Waste Management Framework for Decommissioning of Offshore Installations in Malaysia

by

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CERTIFICATION OF APPROVAL

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Approved by,

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January 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this report, 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.

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ABSTRACT

In the oil and gas industry, offshore platforms are increasing around the world and many of these platforms will reach the end of their operational life and as such, they have to be decommissioned. In many years to come, activities related to decommissioning which is the last stage in the life cycle of an offshore platform where wells are plugged and abandoned, the structures removed and the seafloor cleared of any waste resulting from the operations are going to increase. Many wastes will be identified during the process of clearance. To manage these waste, oil and gas operator have to need proper planning and waste management framework in order to have successful decommissioning projects carried out. This study started with review of literature related to decommissioning with the objective to identify a waste management framework for decommissioning offshore installation in Malaysia by using PETRONAS (PTS) waste management guideline and evaluate other country waste management framework like Gulf of Mexico and North Sea with PTS Waste Management Guideline. Since offshore installations in Malaysia tend to age as they approach the end of their viable life, legal and regulation on waste management should be taken know. Therefore, it is of uttermost importance to develop legal and regulation on waste management for decommissioning offshore installation in Malaysia based on other waste management framework.To accomplish this study, all previous studies on waste management from another country will be utilized as a secondary data to develop legal and regulated on waste management for decommissioning offshore installation in Malaysia that would be used by operator to face the challenges in managing the waste within the law. Having these early waste management framework will serve as a guideline to project decommissioning in Malaysia.

Keywords: Decommissioning; waste management; legal regulation; offshore platforms

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LIST OF ABBREVIATIONS

ASCOPE : Asian Council on Petroleum

IMO : International Marine Organization

UNCLOS : United Nations Convention on the Law of the Sea

OSPAR : Convention for the Protection of the Marine Environment of the North-East Atlantic

OGP : Oil and Gas Production

PTS : PETRONAS

NORM : Naturally Occurring Radioactive Materials

EQA : Environmental Quality Act

DOSH : Department of Safety and Health

DOE : Department of Environment

CHAPTER 1

INTRODUCTION

1.1. BACKGROUND OF STUDY

In the nearing years, offshore platform installation will increase as various existing platform approach their end of service lives and consequently, the oil and gas operators face challenge to manage the decommissioning offshore installation. In Malaysia, the various oil and gas operators in the three regions Peninsular Malaysia Operation (PMO), Sarawak Operation (SKO) and Sabah Operation (SBO) are operating in the shallow water fixed platform [17]. Mostly shallow water platform are suitable in Peninsular Malaysia water, because the water depth is only 50-70m. About 48 percent of the Malaysia platforms are surpasses their 25- year production life. Therefore, a plan has to be in place to removed wells and plugged. This process is called decommissioning. Figure 1 below show that decommissioning is closely related to oil and gas industry in Malaysia as stated previously that many of 280 jacket platforms located off the coast of Malaysia are approaching the end of their useful lives.

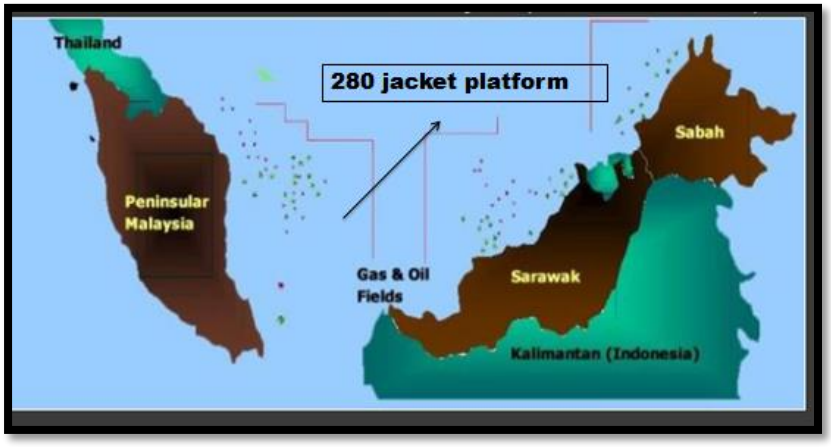

Figure 1: Oil and Gas Offshore Platform

Offshore decommissioning is the process of physical removal, dismantled and disposal of structures at the end of their service life. Decommissioning offshore installations brings along waste management. Each of the removal activity will produce or release scheduled waste material which most of them can be very hazardous to human and environment

According to Khalid [2], from the interview article from Decom world 2011, said that cost for decommissioning offshore platform can up to US$3 million or more depending on the marine support , decommissioning duration process, experience and technical and operational aspects. Each waste that identify from the decommissioning has to manage by government legal and regulation. Currently there is no legal and regulation to handle the waste from decommissioning offshore installation because the decommissioning quite new in Malaysia.

This study is focused on waste management framework for offshore decommissioning in Malaysia. From decommissioning activity will produce waste material which can be very hazardous or non-hazardous to human and environment. Besides that, the removal part has to send to onshore yard for the purpose of disposed or recycle the waste. To manage the waste in onshore or offshore, all oil and gas operator has to follow the appropriate regulatory that fixed by the government. This research will hopefully identify framework or management plan to handle the decommissioning waste and develop the legal and regulation for decommissioning offshore installation in Malaysia

1.2. PROBLEM STATEMENT:

The decommissioning as the last stage in the life cycle of an offshore installation where facilities and platforms are removed, wells plugged and abandoned and the sea floors cleared and the waste from decommissioning identified. Malaysia is among the countries in the world yet to have a comprehensive decommissioning waste

management plan for offshore platform installation. However, there is limited research in this topic of identify the waste management framework for offshore decommissioning in Malaysia and assessing and evaluate the waste management framework with other country like North West Hutton and others. In addition, there is legal and regulation for waste management that has to follow by the oil and gas operators for decommissioning in Malaysia. So many challenges faced by the oil and gas operators in the waste impact the environment and pose effects on the worker's health during the decommissioning offshore installation process. Besides that, with the higher concerns of environmental awareness, the reputation of the oil operators will be affected if the decommissioning wastes are not being handled responsibly and properly. In terms of economic, more costs may be incurred for disposal wastes into the environment during the transportation of the waste from offshore to onshore

1.3. PROJECT OBJECTIVES:

The objectives of the study are:

1. To identify the waste management framework for decommissioning offshore installation in Malaysia
2. To evaluate the waste management framework for other country and compare API guidelines and PTS guidelines and recommend a new waste management framework
3. To develop the legal and regulation of waste management based on other international practice

1.4. SCOPE OF STUDY:

This study is focused in the subject of waste management framework for decommissioning of offshore installation in Malaysia. The waste management plan for decommissioning will be studied and analyzed. This study will be limited to Malaysia's offshore platforms which are mostly fixed platforms. All waste will be disposed onshore. This study will also cover the subject of reviewing the legislations, environmental impact and waste management Best Practice in Malaysia

In this study, the use of secondary data from PETRONAS and other country waste management plan will be adopted in order to come up with best practices of waste management. The developed best practices will then be applied to Malaysia platform data to manage the waste.

1.5. THE RELEVANCY OF THE PROJECT

Waste Management Framework for decommissioning offshore platforms is closely related to the oil and gas industry in Malaysia. It is undeniable that the decommissioning industry of Malaysia is still in its infancy, but with a number of offshore platforms approaching the end of their operational lives, its future potential is evident. About 249 jacket platforms located of Malaysia are approaching the end of their lives [17]. Hence, decommissioning waste management activities will intensify in the near future and decommissioning waste management will be required to determine the legal requirements and environmental impact.

CHAPTER 2

LITERATURE REVIEW.

2.1. DECOMMISSIONING OF OFFSHORE PLATFORMS

On a worldwide scale, decommissioning in the petroleum and gasoline industry is nevertheless in its infancy and it's no longer new. Simply due to public pressure and the resulting political turmoil from the Brent Spar incident showed there are more components to be considered than technology and the applicable regulatory regime [24]. Decommissioning is the procedure which the operator of an offshore oil and gas installation goes through to plan, gaining government approval and move out the removal, disposal or re-use of a structure when it is no longer required for its current function.Based on sustainability feasibility, decommissioning are being examined with increased environmental awareness and the growing prices of material fabrication, the recycling and reusing of fixed offshore platforms and economic perspective, is balanced and at least neutral or positive [17].Technology current available are limited by the decommissioning capacity and techniques and at decommissioning of the Mega structure progress lesson to be learnt for a safer techniques to grown [9].

Decommissioning refers to the dismantling, decontamination and removal of process equipment and facility structures [10]. When production of petroleum or gasoline from a field becomes uneconomical that the well is too pricey to be maintained or low production volume, a determination may be reached by the relevant authorities in conclusion with the platform operator need to stop production and had to abandon the platform. Most of the decommissioning experience by location comes from the Gulf of Mexico, where nearly 5400 platforms have been installed and more than 1000 platforms per year have been decommissioned [8]. Meanwhile approximately 235

facilities have been installed in the North Sea but with most decommissioning restricted to smaller installations making a total of 9 fixed steel platforms that have been decommissioned off the UK. Moving on to Australia, about 53 platforms have been installed offshore to date, an order of magnitude less than the North Sea and two orders of magnitude less than the Gulf of Mexico [16]. Currently, Shell was announced that the Brent Alpha and Brent Bravo will be decommissioning safely because it's not produced since May 2014 and no longer viewed as economical [22].

Around 280 Malaysia platforms are approaching the end of their production [17]. The decommissioning activities in Malaysia are forecasted to be increased in the near future but Malaysia still lacks information on facilities, legal requirements and waste framework. Hence, it is important to have a basic framework to assess the offshore decommissioning activities in Malaysia, particularly regarding the environmental impact assessment as environmental issues are a big concern around the globe now due to arising of global warming and ocean pollutions.

2.1.1. DECOMMISSIONING PROCESS

Worldwide, over 6000 large offshore platforms extract oil and gas from the continental shelf [4]. A platform structure may be left completely or partially in the water (often called 'as rig to 'reef''), removed and then reused as a platform in another location, or hauled to shore for scrapping or recycling [7]. Complete removal means removing all elements of the installation entirely. Partial removal which is allowed under International Marine Organization (IMO) guidelines for large structures denotes leaving some of the installation elements In-situ while re-use means to use the installations for other purposes like artificial reef its shown figure 1 below.

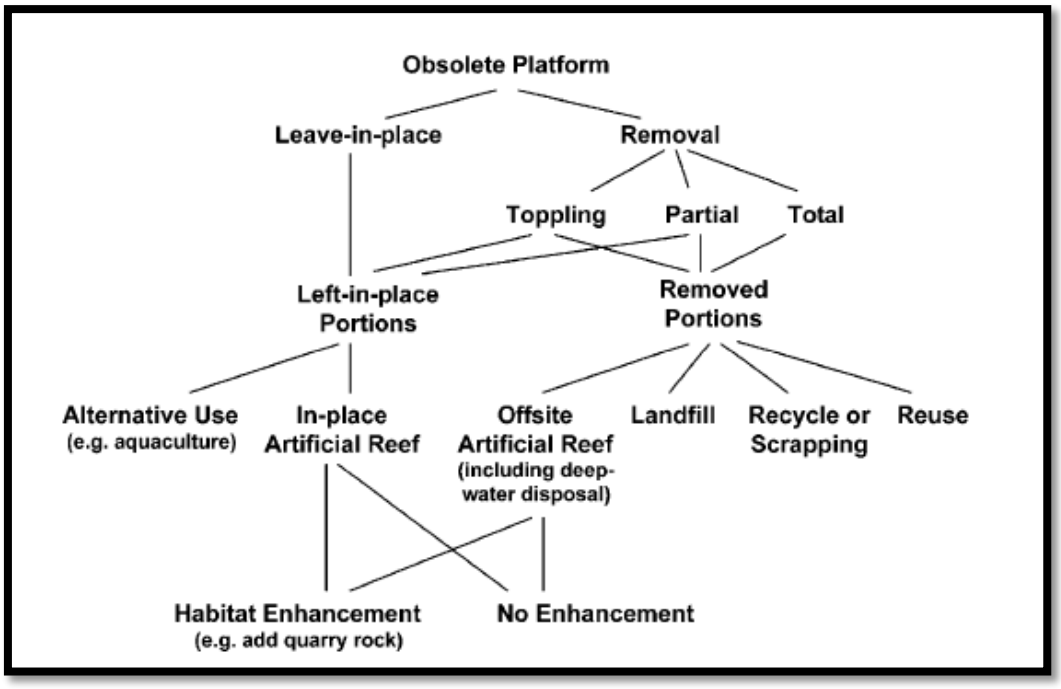

Figure 1: Decommissioning Option for oil and gas platform

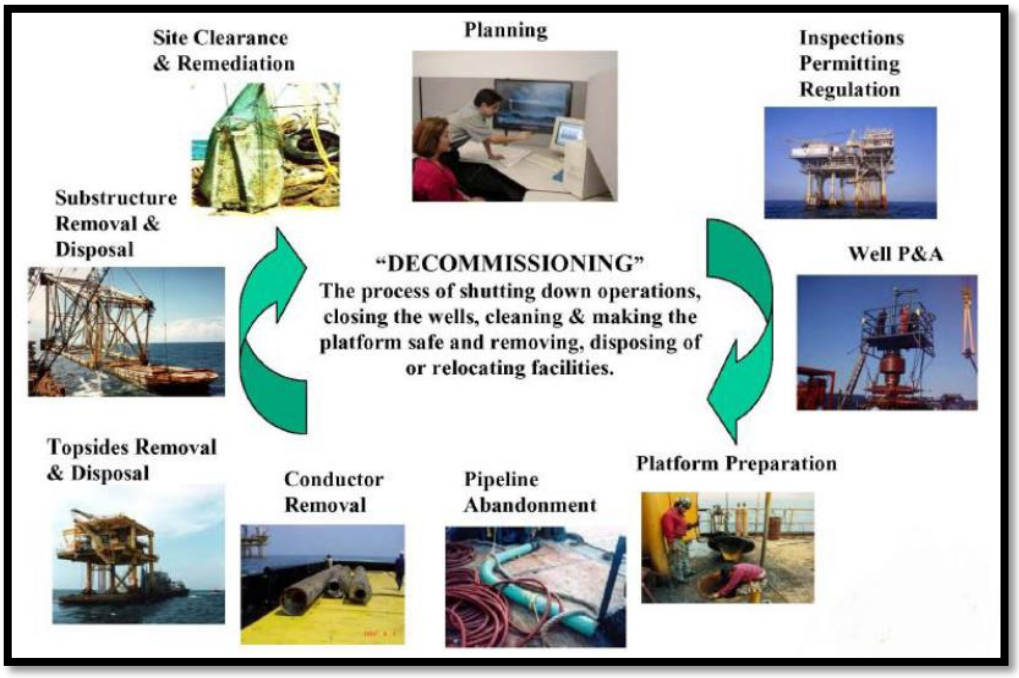

Figure 2: Decommissioning Process

Decommissioning process starts with project management as shown in figure 2. Project management, engineering and planning for decommissioning normally starts three years before the well ceases production [18]. The process usually involves the review of contractual obligations, engineering analysis, operational planning and contracting. After that, operators have to prepare an Inspection Plan which includes the environmental information, permitting regulation and field surveys of the specific platform site. When the permits from government are granted, then operators can proceed with platform preparation. The topsides of the platform which include the tanks, well jacket removal, processing equipment and pipeline abandonment have to be flushed and cleaned in order to make sure there is no residual hydrocarbon. After the topsides preparation, well plugging and abandonment will take place. This involves the well entry preparations, filling the well with fluid, conductor removal, cleaning out the wellbore, plugging of annular space and placement of fluid between plugs. Followed by the removal of conductor and platform, one of the key components in platform removal is mobilization and demobilization of derrick barges. If the platform is small in size, the topsides can be removed in one piece by single lift onto the derrick barge. Else, topsides can be cut into several pieces and removed with platform cranes. Followed by the removal of the jacket as the second step and pipeline. Last but not least is the material disposal and site clearance. Disused platform materials can be recycled, reuse or dispose of in specified landfills. In order to have proper site clearance, operators have to conduct the post decommissioning survey which identifies any environmental damage with wells being abandoned to protect offshore environment from contamination by hydrocarbons. Then, the pipeline network is determined by BPEO tool done and requires effective cleaning and decontamination. Later, facilities are separated from the deck and transported to onshore. The deck is cut and taken onshore and the jacket is then either transported to onshore by toppling or left in-situ to act as an artificial reef. The site is the cleared of any seafloor obstruction [3].

2.2. WASTE MANAGEMENT OF OFFSHORE DECOMMISSIONING

The waste management of offshore decommissioning of in Malaysia is primarily governed by the PETRONAS Waste Management Guidelines 2010 which is based on recognized international guidelines such as the 1989 International Marine Organization Guidelines (IMO) and Standards and the 1982 UN Convention on the Law of the Seas (UNCLOS) which is pro-complete removal of all structures in water depths less than 100 meters and substructures weighing less than 4000 tonnes [12].

Waste management is the key to handling, collecting, transferring, transporting, treating and disposing of waste. In figure 3 shows the key for handling, minimization and disposal applied in the waste management practices [18]. An important aspect of a waste management practices is the need to segregate offshore waste materials according to their characteristics. Apart from safety concerns, an initial waste characterisation will help determine which waste streams has to be combined to simplify storage, treatment, recycling, and/or disposal, and which streams should remain segregated. Failure to recognise the need for waste segregation may result in the creation of a waste mixture. After all waste reduces, the next step is to evaluate reuse of the waste material. The reuse means to return of unused materials for reissue or reuse in other industries. Wastes such as tank bottoms, emulsions, heavy hydrocarbons, and hydrocarbon bearing soil may be used for road oil, road mix, or asphalt. These wastes should be analysed to ensure they are not flammable and have a mixed density and metals content consistent with road oils or mixes. After all waste reduces and reuse, the next step is to evaluate recycling and recovery of the waste should be monitor to considered that metal with NORM (LSA) scale is not sent to the recycling facility along with uncontaminated materials[18]. After recycle have been examined, it will follow by treatment and disposal. Treatment utilizes techniques to minimize the amount and toxicity of waste that has to be disposed. Then for waste disposal, environmentally sound and approved methods should be used [13]**.** In proper

word, waste management includes the work to collecting the waste from the platform, handling the waste, and then transferring the waste from offshore to onshore. Waste management makes good sense for several reasons: to avoid future liability costs, to promote good public relations, and to lessen the need for more prescriptive regulations

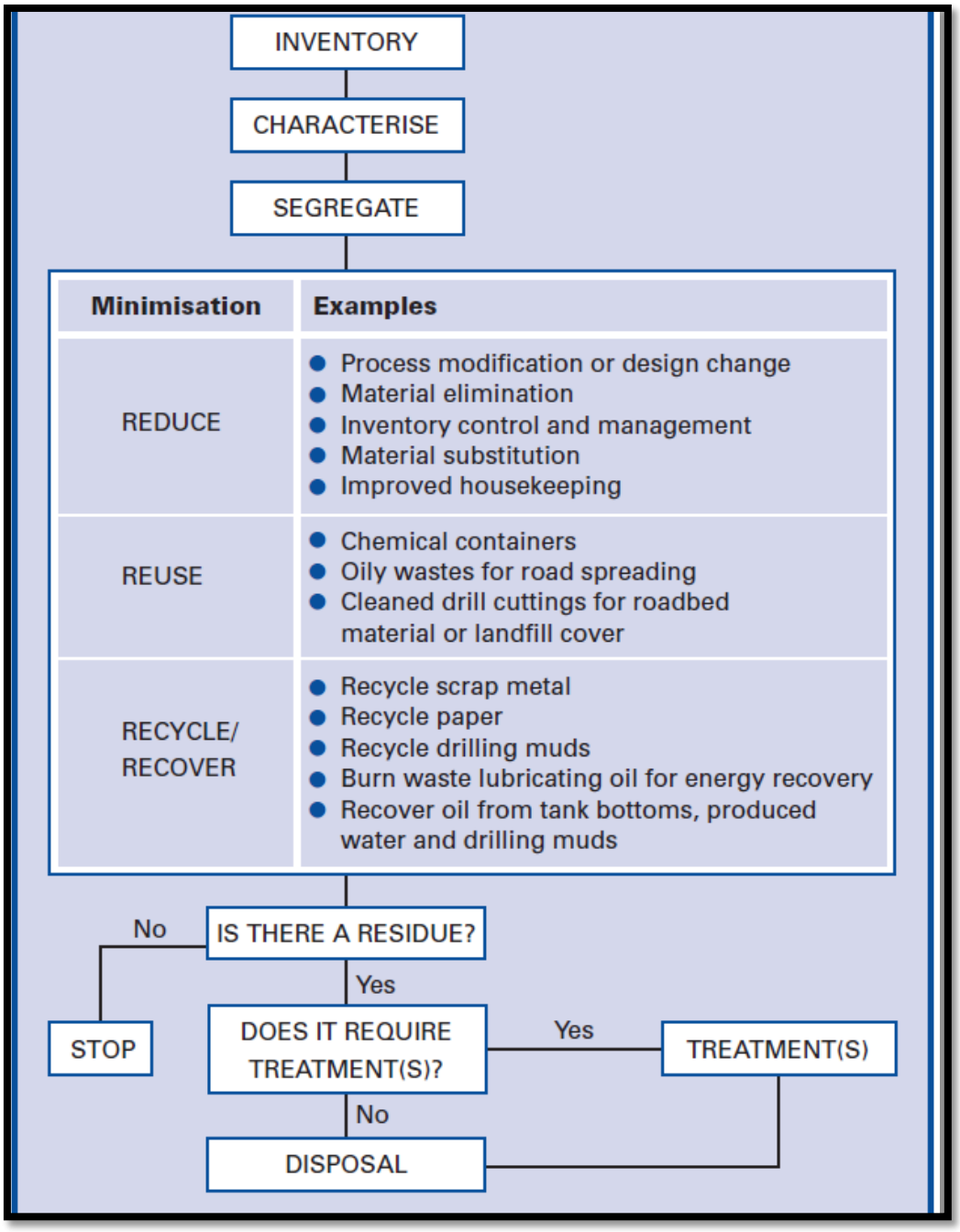

Figure 3: Waste management practices

After the waste transfer to onshore, operator has to manage the waste with treating the waste or disposing the waste to the landfill. Waste and chemical handling offshore are also stringent as part of Key Performance Indicators tracked by PETRONAS on their operator partners [2]. In offshore decommissioning platform, it is really challenging to identify and quantify waste presents and to sustain a strategy in place for the removal of hazardous and non-hazardous waste offshore [16]. It is seen that the ultimate fate of wastes from decommissioning is depending on the nature of the wastes as well as the characteristics of the recipient environment. According to Philippe [15] reveals to that those waste productions may be differentiated under the accompanying assemblies:

Group 1: Hazardous waste (chemicals, painting residues, used oils, polluted packing, Medical waste, soils and contaminated mud)

Group 2: General and inert waste (used fluids, metals, packing, non-biodegradable waste, biodegradable waste, clean materials from civil works).

Group 3: Radioactive waste.

The types of materials involved in decommissioning showed in table 1 that include steel, other metal, other material and others [19**].**

The waste management hierarchy as shown in figure 4 is an internationally accepted guide that widely used for handling waste management practices with the objective of achieving optimal environmental outcomes. Waste management hierarchy introduced to progress the waste that came out from the decommissioning. Diverse countries might bring some different As far as those parts in the waste hierarchy chain of importance.

Waste Categories	Material Type
Steel	High Grade, Various Structural Sections And Tubular
Other Metal	Copper, Cupro-Nickel, Aluminum, Zinc And Numerous Recyclable Materials.
Other Material	Equipment, Pipeline, Caisson
Hydrocarbon	Production hydrocarbon light to heavy sludge, sludge operational gearbox oils, greases, transformer oils (PCB), hydrocarbon gas
Oil	Diesel Oil, Hydraulic Oil, Spent Lubricating Oil
Deposits	Spent Acid And Alkaline, ,Spent Solvent, Hydrocarbon sludge, Scale, Sediment, Sand, calcium salt scales,
Production Chemical	Muds, Drilling Chemical, lubes, anti-freeze, biocides, drill additives/acids, corrosion inhibitors, gases, oxy scavengers, paints, solvents, Chemical mix with halogen, Metal mix chemical, etc.
Hazardous Materials	Heavy metal, PFOs, PVC, Asbestos, mercury, pyrotechnics, biocides and many small quantities of materials contained in electrical system.
Radioactive Waste	LSA/NORMs Scale, TENORM,
Other	Marine Growth, batteries, Phthalates (plasticisers in flooring and cables), Light Bulb

Table 1: Types of Materials Involved In Decommissioning

Based on Schroeder and Love [7], waste hierarchy principles are applied on the waste management strategy decommissioning of the largest fixed steel jacket platforms (North West Hutton) in order to:

- To maximize the amount of material from the platform which was reused or recovered / recycled;
- To minimize the environmental impact of its activities; and
- Achieve the publicly stated objectives of reusing or recovering / recycling 97% by weight of the recovered material

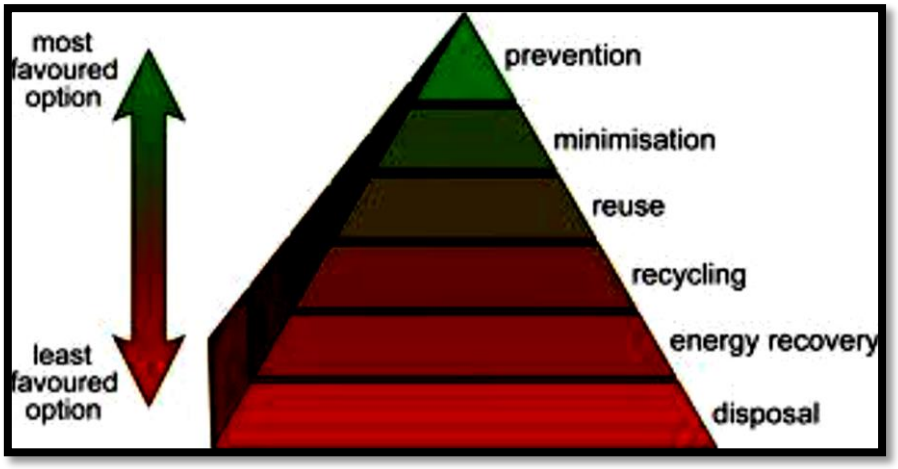

Figure 4: The Waste Management Hierarchy

According to Ataya [26], the waste management hierarchy adopted in offshore Abu Dhabi is as such:

1. Source reduction

   The volume and toxicity of wastes are to be eliminated and reduced by using alternative materials and or more efficient processes, practices or procedures
2. Reuse

   The waste materials or products are to be reuse in their original form
3. Recycling/Recovery

The wastes are to be converted or extracted into reusable materials

4. Treatment

The waste residues are to be destroyed, detoxified or neutralized via physical, biological, thermal and chemical methods.

Waste Management Strategy and Plan was developed during the detailed design phase of North West Hutton (NWH) decommissioning in order to make sure the arrangement between the operator, decommissioning contractor and onshore disposal contractor on the processes [20]. In fact, the waste transfers from offshore to the onshore final disposal point are divided into two that is waste transfer 1 from offshore and waste transfer 2 from onshore shown in figure 5.

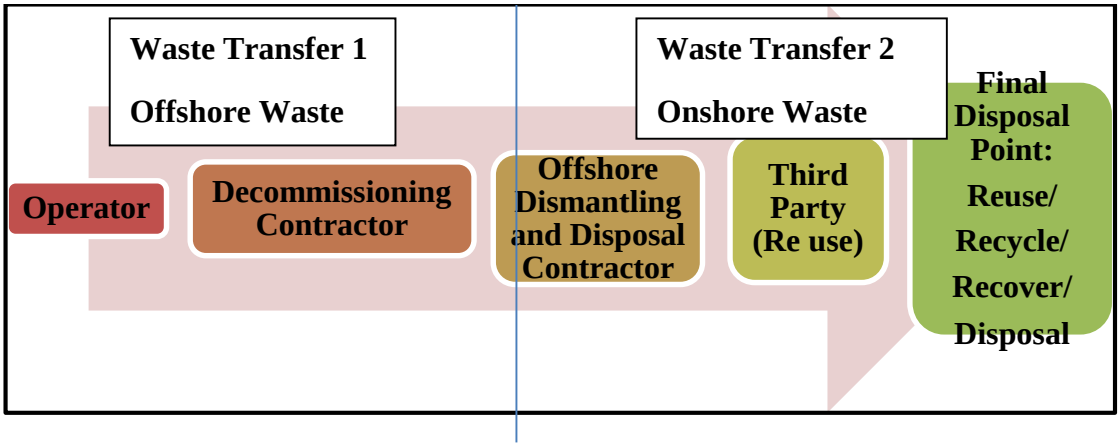

Figure 5: People involve in Waste Management Process

According to Ataya [26], that in offshore platform fields, all the oil and gas operators are confronted with the difficulties of handling waste because of the marine environment easily affected by the pollution surrounding. The majority of these wastes may have critical negative effects to the environment. This is the reason why critical waste need to be adequately managed and legitimately arranged through an orderly approach to handle the waste ,capacity and transfer based on waste administration and minimization guideline and best practice.

2.3 Previous Study

There is limited research in this topic of assessing the types and amount of wastes produced by decommissioning process in the case of the Malaysia offshore platforms. In addition, there is no substantial published literature on the governing legislations and waste management for decommissioning in Malaysia. There will be no accessible information to those decommissioning on Malaysia. Therefore, in place will foresee the possibility waste available, every last one of accessible Decommissioning waste produced for past Decommissioning undertaking will be 4 regions constantly recorded and also contrast with gotten general waste prepare obtain an onside offshore Decommissioning. Furthermore predicted those possibility wastes created toward those Malaysia offshore stages Decommissioning Project. Offshore platform decommissioning case studies are adopted from the other country decommissioning market in order to achieve the second objective for this study, which is to critically assess other established waste management framework from places such as Gulf of Mexico, North Sea and etc.

The North West Hutton (NWH) stage might have been installed over 1983 and also comprised an 18,000 ton card steel jacket support structure and more 20,000 tons from claiming topsides modules. There would additionally waste holding metals, glass strengthened plastic, hydrocarbon sludge, oils, preparation chemicals, penetrating chemicals, asbestos, Furthermore radioactive materials and so forth [6] .

According to White and Goodman [6], based on the previous decommissioning of North West Hutton (NWH) Platform in North Sea, there are a few challenges in waste management;

- Identified and quantified the waste materials present in throughout the decommissioning process to the level of detail.

- Develop a clear strategy for the removal, transportation and waste management activities.
- Provide a clear strategy to hazardous offshore waste management in term of decision making for the level of cleanliness which must comply minimum requirement.
- Method of handling wastes whether to be left in-situ or handled during onshore dismantlement.
- Quantified waste per separated section for removal and consignment onshore as required under regulation for onshore management planning.
- Managing the interfaces between a number of contractors to execute this effectively and in compliance with relevant regulatory requirement.

However, most of the study performed is from North Sea Platform, however lesson learnt and issue arise from their past decommissioning experience can be include in the study for waste management framework [6].

However, for Frigg Decommissioning, evacuations of its topsides and substructures connected distinctive method that starting with single lifts will 'piece small' until destroy. Strict confinements were set for material management [14]. They recognized furthermore figured out how materials Toward applying an earth environmental system (TEAMS) with the specific characteristic for following material starting with the offshore area through a obliteration site and also at long last with the transfer site. This system likewise utilized to log all different naturally related information Similarly as vitality consumption, discharges, emanations should air and in addition the waste materials. In Frigg Decommissioning, the waste taking care of will be generally performed onshore because of those set space during offshore for waste segregation.

In the Gulf for Mexico, those basic evacuation strategy is will cut those deck starting with the jacket and then lift and spot those deck for evacuation to onshore or leave as artificial reef on site. In the Gulf of Mexico, about all of the wastes are brought to onshore for transfer or disposal purpose [11].

2.4 Legal and Regulatory Approaches – Offshore and Onshore

One of the troubles in managing offshore stage decommissioning is the absence of a complete legal regulation of what constitutes in decommissioning. Every oil and gas operator will face the regulatory challenges with how to deal waste generated and how to dispose of this safely within law. Therefore, there have been a few universal and additionally local laws on decommissioning of offshore establishments. Right now, a more practical arrangement is for nations to create exhaustive enactment that handle all known decommissioning issues, and are additionally open sufficiently finished to adjust to unforeseen consequences [1]**.** Decommissioning became the topic of a number of international conventions and treaties, some of which are highlighted below. There are international conventions are particularly important:

1. United Nations Convention on the Law of the Sea (UNCLOS) 1982, which sets a requirement to remove abandoned offshore installations.
2. International Maritime Organization (IMO), through its role as the generally accepted 'competent' international organization pertaining to the shipping of oil and gas.
3. The Oslo and Paris Convention on the Protection of the Marine Environment in the Northeast Atlantic (OSPAR) governs decommissioning in the North East Atlantic

UNCLOS 1958	• Article 5.5 of the United Nations Convention on the Continental Shelf 1958 states that: 'shall entirely remove any installations which are disused'.

	• The above was revised by the requirement of Article 60(3) of UNCLOS 1982:'Remove all installation which is disused or hazardous to verify safety of platform, taking into account any generally accepted international standards established in this regard by the competent international organization. Such evacuation shall due respect to fishing, the protection of the marine environment and the rights and duties of other States. Proper reputation might be given to the depth, position and measurements of any establishments of structures not by any means removed [4].
IMO 1989	• The International Maritime Organization (IMO) is an organization inside the United Nations. Its intention is: 'to give apparatus to participation among Governments in the field of legal regulation and works on identifying with shipping specialized matters that influencing delivery occupied with universal exchange; to energize and encourage the general reception of the most astounding practicable norms in matters concerning sea wellbeing, productivity of navigation and anticipation and control of marine contamination from ships [25]. • In 1989, the IMO published guidelines on the decommissioning of oil and gas facilities (excluding pipelines), which served to effectively establish the agency as the 'competent international organization' within the context of UNCLOS. • The guidelines cover a range of areas, including those associated with the evacuation of offshore installations mostly on shipping removal, and the circumstances in which all or part of an installation may remain on the sea-bed as artificial reef [5].
OSPAR 1998	• The Oslo and Paris Convention on the Protection of the Marine Environment in the Northeast Atlantic (OSPAR) governs

	decommissioning in the North East Atlantic. • The new convention protects the marine environment by controlling disposal of waste at sea and discharge to onshore [21]. • The OSPAR Commission banned the disposal of offshore installations at sea, with effect from February 1999 (though with a few very specific exceptions). OSPAR has a precedent with regards to its relatively stringent requirements – and is influential on decisions in other maritime jurisdictions.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The main purpose of this section is to outline the methodology used for this project. In Chapter One of this report, the problem statement and objectives of study were described and will be discuss further in this chapter. This chapter includes with case study approach, data collection, research methodology, project activities, key milestone and gant chart.

3.2 CASE STUDY APPROACH

The practice of case study as research methodology in project is receiving growing identification among researchers. In many universities in Malaysia, studies related to management are often based on case studies. The case study will help the researches to write up the literature review. In this project case study will help to analyses other country waste management framework for decommissioning offshore installation. The case study approach is a very valuable tool to collect data. This case study will help to solve the two objectives in this project which is on waste management framework and legal regulation. The goal of the study should establish the framework, and then should be applied to all research. In this way, even a single case could be considered acceptable, provided it met the established objective. In this project, it was selected three case studies which are Frigg Decommissioning, North Sea and Gulf of Mexico as a waste management case study.

3.3 DATA COLLECTION

Interviewing is a technique of gathering data from humans by asking questions in verbally manner. There are many different ways of conducting interviews. Structured interviews use an interview schedule that is similar to the survey questionnaire. You the question could be phrased the question in such a way that so the range of responses is limited. This project was applied interviewing method for data collection method in this project. Interviewing is a method collecting data by ask question to the specific person. There are many methods to conduct these types of interview sections. One of the methods used in this project is phone interview which is calling the particular person to get appointment for the phone interview section. Before implement the interview, its need to prepare the questionnaire because with having these questionnaires help the interview section going with smoothly.

3.4 RESEARCH METHODOLOGY AND PROJECT ACTIVITIES

Case study approach is applied to this study. The goal of the case study should establish the objective, and then should be applied to all research. In order to accomplish the desired objective, project activities is outlined based on the intended activities.

Objective 1: To identify the waste management framework for decommissioning Offshore installation in Malaysia

The waste management framework for decommissioning offshore installation in Malaysia will be identified by using the PETRONAS waste management guideline which was published on March 2010. The information from guideline will help to identify the waste management framework for decommissioning offshore platform in Malaysia.

Objective 2: To evaluate the waste management framework for other country and compare API guidelines and PTS guidelines and recommend a new waste management framework.

In order to accomplish this objective, case study was applied to get information for other country waste management framework. From the previous study done on the platform decommissioned all around the world, help to find the comparative of the waste management framework.

Objective 3: To develop the legal and regulation of waste management based on other framework

Legal regulation was important in the waste management framework. International practice about decommissioning offshore installation will contribute more information regarding on legal regulation. An interview section will conduct with PETRONAS management team regarding on legal and regulation of waste management.

PROJECT ACTIVITIES

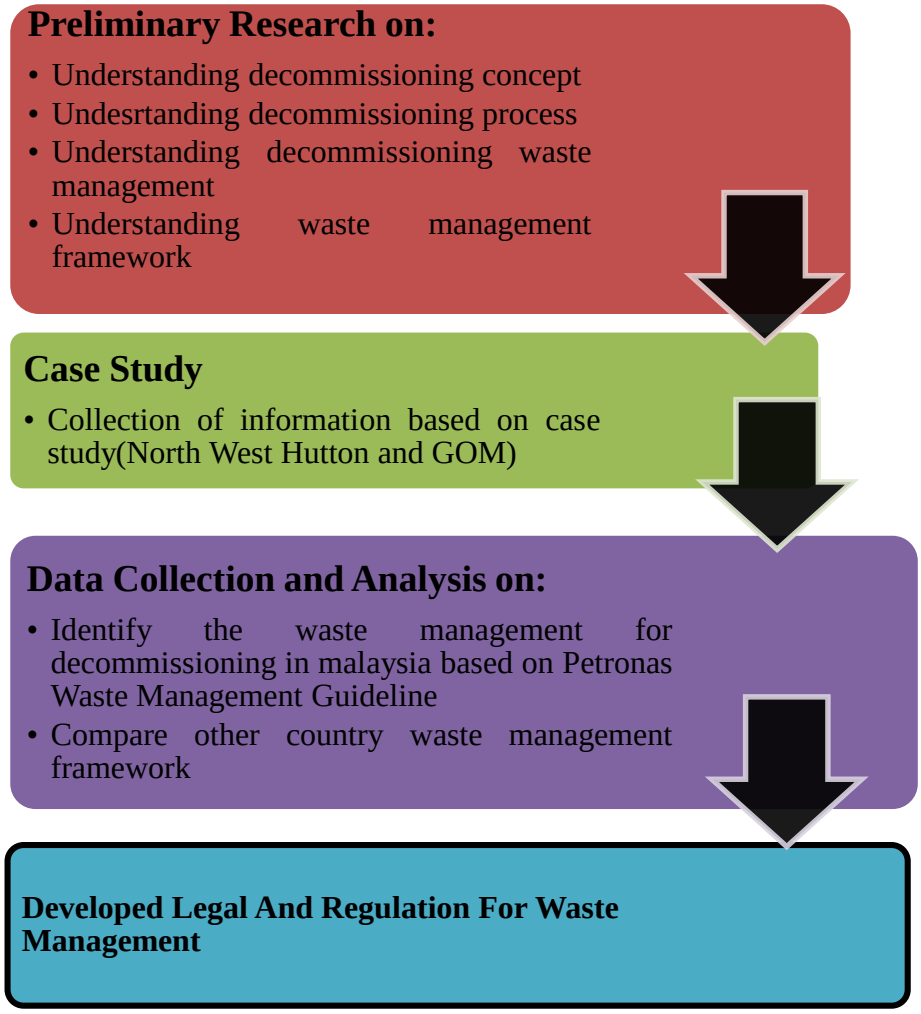

Figure 6: Project activities involved

CHAPTER 4

FINDINGS

a) To identify the waste management framework for decommissioning offshore installation in Malaysia

Malaysia is quite new in the decommissioning offshore platform. Waste management is the one of the decommissioning process in offshore installation. To manage the waste from the decommissioning offshore installation, the major oil and gas operators PETRONAS was establish with the new guideline which is PETRONAS (PTS) Waste Management Guideline on 2010. Based on [20] includes the procedure or framework on how to manage the waste from offshore installation. It also includes the waste management plan for hazardous waste and non-hazardous waste. Figure 7 below shows the waste management framework that listed in PTS Guideline.

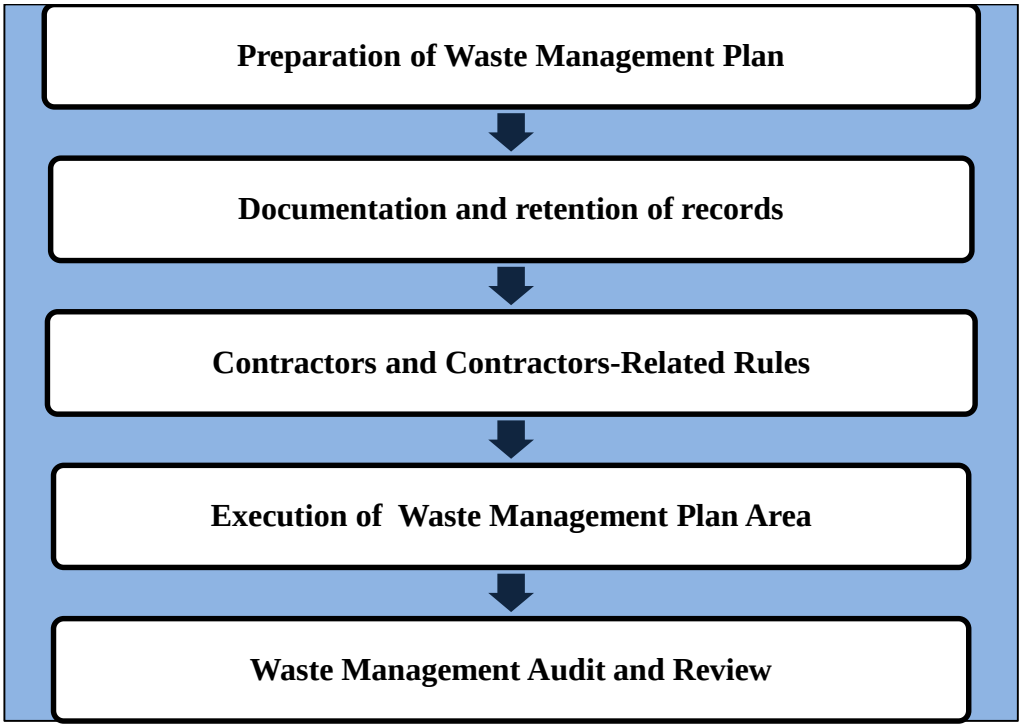

Figure 7: PETRONAS Waste management framework

Preparation of Waste Management Plan

Oil and Gas Operator Unit should prepare a waste management plan with clear objectives and clear goal. A good waste management plan should be reviewed periodically to keep it current and relevant. The framework and nature for waste management have to be applied in compliance with the oil and gas operator's policy and legislative requirements, whilst minimising health, safety and environmental risks and liabilities systematically. Agreement and support from the management team should be obtained. Key personnel or other asset on planning issues should be determined so that management will remind of the timing and scope of the management plan. Operator should build measureable target to achieve the goal on waste management plan. A waste management plan should also include emergency response procedures in case of spill or accidental discharge. Waste management plan was split into two type of waste which is hazardous and non-hazardous waste. Figure 8 below show the plan of waste handling, minimization and disposal decision in the waste management process.

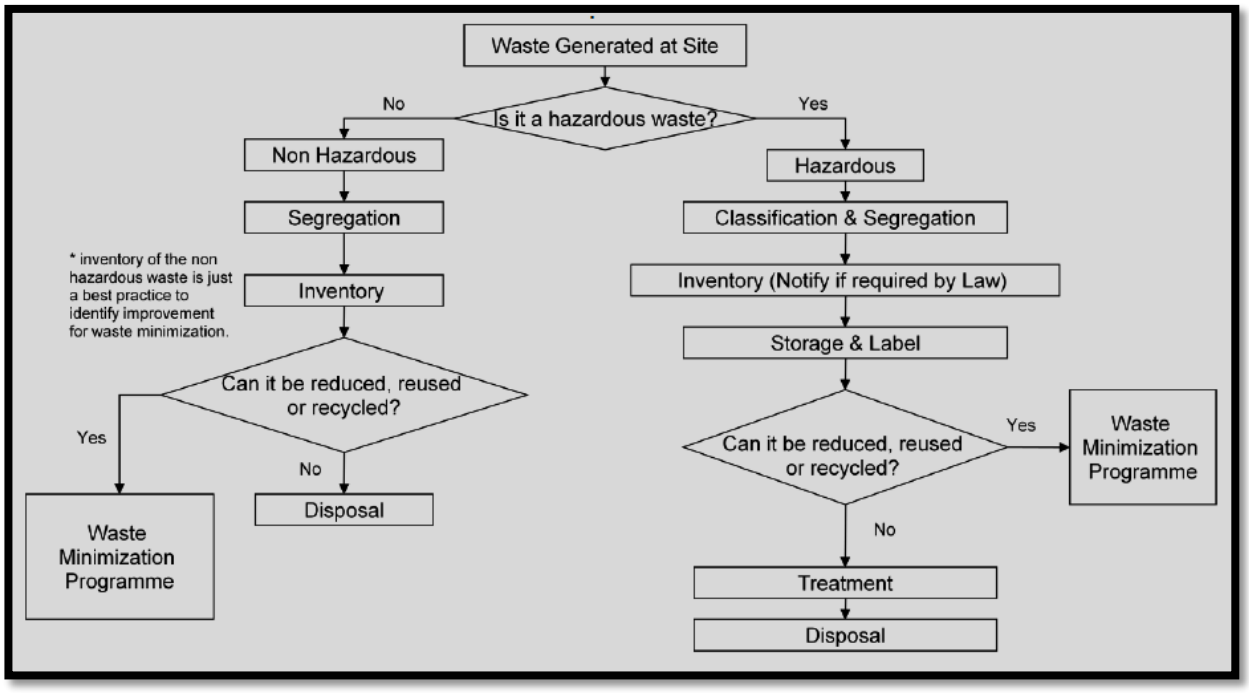

Figure 8: Plan of Waste Handling, in the Waste Management Process

a) Hazardous waste management plan

A successful waste handling process requires several technical decisions. These focus on quantities of waste requiring disposal, giving priority to the prevention and minimisation of hazardous waste materials. Figure 9 below show the step on waste management plan for the hazardous waste. The objectives of this process are to:

- Identify opportunities to prevent and minimise waste generation from operations and processes;
- Identify and eliminate hazards to human health and the environment;
- Minimise exposure to potential liabilities at an acceptable cost.

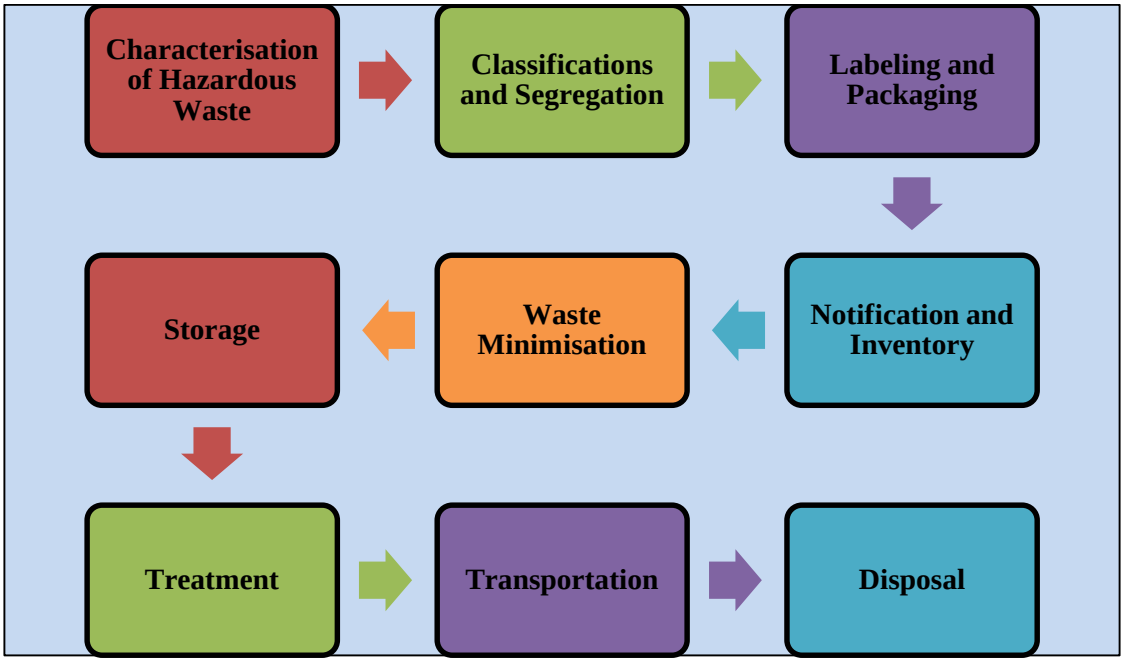

Figure 9: Hazardous Waste management plan

i. Characterisation of Hazardous Waste

Each waste that identified from the offshore installation need to be categorized based on their properties. The properties of waste are split into three which is physical, chemical and toxic. The property of waste will be available on Material Safety Data

Sheets (MSDS), waste production, historical of waste and, waste lab information. There are system will be establish to categorize type of waste according to safety and environment. Malaysian Waste Regulation which is Environmental Quality Act (EQA) was already prepared the list of hazardous wastes that harm to the environment. The listed wastes are focused around the way that the fundamental constituents show no less than one hazardous attribute. Waste that does not meet a listing accurately is still hazardous waste if it displays one of four characteristic: ignitable, corrosive, reactive or toxic.

ii. Classifications and Segregation of Waste

Waste generators shall develop and implement practical procedures and controls for identifying and segregating hazardous waste. These must comply with local legislative requirements. The classifications of hazardous waste are:

- Clinical waste, radioactive waste and sewage sludge shall be identified under distinct categories of hazardous waste. Empty containers shall also merit special attention
- Classification of other hazardous wastes shall be based on an assessment of physic-chemical, toxicological and environmental properties and characteristics.
- Hazard assessment should systematically address occupational health, community health and environmental aspects at all stages in the waste life cycle, including generating, handling, storing, transporting, treating and disposing. Chemical health risk assessment shall follow the methodology outlined in PTS 60.1502 (Chemical Management Guideline). Means of controlling the wastes handlers‟ exposure to the wastes chemical shall be evaluated and recommended (if necessary). Appropriate personal protective equipment (PPE), which is the last defence, shall be worn.
- Hazard assessment should be carried out with a clear focus on prevailing local circumstances to ensure that it is practical and realistic

Clinical waste and radioactive waste (NORM) should always be treated as special categories of hazardous waste. 'Empty' containers such as chemical and oil drums may also require special consideration. A brief description of these different types of hazardous waste is found below

No	Hazardous Waste	Description
1	Oily sludge	Oil sludge or black sludge is a solid or gel in motor oil caused by the oil gelling or solidifying, usually at temperatures lower than 100 degrees Celsius. Sludge can be a major contributor to internal combustion engine problems, and can require the engine to be replaced, if the damage is severe. Sludge is usually caused by the presence of water in the oil, and can accumulate with use. Ways to minimise sludge production and accumulation includes performing frequent oil changes and following the manufacturer's engine maintenance routine
2	Clinical Wastes	This category is most relevant to Oil Production Unit (OPU) with their own clinics. However, medical waste can also be generated at operational locations including platforms, and must always be segregated carefully. Medical waste includes used equipment, e.g. needles, used dressings, biological samples, waste prescription drugs and all potentially pathogenic material.
6	Radioactive Wastes	These can comprise Naturally Occurring Radioactive Materials (NORM) from producing reservoirs in the form of scales or liquid effluents, radioactive sources used in well logging and tracer tests and radioactive

		materials from medical facilities. Radioactive waste shall be defined in terms of its specific activity, complying with local regulations, such as Atomic Energy Act 1954 and PETRONAS Group guidance.

iii. Labelling and Packaging

The storing and labelling requirement of hazardous waste shall follow host country requirements. In the absence of such requirements, the labelling requirements stipulated in the Third Schedule of Malaysian Environmental Quality (Scheduled Wastes) Regulations 2005 shall be followed. All hazardous waste must be labelled at point of generation and not at the temporary/ transit storage area (e.g. supply base).

iv. Notification and Inventory

An accurate and up-to-date inventory of hazardous waste shall be maintained by the site. It shall contain the categories and quantities of hazardous waste being generated, treated and disposed of as well as materials or products recovered from the waste. If required, relevant authorities/ parties shall be notified accordingly. An accurate and up-to-date inventory of hazardous waste shall be maintained by the site.

v. Waste Minimisation

When evaluating the waste management alternative, operators should care the opportunities for waste disposal, volume or poisonous quality, reusing and recovering, or treatment. At the point when a potential waste minimisation practice is recognized, a pilot test may be coveted for assessment. Correction of the waste administration arrangement ought to be made to reflect any minimisation practices executed

vi. Storage

The waste owner should assess and identify a designated waste storage area within his own compound according to the waste/ hazard classification.

- The waste owner should source out appropriate containers that will not chemically react with the waste material.
- The waste should be stored in durable and compatible containers that are in good condition. .
- Filled and empty containers shall be segregated.
- Waste containers should be inspected regularly, or as according to host country requirements, for leaks. A proper written record of the inspection is to be kept.
- The storage duration shall adhere to host country requirements. In the absence of such requirements, the waste shall not be stored on-site for more 180 days or 20 tonnes.
- The storage area should be adequately designed.
- The classification and disposal of empty containers, particularly used chemical drums should be carried out properly.

vii. Treatment

After the waste recovery opportunities, treatment method should be narrated to minimize the quantity of waste or quantity of toxic in waste. Treatment methods include biological methods, thermal methods, chemical methods and physical methods. Some good practices for treatment are as follows:

- To recover oil from tank cleaning residue using appropriate method and technology.
- To contain any oil spillage and send to an oily sump system before reprocessing into the process system.
- To recover platinum from spent catalyst through expertise either in or at other countries

viii. Transportation

Waste owner shall be responsible for making arrangement for transportation of empty drums or containers to the Washing Bay and also transporting hazardous waste to Hazardous Waste Storage. Waste shall be transported using approved waste transporters by relevant authority. In the absence of national or local requirements on hazardous waste transport, the following best practices may be applied on the waste transport contractors:

- Prior to transportation of waste the contractor shall develop a Job Hazard Analysis (JHA).
- Contractor shall develop a Transportation Procedure based on the JHA. This procedure shall also include an emergency response plan in case of road accident(s) involving waste spillage or fire.
- All gazetted road rules and regulations of the country should be obeyed / observed in any shipment of waste.

Waste is not to be transported across country borders unless such transportation is carried out in accordance with international conventions (e.g. Basel Convention) and with prior management approval. A completed Waste Consignment Note should accompany all waste transported for disposal or recycling /reclaim.

ix. Disposal

Disposal option is the final stage on waste management plan that has to be determined. The following criteria should be examined when evaluating waste disposal options. This information will help in determining the long-term fate of a waste and its constituents and should be applied to both onshore and offshore disposal facilities.

- General area overview - Review the relevant laws and regulations of the area and the availability of offshore disposal facilities.
- General site overview - Review the area-wide topographical and geological features. Also, review current and potential future activities around the disposal site. .

- Soil conditions and loading considerations - Determine soil conditions prior to making decisions on loading for land spreading and whether or not pits will require liners
- Environmental sensitivity - Conduct a site evaluation to identify environmentally-sensitive features such as wetlands, urban areas, historical or archaeological sites, protected habitats, or presence of endangered species.
- Air quality - Give consideration to potential air quality impact of waste management facilities

b) Non-hazardous waste management plan

Non-hazardous wastes should be classified according to their source. Wastes which do not fall within the hazardous waste classification are by default classified as non-hazardous waste. The figure 10 below show the non-hazardous waste management plan.

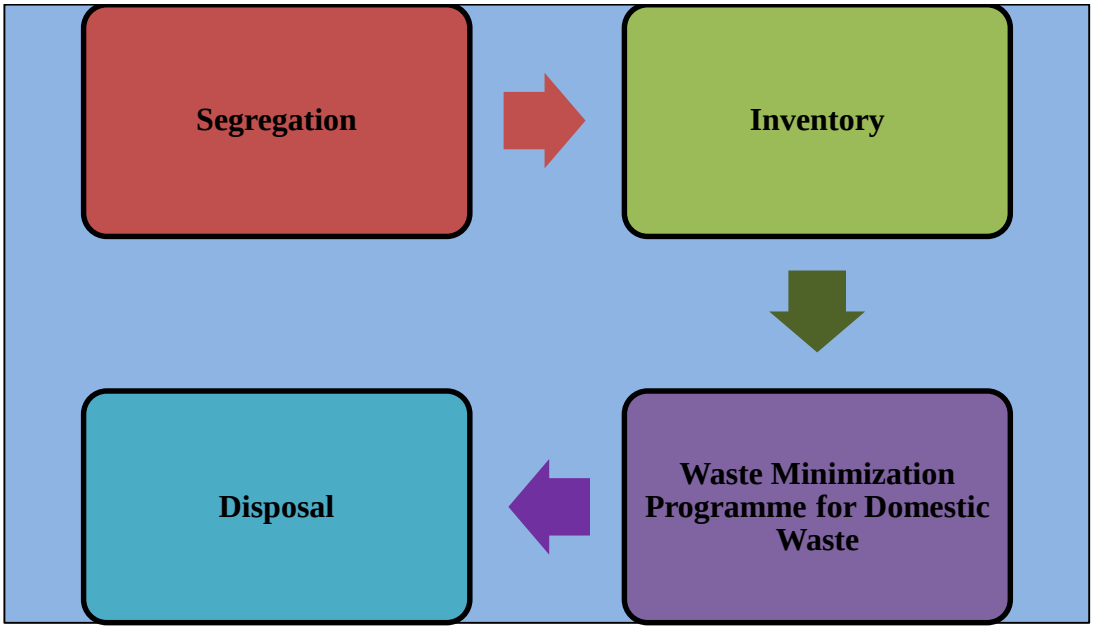

Figure 10: Non-hazardous waste management plan

i. Segregation

The main categories of non-hazardous waste are industrial, office and domestic waste, but further segregation may be required to exploit opportunities for reuse and recycling.

ii. Inventory

The inventory for non-hazardous waste shall follow the respective host country requirements, if any. It should at least contain information on the type and quantity of the waste.

iii. Waste Minimization Programme for Domestic Waste

The first step is to consider reducing the amount and composition of waste produced in the office, followed by purchasing or using materials that can be reused. Collecting, and processing materials to manufacture and sell them as new product is known as a recycle material. Domestic waste should be kept and consolidated into skid bins or containers labelled “DOMESTIC WASTE” at the workplace and strategic areas. Domestic wastes that cannot be recycled are strictly prohibited from the recycling containers and shall be treated as normal garbage or hazardous waste based on its conditions.

iv. Disposal

The disposal of waste to an approved third party facility is preferred over the use of controlled waste management sites. However, in the absence of such facility or country requirements, Operating Units may build/construct a controlled waste management site, with appropriate design and approval obtained from the relevant authorities.

Documentation and retention of records

Business and Operating Units should implement procedures for record keeping, maintenance and control of in-house documents relating to all aspects of waste management. Documents and essential records should be safeguarded against loss, destruction or inaccessibility. In order to be used in possible future litigation, it is essential that these records should be retained for a period of time as specified. PETRONAS HSE Management System (HSEMS) requires records and documents to be kept for five years unless otherwise specified by the authority. The following documents and records shall be retained:

- Waste management plan
- Licenses or permits
- Procedures on waste management
- Inventory on disposal of waste Note: The requirement is only applicable for hazardous waste, but not for the non-hazardous waste. It is merely a best practice.
- Reporting documents to authority
- External communication on waste

Contractors and Contractors-Related Rules

Managements of oil and gas operator unit should ensure that waste is properly handled by their personnel as well as contractors. They should also comply with local and national regulations, international treaties and conventions, PETRONAS Policy and PETRONAS Technical Standard (PTS) for HSE. Responsible companies will take independent and positive management action, similar to what responsible waste generators should take to avoid incidents which can reasonably be expected to cause harm, and to be able to provide evidence proving this. It is important to ensure that a documented audit trail covers all aspects of waste management from generation to

disposal. The transfer of waste to duly certified/ licensed and regularly audited waste transporters and disposal facilities in accordance with legislation is key to the minimisation of a waste generator's potential liability for damage allegedly caused by such waste. From a legal point of view, the waste generator holds responsibility even if the waste has been transferred or disposed of in this manner. Contractors involved in handling, storing and disposing of waste for Business and Operating Units should have a management system consistent with the company's HSE policy and objectives. For guidance see Rules for dealing with waste contractors in Table 2 below.

No	**Rules**
1	The contractor should practise a Health, Safety & Environment management system.
2	The evaluation of a proposed waste contract should take into account • the contractor's size, financial stability and technical capability; • skills of personnel and condition of equipment and facilities; • availability of a HSE policy and the status of its implementation • standard of operation and environmental performance; • the contractor's valid status with authorities; • status of relevant permits to handle or dispose the waste material in question
3	Provide contractor with all relevant environmental, safety, health and technical data relating to waste
4	Require signed confirmation from the contractor that the consignment will be transferred, treated or disposed of at specified locations according to the contractual obligations and provisions of the relevant laws and regulations.
5	Ensure that emergency procedures are in place and are effective.
6	Carry out periodic audits of the contractor/ sub contractor's facilities and operations, including their waste disposal practices (If the (sub)contractors can provide regular audit reports of audits performed by certified outside

	(waste management system) auditors, there may not be a need for the waste generator to conduct additional audits).
7	The waste material transferred to the contractor should be packed and labelled appropriately, and transport notification and documentation completed in accordance with regulatory requirements
8	Review the performance of the contractor periodically and keep a complete documentation.

Table 2: Rules for dealing with waste contractors

The roles and responsibilities of hazardous waste generators, contractors and treatment operators can be summarized as in table 3 below.

Waste Generator Responsibilities	**Waste Contractor Responsibilities**	**Waste Treatment and Disposal Facility Responsibilities**
• Identification and classification of waste labelling • Notification to authority within 30 days • Storage and on site Emergency Response Procedure (ERP) • Upkeep of inventory and disposal records • Provides technical expertise and assistance in case of spillage • Application of license	• Application of license from authority to transport waste • Upkeep of transportation documents • ERP during transportation • Permissible routing	• Application of license from authority to operate and occupy waste treatment or disposal facilities • Upkeep of inventory and disposal records • On-site ERP

from authority to operate on-site waste treatment facility • Application to store hazardous waste more than 180 days or 20 tonnes		

Table 3: Responsibilities of Waste Contractor and Generator

Implementation of Area Waste Management Plan

Incorporate all favoured waste management and disposal alternatives for each one waste in a given working territory into one complete, zone particular waste management plan. The proposed waste management practices ought to be outlined in brief archives for utilization at the field level. Explanation ought to incorporate just the wastes created by the operations in the particular zone or inside an management obligation. Each one waste explanation ought to demonstrate the picked waste management and transfer rehearses.

Waste Management Audit and Review

Business and Operating Units shall carry out audits to systematically verify whether all aspects of waste management conform to the established waste management plans. The suitability, adequacy and effectiveness of the waste management plan shall be regularly reviewed by management at an agreed interval. The waste audit and review shall be conducted as and when required. The findings of the waste audit should be documented.

b) To evaluate the waste management framework for other country and compare API guidelines and PTS guidelines and recommend a new waste management framework

Case Study

There is a few research has been done on waste management framework for decommissioning offshore platform around the world. In order to achieve second objectives of this study, offshore platform decommissioning case studies are adopted from the decommissioning reality which is to critically survey different secure waste management framework from decommissioning places which is Gulf of Mexico and North West Hutton.

Gulf of Mexico (GOM)

One of the decommissioning offshore installations involved is in the Gulf of Mexico. In the Gulf of Mexico, the government bodies will involve in the decommissioning offshore structure. State offices are in charge of structures found in state waters, while the Minerals Management Service (MMS) is in charge of structures in government waters. After all wells are plugged and abandon, the structured has to cleaned properly from the hazardous chemical that attached it.

In the Gulf of Mexico, the common method used in decommissioning is cut the deck and send to onshore or left in-situ as artificial reef. Many decommissioning offshore platform in GOM was idle as artificial reef to reduce cost of lifting to onshore. Operator has the responsibility to carry out the inspection on the structure or waste removed in offshore platform. Any removal platform application or waste handling application must be send to the MMS, to ensure the operator follow the regulation set by the MMS. The application contains the information of the reason of plugged, work requirements, waste identify, site clearance and others. Once the application was approved the MMS, then the operators can proceed with the plug and abandon

activity. Before beginning the activity, operator should inform the MMS to avoid any problem in the future. MMS will inspect the platform based on American Petroleum Institute (API) code. For the waste management also, MMS has followed the guidelines that stated in API. In US, most platform decommissioning based on the guidelines, code that stated in the API. As a conclusion, the operator has to prepare the report after site clearance of the offshore platform to ensure all documents inside the report was follow the regulation set by the MMS and follow the code of the API.

North West Hutton (NWH)

In the coming years, offshore decommissioning movement in the North Sea will unavoidably increase as existing field framework approaches the end of its service life. The decommissioning phase in the platform includes the removal of topside, removal of jacket structure and other heavy structure. Approximately 97% of removal steel structures can be recycled or reused. In UK, most waste management guidelines are not compulsory applied in the offshore platform. Once the removal structure reaches to the onshore, it has to follow the onshore legislation and guideline for which particular removal structure that contain waste. Any waste that receive from the offshore has to meet the legal requirements and follow the shipping requirement which is packing, segregation and allocate the waste in the offshore area to avoid any pollution and environmental impacts.

In the UK legislation, it has introduce the concept of "Duty of Scare" which is someone will appointed to manage the waste and control the waste that receive from the platform. It is easy way to manage the waste properly and disposed it in particular disposal area. The responsibility of the person appointed as "Duty of Scare" is:

- All structure material that contain waste and any waste that come out from offshore platform has to dispose safely with follow legal requirement that set by UK legislation.
- The person must have licenced whenever handle the waste to ensure the safety requirements.

- Waste must send to the landfill site after its meets the waste acceptance criteria.
- All waste from the offshore platform to the onshore has to record by the duty of scare person.

Other than that, it is observed that the oil and gas operator which work in decommissioning platform has to recognise and quantify the waste whenever conducting the view on the offshore platform. The inspection is conducted to the structure, vessel and other waste material especially on the hazardous waste substances which is hydrocarbon, chemicals, diesel oil, naturally occurring radioactive material, PCBs mercury and asbestos. Since the NWH platform comprises of numerous modules, further work was then done after the inspection was carried out with a specific end goal to the waste of each kind of waste in each platform. This included by having the skill to make contemplated presumptions to the rate of every waste material in every module taking into account the areas of key components of the pertinent frameworks.

Waste Management planning in NWH was developed in the initial stage of decommissioning offshore platform with is having a relationship between operator which is BP, decommissioning contractor and the onshore disposal contractor on the process deliverable the waste from offshore to the onshore. The BP (operator) will come out with document to send to the decommissioning contractor about the type of waste, area, quantity of waste and other related info.

Figure11: Party involve the waste management strategy and planning.

In order to manage the waste in the offshore platform, the decommissioning contractor was introduce the waste documentation pack (WDP) which to control the waste in the offshore and onshore that shown in the figure 12 below. Each WDP contain the waste summary sheet (WSS), Controlled Waste Transfer note (CWTN) and Hazardous Waste Consignment note (HWCN). WSS is helping the decommissioning contractor to differentiate the waste and quantify the waste from the offshore platform. It's also act as a proved to show to the operator whenever have the inspection on the decommissioning offshore platform.

WDP will be prepared by the "waste competent person offshore". This person has the responsibility to ensure all information that provided in the WDP is accurate and complete as possible. The person also has to set a detailed document to ensure all waste management parties know their responsibilities in order to manage the waste in the decommissioning offshore platform. The most important document for onshore disposal contractor has to prepare is the plan how to conduct the waste, and the place which need to disposed the waste.

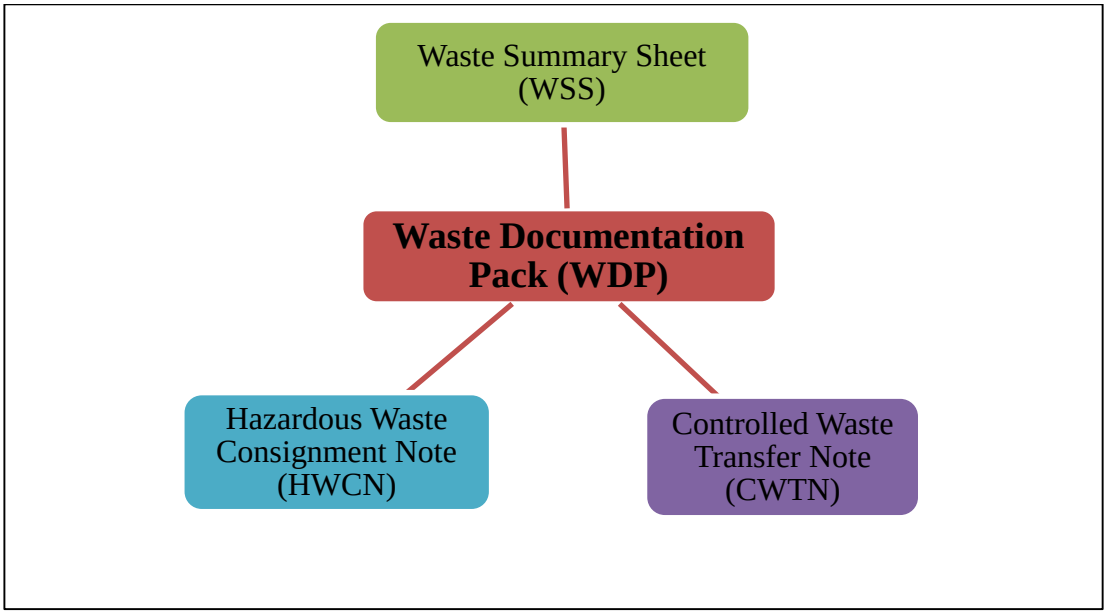

Figure 12: Waste Documentation Pack

The lesson learnt from North West Hutton stage is that some huge unpredictability must be incorporated to the last estimation waste because of the scope of levels of pollution that may be occur in different areas of platform. Other than that, the Duty of Care practice helps in expanding the exactness of data accessible on the waste material at each phase of the waste management process.

Frigg Decommissioning

Waste management in Frigg Decommissioning is more directly on waste separation. Most of waste especially steel in decommissioning offshore platform was bring to onshore for purpose of disposal and recycled. Any permit or approval for waste management in Frigg was accordance to the OSPAR Decision 98/3 and national authority. New procedure was introduced to handle and disposal the waste from decommissioning. Frigg Decommissioning was introduced the Total Environmental Reporting and Management System (TEAMS) which is new software that used for documentation, processing and reporting the waste from the decommissioning platform. This software is very functional in waste management because it can be used as a tracking system or document to all waste moved from the offshore to onshore such as fabrication yard or waste yard and landfill. The system helps to follow up with the waste that send to recycle and reused. Furthermore, the system was followed both Norwegian and UK legislation and record all environmental impact on decommissioning offshore installation.

Comparative Assessment of Case Study

The result from these three case studies are mainly based on the parties involved, the waste management method as a whole and also the rules and regulations involved in the decommissioning offshore installation. Each case study has their own authority involve in the waste management process. Like in Gulf of Mexico, the oil and gas operator has to submit all related document for offshore decommissioning to MMS which was responsible on approval process and operator has to follow all rules and regulation set by the authority. The oil operators also have to obey to the Environmental Protection 49 Agency (EPA) which was authorised by Resource Conservation and Recovery Act (RCRA) to regulate hazardous waste from offshore to onshore. Apart from that, Gulf of Mexico manages the waste according from API guideline which is provided framework about management. More offshore platform in US used API guideline for exploration and production (E&P) process.

Based on the second case study, which is North West Hutton (NWH) having own waste management method to use in the decommissioning offshore platform. NWH practice a good alignment among operators, contractor and disposal contractor. Other than that, NWH have WSS which is help to identify and quantify the waste from decommissioning offshore platform. It is good method that can help the operators and contractor work move smoothly and give easiness to operator in order to handle the waste. WSS provide applicable information about waste containing in each decommissioning platform. With these WSS, the oil and gas operator (BP) can deliver the work to person who in charge of the transportation and handling the waste from offshore to onshore. Moreover, from the last case study of Frigg Decommissioning, it was stated that, the operator used TEAMS which new software introduce to manage the waste from decommissioning. The software helps the operator to record all the information about waste that move from offshore to onshore. It also easiest software to trace the environmental impact such as spilling chemicals on platform and others. The comparison of method for 3 case studies was simplify and stated in the table 4 below.

From these three case study review, it was little bit difference on authority approval in Malaysia. Malaysia is new for decommissioning offshore installation; the operators have to inform the Department of Occupational Safety and Health (DOSH) about the proposal of decommissioning. In the decommissioning proposal strategy, the operators have to supply all information about the platform and have to provide the Environmental Impact Assessment (EIA) which is one of preliminary work in the decommissioning. Operator also has to inform Department of Environment (DOE) about the waste that will transfer from platform. Currently Malaysia oil and gas operator PETRONAS was come out with the waste management guidelines which help decommissioning process in future. The oil and gas operator will face many challenges in the future to decommissioning offshore platform. The operator has to go through all decommissioning process which includes the preliminary work such collect platform information, drawings, approval letter, plans and others.. In addition, decommissioning is a longest process which involves approval from all government bodies that related to offshore decommissioning. The operators have to find contractor which is active in decommissioning and the contractor must follow all aspect and legal regulation that related to decommissioning. Apart from that, finding on local facilities for handling the wastes also a important part in decommissioning. The method to handle the waste will ensure the environment is maintained.

Case Study	**Waste Management Method**
Gulf of Mexico	• Waste manage by authority and follow the API guideline
North West Hutton	• Introduce WDP • Separation work among operator, decommissioning operator and disposal contractor
Frigg Decommissioning	▪ Introduce new software TEAMS

Table 4: Comparison between Three Case Studies

Compare PTS Guideline and API Guidelines

PTS Guideline	API Guideline
Preparationof waste management plan ↓ Documentation and Retention of record ↓ Contractor & Contractor Related Rules ↓ Execution of Waste Management Plan Area ↓ Waste Management Audit And Review	Management Approval ↓ Area Definition ↓ Waste Identification ↓ Regulatory Analysis ↓ Waste Categorisation ↓ Evaluation of Waste Management & Disposal Option ↓ Waste Minimisation ↓ Selection of Preferred Waste Management Practices ↓ Implementation of an area waste management plan ↓ Plan Review and Update

Table 5: Comparison between PTS and API

Currently PETRONAS was released a new waste management guidelines after referring with other country framework. Waste Management guidelines are developed in order to have a good view on the management standard and implementation health and safety at site. In most cases, PETRONAS adopted the American Petroleum Institute (API) as guidelines to develop the waste management framework. API waste management guidelines are published to assist the operator to prepare the method to manage the waste produce from the decommissioning offshore installation and the operating practice. An API guideline is the proposed plan, framework, management and general guideline for combine hazard analysis output into environmental quality assessment (EQA) in determining whether the waste meets the specified criteria that sets by EQA. The comparison between API and PETRONAS was stated in the table 5.

Both PETRONAS and API guideline used Material Safety Data Sheet (MSDS) to identify the characteristics of the waste produced from the decommissioning offshore installation in Malaysia. Other than that, both guidelines have same waste management plan or method which is reduce, reuse, recycling, treatment and disposal.

The difference between API guideline and PETRONAS Guidelines are in contractor and contractor related rules. In API guidelines, there are no rules and responsibilities of the waste contractor or generator. PETRONAS Guidelines stated about the responsibilities of the contractor in the waste management guidelines and people will responsible of the waste from the decommissioning offshore installation. The contractor should need to follow the rules and regulation that set by the national legal regulation and PETRONAS policy. There are few rules are set by PETRONAS to the contractor on waste management guideline. The rules and responsibilities are stated on the objective 1. Other than rules, PETRONAS also divide the waste contractor responsibility into three teams which is waste generator, waste contractor and treatment operator responsibilities. The three parties have their own responsibilities which are stated in the guideline.

Other than that, PETRONAS simplify waste management framework into 5 step but API guidelines purpose waste management with 10 steps. Preparation of waste management plan and documentation and retention of records in PTS guideline simplify the five steps in API guidelines. Furthermore API guideline stated about the regulatory analysis but PETRONAS guidelines not stated about the legal regulation. Regulatory analysis is assessing international legal regulation, to figure out the types of wastes and method to manage it with legal and regulation of the country. Certain waste should identified because there do not have the regulation and management to follow it.

Recommend new waste management framework

Currently PETRONAS was release the waste management guideline for offshore decommissioning which will used by the Malaysian oil and gas operators in the future. Even PETRONAS was release the guidelines, it still have pros and cons in the guideline. The pros that can find from the guideline are on contractor related rules. The rules on waste management are one of the important parts that each contractor has to follow. With this guideline, each contractor can know their rules and responsibility on how to handling the waste from decommissioning offshore platform. Besides that, the cons in the PETRONAS guidelines, is one management approval. Guidelines are not stated clearly about the people involved in the management approval process .It is important to state on the authority involve in the waste management process. Each waste that transfers to the onshore should get approval and declaration form from the authority. Therefore, this project recommends a new waste management framework for the local industry to follow. These new guidelines, its recommend to develop the old PETRONAS waste management guidelines according to API guidelines.

Step 1: Authority Approval

The oil operators have to construct the decommissioning suggestion idea and inform earlier to the Department of Occupational Safety and Health (DOSH), Department of Environment (DOE) and Marine Department. The operator has to list down which authority will involve on the submission for approval process. Authority Submission is one of the preliminary works in the waste management process. Under the Environmental Quality Act (EQA), 1974 and the Regulations thereunder, any industrial activities are required to obtain the following approvals from the Director General of Environmental Quality prior to project implementation:

I. Environmental Impact Assessment reports
II. Platform (site) suitability evaluation
III. Written permission to construct - under Section 19 of the EQA, 1974 (for prescribed premises-scheduled wastes treatment and disposal facilities,
IV. Written approval for installation of incinerator, fuel burning equipment and chimney – under Environmental Quality (Clean Air) Regulation, 1978, EQA, 1974
V. License to use and occupy prescribed premises and prescribed conveyances - under Section 18 of the EQA, 1974.

Step 2: Prepare Environmental Impact Assessment (EIA) and legal regulation

The operators should collaborate with Department of Environment (DOE) when commerce with waste produced from decommissioning offshore platform. Environmental impact assessment is an important technique for ensuring that the likely impacts on the environment of proposed development are fully understood and taken into account before such development is allowed to go ahead. Environmental Impact Assessment (EIA) is required for scheduled activities under the Environmental Quality (Scheduled Activities) (Environmental Impact Assessment) Order 1987. The operator should know all legal regulation for waste management that stated in the

environment quality act (EQA) 1974. Its better if stated the legal and regulation in the waste management guidelines.

Step 3: Identify Operator and Contractor Responsibility

The operators should identify and stated clearly on roles of contractor. It's should also state the responsibility of each partner involve in the waste management for decommissioning offshore platform.

Step 4: Platform identification

The oil and gas operators should identify the platform which will be decommissioning activity will occur. If get the drawing of the platform, its good useful to decommissioning contractor. The platform information should prepare by the operator and will distribute to the related contractor. Each decommissioning contractor must have the full document on which platform will removed

Step 5: Waste identification and classification

The oil and gas operators should identify the waste that will be produces during the decommissioning process. The operator should have the data sheet or any new software to record all data about the waste from decommissioning process. Provide a new data sheet will help the process move quickly. Data sheets also help to separate the waste according to the type of waste such as hazardous waste and non-hazardous waste.

Step 6: Evaluate Waste Management method

The operators have to prepare waste management method which includes the prevention, reuse, recycling, disposal and landfill. Each waste should handle based on this method stated. Choose a better management method for each type of waste. There

are many ways including on Disposal and landfill method. Decommissioning contractor must list down all disposal area before the waste management started.

Step 7: Choose Preferred Waste Management Plan

The operators have to choose better waste management plan after conduct the analyze on the waste treatment and disposal process. After that, the operator should prepare the waste management implementation. All detailed on the waste management method should record it.

Step 8: Review Waste Management

The operators should appoint one department to in charge the waste management framework and always review the waste management plan.

c) To develop the legal and regulation of waste management based on international practice

There is a few research has been done on legal regulation on how to manage the waste from decommissioning offshore platform around the world. In order to achieve last objectives of this study, certain legal regulation was adopted from the decommissioning reality which is to critically survey different secure legal regulation from decommissioning places which is Gulf of Mexico and North West Hutton. The legal regulations that involve in these places are mostly IMO, UNCLOS, and OSPAR. All decommissioning issue will be handling by having a strong and considerable international practice.

International Maritime Organizational

International Maritime Organization (IMO) was indicating the "Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone" in 1989. The IMO guidelines can apply for the waste management and other dismantling purpose in offshore installation. These IMO guidelines more concerned on safety of navigation to prevent any unforeseen circumstances happen in coastal state. IMO also concerned on the safety, pollution happen around platform removal process. IMO cover all aspect of shipping which is on construction, equipment, operation and disposal to ensure the safety of the continental shelf. The regulation stated in IMO guidelines are:

- All offshore decommissioning platforms that standing in less than 75m of water and weighing less than 4000t in air, excluding the deck and superstructure, should be entirely removed.
- All abandoned or disused installations and structure which were installed on or after January 1, 1998, standing in less than 100m of water and weighing less than 4000t in air, excluding the deck and superstructure, should be entirely removed. Special authority will determine which platform should remove based on service life of the platform.

- All abandoned structure must follow the rules of safety and environmental performance.
- In cases of partial removal, an unobstructed water column sufficient to ensure safety of navigation but not less than 55 metres should be provided above any parts remaining on the seabed.
- On or after 1 January 1998, no installation or structure should be placed on any continental shelf or in any exclusive economic zone unless the design and construction of the installation or structure is such that entire removal upon abandonment or permanent disuse would be feasible.

Oslo and Paris Commission (OSPAR)

The 1992 OSPAR convention was establish as international guidelines to protect the marine environment of the North Sea Atlantic. Certain countries such UK, Spain, Netherland, Denmark, Germany and Ireland were used these guidelines for removal purpose. Any removal of offshore installation in UK continental shelf will act according with OSPAR guidelines. The regulations stated in OSPAR convention regarding on waste are:

- Each Contracting Party shall keep, and report to the Commission records of the nature and the quantities of wastes or other matter dumped in accordance of the dates, places and methods of dumping.
- Each contracting party should get the permit to dumping of waste or other regulation matter.
- Each contracting party should ensure no wastes or other matter shall be dumped without authorisation by their competent authorities, or regulation;
- Duty of the Commission to draw up and adopt criteria, guidelines and procedures relating to the dumping of wastes or other matter, to ensure its prevent and eliminate pollution happen around sea.
- Such dumping shall be so conducted as to minimise the likelihood of damage to human or marine life and shall immediately be reported to the Commission,

together with full details of the circumstances and of the nature and quantities of the wastes or other matter dumped.

- In an emergency, if a Contracting Party considers that wastes or other matter the dumping of which is prohibited under decommissioning cannot be disposed of on land without unacceptable danger or damage, it shall forthwith consult other Contracting Parties with a view to finding the most satisfactory methods of storage or the most satisfactory means of destruction or disposal under the prevailing circumstances. The Contracting Party shall inform the Commission of the steps adopted following this consultation. The Contracting Parties pledge themselves to assist one another in such situations.

United Nations Convention on the Law of the Sea (UNCLOS)

The United Nations Convention on the Law of the Sea (**UNCLOS**) also called the Law of the Sea Convention or the Law of the Sea treaty is the international treaty that consequence from the third United Nations Conference on the Law of the Sea (**UNCLOS** III), which hold between 1973 and 1982. This treaty includes 320 articles which cover all legal aspect of sea and its usage. Any offshore structure which are dismantled or recycle shall be removed to ensure the safety of ocean and protect the environment from the pollution [4]. The waste regulations stated in UNCLOS are:

- the prevention, reduction and control of pollution and other hazards to the marine environment, including the coastline, and of interference with the ecological balance of the marine environment, particular attention being paid to the need for protection from harmful effects of such activities disposal of waste, and other devices related to such activities;
- Any activities in offshore should orderly, safe and rational management of the resources of the offshore area, including the efficient conduct of activities in the offshore area and, in accordance with sound principles of conservation, the avoidance of unnecessary waste

The outline from three international practices was indicating in the table 6 below. From these regulation, it can conclude that, each regulation have different method when handling the dumping waste.

International Practice	Regulation
IMO	• Characteristic of decommissioning offshore platform • Safety and environment issue • Authority approval before decommissioning
OSPAR	• Duty of Decommissioning Contracting Party • Disposal of waste produced • Quantity of waste produced
UNCLOS	• Safety and environmental issue on platform

Table 6: International Practice

Existing Legal and Regulation of onshore waste management in Malaysia

Malaysia is new in decommissioning world. There is no legal and regulation for manage the waste from the decommissioning offshore installation. Moreover, there obey with onshore legal regulation and international practice to manage waste from decommissioning. Each waste move to the onshore, it will be sending to disposal place or onshore recycling. The waste send to the yard will be managed by certain authorities and legislation. The main authorities involve for environment or waste management is Department of Safety Health (DOSH) and Department of Environment (DOE).This department are involve to manage the waste after the waste arriving in onshore. DOSH will involve all activity regarding on safety while DOE will manage the environmental issues that happen during decommissioning. The onshore legislation does not practice in offshore, because all waste in offshore will transferred to the onshore. Once the waste moves to the onshore, the waste must meet all onshore

requirements that stated in regulation before being dismantled. All waste must passing the requirement to ensure avoid pollution of the environment or harm to human health. The oil and gas operator have to obey with the Environmental Quality Act (EQA) 1974 for purpose of legislation. This act was applied at whole Malaysia to protect environment from pollution. The following are general waste requirements stated in EQA 1974:

- Measure, take a sample of, analyse, record and report any environmentally hazardous substances, pollutants, wastes, effluents or emissions containing pollutants.
- Prohibit place, deposit or dispose of, or cause or permit to place, deposit or dispose of, except at prescribed premises only, any scheduled wastes on land or into Malaysian waters.
- For the purpose of this Act, any act of receiving or sending, or transit of any scheduled wastes with an approval obtained through falsification, misrepresentation or fraud or which does not conform in a material way with the relevant documents in such form as may be prescribed, shall be an offence.
- The operator should notice information on any environmentally hazardous substances, pollutants or wastes discharged or likely to be discharged therefrom.
- Operator should inspect, examine, seize or detain any scheduled wastes or environmentally hazardous substances and any vehicle or ship used in the conveyance of the scheduled wastes or environmentally hazardous substances.
- Any apparatus used in transferring oil, mixture containing oil or wastes to any ship from a place on land, the person in charge of the apparatus and the employer of that person shall be jointly and severally liable.
- The industries could produce scheduled wastes but which can treat on site to comply with the Environmental Quality (Scheduled Wastes) Regulation or disposed of from their premises.

- The industries produce radioactive material or hazardous wastes which are toxic shall meet the necessary approvals.

Other than this regulation, there is set of legal provisions related to the management of toxic and hazardous wastes were developed based on the “cradle to grave principle”; whereby toxic and hazardous waste generators are responsible for their wastes throughout their disposal process. A facility which generates, stores, transports, treats or disposes scheduled waste is subject to the main following regulations:

I. Environmental Quality (Scheduled Wastes) Regulations 2005;
II. Environmental Quality (Prescribed Conveyance)(Scheduled Wastes) Order 2005;
III. Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment and Disposal Facilities) Regulations 1989;
IV. Customs (Prohibition of Import) Order 2008.

Each waste transfer to the onshore should follow all this regulation before it’s disposed to the land. Onshore regulation can`t practice in offshore because waste produce in offshore its different with onshore waste. Waste that produce in platform should not mix with onshore waste because most offshore waste contains radiochemical material. There was different declaration form have to submit to authority for waste produced in offshore installation. Therefore, it should have regulation for decommissioning offshore installation in Malaysia.

Recommend regulation of waste management for decommissioning offshore installation in Malaysia

In Malaysia, most of the offshore platform reaches their end of service life. There are so many challenges faces by the operator to handle the waste from the decommissioning offshore platform. One of the challenges are no legal and regulation for manage waste that produce from decommissioning offshore platform. According to the interview with PETRONAS, they were following EQA as a waste management regulation on the waste transfer to onshore. Legal, tax, cost, waste, environmental issue overlap each other under EQA. The waste will separate by hazardous waste and non-hazardous waste. The waste will dispose or treat with follow of regulation in EQA which is Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment and Disposal Facilities) Regulations 1989. On behalf of the operator, they must obey with the condition of a waste management licence which does not harm to human health and environment. Any Operator develops to carry out decommissioning or dismantled offshore platform should get approval from the authority at the early stage of decommissioning. Authority will finalize separate guidance and regulation for decommissioning operator on the treating, dismantled and reuse the waste produce from decommissioning platform. The operator should consider all aspects at the beginning stage of decommissioning in order to avoid any pollution or environmental problem that harm to human health. Therefore, the operator (PETRONAS) should have different legal and regulation to manage waste produce from decommissioning to avoid any future problems from the behalf of third parties. There is some recommendation on regulation that should have in EQA especially on waste management for decommissioning offshore platform are stated in table 7 below.

Recommendation on Regulation in Malaysia
a) Type and quantity of waste produced during decommissioning b) Authority involvement in waste decommissioning and list of document required c) Duty of waste generator and contractor d) Storage and labelling of waste produced e) Recycle, or reuse decommissioning waste f) Spill or accidental discharge on offshore g) Removal and disposal of waste

Table 7: Recommendation on Regulation in Malaysia

a) Type of waste produced during decommissioning

Most of the waste generated from the Platform Decommissioning is steel (98%) which can be recycled. There is no documentation available on detail type of waste generated from Malaysia Platform. Therefore, waste generated from decommissioning platform from five different regions is compared in order to identify the potential type waste generated in Malaysia Platform to be used in the assessment. The detail comparison of the waste is tabulate in detail in **appendix section**.

b) Authority involvement in decommissioning and list of document required

The authority that involve in waste management is DOE and DOSH. Each department has different roles in the waste management. The document and forms that recommend to state in the regulation are:

- Information on waste and waste generator
- Information on consignee/receiver/facility
- Licensed transporter
- Contractual agreement (Waste generator + Transporter + Facility operator)

- Insurance coverage
- Emergency Response Procedure
- Shipment schedule, route
- Technical information on waste recovery process
  -Waste component to be recovered
  -Percentage of residue and disposal

c) Duty of waste generator and contractor

Under these new regulations, scheduled wastes listed in the First Schedule are divided into five categories. Waste generators should determine whether their waste is classified under scheduled wastes. New generators of scheduled wastes are required to notify the Department of Environment within one month from the date of generation. Scheduled wastes can be stored, recovered and treated within the premises of the waste generators. Such activities do not require licensing by the Department of Environment. A waste generator may store scheduled wastes generated by him for 180 days or less after its generation provided the quantity of scheduled wastes accumulated on site shall not exceed 20 metric tonnes. However, waste generators may apply to the Director General in writing to store more than 20 metric tonnes of scheduled waste. Waste generators shall also keep an up to-date inventory of scheduled waste generated, treated and disposed. Proper labeling, containers and storage areas as well as prohibition of storage of incompatible waste are also required by law.

d) Storage and labelling of waste produced

The storing and labeling requirement of waste shall follow Malaysia environmental Quality Act (EQA) requirements. All hazardous waste must be labeled at point of generation and not at the temporary/ transit storage area (e.g. supply base).The containers that are used to store scheduled wastes shall be clearly labeled with the date

when the scheduled waste is first generated, name, address and telephone number of the waste generator.

e) Recycle, or reuse decommissioning waste

After the wastes are identified, then the regulation of treating the wastes can be determined according to their nature and ultimately the wastes will be either reused, recycled resale or transported to landfills. In EQA stated that any waste for sale and that the product shall contain a minimum percentage of recycled substances and to carry an appropriate declaration on its recycled constituents, method of manufacture and disposal.

f) Spill or accidental discharge on offshore

This regulation requires any person handling, storing or using oil or mixture containing oil to report discharges and spillages of oil or mixture containing oil into Malaysian waters. No person shall, unless licensed, discharge or spill any oil or mixture containing oil into Malaysian waters in contravention of the acceptable conditions specified under EQA act.

g) Removal and disposal of waste

This regulation require any disposal and off-site facilities for recovery, storage and treatment can only be carried out at prescribed premises licensed by the Department of Environment. However with the signing of the concession agreement between the Government of Malaysia and Kualiti Alam Sdn. Bhd, all off-site treatment and disposal (incineration, wastewater treatment, storage and secure landfill) of scheduled wastes is not allowed.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

Decommissioning as a whole is going to be a big issue in Malaysia since many of the platforms are approaching the end of their production lives. In addition, each platform is unique in terms of size, weight, structure and therefore, requires specific evaluation to determine the waste. Each platform will generate different type of waste. The basic waste management offshore installation is includes the identification of waste based on disposal hierarchy practices.

The study concludes that it is important to identify the waste management framework for decommissioning process. Before start the removal process, every oil and gas operator has to facing the problem on waste generated by the platform. Based on PETRONAS Waste Management Guideline, each waste, whether hazardous or non-hazardous has different waste management plan for handling the waste. Identify waste management plan is one of procedure on PETRONAS waste management framework. Waste management plan show how to handle the type waste by reduces, recycle, recover, treatment and disposal. Therefore, it is importance for the oil and gas operator to be prepared and ready on the waste management framework for decommissioning of offshore installation.

In additional, this study also provide the other country waste management framework for decommissioning offshore installation such as Gulf of Mexico and North Sea as a comparative with the Malaysia waste management framework. Malaysia is new on the waste management for decommissioning installation. Therefore, comparative study with another country framework will help to make improvement on the Malaysia waste management guideline for future use.

Lastly, this study also purpose regulation to manage the waste from decommissioning offshore installation based on international regulation which is IMO, OSPAR, and

UNCLOS. It was also refer EQA as a guideline to develop the regulation for decommissioning.

Recommendation

With the rapidly developing offshore decommissioning market in Malaysia, the government, community and industry should be aware of the opportunities provided by the offshore decommissioning. However, oil and gas operators should adopt effective and efficient waste management framework for offshore decommissioning in order to minimize the impacts of wastes produced from offshore decommissioning process to the environment. At the same time, this good practice will portray a good image of oil operators by showing the responsibility of handling waste. For the scenario in Malaysia, due to lack of experience in decommissioning, all parties involved should play their part responsibly and adopt best framework from the mature decommissioning markets. Especially to the local contractor, they should be prepared and equip themselves for providing the technical services needed in offshore decommissioning. However, it has to be reminded that none of the offshore platforms are similar to each other, thus the waste management for decommissioning offshore platforms has to be done by case to case approach. In Malaysia, the oil and gas operator faced many challenge in regulation of decommissioning. There is no legal regulation followed by the operator. International regulation is not fully meets the Malaysian requirement for handling the waste from decommissioning. Therefore, the operator should put more effort to implement decommissioning regulation for the future used.

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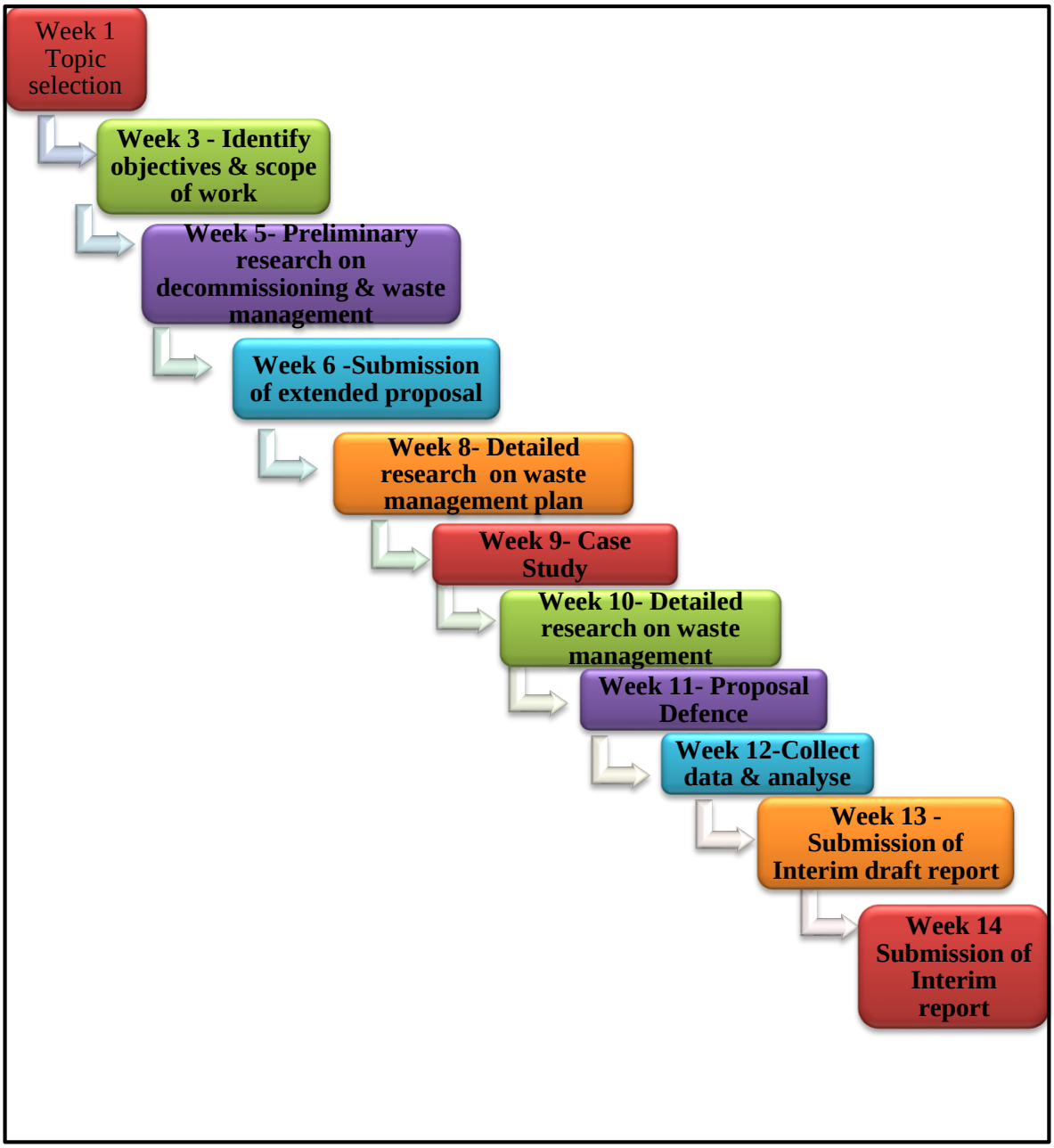
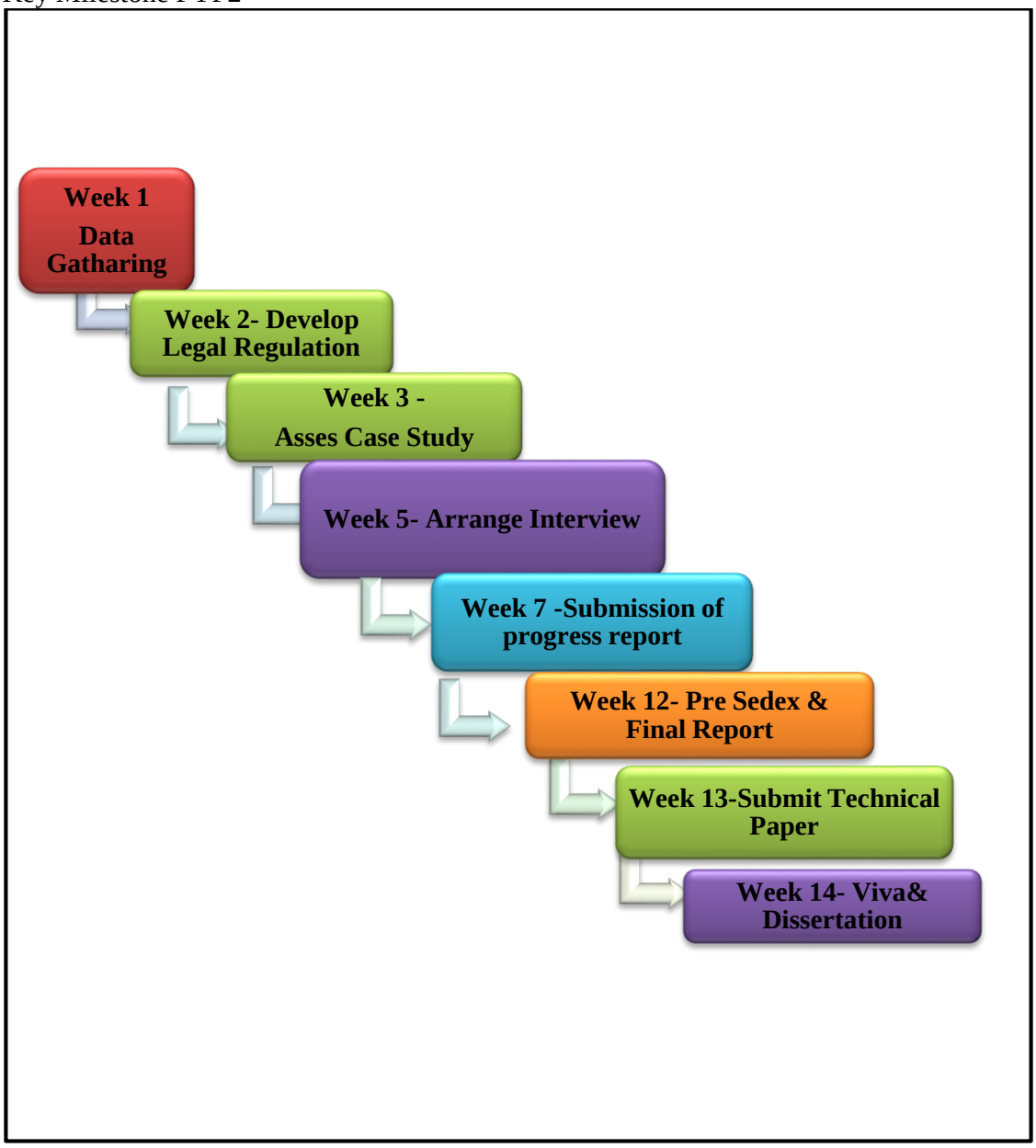
APPENDIX

Key Milestone FYP 1



Key Milestone FYP2



The Gant chart for FYP 1 as follows

		Week													
No	**Detail**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Project Title Selection														
2	Identify Objectives and Scope of work														
3	Preliminary research on decommissioning & waste management plan														
4	Submission of extended proposal														
5	Detailed research and waste management														
6	Proposal defence														
7	Detailed research on waste management framework														
8	Case study														
9	Collect data & analyse														
10	Submission of Interim draft report														
11	Submission of Interim report														

The Gant chart for FYP 2 as follows

		Week													
No	**Detail**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Evaluate the case study														
2	Comparative API and PTS guideline														
3	Develop Legal regulation														
4	Submission of progress report														
5	Collect data on environmental impact														
6	Pre Sedex														
7	Submission of Draft Report														
8	Submission of Final report														
9	Submission of Technical Paper														
10	Viva														
11	Submission of Project Final Dissertation														

6th March 2015

To Whom It May Concern

Dear Sir/ Madam

RE: Acknowledgement for Norasiah Binti Pakir Mohamad to Conduct Final Year Project II

Greetings from University Teknologi PETRONAS!

We are pleased to confirm that the above student is a full time (active student) at Universiti Teknologi PETRONAS, Perak, Malaysia. Currently she is conducting her Final Year Project II interview sessions for the purpose of **Data Collection on Waste Management Framework for Decommissioning of Offshore Installation in Malaysia**. Details of the student are as stated below:

I.C No	: 900220-08-5290
Nationality	: Malaysian
Matrix No	: 16954
Programme	: Bachelor of Engineering (Hons) Civil Engineering
Academic Year	: Final Year Final Semester
FYP title	: Waste Management Framework for Decommissioning of Offshore Installation in Malaysia
Date of study	: March- April 2015

We hope that your authority can assist this UTP student Ms. Norasiah Binti Pakir Mohamad by responding to her questionnaire in her interview for the completion of her project. Your cooperation is highly appreciated, the given information will be used solely for the academic purposes. Summary results will be shared with you once the result is completed.

Thank you in advance for your kind cooperation.

Sincerely,

Dr Noor Amila Wan Abdullah Zawawi
Head
Civil Engineering Department
Universiti Teknologi PETRONAS
Bandar Seri Iskandar, 31750 Tronoh

Interview Question

The purpose of this interview is to evaluate the current situation of waste management in offshore decommissioning activities in Malaysia. The information collected from this interview can help in establishing a waste management framework for offshore decommissioning and develop the existing legal regulation in the local oil and gas industry. This interview will be focusing on the waste management framework and legal regulation on waste management in Malaysia.

1. Is there a waste management framework for offshore decommissioning? What is the name of this framework? When was it established?
2. Is there a Department/Unit in PETRONAS that has been set up to undertake the waste management framework for decommissioning? If yes, what their roles and responsibilities?
3. Who are the authorities involved in terms of waste management for offshore decommissioning in Malaysia? (Give a list of potential waste related authorities, Kualiti Alam etc.)
4. Is there any waste management framework that the local oil and gas operators follow/practice prior to PETRONAS releasing their waste management guideline?
5. Other than PTS waste management guideline, is there any other guideline followed by the oil and gas operators?
6. From the previous decommissioning, how were the waste products handled?
7. What are the challenges faced by the operator in terms of decommissioning waste management

Waste Identification

X-waste present at the region

#- not exact reference

No	Waste Type	North Sea	GOM	Australia	Nigeria	Malaysia
	Metallic (Support Structure)					
1	Bulk Steel	x	x	x	x	x
2	Value Metal		x			
	- Alloy Steel (Jacket)	x				
	- Zinc (Anodes) [1] [2]	x			x	
	- Aluminum (Anode)	x	x		x	
	- Carbon Steel	x	x			
	-Cement (Grout)	x				
	-Iron	x				
	-Titanium	x				
	- Stainless Steel	x			x	
	- Cunifer	x				
	- Monel	x				
	- Copper (Cable)	x	x		x	
	- High Grade Steel		x			
	-Pipeline	x	x	x		
	Non-Metallic			Oil Waste		
	Salable Component					
1	-Equipment					
	• Rotating Equipment • Injection Pump • Prime Movers • Compressor • Gas turbine • Alternator • MV/HV Transformers	x	x	x	x	x
2	WEEE (Electrical and Electronic Equipment)					
3	Topside Cleaning (Residue Material)					
	- Hydrocarbon Sludge (Oil & Gas)	x	x	x	x	x
	- Production Chemical / Chemical residue	x	x	x	x	x
	- Drilling Chemical	x	x	x		
	- Diesel Oil	x				
	- NORMs (Natural Occurring Radioactive Materials) Scale	x	x	x	x	x
	- Hydraulic Oil	x				
	- Lube Oil	x	x			
	- Seal Oil	x				
	- Mercury (present in fluorescent tubes)	x	x		x	x
	- Asbestos [1] [2]	x	x		x	
No	Waste Type	North Sea	GOM	Australia	Nigeria	Malaysia

	- Heating Medium	x				
	- PCBs (polychlorinated biphenyls)	x	x			
	- Sediment (reservoir contaminants)	x				
	- Sands	x		x		#
	- heavy Metal		x	x		
4	Hazardous Confined Waste	x				
	- Hydrocarbon gas	x				#
	- hydrogen Sulphide (H2S)	x				#
	- Benzene	x				#
	- Oxygen	x	x			#
5	Other Hazardous Waste	x				
	- Flame retardants	x				
	– Phthalates (plasticizers in flooring and cables)	x				
	– Hydraulic oil, grease and lubricants	x				
	– Isocyanates from polyurethane paints	x				
	– CFC and HCFC gases released from cooling agents	x				
	– Chloroparaffins	x				
	– Low specific activity (LSA) material	x	x			
	– PFOS (perfluorooctyl sulphonate)	x				
	– PVC (polyvinyl chloride)	x				
	- Organotin compounds	x				
	- Paint	x				
6	Batteries	x			x	
	- Nickel Cadmium	x				
	- Lead Acid	x				
7	Waste from Normallu Unmanned Installation (NUI) Node	x				
	– Aerosols	x				
	– Empty Chemical / Oil drum	x				
	– Pyrotechnics	x				
8	Other					
	Marine Growth	x	x	x	x	x
	Smoke Detector	x				
	Plastic		x			