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Environmental Management in the Petroleum Industry

Sustainability, Global frameworks and Management tools

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Safety, Health and Environment
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Preface

This thesis has been prepared at the Department of Industrial Economics and Technology Management at the Norwegian University of Science and Technology (NTNU). The thesis is written in the Master of Health, Safety and Environment degree.

The idea for this thesis came about as a result of my summer internship with Statoil in the summer of 2012. During my time with the company I was given a task of gathering statistical data on accidental spills on the Norwegian continental shelf and to determine in which areas of the drilling process they occurred. In order to learn more about the underlying causes of the accidental spills and its consequences, the idea of writing this report evolved.

I would like to thank my supervisor Annik Magerholm Fet at NTNU for valuable advice and guidance during this project. Thank you for the motivation and support throughout the process.

Stjørdal, June 11th 2013

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Abstract

The oil companies have traditionally provided the need for fossil fuels through the supply of oil and natural gas. Oil production is regarded a polluting industry and with its relatively large environmental footprint it also produces large amounts of waste that is deposited to the sea, land and water.
As the known natural resources are becoming exhausted, discoveries of new resources are required to fill the growing global need for energy. This is forcing the oil industry to constantly stretch existing reserves and develop new technology to get to the new oil and gas. This is seen through shallow wells drilled on land to deeper wells, the move from land to offshore, from shallow water to deep water, from normal pressures and temperatures to high temperatures and pressures; and lately into shale fracturing technologies.
In order to supply the global market with oil and gas, the oil companies have to explore and discover new reserves. As known reserves are depleted, the new reserves get increasingly more challenging to produce. In this way the oil industry is constantly operating on the edge of available technology. Operating in this area of technology, an inherent risk of failures is increased. This can be seen through the many major accidents and disasters in the petroleum industry.

In this project the main focus is on the activities and processes involved in the drilling and production of oil and gas. Risks and accidents involved with the transportation of oil are mentioned, as it is a major contributor to the total risk of the industry. Governing laws and regulations, national and international, which are meant to control the petroleum industry, are examined. Tools used to measure and compare the various company performances, such as Key Performance Indicators and Benchmarking are also mentioned. A comparison of environmental governance and management between Norway and Uganda is made in order to show the differences between industrial and developing countries of succeeding in such governance.

Environmental Impact Assessment tools are presented and methods used in assessing and managing environmental impacts are discussed. Methods of reducing the effect of unwanted impacts are also identified.
Life cycle perspectives as an integral part of projects are presented and highlighted through examples.
The main future challenges for the petroleum industry are company culture, risk management and contingency planning.

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1.0 Introduction

With the growing global population and increased use of energy consuming technology, the world's need for resources such as food, minerals and energy is steadily increasing. Impacts from exploiting these resources are increasingly threatening the global environment. Global warming, pollution of water, land and sea, and the destruction of the habitats supporting the livelihood of large populations are major issues today. With the emerging economies, developing countries have steadily increased the demand for resources including energy and fossil fuels.

This hunt for oil and gas has led to many disasters causing loss of many lives and major pollutions of the environment. These arise from two main sources:

- Lack of clean production from both drilling and processing
- Accidents causing spills to the environment

With regard to accidents, the oil industry seems to neglect the fact that they happen. Theories surrounding such events have been developed by Nassim Taleb and are known as "Black Swans" (Eccleston 2011). According to Eccleston (2011, p.18) Black Swan theory was developed to explain: 1) "*potentially rare but catastrophic, and difficult to predict events that lie beyond normal expectations*" and 2) "*the psychological biases that tend to blind people to the possibility of such uncertain events*." Black Swan events are normally related to all major scientific discoveries, historical events and artistic accomplishments, but in recent times have been associated with catastrophic environmental impacts that have been indeed difficult to predict. An example of such an event was the Deepwater Horizon drilling rig blowout in the Gulf of Mexico. When looking back at the incident one could say that environmental systems put in place should have given managers the tools and ability to uncovered faults that led to the disaster. In reality it did not, as this was a classic Black Swan event. The catastrophe was extremely rare and predicting it could not be done with any degree of certainty. Environmental managers could play an important role as they are often perfectly positioned to see warning signs and could perform analysis of different scenarios that could have the potential to cause environmental impacts. By furthering the development of effective plans and mitigation methods from merely overseeing more routine or mundane environmental issues normally set by standard environmental laws and regulation, environmental manager could also prevent hard to predict Black Swan events.

To a large extent natural disasters marked the beginning of the modern environmental movement which led to stricter laws and regulations and, in effect, litigation. An idealistic breed of lawyers helped to lead the environmental movement while corporations in their defence hired lawyers to help address regulatory compliance and liability issues. The corporate lawyers often view compliance and regulatory issues in terms of promoting the interest of the company that hired them. The result of this is corporations who claim to promote sustainable development but in reality hire a huge number of lawyers to protect their own interests. Training classes for Health Safety and Environmental specialists teach them how to think like lawyers and at the workplace; emails and memos are being sent out to caution employees about the remote possibility of being "discovered" as part of a lawsuit. This may also have negative implications. Furthermore, a fear of repercussion may cause managers to take the position of "remaining silent" which in turn minimises important communications of potential risks in projects (Eccleston 2011).
Opinions and viewpoints within areas of sustainability can vary widely. This makes it possible for organisational ethics to be interpreted within the narrow confines of existing regulations. This is often seen in dazzling marketing terms and commitments such as "zero harm to the environment" that is often put forth in the core principals of corporations. It is difficult to see how these core principals are integrated into the strategy and daily activity of the organisation.

As previously mentioned, many idealistic lawyers helped lead the initiation of the modern environmental movement. Nevertheless, many lawyers specialise in circumventing HSE quality and security; and at the same time counsel organisational managers on how the protect their own interests with total disregards for the environment.

However, there is another possibility available to government and organisation of reducing risks. This approach can optimize decision-making while avoiding many of the paradoxical legal dilemmas described above. This avenue involves preparing scientifically based assessments which objectively evaluate decision making potential impacts, risks, and reasonable alternatives to what may be a standard or traditional course of action. High quality assessments can provide decision makers on different levels an effective and powerful tool for balancing impacts and risks against the traditional factors such as cost and schedules.

1.1 Purpose and goal

The main goal of this thesis is to evaluate the environmental management of the petroleum industry by examining sustainability, global frameworks and management tools.

This paper will contribute with the following:

1. Give an overview of the evolution history of the petroleum industry with a sustainability perspective.

2. Give an overview of laws and regulations, the governance roles and responsibilities, the use of consents, audits, deviations and sanctions

3. Give a general background of impact assessment and identify tools and methods in assessing environmental and social impacts.

4. Perform a comparative analysis of environmental management and governance of petroleum industry between countries

5. Give an overview of exploration drilling and the environmental governance of the upstream activities

6. Discuss the impacts of oil exploration and production in a life cycle perspective based upon case exemplification.

1.2 The organisation of this report

This thesis is organised into 6 main parts. The thesis begins with the history of the petroleum industry from a sustainability perspective. The intentions of the laws and regulations are presented and compared with industry performances and accident investigation reports. Tools and methods applied in environmental assessments are described before a comparison between Norway and developing countries is performed. At the end a discussion of further challenges and conclusion is made.

1.3. Theory

To be able to assess the quality and relevance of the Petroleum Industry Environmental Management, the framework for the EMS system like EIA, must be established. EIA theories together with governing laws and regulations are described and used as basis for the study.

1.4 Methods

This following will present approaches and methods used in this thesis, their weaknesses and strengths and how they are used in the attempt to answer the main goals of the paper. According to Bryman (2008) qualitative research is a strategy within collection and analysis of data that emphasises on words rather than quantification. On the other end, Bryman (2008) states that in quantitative research; reliability and validity are important criteria when establishing and assessing the quality of research. The reliability of research is determined by how consistent results are over time and how accurate a representation of a given population is for the study at hand. A reliable study will give the researcher the opportunity to draw conclusions, formulate theories, or generalize from the results of the research. Further, the validity of research as said by Mason (1996, p. 24) is whether "you are observing, identifying, or measuring what you say you are". It is not possible to have valid research, without having fulfilled the criteria of reliability. For the purpose of this paper qualitative research methods will be used.

In the beginning of a project it is crucial to get an overview of earlier work on the topic. A literature review was performed to assess existing information as well as determining what issues that could be brought up for further discussion. For this paper the literature review served several purposes; it put background information into context, and served to obtain a current status of the topic.
In order to find reliable and valid information purposive sampling was used. According to Bryman (2008) purposive sampling is strategic sampling which attempts to get a sound correspondence between research question and the sampling of information. Therefore, the sampling of information was based on specific qualifications central to the thesis that in the end helps in answering the research questions.

The main sources of information in this thesis were reports, official websites related to the petroleum industry, sustainability reports of oil companies, academic journals, and personal communication with professionals within the petroleum industry and government. Furthermore, reports and drilling consent applications from oil companies operating on the Norwegian continental shelf (NCS) were obtained and scrutinized for relevant information related to the topic.

2.0 The petroleum industry – an environmental overview

The following chapter will describe the history of the petroleum industry from an environmental perspective. The development from the first production of oil through the development of rotary drilling and the oil industry's move offshore is discussed. Furthermore, the intricate challenges related to deep water drilling and developments are reviewed. Examples of major environmental disasters caused by oil wells blowing out and wrecked oil carriers are listed. It may be argued that some major incidents are missing, but the objective is to demonstrate how often the impossible, which are often said "cannot happen", actually do happen. Various types of operational related spills are included; these being a large contributor to the total spill to the environment and must not be forgotten. A brief background and history of government control, sanctions and environmental laws are also included in this historical overview.

"The deterioration of the environment is in large measure the result of our inability to keep pace with progress. We have become victims of our own technological genius."

President Richard Nixon
(The American Residency Project 2013)

Oil wells drilling history is old, some 2500 years ago, in China, wells were drilled with percussion type chisel bits attached to bamboo poles. These wells could reach depths of 240 m. These days the oil was not the objective of the wells, but the salt. The oil was a waste product, which was burned off in the salt evaporation process. Petroleum products were reported used on streets of Baghdad, which were paved with tar. Kerosene lamps were another application of petroleum as well as the basis in flammable products for different military purposes (OSC 2013b).

In the 13th century Marco Polo described oil fields with around Baku in Azerbaijan. He described shallow pits were dug to allow the oil to seep into and being collected. These pits were hand dug and could be up to 35 meters deep. Some 4,000 metric tons of oil were reported produced from such pits in 1830. The industrial revolution triggered the use of oil and boosted the need for oil and our civilizations dependency on petroleum products was stared. The easy oil from hand-dug holes was soon exhausted and new technologies to produce oil from the underground had to be developed. Today's drilling technology by the use of a derrick was invented in the 1850's by Colonel Drake. Technologies including drilling with a hollow pipe and the use of casing to protect the hole from caving in were introduced. These technologies are similar to today's rotary drilling technology. The use of drilling with hollow pipe and securing the wells from caving in with casings allowed the wells to be drilled deeper, down to several hundred meters, and oil under pressure was discovered. When these over pressured oil reservoirs were drilled into, the oil blew out and spilled over the surrounding land, ending up in ponds where it was collected (OSC 2013b).

In the beginning the pollution this caused was not paid much attention to, the oil was delivered, no one asked how. This could not continue and it was soon realized that this was not a sustainable way of drilling for oil. The use of weighted drilling mud was introduced and later well control equipment capable of closing in flowing wells were developed (OSC 2013b). The hunt for oil resources put the oil industry offshore drilling at Baku at Bibi-Eibat field in 1846 which was 50 years before offshore drilling for oil began off the coast of Summerfield, south of Santa Barbara in California. Wooden piers were built reaching some 450 meters out from the beach. The drilling techniques used on land were used with the exception of steel pipes which were pounded into the seabed from the pier. In 1902 the production stopped and the wells were abandoned. In these days the environmental impact was not an issue and the project left behind ugly beaches polluted by oil and old remains from piers and derricks sticking out into the sea.

Mobile offshore drilling units were introduced by the use of barges. Small mobile barges were towed into the shallow waters were they were ballasted with water resting on the shallow sea bed. The first real step to conquer the sea has been made. Jack up drilling rigs technology was the barge was modified so it could be jacked up on legs standing on the sea bed. The jack up drilling rigs could be used on water depths up to 120 meters offering the drilling technology used to explore the North Sea oil province in the 1960's. Steel jacket structures were built as foundations for the decks where the production facilities were installed (OSC 2013b). The steel structures were followed by concrete platforms installed on the sea bed developing the North Sea giant fields such as the Statfjord, Brent and Troll.

As the shallow waters were being produced, deeper water exploration was required. Drill ships and semi-submersible drilling rigs technologies were developed. Instead of production installations standing on the sea bed, subsea production technology was developed and the Deep Water becomes the new frontier. The deep water discoveries made in the 1980s were developed into subsea producing fields in 1990s. Deep water production increased and by the end of the decade, production from deep water surpassed that in shallow water for the first time (OSC 2013b).

As the move to deep water was not a gradual process; the technology and lessons learned could not be fed into new developments. This itself was a major risk element, as the industry moved faster than the technological development.
Since the year 2000 deep water production capacity has more than tripled. Ten years ago, 1.5 million barrels per day were produced in water depths over 700m. Nine years later the production from depth below 700 m had risen to over 5 million barrels per day (IHS-CERA 2013 & OSC 2013b).
Discoveries in deep waters also comprised a significant portion of new finds. In 2008 total oil and gas discovered in deep water globally exceeded the volume found onshore and in shallow water combined. The world increasing demand of energy is increasingly depending on deep water oil and gas (OSC 2013b).

The "easy oil" is depleted and we cannot expect any significant discovery of such oil any more. Tight gas reservoirs, shale gas, shale oil and oil sands have become new terms of the petroleum industry. These discoveries and the development of the tight reservoirs and shale fracturing technologies are giving land drilling operations a new spring. At the same time the development of deep water reservoirs are on-going, and the move into even more challenging and sensitive areas are growing; Russian oil and gas companies are reviewing plans to develop areas in the Arctic, while Norway and Canada are assessing similar projects. This is giving new environmental challenges that the industry needs to address and solve (OSC 2013b).

2.1 Petroleum activity accidents

When the ancient Chinese drilled the first wells, the objective was to extract the salt from the produced brine. The oil associated with the brines were regarded a pollutant and was burned off. The industry soon faced the environmental problems with oil polluting the land or rivers where ever it spilled into. Both from drilling where blowouts of from pressurized oil reservoirs or spills or leaks from transporting or storing oil became an increasing concern.
The move offshore and into deep waters also had its price; frequent accidents became reminders of the risks related to the petroleum activity (OSC 2013b).

The following is a list of major accidents and spills. The purpose of providing this information is to document that such major accidents are reoccurring within the petroleum industry. In Attachment 1, a more comprehensive list of accidents can be found. This list enhances the statement that "Black Swan" incidents do happen (OSC 2013b, pp. 2-6):

- In 1969 a blowout at the Santa Barbara Channel had resulted in an 800-square-mile slick of oil hitting some 50 km of Southern California beaches and impacted the wild life. The blowout lasted 11 days and ultimately released approximately 80,000 barrels of oil.

- In 1979 the Ixtoc I blowout off Mexico's Bay of Campeche took nine months to cap and released an estimated 3.5 million barrels of oil.

- In 1988, offshore drilling suffered another major calamity, this time in the North Sea. The North Sea Piper Alpha platform, exploded as a result of a fire and a consequent gas leak leading to the death of 167 workers. It was the deadliest accident in oil history.

- A fire at the Kab 121 oil platform belonging to the Mexican state-owned oil company Pemex, in the Gulf of Mexico in late 2007, led to the death of 22 workers. Around 5,000 barrels of oil leaked into the sea.

- The Hasbah blowout in the Persian Gulf killed 19 workers when the exploration well blew out in 1980.

- In 2010 the Macondo well blew out killing 9 workers and spilling some 5 million barrels of oil into the Gulf of Mexico.

- In November 2012, a well containing H2S blew out in Kuwait. The release of the toxic gas reached Kuwait city and the well had to be put on fire.

2.2 Into the deep water

The petroleum industry soon recognised that deep-water conditions had special challenges and a greater need for critical equipment such as blowout preventer (BOP). Under water equipment such as Remote Operated Vehicles (ROV´s) are also important when working the deep seas with regards to maintenance and risk reduction measures.

Up until the BP Deep water Horizon accident, little attention was devoted to containment of a blown out well in the deep water, largely because its occurrence was considered so unlikely it could not happen; a "black swan" type accident. Perhaps the greatest risk factor is the very feature that the deep-water boom is so immensely large in the first place (OSC 2013).

2.2.1 Transportation

The produced oil and gas is transported from the producing wells to processing facilities, either on offshore installation or at the fields on land, where the oil, gas and water phases are separated for further transportation. This may be over land to tank farms at shore and from the oil tankers to their final destination in oil consuming countries. This transportation is a risk on all the transport elements. Below is a list of major accident related to crude oil carriers wrecking at sea (OSC2013a):

- **1967, Torrey Canyon**
  The American tanker Torrey Canyon split in two in March 1967 on the Seven Stones Reef off Land's End in the UK, spilling 120,000 tons of crude oil towards the beaches of southwest England. Around 80 km of French and 200 km of Cornish coast were contaminated. Around 15,000 sea birds were killed. An inquiry found the captain was to blame after he took a short cut to save time in getting to the ship's destination in Milford Haven, Wales.

- **1978, Amoco Cadiz**
  The fully laden 233,000-ton Liberian supertanker Amoco Cadiz sank into the Atlantic Ocean near Portsall, in Brittany in March 1978 after running aground on Portsall Rocks. A full polution alert was ordered and 44 crewmen were evacuated by the French navy. The ship's entire cargo of 1.6 million barrels was released into the sea. At the time it was the largest oil spill in history; it is now ranked as the fifth largest.

- **1996, The Sea Empress**
  The Sea Empress was a single-hull oil tanker that ran aground off the Pembrokeshire coast of Wales in February 1996. An estimated 73,000 tons out of the ship's 130,000 ton cargo of North Sea crude oil spilled into the sea. Around 200 km of coastline were covered in crude oil.

- **1989, Exxon Valdez**

  On March 24, 1989, the tanker Exxon Valdez, en route from Valdez, Alaska to Los Angeles, California, ran aground on Bligh Reef in Prince William Sound, Alaska. The vessel was traveling outside normal shipping lanes in an attempt to avoid ice. Within 6 hours of the grounding, the Exxon Valdez spilled approximately 10.9 million gallons of its 53 million gallon cargo of Prudhoe Bay crude oil. Eight of the eleven tanks on board were damaged. The oil would eventually impact over 1800 km of non-continuous coastline in Alaska, making the Exxon Valdez the largest oil spill to date in U.S. waters. Many of the visible damages from oil spills over the years came from tanker accidents, most notably the collision of the Exxon Valdez that led to between 260,000 and 750,000 barrels of oil leaking out and wreaking havoc on Alaska's coastline.

- **2002, The Prestige**

  The Prestige tanker started leaking fuel off the coast of Galicia, Spain, when it encountered a violent storm about 250 km off Spain's Atlantic coast. During several days, it was pulled far from the shore, but the crippled tanker carrying more than 67,000 tons of oil split in half off the northwest coast of Spain on Tuesday, becoming one of the worst environmental disasters in Spanish history.

2.2.2 Pipeline crossing land

Pipelines are less prudent to disasters like ships wrecking at sea, but they need to be included. Environmental and social disasters have been the consequence of poorly managed pipelines (OSC2013a):

- **2006, Prudhoe Bay**

  The opening of drilling in Prudhoe Bay Alaska and subsequent rapid construction of a 1000 km pipeline through permafrost; oil began reaching Valdez in the summer of 1977, and the pipeline was delivering well over a million barrels a day by the following year. At the Prudhoe Bay oil spill in 2006, 1000m^3 were spilled over 8,000 m^2 of permafrost making it the largest oil spill on Alaska's North Slope to date. The oil had not just left behind a polluted ground, but the leak, and the subsequent discovery that 10 km of pipeline was badly corroded and needed to be replaced. This led to the shutdown of much of Prudhoe Bay oil Field and the loss of hundreds of millions of dollars.

- **1976 & 1996, The Niger delta**

  An estimated 2 million barrels of oil were spilled into the Niger Delta 1976 and 1996 says Nigerian government. These are spills from numerous incidents at the plants or at the oil pipelines. A UN report states that there have been a total of 3 million barrels of oil. The World Bank states the true quantity of petroleum spilled into the environment could be as much as ten times the officially claimed amount. 70% of these spills occurred off-shore, a quarter was in swamps and 6% spilled on land. Some spills are caused by sabotage and thieves, however most are due to poor maintenance by oil companies. The devastation that oil pollution has wrought in the Niger Delta is indisputable. GlobalPost's correspondent Heather Murdock has described what she saw there(Global Post 2012):

  "Oil floats on the delta's waterways, killing and contaminating the plants and animals in one of Africa's most bio-diverse regions. Along the banks of the creeks, muddy fishing villages are slick with oil that washes ashore. Villagers say they drink and bathe in the oily waters and as a result, children are dying of diseases."

2.3 Operational Spills & Emissions

Blowouts and catastrophes with large releases of oil and gas are well known through the news. At the same time massive releases of Green House Gas (GHG) and chemicals are released as a part of the operational processes, drilling, construction or processing and refining.

2.3.1 Flaring gas

Lack of infrastructure in many of the oil producing areas, the associated gas cannot be utilized but being flared off as it is separated from the oil. Each year

150 billion, 10^9, cubic meter gas is flared worldwide, contributing to 400 million, 10^6, ton CO2. This is a higher CO2 emission than the entire Australia. Figure 1 below shows gas flaring on an offshore oil rig.

Figure 1: Gas Flaring (NPD 2013)

2.3.2 Flaring oil

Each day hundreds of thousand barrels of oil are flared off as a part of the refining process. Old technology refineries are using the flaring as the method to cope with peak raw oil input to the refineries. Instead of controlling the oil input or making facilities for handling the excess oil it is burned casing enormous GHG emissions and polluting the area surrounding the refinery.

2.3.3 Produced water

Associated water with oil and gas production is separated from the oil and cleaned to a minimum remain, typically around 40 ppm. Multiplying this value with the world yearly production shows each year 1 million barrels of oil is routinely disposed into the environment. From the Norwegian petroleum activity the produced water is counting for 87% of the spill from the petroleum activity.

Figure 2 below, illustrates releases from the petroleum industry from produced water, accidental releases and ballast and damage.

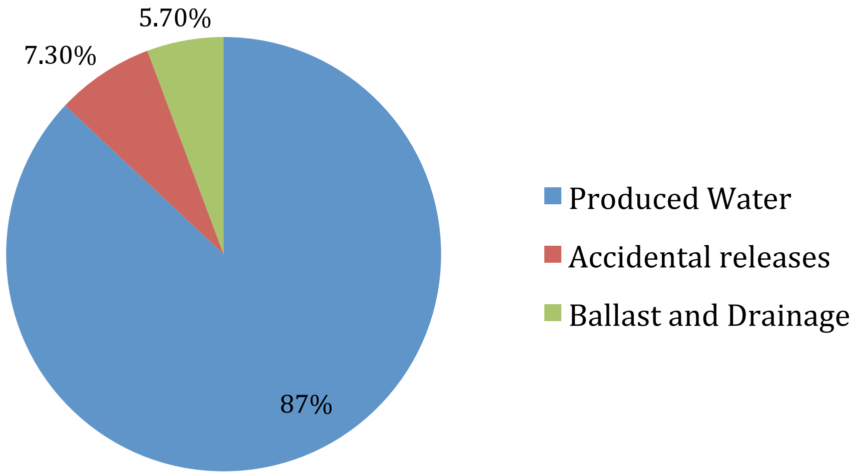

Figure 2: Releases from the petroleum activities per activity, 2010 (NPD 2013).

2.3.4 Restoration

After the oil production is stopped and the field is produced, the wells are plugged and abandoned and the installations are removed. Most nations with activities on their continental shelf have this in place. The oil companies have to set off funds for these purposes when the field life comes to an end.

On land and on old developments this is often not the case. Old oil fields have often been left without any restoration plan or activity in place at all. Even the equipment, rigs and the oil pumps are left behind, let alone vast areas of polluted land. The land is left as a wasteland where the water and soil is poisoned from oil and chemicals used in the process of drilling and produce the reservoir. Nothing can grow and it is not possible to use the land without large green land restoration projects (NPD 2013).

Figure 3 showing the wasteland and the equipment left behind after drilling has ended.

Figure 3: Wasteland (NPD 2013)

2.3.5 Control of the oil industry

From the aforementioned it is well documented that the oil industry has been followed by pollution, numerous oil spills and accidents.

Two main conclusions are drawn:

1. The industry is high risk
2. The risk associated with the petroleum activities need to be better controlled.

The control and contingencies needs to be focused on two main perspectives:

a. Oil disasters
b. Reduced impact on the environment from normal operations by continuously moving towards cleaner production.

3.0 Environmental governance of the petroleum industry

Over the last decades an improved understanding of the global environment and the ecosystems has developed. Out from the universities comes a new breed of engineers; the Health Safety and Environmental (HSE) engineers. They are specialists in fields such as natural science, ecosystems, risk, safety and environmental impact assessments. Mitigation methods as well as environmental management are becoming scientific foundations.

3.1 Legislation and framework of Environmental Impact Assessment (EIA)

In its early day, Environmental Impact Assessment (EIA) was used as part of a rational decision making process and it largely involved a technical evaluation that would lead to objective decision making. EIA was made legislation in the United States in the National Environmental Policy Act (NEPA) 1969 and has since evolved as it has been used increasingly in many countries around the world. International work on the environment has been led by the United Nations Environment Programme (UNEP), since its inception in 1973. UNEP has led and encouraged partnerships between companies and governments through the use of Multilateral Environmental Agreements (MEA's) that have addressed issues such as species loss and the need for conservation at a global and regional level. UNEP has created much of the international environmental law in use today (United Nations Global Compact 2013).

3.2 The Rio Declaration on Environment and Development

The Rio Declaration on Environment and Development, often shortened to Rio Declaration, was a short document produced at the 1992 United Nations "Conference on Environment and Development" (UNCED), informally known as the Earth Summit. The Rio Declaration consisted of 27 principles intended to guide future sustainable development around the worlds. Some of the principles contained in the Rio Declaration may be regarded as third generation rights by European law scholars. It defines the rights of the people to be involved in the development of their economies, and the responsibilities of human beings to

safeguard the common environment. The declaration builds upon the basic ideas concerning the attitudes of individuals and nations towards the environment and development, first identified at the United Nations Conference on the Human Environment held in 1972.
The Rio Declaration states that long term economic progress is only ensured if it is linked with the protection of the environment. If this is to be achieved, then nations must establish a new global partnership involving governments, their people and the key sectors of society. Together human society must assemble international agreements that protect the global environment with responsible development (Sustainable Development 2013)

Within the area of EIA, principle 5 and 17 from the Rio Declaration are seen as the most relevant:

- "Principle 4 of the Rio Declaration, stated "*In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.*"
- "Principle 17 stated "*Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have significant adverse impacts on the environment and are subject to a decision of a competent national authority*. "

  (United Nations General Assembly 2013)

3.3 National laws and regulations

The assessment of environmental impacts was first used in the 1960 and was part of a rational decision making process and involved technical evaluation of environmental impacts, which lead to a more objective decision making.
The origin of the Environmental Impact Assessment system began with the enactment of the National Environmental Policy Act (NEPA) in the United States of America in 1969. Other countries soon followed, although legislation was passed a few years after the United States (Jay et al. 2007).

The Canadian Environmental Assessment Act (CEAA) came into force in 1995 while legislative amendments were introduced in 2001 and came into force in 2003. The Chinese State Environmental Protection Administration (SEPA) used its legislation to halt 30 projects in 2004, including three hydro- power plants under the Three Gorges Project Company. In Europe, The European Directive (85/337/EEC) on Environmental Impact Assessments (known as the *EIA Directive*) was first introduced in 1985 and was amended in 1997. The directive was amended again in 2003, following EU signature of the 1998 Aarhus Convention. In 2001, the issue was enlarged to the assessment of plans and programmes by the so-called *Strategic Environmental Assessment (SEA) Directive* (2001/42/EC), which is now in force (Jay et.al 2007).

3.4 Control mechanisms

The control of the oil industry starts with government law and regulations combined with sanctions, aimed to reduce the risk of accidents or negative impacts the oil industry could have on the environment, and the society.

3.4.1 Thematic versus functional regulations

The first petroleum laws and regulations were thematic type laws and regulations. These were aimed at the oil companies and were specific to how the installation and activities were to be carried out. These had their weaknesses, both technologically, as they were specific, and legally as the regulations specified the solutions. This was not the intention of the regulations and they developed into functional requirements aimed not only at the oil company but at all the main participants in the petroleum activity. The laws specified certain requirements so that the activities were to be designed and performed with no harm to personnel, minimise impact to the environment and include processes for continuous improvement. In this way the industry had to prove to the government on how they were meeting the intentions and requirements in the laws and regulations (Norwegian Petroleum Directorate 2010a).
The functional regulations are process oriented; where the processes ensure that the intentions of the law and regulations are in place. It is the company, or the

licensee holders' responsibility, to describe how activities are carried out. Today's modern type regulations are recognized by the following principals:

1. Functional regulations
2. Coordination between other government bodies, like health, environment, transport.
3. Use of consequence evaluations
4. Risk evaluation, activities are risk based and risk managed.
5. Contingency planning

(Norwegian Petroleum Directorate 2010a)

3.4 International Territories and National state borders

A national law may only be enforced after a country has agreed boundaries with its neighbouring countries. Ownerships of continental shelf have been source of disputes between several neighbouring costal states. Which of the nations who should get the rights of the resources on its continental shelf, may have large impacts depending on which side of the border line the resources happen to be found. In the Barents Sea the Russians claimed longitude lines and principle of population in the coastal areas to be the factors deciding the borderlines between Norway and Russia, as this gave a larger portion of the Barents Sea to Russia. Norway claimed the mid line principle as this would give a larger portion to Norway. The final agreement between Norway and Russia ended up with a compromise and the border was drawn in the middle using the Mid-line Principle (Regjeringen.no 2013).

Figure 4 below shows the compromised line in which Norway and Russia agreed upon on the 15th of September 2010 (Regjeringen.no 2013):

Figure 4: Barents Sea Borderline between Russia and Norway (BBC News 2013)

Once the borderline disputes have been resolved and the neighbouring states have got sovereignty of their offshore territories, the individual nation makes laws regulating the exploration and productions of the resources on the continental shelf. This is done by making a law, a petroleum law. The objective of such a law is firstly to secure the rights of the national state on its continental shelf and secondly to enforce its own national laws. National states law regulates who have the right of the minerals, such as hydrocarbon accumulations, in the ground of the states' territory. This may be the individual landowner, the county or states, of the nation. Hydrocarbons found on land may have private ownership, as federal government may own deposits offshore. These regulations have evolved from thematic regulations to today's more modern functional regulations (Norwegian Petroleum Directorate 2010a). The thematic regulations were product, technical and inspection oriented. These are specific and detail how things should be done. The advantage of the thematic regulations is that they are specific and easy to control. One important disadvantage is that the responsibility; by applying thematic regulations the responsibility could end up as a grey zone between the petroleum company and the government as long as the company is following the instructions given in the regulation (Nerheim 1998). Functional type regulations do not have this problem. Here, the company is required to demonstrate that its own activities and processes are following the intentions of the laws and regulations. The functional regulations are more difficult to monitor and control, thereby requiring skilled government representatives (The Ministry of Petroleum and Energy 2010).

The national governments empower departments, for example the Norwegian Petroleum Directorate, to ensure the laws regulations are adhered to. The departments, with references to the law, makes regulations to detail the country's control activities related to the exploration and extraction of the resources. An example of this is found in the Norwegian Petroleum Law and regulations. Here, the regulation related to the petroleum activities is organized in the main regulation related to health, safety and environment on the Norwegian shelf, the framework regulation (Figure 5 below).
Based upon this, there are sub regulations such as the installation regulation, the activity regulation, the management regulation and the reporting regulations (The Ministry of Petroleum and Energy 2010).

Figure 5 below shows the current steering regulations of the petroleum activities in:

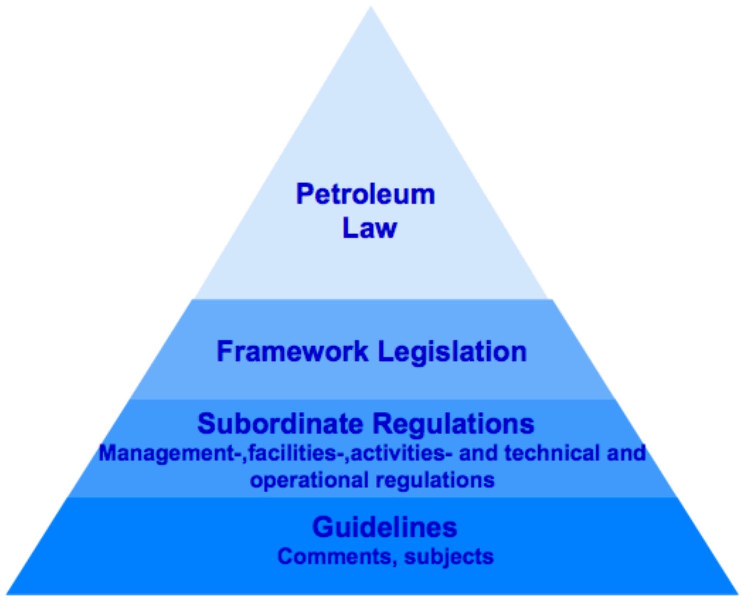

Figure 5: Steering regulations pyramid in Norway

3. 5 The Framework Legislation

This legislation is the bridging document between the Petroleum law and the sub ordinate regulations. It defines Health, Safety and Environment requirements and contains requirement for (Norwegian Petroleum Directorate 2010a & Norwegian Petroleum Directorate 2010b):

- Organization
- Safety and safety as a culture
- Continuous improvement
- Principals for risk minimization
- ”Better to be safe than sorry” principals

Furthermore, it regulates political and principal aspects and must be read and understood as one of the five integrated regulations as shown in figure 6 below:

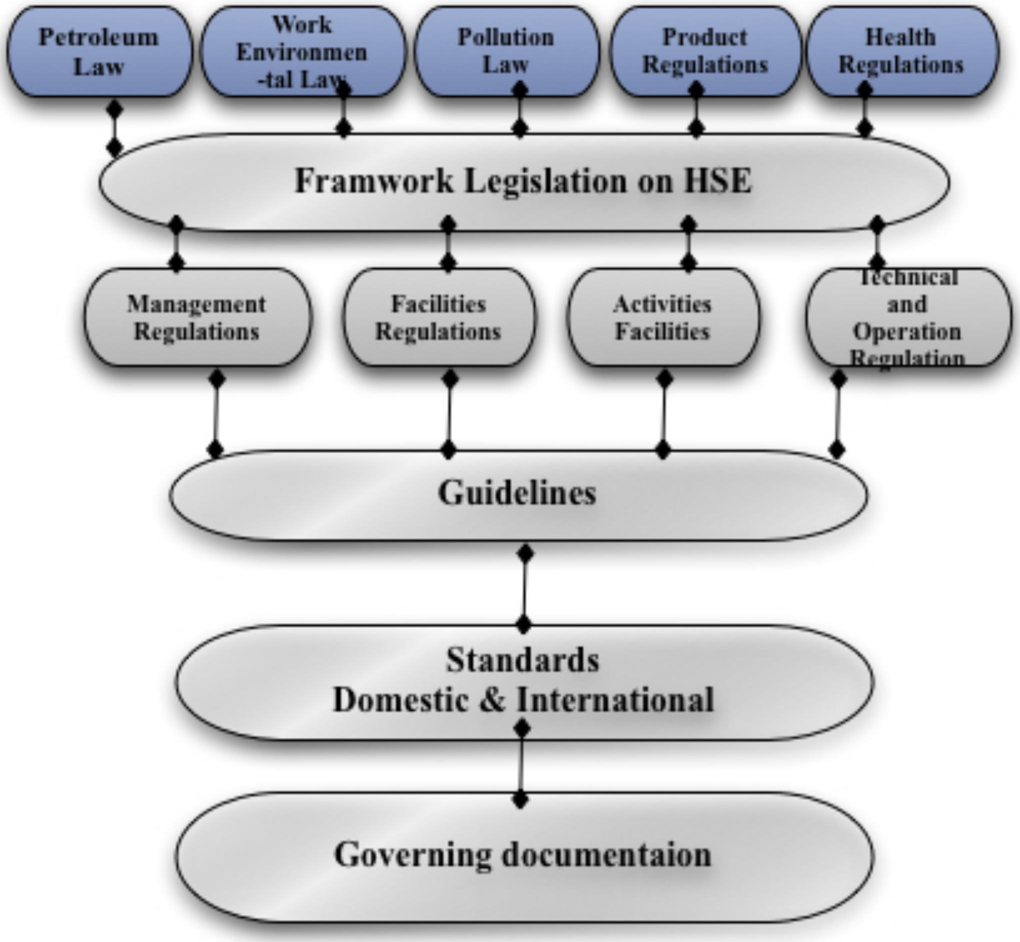

Figure 6: Framework and subordinate regulation structure

3.6 The Subordinate Regulations

There are four subordinate regulations, regulating the following areas of the oil industry:

3.6.1 The Managing regulations

These regulations include all overlaying demands to management and states management of HSE is an integral part of activities. Policies contain mainly common demands such as:

a. Basic principles connected to risk reduction.
b. Management of HSE

c. Resources and processes
d. Analysis
e. Measuring, monitoring and improvement

3.6.2 The Facility regulations

These regulations demands on how facilities are constructed and equipped:

a. The general policies regulate:
    i. Construction of appliances
    ii. Main safety functions and general safety functions
b. Sweeping policies regulate:
    i. Common requirements for cargo, materials etc.
    ii. the planning of work areas
    iii. Physical barriers
    iv. Readiness
c. Particular additional policies regulate
    i. Drilling and well systems
    ii. Housing/living quarters
    iii. Maritime facilities.

3.6.3 The Activity regulations

The activity regulations put forward requirements to planning and execution of activities, monitoring and control. It sets requirement for operational procedures for all activities. Other topics included in the activity regulations are:

d. Maintenance
e. HSE issues
f. Environmental monitoring of the use, emission and oil spills
g. Communication, drill and well activities, marine operations, electrical facilities, lifting operations and submarine operations

3.6.4 Technical and operational regulations

These regulations govern documents and information that is to be sent authorities or be available. It also covers Applications in conjunction with consents for petroleum activities mentioned in the regulations.

As seen from the regulations the law is forcing companies to report findings in their own activities. These reports include their own inspections, risk analyses, near miss accidents and actual accidents occurred. Failing to do these reports could lead to legal prosecutions, where the company and even individuals could be prosecuted (Norwegian Petroleum Directorate 2010a & Norwegian Petroleum Directorate 2010b).

3.7 Involvement of Stakeholders

In Norway the petroleum directorate is governing the petroleum activity. The oil companies liaise with the Norwegian authorities through the petroleum directorate. As the expertise is found in different departments the Petroleum Safety authority is liaising this task as indicated figure 7 below. Here we see that several environmental matters are liaised with the state climate and pollution agency. The petroleum activity related applications for consent is sent to PSA, which is forwarding the applications to the relevant authority departments for hearings. Based on these hearings the process towards the petroleum companies proceeds.

The process of coordination, cooperation and technical advise related to the PSA role is show in figure 7 below:

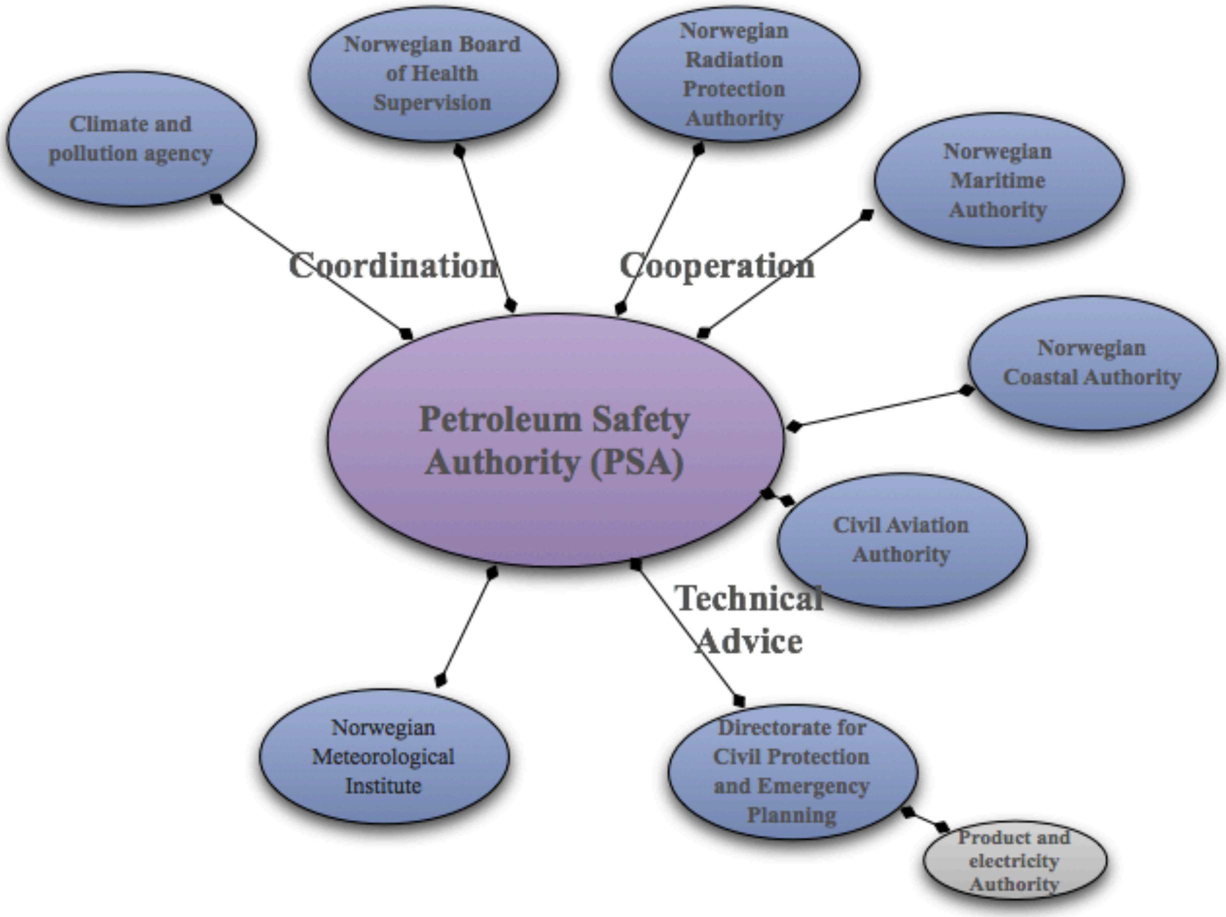

Figure 7: PSA coordinating role

3.8 Government departments roles and responsibilities

The government has given the Petroleum Safety Authority (PSA) the following duties:

- Ensure that the petroleum activity and activities relating to it are supervised in a unified manner.
- Provide information and advice to the players in the industry, establish appropriate collaborative relationships with other HSE regulators nationally and internationally, and contribute actively to a transfer of knowledge from the HSE area to society in general.

- Provide input to the supervising ministry on issues being dealt with by that ministry, and support the ministry on issues at request (PSA 2013a).

The PSA coordinator role relates to the development of regulations and to monitoring that they are being observed. For offshore related activity mentioned specifically by the PSA, are the Climate and Pollution Agency (KLIF), the Norwegian Board of Health and the Norwegian Radiation Protection Authority. The Coastal Directorate and the Norwegian Industrial Safety Organisation are also involved on the landside. Collaborative relations must also be established with local authorities and county councils (PSA 2013a).

3.8.1 Regulatory Principles

The ministry has provided the following important guidelines on how the PSA should discharge its duties:

- Audits should be system-oriented and risk-based
- Audits should be a supplement to and not a replacement for internal control by the industry
- The PSA must strike a balance between its role as high-risk/technology regulator and a labour inspection authority
- Contributing to and collaborating with companies and unions represent a crucial requirement for and principle in the PSA's operations.

(PSA 2013a)

3.8.2 Natural Environment

Regarding the PSA responsibilities for environmental matters, the following could be found on the PSA (PSA 2013b) websites:

- The industry must work purposefully to prevent accidents which can cause acute discharges
- The industry’s efforts to counter major accident risk must also cover the natural environment to a greater extent.

- Work proactively and systematically to learn from major accidents and incidents which have – or could have – led to acute marine pollution in Norway and internationally

- Each player must adopt the necessary measures to prevent acute discharges. These measures must be proportionate to the possible consequences of such pollution.

The PSA will**:**

- Follow up the industry's work during 2013 on preventing acute discharges
- The PSA's contribution to efforts to protect nature and the natural environment from harm is directed first and foremost at the preventive side – in other words, helping to ensure that accidents do not occur (PSA 2013b).

3.9 Governance toolbox

3.9.1 Company comparisons

Several techniques could be used for evaluating and comparing the different companies. Described below are KPI's and Benchmarking, which are the most common techniques used by the industry.

3.9.2 Key Performance Indicators

The information in the following chapter was gathered from documents and information from relevant government departments and official websites. For further work on this topic it is recommended that information and interviews are performed and included.

One of the responsibilities of the PSA and the Norwegian Petroleum Directorate (NPD) is to evaluate the various companies operation in Norway and on the Norwegian Continental Shelf (NCS).

These evaluations include new applicants for licences on the NCS and follow up of the performances of already existing companies.
One main responsibility is to assess company capabilities of operating on the NCS. This could be done by reference to existing work and through the use of performance indicators (KPI's), as included in attachment 02: Example key performance indicators. The information is normalized according to standards found in (OSHA 2013). Furthermore, it should also be asked to compare statistics worldwide with current nation to avoid separate standards (Industrial countries vs. developing countries). Additional information such as measures to reduce energy or chemical consumption should also be requested (OSHA 2013).

3.9.3 Benchmarking

KPI indicators alone are not sufficient in evaluating performance, as they need to be used in combination with benchmarking.

According to Star Gate (2013) benchmarking is described as:

"*a process in which a company compares its performance and practices against one or more organizations. The objective is to identify best practices that will help improve business performance*"

Furthermore, it is useful to compare companies similar to each other and to ones that are regarded as a top performer. Star Gate (2013) describes benchmarking a structured approach that involves data collection, analysis, and reporting (quantitative or qualitative data or a combination of both). The result of the data analysis is a point of reference in which a comparison is made on the company's performance and target improvements.

These two comparative methods, KPI and benchmarking, should not be used separately. The benchmarking determines the performance level of a department or a company and the KPI determine the performance at that specific level.

3.9.4 Company follow up

Based on information from NPD (The Norwegian Petroleum Directorate 2010a) the follow up of the companies is based in the following:

1. Routine reporting
    a. Daily report
    b. End of well reports
    c. Chemical consumption reports
    d. Spills
2. Non-Conformance reporting and mitigations
    a. Company non-conformance reports
    b. Incidents
    c. Interpretation of non-conformance
    d. Bench marking
3. Audits
    a. Company internal audits
    b. External Audits
    c. Department audits
4. Sanctions
    a. Prosecution
    b. Fines
    c. License awards

The items listed above need to be followed up by visits and interviews at the respective authority agencies such as PSA, KliF, etc. Nevertheless, as concluded in chapter 2, Section 2.3.5 Control of the oil industry, the activities are high risk. The PSA main responsibility is to ensure the HSE on the NCS. An important PSE responsibility is to ensure that the oil industry “work proactively and systematically to learn from major accidents and incidents which have – or could have – led to acute marine pollution in Norway and internationally” (PSA 2013b).

One of the concluding recommendations in the final investigation report after Macondo states:

"*Recommendation 2 – Develop and maintain industrial and governmental institutions responsible for future development, validation, advancement, and implementation of Risk Assessment and Management (RAM) technology including definition of RAM goals and objectives for exploration and production of high hazard environment hydrocarbon resources*"
(Deepwater Horizon Study Group 2013, p.13)

In order to test the reliability and validity of these statements, consent applications for drilling activities from 3 different operators on the NCS (Statoil 2012, Wintershall 2011 and Centrica Energy 2011) were analyzed. For comparative purposes, all applications used were for the same geographic area, Haltenbanken, on the NCS, and they were all post the Macondo blowout. Probability and consequence data for a blowout was gathered.

Drilling consent applications compared to similar numbers are reported in Table 01 below together with Macondo blowout data.

Company	Risk for blowout	Duration	Spill volume X1000 m^3	Relief well duration days	Date
Statoil	$1{,}1 \times 10^{-4}$	30 /72 (1)	219 / 526(2)	30 / 72	19.09.2012
Wintershall	$1{,}6 \times 10^{-4}$	20	13	54 (2)	25.06.2011
Centrica	N/A (3)	9 (4)	123(4)	N/A	26.09.2011
Macondo		120	780	150	

Table 01: Risk and spill estimates reported in 3 Drilling Consent applications in the Haltenbanken area compared with Macondo (Statoil 2012, Wintershall 2011, Centrica Energy 2011 & Deepwater Horizon Study Group 2013).

(1) Using same value as relief well
(2) Average value between minimum and maximum expected.
(3) General statement risk is average for the North Sea, Gulf of Mexico and Canada east continental shelf, 1.1.88 – 31.12.09
(4) Max rate for subsea blowout and weighted duration, (Weighted blowout rate and duration is 2,750 m^3 /day x 9 days = 24,7 X1000 m^3)

This is a small sample, but already based on the numbers extracted from the consent applications the following is noted:

- Risk for blowout is low for all applicants
- The duration of the blowout is lower much lower than the Macondo, typically 27% to 35% of the duration of the Macondo, Statoil is closest with its max value which is 50% of the Macondo. Spill volumes vary from Wintershall estimate at 1,6% to Statoil's estimate of 67% of the Macondo spill.

  It is worth noting that Statoil appears to have got their consent to drill a well with a potential Macondo size blowout without the consent application mentioning the high risks or special contingencies. It is at the same time noted that Wintershall´s estimate for a blowout in the same geographical area is only 1,6% of Macondo or 3,8% of the Statoil estimates.

- The time estimated to drill the relief well is varying between 20% to 50% of the time it took to drill the Macondo relief well. The high and the low time of the relief well drilling are both Statoil estimates.

(Statoil 2012, Wintershall 2011, Centrica Energy 2011)

These estimates cannot be verified in this report, but the numbers could indicate the intentions of the PSA regulations are not met. This does not harmonize with e.g. the (PSA 2013a) requirement that:

"Each player needs to have the necessary overview of and control over the most important factors contributing to the risk of acute discharges in their operations" or the PSA duty to *"Ensure that the petroleum activity and activities relating to it are supervised in a unified manner."*

3.9.5 Low validity of impact assessments

This also leads to another concern regarding the input parameters to the blowout impact models may be too low. The validity of the impact on the coast and environment may be underestimated, and as a consequence necessary contingencies may not be put in place.

3.9.6 Organizational and managerial deficits

In the Macondo investigation, as described in the Deepwater Horizon Study Group (2013), two important findings were that the operating teams did not possess a functional safety culture, and secondly the organization was unable to manage risk.

3.9.7 Lower Reliability Organisations

The terms Lower Reliability Organizations (LRO) and Higher Reliability Organizations (HRO) were used in the aforementioned report. An LRO is characterized by a focus on success rather than failure, and production rather than protection. This company culture was recognised as one of the major contributors leading to the blowout. The Deepwater Horizon Study Group (2013, p. 81) states the following:

"*In-place processes propagate inertial blind spots, thereby enabling risks and failures to accumulate and produce catastrophic outcomes In LROs, expensive and "inefficient" learning and diversity in problem solving are not welcomed. Information, particularly bad or useless information, is not actively sought, failures are not taken as learning lessons, and new ideas or divergent views are discouraged. Communications are regarded as wasteful and hence the sharing of information and interpretations between individuals is stymied. In LROs the "failure-to-fail" is treated as success, which, in turn, breeds overconfidence and fantasy*."

The above statement describes a potential minefield for the petroleum industry, or any activity that deals with risks. Treating *"failure-to-fail"* as a success could easily create a company culture of underreporting or neglecting hazards or hazardous conditions above a certain risk potential. Management end up attributing success to themselves based on "only positive reporting" causing the organization to drift into complacency, inattention, and habituated routines. In such cultures, the possibilities to learn from high potential incidents are removed (Weick, Sutcliffe, & Obstfeld 1999, Deepwater Horizon Study Group 2013).

Further, the report discusses re-active cultures. It is only after disasters that the investigations are brought into place and measures to prevent re-occurrence are found. Very infrequently occurring disasters give little or no effective feedback to help indicate how protection can be improved or to demonstrate why it is needed. Furthermore, as the probabilities of catastrophic accidents are low, they may be rationalized by fearless risk-prone management in LRO's focusing on the bottom line rather than on the big picture (Weick & Sutcliffe 2001, Deepwater Horizon Study Group 2013).

LRO's risk management is illustrated by the two figures which will follow below. One is the risk triangle shown in figure 8, where focus is made on large numbers of minor low risk incidents and observations. The risk perception and focus is illustrated (becomes equal to) by the font size used in the risk triangle in figure 8 below. In addition main resources are put on attacking the risks from below, as opposed from the side. Attacking the risk triangle from the side would address all risks categories.

Figure 8: Unbalanced Risk Triangle

The plan, do, act and improve cycle of the Deming's circle becomes unbalanced, as shown in figure 9 below. The boxes and their size are in accordance with the amount of focus and input of each activity described in the circle.

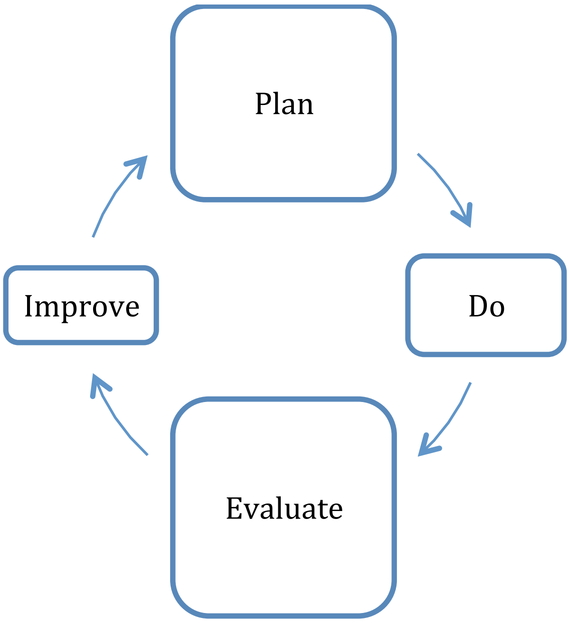

Figure 9: Unbalanced Deming Circle

3.10 Normal operation related waste

Systems for handling domestic and industrial wastes on the oil installations on the NCS are in place since more than a decade. The different waste categories are sorted at the point of origin and disposed in designated bins or containers. These systems are also used elsewhere and have become more and more common within the industry.

3.10.1 Production related waste

Waste from production is mainly produced water, which contributes to 87% of the spill from the petroleum activity (NPD 2013). Produced water is processed to maximum 40 ppm oil in water which is the limit of operational discharge on the NCS (KliF 2011). The Research Council of Norway has coordinated a research program named "Sea and Coast". One of five sub-programs termed PROOFNY has the objective of: "*acquiring increased knowledge on possible long-term effects of discharges from petroleum activities*" (KliF 2011). Results from studies by the PROOFNY group, show that effects from produced water on biomarkers are local. Produced water is quickly diluted down to concentrations below the limit for known biological effects (NPD 2013). The same studies also reveal only small differences in arctic and temperate marine organisms with regards to sensitivity to oil related pollution. The PROOFNY studies in KliF (2011) state that bacterial degradation takes place all the way down to the freezing point, although the process is slowing down with reduced temperature. Although these low effects on the environment from disposal of produced water are documented the produced water is re-injected into the reservoir where possible (KliF 2011).

3.10.2 Drilling related waste

The main discharges from drilling activities come from drilled cuttings. Effects on the seabed fauna have been observed as far out as 3 to 4 km from the discharge point, due to discharge of cuttings drilled with oil based drilling fluids. After this type of discharge was stopped in 1993, the impacted area has been reduced to 500 meters from the facilities. In the case of water based fluids this distance is further reduced. The conclusion of the PROOFNY report is that the effects of operational- and drilling waste discharges are moderate, and they do not occur more than one kilometre from the discharge points (KliF 2011).

4.0 Environmental Impact Assessment

Over the past three decades the growth of environmental awareness and interest has grown immensely. The issues surrounding sustainability and the better management of development in harmony with the environment has become of outmost importance on a national and international scale. Associated with this growth of interest has been the introduction of new legislations, emanating from national to international source, such as the European Commission, that seeks to influence the relationship development and the environment. Environmental impact assessment (EIA) is an important example. Legislation surrounding EIA was introduced in the USA over 35 years ago and the European Community directive in 1985 accelerated its application in EU member states and has since been a major growth area for planning and practice. An example is of its introduction to the UK in 1988 the number of anticipated impact assessments (or impact statements which they are named once the assessment process is completed) escalated from 20 to 600 environmental impact statements per year; and the scope continues to grow today.

According to Glasson, Therivel and Chadwick (2005, p. 4) EIA is in essence; *a* "*systematic process that examines the environmental consequence of development actions, in advance."* The emphasis, which sets in apart from other mechanisms for environmental protection, is the notion of prevention. Although planners have traditionally assessed impacts of development on the environment, they have not done so in a systematic, holistic, and multidisciplinary way required by the EIA process.

The following figure outlines the steps common in a typical EIA process:

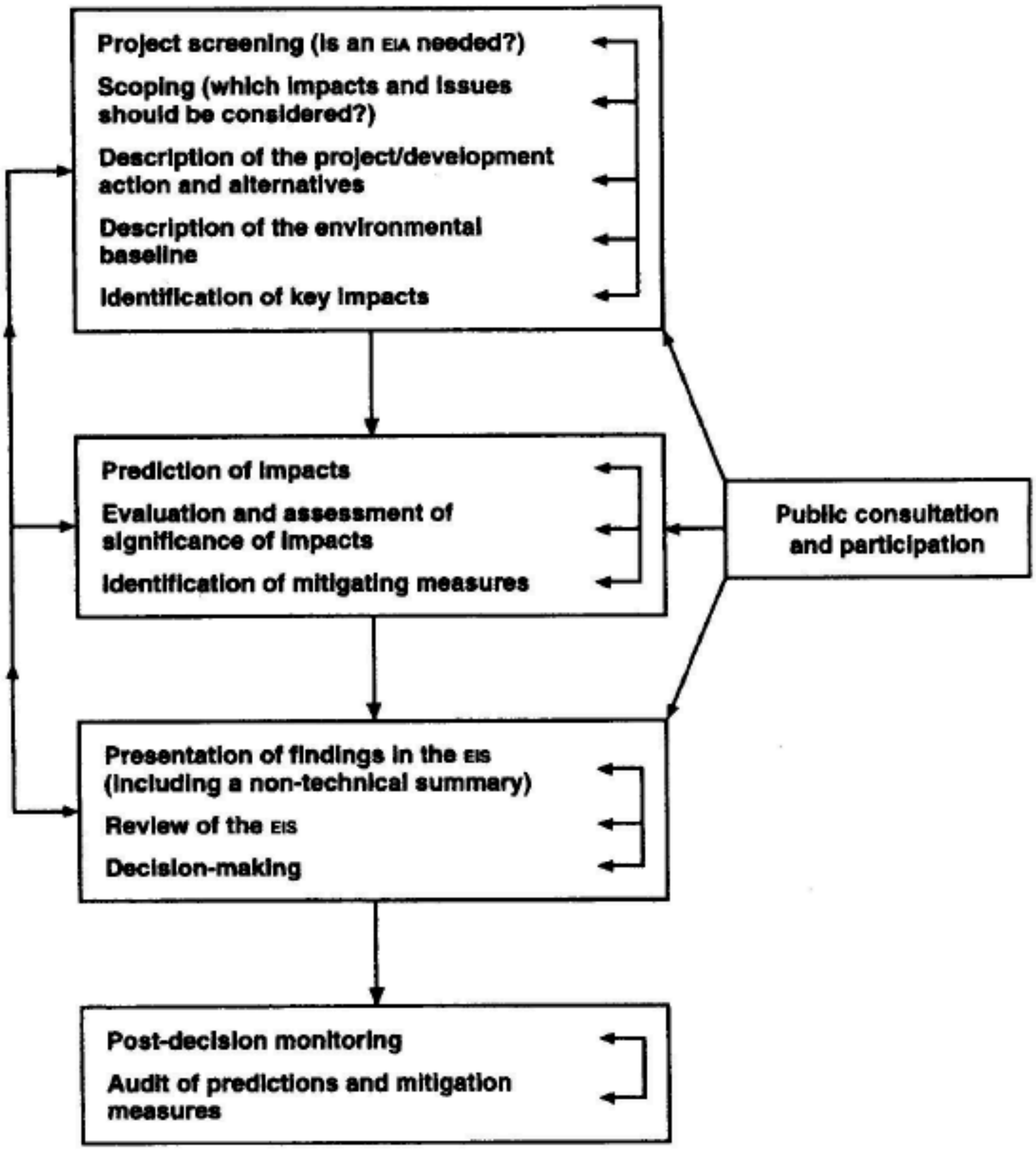

Figure 9: Steps in the EIA process (Glasson, Therivel and Chadwick 2005, p. 4)

The process is briefly described below in a linear fashion although it is important to keep in mind that EIA should be a cyclical activity, with feedback loops and interaction between the various steps (Glasson, Therivel & Chadwick 2005).

Project screening narrows the EIA application to those projects that may have significant environmental impacts. Significance is determined by the EIA regulations that exist in the country at the time of assessment. Scoping seeks to identify at an early stage all the projects potential, crucial and significant impacts and from all the alternatives that may be addressed. The consideration of alternatives ensures that the proponent has considered other feasible approaches to the project. A description of the project or development explains and clarifies the purpose and rationale of the project. Further, an environmental baseline is included to determine the current state of the environment prior to any development project. Then, an identification of possible main impacts is included in order to identify all significant impacts (both positive and negative). Finally, a prediction of impacts aims to identify the magnitude and other changes in the environment with project initiation, by comparison with the situation without that project action. (Glasson, Therivel and Chadwick 2005 & Weathern 1988). Figure 10 below graph shows an example of what such a prediction may look like:

Figure 10: Projected impact of a project (Weathern 1988, p.34)

After impacts are identified mitigating measure are introduced in order to help avoid, reduce, remedy and compensate for any adverse impact. The EIA is also assessed through a period of public consultation. This participation aims to ensure the quality, comprehensiveness and effectiveness of the EIA and that the public opinions are taken into adequately considered in the decision making process. The decision making of the project involves considerations of the project by relevant authority. Once (if) the project is initiated, post decision auditing and monitoring deals with comparing actual to predicted outcomes and can be used as quality assurance. It is considered a vital step in the EIA learning process (Weathern 1988 & Glasson, Therivel and Chadwick 2005).

4.1 Environmental Impact Statement

The environmental impact statement (EIS) documents the information and estimates the impacts derived from various steps in the process. Prevention is said to be better than cure and an EIS revealing many significant and unavoidable impacts would provide with enough information that could contribute to the abandonment or the modification of a proposed development action. The following is the most common contents of an EIS following an EIA (Glasson, Therivel & Chadwick 2005, p. 6):

A Non-technical summary is an important part of the documentation as an EIA can be complex with much technical language and terms. A non-technical summary aims to help improve communication with various parties involved and reflects on the potential complexity of the project in a non-technical, understandable way.

Followed by the non-technical summary are 3 main parts:

Part 1: Methods and key issues

1. Methods statement
2. Summary of key issues

Part 2: Background to the proposed project

3. Preliminary Studies
4. Site description, baseline conditions

5. Description of proposed development

6. Construction activities

Part 3: Environmental impact assessment – topic areas

7. Land use, landscape and visual quality

8. Geology, topography and soils

9. Hydrology and water quality

10. Air quality and water quality

11. Ecology

12. Noise

13. Transport

14. Socio-economic impact

15. Interrelationships between effects

EIA (and EIS) practices vary from country to country, study to study, thus the best practice is constantly evolving. Glasson, Therivel & Chadwick (2005) puts forth a UN study that advocates changes in the process and documentation. The UN study enhances the importance of giving greater emphasis to the socio-economic elements, public participation and to the monitoring phase of the project.

4.2 Cumulative Impact Assessment

Under the best circumstances EIA can be a complex and challenging task, Experience indicates that the scope and quality varies widely throughout a country (such as in the USA) and internationally. In recent times the United States council on Environmental Quality has according to Eccleston (2011) indicated that there is increasing evidence that the most destructive environmental adverse effect comes not only from direct and indirect effects of a given action, but instead from a combination of individual minor effects of numerous actions over time. This has seen the emerging tool of having an cumulative impact analysis (CIA) and has also been integrated into the National Environmental Policy Act (NEPA) in the USA (Eccleston 2011). Eccleston (2011,

p. 3) defines CIA as: "*the changes to the environment caused by an action in combination with other past, present and reasonably foreseeable human activity.*" Although there are many definitions used, the concept of CIA derives from observation that an impact of a particular project on an environmental resource may be considered insignificant when assessed in isolation; yet the combined impact may be quite significant when seen in context with other past, present or foreseeable future activities (Eccleston 2011).

4.3 Additive & Synergistic Cumulative Impacts

Eccleston (2011) puts forth two types of cumulative impacts:

The first type; *additive impacts* occur when the level of combined effects is equal to the sum of individual effects.

Examples are:

- Multiple air emission sources affecting regional air quality
- Multiple point and non-point discharges to watershed
- Multiple water withdrawals from a river basing or aquifer
- Multiple losses of forest cover in a landscape

The second type of cumulative impact is *synergistic impact, which* opposed to additive impacts are effects of impacts is greater than expected result. Synergistic effects are usually much more complex and difficult to assess than additive impacts and are often not expressed quantitatively (or cannot be). They are often the result of interaction between two or more activities that result in combined effects that are greater than the sum of the individual project effects (Eccleston 2011). An example could be the release of two different chemicals to sea may cause an interactive effect between the two chemicals, which would be greater than the individual effect of the same case would be.

Figure 11 shows suggested steps in a cumulative impact analysis given by Eccleston (2011, p. 45-46):

Key impact assessment components	Cumulative impact analysis steps
Scoping	1. Identify the significant cumulative impact issues associated with the proposed action and define the assessment goals.
	2. Establish the defensible geographic and time frame scope for the CIA. Using the Proximate Cause Test, determine defensible direct or indirect effect bounds of the analysis (i.e., a reasonably close causal relationship rather than a remote or overly speculative chain of causation).
	3. Identify other past, present, and reasonably foreseeable future actions affecting the resources, ecosystems, and human communities of concern that must be considered in the CIA.
Describing the affected environment	4. Characterize the resources, ecosystems, and human communities identified during scoping in terms of their response to change and capacity to withstand stresses.
	5. Characterize the stresses affecting these resources, ecosystems, and human communities and their relationship to regulatory thresholds or other applicable threshold values.
	6. Define and describe the baseline conditions (affected environment) for the resources, ecosystems, and human communities.
Determining the environmental consequences	7. Identify and define environmental disturbances (e.g., emissions, effluents, noise, waste) produced by past, present, and reasonably foreseeable future actions that could affect the resources, ecosystems, and human communities.
	8. Identify the important cause-and-effect relationships in which these environmental disturbances would affect human activities and resources, ecosystems, and human communities (e.g., how would the environmental disturbances affect humans and environmental resources?).
	9. Determine a defensible spatial and temporal bound of analysis for the effects of other present and reasonably foreseeable future actions, based on the temporal and spatial *effects* of the proposal on each resource of concern identified in Step 2.
	10. Combine or "add" the effects of the past, present, and reasonably foreseeable future actions together to produce a "cumulative impact baseline" for the resources, ecosystems, and human communities that could be significantly affected.

Key impact assessment components	Cumulative impact analysis steps
	11. Combine or add the impacts of the proposal to the cumulative impact baseline to determine how the project would affect the cumulative impact baseline.
	12. Determine the magnitude and significance of the cumulative effect.
	13. Modify or add alternatives or mitigation measures to avoid or reduce the cumulative effects.
	14. Include an uncertainty analysis that discusses areas of uncertainty and potential errors.
	15. Monitor the cumulative effects of the selected alternative.
	16. Consider using an environmental management system or adaptive management approach for monitoring and addressing any impacts that exceed original projections.

Figure 11: 16 steps in Cumulative Impact Analysis

From these 16 steps it is seen that the first component is to establish the scope of the assessment, which is then followed by a description of the affected environment. Finally, the cumulative environmental consequence of the proposed action is determined.

4.4 Social Impact Assessment

Social impact assessment (SIA) is defined by Vanclay (2002, p. 388) as:

"*the process of analysing (predicting, evaluating and reflecting) and managing the intended and unintended consequences on the human environment of planned interventions (policies, programs, plans, and projects) and any social change processes invoked by those interventions so as to bring about a more sustainable and equitable biophysical and human environment*"

In other words; its main purpose is to analyse and manage intended and unintended social consequences of a development. Its objective is therefore to ensure that community benefits are maximised and costs minimised (Burge & Vanclay 1995).

With regard to the NCS, the social impact and effects of the petroleum activities are twofold. The petroleum activity is creating employment and is boosting activity along the coast. Traditionally the coast is an area with a low number of jobs, thus increased employment and activity is welcomed with its many positive effects. However, the negative effects are related to the fear of pollution and the possible environmental effects should a major blowout or similar accidental spill occur. The defined consequence of this is the oil slick hitting the coast and polluting the beaches. Beach and beach ecosystem habitats will be impacted by the oil spill.

Social impact as a result of the presence of petroleum industry and possible environmental accidents could be related to 3 categories:

4.4.1 Fisheries

Fisheries off the coast will be impacted as long as the oil is present on the sea, this will cause loss of income for the fisheries in question.

4.4.2 Fish farming

One of the main incomes for the coastal population of Norway is fish farming. This industry is scattered all along the coast and is likely to be impacted by an oil slick. Even if the effects may be mitigated, by moving the facilities, it is likely the public will refrain from buying the products fearing it may be polluted. This was seen in the case of the Macondo oil reaching similar fish farms of the Gulf coast.

4.4.3 Recreation and tourism

The coast is important for recreation and tourism. This will suffer in areas where the oil has hit the beach. Recreational areas will be lost for a long time, and tourists are most likely to choose other destinations.
Impacts expected are increased unemployment on the cost. Social effects and consequences of unemployment are documented elsewhere and will not be further discussed in this thesis.

5.0 Comparative analysis of petroleum governance between Uganda and Norway

The following chapter is an analysis of the management and governance approaches to petroleum activities of Norway and Uganda. One of the countries is rich and industrialised, with a relative long experience with petroleum activities. The other is an underdeveloped country with little experience in petroleum activities. The analyses will look at the petroleum laws, belonging regulations and how the activities are monitored. It will also examine how the laws and regulations are enforced. The different countries approach to the petroleum activity is compared and a gap analyses is made before it is suggested how this gap could be closed.

5.1 Petroleum industry governance in Uganda

With possibly the largest onshore oil discovery in sub-Saharan Africa, the Ugandan government is now facing similar political governance issues as Norway did in the 1960. The government of Uganda have, and are today, still putting in place legislation and resource management approaches to govern its newly found resource (The Times 2010).
"The national oil and gas policy" for Uganda is outlining the strategy for the petroleum development in Uganda. This policy has been put in place by use of consultancy services as well as cooperation with other government institutions like cultural and civil societies (*Ministry of Energy and Mineral Development 2008)*. In attachment 3, Uganda's petroleum provinces are shown in a map and the map also depicts several "unlicensed" fields.

One of the consultants used in the national oil and gas policy document is Farouk al Kasim, a former director at the Norwegian Petroleum Directorate, being one of the architects of the modern Norwegian Petroleum regulations. Reading the *Ministry of Energy and Mineral Development (2008, p. ix.)* for Uganda many similarities are seen, like in the objectives of the policies which are:

1. *To ensure efficiency in licensing areas with the potential for oil and gas production in the country.*
2. *To establish and efficiently manage the country's oil and gas resource potential.*
3. *To efficiently produce the country's oil and gas resources.*
4. *To promote valuable utilization of the country's oil and gas resources.*
5. *To promote the development of suitable transport solutions which give good value to the country's oil and gas resources.*
6. *To ensure collection of the right revenues and use them to create lasting value for the entire nation.*
7. *To ensure optimum national participation in oil and gas activities.*
8. *To support the development and maintenance of national skills and expertise.*
9. *To ensure that oil and gas activities are undertaken in a manner that conserves the environment and biodiversity.*
10. *To ensure mutually beneficial relationships between all stakeholders in the development of a desirable oil and gas sub sector for the country.*

5.1.1 Environmental policy

Objective 9 is describing how the environmental resource, pollution or hazard strategies and actions are addressed (Ministry of Energy and Mineral Development, p. 28).

Strategies:

1. Ensure availability of the necessary institutional and regulatory framework to address environment and biodiversity issues relevant to oil and gas activities.
2. Ensure presence of the necessary capacity and facilities to monitor the impact of oil and gas activities on the environment and biodiversity.
3. Require oil companies and their contractors/subcontractors to use self-regulation and best practices in ensuring environmental protection and biodiversity conservation.

4. Require oil companies and any other operators to make the necessary efforts to return all sites on which oil and gas activities are undertaken to their original condition as an environmental obligation.

Actions*:*

1. Upgrade the relevant Environment and Biodiversity legislation to address oil and gas activities.
2. Strengthen the institutions with a mandate to manage the impact of oil and gas activities on the environment and biodiversity.
3. Develop physical master plans; environmental sensitivity maps and oil spill contingency plans for the oil and gas producing region and any transport corridors.

These are modern type requirements similar to the Norwegian Petroleum laws and regulations. The main principals found in the Norwegian laws and regulations are found and are listed below:

1. Functional
2. Coordination between other government bodies, like health, environment, transport.
3. Use of consequence evaluations
4. Risk evaluation, activities are risk based and risk managed.
5. Contingency planning

(Norwegian Petroleum Directorate 2010a)

The activities are founded on, like in Norway, the principles of sustainability. Technology and processes should be put in place; these should be continuously maintained and improved. Risk should be managed by best available technology, and risk should be held "as low as reasonably possible"(ALARP)(Norwegian Petroleum Directorate 2010a).

Although the actual petroleum laws and regulations are not formally written yet they can be easily extracted from the policy document. Through cooperation, other countries' laws and regulations could be used and necessary local adaptions included in the Ugandan system.

Petroleum development plans, based on modern principles, are put in place by the action points listed in the national oil and gas development policy (Ministry of Energy and Mineral Development 2008, p. 23):

1. Put in place appropriate petroleum legislation.
2. Acquire and prepare data for licensing.
3. Carry out promotional efforts.
4. Prepare procedures and criteria for competitive licensing.
5. Undertake open and transparent licensing rounds.

5.2 Further comparisons and analysis

Comparing the two countries law and regulations discloses similarities and differences. As described in the paper the structure of the laws and regulations are based on the same principles and as mentioned previously they even have input from the same person, namely the former director at the Norwegian Petroleum Directorate, Farouk al Kasim.

Figure 12 below show comparisons between the governance in Norway and Uganda

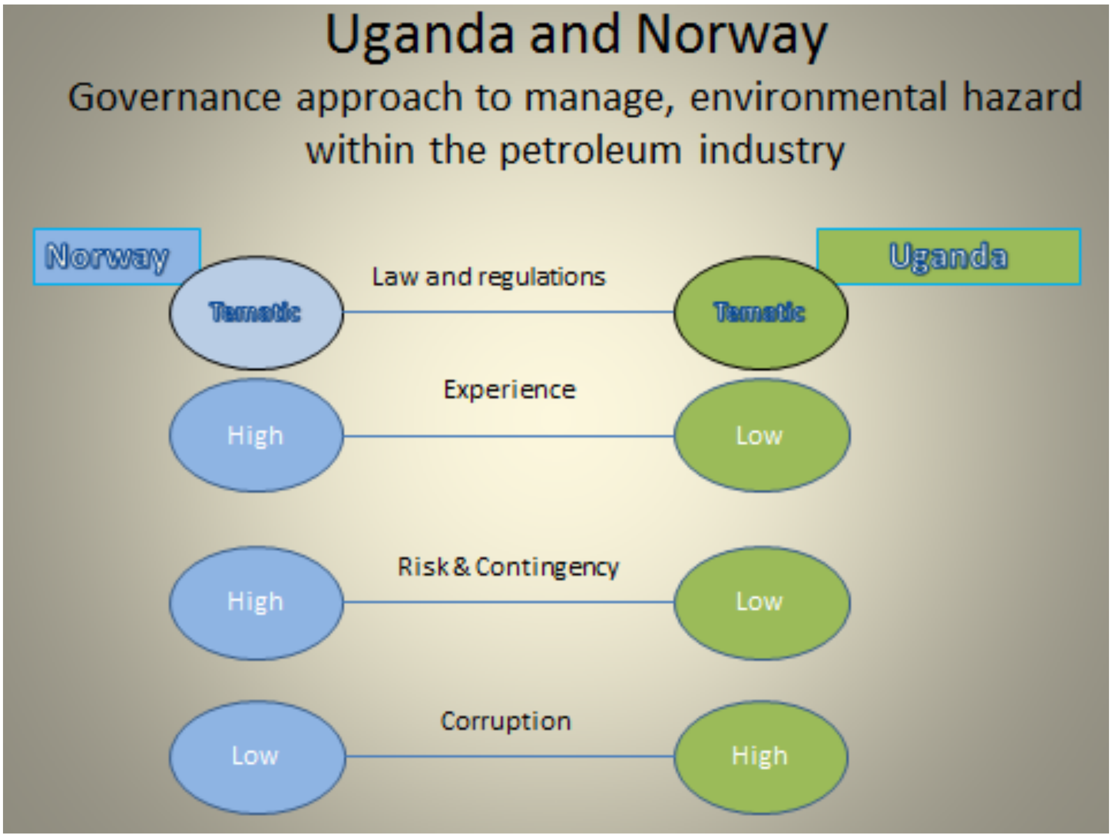

Figure 12: Comparison between the governance in Norway and Uganda

5.2.1 Functional laws and regulations

The main difference is that in Norway the laws and regulations have developed over time, as in Uganda they are put in place without maturing over time within the country and its culture and demand. Although with the best of intentions this is a challenge. The "Norwegian" type regulations require high expertise and experience to control. In a way one have to "beat the oil companies on their home ground". The government agency representatives have to challenge the solutions and processes proposed by the oil companies (Attachment 05: Laws and regulations structure).

5.2.2 Interdepartmental cooperation

Norway has a long tradition of coordinating activities within and between different government department and institutions. As an example, the petroleum directorate are delegating the environmental issues related to a company application to the directorate of environment. In Uganda this interdepartmental cooperation has not the long tradition as in Norway, and both cross understanding and timely respond to such requests are required.
(Attachment 6: The Norwegian Petroleum Directorate coordinating role)

5.2.3 Consequence evaluation

Implications, positive and negative, the activity has for a country is a part of the petroleum development policy. The question on how these consequences are interpreted is more difficult to answer. Compared to Norway, which is one unified country, Uganda is a tribal nation. In such countries, the experience is often that the persons involved are looking at the consequences for their area and tribe rather than including the country as a whole. Nigeria is a tragic example of this, as parts of the country are benefiting from the petroleum activities' revenue and other parts are suffering to an extent that the country is on the brink of civil war. Law and order has ceased to exist (Okuonzi 2004).
For the purpose of providing an example one could claim that in third world countries the culture surrounding personal safety is very from ours. Our culture is to put the safety belt on when driving the car as a reflex, whilst in countries in the third world cars do not even have safety belts. Another example relate to waste management, whereas in third world countries waste collection probably only exists at a primitive stage, and everything goes in the same bin and ends up in the same pile.

5.2.4 Risk evaluation

In Norway, activities are risk based which means they are controlled in a manner that is reducing risk. Technology and skill are key elements in this process. Both factors are present in Norway while Uganda is in a different stage. The people of Uganda have not gone through the evolvement of our risk management, their concerns are ruled by the poverty of the country, and they cannot afford the extra cost related to safety end pollution control.

In order to cope with major disasters contingency planning is necessary. This involves cooperation between the companies and the country's infrastructure. This may be in relation to major accidents requiring evacuation and hospitalisation of personnel. It could also be environmental disasters such as blowouts. This is present in Norway, but Uganda does not yet have these resources.

5.2.5 Environmental baseline

In order to assess environmental degradation due to petroleum activities and ensure sustainable development, an environmental baseline of the current state of environment is essential in Uganda. Sampling environmentally threatened fauna, flora and ecosystems creates this baseline and ensures protection of the environment. The results and data collected prior to activities will be part of the impact assessment and monitoring throughout Uganda's oil development in order to sustain its goals of a prosperous future.

5.3 Summary of further comparisons

From the above comparisons it is seen that Uganda is lacking the necessary resources to fully govern the principals outlined in the Norwegian regulations. Adaptions have to be made and in a start-up phase only the highest priority actions should be prioritized. The "80 – 20 Rule" from the Norwegian Petroleum Directive (2010) could be found effective; 80% of the required actions could be achieved with 20% of the resources. The last 20% of the activities, requiring 80% of the resources could be a part of the improvement plan.

5.3.1 Corruption

The biggest obstacle is not yet mentioned. Uganda is ranked as one of the most corrupt countries in the world ranked as number 130 on Forbes' corruption ranking (Forbes 2010).

Nigeria, another major African oil producing country, is on the same ranking as Uganda. It has been shown that the result of Nigeria's petroleum industry lead to the ecological collapse of the Niger delta, agriculture is no longer possible, and fisheries are no longer possible for the same reason.

Without solving the corruption problem, there is little chance of Uganda achieving much of its national oil and gas policy. This is outside the scope of this paper and is only recognised as the single biggest obstacle for Uganda's future as a modern country in general and as petroleum producer specifically (Okuonzi 2004).

5.4 Conclusion of the comparative analysis

A comparison of the governance approach to manage the petroleum resources in Norway and Uganda has been made. The basis of the comparison is the Norwegian petroleum law and regulations and Uganda's national oil and gas policy. Although the approach and the use of modern laws and regulations that exist in both countries are the same, large differences have been found. The culture and stage of development of the two countries is very different and copying one principle of law and regulations from one country to another is not necessarily successful. A large degree of local adaption, training of own personnel and elimination of corruptions are key elements, which have to be resolved. Cooperation between countries, by sharing experiences is positive and an essential activity assisting countries comparable to Uganda to achieve its goals of a sustainable and a prosperous future.

It is important to mention that the findings regarding Uganda are expected to be valid for most developing countries. The environmental challenges will be more complex in developing than in industrialized countries where the availability of local expertise and strong local governance exist. The positive results seen on the NCS regarding waste management and operational spills are not necessarily transferred to developing countries. The effect of weaker governance could be that old obsolete equipment is exported for use in developing countries. The effects of old equipment is shown earlier in this report.

The industry dual standard, one good standard in the industrial world and a poor standard in the developing world, is possibly the main obstacle in the protection of the environment in developing countries.

6. Petroleum activities in a Life Cycle Perspective

The petroleum activities should be planned and executed in a life cycle perspective. For a petroleum field development this includes activities from Exploration, through field development through the producing phase ending with the termination and restoration phase.
This is illustrated in figure 13 below where also the main sub activities are included.

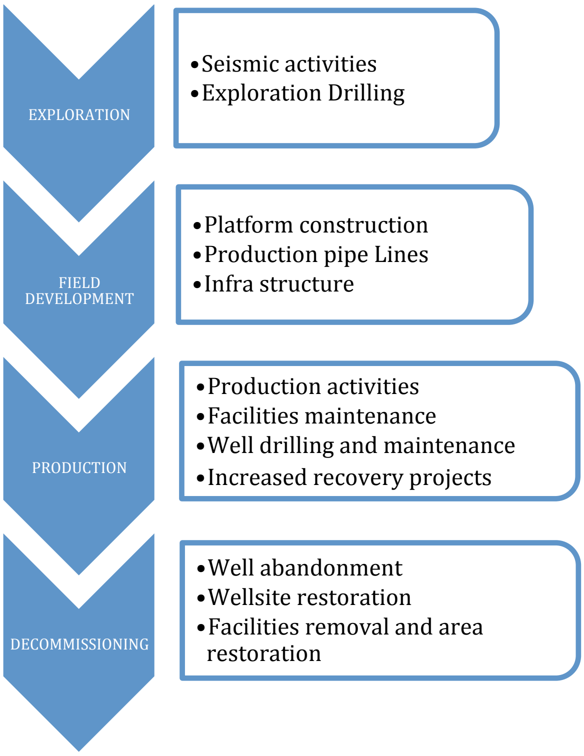

Figure 13: Field development life cycle

Based on this model, the relationships between different phases in a field life cycle become more visible due to the possibility of re-use of resources from one phase to another. The Life Cycle Perspective defines the life time for the equipment and specifications of materials and equipment is based on this principle. Furthermore, the termination phase becomes apparent and it requires funds and plans in order to be completed (Fet 2012).

6.1 Decommissioning

The Climate and Pollution Agency (KliF) report "Decommissioning of offshore installations" shows the number and weight of the offshore installations on the Norwegian continental shelf that are to be decommissioned (KliF 2011).
Table 02 below show the number of installations and total weight in tonnes per category of installations offshore:

Category	Number	Total weight (Tonnes)
Concrete installations	12	480 000 (topsides)
		4 600 000 (Concrete sub structures)
Fixed steel installations	88	1000 000
Floating installations (Steel)	19	715 000
Subsea systems	348	118 000

Table 02: Number and total weight of different categories of installations currently standing on the Norwegian Continental Shelf. (KliF 2011)

A number of measures are recommended such as expertise in dealing with different types of waste, including hazardous wastes (for example heavy metals), radioactive waste and low specific activity (LSA) scales.

The amounts of LSA with activities exceeding10Bq/g are listed in the table 03 below:

	Quantity radioactive scale (tonnes)		Total quantity 2010 – 2020 (Tonnes)
	2010 -2015	2015 - 2020	
Large Platforms	42	54	96
Steel Jacket Platforms	0	0	0
Sub Sea Systems	No Data	No data	No Data
Total	42	54	96

Table 03: Estimated quantities radioactive waste (scale with an activity concentration exceeding10Bq/g) from decommissioning of offshore installations from the Norwegian continental shelf (KliF 2011).

Klif (2011) recommends early planning for decommissioning of the facilities, preferably when the field development and operation are planned. Relevant documentation and records of materials, chemicals used, construction drawings and maintenance records including scale radioactive measurements made during the production phase, must be made available. Furthermore, transfer of experience for personnel who have worked on the installations is recommended (KliF 2011).

Further, the shore facilities receiving the hazardous waste must be designed to allow safe handling of LSA and other hazardous materials. This should be done with no risk of runoff or infiltration into the soil. In addition, decommissioning facilities should have effective collection systems and on-site treatment plant for contaminated water, including surface water (KliF 2011).

6.1 Sub Activities and Life Cycle Assessments

As the life cycle of the entire field development is performed as above, sub activities should also be life cycle assessed. As an example drilling fluid management is used (Valstad 2012).

6.1.1 Drilling Fluid Management

Within the drilling activity, drilling fluid management exists. Drilling fluid is used for the drilling process and is regarded as the highest contributor to chemical consumption and chemical waste. The design of drilling fluid facilities and drilling fluid management should be made with life cycle principles.

This is illustrated by a material flow diagram of the drilling fluid process in Figure 14 below. Materials or chemicals are input on one side and the wanted product is output on the other side. This process also results in emissions to the air and waste to sea/water and land. Several technologies and procedures are put in place to reduce the total chemical consumption (Valstad 2012).

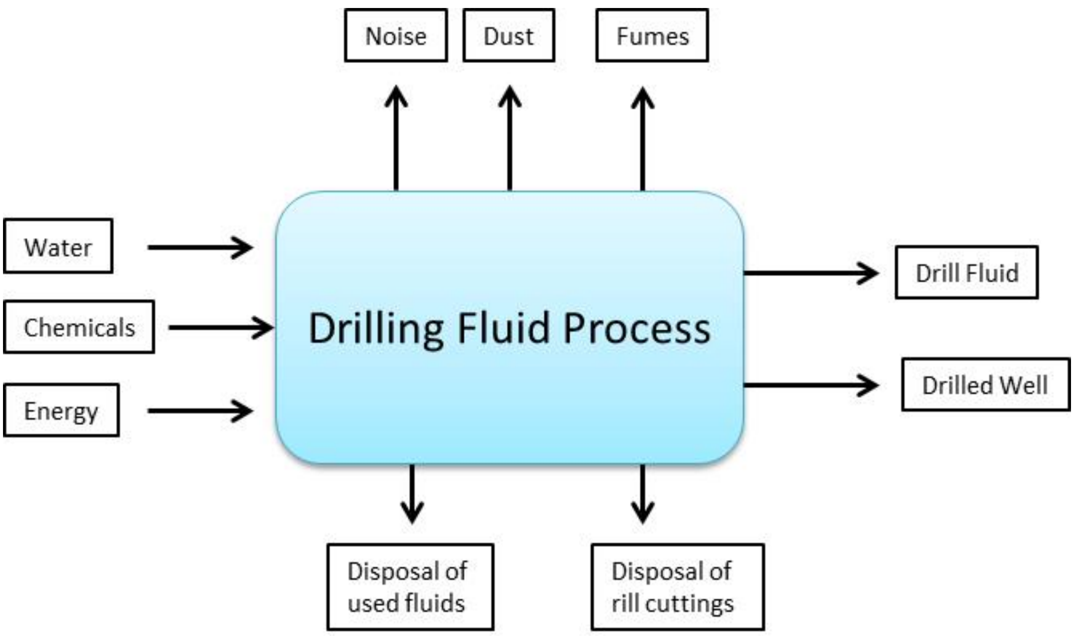

Figure 14: Material Flow of the Drilling Fluid Process

When designing the drilling fluid system with a life cycle perspective, the following considerations are made based on the material flow of the drilling fluid process in figure 14.

1. **Input: to the Drilling Fluid process.**
   Drilling fluid is built by adding chemicals to a base fluid. For water based drilling fluid water is the base fluid, for oil-based fluid various types of oils are used. Several technologies of blending chemicals into the base fluid exist, from cheap solution through so-called mixing hoppers through chemical shearing hoppers through sharing systems allowing the chemicals to be sheared into the base fluid.
   Improved shearing effects reduce the amount of chemicals required to obtain certain parameters. Investing in more costly chemical mixing equipment will reduce the cost and reduce the total amount of chemicals used for the same volume of fluid. From a life cycle perspective, the investment in more expensive technology becomes the most cost effective solution.

2. **Output: Emissions to the air**
   - **Dust**
     The mixing of chemicals produces dust in to the air resulting in spill, waste of chemicals; and the dust is potentially harmful to the personnel involved in the process. Life cycle assessments justify reduction of the dust from chemical by investing in technology.
   - **Fumes**
     In the case of oil base fluids, fumes from evaporation may create a health hazard
   - **Noise**
     The drilling fluid cleaning system, the shale shakers produce noise. This is harmful to the personnel. It could also have an effect in case the activity is in populated area or in a area with wild life. Technology is available with equipment with less noise and constructions for enclosing the shakers.

3. Output: Waste to the sea, water and land

One of the main tasks of the drilling fluid is to carry drilled cuttings to the surface during the drilling process. The drilling fluid is a closed system and the drilled cuttings need to be separated from the drilling fluid on the surface. This is happening on large when the drilling fluid is arriving at the surface polluted with drilled cuttings. The cuttings are removed on big vibrating sieves called shale shakers. Late technologies have made big improvements in the shale shaker efficiency. This has resulted in less disposal of drilling fluid attached to the cuttings and less cuttings material on the recovered fluids. The end result is less use if drill fluid and higher recovery and recycling of the drilling fluid. Investments in expensive shale shaker technology will reduce the consumption of drilling fluid required per meters drilled.

Figure 15 illustrates this below by comparing old and new technology. A column showing properly maintained old technology is also included.

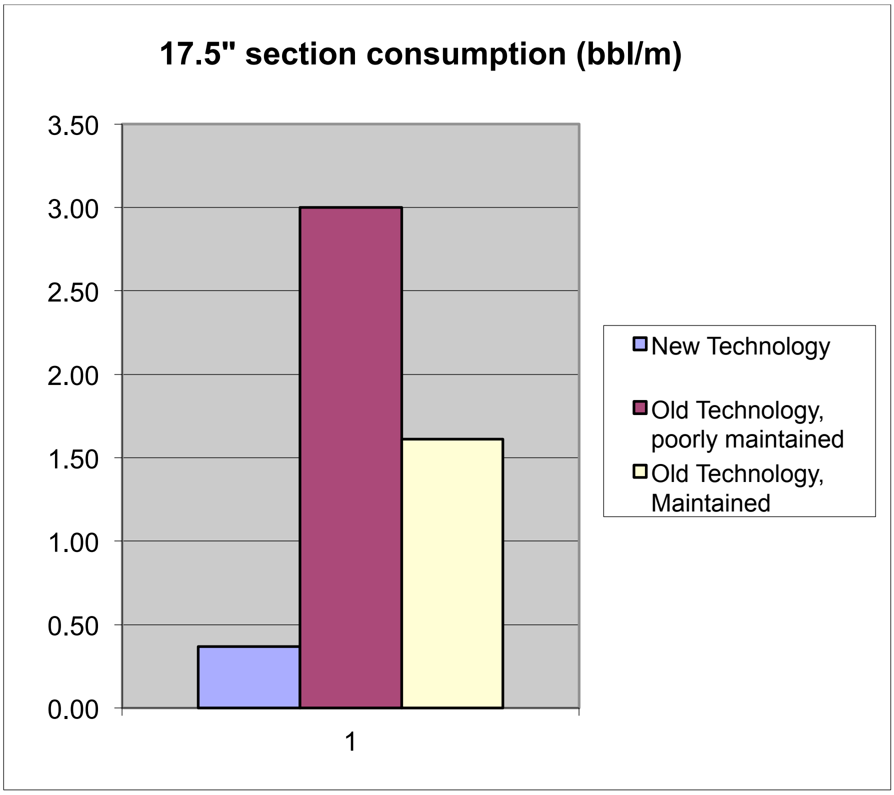

Figure 15: drilling fluid built in the 17 ½" hole section of a land well.

It is seen from the graph that the fluid consumption for the 17 ½" section is less than the theoretical volume of the drilled hole. This is a result of the re-use of the drilling fluid from the previous section. The new technology processes a cleaner mud out of the shale shakers, which allows the mud from the previous sections to be re-used in the next section.

6.1.2 Revised contract strategies

This improved technology enabling the re-use of drilling fluids opens for new contract strategies. The drilling fluid companies have traditionally been paid for the chemicals used in making new drilling fluids, which is in contradiction to the principles of life cycle assessment and sustainable operations. The contract must be moved from chemical payments to compensations for re-use and recycling of the drilling fluids (Valstad 2012).

7. Summary and Discussion

This thesis has examined the petroleum industry from an environmental perspective. This was done from a historical view up till present time. The control mechanisms of the oil companies exist through laws, regulation and in the companies internal management systems. The authorities governing mechanisms and the aforementioned oil company control mechanisms were established through a literature review and subsequently analysed. Norwegian petroleum laws and regulations were used as examples and compared with a developing country. For future studies, it is recommended to include interviews with relevant government bodies in which the bureaucrats' roles, responsibilities and work methods such as the "governing toolbox" are examined. This will increase the reliability of the statements in this thesis, which are mostly based on a qualitative approach. Nevertheless, the literature review and information gathered through the qualitative research revealed modern and comprehensive regulations. The regulations were found to put high demands on both the companies and the governing authorities. The main goals of the thesis: "*to evaluate the environmental management of the petroleum industry by examining sustainability, global frameworks and management tools*", are met. The consent applications showed environmental awareness and contingency plans, but the inconsistency between the applications opens for further analysis. Likewise, the Macondo well blowout investigation examined in this thesis, contained findings and conclusions that should be tested on the operators on the Norwegian Continental Shelf.

8. Conclusion and Further Challenges

This research has aimed at providing an overview of the state of the environmental management of the petroleum industry. From a historical perspective large improvement in the environmental management was found. Petroleum activity on the NCS seems to have minimal impact on the environment, and continuous improvement processes have reduced the consumption of chemicals, their toxicity and the amounts of waste. Increased recycling have been demonstrating, documenting the petroleum is developing into direction towards sustainability. Good control on waste handling and day-to-day pollution control was demonstrated. Life Cycle Assessments are observed, but does not seem to be fully incorporated in the company policies, e.g. decommissioning requirements have not been seen in the field development planning phase.

Modern functional regulations are in place, but it was noted that the intentions in the regulations were not always met. More specifically, the requirements to risk assessment, HSE culture and contingency planning seem to have shortcomings. The search into company consent applications revealed little learning from the Macondo blowout. Both company and governance shortcomings become visible through the review of blowout risk assessments, which appeared to be vague and inconsistent. Recommendations from the "Final Report on the Investigation of the Macondo Well Blowout" are not visible in the subsequent consent applications investigated in this thesis.

Furthermore, the report pointed at a poor company culture as being one of the major contributing factors leading to disasters. A lower reliability type organization focusing on production rather than protection existed within the company contributing to an organization unable to manage risk. With this perspective in mind, the inevitable question appears: Is this description representative for the companies operating on the NCS?

The main finding, conclusion and recommendation of this thesis would be to audit all companies on the NCS for this type of company culture. In this way one could do away with lower reliability organisations and replace them with higher reliability organisations. This type of organisations and culture must form the backbone of any company in order to meet future challenges of sustainable activities.

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10. Attachments

Attachment 1: List of major accidents since 1955 (Westergaard 1987)

Year	*Rig Name*	*Rig Owner*	*Type*	*Damage / details*
1955	*S-44*	*Chevron Corporation*	*Sub Recessed pontoons*	*Blowout and fire. Returned to service.*
1959	*C. T. Thornton*	*Reading & Bates*	*Jackup*	*Blowout and fire damage.*
1964	*C. P. Baker*	*Reading & Bates*	*Drill barge*	*Blowout in Gulf of Mexico, vessel capsized, 22 killed.*
1965	*Trion*	*Royal Dutch Shell*	*Jackup*	*Destroyed by blowout.*
1965	*Paguro*	*SNAM*	*Jackup*	*Destroyed by blowout and fire.*
1968	*Little Bob*	*Coral*	*Jackup*	*Blowout and fire, killed 7.*
1969	*Wodeco III*	*Floor drilling*	*Drilling barge*	*Blowout*
1969	*Sedco 135G*	*Sedco Inc*	*Semi-submersible*	*Blowout damage*
1969	*Rimrick Tidelands*	*ODECO*	*Submersible*	*Blowout in Gulf of Mexico*
1970	*Stormdrill III*	*Storm Drilling*	*Jackup*	*Blowout and fire damage.*
1970	*Discoverer III*	*Offshore Co.*	*Drillship*	*Blowout (S. China Seas)*
1971	*Big John*	*Atwood Oceanics*	*Drill barge*	*Blowout and fire.*
1971	*Unknown*	*Floor Drilling*	*Drill barge*	*Blowout and fire off Peru, 7 killed.*

1972	*J. Storm II*	*Marine Drilling Co.*	*Jackup*	*Blowout in Gulf of Mexico*
1972	*M. G. Hulme*	*Reading & Bates*	*Jackup*	*Blowout and capsize in Java Sea.*
1972	*Rig 20*	*Transworld Drilling*	*Jackup*	*Blowout in Gulf of Martaban.*
1973	*Mariner I*	*Sante Fe Drilling*	*Semi-sub*	*Blowout off Trinidad, 3 killed.*
1975	*Mariner II*	*Sante Fe Drilling*	*Semi-submersible*	*Lost BOP during blowout.*
1975	*J. Storm II*	*Marine Drilling Co.*	*Jackup*	*Blowout in Gulf of Mexico.[citation needed]*
1976	*Petrobras III*	*Petrobras*	*Jackup*	*No info.*
1976	*W. D. Kent*	*Reading & Bates*	*Jackup*	*Damage while drilling relief well.[citation needed]*
1977	*Maersk Explorer*	*Maersk Drilling*	*Jackup*	*Blowout and fire in North Sea[citation needed]*
1977	*Ekofisk Bravo*	*Phillips Petroleum*	*Platform*	*Blowout during well workover.[26]*
1978	*Scan Bay*	*Scan Drilling*	*Jackup*	*Blowout and fire in the Persion Gulf.[citation needed]*
1979	*Salenergy II*	*Salen Offshore*	*Jackup*	*Blowout in Gulf of Mexico*
1979	*Sedco 135F*	*Sedco Drilling*	*Semi-submersible*	*Blowout and fire in Bay of Campeche Ixtoc I well.[26]*
1980	*Sedco 135G*	*Sedco Drilling*	*Semi-submersible*	*Blowout and fire of Nigeria.*

1980	*Discoverer 534*	*Offshore Co.*	*Drillship*	*Gas escape caught fire.[citation needed]*
1980	*Ron Tappmeyer*	*Reading & Bates*	*Jackup*	*Blowout in Persian Gulf, 5 killed.[citation needed]*
1980	*Nanhai II*	*Peoples Republic of China*	*Jackup*	*Blowout of Hainan Island.[citation needed]*
1980	*Maersk Endurer*	*Maersk Drilling*	*Jackup*	*Blowout in Red Sea, 2 killed.[citation needed]*
1980	*Ocean King*	*ODECO*	*Jackup*	*Blowout and fire in Gulf of Mexico, 5 killed.[27]*
1980	*Marlin 14*	*Marlin Drilling*	*Jackup*	*Blowout in Gulf of Mexico[citation needed]*
1981	*Penrod 50*	*Penrod Drilling*	*Submersible*	*Blowout and fire in Gulf of Mexico.[citation needed]*
1985	*West Vanguard*	*Smedvig*	*Semi-submersible*	*Shallow gas blowout and fire in Norwegian sea, 1 fatality.*
1981	*Petromar V*	*Petromar*	*Drillship*	*Gas blowout and capsize in S. China seas.[citation needed]*
1983	*Bull Run*	*Atwood Oceanics*	*Tender*	*Oil and gas blowout Dubai, 3 fatalities.*
1988	*Ocean Odyssey*	*Diamond Offshore*	*Semi-submersible*	*Gas blowout at BOP and fire in the UK North Sea, 1 killed.*

		Drilling		
1989	*Al Baz*	*Sante Fe*	*Jackup*	*Shallow gas blowout and fire in Nigeria, 5 killed.[28]*
1993	*Actinia*	*Transocean*	*Semi-submersible*	*Sub-sea blowout in Vietnam. .[29]*
2001	*Ensco 51*	*Ensco*	*Jackup*	*Gas blowout and fire, Gulf of Mexico, no casualties[30]*
2002	*Arabdrill 19*	*Arabian Drilling Co.*	*Jackup*	*Structural collapse, blowout, fire and sinking.[31]*
2004	*Adriatic IV*	*Global Sante Fe*	*Jackup*	*Blowout and fire at Temsah platform, Mediterranean Sea[32]*
2007	*Usumacinta*	*PEMEX*	*Jackup*	*Storm forced rig to move, causing well blowout on Kab 101 platform, 22 killed.[33]*
2009	*West Atlas / Montara*	*Seadrill*	*Jackup / Platform*	*Blowout and fire on rig and platform in Australia.[34]*
2010	*Deepwater Horizon*	*Transocean*	*Semi-submersible*	*Blowout and fire on the rig, subsea well blowout, killed 11 in explosion.*
2010	*Vermilion Block 380*	*Mariner Energy*	*Platform*	*Blowout and fire, 13 survivors, 1 injured.*
2012	*KS Endeavour*	*KS Energy Services*	*Jack-Up*	*Blowout and fire on the rig, collapsed, killed 2 in explosion.*

Attachment 2: Key Performance Indicators (KPI)

A List of abbreviations and definitions are found at the end of this attachment (p.88).

2.1. Health Statistics

2.1.1 Domestic

Year	Total Sick leave		Leave longer than 4 weeks		Work Related		Non Work related	
	Nr	Freq	Nr	Freq	Nr	Freq	Nr	Freq
n								
n-1								
n-2								
n-3								
n-4								

2.1.2 World Wide

Year	Total Sick leave		Leave longer than 4 weeks		Work Related		Non Work related	
	Nr	Freq	Nr	Freq	Nr	Freq	Nr	Freq
n								
n-1								
n-2								
n-3								
n-4								

2.2 Safety Statistics

2.2.1 Domestic

Year	Fatality		LTA		Alt. Work		Medical Treatment		First Aid Case		Car Accident	
	No	fr	No	fr	No	fr	No	fr	No	fr	No	fr
n												
n-1												
n-2												
n-3												
n-4												

2.2.2 World Wide

Year	Fatality		LTA		Alt. Work		Medical Treatment		First Aid Case		Car Accident	
	No	fr	No	fr	No	fr	No	fr	No	fr	No	fr
n												
n-1												
n-2												
n-3												
n-4												

2.3 Environmental Statistics

2.3.1 A: Chemical Consumption

Year	#Black	# Green	#Yellow	#Green	Substituted	Recycled
n						
n-1						
n-2						
n-3						
n-4						

2.3.2 B: Emissions and spills

Year	CO2	NOX			Spills
n					
n-1					
n-2					
n-3					
n-4					

2.4. Abbreviations

>4weeks = Long term sick leave

Fr = Frequency; Normalised over 200,000 / 1,000,000 Manhours or Kilometres (for Vehicle Accidents).

LTA – Lost Time Accident

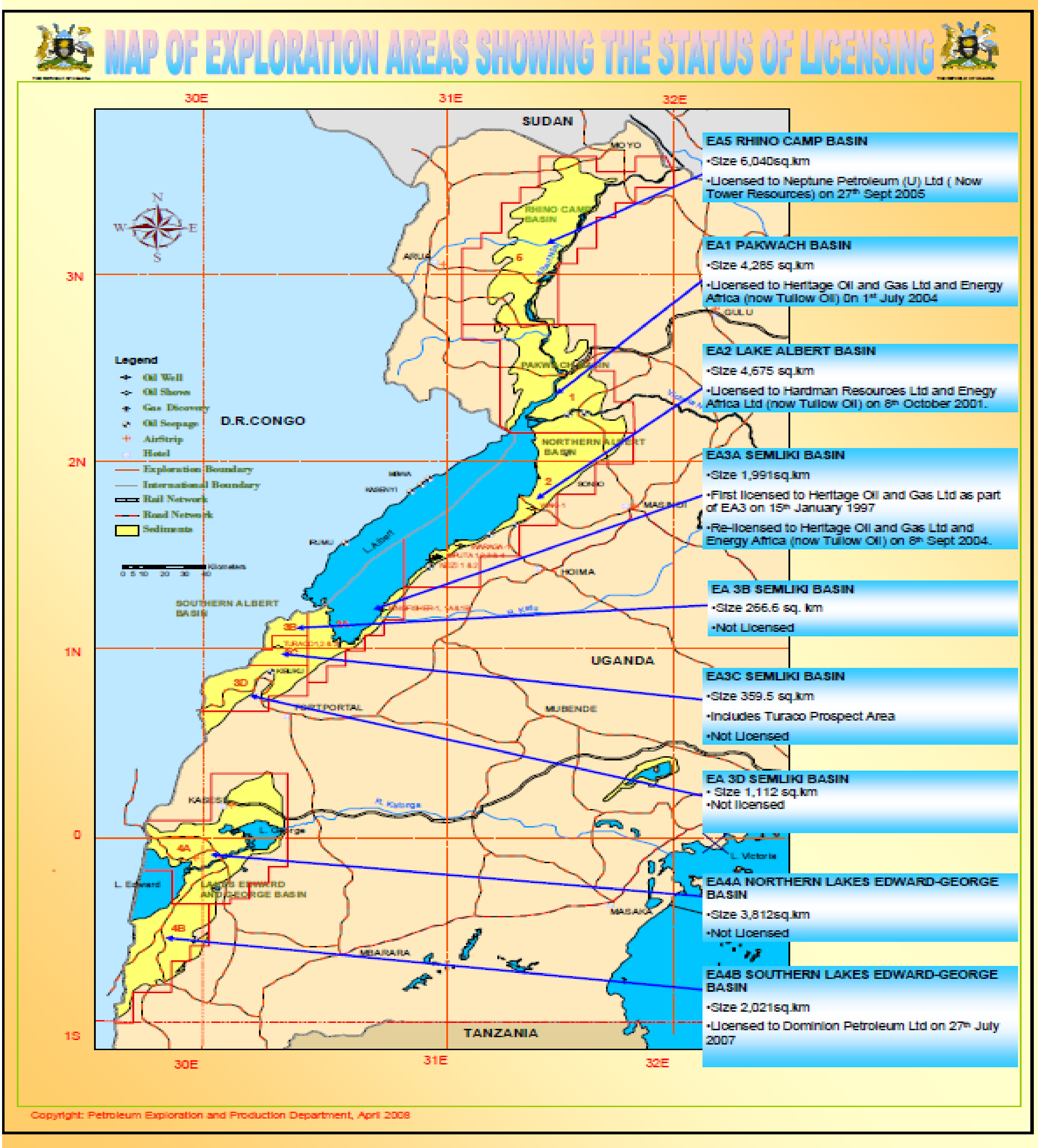
Alt. Work – Alternative Work

MTC – Medical Treatment Case

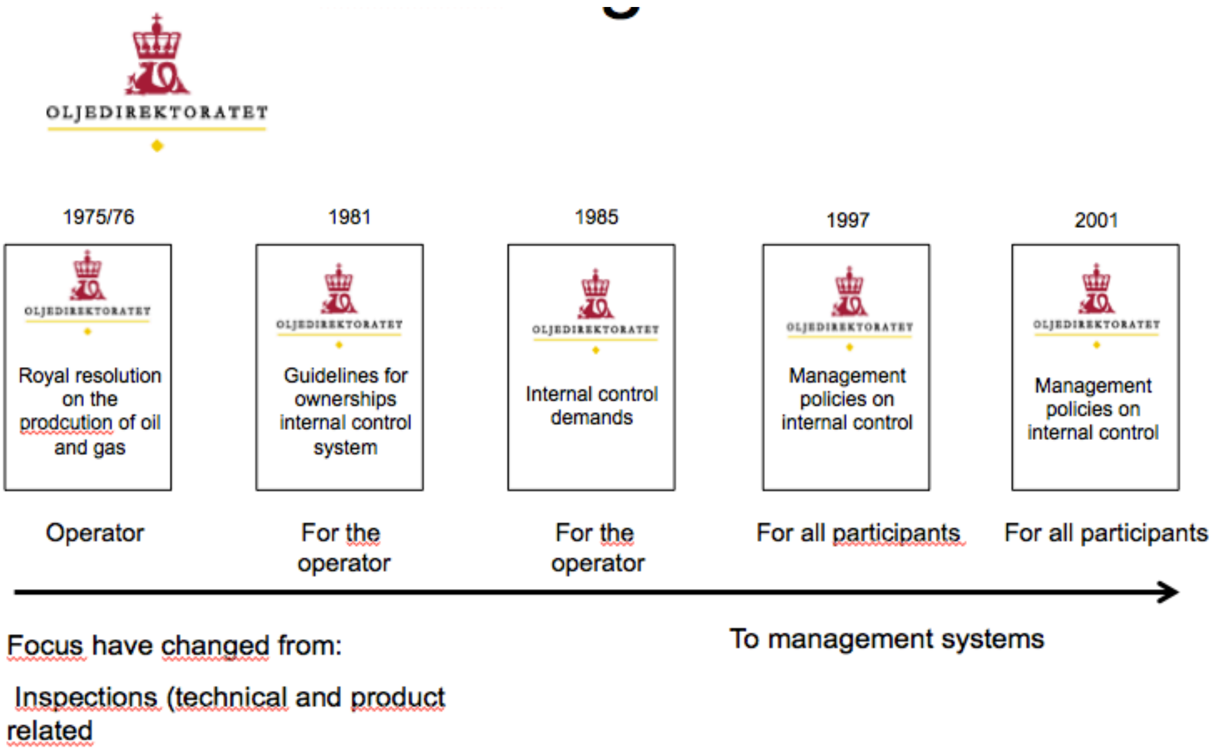
Spills – Spill of material >1Bbl, causing impact on the environment (Chemical / Oil / Mud etc.)

Attachment 03. Uganda's petroleum provinces

(Ministry of Finance Planning and Economic Development. 2010)

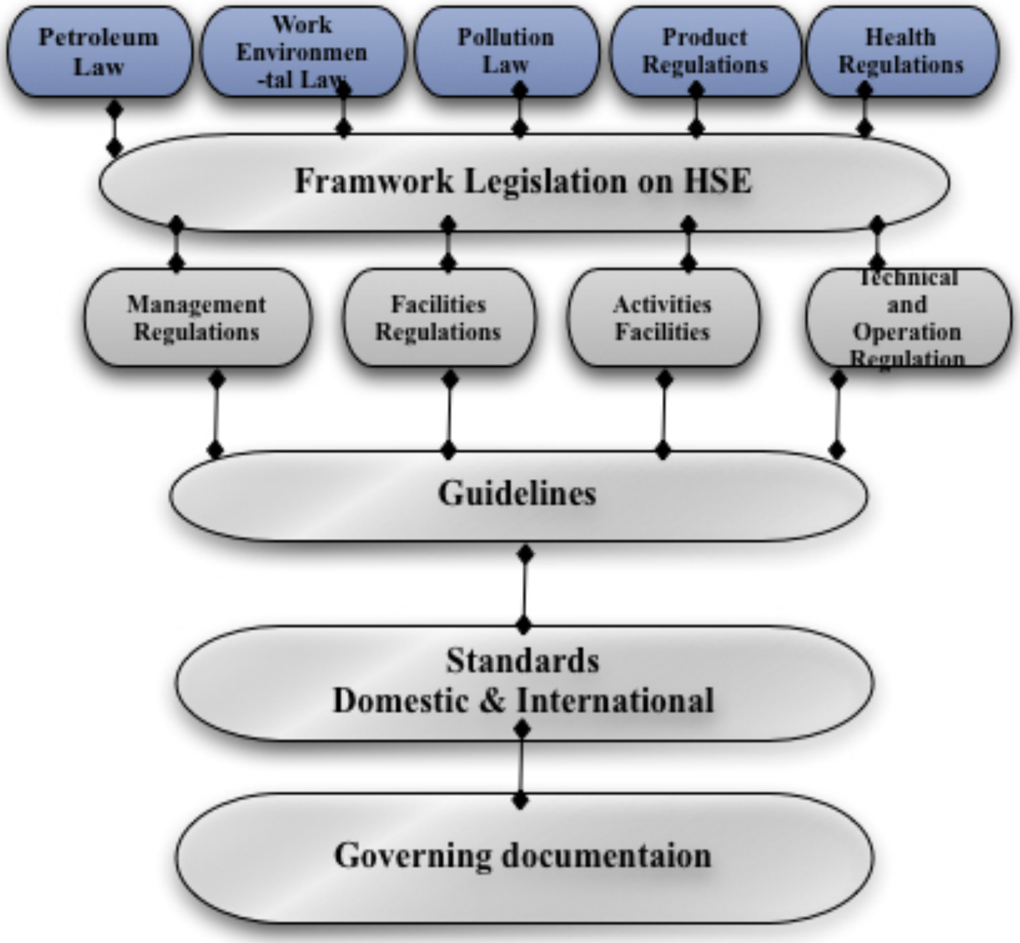


Attachment 04: Change from inspection focus to management systems

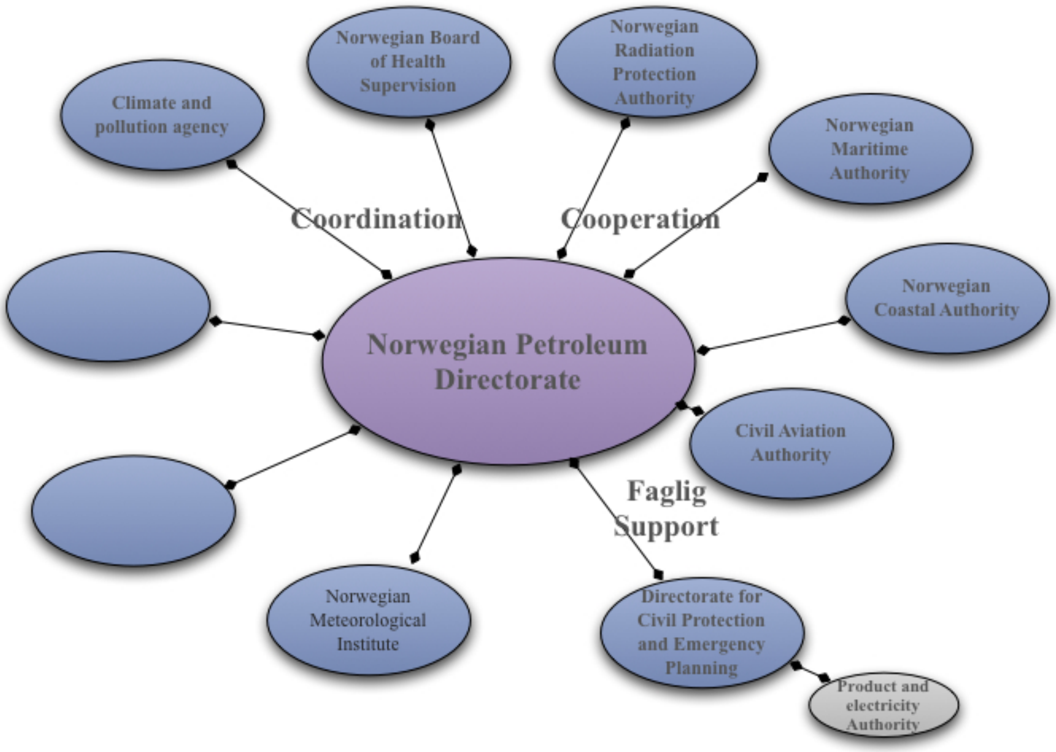


(Norwegian Petroleum Directorate 2010a)

Attachment 05: Laws and regulations structure



Attachment 06: The Norwegian Petroleum Directorate coordinating role



Attachment 07: Law and Regulations Pyramid