Development of Emergency Planning and Response Model Based on OSHA Process Safety Management Requirement

by

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Dissertation submitted in partial fulfilment of

the requirement for the

Bachelor of Engineering (Hons.) Chemical Engineering

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CERTIFICATION OF APPROVAL

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Approved by,

_____

(PROF. DR. AZMI MOHD SHARIFF)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, 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.

SHAHIRAH BINTI MOHAMED LOQMAN

ABSTRACT

When incidents happen and the consequences are not mitigated effectively, one of the indicated failures consists of ineffective emergency response planning (EPR). EPR is an important aspect of the Process Safety Management (PSM) Standards and the guidelines are stated in CFR 1910.119 (n) which explains the minimum elements of emergency response and procedures in handling emergency or small releases. Despite its implementation in 1992, CSB finds ineffective EPR system in certain accidents such as the Missouri DPS Enterprise Chlorine Gas Release accident in 2002. DPS EPR failed in planning on location of emergency equipment and accessibility. Many other accidents has occurred throughout the decade and even though organizations have their own EPR system, there are issues in meeting minimum PSM requirements. There also exists the problem of self-regulatory policies practiced by organizations which might not meet these requirements as well. To help organizations meet these minimum requirements, the purpose of this paper is to present a structured and easy technique to plan and implement EPR as per PSM requirements. A model has been developed based on this technique and its application has been tested as a case study in a refinery in Malaysia and discussed in this report. The results reflected the feasibility of this model as it helped users track and manage documents better. This technique has the potential to help users manage EPR better to reduce adverse impacts to people, environment and assets.

ACKNOWLEDGEMENT

With Allah's Blessings, this project has had its opportunity to flourish because of the following amazing individuals.

Many thanks and appreciation to Professor Dr Azmi Mohd Shariff as my supervisor and mentor in conducting this project. It has been an honour to work alongside an esteemed individual in the Chemical Engineering Department, with his vast knowledge in process safety. My passion for process safety has further extended by involving in this project and getting great guidance from him and his postgraduate candidate, Noor Diana Abdul Majid. Madam Diana's advice and help throughout this project has made the journey less burdened and more enjoyable as we both learn more and more regarding emergency response.

Thank you to Universiti Teknologi PETRONAS Chemical Engineering Department for allowing me to contribute in some small way to its research in Process Safety. Thank you to Zackaria Abdulah and his team in welcoming us warmly to conduct our case study. And, thank you to family members and friends for their support throughout this journey.

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ABBREVIATIONS AND NOMENCLATURES

OSHA	Occupational Safety and Health Administration
PSM	Process Safety Management
EPR	Emergency Planning Response
EAP	Emergency Action Plan
CSB	US Chemical Safety Board
CCPS	Center for Chemical Process Safety
DOSH	Department of Occupational Safety & Health
DOE	Department of Environment (Malaysia)
CAER	Community Action Emergency Response
CICM	Chemical Industries Council Malaysia
P&ID	Process & Instrumentation Diagram
HCl	Hydrochloric Acid

CHAPTER 1: PROJECT BACKGROUND

1.1 Background of Study

Process industries utilizing chemicals of hazardous category or equipment in high operating conditions are exposed to a high number of risks. Despite many attempts to incorporate inherent safety design into the process [1, 2], accidents in the industry are prone to occur. Machinery failures, process upsets, human errors, inadequate management systems and external factors can cause incidents such as explosion, chemical toxic release and fires putting many lives at stake. These incidents have the potential to cause high fatalities, damage assets and the environment, as well as cause business interruption [3, 4].

The consequences arising from such incidents can be properly managed if the organization implements an effective EPR system [5, 6]. Many of these systems lacked proper planning, communication between vital parties, and adequate training for employees [3]. One of the reasons accidents still occur decades later, is unsuccessful execution of response to emergencies was due to insufficient emergency response training and education for all employees [7, 8]. When employees hesitate to react to sudden chemical release, decisions are often delayed [9]. Additionally, the lack of initiative communication with the surrounding community also contributes to this matter and is the reason why more people are exposed than necessary [10].

In addition to that, management of EPR can be time-consuming and adequate information are difficult to gather for predicting emergency scenarios [7, 11].This leads to many communication breakdown when responding to emergencies.

One of the established standards which has been used in developing EPR systems is the Occupational Safety and Health Administration (OSHA) Process Safety Management (PSM) of Highly Hazardous Chemicals, 29 CFR 1910.119 [12]. Many countries and organizations have adapted PSM as a guidance for handling hazardous chemicals in the manufacturing industry. The main objective of this standard is to manage highly hazardous chemicals which are present in the process above a certain threshold quantity and reduce the frequency of incidents happening such as fire, explosion and chemical toxic release. PSM is an OSHA standard which governs a safe work practice approach to control and contain hazards, prevent and mitigate loss events. Since its implementation in 1992, the number of accidents have significantly

reduced, leading to higher productivity, improved perception towards process safety and reduction of human error [4].

The PSM Standards contains 14 elements, including Emergency Planning & Response (EPR) in CFR 1910.119 (n) [12]. EPR is a compulsory practice in preparing for any unexpected and emergency events. When preventive measures in the process fail, EPR plays a vital role in mitigating such events and ensuring minimum risk exposures to workers and surrounding community. Consequently, EPR guides in the planning for emergency action plans [13] and response procedures which includes responding to small and large chemical release. PSM provides guidelines on how EPR can be incorporated within the scopes of waste handling or clean-up operations [14]. However, incidents are still occurring and the numbers have rose recently in the past few years despite PSM Standards being implemented almost 3 decades ago [15].

Despite companies having their own EPR system, accidents are still occurring due to lack of meeting the minimum requirements of PSM Standards. All of the issues identified from CSB investigation findings pinpoint to the fact there lacks a structured technique in managing EPR in the organization. Self-regulatory practices can also contribute to this problem as the minimum requirements may not be fully addressed.

In conclusion, to help organizations meet these minimum requirements, the purpose of this paper is to present a structured and easy technique for organizations to plan and implement EPR as per PSM requirements. This technique represents a proposed strategy for organizations to determine which criteria of the 1910.119 (n) organizations are met in order to better plan the EPR. A framework has been created based on OSHA CFR 1910.119 (n) and a model has been developed to reflect this framework. Process and Instrumentation Diagram (P&ID) are used as a foundation to segregate the areas for better management and comprehensive coverage of the plant. The model is tested as a case study in a refinery in Malaysia designated as Plant X, and the results are discussed in this paper.

1.2 Problem Statement

Despite companies having their own EPR system, accidents are still occurring due to lack of meeting the minimum requirements of PSM Standards. All of the issues identified from CSB investigation findings pinpoint to the fact there lacks a structured technique in managing EPR in the organization. Self-regulatory practices can also contribute to this problem as the minimum requirements may not be fully addressed.

This paper presents a structured technique that identifies all of these issues and addresses it accordingly.

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1.3 Objective

The objective of this research study is to present a structured and easy technique to manage and implement EPR to meet minimum PSM requirements. This is done by developing an EPR framework and prototype of a model to be tested in a case study.

1.4 Scope of Study

EPR is commonly applied in all industries and the scope of this paper revolves around the development of emergency response for industries covered under PSM. PSM is covered under OSHA's *29 Code of Federal Regulations (CFR)* 1*910.119: Process Safety Management of Highly Hazardous Chemicals* and is directly applicable to all manufacturing industries – particularly to those pertaining to chemicals, transportation equipment and fabricated metal products. This standard is also applicable to pyrotechnics and explosives manufacturing industries covered under OSHA rules.

The following shows the sections of 1910 this project is set in:

- 1910.119 (n): Emergency Planning & Response (Table 6)
- 1910.38: Emergency Action Plan (EAP) (Table 4)
- 1910.120: Hazardous Waste Operations and Emergency Response (Table 7 - 9)

All of the above sections will be included when developing a structured framework. This framework is then used to build an EPR model in Microsoft Access and later be validated through a case study. Hence, the scope of study for this paper includes:

- Analyze OSHA PSM Standards for EPR
- Develop a framework for EPR
- Develop an EPR model based on framework
- Conduct case study to verify feasibility of model

CHAPTER 2: LITERATURE REVIEW

2.1 Learning from Incidents and Why EPR Fails

Many incidents over the years have involved fatalities where the consequences could have been minimized if the ERP was adequate. This included workers and surrounding community being aware of their own responsibilities in responding to emergencies [5]. As a result of lack of ER planning and organization accountability usually leads to confusion and disorder when responding skills are the most needed.

Below shows the statistics for Malaysian death tolls in relation to the process industry[16] and has a rate of more than 10 in 100,000:

Country	Death	Death rate ($1/10^5$)	Year
United States	5900	4.0	2001
Japan	1790	2.79	2001
Germany	1155	7.0	2001
Canada	882	7.1	2000
France	730	4.4	2000
Australia	198	2.0	2002
United Kingdom	210	0.8	2001
Austria	122	4.5	2001
Denmark	50	2.0	2001
China	14,924	14.14	2002
Russia	4370	15	2001
Brazil	2503	11.5	2000
South Korea	1298	6.16	2001
Italy	1155	7.0	2000
Ukraine	1321	9.2	1999
Mexico	1502	12.0	2001
Argentina	915	18.6	2000
Malaysia	858	10.8	2002
Thailand	616	11.3	2000
Polland	510	5.0	2001

Figure 1: Comparison of death tolls and rates of industrial accidents between China and other countries (1999-2001)

Looking into one of the industry's worst tragedy, the Piper Alpha had a very weak and flawed emergency response planning as it lacked many firefighting protections and employee training in responding to emergencies. The safety practices were poorly implemented and understood too. Furthermore, drills and exercise were rarely done and much equipment for emergencies failed [6].

One of the reasons why EPR fail is because there is an insufficient training and education for all employees [17]. When employees are not sure how to react to sudden chemical release, this delays the process in mitigating the event and proves to be a prominent challenge faced by all employees when dealing with emergencies. In

sudden emergency situations, they find themselves in unfamiliar conditions with lack of knowledge and information to proceed with any decision making actions. This increases the chances of making mistakes which could have severe consequences [9]. When under pressure, an untrained employee is prone to making crucial mistakes and endangering anyone exposed. The additional hazardous environment does not help either. This situation has been reflected in a propane explosion incident which occurred at a convenience store in West Virginia [8].

Training, drills and exercises are important as they provide a sense of similar situation akin to a real emergency. Via drills, employers can identify flaws in their response planning such as accessibility of emergency equipment, evacuation routes, functionality of alarms and equipment, etc. These are very important findings which can improve the organization's EPR and help quicken response time in the event of an actual emergency [3].

Figure 2: Propane Explosion in West Virginia killing 4 people

Another finding from accident investigations relating to failed EPR is the lack of concern for community awareness in responding to emergencies. In several incidents investigated by CSB, most emergency releases cause hazardous exposure to the surrounding community. This can be seen in the West Virginia Convenience Store Propane Explosion (CSB, 2008), Missouri DPS Enterprise Chlorine Gas Release (CSB, 2002) and Massachusetts FAI Ink Factory Explosion (CSB, 2006) incidents. All incidents exposed the nearby residents to fire and toxic hazards. However, they

were not evacuated efficiently due to improper planning and communication between the plant and local authorities, such as police force and fire fighters [18].

KTVI-TV, St. Louis, Missouri

Figure 3: DPS Chlorine Gas Release resulting in a toxic exposure

Because of insufficient communication, it resulted in delayed community evacuation and unnecessary exposure to risks. Both figures of authority and local residents were reported of being sent to hospitals for further medical surveillance. CSB has claimed the importance of establishing and encouraging Local Emergency Planning Committee (LEPC) which aims to act as a middle person between plant employers and the surrounding community. Furthermore, several recommendations have been made by CSB to improve community notification systems which include alarms, evacuation routes or any specific procedures [19].

2.2 Emergency Planning and Response in PSM Standards

2.2.1 Overview of EPR in PSM

EPR in compliance with the PSM system looks into the scope of chemicals that need to comply with certain emergency procedures and pre-planning governed under the PSM System. The PSM System basically governs manufacturing industries in possession of hazardous chemicals. This scope has been defined by PSM in the Code of Federal Regulations (CFR) 1910.119 *(Process Safety Management of Highly Hazardous Chemicals)* paragraph (a).

This paragraph states all the necessary chemicals (listed in the Appendix) and flammable gas/liquid below a flash point of 100°F on site in one location in the minimum amount of 10,000 pounds. To determine the range of measuring the inventory *on site in one location*, OSHA defines it as:

> *"…a chemical existing in contiguous (nearby or in actual contact) areas under control in any group of vessels that are interconnected, or in separate vessels that are located in such proximity that it pose potential catastrophic release."* [20]

There are also exceptions for certain chemicals from complying with PSM and this has also been stated in 1910.119 paragraph (a).

Chemicals listed under this section hence are mandatory to comply with the section stating the EPR requirements: 1910.119 paragraph (n). 1910.119 (n) details out the EPR requirement for manufacturing companies complying with PSM:

> *"Develop and implement an emergency action plan (EAP) for the entire plant in accordance with the provisions of 29 CFR 1910.38. In addition, the emergency action plan shall include procedures for* ***handling small releases****. Employers covered under this standard may also be subject to the hazardous waste and emergency response provisions contained in 29 CFR 1910.120 (a), (p) and (q)"* [20]

From this statement, we know there are two other CFR that must be taken into account when developing an EPR along with developing procedures for small releases or spills. The 2 CFR involved are:

- 29 CFR 1910.38 *(Emergency Action Plan)*
- 29 CFR 1910.120 *(Hazardous Waste Operations and Emergency Response)*

CFR 1910.38 covers the basic elements when developing one's own EAP while CFR 1910.120 deals in detail the response procedures relating to toxic, flammable or explosive chemicals. Our framework later on will explain in detail the necessary requirements based on 3 different scenarios provided in 1910.120.

Furthermore, PSM also states the need for employers to provide procedures for small releases. From a given statement of OSHA's website in 1990, the following conditions must be met in order to classify it as an **emergency release** [21]:

1. The release or situation must pose an emergency. Examples are: it may cause high levels of exposures to toxic substances, it is life or injury threatening, employees must evacuate the area, it poses IDLH conditions, it poses a fire and explosion hazard (exceeds or has potential to exceed 25% of the LEL), it requires immediate attention because of danger, or presents an oxygen deficient condition. Nuisance spills, minor releases, etc., which do not require immediate attention (due to danger to employees) are not considered emergencies.
2. An ordinary spill that can be safely handled by the workers is not an emergency. Such employees must have the proper equipment and training under other OSHA standards such as the Hazard Communication Standard (1910.1200).

These requirements will further be looked into detail in the following sections.

2.2.2 Emergency Action Plan in CFR 1910.38

In this section, we see the requirements of 1910.28 for employers in preparing an emergency action plan for employees not covered under process areas. According to OSHA 29 CFR 1910.38, an Emergency Action Plan (EAP) is a:

> *"...written document which aims to organize an employer and employee's actions and responses during workplace emergencies"*

To comply with the first rule mentioned in PSM System, employers must comply and have a written EAP whenever an OSHA standard requires it to be

available. If an EAP is unavailable, they are advised to develop one within the contents of this section. However, organizations lesser than 10 people are exempted from developing this written document. They can opt to communicate the EAP orally.

To explain further the requirements of 1910.38, we see the minimum elements stated as a requirement for organizations to comply to when developing their EAP. This has been explained in 1910.38 paragraph (c) [13]:

1. **1910.38 (c) 1**: Procedures for reporting a fire or other emergency
2. **1910.38 (c) 2**: Procedures for emergency evacuation, including type of evacuation and exit route assignments
3. **1910.38 (c) 3:** Procedures to be followed by employees who remain to operate critical plant operations before they evacuate
4. **1910.38 (c) 4:** Procedures to account for all employees after evacuation
5. **1910.38 (c) 5:** Procedures to be followed by employees performing rescue or medical duties
6. **1910.38 (c) 6:** The name or job title of every employee who may be contacted by employees who need more information about the plan or an explanation of their duties under the plan.

Furthermore, employers are required to have and maintain an alarm system for the purpose of notifying all employees during time of egress. Employers are also required to ensure all employees have undergone basic training in knowing how to respond to emergencies or assist in evacuating others from a location.

The final element in preparing an EAP is the review process involved. 1910.38 has specified under paragraph (f) that employers should review the EAP with each employee covered by the plan whenever the plan changes or their responsibilities changes.

2.3.3 Hazardous Waste Operations and Emergency Response in CFR 1910.120

In this section we see in detail the 3 given scenarios 1910.120 has listed for users to categorize their procedures when handling hazardous wastes:

1. **1910.120 (a) 1 (i/ii/iii):**

   This part mentions the scope for **clean-up operations** (voluntary or otherwise) which might be required from any of the following parties: Governmental body, sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) under the US requirements or voluntary

clean up recognized by any governmental bodies as uncontrolled hazardous wastes.

Any scenarios complying with this section will be required to carry out emergency response procedures based on the requirements of **1910.120 (b) – (o).** These sections explain the basic elements needed when responding to clean up operations of hazardous wastes.

2. 1910.120 (a) 1 (iv):

This part includes the scope for operations involving hazardous wastes that are conducted at the following locations:

- Treatment facilities
- Storage facilities
- Disposal facilities

If an organization falls into this requirement, it will need to comply with all the requirements stated in that of **1910.120 (p)** only.

3. 1910.120 (a) 1 (v):

This part covers the scope for emergency response operations for releases or substantial threats of hazardous substances regardless of location. Organizations that fall into this category are subjected to comply with **1910.120 (q)** only.

2.2.3 Procedures for Small or Incidental Releases

This section looks in to how small or incidental releases should be handled in the context of PSM. 1910.119 (n) mentions the need for organizations to prepare procedures in handling small releases of highly hazardous chemicals in process areas. OSHA has defined in its website, small releases as incidental releases as well with the following criteria, differentiating it from emergency releases [21]:

- Release does not pose a significant safety or health hazard to employees in the immediate vicinity or to the employee cleaning it up
- Do not have the potential to become an emergency within a short time frame

- Limited in quantity, potential exposure, or toxicity and present minor safety or health hazards to employees in the immediate work area or those assigned to clean them up.

Emergency releases are the opposite of incidental release. Emergency releases are also known as major releases and pose immediate safety and health hazard to employees in the area. Besides that it may cause high levels of exposure to toxic or flammable substances which might pose Immediate Danger to Life & Health (IDLH) conditions.

After distinguishing the type of release, organizations can start planning for unwanted incidental releases of highly hazardous chemicals in the process area. In the case it happens, the employers must inform employees of the actions or procedures to take. If evacuation is to take place, then the emergency action plan shall be activated. For outdoor processes, employees must evacuate to a safe refuge area upwind of any release. For situations where certain employees are involved in cleaning up the incidental spill, it has been explained that procedures must be pre-planned and communicated upon implementation. The training was to include Hazard Communication standard training as well by addressing, identify and meet the training needs for employees expected to handle the release.

In developing the model later on, this section will be included prior to planning for an emergency release. It will be a compulsory section for users to check their existing EPR systems for this procedure.

2.3 Current Emergency Planning and Response Practices in Organizations

In this section we look into how organizations in Malaysia and abroad usually manage EPR and traits imposed as an extension of complying with federal, local or state laws. In an overview, emergency planning and response is seen as a physical design which provides a mean of escape along with the implementation of procedures and supporting equipment [9]. The general EPR comprises of the following generic elements [10, 20]:

1. Business specific information
2. Emergency contact section
3. Roles and responsibilities
4. Critical operations identifying safety critical operations
5. Evacuation plans
6. Communication plans

Additional EPR elements might include in more detail [22]:

1. Announcement of emergency conditions
2. Gathering of all emergency response team (ERT) and isolation of area
3. Leak prevention or emergency closure procedures
4. Report to incident commander
5. Initiate water mist facility
6. Medical team aid
7. Disaster evaluation
8. Outside communication
9. Disaster elimination efforts
10. Facing difficulties arising from incidents

In addition to this, let's take a look at Exxon Mobil's EPR system. They have established an EPR based on the acronym PEAR which stands for People, Environment, Assets and Reputation [11]. They integrate a tactical and strategic response procedure which determines the impact to all four entities of PEAR. From this, each unit in their business divisions are entitled to special teams specialised in responding to emergencies. These teams are called Emergency Support Group (ESG). ESG further extends into multiple teams in more detailed specialisation. For example,

Incident Command System is an integral part of the EPR and has a specialised team responsible for it.

Exxon Mobil has also produced their own model and process which integrates OSHA requirements as well as adding their own unique traits to it. They also have a rigorous drill trainings in all types of scenarios.

Figure 4: Exxon Mobil's EPR System based on classification of emergencies

Additionally, if we were to look at General Electric (GE) EPR, they presented in a more basic approach which fundamentally aims to comply with all local laws as a priority. They obtained their guidelines from National Fire Protection Agency (NFPA) OSHA and the Department of Homeland Security [23]. When planning their emergency respond they consider the impacts on surrounding community in respect to the severity of the incident.

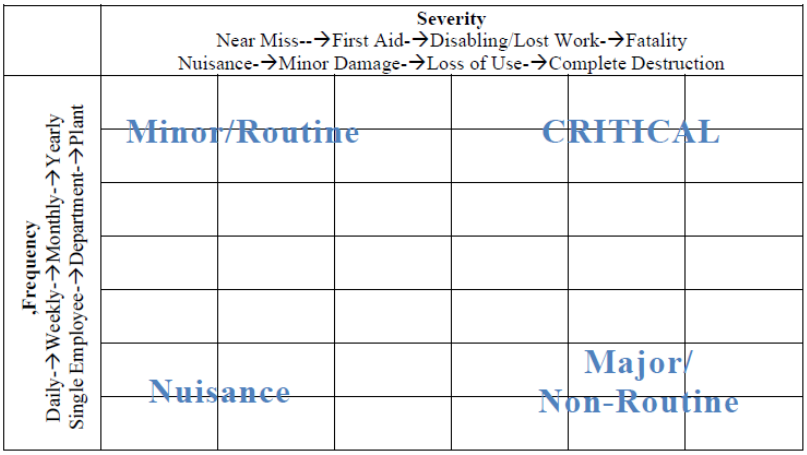

Figure 5: Severity Chart used by GE

From this we can conclude that companies are actively following the local laws set by OSHA and other equivalent governmental bodies. Organisations are free to implement the regulations in their own way and improve on it as they see fit.

Furthermore, below is a summarised table comparing PSM Standards and current Malaysian practise in managing EPR:

EPR Elements	US OSHA PSM	Malaysian OSHA
Small spills response	• CFR 1910.119 (n) • CFR 1910.1200 (Hazard Communication)	• Classification, labelling and safety data sheet (CLASS) 2014 Regulations
Emergency access & egress	• CFR 1910.38	• OSHA 1994 Section1 5 (Employer's Responsibilities)
Community response	• NA	• Control of Industrial Major Accident Hazards (CIMAH) 1996 Regulations
Emergency response to emergency situations (fire, explosion, chemical toxic release)	• CFR 1910.120 (p)	• CIMAH • Majlis Keselamatan Negara (MKN) 20 • Incident Command System (ICS)

Cleaning up operations after emergencies have been handled	• CFR 1910.120 (b) – (o)	• HSE Management System (MS) • Department of Environment (DOE) Regulations
Handling wastes after emergencies have been handled	• 1910.120 (p)	• CLASS 2014 Regulations • DOE Regulations

Table 1: Comparison between PSM Standards and Malaysian EPR Practices

All information were gathered after interviewing industrial practitioners and NIOSH trainers. We see that current Malaysian practices combine many Malaysian regulations and the PSM comprises all into minimal elements. After further reading, we found that the Malaysian regulations are not as comprehensive as PSM and that is why this study aims to produce a model to aid industry users to use PSM to complement existing management of EPR, instead of replacing it.

CHAPTER 3: METHODOLOGY

In this section we will highlight the following methodologies used in this project:

- Overview process
- Development of EPR Framework
- Development of EPR Model Prototype using Microsoft Access
- Usage of actual plant P&ID for validating the prototype
- Suggested milestones and Gantt chart

3.1 Overview Methodology

The methodology which will be used for developing the EPR model is as follows and the following sections will highlight mandatory steps in developing the framework:

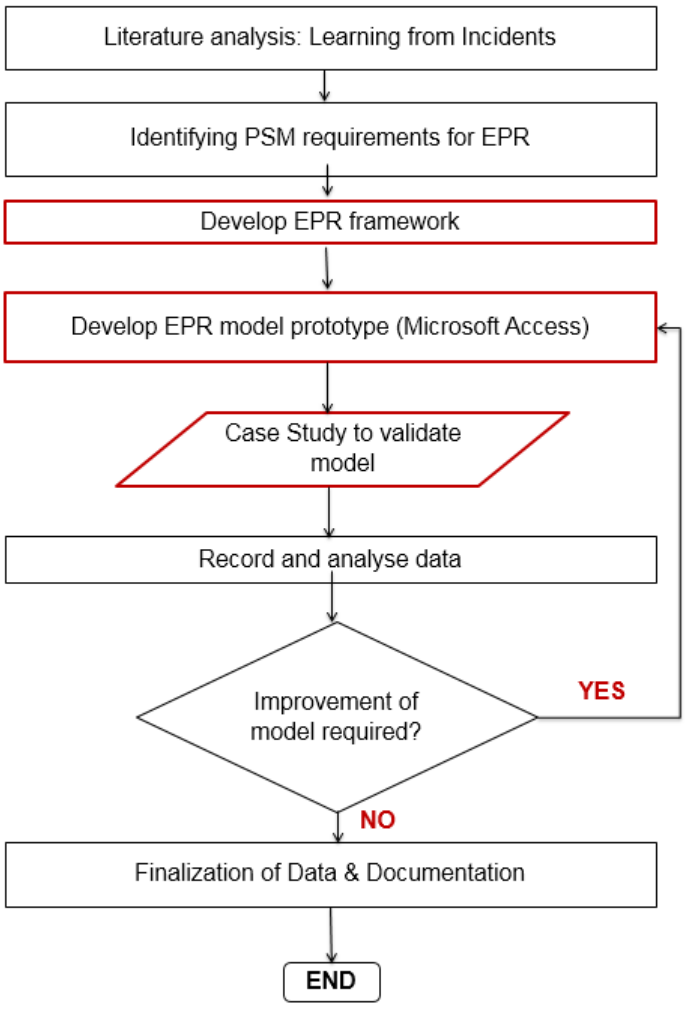

Figure 6: Project Activities

3.2 Development of EPR Framework

PSM requires the employer to meet certain requirements when planning for emergency response, but specific methodologies are not mentioned. The framework in Figure 7 summarises vital information and a strategy to manage EPR documentation and implement it as per PSM requirements. This framework acts as a basis for employers to manage their EPR in an organized matter, eliminating any gaps that might be overlooked.

Based on the framework developed, the user is required to obtain the inventory of the chemical of study and check if it is within the PSM scope based on its threshold quantity. The list of chemicals involved and the threshold quantity is listed in PSM 1910.119 Appendix A (it is located in this report as Appendix 7.4). Then the user is required to update or review documents pertaining to incidental or small releases and update emergency action plan procedures based on CFR 1910.38 (a).

The next step is determining the scope of the operation and if it is applicable for clean-up operations, waste handling and emergency responses to hazardous chemical releases. These scopes are mentioned in the section 1910.120 (a) 1 (i – v). By adhering to any of these scopes, the user is then required to complete standards listed by PSM. These standards include various procedures for responders' responsibilities, decontamination and waste handling, and chemical clean-up procedures. All of these procedures are included in the model developed in this study.

In addition to that, the procedure for engaging with communities for emergency response has also been included in this framework as an initiative to complement the development of EPR. Guidelines have been provided by the publication "Community Awareness and Emergency Response: Code of Management Practices" [24].

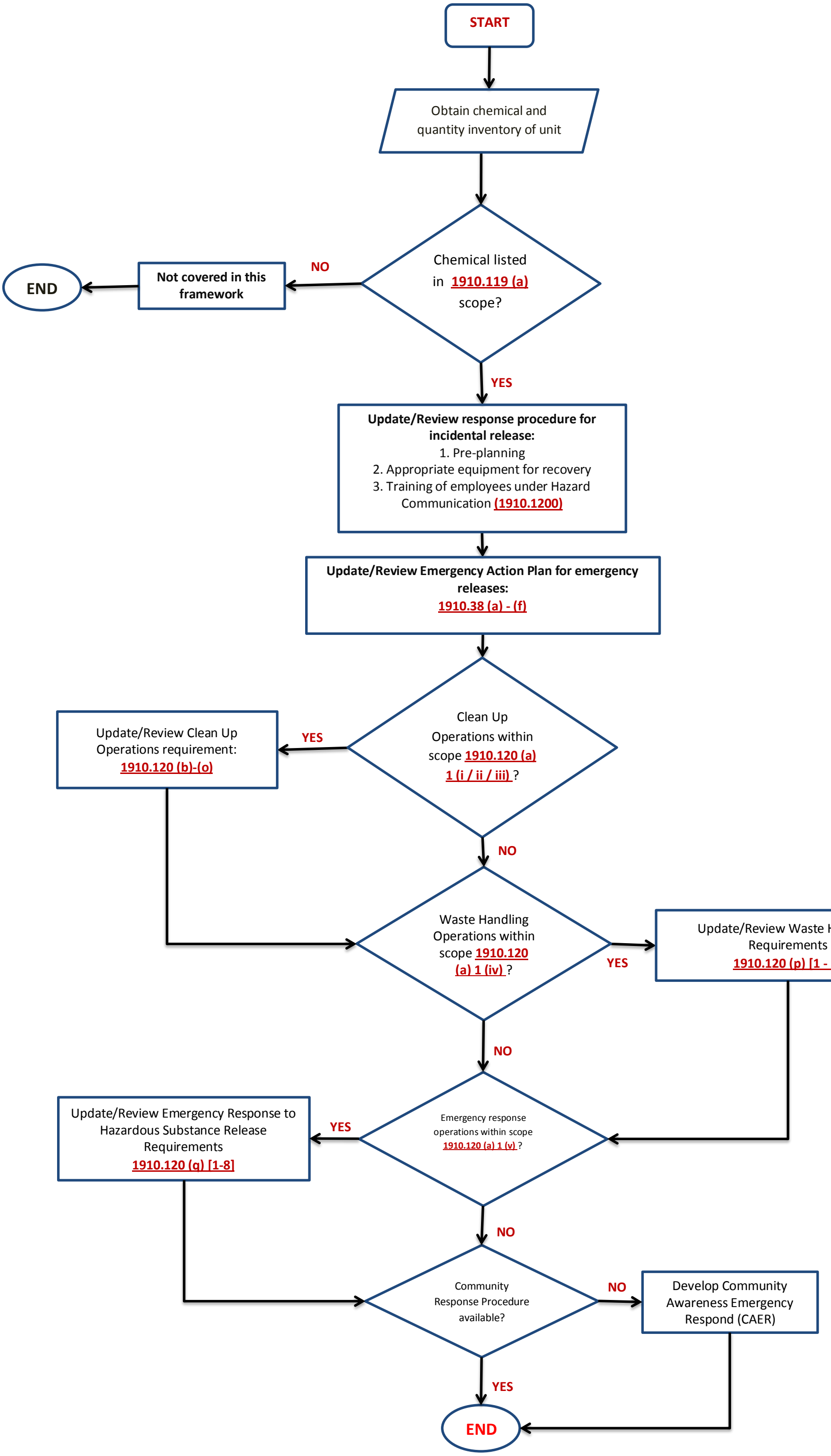

Figure 7: EPR framework suggested by this study

3.3 Development Prototype of EPR Model

A model was created using Microsoft Access which acts as a management database. This model displays all the PSM requirements for EPR which follows the framework in Figure 7. The prototype consists of six interfaces representing the above framework and one main page to keep the overall progress. All 6 interfaces have the function of tracking a specific standard's completion, proof of documentation and latest updated version, and staff accountable for closing any action items.

To utilise this model, the user first chooses a node or equipment and determines if there are any developed incidental or small spill procedures in place. These types of releases are categorised as small spills which can be safely handled by the organization's own employees who have had proper training. They are then required to update or develop an emergency action plan (EAP) which focuses more on personal safety such as evacuation of employees, medical rescue, training and methods in reporting incidents.

The user is then required to fulfil the requirements of clean-up operations based on the criteria met in the PSM Standards. Handling of wastes is the next step and this section is required for any handling of wastes conducted at any treatment, storage and disposal facilities, Furthermore, the emergency response operations procedure is developed or updated to cover scopes requiring any employees to respond to emergencies for any hazardous substance release.

The final stage is an additional step for users to ensure a communication programme is established between the employer and surrounding community regarding current hazards existing in the plant. This is to initiate a communication medium where communities can also give feedback or concerns and employers take necessary actions.

By completing any of the main requirements of Figure 7, users can tick their compliance in the main page of the model any incompliance will be easily traced and remarked.

3.4 Piping & Instrumentation Diagram (P&ID) as Basis for Case Study

For this study, it is recommended to organize the EPR management according to areas in the plant. Hence, users are suggested to utilize existing plant P&ID and selects a node or specific equipment to plan EPR management. Using P&ID as foundation is vital as it consists information of all equipment and auxiliaries in the plant. Furthermore, information regarding the process can be easily traced.

The P&ID can be divided into several nodes depending on type of equipment present in a certain area. This mode of analysis aids users in segregating different sections of the plant to be studied and ensure a wider area coverage. Once information has been compiled and updated for the selected equipment or stream, users can carry out the study using the model. The cycle continues until all nodes or equipment have been identified that requires emergency response planning.

The process of implementing the framework in Figure 7 in process plant is reflected in Figure 8.

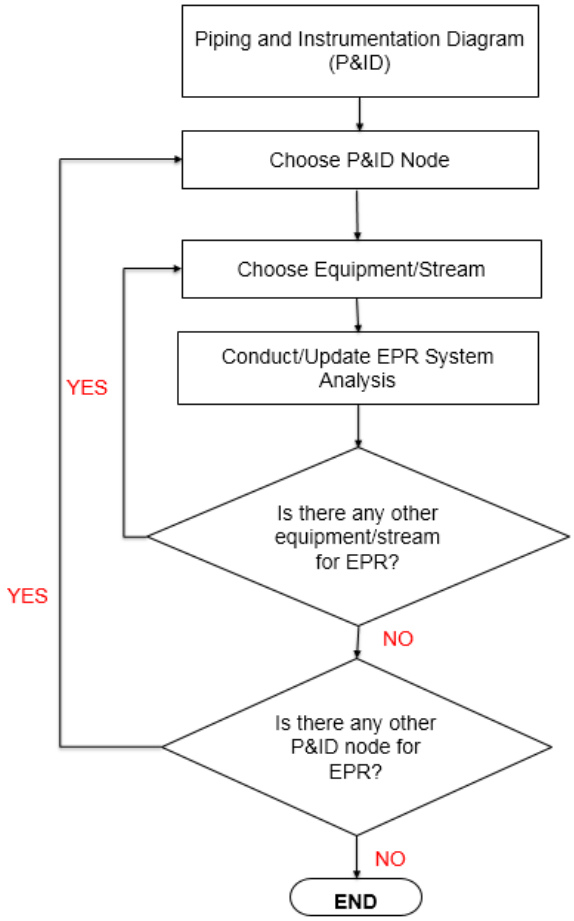

Figure 8: EPR model validated by using P&ID as a foundation

3.5 Key Milestones

Below is the Gantt chart for this project consisting of 2 semesters. The model will be developed and case studies carried out to determine its feasibility and practical use in the industry:

	Activities	Week No													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gantt Chart	Selection of Project Topic														
	Preliminary Research														
Milestone (1)	Familiarize and identify OSHA requirements														
Gantt Chart	Study incidents related to EPR to identify gaps														
	Study current organization's EPR systems														
Milestone (2)	Identify gaps and improvement methods														
Milestone (3)	Submission of extended proposal														
	Proposal defence														
Gantt Chart	Develop EPR Framework & familiarize with Access software														
	Learn from previous models developed														
Milestone (4)	Develop finalized EPR framework in compliance with PSM Systems														
Milestone (5)	Submission of draft interim report														
	Submission of interim report														

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
Gantt Chart	Develop Access model based on EPR framework created														
	Test run model and collect data for analysis														
	Diagnosis and troubleshooting														
Milestone (1)	Testing and diagnose of feasibility of prototype														
Milestone (2)	Submission of Progress Report														
Gantt Chart	Remodelling and retesting of data														
Milestone (3)	Finalizing model final data collection and comparison														
Milestone (4)	Pre-Sedex														
Milestone (5)	Submission of draft final report														
Milestone (6)	Submission of dissertation (soft bound)														
	Submission of Technical Paper														
Milestone (7)	Viva														
	Submission of Project Dissertation (Hard Bound)														

Table 3: Gantt chart & milestone for FYP2

Key milestones for this project for this semester includes:

- Literature review of related materials for EPR including learning from incidents & identification of OSHA PSM Standard requirements for EPR
- Development of EPR framework & EPR model prototype
- Case study of model in actual process industry
- Analysis of results from case study
- Documentation

CHAPTER 4: RESULTS & DISCUSSION

To validate the feasibility of our EPR model, a case study was conducted using real data from a local oil and gas refinery in Malaysia, dubbed as Plant X for confidentiality purposes. This section displays the functionality of the model and its feasibility in the industry. How the model interfaces function shall also be discussed here. For demonstration, one node is selected in the process area of Plant X and shall be presented here.

Referring to the process suggested in Figure 8, Figure 9 shows the overview of Plant X's utilities area. This overall plant layout of the utilities area was divided into several nodes according to its design as a utilities area. Despite this case study not having obtained the real P&ID data, it has been demonstrated that using any plant information to be segregated is applicable in this study. Although the ideal situation would be to obtain a P&ID documentation.

The red circle indicates the location of the hydrochloric storage tank, T-3280, in Node 1, which is the main focus of this case study. T-3280 stores aqueous hydrochloric acid (HCl) which is used for adjusting pH of water streams which are used in processes. HCl is stored in the utilities area in amounts exceeding 1000 kg. For this case study, the scenario is the release of HCl to the surrounding area and how the situation is mitigated through EPR management.

The current EPR Plant X has set for HCl is to be cross-checked with the model that has been developed in this study. The model aims to highlight any gaps Plant X has in complying with PSM requirements.

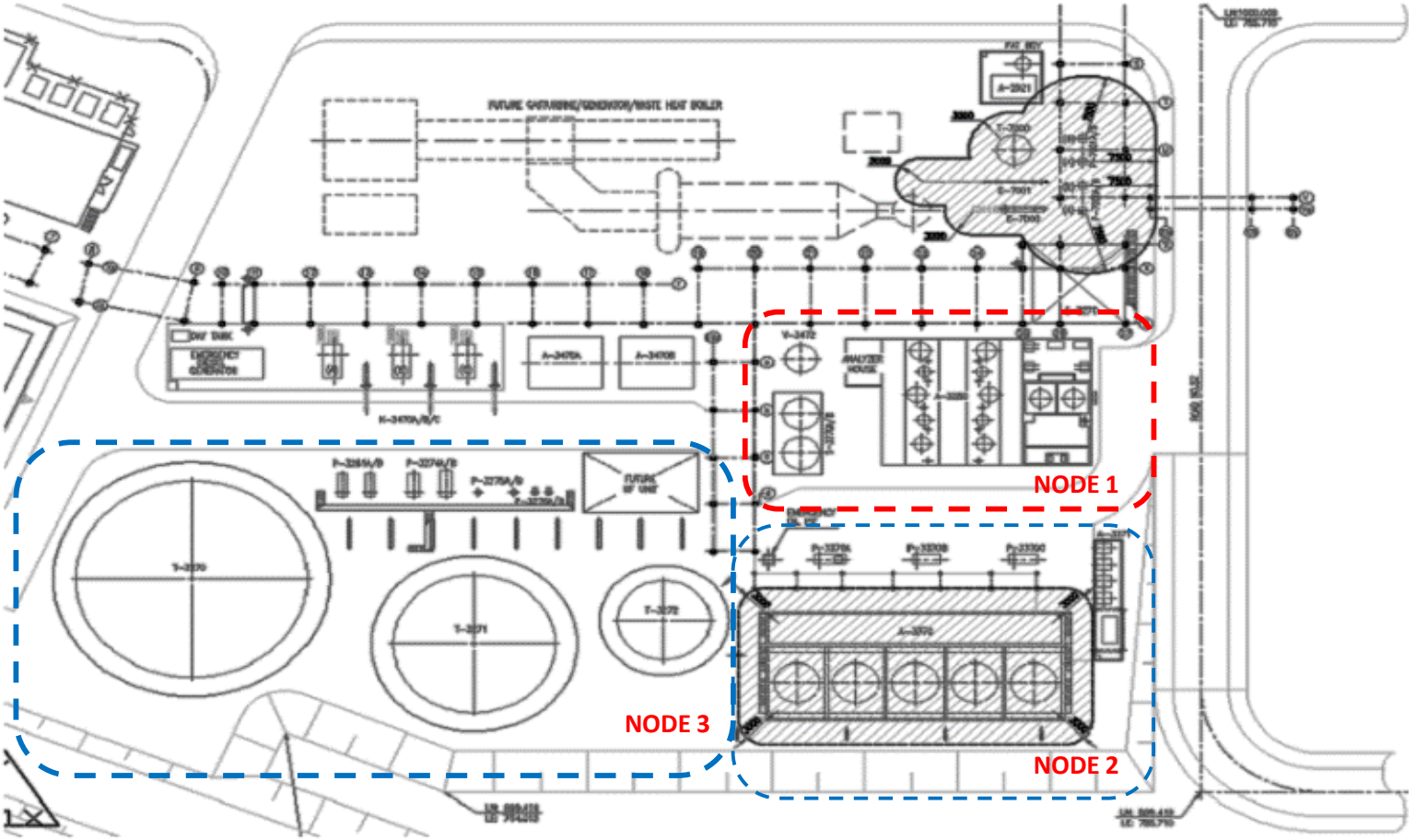

Figure 9: Node 1 selected to conduct case study on

4.1 EPR Requirements Main Page

This section highlights Figure 10 which reflects the main page of the EPR model that consists the columns 'EPR Requirement', 'Compliance', 'Remarks', 'Action By', and 'Due Date'. This main page serves as a central control system based on the framework (Figure 7) which gives an overview of user's compliance with PSM.

This page captures data for easy monitoring and tracking of incomplete items as well as accountable persons and when the action items should be completed. Any incomplete sections can be verified with further information under "Remarks".

From Figure 10, 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. From this main page Plant X can know which areas they are currently having difficulties in complying with. It makes it easier to pinpoint gaps and identify employees accountable for closing these action items. This is seen from the initials "ZA" in the 'Action By' column and ZA is responsible in ensuring all of the items are closed by March 2015.

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

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

Figure 10: EPR Requirements

4.2 Incidental Releases

In this section, users will need to prepare a procedure for incidental or small releases of chemicals. These types of releases are categorized as non-emergency which do not cause immediate danger to surrounding workers and can be handled by trained employees using the right equipment [21].

Hence, PSM Standard requires for users to initiate a pre-planning of responding to small releases, the equipment of recovery and provide the necessary training for employees. These elements are reflected in a written document and the model in Figure 11 keeps track of the users' progress using a checklist. The model also allows users to manage names and locations of reports which can be in the form of online or hardcopy version. These columns ensure that the documents will still be easily traced in the event a change in the organization's resources occur.

The column "Last Updated" has also been added to allow users to be aware of the necessity of updating documents. This column gives an indication of how well documents are reviewed and implemented in the work site. Good implementation gives way to documentation being periodically reviewed constantly. Furthermore, the period of review and updating the document is solely based on the user's convenience and needs. For this purpose, the model allows users to identify accountable persons and due dates for when the section needs to be updated or completed.

From Figure11, Plant X has fully completed all of these requirements by having its own pre-incident planning (PIP) document.

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

Requirement	Complete	Incomplete	Name of Report	Evidence Location	Last Update	Remarks	Action by	Due Date	Click to Add
Pre-Planning	☑	☐	PIP32072 - U3270	C:\Plant X EPR\PIP32702-Hydrochloric Acid (HCL) Leak at Process Area..pdf	20/5/2014				
Equipment for recovery	☑	☐	PIP32072 - U3270	C:\Plant X EPR\PIP32702-Hydrochloric Acid (HCL) Leak at Process Area..pdf	20/5/2014				
Training	☑	☐	HSSE-ERP	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014				

Figure 11: Incidental Releases

4.3 Emergency Action Plan (EAP)

Figure 12 shows the requirements for organizations in implementing an EAP (CFR 1910.38). EAP is a written document which highlights procedures for employees not covered under process areas. EAP consists methods of reporting incidents, evacuation and performing rescue and medical duties. Users are also required to develop or update their EAP and include the procedures of alarm systems, training employees for evacuation and reviewing the document according to the organization's policies. The checklist method implemented in the interface (Figure 12) allows users to monitor their progress.

Furthermore, certain requirements of the model may have substandard which are additional requirements set by PSM. Figure 13 shows an example of how substandards are checked for "Minimum elements of EAP 1910.38 (c)". This substandard tracks all related documents containing the information along with the location stored and last updated date. Any additional information can be included in the "Remarks" column and users can also describe their own practices in the "Description" column.

Based on Figure 12, Plant X has completed all the requirements of the EAP and these information are available in their document labelled "HSSE-ERP".

EPR Requirement | Incidental Releases | **Emergency Action Plan** | Clean Up Operatio... | Waste Handling Requirements | ER to Hazardous Substance Release Requirements

Standard	Description	Complete	Incomplete	Remarks	Action By	Due Date
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 12: Emergency Action Plan (EAP)

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

Sub Standard	Requirements	Description	Available	Not Available	Name of Report	Evidence Location	Last Updated	Remarks
1910.38 (c) 1	Procedures for reporting a fire or other emergency		☑	☐	HSSE-ERP: Section 8 Communications & control	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014	
1910.38 (c) 2	Procedures for emergency evacuation, including type of evacuation and exit route assignments		☑	☐	HSSE-ERP: Section 5.4 SRC Evacuation Procedure	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014	
1910.38 (c) 3	Procedures to be followed by employees who remain to operate critical plant operations before they evacuate		☑	☐	HSSE-ERP: Section 3 SRC ICS Organization	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014	
1910.38 (c) 4	Procedures to account for all employees after evacuation		☑	☐	HSSE-ERP: Section 5.4 SRC Evacuation Procedure	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014	
1910.38 (c) 5	Procedures to be followed by employees performing rescue or medical duties		☑	☐	HSSE-ERP: Section 5.7 Emergency Operation & Mitigation	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014	
1910.38 (c) 6	The name or job title of every employee who may be contacted by employees who need more information about the plan or an explanation of their duties under the plan		☑	☐	HSSE-ERP: Records of Amendment	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014	

Figure 13: Substandard for 1910.38 (c) Minimum Elements of an EAP

4.4 Clean Up Operations

If organizations need to comply with any local federal or state regulations in conducting clean-up operations after an emergency situation occurs, then this section needs to be filled out. For example, Plant X adheres to local regulations set by Malaysian Department of Environment (DOE) for the spillage of HCl. The model in Figure 14 displays the application of PSM to suit local regulations.

By adhering to clean-up regulations, there are 14 elements in this model that users have to comply with (Figure 14). Each standard has their own substandard and users will check accordingly. This model allows users to monitor documents' completion within the 14 elements and remark any non-compliance. Only by fulfilling the elements in the substandard can the user tick "Complete" in the main interface. For instance, in Figure 14, Plant X's clean-up operation reflects an incomplete information on training, decontamination procedures, illumination and sanitation at temporary work places erected in emergency locations. Using Sanitation of Temporary Work Place 1910.120 (n) as an example, Figure 15 reflects which substandard Plant X did not have information on in its documents.

EPR Requirement | Incidental Releases | Emergency Action Plan | **Clean Up Operations** | Waste Handling Requirements | ER to Hazardous Substance Release Requirements | Community EPR

Standard	Description	Complete	Incomplete	Remarks	Action By	Due Date
1910.120 (b)	Safety & Health Programme	☑	☐			
1910.120 (c)	Site Characterization Analysis	☑	☐			
1910.120 (d)	Site Control	☑	☐			
1910.120 (e)	Training	☐	☑	Elements of training or exemptions are not included in procedures	ZO	6/3/2015
1910.120 (f)	Medical Surveillance	☑	☐			
1910.120 (g)	Engineering Controls, Work Practices & PPE	☑	☐			
1910.120 (h)	Monitoring	☑	☐			
1910.120 (i)	Informational Program	☑	☐			
1910.120 (j)	Handling Drums & Containers	☑	☐			
1910.120 (k)	Decontamination	☐	☑	No decontamination procedure found for HCl	FR	27/3/2015
1910.120 (l)	Emergency Response by Employees at Uncontrolled Hazardous Waste Sites	☑	☐			
1910.120 (m)	Illumination	☐	☑	Not mentioned in any document	FF	27/3/2015
1910.120 (n)	Sanitation at Temporary Work Place	☐	☑	Supply of potable water, temporary toilet facilities and temporary sleeping quarters not mentioned	FF	27/2/2015
1910.120 (o)	New Technology Programme	☑	☐			

Figure 14: Clean Up Operations

EPR Requirement | Incidental Releases | Emergency Action Plan | **Clean Up Operations** | Waste Handling Requirements | ER to Hazardous Substance Release Requirements | Community EPR

Standard	Description	Complete	Incomplete	Remarks	Action By	Due Date	*Click to Add*
1910.120 (n)	Sanitation at Temporary Work Place	☐	☑	Supply of potable water, temporary toilet facilities and temporary sleeping quarters not mentioned	FF	27/2/2015	

Sub-Standard	Requirements	Descriptions	Available	Not Available	Location of Report	Evidence Location	Last Updated	Remarks
1910.120 (n) 1	Adequate supply of potable water for dispensing drinking water is to be provided, marked and equipped with a tap	Mention of drinking water supply in general	☑	☐	HSSE-SIG-P019 (Food & Drinking Water Safety)	C:\Plant X EPR\hsse_sig_p019_Food.pdf	25/8/2014	
1910.120 (n) 2	Non-potable water, such as for fire fighting purposes, shall be identified and no cross-connection with potable water system		☐	☑				No mention of water for fire fighting purposes
1910.120 (n) 3	Toilet facilities provided for all employees even for temporary field conditions (special toilets) unless prohibited by local laws		☐	☑				NA
1910.120 (n) 4	Food handling facilities must meet applicable laws, ordinances and regulations of jurisdiction of location	Food Hygiene Regulations 2009	☑	☐	HSSE-SIG-P019 (Food & Drinking Water Safety)	C:\Plant X EPR\hsse_sig_p019_Food.pdf	25/8/2014	
1910.120 (n) 5	If temporary sleeping quarters are required, it shall be heated, ventilated and lighted		☐	☑				Not mentioned
1910.120 (n) 6	Washing facilities provided for employees engaged in operations where hazardous substances may be harmful to them.		☑	☐	DOSH USECHH Legal Resiter	Hard Copy in HSSE Department	22/8/2014	
1910.120 (n) 7	Showers and change rooms provided for employeesexposed to hazardous substances operations for more than 6 months.		☑	☐	Safety Shower Eyewash Checklist	C:\Plant X EPR\hsse_saf_p029_Safety_Shower_Eyewash.pdf	22/3/2009	
1910.120 (n) 7	Showers located in areas with low exposure and a ventilation system provided. They are required to shower before leaving the workplace		☑	☐	Safety Shower Eyewash Checklist	C:\Plant X EPR\hsse_saf_p029_Safety_Shower_Eyewash.pdf	22/3/2009	

Figure 15: Substandards of 1910.120 (n) Clean Up Operations

4.5 Waste Handling Requirements

This section applies to organizations complying with any local regulations of waste handling involved in any operations at treatment, storage or disposal. The interface of the model for this section consists of 8 elements to be complied with respective substandards. The model includes checking for hazard communication methods, medical surveillance for affected employees, training for employees handling the wastes, decontamination procedures, implementation of new equipment in the work site and how wastes are handled.

For the spillage of HCl, Plant X adheres to Malaysia DOE regulations in handling wastes. Hence, this section is applicable to be complied with. From Figure 16, it is seen that Plant X has incomplete information for trainer's competency and methods of decontaminating affected areas and equipment contaminated with HCl. The person responsible and due date are filled in the appropriate columns.

EPR Requirement | Incidental Releases | Emergency Action Plan | Clean Up Operatio... | **Waste Handling Requirements** | ER to Hazardous Substance Release Requirem

Standard	Description	Complete	Incomplete	Remarks	Due Date	Action By
1910.120 (p) 1	Safety & Health Program	☑	☐			
1910.120 (p) 2	Hazard Communication Program (1910.1200)	☑	☐			
1910.120 (p) 3	Medical Surveillance Program (1910.120 (f))	☑	☐			
1910.120 (p) 4	Decontamination Program (1910.120 (k))	☐	☑	No decontamination procedure found for HCl	10/3/2015	FR
1910.120 (p) 5	New Technology Program (1910.120 (o))	☑	☐			
1910.120 (p) 6	Material Handling Program (1910.120 (j))	☑	☐			
1910.120 (p) 7	Training Program	☐	☑	No information of trainer's competency	11/3/2015	ZS
1910.120 (p) 8	Emergency Response Program	☑	☐			

Figure 16: Waste Handling Model

4.6 Emergency Response to Hazardous Substance Release

This section applies to organizations who have employees engaged in emergency response regardless of the location. The spillage of HCl can potentially cause a vapor cloud to occur, and this section is required for users to check for.

Figure 17 shows the interface of the model which displays 11 requirements for this section covering procedures of mitigating, decontamination, support personnel, training, medical duties and PPE. All 11 requirements have substandard which must also be complied with. The interface allows users to track their compliance and describe their practices and specific documents which contain these information, along with identifying persons responsible in closing any action items. Furthermore, the Post Emergency Response Operations 910.120 (q) 11 standard refers to the entire Clean Up Operations model. For users to tick "Complete" for this standard, the Clean Up Operations model must be fully completed.

Based on Figure 17, Plant X did not comply with decontamination procedures and training contents for their responders and trainers. They had incomplete information for decontamination procedures as mentioned in the Waste Handling section. Its training content did not document how trainers' competencies are verified either.

EPR Requirement | Incidental Releases | Emergency Action Plan | Clean Up Operatio... | Waste Handling Requirements | ER to Hazardous Substance Release Requirements

Standard	Description	Complete	Incomplete	Remarks	Action By	Due Date
1910.120 (q) 1	ERP in writing	☑	☐			
1910.120 (q) 2	Elements of ERP	☑	☐			
1910.120 (q) 3	Procedures of ERP	☐	☑	No decontamination procedure found for HCl	FR	10/3/2015
1910.120 (q) 4	Skilled Support Personnel	☑	☐			
1910.120 (q) 5	Specialist Employees	☑	☐			
1910.120 (q) 6 (i)	Training First Responder Awareness Levels	☐	☑	No information on training contents.	ZO	6/3/2015
1910.120 (q) 6 (ii)	Training First Responder Operations Levels	☐	☑	No information on training contents.	ZO	6/3/2015
1910.120 (q) 6 (iii)	Training HAZMAT Technician	☐	☑	No information on training contents.	ZO	6/3/2015
1910.120 (q) 7	Trainers	☑	☐			
1910.120 (q) 8	Training Refreshers	☑	☐			
1910.120 (q) 9	Medical Surveillance and Consultation	☑	☐			
1910.120 (q) 10	Chemical Protective Suit	☑	☐			
1910.120 (q) 11	Post Emergency Response Operations	☐	☑	Check for Clean Up Operations section incomplete	ZA	2/3/2015

Figure 17: Emergency Response to Hazardous Substance Release

4.7 Community Emergency Planning Response

This section is not mentioned by PSM Standards and is an added feature to complement the model. Community emergency response is vital to ensure that smooth evacuation and coordination happens in a tragic event [10, 19] which can be considered when developing the EPR system. For this technique, we referred to Community Awareness and Emergency Response: Code of Management Practises published by Chemical Industries Council Malaysia [24] to develop the model.

Figure 18 displays the interface of the model and specific criteria in establishing solid communication between organization and community. The interface covers the following:

- How community's concerns or questions are being held
- How communities are educated about present hazards in the plant
- Continuing dialogue between community and organization
- Openness policy for communities to understand surrounding hazards or risks
- Evaluation of effectiveness of communication between organization and community

The model allows users to monitor the availability of these requirements, location of report and when it was last updated. Users can also describe current practises, add additional information in the "Remarks" column and state persons accountable in updating the document. Based on Figure 18, Plant X has all of these information available in its respective document.

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

Requirements	Description	Complete	Incomplete	Name of Report	Evidence Location	Last Updated	Remarks	Action By	Due Date
An on-going assessment of community questions and concerns about the plant.	Describe how Public Complaints are handled	☑	☐	HSSE-ERP: Section 9.4 Interaction with the fenceline community	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014			
An outreach programme to educate responders, government officials, the media, other businesses and the community about the facility's emergency response programme and risks to the community associated with the facility.	Community representatives are selected and responsible as medium of communicators to the other communities	☑	☐	HSSE-ERP: Section 9.4 Interaction with the fenceline community	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014			
A continuing dialogue with local community to respond to questions and concerns about HSE and to address other issues of interest to the community	Describe how Public Complaints are handled	☑	☐	HSSE-ERP: Section 9.4 Interaction with the fenceline community	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014			
A policy of openness that provides convenient ways for interested persons to become familiar with the facility; its operations and products and the efforts to protect SHE	any plant upsets/nuisance are immediately informed to the community	☑	☐	HSSE-ERP: Section 9.4 Interaction with the fenceline community	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014			
A regular evaluation of the effectiveness of the on-going community communications efforts	Evaluation done with public complaint received	☑	☐	HSSE-ERP: Section 9.4 Interaction with the fenceline community	C:\Plant X ERP\HSSE-ERP.pdf	1/12/2014			

Figure 18: Community EPR

CHAPTER 5: CONCLUSION

A systematic approach towards the EPR element for PSM implementation in process industries is presented in this paper to comply with the requirements of CFR 1910.119 (n). A framework for EPR requirements has been developed based on PSM Standards. Furthermore, a model has been developed based on this framework with features which allows users to track documents easily and provide a basis for gap analysis to be carried out. This assists users to better manage their EPR system and improve accordingly. The model utilizes P&ID as the foundation to conduct studies on as it consists most information of a plant. The conducted case study was done in a local refinery in Malaysia and results have shown how the model aids users in managing EPR in compliance with PSM Standards. Users have a bigger overview of what they are complying with and what gaps exist in their system. The findings conclude that this concept and structured technique is feasible and has the potential to be implemented in the industries. This proposed technique can also be used by organizations and customized to develop similar models in order to ensure that emergency response can be well planned and managed in real life situations.

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CHAPTER 7: APPENDIX

7.1 1910.38: Emergency Action Plan

1910.38 : Emergency Action Plan		
PSM Elements	**Standard**	**Description of Standard**
Application	38 (a)	Employer must have an emergency action plan whenever an OSHA standard in this part requires one. The requirements in this section apply to each such emergency action plan
Written and oral emergency action plans	38 (b)	An emergency action plan must be in writing, kept in the workplace, and available to employees for review. However, an employer with 10 or fewer employees may communicate the plan orally to employees.
Minimum elements of an emergency action plan	38 (c)(1)	Procedures for reporting a fire or other emergency
	38 (c)(2)	Procedures for emergency evacuation, including type of evacuation and exit route assignments
	38 (c)(3)	Procedures to be followed by employees who remain to operate critical plant operations before they evacuate
	38 (c)(4)	Procedures to account for all employees after evacuation
	38 (c)(5)	Procedures to be followed by employees performing rescue or medical duties
	38 (c)(6)	The name or job title of every employee who may be contacted by employees who need more information about the plan or an explanation of their duties under the plan
Employee Alarm System	38 (d)	An employer must have and maintain an employee alarm system. The employee alarm system must use a distinctive signal for each purpose and comply with the requirements in § 1910.165
Training	38 (e)	An employer must designate and train employees to assist in a safe and orderly evacuation of other employees
Review of emergency action plan	38 (f)(1)	An employer must review the emergency action plan with each employee covered by the plan when the **plan is developed or the employee is assigned initially to a job**;
	38 (f)(2)	An employer must review the emergency action plan with each employee covered by the plan when the **employee's responsibilities under the plan change**
	38 (f)(3)	An employer must review the emergency action plan with each employee covered by the plan when the **plan is changed**

Table 4: 1910.38 Emergency Action Plan Requirements

7.2 1910.119: Process Safety Management of Highly Hazardous Chemicals (Scope & Application)

1910.119: Process safety management of highly hazardous chemicals.		
Info: preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. These releases may result in toxic, fire or explosion hazards.		
PSM Elements	**Standard**	**Description of Standard**
Application	119 (a) 1 (i)	A process which involves a chemical at or above the specified threshold quantities listed in appendix A to this section
	119 (a) 1 (ii)	A process which involves a **flammable liquid or gas** (as defined in 1910.1200(c) of this part) on site in one location, in a quantity of 10,000 pounds (4535.9 kg) or more except for: (A) Hydrocarbon fuels used solely for workplace consumption as a fuel (e.g., propane used for comfort heating, gasoline for vehicle refueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by this standard; (B) Flammable liquids stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration.
	119 (a) 2	This section **does not apply** to: (i) Retail facilities; (ii) Oil or gas well drilling or servicing operations; or, (iii) Normally unoccupied remote facilities.

Table 5: 1910.119 Process Safety Management of Highly Hazardous Chemicals (Scope & Application)

1910.119: Process safety management of highly hazardous chemicals.		
PSM Elements	**Standard**	**Description of Standard**
Emergency Planning and Response	119 (n)	Develop and implement an emergency action plan for the entire plant in accordance with the provisions of 29 CFR 1910.38. In addition, the emergency action plan shall include procedures for handling small releases. Employers covered under this standard may also be subject to the hazardous waste and emergency response provisions contained in 29 CFR 1910.120 (a), (p) and (q).

Table 6: 1910.119 (n) Emergency Planning and Response

7.3 1910.120 (a), (p) & (q): Hazardous Waste Operations and Emergency Response

1910.120 : Hazardous Waste Operations and Emergency Response		
PSM Elements	**Standard**	**Description of Standard**
CFR 1910.120(a) : Scope, Applications & Definitions		
Scope	120 (a)(1)(i)	Scope for **clean-up operations** required by a governmental body, whether Federal, state, local or other involving hazardous substances that are conducted at uncontrolled hazardous waste sites (including, but not limited to, the EPA's National Priority Site List (NPL), state priority site lists, sites recommended for the EPA NPL, and initial investigations of government identified sites which are conducted before the presence or absence of hazardous substances has been ascertained)
	120 (a)(1)(ii)	Scope for **corrective actions involving clean-up operations** at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 U.S.C. 6901 et seq.);
	120 (a)(1)(iii)	Scope for **voluntary clean-up operations** at sites recognized by Federal, state, local or other governmental bodies as uncontrolled hazardous waste sites
	120 (a)(1)(iv)	Scope for operations involving **hazardous wastes that are conducted at treatment, storage, and disposal** (TSD) facilities regulated by 40 CFR parts 264 and 265 pursuant to RCRA; or by agencies under agreement with U.S.E.P.A. to implement RCRA regulations
	120 (a)(1)(v)	Scope for **emergency response operations for releases of, or substantial threats of releases of, hazardous substances** without regard to the location of the hazard.
Applications	120(a)(2)(i)	All requirements of part 1910 and part 1926 of title 29 of the Code of Federal Regulations apply pursuant to their terms to hazardous waste and emergency response operations whether covered by this section or not. If there is a conflict or overlap, the provision more protective of employee safety and health shall apply without regard to 29 CFR 1910.5(c)(1)
	120(a)(2)(ii)	Hazardous substance clean-up operations within the scope of paragraphs (a)(1)(i) through (a)(1)(iii) of this section must comply with all paragraphs of this section except paragraphs (p) and (q)
	120(a)(2)(iii)	Operations within the scope of paragraph (a)(1)(iv) of this section must comply only with the requirements of paragraph (p) of this sect
	120(a)(2)(iv)	Emergency response operations for releases of, or substantial threats of releases of, hazardous substances which are not covered by paragraphs (a)(1)(i) through (a)(1)(iv) of this section must only comply with the requirements of paragraph (q) of this section

Definitions	120(a)(3)	Definitions given for: - Buddy System - Clean Up Operation - Decontamination - Emergency Response - Facility - Hazardous Materials Response Team (HAZMAT) - Hazardous substance - Hazardous waste - Hazardous waste operation - Hazardous waste site - Health Hazard - Immediately dangerous to life (IDLH) - Oxygen deficiency - Permissible exposure limit (PEL) - Published exposure level - Post emergency reponse - Qualified person Site safety and health supervisor - Small quantity generator - Uncontrolled hazardous waste site

Table 7: 1910.120 (a) Scope for EPR Requirements

CFR 1910.120(p) : Certain Operations Conducted Under the Resource Conversation and Recovery Act of 1976 (RCRA)		
Safety and Health Program	120(p)(1)	The employer shall develop and **implement a written safety and health program** for operations that shall be available for inspection by employees, their representatives and OSHA personnel. The program shall be designed to **identify, evaluate and control safety and health hazards** in their facilities for the purpose of employee protection, to provide for emergency response meeting the requirements of paragraph (p)(8) of this section and to address as appropriate site analysis, engineering controls, maximum exposure limits, hazardous waste handling procedures and uses of new technologies
Hazard Communication Program	120(p)(2)	The employer shall implement a hazard communication program meeting the requirements of 29 CFR 1910.1200 as part of the employer's safety and program.
Medical Surveillance Program	120(p)(3)	The employer shall develop and implement a medical surveillance program meeting the requirements of paragraph (f) of this section.
Decontamination Program	120(p)(4)	The employer shall develop and implement a decontamination procedure meeting the requirements of paragraph (k) of this section
New technology Program	120(p)(5)	The employer shall develop and implement procedures meeting the requirements of paragraph (o) of this section for introducing new and innovative equipment into the workplace
Material handling Program	120(p)(6)	Where employees will be handling drums or containers, the employer shall develop and implement procedures meeting the requirements of paragraphs (j)(1) (ii) through (viii) and (xi) of this section, as well as (j)(3) and (j)(8) of this section prior to starting such work

Training Program (i) New Employees	120(p)(7)(i)	The employer shall develop and implement a training program, which is part of the employer's safety and health program, for employees exposed to health hazards or hazardous substances at TSD operations to enable the employees to perform their assigned duties and functions in a safe and healthful manner so as not endanger themselves or other employees. The initial training shall be for **24 hours and refresher training shall be for eight hours annually**. Employees who have received the initial training required by this paragraph shall be given a written certificate attesting that they have successfully completed the necessary training.
Training Program (ii) Current employees	120(p)(7)(ii)	Employers who can show by an employee's previous work experience and/or training that the employee has had training equivalent to the initial training required by this paragraph, shall be **considered as meeting the initial training requirements** of this paragraph as to that employee. Equivalent training includes the training that existing employees might have already received from actual site work experience. Current employees shall receive **eight hours of refresher training annually**
Training Program (iii) Trainers	120(p)(7)(iii)	Trainers who teach initial training shall have satisfactorily completed a training course for teaching the subjects they are expected to teach or they shall have the academic credentials and instruction experience necessary to demonstrate a good command of the subject matter of the courses and competent instructional skills.
Emergency response plan	120(p)(8)(i)	An emergency response plan shall be developed and implemented by all employers. The emergency response plan shall be a written portion of the employer's safety and health program required in paragraph (p)(1) of this section. Employers who will evacuate their employees from the worksite location when an emergency occurs and who do not permit any of their employees to assist in handling the emergency are exempt from the requirements of paragraph (p)(8) if they provide an emergency action plan complying with 29 CFR 1910.38

Elements of Emergency Response	120 (p)(8)(ii)	The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following areas to the extent that they are not addressed in any specific program required in this paragraph: (A) Pre-emergency planning and coordination with outside parties. (B) Personnel roles, lines of authority, and communication. (C) Emergency recognition and prevention. (D) Safe distances and places of refuge. (E) Site security and control. (F) Evacuation routes and procedures. (G) Decontamination procedures. (H) Emergency medical treatment and first aid. (I) Emergency alerting and response procedures. (J) Critique of response and followup. (K) PPE and emergency equipment.
Training for ER Employees	120 (p)(8)(iii)(A)	*(A)* Training for emergency response employees shall be **completed before they are called upon to perform in real emergencies**. Such training shall include the elements of the emergency response plan, standard operating procedures the employer has established for the job, the personal protective equipment to be worn and procedures for handling emergency incidents.
Training for members of TSF facility	120 (p)(8)(iii)(B)	(B) Employee members of **TSD facility** emergency response organizations shall be trained to a level of competence in the recognition of health and safety hazards to protect themselves and other employees.
Training Documentation	120 (p)(8)(iii)(C)	(C) The method used to demonstrate competency for certification of training **shall be recorded and maintained** by the employer.
Procedures for handling emergency incidents (A) Information	120 (p)(8)(iv)(A)	(A) The following elements shall be included for emergency response plans to the extent that they do not repeat any information already contained in the emergency response plan: (1) Site topography, layout, and prevailing weather conditions. (2) Procedures for reporting incidents to local, state, and federal governmental agencies
Procedures for handling emergency incidents	120 (p)(8)(iv)(B)	(B) The emergency response plan shall be **compatible and integrated with the disaster, fire and/or emergency response plans** of local, state, and federal agencies.

(B) Compatibility		
Procedures for handling emergency incidents (C) Drills & Exercise	120 (p)(8)(iv)(C)	(C) The emergency response plan shall be **rehearsed regularly** as part of the overall training program for site operations.
Procedures for handling emergency incidents (D) Management Review	120 (p)(8)(iv)(D)	(D) The site emergency response plan shall be **reviewed periodically** and, as necessary, be amended to keep it current with new or changing site conditions or information.
Procedures for handling emergency incidents (E) Employee Alarm System	120 (p)(8)(iv)(E)	(E) An **employee alarm system** shall be installed in accordance with 29 CFR 1910.165 to notify employees of an emergency situation
Procedures for handling emergency incidents (F) Site Response Capabilities	120 (p)(8)(iv)(F)	(F) The employer shall **evaluate the incident and the site response capabilities** and proceed with the appropriate steps to implement the site emergency response plan.

Table 8: 1910.120 (p) Waste Handling Requirements

CFR 1910.120(q) : Emergency Response to Hazardous Substance Release		
Emergency Response Plan	120(q)(1)	An emergency response plan shall be **developed and implemented** to handle anticipated emergencies prior to the commencement of emergency response operations. The plan shall be in **writing** and available for inspection and copying by employees, their representatives and OSHA personnel. This section is for employers who have employees assisting in handling emergency responses.
Elements of Emergency Response	120(q)(2)(i)	Pre-emergency planning and coordination with outside parties.
	120(q)(2)(ii)	Personal roles, lines of responsibility and communication
	120(q)(2)(iii)	Emergency recognition and prevention
	120(q)(2)(iv)	Safe distances and places of refuge
	120(q)(2)(v)	Site security and control
	120(q)(2)(vi)	Evacuation routes and procedures
	120(q)(2)(vii)	Decontamination.
	120(q)(2)(viii)	Emergency medical treatment and first aid
	120(q)(2)(ix)	Emergency alerting and response procedures
	120(q)(2)(x)	Critique of response and followup.
	120(q)(2)(xi)	PPE and emergency equipment.
	120(q)(2)(xii)	Emergency response organizations may use the local emergency response plan or the state emergency response plan or both, as part of their emergency response plan to avoid duplication
Procedures for Handling Emergency Response	120(q)(3)(i)	The senior emergency response official responding to an emergency will the **individual in charge of a site-specific Incident Command System(ICS)**
	120(q)(3)(ii)	Individual in charge of site-specific ICS shall **identify** allhazardous substances or conditions present. They shall also address **approproate site analysis**, engineering controls, maximum exposure limit, handling procedures and use of any new technologies.
	120(q)(3)(iii)	Site-specific ICS individual shall implement appropriate emergency operations, and assure that the personal protective equipment worn is appropriate for the hazards to be encountered
	120(q)(3)(iv)	Employees engaged in emergency response and exposed to hazardous substances presenting an inhalation hazard or potential inhalation hazard **shall wear positive pressure self-contained breathing apparatus** while engaged in emergency response
	120(q)(3)(v)	Site-specific ICS individual shall limit the number of emergency response personnel at the emergency site. Buddy system to be used for operations in hazardous areas

	120(q)(3)(vi)	Back-up personnel shall stand by with equipment ready to provide assistance or rescue.
	120(q)(3)(vii)	The individual in charge of the ICS shall designate a safety official, who is knowledgable in the operations being implemented at the emergency response site
	120(q)(3)(viii)	In an IDLH situation, the safety official shall have the authority to **alter, suspend, or terminate those activities**. The safety official shall immediately inform the individual in charge of the ICS of any actions needed to be taken to correct these hazards at the emergency scene
	120(q)(3)(ix)	After carrying out emergency oprations, ICS individual in charge shall conduct appropriate **decontamination procedures**.
	120(q)(3)(x)	When deemed necessary, **approved selfcontained compressed air breathing apparatus** may be used with approved cylinders from other approved self-contained compressed air breathing apparatus provided that such cylinders are of the same capacity and pressure rating. All compressed air cylinders used with self-contained breathing apparatus shall meet U.S. Department of Transportation and National Institute for Occupational Safety and Health criteria
Skilled Support Personnel	120(q)(4)	Initial briefing to personnel that are needed for temporarily to perform immediate emergency support work, that cannot be conducted by the employer's own employees. They are **not required to meet the training required in this paragraph**. The initial briefing shall include **instruction in the wearing of appropriate personal protective equipment**, **what chemical hazards are involved, and what duties are to be performed.**
Specialist Employees	120(q)(5)	Employees who work with and are trained in the hazards of specific hazardous substances, and who will be called upon to provide technical advice or assistance at a hazardous substance release incident to the individual in charge, **shall receive training or demonstrate competency in the area of their specialization annually**.
Training - First Responder Awareness Level	120(q)(6)(i)(A)	Understanding of **hazard substances and risks** associated in an incident
	120(q)(6)(i)(B)	Understanding of **potential outcomes** associated with the emergency situation
	120(q)(6)(i)(C)	Able to recognize **presence of hazardous substances** in an emergency
	120(q)(6)(i)(D)	Abilitiy to identify **hazarduos substance itself** when possible
	120(q)(6)(i)(E)	Understanding of the **role of first responder's responsibilities**
	120(q)(6)(i)(F)	Able to realize the need for **additioanl resources to notify** communication center
	120(q)(6)(ii)(A)	Knowledge in **basic hazard and risk assessment techniques**

Training - First Responder Operations Level	120(q)(6)(ii)(B)	Able to select **proper PPE** provided
	120(q)(6)(ii)(C)	Understand basic hazardous material **terms**
	120(q)(6)(ii)(D)	Know how to perform **basic control, contrainment/confinement operations** within capability of resources & PPE
	120(q)(6)(ii)(E)	Know how to implement basic **decontamination** procedures
	120(q)(6)(ii)(F)	Understand relevant standard **operating & terminating procedures**
Training - Hazardous Materials Technician	120(q)(6)(iii)(A)	Able to implement ICS
	120(q)(6)(iii)(B)	Know how to **implement** the employer's emergency response plan.
	120(q)(6)(iii)(C)	Understand hazard risks associated with employees working in chemical protective clothing
	120(q)(6)(iii)(D)	Know how to implement local emergency response plan
	120(q)(6)(iii)(E)	Know how to implement state emergency response plan
	120(q)(6)(iii)(F)	Understand importance of decontamination procedures
Trainers	120(q)(7)	Trainers shall have the training and/or academic credentials and instructional experience necessary to demonstrate competent instructional skills and a good command of the subject matter
Training Refreshers	120(q)(8)(i)	Those receiving training in this paragraph shall undergo annual refresher traiing, or demonstrate competency in those areas annually
	120(q)(8)(ii)	Employer to keep all statements of competencies and records of methodology used to demonstrate competencies
Medical Surveillance and Consultation	120(q)(9)(i)	Members of HAZMAT or specialised team will receive baseline physical examination and provided with medical surveillance [paragraph (f)]
	120(q)(9)(ii)	Any emergency response employee displaying signs or symptoms after exposure shall be provided with medical consultation [paragprah (f)(3)(ii)]
Chemical Protective Clothing	120(q)(10)	Chemical protective suits used by HAZMAT or specialised team shall meet the requirements [paragrahp (g)(3) - (5)]
Post Emergency Response Operations (Clean-Up)	120(q)(11)(i)	Clean up of all hazardous materials, contaminated areas & equipment to comply with requirements of paragraph (b) - (o)
	120(q)(11)(ii)	Employees involved in clean-up have undergone training [CFR 1910.38, 1920.134 & 1920.1200]

Table 9: 1910.120 (q) ER to Release of Hazardous Substances

7.4 List of Chemicals in Appendix A of 1910.119

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** H
- **Subpart Title:** Hazardous Materials
- **Standard Number:** 1910.119 App A
- **Title:** List of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory).
- **GPO Source:** e-CFR

This Appendix contains a listing of toxic and reactive highly hazardous chemicals which present a potential for a catastrophic event at or above the threshold quantity.

CHEMICAL NAME	CAS*	TQ**
Acetaldehyde	75-07-0	2500
Acrolein (2-Popenal)	107-02-8	150
Acrylyl Chlorde	814-68-6	250
Allyl Chlorid	107-05-1	1000
Allylamine	107-11-9	1000
Alkylaluminum	Varies	5000
Ammonia, Anhydrous	7664-41-7	10000
Ammonia solutions (greater than 44% ammonia by weight)	7664-41-7	15000
Ammonium Perchlorate	7790-98-9	7500
Ammonium Permanganate	7787-36-2	7500
Arsine (also called Arsenic Hydride)	7784-42-1	100
Bis(Chloromethyl) Ether	542-88-1	100
Boron Trichloride	10294-34-5	2500
Boron Trifluoride	7637-07-2	250
Bromine	7726-95-6	1500
Bromine Chloride	13863-41-7	1500
Bromine Pentafluoride	7789-30-2	2500
Bromine Trifluoride	7787-71-5	15000
3-Bromopropyne (also called Propargyl Bromide)	106-96-7	100
Butyl Hydroperoxide (Tertiary)	75-91-2	5000
Butyl Perbenzoate (Tertiary)	614-45-9	7500
Carbonyl Chloride (see Phosgene)	75-44-5	100
Carbonyl Fluoride	353-50-4	2500
Cellulose Nitrate (concentration greater than 12.6% nitrogen	9004-70-0	2500
Chlorine	7782-50-5	1500
Chlorine Dioxide	10049-04-4	1000
Chlorine Pentrafluoride	13637-63-3	1000
Chlorine Trifluoride	7790-91-2	1000
Chlorodiethylaluminum (also called Diethylaluminum Chloride)	96-10-6	5000

1-Chloro-2,4-Dinitrobenzene	97-00-7	5000
Chloromethyl Methyl Ether	107-30-2	500
Chloropicrin	76-06-2	500
Chloropicrin and Methyl Bromide mixture	None	1500
Chloropicrin and Methyl Chloride mixture	None	1500
Cumene Hydroperoxide	80-15-9	5000
Cyanogen	460-19-5	2500
Cyanogen Chloride	506-77-4	500
Cyanuric Fluoride	675-14-9	100
Diacetyl Peroxide (concentration greater than 70%)	110-22-5	5000
Diazomethane	334-88-3	500
Dibenzoyl Peroxide	94-36-0	7500
Diborane	19287-45-7	100
Dibutyl Peroxide (Tertiary)	110-05-4	5000
Dichloro Acetylene	7572-29-4	250
Dichlorosilane	4109-96-0	2500
Diethylzinc	557-20-0	10000
Diisopropyl Peroxydicarbonate	105-64-6	7500
Dilauroyl Peroxide	105-74-8	7500
Dimethyldichlorosilane	75-78-5	1000
Dimethylhydrazine, 1,1-	57-14-7	1000
Dimethylamine, Anhydrous	124-40-3	2500
2,4-Dinitroaniline	97-02-9	5000
Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone Peroxide; concentration greater than 60%)	1338-23-4	5000
Ethyl Nitrite	109-95-5	5000
Ethylamine	75-04-7	7500
Ethylene Fluorohydrin	371-62-0	100
Ethylene Oxide	75-21-8	5000
Ethyleneimine	151-56-4	1000
Fluorine	7782-41-4	1000
Formaldehyde (Formalin)	50-00-0	1000
Furan	110-00-9	500
Hexafluoroacetone	684-16-2	5000
Hydrochloric Acid, Anhydrous	7647-01-0	5000
Hydrofluoric Acid, Anhydrous	7664-39-3	1000
Hydrogen Bromide	10035-10-6	5000
Hydrogen Chloride	7647-01-0	5000
Hydrogen Cyanide, Anhydrous	74-90-8	1000
Hydrogen Fluoride	7664-39-3	1000
Hydrogen Peroxide (52% by weight or greater)	7722-84-1	7500
Hydrogen Selenide	7783-07-5	150
Hydrogen Sulfide	7783-06-4	1500
Hydroxylamine	7803-49-8	2500
Iron, Pentacarbonyl	13463-40-6	250
Isopropylamine	75-31-0	5000
Ketene	463-51-4	100
Methacrylaldehyde	78-85-3	1000
Methacryloyl Chloride	920-46-7	150
Methacryloyloxyethyl Isocyanate	30674-80-7	100
Methyl Acrylonitrile	126-98-7	250
Methylamine, Anhydrous	74-89-5	1000
Methyl Bromide	74-83-9	2500
Methyl Chloride	74-87-3	15000
Methyl Chloroformate	79-22-1	500
Methyl Ethyl Ketone Peroxide (concentration greater than 60%)	1338-23-4	5000
Methyl Fluoroacetate	453-18-9	100
Methyl Fluorosulfate	421-20-5	100

Methyl Hydrazine	60-34-4	100
Methyl Iodide	74-88-4	7500
Methyl Isocyanate	624-83-9	250
Methyl Mercaptan	74-93-1	5000
Methyl Vinyl Ketone	79-84-4	100
Methyltrichlorosilane	75-79-6	500
Nickel Carbonly (Nickel Tetracarbonyl)	13463-39-3	150
Nitric Acid (94.5% by weight or greater)	7697-37-2	500
Nitric Oxide	10102-43-9	250
Nitroaniline (para Nitroaniline	100-01-6	5000
Nitromethane	75-52-5	2500
Nitrogen Dioxide	10102-44-0	250
Nitrogen Oxides (NO; NO(2); N2O4; N2O3)	10102-44-0	250
Nitrogen Tetroxide (also called Nitrogen Peroxide)	10544-72-6	250
Nitrogen Trifluoride	7783-54-2	5000
Nitrogen Trioxide	10544-73-7	250
Oleum (65% to 80% by weight; also called Fuming Sulfuric Acid)	8014-95-7	1000
Osmium Tetroxide	20816-12-0	100
Oxygen Difluoride (Fluorine Monoxide)	7783-41-7	100
Ozone	10028-15-6	100
Pentaborane	19624-22-7	100
Peracetic Acid (concentration greater 60% Acetic Acid; also called Peroxyacetic Acid)	79-21-0	1000
Perchloric Acid (concentration greater than 60% by weight)	7601-90-3	5000
Perchloromethyl Mercaptan	594-42-3	150
Perchloryl Fluoride	7616-94-6	5000
Peroxyacetic Acid (concentration greater than 60% Acetic Acid; also called Peracetic Acid)	79-21-0	1000
Phosgene (also called Carbonyl Chloride)	75-44-5	100
Phosphine (Hydrogen Phosphide)	7803-51-2	100
Phosphorus Oxychloride (also called Phosphoryl Chloride)	10025-87-3	1000
Phosphorus Trichloride	7719-12-2	1000
Phosphoryl Chloride (also called Phosphorus Oxychloride)	10025-87-3	1000
Propargyl Bromide	106-96-7	100
Propyl Nitrate	627-3-4	2500
Sarin	107-44-8	100
Selenium Hexafluoride	7783-79-1	1000
Stibine (Antimony Hydride)	7803-52-3	500
Sulfur Dioxide (liquid)	7446-09-5	1000
Sulfur Pentafluoride	5714-22-7	250
Sulfur Tetrafluoride	7783-60-0	250
Sulfur Trioxide (also called Sulfuric Anhydride)	7446-11-9	1000
Sulfuric Anhydride (also called Sulfur Trioxide)	7446-11-9	1000
Tellurium Hexafluoride	7783-80-4	250
Tetrafluoroethylene	116-14-3	5000
Tetrafluorohydrazine	10036-47-2	5000
Tetramethyl Lead	75-74-1	1000
Thionyl Chloride	7719-09-7	250
Trichloro (chloromethyl) Silane	1558-25-4	100
Trichloro (dichlorophenyl)		

Silane	27137-85-5	2500
Trichlorosilane	10025-78-2	5000
Trifluorochloroethylene	79-38-9	10000
Trimethyoxysilane	2487-90-3	1500

Footnote* Chemical Abstract Service Number

Footnote** Threshold Quantity in Pounds (Amount necessary to be covered by this standard.)

[57 FR 7847, Mar. 4, 1992; 76 FR 80738, Dec. 27, 2011]

Next Standard (1910.119 App B)

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