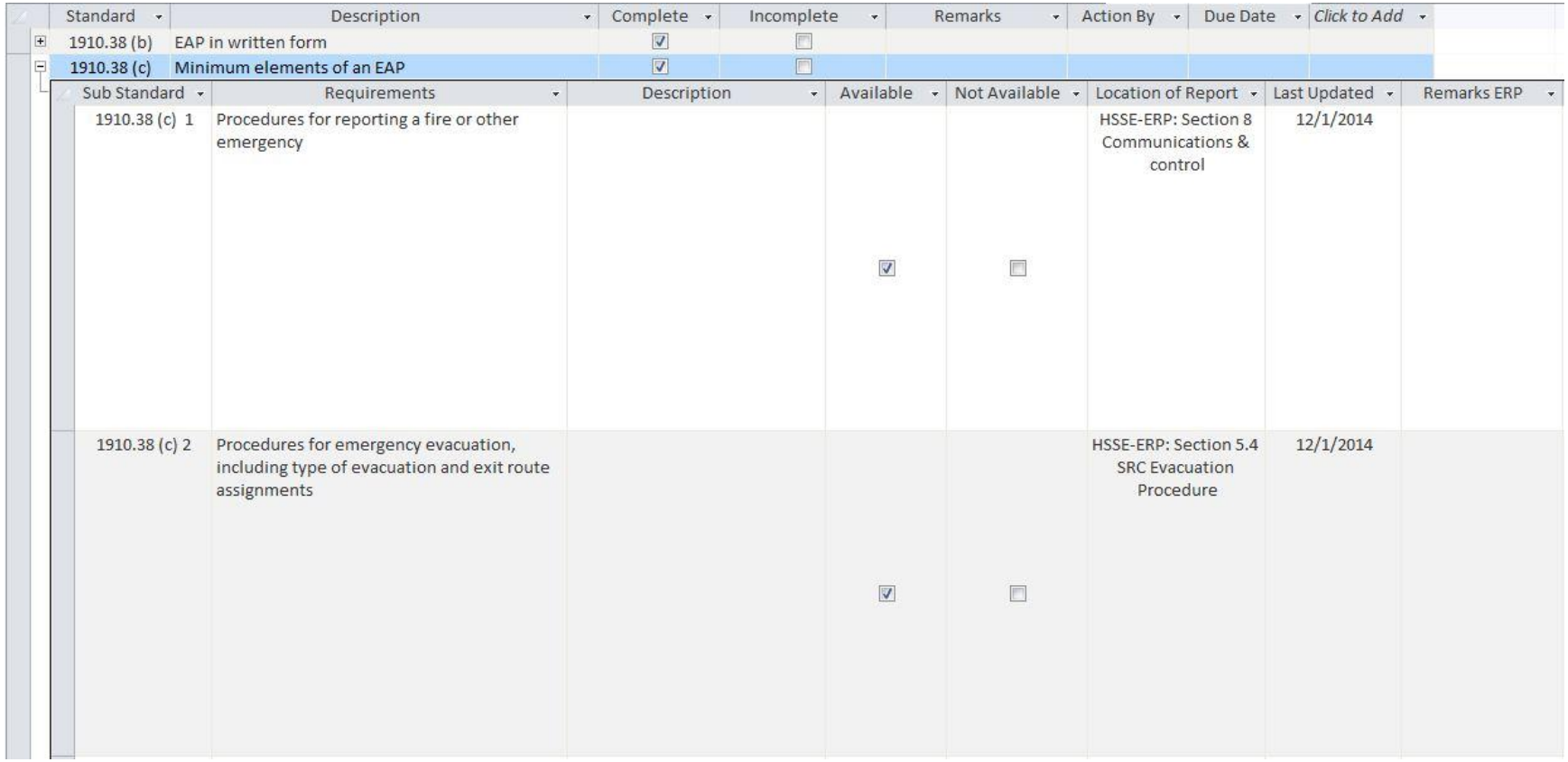


Figure 14: Example of Sub Standard in Emergency Action Plan Requirement



Standard	Description	Complete	Incomplete	Remarks	Action By	Due Date	Click to Add
1910.38 (b)	EAP in written form	☑	☐				
1910.38 (c)	Minimum elements of an EAP	☑	☐				

Sub Standard	Requirements	Description	Available	Not Available	Location of Report	Last Updated	Remarks ERP
1910.38 (c) 1	Procedures for reporting a fire or other emergency		☑	☐	HSSE-ERP: Section 8 Communications & control	12/1/2014	
1910.38 (c) 2	Procedures for emergency evacuation, including type of evacuation and exit route assignments		☑	☐	HSSE-ERP: Section 5.4 SRC Evacuation Procedure	12/1/2014	

Figure 15: Zoom in of Figure 14- Part a

Responsible Person/ Team	Responsibilities	Experience
1. Incident Commader (IC) 2. Emergency Coordinator 3. First Intervention Team Leader (FITL) 4. Shift Team Leader (STL) 5. Public Information Officer (PIO)	1. a) Communicate emergencies via walkie-talkie (channel 6/12) b) Coordinate and mitigate the emergency through Emergency Operation Centre (EOC) 2. Communicate emergencies via walkie-talkie (channel 12) 3. Communicate emergencies via walkie talk (channel 6) 4. a)Received report/complaint from the public for an incident/concern and can page the Public Information Officer (PIO) to respond if required b) Assign the Utility Panel Opertor to contact Duty Emergency Support Team (EST) and Emergency Management Team (EMT) members via the EMS Alert System. 5. Deal or transfer the call requesting for information in case of emergenceis of Tier 2/3 where Emergency Operation Centre (EOC) have been activated.	1. a) Good command & control b) Calm and posses leadership quality 3. a) Candidate: During Office Hours: Operations Personnel, Security & HSSE Assistant, Emergency Support Team (EST). Unit/ Location Personnel, In House Contractor b) Candidate: After Office HoursL Operations Personnel, Security Personnel, Emergency Support Team (EST) 5. a) Good in written and verbal communication b) Candidate: Emergency Management Team (EMT) Human Resource, L&D team, Manufacturing Excellence Team, Lean Coach (Tier 2) c) Candidate: Indident Command Team (ICT): CX
1. Chief Fire Marshall Name: Zackaria Abdullah, Location: SRC Main Office Name: John Lim, Location: Lube Oil Blending Plant (LOBP), Production Mgt 2. Fire Marshall - Telephone Operator (SRC Main Office, Ground Floor) - Rizal Husin (SRC Main Office, 1st floor) - Mohd Sufian (SRC Main Office, 2nd floor) - Ginny Lim (SRC Main Office, 3rd floor) - Ganasagaran (SRC Main Office, Fire Station) - Muhaizad Marof (Old Engineering Office, QMI) - Kamarul (Old Fire Station, TDE Site Office) - Fuad Mohamed (New Engineering Workshop, Ground floor)	1. a) Coordinate all activities related to the ermgency including evacuation, fire fighting and security. b) Determine the location of the incident with Fire Marshalls or from the local fire monitoring panel. c) Receive and request reports fro, Fire Marshals. d) Receive whether a search and rescue operation is to be mounted for missing person. 2. a) Ensure all personnel and visitors in area under charge evacuate immediately to the nearest pre-determined assembly point upon activation of alarm. b) Ensure injured personnel are attended to by First Aiders. c) Account for all personnel to ensure nobody is left behind and initiate search where necessary. d) Ensure that the work places have been rendered safe.	2. Representatives from each floor area

Figure 16: Zoom in of Figure 14- Part b

Person Consulted	Date Consulted	Remarks EP
		The Emergency Coordinator and Shift Team Leader (STL) experience does not being describe in HSSE- ERP report
		Does not explain in details experience of Chief Fire Marshall

Figure 17: Zoom in of Figure 14- Part c

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

A systematic technique towards the Employee Participation element for PSM implementation in process industries is presented in this work with the aim to comply with the requirements of PSM CFR 1910.119 (c). A framework for Employee Participation requirements has been developed based on PSM Standards. Furthermore, a model has been developed based on this framework with that has features to allow users to track documents or information easily and to provide a basis for gap analysis to be carried out. This system assists users to better manage their Employee Participation in PSM implementation. The model utilizes P&ID as the foundation to conduct the studies on as it consists most of the information of a plant and to ensure better data tracking system. The case study was done in a local refinery in Malaysia and the results have shown how the model aids users in managing employee participation in compliance with PSM Standards. The system provides users a bigger overview of what they are complying with and what gaps exist in their system. The findings conclude that the proposed concept and structured technique is feasible for users to comply with employee participation according to PSM CFR 1910.119 (c) and has the potential to be implemented in the industries. This proposed technique can also be used by organizations and can be customized for the development of similar models in order to ensure that active participation of employees and ease the employers on providing consultation in real practice situations.

5.2 Recommendations

1. The proposed model can be improved further by implementing a score system for the employee participation findings as a guide for the users to prioritize on which corrective action should be implemented first.
2. To further enhance the effectiveness of the model, integration between PSM elements can be included in future work. P&ID is used to conduct the employee

participation review and usually when a node is selected, there will be an overlap of PSM elements in the node studied. Integration between PSM elements will further improve the employee participation process of PSM program.

3. Continuous research should be conducted at Plant X or at any process industries for more process units and/or major process equipment's while given a longer time frame to collect the data for Employee Participation CFR 1910.119 (c).
4. Responsible custodian must develop and maintain high security for the model to prevent information leak by irresponsible individuals.

REFERENCES

Centre for Chemical Proces Safety (CCPS), (2007). Guidelines for Risk Based Process Safety. New Jersey: John Wiley & Sons.

Hardy, T. L. (2013). Elements of Process Safety Management: Case Studies. p. 2- 3.

Hendershot, D. (2009). Process safety in the American Institute of Chemical Engineers—A brief history and current resources. *Journal of Chemical Health and Safety, 16*(1), 43-44.

Joseph, G., Kaszniak, M., & Long, L. (2005). Lessons after Bhopal: CSB a catalyst for change. *Journal of Loss Prevention in the Process Industries, 18*(4–6), 537-548.

Martineau, R. J. and Novello, D. P. (2004). *The Clean Air Act Handbook*. 2nd edition. Chicago: American Bar Association.

Mason, E. (2001a). Elements of process safety management: part 1. *Chemical Health and Safety, 8*(4), 22-24.Mason, E. (2001b).

Elements of process safety management: Part 2. *Chemical Health and Safety, 8*(5), 23-26.

UK Health and Safety Executive, Employee Involvement in Health and Safety: Some Examples of Good Practice, WPS/00/03, 2001, www.hse.gov.uk/research/hsl_pdf/2001/employ-i.pdf.

US Chemical Safety and Hazard Investigation Board (CSB), (2008). Investigation Report: Velero McKee Propane Fire (Sunray, Texas). Report No: 2007-05-I-TX-R8.

US Chemical Safety and Hazard Investigation Board (CSB), (2011a). Investigation Report: DuPont Corporation Toxic Chemical Releases. Report No: 2010-8-I-WV-R5.

US Chemical Safety and Hazard Investigation Board (CSB), (2011b). Investigation Report: DuPont Corporation Toxic Chemical Releases. Report No: 2010-6-I-WV-R3.

US Department of Energy (DOE), (1996). Process Safety Management for Highly Hazardous Chemicals. Washington, US.

US Occupational Safety and Health Administration (OSHA), (1992). Process Safety Management of Highly Hazardous Chemicals *Occupational Safety and Health Standards* (Vol. 29 CFR 1910.119). Washington, US.

US Occupational Safety and Health Administration (OSHA), (2000). *Process Safety Management*: US OSHA.

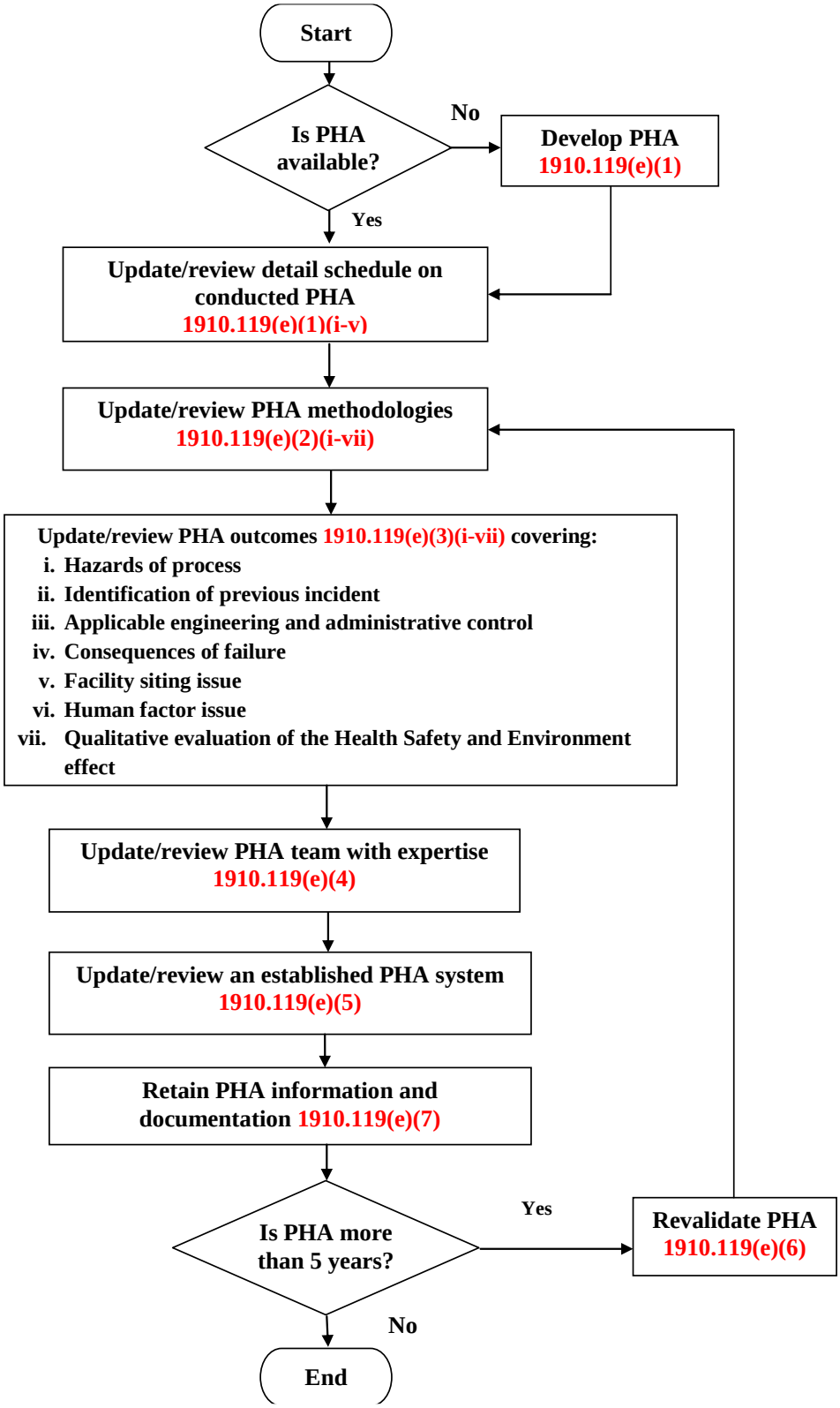
APPENDICES

Appendix A: OSHA Employee Participation Inspection

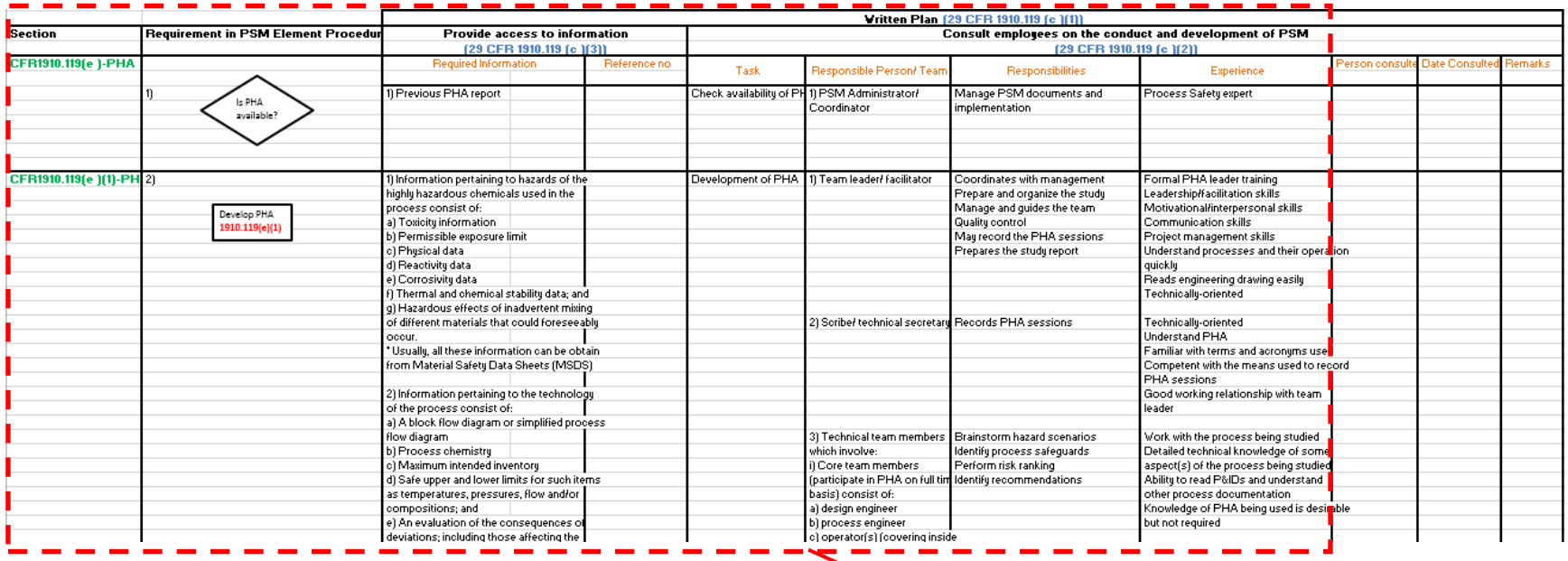
1910.119(C): Employee Participation		
I. PROGRAM SUMMARY The intent of this paragraph is to require employers to involve employees at an elemental level of the PSM program. Minimum requirements for an Employee Participation Program for PSM must include a written plan of action for implementing employee consultation on the development of the process hazard analyses and other elements of process hazard management contained within 1910.119. The employer must also provide ready access to all the information required to be developed under the standard.		
II. QUALITY CRITERIA REFERENCES A. 1910.119(c): Employee Participation		
III. VERIFICATION OF PROGRAM ELEMENTS	**Criteria References**	**Met Y/N**
A. Records Review 1. Does a written program exist regarding employee participation? Field Note References(s):	119(c)(1)	
2. Does the written program include consultation with employees and their representative(s) on the conduct and development of process hazard analyses and on the development of other elements of the PSM standard? Field Note Reference(s):	119(c)(2)	
3. Does the written program include consultation with employees (including contractor employees) and their representatives, access to process hazard analyses and all other information developed as required by the PSM standard? Field Note Reference(s):	119(c)(3)	
B. On-site Conditions Not Applicable	119(c)(2)	
C. Interviews 1. Based on interviews with a representative number of employees and their representatives, have they been consulted on the conduct and development of the process hazard analyses? Field Note Reference(s):	119(c)(2)	
2. Based on interviews with a representative number of employees and their representatives, have they been consulted on the development of other elements of the Process Safety Management Program? Field Note Reference(s):	119(c)(2)	
3. Based on interviews with a representative number of employees (including contractor employees) and their representatives, have they been informed of their rights of access and provided access to process hazard analyses and to all other information required to be developed by the PSM standard? (Ask about unreasonable delays in access to information and whether time is given during the working hours to access information required by the PSM standard.) Field Note Reference(s):	119(c)(3)	

Source: OSHA Instruction CPL 02-02-045A (Revised) Directorate of Compliance Programs, 1992.

Appendix B: Process Hazard Analysis (PHA) Framework



Appendix C: Testing of Preliminary Employee Participation Model on Process Hazard Analysis (PHA)



Section	Requirement in PSM Element Procedur	Written Plan (29 CFR 1910.119 (c)(1))								
		Provide access to information (29 CFR 1910.119 (c)(3))		Consult employees on the conduct and development of PSM (29 CFR 1910.119 (c)(2))						
CFR1910.119(e)-PHA		Required Information	Reference no	Task	Responsible Person/ Team	Responsibilities	Experience	Person consulte	Date Consulted	Remarks
	1) Is PHA available?	1) Previous PHA report		Check availability of PH	1) PSM Administrator/ Coordinator	Manage PSM documents and implementation	Process Safety expert			
CFR1910.119(e)(1)-PH	2) Develop PHA 1910.119(e)(1)	1) Information pertaining to hazards of the highly hazardous chemicals used in the process consist of: a) Toxicity information b) Permissible exposure limit c) Physical data d) Reactivity data e) Corrosivity data f) Thermal and chemical stability data; and g) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur. * Usually, all these information can be obtain from Material Safety Data Sheets (MSDS) 2) Information pertaining to the technology of the process consist of: a) A block flow diagram or simplified process flow diagram b) Process chemistry c) Maximum intended inventory d) Safe upper and lower limits for such items as temperatures, pressures, flow and/or compositions; and e) An evaluation of the consequences of deviations; including those affecting the		Development of PHA	1) Team leader/ facilitator	Coordinates with management Prepare and organize the study Manage and guides the team Quality control May record the PHA sessions Prepares the study report	Formal PHA leader training Leadership/facilitation skills Motivational/interpersonal skills Communication skills Project management skills Understand processes and their operation quickly Reads engineering drawing easily Technically-oriented			
					2) Scribe/ technical secretary	Records PHA sessions	Technically-oriented Understand PHA Familiar with terms and acronyms use Competent with the means used to record PHA sessions Good working relationship with team leader			
					3) Technical team members which involve: i) Core team members (participate in PHA on full tim basis) consist of: a) design engineer b) process engineer c) operator(s) (covering inside	Brainstorm hazard scenarios Identify process safeguards Perform risk ranking Identify recommendations	Work with the process being studied Detailed technical knowledge of some aspect(s) of the process being studied Ability to read P&IDs and understand other process documentation Knowledge of PHA being used is desirable but not required			

Will focus and zoom only for this part in appendix

		Written Plan (29 CFR 1910.119 (c)(1))						
Section	Requirement in PSM Element Proced	Provide access to information (29 CFR 1910.119 (c)(3))		Consult employees on the conduct and development of PSM (29 CFR 1910.119 (c)(2))				
CFR1910.119(e)-PHA		Required Information	Reference no	Task	Responsible Person/ Team	Responsibilities	Experience	Pe
	1) 	1) Previous PHA report		Check availability of PHA	1) PSM Administrator/ Coordinator	Manage PSM documents and implementation	Process Safety expert	
CFR1910.119(e)(1)-PHA	2) 	1) Information pertaining to hazards of the highly hazardous chemicals used in the process consist of: a) Toxicity information b) Permissible exposure limit c) Physical data d) Reactivity data e) Corrosivity data f) Thermal and chemical stability data; and g) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur. * Usually, all these information can be obtain from Material Safety Data Sheets (MSDS)		Development of PHA	1) Team leader/ facilitator	Coordinates with management Prepare and organize the study Manage and guides the team Quality control May record the PHA sessions Prepares the study report	Formal PHA leader training Leadership/facilitation skills Motivational/interpersonal skills Communication skills Project management skills Understand processes and their operation quickly Reads engineering drawing easily Technically-oriented	
		2) Information pertaining to the technology of the process consist of: a) A block flow diagram or simplified process flow diagram b) Process chemistry c) Maximum intended inventory d) Safe upper and lower limits for such items as temperatures, pressures, flow and/or compositions; and e) An evaluation of the consequences of deviations; including those affecting the safety and health of employees.			2) Scribe/ technical secretary	Records PHA sessions	Technically-oriented Understand PHA Familiar with terms and acronyms used Competent with the means used to record PHA sessions Good working relationship with team leader	
		3) Information pertaining to the equipment in the process consists of: a) Materials of construction b) Piping and instrumentation diagrams			3) Technical team members which involve: i) Core team members (participate in PHA on full time basis) consist of: a) design engineer b) process engineer c) operator(s) (covering inside and outside activities) d) maintenance technician(s) or engineer(s) e) controls engineer f) safety engineers	Brainstorm hazard scenarios Identify process safeguards Perform risk ranking Identify recommendations	Work with the process being studied Detailed technical knowledge of some aspect(s) of the process being studied Ability to read P&IDs and understand other process documentation Knowledge of PHA being used is desirable but not required	

		b) Piping and instrumentation diagrams c) Electrical classification d) Relief system design and basis e) Ventilation system design f) Design code employed g) Material and energy balances for processes; and h) Safety systems (such as interlocks, detection and suppression systems, etc.)			ii) Specialty team members (attend only certain session where their expertise is needed) a) instrumentation/electrical engineer b) mechanical engineer c) programmer d) inspection/materials engineer e) research scientist/ chemist f) environmental engineer/ regulatory specialist g) quality assurance/ quality control specialist h) industrial hygienist i) industrial engineer			
					4) Other technical members	Provide information on equipment desig maintenance, operation, and so on	Similar to core and specialty technical team members	
					5) Interpreter	Ensure that team members communica effectively	High level of ability Knows technical term in language used	
					6) Site coordinator	Liaison between team and local facility Ensure adequate facilities, such as a meeting room, and other team needs	Available for the duration of the study Well connected	
CFR1910.119(e)(i-v) – PHA	Update/review detailed schedule on conducted PHA **1910.119(e)(1)(i-v)**	1) Schedule for PHA development and implementation		Update/review PHA on detailed schedule.	1) PSM Administrator/ Coordinator	Check the schedule and follow up with employees on planed schedule	Process Safety expert	
CFR1910.119(e)(2)(i-vii)- PHA	Update/ review PHA methadologies **1910.119(e)(2)(i-vii)**	1) PHA methadologies used by the company. Example: HAZOP		Update/review PHA methadologies.	1) PSM Administrator/ Coordinator	To update and inform the PHA team to review the methadologies if necessary	Process Safety expert	
					2) PHA team	Review methadologies and update the cahnges to administrator.	Refer to section **CFR1910.119(e)(1)-PHA**	

CFR1910.119(e)(3)(i–vii)– PHA Update/ review PHA outcomes **1910.119(e)(3)(i-vii)** covering: i. Hazard of the process ii. Identification of previous incident iii. Applicable engineering and administrative control iv. Consequences of failure v. Facility sitting issue vi. Human factor issue vii. Qualitative evaluation of the Health Safety and Environmental effect	1) Refer to section **CFR1910.119(e)(1)–PHA** 2) Track record of previous incident based on similar industry 3) List of the aplicable engineering and administrative control from suppliers through cattalouge, online etc or through experience 4) Plot plan diagram 5) Standard code of practice for safe sitting of facilities 6) Human factor analysis such as Human Factor Analysis and Classification System (HFACS) based upon James Reason's swiss cheese model 7) Health and Safety Risk Matrix	Update/ review PHA outcomes.	1) PHA team	Review and update PHA outcomes.	Refer to section **CFR1910.119(e)(1)–PHA**
CFR1910.119(e)(4) – PHA Update/review PHA team with expertise **1910.119(e)(4)**	1) List of experts based on the process and facilities identified in P&ID	Update/ review PHA tea with expertise	1) Process Safety Manager	To compile information on the expertise available within the plan and specialist required externally	Process Safety expert
CFR1910.119(e)(5) –PHA Update/review an established PHA system **1910.119(e)(5)**	1) PHA study outcome	Update/review an established PHA system	1) PHA team	Provide recommendations and required actions from the PHA study	Refer to section **CFR1910.119(e)(1)–PHA**
CFR1910.119(e)(6) – PHA Revalidate PHA if PHA is more than 5 years **1910.119(e)(6)**	1) PHA report and schedule	Revalidate PHA	1) PSM Administrator/ Coordinator	To check the review date from PHA schedule and coordinate the PHA team to revalidate the PHA study	Process Safety expert
			2) PHA team	To revalidate the PHA study	Refer to section **CFR1910.119(e)(1)–PHA**
CFR1910.119(e)(7) – PHA Retain PHA information and documentation **1910.119(e)(7)**	1) PHA report/ database	Retantion of PHA document	1) PSM Administrator/ Coordinator	To retain the PHA document	Process Safety expert

Appendix D: Emergency Response Plan (ERP) Framework